Macroeconomics: Economic Growth (Licence 3)
Lesson 10: Population and Institutions

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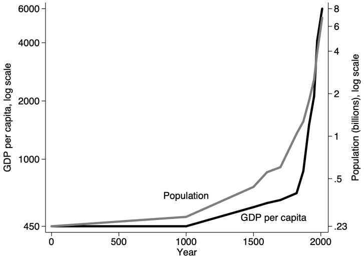
Population

Lesson 10:

- We've seen conflicting effects of population:
  - (1) **Negative in the Solow model:** more people means spreading capital across more workers;
  - (2) **Positive in the Romer/Schumpeter model:** more people means more ideas/innovations.
  - Can add another possible negative effect. Malthusian effects occur when there is a fixed/limited resource (e.g. land) and then more people lowers living standards.
  - While Malthusian effects appear to be true, **overall the positive effect of population** wins over the long run.

Schumpeterian model



- Malthusian Era (1 million BC to 1800-ish AD)
  - Low population growth rates: 0.02-0.27% per year
  - Low y growth rates: 0-0.14% per year
- Post-Malthusian Era (1800-ish AD to 1920-ish AD)
  - Both population and y accelerate
- Modern Growth Era (1920-ish AD to now)
  - Population growth rates: falling below 0.5% per year
  - y growth rates: approaching long-run trend of 1.85% per year

Population

Malthusian Economy

- Production now includes a fixed factor, X (land that replaces capital stock)

$$Y = BX^{\beta}L^{1-\beta} \quad (1)$$

- where B is a measure of productivity. Output per worker is

$$y = B\left(\frac{X}{L}\right)^{\beta} \quad (2)$$

- Note that output per worker depends negatively on L - this is the Malthusian effect
- Malthusian effect: higher L (higher Y) but lower y: given the fixed factor (land), more people are working, lower is the per capita output

Population

Malthusian Economy

- **Population growth is now endogenous** - determined inside the model

$$\frac{\dot{L}}{L} = \theta(y - \underline{c}) \tag{3}$$

- where $\underline{c}$ is the **subsistence level of consumption**.
- Note that $\frac{\dot{L}}{L}$ can be negative for relatively low level of y.
- Think of food
  - If food (y) is lower than the quantity of food at the subsistence level ($\underline{c}$), the survival rates of children cannot be enough to replace their parents (thus population declines)

Population

Malthusian Economy

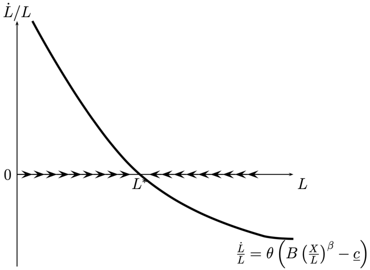
- Substitute the production function of income per capita in the eq. for population growth

$$\frac{\dot{L}}{L} = \theta \left(B \left(\frac{X}{L} \right)^{\beta} - \underline{c} \right) \qquad (4)$$

- The growth rate of population negatively depends on the size of population

- If population increases (L), income per capita, y, decreases and the population growth rate decreases (and it can become negative)

Malthusian Economy



- If population decreases (L), income per capita, *y*, increases and the population growth rate increases
- $L*$ is the long run steady state in the Malthusian Economy since population growth is zero and population size can be sustained.
- If $L < L*$, $\frac{\dot{L}}{L} > 0$ population size grows till $L*$.
- If $L > L*$, $\frac{\dot{L}}{L} < 0$ population size is shrinking till $L*$.

Population

Malthusian Equilibrium

- In steady state, we have that $\frac{\dot{L}}{L} = \theta\left(B\left(\frac{X}{L}\right)^{\beta} - \underline{c}\right) = 0$ and solving for L^*, we have:

$$L^* = \left(\frac{B}{\underline{c}}\right)^{1/\beta} X \tag{5}$$

- **Implications of Malthusian Equilibrium:**
  - Larger ressources (land areas, higher X) can sustain larger population (higher L)
  - Higher technology (productivity, higher B) can sustain larger population (given the same area of land, because it makes the land more productive)
  - Higher subsistence requirements, less population can be sustained (given the same X and B)

Population

Malthusian Equilibrium

- Plugging the steady state endogenous Population $L^* = \left(\frac{B}{\underline{c}}\right)^{1/\beta} X$ into the income per capita equation $y = B\left(\frac{X}{L}\right)^{\beta}$, we get that:

$$y^* = \underline{c}. \tag{6}$$

- Any productivity or ressources increase gets translated into higher populations, not higher living standards.

- **The Malthusian mechanism at work can be summarize as follows:**
  - If $y > c$ there is positive growth in population and, given fixed X (and B), a larger L induces a lower y,
  - If the economy has higher living standards, fertility rates (and survival rates) increase, but the larger population eats out this prosperity (driving y back to y^*)
  - This is the reaction Malthus described in 1978

Population

Malthusian Equilibrium

- Any exogenous decline in population (L drops) will temporarily raise living standards (the remain people had access to more resosurces)

- Eventually population will growth lowering living standards (due to fixed amount of ressources).

