The future of growth

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Introduction to Economic Growth

Historical versus long-run

We've used data on historical growth, but that need not be the same as long-run growth.

- Historical growth includes lots of transitions
- Convergence via physical capital accumulation
- Catch-up growth via diffusion and adoption of technologies
- Transitory growth via changes in education, R&D, and energy use

What is the underlying long-run rate of growth from the sense of Romer/Schumpterian set-up?

Production

Let GDP per capita be determined by

$$y_t = \left(\frac{K_t}{Y_t} \right)^{\alpha/(1-\alpha)} A_t h_t \frac{L_t}{N_t},$$

so that the growth rate is

$$g_y = \frac{\alpha}{1-\alpha} g_{KY} + g_A + g_h + g_{LN}. \tag{1}$$

Long-run growth

		Long-Run Growth Estimates:		
Component	Historical (1)	Baseline (2)	Lower $\frac{\lambda}{1-\phi}$ (3)	$g_L = 0$ (4)
GDP per capita (g_y)	1.98%	0.43%	0.31%	$\approx$ 0%
Capital/output ($\frac{\alpha}{1-\alpha} g_{KY}$)	-0.15%	0%	0%	0%
Human capital (g_h)	0.55%	0%	0%	0%
Labor force (g_{LN})	0.25%	0%	0%	0%
Productivity (g_A)	1.32%	0.43%	0.31%	0%
Productivity breakdown:				
–Misallocation	0.30%	0%	0%	0%
–R&D intensity ($\frac{\lambda}{1-\phi} g_{sR}$)	0.63%	0%	0%	0%
–Population ($\frac{\lambda}{1-\phi} g_L$)	0.39%	0.39%	0.28%	$\approx$ 0%

Long-run growth

The underlying rate of growth is probably around 0.39% per year.

- Lots of productivity growth appears to be because of rising s_R
- Remember that population growth is the ultimate determinant, and it isn't that big?
- "Misallocation" here refers to improvements in allocations over time via changes in who's allowed to participate in economic activity

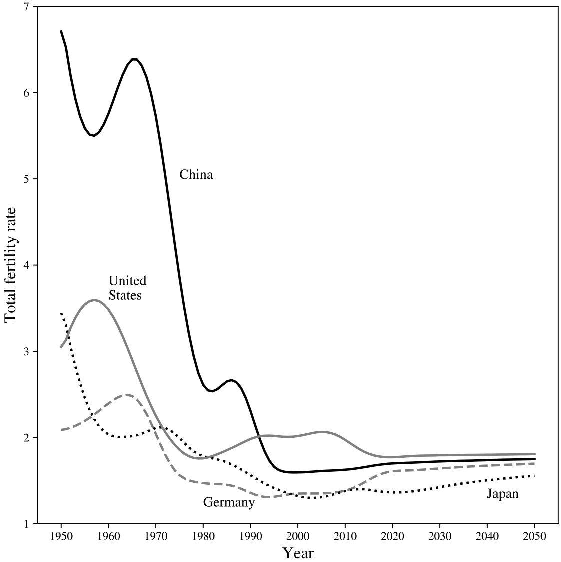
Most sources of growth could die out because they are inherently transitory. For example, you can't raise the labor force participation rate above 100%.

Slow population growth

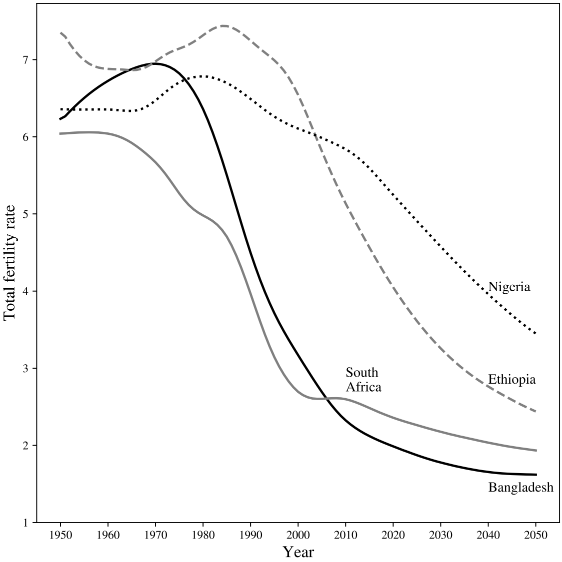
The last column considered what happens if $g_L \approx 0$.

