Development Economics Problem Set 3

Professor Anant Nyshadham

Spring 2018

1. **Where does capital go?** Easterly and Levine (2001) assert that capital flows where it is already abundant. This questions asks you to do some calculations to check that.

   Go to the World Bank's data website `http://databank.worldbank.org/data/databases.aspx` and select the World Development Indicators. Download the series "Foreign direct investment, net inflows (BoP, current US$)", "GNI per capita, PPP (current international $)", and "Population, total" and one other variable of your choosing for 2014 for all available countries (the data for many countries for 2015 is still not available). When you download it, get the the countries on the rows and series on the columns by clicking on "Modify Orientation," "Custom" and Time on Page, Country on Row, Series on Column , and export the data into a spreadsheet.

   (a) Sort the data by GNI per capita. Note that a number of countries do not have GNI per capita data. What is the ratio of the highest to the lowest GNI per capita? (We talked about variations on this number, but it is useful to see what it is in the data you've downloaded).

   (b) Calculate the sum of FDI in the world. What fraction of the total did the 20 poorest nations have?

   (c) What fraction of the total FDI did the 20 richest nations with FDI reported have?

   (d) What fraction of the total FDI does China receive? Since China is the most populous nation, and has a huge economy, even though it is not among the richest in per capita terms, does the importance of China suggest that comparing total inflows of FDI to GNI per capita is problematic?

   (e) Calculate FDI per capita. Make a scatter (X-Y) chart with GNI per capita on the x-axis and FDI per capita on the y-axis. (Exclude the two richest countries, and the countries which have no GNI.) Print the chart and include it with your problem set. Does it support the assertion that capital flows to countries that are rich already?

   (f) Make a scatter (X-Y) chart with GNI per capita on the x-axis and the other variable you downloaded on the y-axis. Is GNI per capita related to your variable? Why?

2. **Computing residuals** The Easterly and Levine (2001) paper shows a breakdown of the determinants for growth accounting in table 1. The basic idea is to find all of the things that add into growth, and determine which changes contributed which shares. Using the

Penn World Tables,[1] a compendium of national accounts for many countries over time (used by both the Easterly and Levine (2001) and the Mankiw, Romer, and Weil (1992) papers, although in different versions), this question asks you to do a growth accounting exercise for Brazil.

Suppose m is the fraction of the population P that works. Our standard Cobb-Douglas production function looks like:

$$Y = AK^{\alpha}(mP)^{1-\alpha}.$$

In class we have just used the labor force $L = mP$ and assumed that $m = 1$.

(a) Most of the time we use per capita when describing a country, so write GDP per capita y in terms of $k = K/P$, m, A, and α.

(b) If many things are growing at the same time we can consider how they grow together with some simple rules. If $Y = WX^{\alpha}Z^{\beta}$, then

$$\frac{\Delta Y}{Y} = \frac{\Delta W}{W} + \alpha\frac{\Delta X}{X} + \beta\frac{\Delta Z}{Z}.$$

Use this growth rule to find the growth of income per person in terms of the growth of A, k, and m. You should end up with an equation that looks just exactly like Easterly and Levine equation 2 except with growth in m instead of n.

(c) With $k = K/P$ the chain rule says that $\Delta K = P\Delta k + k\Delta P$. Write the growth in population $\Delta P/P = n$. Show how to combine this equation with the capital accumulation equation $\Delta K = sY - \delta K$ to find the standard expression for capital per person growth $\Delta k = sy - (n + \delta)k$.

(d) The share of investment in GDP (I/Y) is savings (s). As an example: if $k_{1950} = 3000$, $y_{1950} = 1000$, $\delta = 0.05$, $n = 0.03$, and $I/Y = 0.25$, calculate k_{1951}.

(e) From the Penn World Tables, I have downloaded data on Brazil and put it into a spreadsheet. We want to find the series that lead into our model above.

   i. First find m, the share of population working or $m = L/P$. This variable does not exist in the basic PWT data, but we can figure it out by combining Real GDP per capita (rgdpch) and Real GDP per Worker (rgdpwok). Find m for all years. How has it changed from the 1950's to today? How is m related to the dependency ratio?

   ii. Find the growth rate in population n for each year starting in 1951 (it is a growth rate so calculate growth in 1951 as the change from 1950 divided by population in 1950). What is the average population growth in Brazil since 1950?

   iii. Next find k. Capital per person is hard, since we don't know capital to start with. A common approach is to make a reasonable guess and update the guess using

[1] The data are posted at www.anantnyshadham.com/teaching in a link to the right of the link for this problem set. They are originally taken from Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.3, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, November 2012. datacentre.chass.utoronto.ca/pwt/

investment. Since capital depreciates over time, the guess becomes less and less important over time. Guess that the capital output ratio in 1950 is 3, and find k for 1950. The variable ki is the percentage of investment in GDP (I/Y). We can use the capital increase equation we found earlier to calculate k in 1951, assuming that $\delta = .05$. So

$$k_{1951} = (ki/100)y_{1950} - (n + \delta)k_{1950} + k_{1950}.$$

Find k for all years. As a check on your calculations, find the capital output ratio $a = K/Y = k/y$ for all years. It should be 3 in 1950. What is the average? Was 3 a bad guess? Does your answer imply that Brazil is more or less efficient than 3?

