Econ 580, Lecture Notes 2

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Question: where do cross-country differences in Y/N come from?

Fundamental determinants are "institutions," or geography, and perhaps even policies

What are the mechanism through which these elements affect labor participation rates (L/N) and productivity (Y/L)?

Most of the variance of Y/N is due to variance in $y = Y/L$, so it makes sense to focus on productivity differences

Two main candidates: capital (broadly speaking) or TFP (efficiency, technology)

Romer talks of "object gaps" vs "idea gaps

If $Y = TFP \cdot K^{\alpha} L^{1-\alpha}$, then one could in principle just do a variance decomposition analysis for $y = TFP \cdot (K/L)^{\alpha}$

But note that some of the variation in K/L may be due to the variation in TFP

This is because $r = TFP \cdot \alpha(K/L)^{\alpha-1}$ implies

$$K/L = (\alpha TFP/r)^{1/(1-\alpha)}$$

A better decomposition takes this endogeneity of K/L into account

Note that $r = \alpha Y/K$, so $k \equiv K/Y = \alpha/r$ is not affected by TFP

We can write $1 = TFP \cdot (K/Y)^{\alpha}(L/Y)^{1-\alpha}$, or $y = TFP^{1/(1-\alpha)}k^{\alpha/(1-\alpha)} \equiv AX$

Note: with A we write the p.f. as $Y = K^{\alpha}(AL)^{1-\alpha}$ rather than $Y = TFP \cdot K^{\alpha}L^{1-\alpha}$

Note: this decomposition doesn't allow K investment to affect A... we will come back to this!

Can differences in X explain large differences in y across countries?

The problem is that $\alpha \approx 1/3$, so $\alpha/(1-\alpha) = 1/2$. A factor of 10 difference in y requires a factor of 100 difference in K/Y. Is this consistent with the data?

Data from the PWT (WDI), at market exchange rates, CR GDP/cap = \$4k, whereas at international dollars it is \$8k, whereas US is the same (normalization)

Other countries: Honduras (\$1k, \$3k), Jamaica (\$3k, \$3.5k), China (\$1k, \$4k)

K constructed by accumulating I,

$$K_{t+1} = I_t + (1 - \delta)K_t$$

Initial K can be constructed by assuming that countries are in steady state in 1960, so that $K_{1960} = Y_{1960} \cdot k_{1960}$, with

$$k_{1960} = \frac{I/Y}{\delta + g + n}$$

Here I/Y, g and n can be calculated for each country according to $1960 - 70$, but there are other ways...

How much of the cross-country variation in y is "ac-counted for" by the variation in k and how much by the variation in A?

Starting from $y = Ak$, then $\ln y = \ln A + \ln X$, so

$$\begin{aligned} \frac{var \ln y}{var \ln y} &= \frac{cov(\ln y, \ln A + \ln X)}{var \ln y} \\ &= \frac{cov(\ln y, \ln A) + cov(\ln y, \ln X)}{var \ln y} \end{aligned}$$

hence

$$1 = \frac{cov(\ln y, \ln A)}{var \ln y} + \frac{cov(\ln y, \ln X)}{var \ln y} = \widehat{\beta}_A + \widehat{\beta}_k$$

where $\widehat{\beta}_A$ ($\widehat{\beta}_k$) is the coefficient of the OLS regression of $\ln A$ on $\ln y$ ($\ln k$)

Note: this is simply a variance decomposition when the covariance between $\ln A$ and $\ln k$ is shared equally between A and k,

$$var \ln y = var \ln A + var \ln k + 2cov(\ln A, \ln X)$$

$$1 = \frac{var \ln A + cov(\ln A, \ln X)}{var \ln y} + \frac{var \ln k + cov(\ln A, \ln X)}{var \ln y}$$

$$1 = \frac{cov(\ln y, \ln A)}{var \ln y} + \frac{cov(\ln y, \ln X)}{var \ln y}$$

Homework: go to klenow.com, download the Appendix for KRC ("The Neoclassical Revival...") and do this decomposition. Also graph $k^{1/2}$ and $A = y/k^{1/2}$ against y

Perhaps k is badly measured. Another approach is to think of A as being common, and then back out k so that $y_i = Ak_i^{1/2}$

But then k would need to vary a lot, generating large differences in $r_i = \alpha/k_i$... problematic implications for capital flows and convergence (homework: think of these implications)

For the NGT to be a good empirical theory, we need an α on the order of 2/3

In this case $\alpha/(1-\alpha) = 2$, so factor of 10 differences in y require only factor of around 3 differences in k

But how to get α up to 2/3? Human capital!

MRW use $Y = K^{\alpha}H^{\beta}(AL)^{1-\alpha-\beta}$ with K and H "produced" in the same way as Y,

$$Y = C + I_K + I_H$$

with

$$K_{t+1} = I_{K,t} + (1-\delta)K_t \quad \text{and} \quad H_{t+1} = I_{H,t} + (1-\delta)H_t$$

We can think of this also as

$$\begin{aligned} C &= K_C^{\alpha} H_C^{\beta} (AL_C)^{1-\alpha-\beta} \\ I_K &= K_K^{\alpha} H_K^{\beta} (AL_K)^{1-\alpha-\beta} \\ I_H &= K_H^{\alpha} H_H^{\beta} (AL_H)^{1-\alpha-\beta} \end{aligned}$$

Note also that

$$\begin{aligned} \frac{I_K}{Y} &= \frac{K_K}{K} = \frac{H_K}{H} = \frac{L_K}{L} \\ \frac{I_H}{Y} &= \frac{K_H}{K} = \frac{H_H}{H} = \frac{L_H}{L} \end{aligned}$$

