## Lecture 6

# Economic Growth: Human Capital

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## Economic Growth and Economic Fluctuations

## Why Study Other Growth Models?

- **Because the Solow Model comes up short.**
- **Recall from Lecture 2 that in the Long-Run:**
  - **firms hire labor up to the point where the wage equals price times marginal product of labor (MPL):** $w = p \cdot MPL$
  - **firms hire capital up to the point where the rental rate on capital equals price times marginal product of capital (MPK):** $r = p \cdot MPK$
- **Next recall from Lecture 4, the production function that incorporates technological progress:**

$$Y = K^{\alpha} \cdot (AL)^{1-\alpha}$$

- **The MPL of this production function is:**

$$MPL = (1-\alpha) \cdot K^{\alpha} \cdot A^{1-\alpha} \cdot L^{-\alpha}$$

- **The MPK of this production function is:**

$$MPK = \alpha \cdot K^{\alpha-1} \cdot (AL)^{1-\alpha}$$

- **Finally, recall from Lecture 3, that if economic profit is zero, then:**

$$p \cdot Y = r \cdot K + w \cdot L$$

# Why Study Other Growth Models?

- **Now bring all three of those conditions together:**

$$p \cdot Y = r \cdot K + w \cdot L$$

$$p \cdot Y = p \cdot MPK \cdot K + p \cdot MPL \cdot L$$

$$Y = \alpha \cdot K^{\alpha-1} \cdot (AL)^{1-\alpha} \cdot K + (1-\alpha) \cdot K^{\alpha} \cdot A^{1-\alpha} \cdot L^{-\alpha} \cdot L$$

$$Y = \alpha \cdot Y + (1-\alpha) \cdot Y$$

- **This implies that:**
  - **Capital's share of national income is equal to $\alpha$ and**
  - **Labor's share of national income is equal to $(1-\alpha)$**
- **In practice, we know that capital's share of national income is roughly constant across countries and approximately one-third, i.e. $\alpha \approx 1/3$**
- **Next, consider two countries. According to the Penn World Tables, in 2000, real GDP per worker was $64,437 in the US and $1479 in Nigeria.**
- **Now if the US and Nigeria share the same technology and if differences in capital per worker explain differences in output per worker and if $\alpha \approx 1/3$, then capital per worker is 83,077 times higher in the US than it is in Nigeria.**
- **Does that look right to you? … I didn't think so.**

# What's wrong with the Solow Model?

- **The Solow Model that we examined in the previous lecture assumes that output is produced using:**
  - **physical capital** (i.e. machinery, buildings, etc.)
  - **human labor**
- In an extension of that model, we also incorporated technological progress
- **If we were to use the Solow Model to examine levels of output across countries, then we would have to assume that there are no difference in human labor across countries** (i.e. that human labor is homogenous)
- **Is that assumption realistic? No.**
- **If you ever work with a poorly educated person, you'll notice that they're much less productive than you are.**
- **When a complication arises in the task that they are performing, they don't know what to do and often make bad decisions.**
- **Models of economic growth that incorporate "Human Capital" attempt to examine differences in education levels.**

# What is Human Capital?

- **The Solow Model that we examined in the previous lecture assumes that the Marginal Product of Labor is positive.**
- **But what would be the marginal product of a person without any child-rearing or education at all?** (i.e. someone who was "raised by wolves").
- **It would be virtually zero.**
- **In this sense, all of the returns to human labor must reflect returns to human capital.**

- **If we assume that there is some minimum level of human capital that human beings acquire more or less automatically** (e.g. the ability to walk and talk, etc.)**, then:**
  - **we can interpret this minimum level as the input of "raw labor"**
  - **and separately examine differences in output levels that occur because some societies have higher average levels of human capital than others**

# the Mankiw-Romer-Weil Model

- **In 1992, N. Gregory Mankiw, David Romer and David N. Weil published a variant of the Solow Model that better explains cross-country differences in GDP per worker.**
- **In particular, they explored the relationship between cross-country differences in human capital per worker and cross-country differences in output per worker.**
- **Like Solow, they divide output among consumption and investment:**

$$Y = C + I$$

- **but they further divide investment into investment in physical capital and investment in human capital:**

$$I = I_K + I_H$$

- **and they assume that output is produced using physical capital,** $K$**, human capital,** $H$**, and effective labor,** $AL$

$$Y = K^{\alpha} \cdot H^{\beta} \cdot (AL)^{1-\alpha-\beta} \qquad \text{where: } \begin{matrix} 0 < \alpha < 1 & 0 < \beta < 1 \\ 0 < \alpha + \beta < 1 \end{matrix}$$

# Physical and Human Capital

- **The underlying theory behind the Mankiw-Romer-Weil Model:**
  - **countries with higher levels of:**
- **technology,**
- **physical capital per worker and**
- **human capital per worker**
  - **have higher levels of output per worker.**

- **If their theory is correct, then all we have to do to increase output per worker – and lift billions of people out of poverty – is:**
  - **provide them with technological "know-how"**
  - **increase the amount of physical capital they have to work with and**
  - **provide them with more schooling – to increase their levels of human capital**

# MRW Steady State

- **In the Mankiw-Romer-Weil Model, the economy must converge to a steady state where:**
  - **physical capital per unit of effective labor is constant over time**
  - **human capital per unit of effective labor is constant over time**

- **For example, imagine a country devastated by war and emigration:**
  - **its physical capital stock was destroyed by bombing campaigns**
  - **its human capital stock was depleted by the emigration of its best and brightest to America**
- **Is the country now doomed to perpetual poverty? No.**

- **If the economy devotes a large share of its** (substantially reduced) **output to investment in new physical and human capital, then:**
  - **over time it will replace its lost physical capital stock**
  - **over time it will replace its lost human capital stock**
  - **over time it will converge to a higher steady state level of output per unit of effective labor**

- **This is an incredibly optimistic model!**
- **All a country needs is high saving rates!**

# MRW Steady State

- **Now, imagine a very rich country:**
  - **it has so many factories and machines that its physical capital stock** (per unit of effective labor) **is the highest in the world**
  - **it boasts the best universities in the world and its human capital stock** (per unit of effective labor) **is also the highest in the world**
- **Will this country always be the richest in the world? Not necessarily.**
- **If the residents of this country suddenly become decadent and consume all of their output and stop investing new physical and human capital, then over time:**
  - **its physical capital stock** (per unit of effective labor) **will diminish**
  - **its human capital stock** (per unit of effective labor) **will diminish**
  - **over time it will converge to a lower steady state level of output per unit of effective labor**

**"Lazy hands make a man poor, but diligent hands bring wealth."**
**– Proverbs 10:4**

# So what do we want?

- **If we want our economy's living standards to be higher, then we want:**
  - **a higher physical capital saving rate,** $s_K$
  - **a higher human capital saving rate,** $s_H$
  - **a lower rate of physical and human capital depreciation,** $\delta$
  - **a lower labor force growth rate,** $n$
  - **a HIGHER rate of technological progress,** $g$
- All of these should be intuitive, although the last "want" – a higher rate of technological progress – can be confusing.
- After all, doesn't a higher rate of technological progress reduce the steady state level of output per unit of effective labor? Yes, but …
  - A person doesn't consume output per unit of effective labor
  - A person consumes output per worker
- Recall from Lecture 4 that when we incorporate technological progress into the model the steady state growth rate of output per worker is equal to the rate of growth of technological progress.
- **A faster rate of growth of technological progress implies a rapidly rising standard of living for the residents of that economy**