The behavior of agriculture production function of Developed and Developing countries: A Panel data analysis

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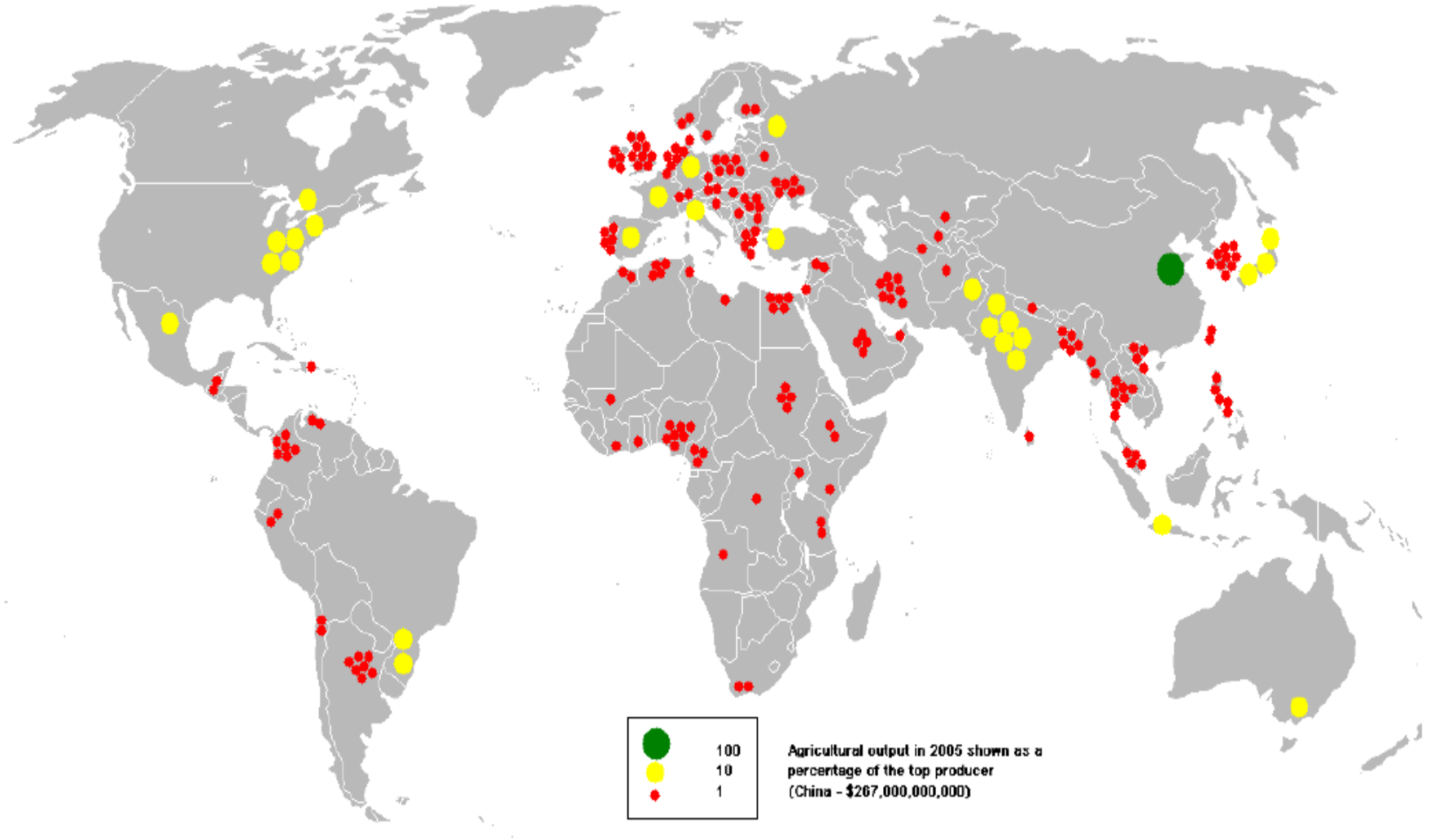
Econometrics of Panel Data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Agricultural output in 2005 shown as a percentage of the top producer
(China - $267,000,000,000)

Introduction

Objective: Impact of total inputs on total agriculture production: A panel data analysis.

