

Evaluating the Solow Growth Model using the MRW Framework

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Textbook Solow Model, 1960-1985

| ## | Non-Oil | Intermediate | OECD |
|---------------------------|----------|--------------|----------|
| ## Observations | "80" | "64" | "20" |
| ## Intercept | "-3.675" | "-3.621" | "-0.176" |
| ## se | "1.062" | "0.785" | "1.684" |
| ## p | "0.001" | "0.000" | "0.918" |
| ## ln(I/GDP) | "0.998" | "1.055" | "1.116" |
| ## se | "0.138" | "0.119" | "0.352" |
| ## p | "0.000" | "0.000" | "0.006" |
| ## ln(n + g + d) | "-1.184" | "-1.185" | " 0.060" |
| ## se | "0.436" | "0.327" | "0.525" |
| ## p | "0.008" | "0.001" | "0.910" |
| ## Adjusted R Squared | "0.488" | "0.667" | "0.304" |
| ## see | "0.730" | "0.526" | "0.276" |
| ## Restricted Regression: | " " | " " | " " |
| ## Constant | "-3.352" | "-3.420" | "-1.013" |
| ## se | "1.026" | "1.079" | "0.716" |
| ## p | "0.000" | "0.000" | "0.558" |
| ## ln(I/GDP) - ln(n+g+d) | "1.026" | "1.079" | "0.716" |
| ## se | "0.116" | "0.095" | "0.352" |
| ## p | "0.000" | "0.000" | "0.019" |
| ## Adjusted R Squared | "0.493" | "0.672" | "0.230" |
| ## see | "0.726" | "0.523" | "0.291" |
| ## Test of Restriction: | " " | " " | " " |
| ## p | "0.708" | "0.736" | "0.105" |
| ## Implied alpha | "0.506" | "0.519" | "0.417" |

Textbook Solow Model, 1985-2010

| ## | Non-Oil | Intermediate | OECD |
|---------------------------|----------|--------------|----------|
| ## Observations | "80" | "64" | "20" |
| ## Intercept | "-8.862" | "-7.327" | " 0.021" |
| ## se | "1.033" | "0.846" | "2.715" |
| ## p | "0.000" | "0.000" | "0.994" |
| ## ln(I/GDP) | "1.044" | "1.377" | "0.681" |
| ## se | "0.272" | "0.245" | "0.741" |
| ## p | "0.000" | "0.000" | "0.371" |
| ## ln(n + g + d) | "-3.256" | "-2.351" | "-0.629" |
| ## se | "0.420" | "0.364" | "0.620" |
| ## p | "0.000" | "0.000" | "0.324" |
| ## Adjusted R Squared | "0.606" | "0.705" | "0.016" |
| ## see | "0.753" | "0.566" | "0.294" |
| ## Restricted Regression: | " " | " " | " " |
| ## Constant | "-7.526" | "-6.829" | " 0.055" |
| ## se | "1.824" | "1.739" | "0.651" |

| | | | |
|--------------------------|---------|---------|---------|
| ## p | "0.000" | "0.000" | "0.983" |
| ## ln(I/GDP) - ln(n+g+d) | "1.824" | "1.739" | "0.651" |
| ## se | "0.188" | "0.145" | "0.741" |
| ## p | "0.000" | "0.000" | "0.135" |
| ## Adjusted R Squared | "0.540" | "0.694" | "0.071" |
| ## see | "0.814" | "0.577" | "0.286" |
| ## Test of Restriction: | " " | " " | " " |
| ## p | "0.000" | "0.073" | "0.962" |
| ## Implied alpha | "0.646" | "0.635" | "0.394" |

