1. Estimate model (1) using Panel Least Squares estimation method and PGLS assuming Heteroskedasticity, and test whether there exists Heteroskedasticity problem.

```
. xtgls y x1 x2 x3 x4 x5 x6 x7, igls panels(heteroskedastic) nolog


Cross-sectional time-series FGLS regression

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

Estimated covariances      =       255          Number of obs     =      1,275
Estimated autocorrelations =         0          Number of groups  =        255
Estimated coefficients     =         8          Time periods      =          5
                                                Wald chi2(7)      =    3850.64
Log likelihood             =   519.361          Prob > chi2       =     0.0000
```

y	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
x1	.0834067	.0045748	18.23	0.000	.0744403	.0923732
x2	.0163976	.0032919	4.98	0.000	.0099456	.0228497
x3	-.3631261	.0505673	-7.18	0.000	-.4622362	-.264016
x4	.3191455	.1093883	2.92	0.004	.1047484	.5335426
x5	-.1093301	.0043601	-25.07	0.000	-.1178758	-.1007844
x6	.1361732	.0275038	4.95	0.000	.0822667	.1900797
x7	-.2282655	.0063087	-36.18	0.000	-.2406303	-.2159007
_cons	-.037658	.0426502	-0.88	0.377	-.1212509	.0459349

```
. est store het

. 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

```
. est store pgls

. local df=e(N_g)-1

. lrtest het, df(`df')

Likelihood-ratio test                                 LR chi2(254)=    619.86
(Assumption: pgls nested in het)                      Prob > chi2 =    0.0000
```

Since LR-chi2 test = 619.86 with p-value of 0.0000 which less than 0.05, the null hypothesis of heteroskedasticity is rejected. Therefore, there exists Heteroskedasticity problem.

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 test, also state null hypothesis of the tests. Then, determine the most appropriated model. Also, give explanation of the choosing criterion (perform the tests), and make interpretation of the estimated models.

```
. 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

```
. 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

                                                F(7,1013)         =      87.64
corr(u_i, Xb)  = -0.2003                        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

. est store fixed
. 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

                                                Wald chi2(7)      =     663.43
corr(u_i, X)   = 0 (assumed)                    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)				

```
. est store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |    fixed       random       Difference          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

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      190.39
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

There exist significant fixed effects in fixed effects test. In Hausman test, since chi2=190.39 with p-value of 0.0000 which is less than 0.05, the null hypothesis is rejected. Therefore, the fixed effects model is more appropriated than the random effects model.