Data: Panel data of 22 countries from 1980-2007.

Data Source: Food and Agriculture Organization(FAO-STAT, 2007)

Variables:

Independent:
Farm Mechanization (Number of Tractors) in Use
Total Area equipped for irrigation (1000 Ha)
Total Fertilizer Consumption (tonnes)
Livestock Production (Gross Production in 1000 $)
Farm Area (1000 Ha)

Dependent: Agriculture Production (1000 $)

Countries

Developed Agriculture Giants (Region-1)	Developing Agriculture Giants (Region-2)
Australia	Argentina
Canada	Bangladesh
France	Brazil
Germany	China
Italy	India
Japan	Indonesia
Poland	Iran
Spain	Mexico
Turkey	Nigeria
United Kingdom	Pakistan
United States of America	Viet Nam

Variables	Lof Form
Farm Mechanization	Lnmec
Total Area equipped for irrigation	Lnarea
Total Fertilizer Consumption	Lnfert
Livestock Production	Lnlive
Farm Area	Lnareaf
Agriculture Production	lnagprod

Equations for Panel Analysis

Pooled Analysis (Pooled OLS Method)

$$Y_{it} = \alpha + \beta X_{it} + \upsilon_{it}$$

Fixed Effects/LSDV

One way fixed effects

$$Y_{it} = \alpha_i + \beta X_{it} + \upsilon_{it}$$

$$Y_{it} = \alpha_t + \beta X_{it} + \upsilon_{it}$$

Equations for Panel Analysis

Random Effects

One way Random effects

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_i + \upsilon_{it}$$

$$\varepsilon_i \sim i.i.d\, N(0, \sigma^2)$$

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_t + \upsilon_{it}$$

$$\varepsilon_t \sim i.i.d\, N(0, \sigma^2)$$

Hausman Test

- Named after Jerry A. Hausman
  - Êvaluates the significance of two different estimators.
  - whether random effect estimation could be almost as good as Fixed effects
- Following Chi-Square test statistics can be used to test for the selection among the FE and RE models
  - H_0: Random effects are consistent and efficient
  - H_1: Random effects are inconsistent

$$H = \frac{(\hat{\beta}^{FE} - \hat{\beta}^{RE})'(\hat{\beta}^{FE} - \hat{\beta}^{RE})}{[Var(\hat{\beta}^{FE}) - Var(\hat{\beta}^{RE})} \sim \chi^2(k)$$

Results

Pooled Regression (OLS)

```
. reg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec
```

Source	SS	df	MS
Model	322.344603	6	53.7241005
Residual	36.5074241	496	.073603678
Total	358.852027	502	.714844675

Number of obs	503
F(6, 496)	729.91
Prob > F	0.0000
R-squared	0.8983
Adj R-squared	0.8970
Root MSE	.2713

lnagprod	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnarea	.1242031	.0096355	12.89	0.000	.1052716	.1431347
lnareaf	-.0050044	.0143035	-0.35	0.727	-.0331074	.0230985
lnforst	.1072546	.0126107	8.51	0.000	.0824776	.1320317
lnlive	.7050269	.0311885	22.61	0.000	.643749	.7663047
lnfert	.0292978	.0119999	2.44	0.015	.0057209	.0528748
lnmec	-.1391946	.0121685	-11.44	0.000	-.1631029	-.1152864
_cons	4.459387	.23873	18.68	0.000	3.990341	4.928434

Pooled Regression (OLS) for Region 1

```
. use "E:\agri panels\my data qamar.dta", clear

. reg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==1
```

Source	SS	df	MS		
Model	94.9615281	6	15.8269213	Number of obs	253
Residual	4.64062476	246	.018864328	F(6, 246)	838.99
				Prob > F	0.0000
				R-squared	0.9534
				Adj R-squared	0.9523
Total	99.6021529	252	.395246638	Root MSE	.13735

lnagprod	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnarea	.0738552	.0089828	8.22	0.000	.0561623	.0915481
lnareaf	.1358305	.0137084	9.91	0.000	.1088296	.1628314
lnforst	-.1682126	.0152818	-11.01	0.000	-.1983125	-.1381127
lnlive	.4059535	.0282559	14.37	0.000	.350299	.4616079
lnfert	.1985127	.0183773	10.80	0.000	.1623157	.2347098
lnmec	.3696203	.0304269	12.15	0.000	.3096898	.4295508
_cons	3.289673	.2304786	14.27	0.000	2.83571	3.743636