Textbook Solow Model, 1960-2010

| ## | Non-Oil | Intermediate | OECD |
|---------------------------|----------|--------------|----------|
| ## Observations | "80" | "64" | "20" |
| ## Intercept | "-6.180" | "-5.545" | " 1.119" |
| ## se | "0.927" | "0.798" | "1.681" |
| ## p | "0.000" | "0.000" | "0.515" |
| ## ln(I/GDP) | "1.421" | "1.647" | "0.325" |
| ## se | "0.277" | "0.282" | "0.478" |
| ## p | "0.000" | "0.000" | "0.506" |
| ## ln(n + g + d) | "-1.894" | "-1.448" | "-0.667" |
| ## se | "0.354" | "0.294" | "0.504" |
| ## p | "0.000" | "0.000" | "0.203" |
| ## Adjusted R Squared | "0.528" | "0.641" | "0.064" |
| ## see | "0.825" | "0.625" | "0.287" |
| ## Restricted Regression: | " " | " " | " " |
| ## Constant | "-6.089" | "-5.505" | " 1.078" |
| ## se | "1.616" | "1.550" | "0.489" |
| ## p | "0.000" | "0.000" | "0.519" |
| ## ln(I/GDP) - ln(n+g+d) | "1.616" | "1.550" | "0.489" |
| ## se | "0.171" | "0.144" | "0.478" |
| ## p | "0.000" | "0.000" | "0.087" |
| ## Adjusted R Squared | "0.529" | "0.645" | "0.107" |
| ## see | "0.824" | "0.621" | "0.280" |
| ## Test of Restriction: | " " | " " | " " |
| ## p | "0.373" | "0.691" | "0.678" |
| ## Implied alpha | "0.618" | "0.608" | "0.329" |

Augmented Solow Model, 1960-1985

| ## | Non-Oil | Intermediate | OECD |
|------------------|---------|--------------|---------|
| ## Observations | "80" | "64" | "20" |
| ## Intercept | "-5.02" | "-4.23" | "-2.84" |
| ## se | "0.82" | "0.80" | "1.70" |
| ## p | "0.00" | "0.00" | "0.11" |
| ## ln(I/GDP) | "0.52" | "0.80" | "1.03" |
| ## se | "0.12" | "0.16" | "0.30" |
| ## p | "0" | "0" | "0" |
| ## ln(n + g + d) | "-1.23" | "-1.19" | " 0.26" |
| ## se | "0.33" | "0.32" | "0.45" |
| ## p | "0.00" | "0.00" | "0.57" |
| ## ln(School) | "0.70" | "0.34" | "0.26" |
| ## se | "0.09" | "0.14" | "0.29" |

| | | | |
|---------------------------|---------|---------|---------|
| ## p | "0.00" | "0.02" | "0.01" |
| ## Adjusted R Squared | "0.71" | "0.69" | "0.51" |
| ## s.e.e | "0.55" | "0.51" | "0.23" |
| ## Restricted Regression: | " " | " " | " " |
| ## Intercept | "-5.00" | "-4.15" | "-2.50" |
| ## se | "0.53" | "0.81" | "0.53" |
| ## p | "0.00" | "0.00" | "0.25" |
| ## ln(I/GDP) - ln(n+g+d) | "0.53" | "0.81" | "0.53" |
| ## se | "0.11" | "0.14" | "0.30" |
| ## p | "0.00" | "0.00" | "0.11" |
| ## ln(School) - ln(n+g+d) | "0.70" | "0.34" | "0.37" |
| ## se | "0.09" | "0.14" | "0.45" |
| ## p | "0.00" | "0.02" | "0.25" |
| ## Adjusted R Squared | "0.71" | "0.70" | "0.25" |
| ## s.e.e | "0.55" | "0.50" | "0.29" |
| ## Test of Restriction: | " " | " " | " " |
| ## p | "0.97" | "0.89" | "0.01" |
| ## Implied a | "0.24" | "0.38" | "0.28" |
| ## Implied b | "0.31" | "0.16" | "0.19" |

Augmented Solow Model, 1985-2010

| ## | Non-Oil | Intermediate | OECD |
|---------------------------|----------|--------------|----------|
| ## Observations | "80" | "64" | "20" |
| ## Intercept | "-11.75" | "-10.10" | " -3.23" |
| ## se | "0.91" | "1.24" | "3.68" |
| ## p | "0.00" | "0.00" | "0.39" |
| ## ln(I/GDP) | "0.82" | "1.06" | "0.77" |
| ## se | "0.22" | "0.25" | "0.73" |
| ## p | "0.0" | "0.0" | "0.3" |
| ## ln(n + g + d) | "-2.79" | "-2.50" | "-0.90" |
| ## se | "0.34" | "0.35" | "0.64" |
| ## p | "0.00" | "0.00" | "0.18" |
| ## ln(School) | " 1.17" | " 0.80" | "-0.90" |
| ## se | "0.17" | "0.27" | "0.40" |
| ## p | "0.00" | "0.01" | "0.22" |
| ## Adjusted R Squared | "0.76" | "0.74" | "0.05" |
| ## s.e.e | "0.59" | "0.53" | "0.29" |
| ## Restricted Regression: | " " | " " | " " |
| ## Intercept | "-11.61" | "-10.06" | " -2.76" |
| ## se | "1.04" | "1.26" | "0.56" |
| ## p | "0.00" | "0.00" | "0.42" |
| ## ln(I/GDP) - ln(n+g+d) | "1.04" | "1.26" | "0.56" |
| ## se | "0.17" | "0.20" | "0.73" |
| ## p | "0.0" | "0.0" | "0.2" |
| ## ln(School) - ln(n+g+d) | "1.27" | "0.87" | "0.48" |
| ## se | "0.16" | "0.27" | "0.64" |
| ## p | "0.00" | "0.00" | "0.22" |
| ## Adjusted R Squared | "0.75" | "0.74" | "0.10" |
| ## s.e.e | "0.60" | "0.54" | "0.28" |
| ## Test of Restriction: | " " | " " | " " |
| ## p | "0.12" | "0.23" | "0.72" |
| ## Implied a | "0.31" | "0.40" | "0.27" |