(f) Now calculate the growth rates of the important variables in the growth accounting equation we found in b. Starting in 1960, find the $(y_{1960} - y_{1959})/y_{1959}$, and similarly for $\Delta k/k$ and $\Delta m/m$. Do the same thing for all the years after 1960. Why does it make sense to start so long after the data begins (the exact date is somewhat arbitrary)? What is the average growth in y?

(g) Let's assume that $\alpha = 1/3$. Now find for each year starting in 1960 the "Solow Residual," the part left over after accounting for labor force growth and capital growth. Since we know α, $\Delta y/y$, $\Delta k/k$ and $\Delta m/m$, we can calculate $\Delta A/A$ from part (b). What is the average TFP growth rate?

(h) Find the share of growth contributed by the residual. (Hint: Just divide growth in A by growth in y.) What is the average share of TFP in growth? Has Brazil grown by making better use of inputs, or just increasing inputs, or some of both?

(i) Graph the five year rolling average (add up the previous five years and divide by 5) of TFP growth, and growth in y on the same graph with year on the y axis. Print your graph and include it with your problem set. The 1980s and 1990s are sometimes thought of as lost decades for Latin America. Does your graph support that assertion, and offer a reason why?

(j) Brazil suffered from high inflation in 1991-1994, and the Russian currency collapse in 1998 brought a currency crisis in Brazil in 1998-1999. Since TFP picks up everything that is left, does your graph suggest that the Solow Model, which ignores financial markets and the positive or negative effects of inflation, might be leaving something out?

3. **The O-ring in study groups** The study group can be very important in university, and especially for medical school and law school. This question considers a group of five students who come together to study five chapters in a book. The amount of the book they cover determines their grades (each group member gets the same grade). Students are of different "qualities" in that they help their group cover different fractions of the assigned chapter (no student can study more than one chapter). The five students, with the proportion of his or her assigned chapter each student can cover in parentheses, are: Annie (0.9), Bob (0.6), Carl (0.5), Damon (.6), and Ernesto (0.8).

   (a) First suppose that the book is made up of chapters on entirely different topics. So the amount of the chapter Bob covers does not affect the group's understanding of Ernesto's chapter.

i. How much of the book do they cover, and what is the group's grade? (If they cover 85% of the book, they get a grade of 85.)

ii. Suppose the group switched out Carl for Carlita who covers 0.6 of her chapter. How much better is the group's grade?

iii. Suppose the group instead switched out Ernesto for Enrique who covers 0.9 of his chapter. How much better is the group's grade?

iv. What is the marginal return (in terms of better group score) of getting someone who can cover a fraction 0.1 (10 percentage points) more of her chapter? Is it the same for the entire group?

(b) Now suppose that the first chapter sets up the notation and terms for the rest of the book. So how well Annie covers the first chapter determines how well Bob can cover his chapter. The rest of the chapters are unrelated, and the group is still tested on the first chapter. To be precise, if q_A is Annie's coverage, then the grade they receive is given by:

$$\text{Grade} = 100 * (q_A + q_A * (q_B + q_C + q_D + q_E))\,/5$$

i. Explain how the grade production function captures the description of the way the book is set up.

ii. What proportion of the book do they cover?

iii. If Annie is sick and can't study ($q_A = 0$ instead of 0.9), what is the group's score?

iv. Suppose the group dropped Carl for Carlita who covers 0.6 of her chapter. How much better does the group score?

v. Suppose the group instead dropped Ernesto for Enrique who covers 0.9 of his chapter. How much better does the group score?

vi. Suppose instead the group can get Anjini, who can cover 100% of her chapter to replace Annie. How much better does the group score?

vii. With Anjini in the group, suppose the group dropped Carl for Carlita. How much better does the group score? Is the marginal value of Carlita the same with Anjini as it was with Annie? Why or why not?

(c) Compare the two grade production functions, calling the first one additive and the second one multiplicative to separate them. Let's assume that there are two groups which are identical except that one is lead by Anjini and the other by Annie (so the rest of each group is composed of Bob, Carl, Damon, and Ernesto). In both production functions Annie and Anjini would like to work with better students. Let's suppose both Carl and Carlita are paid tutors, who help the study group, but do not get graded. The rest of the group is graded the same way, but Carl and Carlita go wherever the money is best.

i. What is the marginal value in grades of Carlita (dropping Carl for Carlita) for the group with Annie, and for the group with Anjini under each production function?

ii. If both Annie and Anjini offer Carlita \$100 times the improvement in grades (so 100 times the difference in grades between when she is in the group and when Carl is in the group), how much are they offering under each production function?

iii. If Carlita goes to the group where she is offered more, will she end up with Anjini or Annie (or is she indifferent) for each production function?

(d) Under either grade production function, is it better to go to a school with lots of good students with whom to study? Under which production function is the incentive for good students to congregate stronger? Does this model explain why good students tend to go to the best schools they can get into (and why there is such a premium on getting into the best schools), even though a better student may get more attention and resources if he or she goes where talent is scarce? (It may help to consider what the average score in each production function is if all of the students are 0.5, and if all of the students are 0.6).

(e) Some state schools are willing to offer a free ride plus a stipend to very good students. Does the multiplicative grade production function explain why good students (who can presumably get into better schools) have to be offered such a sweet deal, and why it is in the best interests of the school to offer such a deal?