Pooled Regression (OLS) for Region 2

```
. reg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==2
```

Source	SS	df	MS
Model	243.288096	6	40.548016
Residual	15.9614792	243	.0656851
Total	259.249575	249	1.04116295

Number of obs	250
F(6, 243)	617.31
Prob > F	0.0000
R-squared	0.9384
Adj R-squared	0.9369
Root MSE	.25629

lnagprod	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnarea	.0787177	.0223554	3.52	0.001	.0346826	.1227529
lnareaf	.0798239	.0297802	2.68	0.008	.0211637	.1384841
lnforst	.1585364	.016749	9.47	0.000	.1255447	.1915281
lnlive	.5502878	.0465366	11.82	0.000	.4586212	.6419544
lnfert	.0807251	.016978	4.75	0.000	.0472822	.1141679
lnmec	-.1078122	.0182771	-5.90	0.000	-.143814	-.0718104
_cons	4.473934	.3023503	14.80	0.000	3.878372	5.069496

One-way Individual Fixed Effects

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec, fe

Fixed-effects (within) regression               Number of obs      =       503
Group variable: count                           Number of groups   =        22

R-sq:  within  = 0.8813                         Obs per group: min =        20
       between = 0.8401                                        avg =      22.9
       overall = 0.8425                                        max =        23

                                                F(6,475)           =    587.76
corr(u_i, Xb)  = -0.6282                        Prob > F           =    0.0000

------------------------------------------------------------------------------
    lnagprod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnarea |   .1984311   .0271965     7.30   0.000     .1449907    .2518714
     lnareaf |    .079063    .091452     0.86   0.388    -.1006374    .2587634
     lnforst |   .0609146   .0134605     4.53   0.000     .0344651    .0873641
      lnlive |   .5148999   .0212141    24.27   0.000     .4732149    .5565849
      lnfert |   .0870866    .006443    13.52   0.000     .0744262     .099747
       lnmec |   .0688433   .0128702     5.35   0.000     .0435537    .0941329
       _cons |   3.292194   .8727696     3.77   0.000     1.577227    5.007161
-------------+----------------------------------------------------------------
     sigma_u |  .44100577
     sigma_e |  .06752422
         rho |  .97709309   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(21, 475) =   358.66                 Prob > F = 0.0000
```

One-way Individual Random Effects

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec, re

Random-effects GLS regression                   Number of obs      =       503
Group variable: count                           Number of groups   =        22

R-sq:  within  = 0.8808                         Obs per group: min =        20
       between = 0.8347                                        avg =      22.9
       overall = 0.8389                                        max =        23

Random effects u_i ~ Gaussian                   Wald chi2(6)       =   3516.54
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

lnagprod	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnarea	.1754189	.0224302	7.82	0.000	.1314566	.2193812
lnareaf	.0232222	.0458931	0.51	0.613	-.0667266	.113171
lnforst	.0594646	.0131319	4.53	0.000	.0337265	.0852026
lnlive	.5266411	.0192275	27.39	0.000	.4889558	.5643264
lnfert	.0888439	.0063902	13.90	0.000	.0763194	.1013685
lnmec	.055645	.0124694	4.46	0.000	.0312054	.0800846
_cons	4.064403	.4684105	8.68	0.000	3.146335	4.982471
sigma_u	.303313					
sigma_e	.06752422					
rho	.95277961	(fraction of variance due to u_i)				

Hausman test: 1-way FE vs RE

```
. hausman ref rer
```

	Coefficients (b) ref	(B) rer	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnarea	.1984311	.1754189	.0230122	.0153798
lnareaf	.079063	.0232222	.0558408	.079103
lnforst	.0609146	.0594646	.0014501	.0029562
lnlive	.5148999	.5266411	-.0117412	.0089632
lnfert	.0870866	.0888439	-.0017573	.0008235
lnmec	.0688433	.055645	.0131983	.0031869

```
                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(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       34.10
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

One Way Individual FE for Region 1

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==1, fe

Fixed-effects (within) regression               Number of obs      =       253
Group variable: count                           Number of groups   =        11

