EC 2273 Problem Set 1

Professor Nyshadham

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Answer Key

1. **A visual look at the world** In the first class I asked you to write down three characteristics of an "under-developed" nation. (If you have lost your list, go to Lecture 1 on my website (www.anantnyshadham.com/teaching) where I wrote some on one of the lecture slides.) Go to www.gapminder.org/world which has aggregated data to examine inequality across nations in a visual form. I have used many of the graphs and maps in lecture.

   (a) Choose one of your characteristics and graph it against log income per person (GDP/capita PPP$). Try to find the indicator closest in meaning to your chosen one, but you may substitute if not enough countries have data. We have already looked at Life Expectancy, so find a different indicator if you choose to look at health. Print out your graph and include it at the end of your problem set (right clicking or its Mac equivalent on the graph should bring up a print option).

   (b) Is your indicator increasing with income per person? How does changing the axes from lin to log change the relationship? Is the relationship approximately linear, or is it changing at different income levels?

   (c) What areas of the world have the lowest values, what areas have the highest? Or is there no geographical relationship?

   Answer: Check to make sure answer the previous three questions and answers are reasonably done.

   (d) Graph log electricity consumption per person against log income per person. Instead of income, could we rank the world by electricity consumption and would that change the "development rankings"?

   Answer: No it would not change the relationship much—the relationship is nearly linear and very tight.

   (e) Does China use more or less electricity than its income per capita would suggest?

Answer: China is above most of the other countries at its income level in electricity consumption.

(f) What is likely to happen to world electricity consumption as countries like China and India have higher income per capita?

Answer: Lots more electricity usage.

(g) Select China, the United States, and either Mexico or Brazil and play the graph again so that each country leaves a trail (click on the circles representing each country to select them). In order to overcome questionable statistics, some China analysts use electricity as a proxy to judge how fast China is growing. Does that make sense historically? Does it make sense for the United States? How about Mexico or Brazil?

Answer: See attached graph. Electricity consumption in China and the US has been approximately linear with (log) income. Electricity consumption in Mexico and Brazil has increased (in the 1980s) even without growth in income per person so using electricity consumption would not necessarily give a good indication of GDP.

2. **International Comparison Project** Go to the World Bank's International Comparison Project website and find the summary table for the ICP report. http://siteresources.worldbank.org/ICPINT/Resources/icp-final-tables.pdf.

(a) The price index column is the PPP/exchange rate. It gives a measure of how far a dollar will go in that country (more exactly, it is the number of dollars, converted at the official exchange rate, that it costs to buy the basket of goods). Lower is cheaper. What country has the lowest cost of living for those with dollars.

Answer: Tajikistan with price index of 24.

(b) When Kenyans vacation to Uganda, do they find prices cheap or expensive?

Answer: Cheap, Uganda price index 35, Kenya 39.

(c) What country has the highest cost of living (according to these data, which are now slightly old)?

Answer: It should be Iceland with 154 price index (US =100)

(d) Suppose you win free airfare to the Asia/Pacific region, but are on a tight budget otherwise. If you want to get the best value for your dollar, what country should you go to? (PPP tourism is what economists do for fun!)

Answer: Laos (or Lao PDR) at 28.

3. **The new Human Development Index** The UN Development Program developed a new version of the HDI in 2010. Like its predecessor the new HDI combines three components: life expectancy, education, and income. On my website (www.anantnyshadham.com/teachi

there is a spread sheet with data from the World Bank that we will use to calculate a version of the HDI (it will not be exactly the same as the UN's because the data are slightly different).

(a) As in Todaro and Smith, construct the GDP index using 100 as the smallest income and 87,478 as the largest. Which countries rank highest and lowest?

Answer: Luxembourg highest. Burundi lowest.

(b) Calculate the Health Index using a highest life expectancy of 83.6 and a lowest of 20. Which countries are highest and lowest?

Answer: San Marino highest, Sierra Leone lowest.

(c) Calculate a simple education index using the "School enrollment, primary (% net)" divide by 100. Which country has the highest rate of enrollment and which the lowest? Do the countries for which there is not any information look like they do well in other dimensions? Should it worry us to exclude them because they are missing data on primary school completion rates?

Answer: Japan highest, Eritrea lowest. The countries without information are generally not very rich. We might be worried that we are not ranking them because they do not have any information, but they don't have information because they are poor.