| | | | |
|--------------|--------|--------|--------|
| ## Implied b | "0.38" | "0.28" | "0.24" |
|--------------|--------|--------|--------|

Augmented Solow Model, 1960-2010

| | | | |
|---------------------------|----------|--------------|----------|
| ## | Non-Oil | Intermediate | OECD |
| ## Observations | "80" | "64" | "20" |
| ## Intercept | "-10.49" | " -9.40" | " -1.05" |
| ## se | "0.87" | "1.24" | "2.52" |
| ## p | "0.00" | "0.00" | "0.68" |
| ## ln(I/GDP) | "0.99" | "1.20" | "0.26" |
| ## se | "0.21" | "0.28" | "0.48" |
| ## p | "0.0" | "0.0" | "0.6" |
| ## ln(n + g + d) | "-1.89" | "-1.70" | "-0.85" |
| ## se | "0.26" | "0.27" | "0.52" |
| ## p | "0.00" | "0.00" | "0.12" |
| ## ln(School) | " 1.38" | " 1.10" | "-0.85" |
| ## se | "0.17" | "0.29" | "0.39" |
| ## p | "0.00" | "0.00" | "0.27" |
| ## Adjusted R Squared | "0.74" | "0.71" | "0.08" |
| ## s.e.e | "0.61" | "0.57" | "0.28" |
| ## Restricted Regression: | " " | " " | " " |
| ## Intercept | "-10.39" | " -8.99" | " -1.14" |
| ## se | "0.83" | "0.96" | "0.32" |
| ## p | "0.00" | "0.00" | "0.64" |
| ## ln(I/GDP) - ln(n+g+d) | "0.83" | "0.96" | "0.32" |
| ## se | "0.16" | "0.21" | "0.48" |
| ## p | "0.00" | "0.00" | "0.29" |
| ## ln(School) - ln(n+g+d) | "1.32" | "1.01" | "0.46" |
| ## se | "0.16" | "0.28" | "0.52" |
| ## p | "0.00" | "0.00" | "0.23" |
| ## Adjusted R Squared | "0.74" | "0.70" | "0.13" |
| ## s.e.e | "0.61" | "0.57" | "0.28" |
| ## Test of Restriction: | " " | " " | " " |
| ## p | "0.24" | "0.20" | "0.86" |
| ## Implied a | "0.26" | "0.32" | "0.18" |
| ## Implied b | "0.42" | "0.34" | "0.26" |

Descriptive Statistics of dependent and independent variables

| | | | | |
|-----------------|-------------|--------------|---------------|--------------|
| ## | log10 | st | ngdt | school10 |
| ## nbr.val | 64.0000000 | 64.00000000 | 64.00000000 | 64.00000000 |
| ## nbr.null | 0.0000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| ## nbr.na | 0.0000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| ## min | 0.6485390 | 2.30696382 | -2.92143547 | 3.49706547 |
| ## max | 4.6960982 | 3.57308169 | -1.61811359 | 4.58219508 |
| ## range | 4.0475592 | 1.26611787 | 1.30332189 | 1.08512962 |
| ## sum | 186.3745244 | 191.70131856 | -155.80518938 | 267.44673516 |
| ## median | 2.9186779 | 3.02869813 | -2.35233279 | 4.23844811 |
| ## mean | 2.9121019 | 2.99533310 | -2.43445608 | 4.17885524 |
| ## SE.mean | 0.1303325 | 0.04014461 | 0.03840786 | 0.03401729 |
| ## CI.mean.0.95 | 0.2604488 | 0.08022261 | 0.07675198 | 0.06797814 |
| ## var | 1.0871407 | 0.10314176 | 0.09441048 | 0.07405929 |
| ## std.dev | 1.0426604 | 0.32115690 | 0.30726288 | 0.27213836 |

```
## coef.var      0.3580439    0.10721909   -0.12621418    0.06512271
```