R-sq:  within  = 0.6460                         Obs per group: min =        23
       between = 0.7882                                        avg =      23.0
       overall = 0.7839                                        max =        23

                                                F(6,236)           =     71.77
corr(u_i, Xb)  = -0.7009                        Prob > F           =    0.0000
```

lnagprod	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnarea	.2235891	.0368469	6.07	0.000	.1509983	.2961798
lnareaf	.1958662	.1373053	1.43	0.155	-.0746345	.4663669
lnforst	.0640553	.0251628	2.55	0.012	.0144829	.1136276
lnlive	.552667	.0391985	14.10	0.000	.4754432	.6298907
lnfert	.0426012	.0188531	2.26	0.025	.0054594	.0797431
lnmec	.0188415	.0255613	0.74	0.462	-.0315159	.0691989
_cons	2.403687	1.40648	1.71	0.089	-.367173	5.174548
sigma_u	.42192404					
sigma_e	.05421511					
rho	.98375723	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(10, 236) =   134.28                 Prob > F = 0.0000
```

One way Individual RE for Region 1

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==1, re

Random-effects GLS regression                   Number of obs      =       253
Group variable: count                           Number of groups   =        11

R-sq:  within  = 0.6386                         Obs per group: min =        23
       between = 0.8966                                        avg =      23.0
       overall = 0.8915                                        max =        23

Random effects u_i ~ Gaussian                   Wald chi2(6)       =    598.11
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

lnagprod	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnarea	.1732466	.0247917	6.99	0.000	.1246557	.2218375
lnareaf	-.0306804	.0341448	-0.90	0.369	-.0976029	.0362421
lnforst	.0685978	.0207805	3.30	0.001	.0278688	.1093269
lnlive	.5684469	.0372975	15.24	0.000	.4953452	.6415486
lnfert	.0472858	.0155275	3.05	0.002	.0168526	.0777191
lnmec	.0228582	.0259226	0.88	0.378	-.0279491	.0736654
_cons	4.702929	.5953787	7.90	0.000	3.536008	5.86985
sigma_u	.12909677					
sigma_e	.05421511					
rho	.85007702	(fraction of variance due to u_i)				

Hausman test for region 1: Individual Oneway

```
. hausman owfero owrero
```

	Coefficients (b) owfero	(B) owrero	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnarea	.2235891	.1732466	.0503425	.0272591
lnareaf	.1958662	-.0306804	.2265466	.1329921
lnforst	.0640553	.0685978	-.0045426	.0141893
lnlive	.552667	.5684469	-.0157799	.0120592
lnfert	.0426012	.0472858	-.0046846	.0106929
lnmec	.0188415	.0228582	-.0040167	.

```
                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(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =       15.52
            Prob>chi2 =      0.0166
            (V_b-V_B is not positive definite)
```

One Way Individual FE for Region 2

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==2, fe

Fixed-effects (within) regression               Number of obs      =       250
Group variable: count                           Number of groups   =        11

R-sq:  within  = 0.9143                         Obs per group: min =        20
       between = 0.8719                                        avg =      22.7
       overall = 0.8746                                        max =        23

                                                F(6,233)           =    414.14
corr(u_i, Xb)  = -0.4932                        Prob > F           =    0.0000
```

lnagprod	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnarea	.0913181	.0537479	1.70	0.091	-.0145758	.1972121
lnareaf	.0612339	.1445496	0.42	0.672	-.2235574	.3460253
lnforst	.0556717	.0187598	2.97	0.003	.0187111	.0926322
lnlive	.5410274	.0336096	16.10	0.000	.4748099	.6072449
lnfert	.0973509	.0085921	11.33	0.000	.0804228	.1142791
lnmec	.0631571	.0176184	3.58	0.000	.0284453	.0978689
_cons	4.164182	1.476421	2.82	0.005	1.255341	7.073024
sigma_u	.43100794					
sigma_e	.07740888					
rho	.9687519	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(10, 233) =   243.07              Prob > F = 0.0000
```

One way Individual RE for Region 2

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==2, re

Random-effects GLS regression                   Number of obs      =       250
Group variable: count                           Number of groups   =        11

R-sq:  within  = 0.9139                         Obs per group: min =        20
       between = 0.8742                                        avg =      22.7
       overall = 0.8780                                        max =        23

