Section #3

1 Outline

1. More Econometrics!
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2 Structural Estimation

Last week, we saw an example of a "reduced-form regression" which means we weren't estimating a regression equation based off of a economic model that specifies the exact relationship between the exogenous and endogenous variables. In particular, we didn't know exactly what behavioral model was driving a woman's decision to have a child before age twenty-two. In this section, we will look at an example of structural estimation where we will use data to identify the parameters of an economic model.

2.1 Simple Solow Growth Model

Let's return to the Solow Growth Model which describes the evolution of cross-country variation in income per capita. The starting point of the Solow Growth Model is the aggregate production function. It assumes that the income process of any country (indexed by j) can be described by the following equation:

$$Y_j(t) = F(K_j(t), L_j(t), A_j(t)) \tag{1}$$

where $K_j(t)$ is country j's capital stock at time t, $L_j(t)$ is country j's labor force, and $A_j(t)$ is country j's index of total factor productivity. Following along with the approach of a well-known article on economic growth by Mankiw, Romer, and Weil (1992), [1] we will assume that the production function depicted in equation (1) is Cobb-Douglas with exponents α and $1-\alpha$. Specifically,

$$Y_j(t) = K_j(t)^{\alpha}(A_j(t)L_j(t))^{1-\alpha} \tag{2}$$

[1] *A Contribution to the Empirics of Economic Growth* http://www.jstor.org/stable/2118477

In writing the above equation we assumed that this is exactly the way output in any country can be described and we've also assumed that technology augments labor and not capital. MRW use the Solow Model and logarithm rules to construct a regression equation to measure differences in cross-county income per capita. If you'd like to see the details, see the paper, but it is 100% NOT necessary to know how to derive any of these results for this class. They rearrange (2) as follows:

$$\ln y_j = \text{constant} + \frac{\alpha}{1-\alpha}\ln(s_{k,j}) - \frac{\alpha}{1-\alpha}\ln(n_j + g + \delta_k) + A_j \tag{3}$$

The actual regression they run is:

$$\ln y_j = \text{constant} + \beta_1 \ln(s_{k,j}) + \beta_2 \ln(n_j + g + \delta_k) + \varepsilon_j \tag{4}$$

where y_j is country j's income per capita, $s_{k,j}$ is a country's average savings rate (Investment/GDP), and $n_j + g + \delta_k$ is the sum of a country's population growth rate, technology growth rate and capital depreciation rate. For 1985, the population growth rate is the average growth rate from 1950 to 1984 and for 2000 it's the average growth rate from 1985 to 2000. MRW assume that all countries have the same technology growth rate and so $\delta + g = 0.05$. Notice that the coefficients on this regression equation have a particular meaning. They relate back to the exponents of the Cobb-Douglas production function and so by using data to estimate this equation we are identifying parameters of an economic model (provided the model is correct and it's identified). The first two columns of Table 1 display the results of estimating equation (5) using data on 118 countries from the Penn World Table 8.0 for the year 1985 and 2000.

1. Using the estimated coefficients, what are the implied α's according to the data in 1985 and 2000? How does this compare to what you know about National Accounts Data?

2. According to this simple Solow Model, what would you conclude about the role of technology in explaining cross-country variation in income per person?

2.2 Solow Growth Model with Human Capital

Now we modify our assumption about the model to also allow for differences in human capital to explain differences in income per person across countries. So now countries can differ in their saving rates, population growth rates, and their initial technology level. The production function in this case will be

$$Y_j(t) = K_j(t)^{\alpha} H_j(t)^{\beta} (A_j(t) L_j(t))^{1-\alpha-\beta} \tag{5}$$

where $H_j(t)$ is a measure of country j's human capital. Using this production function we can derive a new regression equation of the form

$$\ln y_j = \text{cst} + \frac{\alpha}{1-\alpha-\beta}\ln(s_{k,j}) - \frac{\alpha}{1-\alpha-\beta}\ln(n_j + g + \delta_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_{h,j}) - \frac{\beta}{1-\alpha-\beta}\ln(n_j + g + \delta_h) + A_j \tag{6}$$

where $s_{h,j}$ is a measure of how much country j invests in its human capital. We'll take this to be a country's average years of schooling for the working population (15-64). The results of estimating this regression equation are shown in columns (3) and (4) of Table 1 for the years 1985 and 2000 respectively.

