EXCERSISES IN APPLIED PANEL DATA ANALYSIS #6

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1. Introduction

This R example will introduce you to estimation of the unobserved effects model under in the two-way setting under both the fixed and random effects framework. This simple adaptation of both models is easy to implement in the `plm` environment, requiring changing `effect="individual"` to `effect="two-way"`.

2. Two-way Estimation of the Unobserved Effecs Model

2.1. **Estimating the Demand for Gasoline.** In a classic study Baltagi & Griffin (1983) estimated a demand equation for gasoline at the country level. Their balanced panel constituted 18 OECD countries over the period 1960-1978. Their baseline econometric model is

$$\ln(Gas/Car)_{it} = \beta_0 + \beta_1 \ln(GDP/Pop)_{it} + \beta_2 \ln(P_{Gas}/P_{GDP})_{it} + \beta_3 \ln(Car/Pop)_{it} + c_i + \varepsilon_{it}, \tag{1}$$

where Gas/Car is gasoline consumption per car, GDP/Pop is per capita income, P_{Gas}/P_{GDP} is the price of gasoline and Car/Pop is the stock of cars per capita. The key coefficient of interest in β_2, which identifies the price elasticity of gasoline.

To allow for time specific effects we augment the model as

$$\ln(Gas/Car)_{it} = \beta_0 + \beta_1 \ln(GDP/Pop)_{it} + \beta_2 \ln(P_{Gas}/P_{GDP})_{it} + \beta_3 \ln(Car/Pop)_{it} + c_i + d_t + \varepsilon_{it}. \tag{2}$$

```
> library(plm)
> ## Load in dataset of Baltagi and Griffin (1983)
> data("Gasoline")
```

Now we estimate this two-way unobserved effects model using the different estimators discussed in class.

```
> gas.pooled <- plm(lgaspcar~lincomep+lrpmg+
+                         lcarpcap,
```

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```
+                    model="pooling",data=Gasoline)
> gas.wn    <- plm(lgaspcar~lincomep+lrpmg+
+                     lcarpcap,
+                   model="within",
+                   effect="twoways",
+                   data=Gasoline)
> gas.rd.swar <- plm(lgaspcar~lincomep+lrpmg+
+                       lcarpcap,
+                       model="random",
+                       effect="twoways",
+                       random.method="swar",
+                       data=Gasoline)
> gas.rd.wh <- plm(lgaspcar~lincomep+lrpmg+
+                         lcarpcap,
+                       model="random",
+                       effect="twoways",
+                       random.method="walhus",
+                       data=Gasoline)
> gas.rd.amem <- plm(lgaspcar~lincomep+lrpmg+
+                         lcarpcap,
+                       model="random",
+                       effect="twoways",
+                       random.method="amemiya",
+                       data=Gasoline)
```

To extract the estimates of the variance components from the random effects models extract `ercomp` from the model summary. Notice here that some of these estimated time effects have a negative variance.

```
> sum.pool <- summary(gas.pooled)
> sum.wn   <- summary(gas.wn)
> sum.rdsa <- summary(gas.rd.swar)
> sum.rdam <- summary(gas.rd.amem)
> sum.rdwh <- summary(gas.rd.wh)
```

```
> rbind(sum.pool$coefficients[,1],sum.pool$coefficients[,3])
```

```
     (Intercept)   lincomep       lrpmg    lcarpcap
[1,]    2.391326  0.8899617  -0.8917979  -0.7633727
[2,]   20.450166 24.8552290 -29.4179589 -41.0232487
```

```
> rbind(sum.wn$coefficients[,1],sum.wn$coefficients[,3])
```

```
      lincomep      lrpmg    lcarpcap
[1,] 0.0513685 -0.1928497  -0.5934477
[2,] 0.5621034 -4.4995447 -21.4478725
```

```
> rbind(sum.rdam$coefficients[,1],sum.rdam$coefficients[,3])
```

```
     (Intercept)  lincomep      lrpmg    lcarpcap
[1,]  -0.2391294 0.1681926 -0.2321885  -0.6023707
[2,]  -0.6830073 2.0907347 -5.6534482 -23.3117300
```

```
> rbind(sum.rdwh$coefficients[,1],sum.rdwh$coefficients[,3])
```

```
     (Intercept)  lincomep       lrpmg    lcarpcap
[1,]    1.910077 0.5433447  -0.4672158  -0.6058069
[2,]   11.422079 9.9345430 -11.9772456 -24.8432050
```

```
> rbind(sum.rdsa$coefficients[,1],sum.rdsa$coefficients[,3])
```

```
     (Intercept)  lincomep       lrpmg    lcarpcap
[1,]    2.040793 0.5645618  -0.4049364  -0.6093596
[2,]   10.656419 9.2773426 -10.0308693 -23.4640899
```

```
> ## Error Components
> sum.rdam$ercomp
```

```
                    var  std.dev share
idiosyncratic 0.006526 0.080784 0.032
individual    0.182611 0.427330 0.884
time          0.017412 0.131954 0.084
theta  : 0.9567 (id) 0.8572 (time) 0.8553 (total)
```

```
> sum.rdwh$ercomp
```

```
                  var std.dev share
idiosyncratic 0.01365 0.11685   0.3
individual    0.03187 0.17853   0.7
time          0.00000 0.00000   0.0
theta  : 0.8515 (id) 0 (time) 0 (total)
```

```
> sum.rdsa$ercomp
```

```
                    var  std.dev share
idiosyncratic 0.006591 0.081183 0.147
individual    0.038340 0.195805 0.853
time          0.000000 0.000000 0.000
theta  : 0.9053 (id) 0 (time) 0 (total)
```

Notice the wide difference in the estimates of the θs across the three different random effects specifications for the feasible GLS estimator.

2.2. **Public Capital Productivity Puzzle.** Munnell (1990) and Baltagi & Pinnoi (1995) use a balanced panel to estimate the impact of state level public and private capital stocks on state level output. Munnell's (1990) work ignored the panel structure of the data and found a statistically significant positive effect of public capital on state output levels.