Random effects u_i ~ Gaussian                   Wald chi2(6)       =   2526.20
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

lnagprod	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnarea	.0492367	.0434725	1.13	0.257	-.0359678	.1344413
lnareaf	.0016181	.0816132	0.02	0.984	-.1583409	.1615771
lnforst	.0593492	.0182904	3.24	0.001	.0235007	.0951976
lnlive	.5593302	.0278069	20.11	0.000	.5048296	.6138309
lnfert	.1014545	.0084808	11.96	0.000	.0848324	.1180766
lnmec	.0535787	.016736	3.20	0.001	.0207766	.0863807
_cons	4.901515	.8182676	5.99	0.000	3.29774	6.50529
sigma_u	.35420046					
sigma_e	.07740888					
rho	.95441514	(fraction of variance due to u_i)				

Hausman test for region 2: Individual Oneway

```
. hausman owfert owrert
```

	Coefficients (b) owfert	(B) owrert	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnarea	.0913181	.0492367	.0420814	.0316066
lnareaf	.0612339	.0016181	.0596158	.1193058
lnforst	.0556717	.0593492	-.0036775	.0041705
lnlive	.5410274	.5593302	-.0183028	.018878
lnfert	.0973509	.1014545	-.0041036	.0013784
lnmec	.0631571	.0535787	.0095784	.0055058

```
                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(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =        8.95
            Prob>chi2 =      0.1763
            (V_b-V_B is not positive definite)
```

One way Time FE

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec, fe

Fixed-effects (within) regression               Number of obs      =       503
Group variable: time                            Number of groups   =        23

R-sq:  within  = 0.8964                         Obs per group: min =        21
       between = 0.9848                                        avg =      21.9
       overall = 0.8982                                        max =        22

                                                F(6,474)           =    683.26
corr(u_i, Xb)  = 0.1208                         Prob > F           =    0.0000
```

lnagprod	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnarea	.1244821	.009804	12.70	0.000	.1052175	.1437468
lnareaf	-.0018538	.0146735	-0.13	0.900	-.0306869	.0269792
lnforst	.1088716	.012869	8.46	0.000	.0835844	.1341589
lnlive	.6934163	.0324222	21.39	0.000	.6297072	.7571254
lnfert	.0291601	.0122587	2.38	0.018	.005072	.0532482
lnmec	-.1362666	.0124891	-10.91	0.000	-.1608075	-.1117258
_cons	4.546026	.2475425	18.36	0.000	4.05961	5.032442
sigma_u	.03019112					
sigma_e	.27590952					
rho	.01183194	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(22, 474) =     0.25                 Prob > F = 0.9998
```

One way Time RE

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec, re

Random-effects GLS regression                   Number of obs      =       503
Group variable: time                            Number of groups   =        23

R-sq:  within  = 0.8963                         Obs per group: min =        21
       between = 0.9848                                        avg =      21.9
       overall = 0.8983                                        max =        22

Random effects u_i ~ Gaussian                   Wald chi2(6)       =   4379.46
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

lnagprod	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnarea	.1242031	.0096355	12.89	0.000	.1053178	.1430885
lnareaf	-.0050044	.0143035	-0.35	0.726	-.0330388	.0230299
lnforst	.1072546	.0126107	8.51	0.000	.0825381	.1319712
lnlive	.7050269	.0311885	22.61	0.000	.6438985	.7661552
lnfert	.0292978	.0119999	2.44	0.015	.0057784	.0528173
lnmec	-.1391946	.0121685	-11.44	0.000	-.1630445	-.1153447
_cons	4.459387	.23873	18.68	0.000	3.991485	4.927289
sigma_u	0					
sigma_e	.27590952					
rho	0	(fraction of variance due to u_i)				

Hausman test: 1way-time FE vs RE

```
. hausman tfe tre
```

	Coefficients (b) tfe	(B) tre	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnarea	.1244821	.1242031	.000279	.0018095
lnareaf	-.0018538	-.0050044	.0031506	.0032742
lnforst	.1088716	.1072546	.001617	.002565
lnlive	.6934163	.7050269	-.0116105	.0088589
lnfert	.0291601	.0292978	-.0001377	.0025053
lnmec	-.1362666	-.1391946	.002928	.0028115

```
                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(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                   =        2.25
         Prob>chi2 =      0.8955
```

one-way Time FE for Region 1

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==1, fe

Fixed-effects (within) regression               Number of obs      =       253
Group variable: time                            Number of groups   =        23

