



2. Estimate the above three models including Panel Least Squares model, Fixed effects model, and Random-effects model. Perform fixed effects tests and random effects tests, also state null hypothesis of the tests. Then, determine the most appropriated model. Also, give explanations of the choosing criterion (perform the tests), and make interpretations of the estimated models.

**Panel Least Squares model**

```
. xtset crossid time
    panel variable: crossid (strongly balanced)
    time variable: time, 40 to 44
    delta: 1 year

. xtgls y x1 x2 x3 x4 x5 x6 x7

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares
Panels: homoskedastic
Correlation: no autocorrelation

Estimated covariances = 1          Number of obs = 1,275
Estimated autocorrelations = 0      Number of groups = 255
Estimated coefficients = 8          Time periods = 5
Wald chi2(7) = 899.95
Log likelihood = 209.4322          Prob > chi2 = 0.0000
```

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x1	.0794732	.0093881	8.47	0.000	.0610728	.0978735
x2	.0183375	.0051421	3.57	0.000	.0082592	.0284158
x3	.0977707	.0526329	1.86	0.063	-.0053879	.2009293
x4	.0873838	.2186064	0.40	0.689	-.3410767	.5158444
x5	-.1076457	.0069214	-15.55	0.000	-.1212114	-.0940801
x6	-.1432493	.0186811	-7.67	0.000	-.1798637	-.106635
x7	-.2712849	.011995	-22.62	0.000	-.2947946	-.2477753
_cons	-.0107965	.0860341	-0.13	0.900	-.1794201	.1578272

**Fixed effects model**

```
. xtreg y x1 x2 x3 x4 x5 x6 x7 , fe

Fixed-effects (within) regression          Number of obs = 1,275
Group variable: crossid                   Number of groups = 255

R-sq:                                     Obs per group:
    within = 0.3772                        min = 5
    between = 0.1103                       avg = 5.0
    overall = 0.1644                       max = 5

corr(u_i, Xb) = -0.2003                    F(7,1013) = 87.64
                                           Prob > F = 0.0000
```

y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
x1	-.1256447	.0180942	-6.94	0.000	-.161151	-.0901384
x2	.0123739	.008023	1.54	0.123	-.0033697	.0281176
x3	.0747825	.039773	1.88	0.060	-.0032643	.1528293
x4	.6493144	.2855092	2.27	0.023	.0890573	1.209572
x5	-.1104883	.0061097	-18.08	0.000	-.1224773	-.0984992
x6	-.1461423	.0141035	-10.36	0.000	-.1738178	-.1184669
x7	-.0951497	.0121853	-7.81	0.000	-.1190611	-.0712383
_cons	1.756067	.1658407	10.59	0.000	1.430636	2.081497
sigma_u	.22676694					
sigma_e	.11725953					
rho	.78902632	(fraction of variance due to u_i)				

F test that all u\_i=0: F(254, 1013) = 11.40      Prob > F = 0.0000 < 0.05

$H_0: \alpha_1 = \alpha_2 = \dots = \alpha_n = \alpha$

$H_a: \text{otherwise}$

Since p-value (0.00) is less than 0.05,  $H_0$  is rejected.

there are significant fixed effects in this model.

**Random effects model**

```
. . xtreg y x1 x2 x3 x4 x5 x6 x7 , re
```

```
Random-effects GLS regression           Number of obs   =   1,275
Group variable: crossid                 Number of groups =    255

R-sq:                                   Obs per group:
    within = 0.3492                      min =           5
    between = 0.3404                     avg =           5.0
    overall = 0.3377                     max =           5

corr(u_i, X) = 0 (assumed)              Wald chi2(7)    =   663.43
                                           Prob > chi2     =   0.0000
```

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x1	-.0145018	.0133366	-1.09	0.277	-.040641	.0116375
x2	.0146948	.0064463	2.28	0.023	.0020604	.0273292
x3	.0985565	.0399464	2.47	0.014	.020263	.1768501
x4	.4693539	.2493856	1.88	0.060	-.0194329	.9581407
x5	-.1117985	.005959	-18.76	0.000	-.1234779	-.100119
x6	-.1541318	.014125	-10.91	0.000	-.1818163	-.1264472
x7	-.1494529	.0115006	-13.00	0.000	-.1719937	-.1269122
_cons	.7714573	.1226841	6.29	0.000	.5310009	1.011914
sigma_u	.15944933					
sigma_e	.11725953					
rho	.64900604	(fraction of variance due to u_i)				

**Hausman test**

```
. hausman fixed random
```

	Coefficients			
	(b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
x1	-.1256447	-.0145018	-.1111429	.0122284
x2	.0123739	.0146948	-.0023208	.0047765
x3	.0747825	.0985565	-.0237741	.
x4	.6493144	.4693539	.1799605	.1390048
x5	-.1104883	-.1117985	.0013102	.0013484
x6	-.1461423	-.1541318	.0079894	.
x7	-.0951497	-.1494529	.0543033	.0040273

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

$$\begin{aligned} \chi^2(7) &= (b-B)'[(V_b-V_B)^{-1}](b-B) \\ &= 190.39 \\ \text{Prob}>\chi^2 &= 0.0000 < 0.05 \\ & \text{(V}_b\text{-V}_B \text{ is not positive definite)} \end{aligned}$$

Ho:  $\beta_{RE} = \beta_{FE}$     Ha: otherwise

since the p-value (0.00) is less than 0.05 with  $\chi^2 = 190.39$  in Hausman test, Ho is rejected. Therefore, the fixed effects model is more appropriated than random model.