Summary of Augmented Model, 1960-2010, Intermediate countries

```
##
## Call:
## lm(formula = log10 ~ st + ngdt + school10, data = dfi)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.34337 -0.38644  0.05993  0.39925  1.24967
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -9.4035     1.2425  -7.568 2.68e-10 ***
## st              1.1979     0.2805   4.270 7.07e-05 ***
## ngdt          -1.6965     0.2741  -6.190 5.91e-08 ***
## school10       1.1002     0.2883   3.816 0.000324 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5654 on 60 degrees of freedom
## Multiple R-squared:  0.72, Adjusted R-squared:  0.706
## F-statistic: 51.42 on 3 and 60 DF, p-value: < 2.2e-16
```

Ramsey Reset test

```
##
## RESET test
##
## data:  model50Ai
## RESET = 0.67537, df1 = 3, df2 = 57, p-value = 0.5707
```

VIFs

```
##      st      ngdt school10
## 1.599680 1.397621 1.213531
```

Breusch-Pagan test

```
##
## studentized Breusch-Pagan test
##
## data:  model50Ai
## BP = 4.5058, df = 3, p-value = 0.2118
```

Summary of model with human capital replacing SCHOOL

```
##
## Call:
## lm(formula = log10 ~ st + ngdt + hc_10, data = dfi)
```

```
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.57508 -0.18744  0.03439  0.30421  0.77608
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -2.9161     0.6328  -4.608 2.17e-05 ***
## st           0.4377     0.2420   1.809  0.0755 .
## ngdt        -0.9323     0.2115  -4.408 4.39e-05 ***
## hc_10        2.4439     0.2938   8.319 1.40e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4295 on 60 degrees of freedom
## Multiple R-squared:  0.8384, Adjusted R-squared:  0.8303
## F-statistic: 103.8 on 3 and 60 DF,  p-value: < 2.2e-16
```

Table of model with human capital index replacing SCHOOL

```
##                               Non-Oil Intermediate OECD
## Observations                "80"      "64"      "20"
## Intercept                   "-2.79"   "-2.92"    " 1.00"
## se                          "0.57"   "0.63"    "1.15"
## p                           "0.0"    "0.0"     "0.4"
## ln(I/GDP)                   "0.23"   "0.44"    "0.22"
## se                          "0.18"   "0.24"    "0.33"
## p                           "0.20"   "0.08"    "0.51"
## ln(n + g + d)               "-0.95"  "-0.93"   "-0.19"
## se                          "0.21"   "0.21"    "0.36"
## p                           "0.00"   "0.00"    "0.61"
## ln(School)                  " 2.88"   " 2.44"   "-0.19"
## se                          "0.21"   "0.29"    "0.34"
## p                           "0"      "0"       "0"
## Adjusted R Squared          "0.86"   "0.83"    "0.56"
## s.e.e                       "0.45"   "0.43"    "0.20"
## Restricted Regression:      ""       ""       ""
## Intercept                   "-3.95"  "-3.44"   " 1.16"
## se                          "-0.08"   " 0.12"   "-0.22"
## p                           "0.00"   "0.00"    "0.38"
## ln(I/GDP) - ln(n+g+d)      "-0.08"   " 0.12"   "-0.22"
## se                          "0.21"   "0.27"    "0.33"
## p                           "0.71"   "0.66"    "0.46"
## ln(School) - ln(n+g+d)     "2.14"   "1.70"    "1.07"
## se                          "0.22"   "0.29"    "0.36"
## p                           "0"      "0"       "0"
## Adjusted R Squared          "0.79"   "0.77"    "0.45"
## s.e.e                       "0.55"   "0.50"    "0.22"
## Test of Restriction:       ""       ""       ""
## p                           "0.00"   "0.00"    "0.04"
## Implied a                   "-0.02"   " 0.04"   "-0.12"
## Implied b                   "0.70"   "0.60"    "0.58"
```

Simple Correlation between income per capita in 2010 and human capital

```
## [1] 0.8750941
```