R-sq:  within  = 0.9602                         Obs per group: min =        11
       between = 0.0160                                        avg =      11.0
       overall = 0.9521                                        max =        11

                                                F(6,224)           =    901.39
corr(u_i, Xb)  = -0.0269                        Prob > F           =    0.0000

------------------------------------------------------------------------------
    lnagprod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnarea |   .0736111   .0086856     8.48   0.000     .0564951    .0907271
     lnareaf |   .1464405   .0133675    10.95   0.000     .1200984    .1727825
     lnforst |  -.1995509   .0156631   -12.74   0.000    -.2304169    -.168685
      lnlive |   .3788202   .0276737    13.69   0.000      .324286    .4333543
      lnfert |   .2455458   .0194472    12.63   0.000     .2072229    .2838687
       lnmec |   .3767237   .0294893    12.77   0.000     .3186118    .4348355
       _cons |    3.35811   .2232237    15.04   0.000     2.918223    3.797997
-------------+----------------------------------------------------------------
     sigma_u |  .05862119
     sigma_e |  .13261366
         rho |   .1634625   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(22, 224) =     1.81                 Prob > F = 0.0169
```

one-way Time RE for Region 1

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==1, re

Random-effects GLS regression                   Number of obs      =       253
Group variable: time                            Number of groups   =        23

R-sq:  within  = 0.9591                         Obs per group: min =        11
       between = 0.0323                                        avg =      11.0
       overall = 0.9534                                        max =        11

Random effects u_i ~ Gaussian                   Wald chi2(6)       =   5033.92
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

lnagprod	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnarea	.0738552	.0089828	8.22	0.000	.0562493	.0914611
lnareaf	.1358305	.0137084	9.91	0.000	.1089625	.1626985
lnforst	-.1682126	.0152818	-11.01	0.000	-.1981644	-.1382608
lnlive	.4059535	.0282559	14.37	0.000	.3505728	.4613341
lnfert	.1985127	.0183773	10.80	0.000	.1624938	.2345317
lnmec	.3696203	.0304269	12.15	0.000	.3099847	.429256
_cons	3.289673	.2304786	14.27	0.000	2.837943	3.741403
sigma_u	0					
sigma_e	.13261366					
rho	0	(fraction of variance due to u_i)				

Hausman test: 1-way Time FE vs RE for Region 1

```
. hausman owfero owrero

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |    owfero       owrero       Difference          S.E.
-------------+------------------------------------------------------------
      lnarea |    .0736111     .0738552      -.0002441               .
    lnareaf  |    .1464405     .1358305          .01061              .
     lnforst |   -.1995509    -.1682126      -.0313383        .0034352
      lnlive |    .3788202     .4059535      -.0271333               .
      lnfert |    .2455458     .1985127       .0470331        .0063615
       lnmec |    .3767237     .3696203       .0071034               .
------------------------------------------------------------------------------
                           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(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       53.26
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

One-way Time FE for Region 2

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==2, fe

Fixed-effects (within) regression               Number of obs      =       250
Group variable: time                            Number of groups   =        23

R-sq:  within  = 0.9388                         Obs per group: min =        10
       between = 0.9883                                        avg =      10.9
       overall = 0.9367                                        max =        11

                                                F(6,221)           =    565.21
corr(u_i, Xb)  = 0.1693                         Prob > F           =    0.0000
```

lnagprod	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnarea	.1194158	.0252862	4.72	0.000	.0695829	.1692487
lnareaf	.1250522	.0324614	3.85	0.000	.0610787	.1890257
lnforst	.1735717	.0174792	9.93	0.000	.1391244	.208019
lnlive	.4650498	.052334	8.89	0.000	.3619124	.5681873
lnfert	.0616669	.0183857	3.35	0.001	.0254332	.0979005
lnmec	-.0998258	.0188155	-5.31	0.000	-.1369065	-.062745
_cons	4.885692	.3260326	14.99	0.000	4.243161	5.528223
sigma_u	.08122887					
sigma_e	.25961789					
rho	.08916442	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(22, 221) =     0.72                 Prob > F = 0.8182
```