We again have $y = AX$, but now

$$X = (K/Y)^{\alpha/(1-\alpha-\beta)} (H/Y)^{\beta/(1-\alpha-\beta)}$$

In steady state, where A grows at g and Y, K, H all grow at $g + n$ (with k and H/Y constant) we have

$$k = \frac{I_K/Y}{g + n + \delta} \text{ and } H/Y = \frac{I_H/Y}{g + n + \delta}$$

Note treatment of quality (important later on): higher A, H/Y or K/Y implies a higher H given L_H/L

Using the standard measure of I_K/Y, and using the approximation

$$\frac{I_H}{Y} = \frac{L_H}{L} \approx (\text{sec enroll rate}) \cdot \left[\frac{\text{pop 12-17}}{\text{pop 15-64}}\right]$$

MRW estimate α and β by running an OLS regression of

$$\ln y_i = a + \frac{\alpha}{1-\alpha-\beta} \ln(I_K/Y)_i + \frac{\beta}{1-\alpha-\beta} \ln(I_H/Y)_i + \varepsilon_i$$

They find $\alpha = 0.3$, $\beta = 0.28$ and $R^2 = 0.78$

Table 1 THE ROLES OF A AND X IN 1985 PROSPERITY[a]

Source[a]	$cov[\ln(Y/L), \ln(Z)]/var \ln(Y/L)$			
	$Z = \left(\frac{K_Y}{Y}\right)^{\frac{\alpha}{1-\alpha-\beta}}$	$Z = \left(\frac{H_Y}{Y}\right)^{\frac{\beta}{1-\alpha-\beta}}$	$Z = X$	$Z = A$
MRW0	29	49	78	22
MRW1	.27	49	76	.24
MRW2	31	47	78	.22
MRW3	.29	11	40	60
MRW4	29	04	33	67

[a]MRW0 from MRW (uses their data appendix) MRW1 MRW0 but with K_Y/Y instead of K/Y MRW2 MRW1 but with L = worker instead of working-age population, 14 countries in/out MRW3 MRW2 but with all enrollment rather than just secondary enrollment MRW4 MRW3 but with (K, H, L) shares of (0 1, 0 4, 0 5), not (0 20, 0 28, 0 42), in H production

What about correlation between investment rates and TFP?

Not clear how to think of β

Better to use independent measures of α and β... $\alpha = 0.3$ is fine, not clear about β

There is a better way to incorporate human capital (below), but use $\alpha = 0.3$, $\beta = 0.28$ for now

MRW1 - measured output is not $C + I_K + I_H$... part of I_H goes unmeasured (value of student's time)

Assume that in fact measured Y is simply $C + I_K$. Then what matters for explaining Y/L is not K/Y and H/Y but rather K_Y/Y and H_Y/Y, where $K_Y \equiv K_C + K_K$ and $H_Y = H_C + H_K$.

In KRC we measure $K_Y = (1 - L_H/L)K$ and $H_Y = (1 - L_H/L)H$

MRW2 - better data

MRW3 - overall enrollment rates,

$$\frac{I_H}{Y} = \frac{L_H}{L} = (\text{enroll rate}) \cdot \left[\frac{\text{pop 7-19}}{\text{pop 15-64}}\right]$$

MRW4 - human capital accumulation is less capital intensive than the production of C and I_K,

$$I_H = K_H^{1-\phi-\lambda} H_H^{\phi} (AL_H)^{\lambda}$$

Evidence suggests that the physical capital share is 0.1 and the human capital share is 0.4 (i.e., $\lambda = 0.5$ and $\phi = 0.4$).

Two opposite effects on H_Y/Y: (1) higher L_H/L leads to more H_Y/Y than in MRW, but (2) higher K_Y/Y leads to less H_Y/Y. Empirically, this implies that H_Y/Y varies less

In sum, from 78% vs 22% decomposition in MRW1, to 33% to 67% decomposition in MRW4

Problem: if human capital investment equals schooling, then we cannot model human capital as some disembodied capital

Think of schooling as an investment of the first s years of finite lives (for now exogenous)

Differences in wages associated with differences in s tell us about the returns to schooling... no need for β: use $Y = K^{\alpha}(AH)^{1-\alpha}$ with $H = \int_{\Omega} h(s)dF(s)$

It is reasonable to assume that $h(s) = Bw(s)$ so that h is proportional to w... microeconomic research (Mincer regression) tells us that $w(s) \sim e^{\gamma s}$ –> each additional year of schooling increases an individual's wage by approximately the same percentage amount (Bils and Klenow, 2000)

We then have $y = AX$, with $X = k^{\alpha/(1-\alpha)}h$

Using $\phi = 0.095$ (BK), KRC find a decomposition of 34% vs 64% (BK4)

Note: KRC actually use $Y = K^{\alpha} H^{\beta} (AL)^{1-\alpha-\beta}$ with $\alpha = 0.3$ and $\beta = 0.28$... results don't change significantly (homework: check!)

Similar results in Hall and Jones (1999)

What about quality differences in schooling across countries?

Using

$$h(s) = (K_H/L_H)^{1-\phi-\lambda}\, h_T^{\phi} \left(Ae^{(\gamma/\lambda)s}\right)^{\lambda}$$

then

$$quality = (K_H/L_H)^{1-\phi-\lambda}\, h_T^{\phi} A^{\lambda}$$

With $\lambda = 0.5$ and $\phi = 0.4$, KRC find a decomposition of 56% vs 43% (BK2)

But this implies large differences in quality of schooling, with a "statistical elasticity" of quality w.r.t. y of 0.95%

Borjas (1987) uses wage data for immigrants in U.S. from different countries and finds an elasticity closer to 12%

A closer approximation to this world is to assume $\lambda = 1$ and $\phi = 0$ as in BK4

Relation to Hendricks (2002)