```
> library(plm)
> data("Produc")
> pubcap.data <- Produc
> ## Take logs of pcap, hwy, water, util, pc, gsp and emp
> pubcap.data$lpubc <- log(pubcap.data$pcap)
> pubcap.data$lhwy  <- log(pubcap.data$hwy)
> pubcap.data$lwatr <- log(pubcap.data$water)
> pubcap.data$lutil <- log(pubcap.data$util)
> pubcap.data$lprvc <- log(pubcap.data$pc)
> pubcap.data$lgsp  <- log(pubcap.data$gsp)
> pubcap.data$lemp  <- log(pubcap.data$emp)
> ## Pooled OLS, no public capital,
> ## Cobb-Douglas specification
> model.pool1 <- plm(lgsp~lprvc+lemp+unemp,
+                    data=pubcap.data,model="pooling")
> ## Pooled OLS, aggregate public capital,
> ##Cobb-Douglas specification
> model.pool2 <- plm(lgsp~lprvc+lemp+lpubc+unemp,
+                    data=pubcap.data,model="pooling")
> ## Pooled OLS, decomposed public capital,
> ## Cobb-Douglas specification
> model.pool3 <- plm(lgsp~lprvc+lemp+lhwy+lwatr+lutil+unemp,
+                    data=pubcap.data,model="pooling")
> ## Fixed Effects Framework, no public capital,
> ## Cobb-Douglas specification
> model.wn1 <- plm(lgsp~lprvc+lemp+unemp,
+                  data=pubcap.data,
+                  model="within",effect="twoways")
> ## Fixed Effects Framework, aggregate public capital,
> ## Cobb-Douglas specification
> model.wn2 <- plm(lgsp~lprvc+lemp+lpubc+unemp,
+                  data=pubcap.data,
+                  model="within",effect="twoways")
> ## Fixed Effects Framework, decomposed public capital,
> ## Cobb-Douglas specification
```

```
> model.wn3 <- plm(lgsp~lprvc+lemp+lhwy+lwatr+lutil+unemp,
+                  data=pubcap.data,
+                  model="within",effect="twoways")
> sum.pool1 <- summary(model.pool1)
> sum.pool2 <- summary(model.pool2)
> sum.pool3 <- summary(model.pool3)
> sum.wn1 <- summary(model.wn1)
> sum.wn2 <- summary(model.wn2)
> sum.wn3 <- summary(model.wn3)
> ## Print out Coefficient estimates and t-statistics
> sum.pool1$coefficients[,c(1,3)]
               Estimate   t-value
(Intercept)  1.947921847 39.791513
lprvc        0.355413109 38.054099
lemp         0.694710029 82.424135
unemp       -0.006070062 -4.092927
> sum.pool2$coefficients[,c(1,3)]
               Estimate   t-value
(Intercept)  1.643302263 28.535869
lprvc        0.309190167 30.100327
lemp         0.593934898 43.203240
lpubc        0.155007005  9.036324
unemp       -0.006732976 -4.753664
> sum.pool3$coefficients[,c(1,3)]
               Estimate    t-value
(Intercept)  1.926004375 36.6835744
lprvc        0.312023086 28.1418784
lemp         0.549695456 35.3800440
lhwy         0.058881719  3.8206480
lwatr        0.118580557  9.5965597
lutil        0.008555123  0.6924966
unemp       -0.007270503 -5.2546498
> sum.wn1$coefficients[,c(1,3)]
          Estimate   t-value
lprvc  0.163879211  6.001605
lemp   0.757302852 29.097231
unemp -0.004688403 -4.423563
> sum.wn2$coefficients[,c(1,3)]
```

```
          Estimate   t-value
lprvc  0.168828035  6.104497
lemp   0.769306196 27.336786
lpubc -0.030176057 -1.120265
unemp -0.004221093 -3.706493
> sum.wn3$coefficients[,c(1,3)]
          Estimate   t-value
lprvc  0.157221692  5.750097
lemp   0.805229633 28.376279
lhwy   0.061697854  2.011517
lwatr  0.041730692  2.713827
lutil -0.094685617 -5.615344
unemp -0.003959286 -3.354968
```

References

Baltagi, B. H. & Griffin, J. M. (1983), 'Gasoline demand in the OECD: An application of pooling and testing procedures', *European Economic Review* **22**, 117–137.

Baltagi, B. H. & Pinnoi, N. (1995), 'Public capital stock and state productivity growth: Further evidence from an error components model', *Empirical Economics* **20**, 351–359.

Munnell, A. H. (1990), 'How does public infrastructure affect regional economic performance?', *New England Economic Review* **September**, 11–32.