One-way Time RE for Region 2

```
. xtreg lnagprod lnarea lnareaf lnforst lnlive lnfert lnmec if region==2, re

Random-effects GLS regression                   Number of obs      =       250
Group variable: time                            Number of groups   =        23

R-sq:  within  = 0.9376                         Obs per group: min =        10
       between = 0.9906                                        avg =      10.9
       overall = 0.9384                                        max =        11

Random effects u_i ~ Gaussian                   Wald chi2(6)       =   3703.86
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

lnagprod	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnarea	.0787177	.0223554	3.52	0.000	.0349019	.1225335
lnareaf	.0798239	.0297802	2.68	0.007	.0214559	.138192
lnforst	.1585364	.016749	9.47	0.000	.125709	.1913638
lnlive	.5502878	.0465366	11.82	0.000	.4590777	.6414979
lnfert	.0807251	.016978	4.75	0.000	.0474488	.1140013
lnmec	-.1078122	.0182771	-5.90	0.000	-.1436347	-.0719897
_cons	4.473934	.3023503	14.80	0.000	3.881338	5.06653
sigma_u	0					
sigma_e	.25961789					
rho	0	(fraction of variance due to u_i)				

Hausman Test: one-way Time FE vs RE for Region 2

```
. hausman owfert owrert
```

	Coefficients (b) owfert	(B) owrert	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnarea	.1194158	.0787177	.0406981	.0118163
lnareaf	.1250522	.0798239	.0452283	.0129183
lnforst	.1735717	.1585364	.0150353	.0049996
lnlive	.4650498	.5502878	-.085238	.0239413
lnfert	.0616669	.0807251	-.0190582	.0070555
lnmec	-.0998258	-.1078122	.0079864	.0044688

```
                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(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =       13.63
            Prob>chi2 =      0.0341
```

Comparison

Regressions	Hausman test suggest	lnarea	lnareaf	lnforst	lnlive	lnfert	lnmec
Pooled Regression for All		0.124 **	-0.005	0.107 **	0.705 **	0.029 *	-0.139 **
Pooled Regression for Reg 1		0.073 **	0.135 **	-0.168 **	0.405 **	0.198 **	0.369 **
Pooled Regression for Reg 2		0.078 **	0.079 **	0.158 **	0.550 **	0.080 **	-0.107 *
Cross Country for All	FE	0.198 **	0.079	0.0609 **	0.514 **	0.006 **	0.012 **
Cross Country for Reg 1	FE	0.223 **	0.195	0.064 *	0.552 *	0.042	.0188
Cross Country for Reg 2	RE	0.049	0.001	0.059 **	0.559 **	0.101 **	0.053 **
Temporal for All	RE	0.124 **	-0.005	0.107 **	0.705 **	0.029 *	-0.139 **
Temporal for Reg 1	FE	0.073 **	0.146 **	-0.199 **	0.378 **	0.245 **	0.376 **
Temporal for Reg 2	FE	0.119 **	0.125 **	0.173 **	0.465 **	0.061 **	-0.099 **

conclusion

- Hausman suggests that: ín cross sectional analysis for all countries FE are better then RE
  - All coefficients are positive
  - All coefficients are significant except farm area.
- In cross sectional analysis for Region 1, FE are better then RE.
  - Coefficients for area, forest and livestock are positive and significant
  - Coefficients for farm area, fertilizer and mechanization is positive but nonsignificant.
- For Region 2, RE are better then FE.
  - Total area and Farm Area are positive but nonsignificant

Conclusion

- Temporal effects for all countries, RE are better then FE.
  - Farm area is negative but not significant
  - Mechanization is negative and significant across time
- Temporal effects for region 1, FE are better then RE.
  - All coefficients are significant
  - Coefficient for the total forest is negative in Region 1
- Temporal effects for Region 2, FE are better the RE.
  - All coefficients are significant and positive except mechanization

REFERNCES

- Econometric Analysis of Panel Data by Badi H. Baltagi, 3rd Edition.
- Jerry A. Hausman: *Specification Tests in Econometrics.* In: *Econometrica*. Band 46, S. 1251-1271

Thank You