# Extending MRW

Importing the csv we made in python

```
library(plm)
library(lmtest)
setwd('C:\\Users\\Administrator\\Documents\\personal\\mrw1992')
df = read.csv('data\\panel_mrw.csv')
```

## Regressions

The first model is the base model done in MRW. This is without the human capital variable added.

We do everything in a panel data style. The equation we estimate is:

$$log(Y_{it}/L_{it}) = a_i + \alpha(1-\alpha)log(s_{it}) - \alpha(1+\alpha)log(n_{it} + g_{it} + \delta_{it}) + \epsilon_{it}$$

Here $\alpha_i$ is our country fixed effect. #elaborate here#

```
mdl <- plm(ly ~ ls + lngd, data=df, index=c("country", "year"), model="within")
coeftest(mdl, vcov.=function(x) vcovHC(x, type="sss"))
```

```
##
## t test of coefficients:
##
##        Estimate Std. Error t value  Pr(>|t|)
## ls     0.453284   0.045212 10.0256 < 2.2e-16 ***
## lngd  -0.196648   0.031035 -6.3363 2.554e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
implied_alpha <- mdl$coeff[1]/(1 + mdl$coeff[1])
```

Implied alpha turns out to be 0.3119035. The implied alpha seems to be good. But there are still 2 issues-one is that the R-squared and adjusted R-sqares are too low (~.18) which means these variables can barely explain the variation in output per capita. The other issue is that the absolute coefficients for $log(savings)$ and $log(n + g + d)$ don't seem to be the same, although the signs are as the Solow model predicts.

```
mdl_restr = plm(ly ~ (ls_lngd), data=df, index=c("country", "year"), model="within")
coeftest(mdl_restr, vcov.=function(x) vcovHC(x, type="sss"))
```

```
##
## t test of coefficients:
##
##          Estimate Std. Error t value  Pr(>|t|)
## ls_lngd 0.415715   0.044842  9.2707 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
implied_alpha <- mdl_restr$coeff[1]/(1 + mdl_restr$coeff[1])
```

The implied alpha is still very similar but if we do an F test to test whether our unrestricted and restricted models are similar, we reject the hypothesis that they are the same. Which means the restriction of the magnitude of the coefficients doesn't seem to hold.

```
pFtest(mdl, mdl_restr)
```

```
##
##  F test for individual effects
##
## data:  ly ~ ls + lngd
## F = 1.3572, df1 = 340, df2 = 5140, p-value = 2.484e-05
## alternative hypothesis: significant effects
```

## Adding Human Capital

Lets see if adding human capital to our regressions changes any results.

```
mdl_hc <- plm(ly ~ ls + lngd + lschool, data=df, index=c("country", "year"), model="within")
coeftest(mdl_hc, vcov.=function(x) vcovHC(x, type="sss"))
```

```
##
## t test of coefficients:
##
##          Estimate Std. Error t value Pr(>|t|)
## ls       0.022808   0.018756   1.216   0.2240
## lngd    -0.014563   0.011869  -1.227   0.2199
## lschool  4.103742   0.137716  29.799   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
implied_alpha <- mdl_hc$coeff[1]/(1 + mdl_hc$coeff[1] + mdl_hc$coeff[3])
```

```
mdl_hc_restr <- plm(ly ~ ls_lngd + lsch_lngd, data=df, index=c("country", "year"), model="within")
coeftest(mdl_hc_restr, vcov.=function(x) vcovHC(x, type="sss"))
```

```
##
## t test of coefficients:
##
##           Estimate Std. Error t value  Pr(>|t|)
## ls_lngd   0.414534   0.040635  10.201 < 2.2e-16 ***
## lsch_lngd 0.386832   0.038271  10.108 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
implied_alpha <- mdl_hc_restr$coeff[1]/(1 + mdl_hc_restr$coeff[1] + mdl_hc_restr$coeff[2])
```

Testing the two models

```
pFtest(mdl_hc, mdl_hc_restr)
```

```
##
##  F test for individual effects
##
## data:  ly ~ ls + lngd + lschool
## F = 16663, df1 = 1, df2 = 5139, p-value < 2.2e-16
## alternative hypothesis: significant effects
```

Once again, we clearly reject the null that both the models are similar, which means our restriction doesn't hold.