- The Romer/Schumpeter models tell us $g_A \approx 0$ in this case
- The rate at which we increase ideas can't keep up with the size of the stock, A
- We innovate, but it becomes minor compared to the stock of ideas we already have

Demographic change



Demographic change



Negative population growth

What happens if population goes *down* worldwide? From Romer/Schumpeter we have

$$g_A = \theta \frac{s_R^\lambda L_0^\lambda e^{\lambda g_L t}}{A_t^{1-\phi}}.$$

and if $g_L < 0$

- $e^{\lambda g_L t} = 0$
- Innovation just *stops*
- New ideas flow so slowly we effectively stagnate

Demographic optimism

Even if overall population growth slows down or reverses, still have innovation?

- Vast majority of world does not engage in innovation
- Even if population doesn't grow, if you include several billion Africans and Asians in innovation networks, we add to R&D efforts for centuries
- The key is that we care about the number of R&D workers, which combines s_R and L
- There is scope to raise worldwide s_R from around zero to 2-3%

Automating production

Automation has been going on for centuries. New instances like AI may be just another example or a fundamental change. Consider

$$Y = AX_1^{1/n} X_2^{1/n} ... X_n^{1/n}.$$

as how we produce GDP.

- Different varieties, like Romer
- But we can produce each X using either capital or labor
- Let m tasks be done by capital, the other $n-m$ by labor

$$Y = AK^{m/n} L^{1-m/n}. \tag{2}$$

Automating production

With

$$Y = AK^{m/n}L^{1-m/n}. \tag{3}$$

we are changing the α term in the Solow/Romer. Note that the A here does *not* sit "inside" of any terms so

$$g_y^{ss} = \frac{g_A}{1 - m/n}. \tag{4}$$

The larger is m (the more automation) the higher is the growth rate, even given productivity growh.

Does this make sense?

If m goes up, this would imply that the share of GDP going to capital rises, but that doesn't appear to be the case in the long-run

- It could be that n is expanding (new varieties) just as fast as we automate (m rises)
- It could be that tasks are complements, and as m goes up the remaining tasks that labor does are more valuable.
- Examples are computers. Spreadsheets and programs can do all the tedious accounting work. There are more accountants with better pay now than in the past.

AI and innovation

A possibility is that we can (or have already) automated parts of the innovation process. Let

$$dA = \theta A^{\phi} X_1^{1/n} X_2^{1/n} ... X_n^{1/n}.$$

and we can assign R&D tasks to capital (computers, AI) or people

$$dA = \theta A^{\phi} K^{m/n} L_R^{1-m/n}.$$

and now

$$dA = \theta s_R^{1-m/n} \left(\frac{K}{AL} \right)^{m/n} A^{\phi + m/n} L,$$

AI and innovation

If we have

$$dA = \theta s_R^{1-m/n} \left(\frac{K}{AL} \right)^{m/n} A^{\phi + m/n} L,$$

then in steady state we could have

$$dA = \hat{\theta} A^{\phi + m/n} L, \tag{5}$$

where $\hat{\theta} = \theta s_R^{1-m/n} (K/AL)^{m/n}$ so that the growth rate is

$$g_A = \frac{1}{1 - \phi - m/n} g_L. \tag{6}$$

Singulatiry

Given

$$g_A = \frac{1}{1 - \phi - m/n} g_L. \tag{7}$$

then if $\phi \approx 0$

- If m/n goes up, this raises the growth rate.
- If $m/n \to 1$ the growth rate goes to infinity
- Automation feeds itself in this case and makes explosive growth possible

But probably not

However, we think that $\phi < 0$ in most cases

$$g_A = \frac{1}{1 - \phi - m/n} g_L. \tag{8}$$

and then

- If m/n goes up, this raises the growth rate.
- But even if $m/n \to 1$ the growth rate is pinned down
- If ideas get harder to find, they get harder to find even for computers (more processing, etc.)
- Even AI can't create explosive growth