Table 1: Solow Model Growth Accounting

	(1) 1985	(2) 2000	(3) 1985	(4) 2000
$\ln(s_k)$	0.8280***	1.0113***	0.2743**	0.4476**
	(0.1461)	(0.2450)	(0.1247)	(0.1944)
$\ln(n_j + g + \delta)$	-1.3266**	-3.6460***	-0.2188	-1.0077*
	(0.5679)	(0.6835)	(0.4434)	(0.5873)
$\ln(s_h)$			1.5519***	2.2449***
			(0.1646)	(0.2392)
Adj. R-Squared	0.28	0.34	0.59	0.63
Implied α				
Implied β				
Obs.	118	118	118	118

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

1. Using the estimated coefficients, what are the implied α's and β's according to the data in 1985 and 2000? How does this compare to the simple model?

2. After the addition of human capital to the growth model, would you change your conclusion from above about the role of technology in cross-country income variation?

3. Can you think of any problems with assuming that technology growth rates are independent of each country's human and physical capital stocks?

3 Asymmetric Information & Financial Markets

3.1 Definitions

1. **Asymmetric Information:** Demanders and suppliers have different knowledge about the value or cost of a good. For instance, the seller of a used car has an incentive to hide from a buyer whether a car is a "lemon".
2. **Adverse Selection:** Suppliers can't distinguish between more costly and less costly users. For instance, an all-you-can-eat buffet usually does not differentiate pricing between obese people with large appetites and thin people with smaller appetites; the former will be more costly for the restaurant, while the latter will be cheaper.
3. **Moral hazard:** Demanders may change their behavior after buying the good. For instance, once you have medical insurance, you go hang-gliding more often, since the insurance will cover the additional expected cost of injury.

3.2 Group Exercise: Asymmetric Information & Investing

3.2.1 Setup

1. Divide into groups of two. One of you will be a **bank**, and one of you will be a **start-up**.
2. Each bank can choose whether or not to loan $400k to a start-up.
   (a) Assume the interest rate is 10%.
   (b) If a start-up has a return of less than the cost of the loan ($400k + 40k = $440k), then the start-up defaults and the bank gets nothing.
3. Each start-up will learn their expected return one year from now, determined by rolling a single die, times $100k.
   (a) If you roll an odd number, then you are a "good" start-up. If you roll an even number, you're a "bad" start-up.
   (b) "Good" start-ups return twice the value of their roll; "bad" start-ups simply get the value of their roll.
   (c) In order to earn their return, all start-ups must borrow $400k from a bank.
   (d) To simplify things, a start-up's profits are their return minus their loan repayment (principal + interest)
4. The first time we play, ***after*** the banks decide whether or not to take the loan, the start-ups roll their die, determining their return and whether or not they're "good" or "bad". The start-ups calculate their profits, and announce if they default or repay. The banks then calculate the returns.
5. We will add up all of the profits from banks and start-ups on the board.
6. Restart the game, but now the bank knows whether you are a "good" or "bad" start-up from the beginning.

   (a) Banks decide whether or not to loan.
   (b) Start-ups roll their die for returns, calculate their profits and announce repayment/default
7. Add up all of the profits again, and compare the "welfare" between the two situations.

3.2.2 Questions

1. What is the expected return for "bad" start-ups? For "good" start-ups?

2. Did welfare improve when banks could tell "bad" from "good"?

3. What "loss to society" results when banks cannot tell "bad" from "good"?

4. What interest rate would the banks have to charge to "bad" start-ups to break-even on average?

5. What interest rate would the banks have to charge "good" start-ups to break-even on average?

6. How can banks try to solve or lessen the problems that arise from asymmetric information?