REPLICATION EXERCISE 1: MANKIW, ROMER, AND WEIL (1992)

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Joint classroom discussion: MRW (1992)

(1) Read introduction to Mankiw, Romer, and Weil (1992); What are the three main points this paper addresses? (10 min)

(2) Read the model section I.A:
   (a) Come up with an linearized equation of the basic Solow model that can be estimated using a linear regression framework.[1] (10 min)
   (b) Why should we expect the elasticity of income per capita with respect to the saving rate of 0.5 and the elasticity of income per capita with respect to $n+g+\delta$ of -0.5? This gives us testable predictions! (5 min)[2]

(3) Based on the model you derived in 2.a, what are the predictions for real income across countries? Make predictions for relation between income of the country and parameters s, n, g, and δ (10 min)
   (a) What assumptions the authors make about g and δ? Discuss the validity of these assumptions. Section I.D can help. (10 min)
   (b) How do the authors understand the term A(0)? Any specific ideas what this might reflect? How can we use this assumption for our regression specification? How do we explain, in terms of parameters, that countries might differ with respect to their initial conditions? Section I.B can help. (5 min)

(4) What assumptions do we have to make in order to be able to use OLS in order to estimate the linear equation you defined above? Are these assumptions likely true or violated? Use the arguments of MRW (especially, refer to three papers they cite for their support) and come up with your own arguments if you feel the MRW ones are insufficient. Again, Section I.B is a reference. (5 min)

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[1]Read the section I.A, familiarize yourself with the model and derive the intermediate steps between (5) and (6).

[2]Note: MRW notation is slightly different from the one we used in the lecture. Despite that, their predictions are the same.
   (i) Growth rates in exponential form rather than our $1 + n$. A good approximation for small numbers.
   (ii) Effective unit of labor as a share of capital used over (technology * labor).

Individual team work: MRW (1992)

(1) Download the Penn World Tables 6.1 data from: http://www.rug.nl/ggdc/productivity/pwt/pwt-releases/pwt-6.1.[3] , [4,5] (5 min)
  - (a) Import the data into Stata and familiarize yourself with the dataset (save the data sheet as a .csv file). Restrict the sample to two years as in MRW: 1960 and 1985. (10 min)
  - (b) Which variables do MRW use to measure n, s, and Y/L (hint: read MRW Data and Samples section I.C)? Which variables from PWT will you use? (15 min)
  - (c) Create the variables you need in order to run the regression estimating the model you derived in point 2.a in the classroom discussion (hint: also look into the note to Table 1 to get a better idea of how the variables are constructed).[6] (5 min) — DISCUSS YOUR CHOICES WITH ME AT THIS POINT!
  - (d) Create dummy variables for the two rightmost sets of countries MRW use in Table I (Intermediate and OECD; see lists below).[7] (10 min)

(2) Run the regression using OLS on both subsamples of countries.[8] (10 min)
  - (a) Are the coefficients as expected? Comment?[9]
  - (b) Do the results support the predictions of the Solow model? Why (not)? Provide a formal test. Section I.D can help.

(3) Now we use the fact that the model predicts not just signs of the coefficients, but also the magnitudes (see point 2.b of our classroom discussion). Rather than estimating the coefficients independently, we can impose a restriction on the regression.

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[3] Few issues while you are in Excel:
  - (a) You will need to replace all "na" entries with a ".", and the "," separating the decimals to ".", so that Stata still reads the values as numbers and not as text.
  - (b) Change the formatting of all the cells to "Text", otherwise the large integers load with a weird character inside.
  - (c) Also, all variable names must be without a space.

[4] Although the variable descriptions are in the first tab, the variables will not be described once you load the data to Stata, you might want to download the codebook (http://www.rug.nl/ggdc/docs/appendix_pwt_61.pdf) describing the variables for easier orientation.

[5] Cite as: Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, October 2002.

[6] The `reshape` command in Stata might be useful when you need to convert the time series to a "cross-section" format in which you have data for both 1960 and 1985 on the same row in the dataset. See `help reshape` for the syntax.

[7] You'll see later that we don't have data for all countries in the subsamples; let's just take it as a fact, results are still fairly consistent with the MRW original.

[8] Use `outreg2` command to store the regression results.

[9] Whenever commenting on results, discuss both the coefficients and the explanatory power of the model.

(a) Write down the new econometric model where you impose that the coefficients for s and $(n + g + \delta)$ are equal in absolute values and of opposing signs. (5 min)

(b) What do you expect would happen with the predictive power of the newly model in: (2 min)
   (i) Theory if Solow model was the ideal/perfect model, and
   (ii) In practice using our data?