(d) Combine these three indexes to create the New Human Development Index:

$$NHDI = H^{1/3}ED^{1/3}INC^{1/3}.$$

Which country ranks first and last? The US is close to Greece, but for different reasons. Where does the US do well compared to Greece, where does Greece beat the US? Should we worry about the data inputs?

Answer: Eritrea last, Norway first. The US has a higher income than Greece, but Greece has a higher education and life expectancy. The primary school completion rate seems suspiciously bad for the US, suggesting that we might want to look for other data.

(e) In the spreadsheet there are other potential variables (there are many more from World Bank's data source). Define your own human development index by including other variables or using other weights. The exponents should sum to one, but you can give something a higher weight by increasing its exponent. For example, if I built an index of World Cup wins that varies from 0 to 1 (where 1 is Brazil and 0 is the US), and believe that my index is the most important measure of human development, then I could define my Super HDI:

$$SHDI = WCI^{0.7}H^{0.1}ED^{0.1}INC^{0.1}.$$

Make your own human development index, write the formula for it, and tell which country does best, which worst, and about where the US falls.

Answer: Any reasonable answer is fine.

4. **A Malthus Model** Suppose population growth is given by the equation:

$$P_{t+1} = (1 + g(Y/P))P_t$$

with $g(Y/P) = Y/P - c$. Production is a Cobb-Douglas production function of the form:

$$Y = T^{\alpha}P^{1-\alpha}$$

where T is land, P is population, and Y is food production. α represents the importance of population and land in production, and is generally between 0 and 1. Show your work.

   (a) Find food per person Y/P.

   Answer:

$$Y/P = (T/P)^{\alpha}$$

   (b) What population P leads to zero population growth?

   Answer: $P_t = P_{t+1}$ implies that $Y/P = c = (T/P)^{\alpha}$. Solving for P should give $P = T/c^{1/\alpha}$.

5. **The Pharaoh's Laffer curve** A famous observation in Public Finance is that for very high tax rates it may be possible to raise total tax revenue by reducing tax rates since at very high tax rates the incentives for work are so bad that few people work. Cutting tax rates encourages more work, and so raises tax revenue. (Few believe any country is near such a high point of taxes.) Suppose an absolute dictator, the Pharaoh, wanted to tax the people to maximize his own revenue to build the biggest pyramid with all of the latest death traps. And mummies, no respectable dead Pharaoh can be without mummy minions. Since taxing a Malthusian population reduces population, what is the poor Pharaoh to do?

   Note: This question is challenging, it is alright if you do not get it immediately, and it does not count much, so do your best. It is an example of how modeling in economics works using mathematics to reach an interesting conclusion.

   (a) Using the Malthusian model above, suppose the Pharaoh taxes at rate τ so that a total of τY goes to the Pharaoh. What is per capita income (not counting the Pharaoh) left for the rest of the population in terms of P and T and τ? (Hint: you have already done the work for this question in the Malthusian question).

   Answer: $(1 - \tau)(T/P)^{\alpha}$.

   (b) What is the constant population with a tax τ? Is it declining as τ increases? (You do not have to show what happens formally using calculus, although you are welcome to. But you should simplify until it is clear how P changes with τ.)

Answer: Since $c = (1-\tau)(T/P)^{\alpha}$ for a stable population, population is given by $P = T/(c/(1-\tau))^{1/\alpha}$ which simplifies (for later) as $P = T(1-\tau)^{1/\alpha}/(c^{1/\alpha})$. As τ increases P decreases.

(c) What is the total production with a constant population (you should be able to write it in terms of T, τ, α and c, the "parameters" of our model)? **Answer:** Plug into production function $Y = T(1-\tau)^{(1-\alpha)/\alpha}/(c^{(1-\alpha)/\alpha})$

(d) What is the Pharaoh's take of total production?

Answer: The Pharaoh gets a fraction τ of total production: $T\tau(1-\tau)^{(1-\alpha)/\alpha}/(c^{(1-\alpha)/\alpha})$

(e) Let $\alpha = 1/2$. What τ maximizes revenue? (Hint: You only care about maximizing the part of the expression with τ in it, which should should be quadratic. For a quadratic $ax^2 + bx + c$ the max or min occurs when $2ax + b = 0$.)

Answer: Find max of $\tau(1-\tau)^{(1-\alpha)/\alpha}$. With $\alpha = 1/2$ this simplifies to $\tau(1-\tau) = \tau - \tau^2$. The max is at $1 - 2\tau = 0$ or $\tau = 1/2$.