(c) Run this regression on both subsamples of countries and test the predictions of Solow model with respect to the respective income elasticities. What do you conclude? (test using `nlcom` function in Stata whether the parameter α is statistically significantly different from $1/3$)[10]. Calculate the actual value of α. (8 min)

(d) What happened to the predictive power of the model compared to the unrestricted model? Comment. (2 min)

(e) Are your results consistent with MRW findings? Is the Solow model an appropriate model based on your findings? Comment. (3 min)

Joint classroom discussion (Week 2)

(1) Now skip to section III in MRW (Endogenous Growth and Convergence). In this section the authors test the convergence hypothesis. Unlike in the previous part, we assume that the countries were out of the steady-state at the beginning of the period, but they reached the steady-state by the end of the period. For now we will forget about the role of human capital. Rewrite equation (16) in MRW accordingly and test it.[11] (15 min)

(2) What assumptions do we have to make about the production functions of respective countries? Why this was not an issue in the first part of the analysis? What potential bias is introduced if this assumption is violated? See section 3.A (5 min)

Individual team work: MRW (1992) convergence

(1) Using the model you derived above, let's now examine convergence for the period from 1960 to 1985. First run the regression without controlling for s and for $n+g+\delta$. Run the regression for both the intermediate and the OECD samples. How would we call the model estimated here? Comment. (5 min)

(2) Second, run the regression in which you control for s and for $n + g + \delta$. Run the regression for both the intermediate and the OECD samples. How would we call the model estimated here? Comment. (5 min)

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[10]You can see from point 2.a in the classroom discussion that the parameter α does not enter our model in a linear fashion and needs to be derived from the estimated coefficients. Do the calculations and use the appropriate `nlcom` command. Then formally test for the difference of the obtained nonlinear combination of estimators from $1/3$.

[11]Essentially, take equation (13) as given, and provide the intermediate steps between equations (14), (15) and (16) in MRW. If you are interested in deriving the intermediate steps between (13) and (14), for the log-linearization see e.g. Chapter 3.2 of Acemoglu: Introduction to Modern Economic Growth (2009).

(3) Third, run the restricted model in which you impose a restriction that coefficients for s and $(n + g + \delta)$ are equal in absolute values and of opposing signs. The estimated parameters allow you to measure the "convergence rate" parameter λ. Calculate it algebraically from equation (16). Then estimate lambda using `nlcom` function in Stata and test if λ is statistically significantly different from 0. (15 min)

(4) Save the coefficients from the second model for both samples (intermediate and OECD) and generate the predicted values of growth rate for all countries (use `predict` function). Plot this newly generated variable with the initial log output per worker (for inspiration see panel B of Figure I). Comment. (15 min)

Individual team work: MRW (1992), adding human capital

In the lecture we discussed the role of human capital as a crucial factor determining the differences in countries' wealth. Let's examine the role of human capital.

(1) Read Section II in MRW.

(2) Download the Barro & Lee data for working age population from: http://barrolee.com/data/yrsch.htm in a .dta format (Stata). Open the data in Stata. (5 min)

(3) Merge the Barro & Lee dataset with the Penn world tables data you used up until now. You will especially need data on the percentage of secondary and tertiary school enrolment (do not include the "completed" degrees) in the respective countries in 1960; share of individuals attending at least secondary education will be used as a proxy of initial human capital.[12],[13] (11 min)

  (a) Why is this a good measure of human capital (alternatively, under what assumptions can we use this measure as a proxy for s_h)? (2 min)

  (b) Why is this a bad measure? (2 min)

(4) Extend the second regression specification in the model (the non-restricted one) above by including the initial values of primary and secondary enrolment rate. Comment on regression results. How can we interpret the coefficient of the $ln(s_h)$ variable? (5 min)

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[12]Be careful here, some of the country names might differ, which would result in some countries not matching. You can, for example, copy the names from both datasets to Excel and compare where they differ and recode the variables so that you can match based on country names. Alternative approach is to match the datasets and then list all those observations that did not match, i.e. `_merge!=3`. You can also match based on the three-letter abbreviations.

[13]Note that we use a different proxy that the one originally used in MRW. I would argue that it is a reasonable replacement. See how MRW describe the construction of the SCHOOL variable on p. 419. Feel free to prove me wrong.

List of intermediate set of countries

Algeria	Guatemala	Pakistan
Argentina	Haiti	Panama
Australia	Honduras	Paraguay
Austria	Hong Kong	Peru
Bangladesh	India	Philippines
Belgium	Indonesia	Portugal
Bolivia	Ireland	Senegal
Botswana	Israel	Singapore
Brazil	Italy	South Africa
(Burma)[14]	Jamaica	Spain
Cameroon	Japan	Sri Lanka
Canada	Jordan	Sweden
Chile	Kenya	Switzerland
Colombia	Korea, Republic of	Syria
Costa Rica	Madagascar	Tanzania
Cote d'Ivoire	Malawi	Thailand
Denmark	Malaysia	Trinidad &Tobago
Dominican Republic	Mali	Tunisia
Ecuador	Mexico	Turkey
El Salvador	Morocco	United Kingdom
Ethiopia	Netherlands	United States
Finland	New Zealand	Uruguay
France	Nicaragua	Venezuela
Germany	Nigeria	Zambia
Greece	Norway	Zimbabwe

List of OECD countries

Australia	Greece	Spain
Austria	Ireland	Sweden
Belgium	Italy	Switzerland
Canada	Japan	Turkey
Denmark	Netherlands	United Kingdom
Finland	New Zealand	United States
France	Norway	
Germany	Portugal	

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[14]Not in our sample.