E.G. Black Death in Europe, 14th-15th century

- England: population falls from 3.75 million to 2 million, real wage doubles
- Italy: population falls from 10 million to 7 million, real wage up by 2.5 times

By 1500 both had wages back to pre-Black Death levels, and populations back at prior levels

Population

Malthusian Equilibrium

- The malthusian model is used to describe how living standard could remain constant over long periods of time
- Key factors to explain this result are the **fixed land and the positive relationship between income and population growth** $\rightarrow$
- However stagnation is not observed in the data for the whole history; in the post Malthusian and Modern era:
  - Population has increased exponentially
  - And income per capita and living standards show positive growth rates
- To allow for these increases we need to incorporate technological change

Technological change in malthusian model

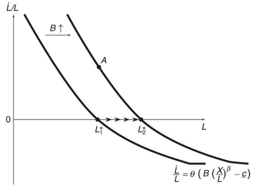
Technological change

- One time shift in technology (B) for a fixed amount of land (X):

$$y = B\left(\frac{X}{L}\right)^{\beta} \tag{7}$$

$$\frac{\dot{L}}{L} = \theta\left(B\left(\frac{X}{L}\right)^{\beta} - \underline{c}\right) \tag{8}$$

Technological change in malthusian model



- In the short run, an increase in B increases income and so population growth rates for a given level of population
- As L increases income starts to decrease and so the population growth rates
- a one-time increase in B leads to larger population size from L1 to L2
- But does not affect income per capita in the steady state. Why?
- This matches quite well the Malthusian era data as we observe stagnant y, low growth rates of population, but at the same time population size grew over long period of time

Continuous Technological Change

Continuous Technological Change

- Rather than an exogenous shock of technology
- One can consider continual constant growth of B

Continuous Technological Change

Take the logs and derivative relative to time of production function

- Since X is fixed, $\frac{\dot{X}}{X} = 0$ the dynamics of income is

$$y = B\left(\frac{X}{L}\right)^{\beta} \tag{9}$$

to get

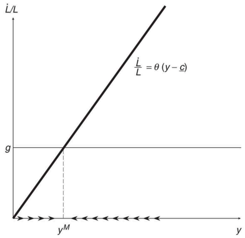
$$\frac{\dot{y}}{y} = \frac{\dot{B}}{B} - \beta\frac{\dot{L}}{L} \tag{10}$$

and let $g = (1/\beta)\dot{B}/B$ for convenience.Then

- If $\dot{L}/L < g$, output per worker is rising $\frac{\dot{y}}{y} > 0$
- If $\dot{L}/L > g$, output per worker is falling $\frac{\dot{y}}{y} < 0$
- If $\dot{L}/L = g$, output per worker is constant $\frac{\dot{y}}{y} = 0$

Continuous Technological Change

FIGURE 8.4 DYNAMICS OF INCOME PER CAPITA WITH CONSTANT $\dot{B}/B$



- $\dot{L}/L = g$, output per worker is constant $\frac{\dot{y}}{y} = 0$
- At the point of intersection y_M of the Malthusian steady state
- If $y < y_M$, then $\dot{L}/L < g$ and $\frac{\dot{y}}{y} > 0$
- If $y > y_M$, then $\dot{L}/L > g$ and $\frac{\dot{y}}{y} < 0$
- What happens if technology growth increases?

Continuous Technological Change

- What happens if technology growth increases?
- The steady state level of income per capita increases
- However, in the Malthusian model constant technology growth **does not lead to sustained growth in income per capita**
- But it leads to sustain growth in population size
- Since in the steady state: $\dot{L}/L = g > 0$, output per worker is constant $\frac{\dot{y}}{y} = 0$, so number of people is increasing in the steady state.
- As long as there is technological progress, population will grow
- Malthusian model: growing population but stagnant income per capita

Endogenous Technology

- **With constant technological progress at g**
  - Population size grows continuously (matching Malthusian era data)
  - Steady state output per worker is stagnant (matching Malthusian era data)
  - **But where does g come from?**
  - We can introduce endogenous technological progress

Endogenous Technology

- **Endogenous growth theory**

$$\frac{\dot{B}}{B} = \nu \frac{s_R L^{\lambda}}{B^{1-\phi}} \tag{11}$$

- which is just like our endogenous model from before. But focus on non-steady state behavior.

- If L is very small compared to B, then as L goes up, $\dot{B}/B$ goes up. So the more people, the faster is technological progress. Scale effects.

- $\frac{\dot{B}}{B}$ will raise as long as $\lambda \frac{\dot{L}}{L} > (1-\phi)\frac{\dot{B}}{B}$, this holds for small ratios of L to B.

- Higher $\frac{\dot{B}}{B}$ leads to higher $\frac{\dot{L}}{L} = n$ which in this endogenous technology models determines increases in technological growth leading to a virtuous cycle as in modern growth era.

Kremer (1993) Model

- This is the reasoning behind the work of **Kremer (1993)**:

- The model tries to explain the **relationship between population growth and population size over the history**
- Simplify endogenous technology by setting $\lambda = 1$ and $\phi = 1$
- Assume $s_R = 1$ (for simplicity; i.e. all the population participates to research activities)

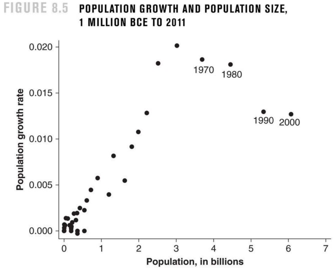
$$\frac{\dot{B}}{B} = \nu \frac{s_R L^{\lambda}}{B^{1-\phi}} = \nu L \tag{12}$$

and combine with the steady state condition that $\dot{L}/L = g = 1/\beta(\dot{B}/B)$ gives us

$$\frac{\dot{L}}{L} = \frac{\nu}{\beta} L \tag{13}$$

- Implication is that the growth rate of population (which depends on technological growth) is positively related to the *size* of the population (which drives technological growth).

Kremer (1993) Model



- The predictions of Kremer can be tested with data and it seems to hold until the second half of 20 century;
- The growth rate of popuation (which depends on technological growth) is positively related to the *size* of the population
- Note that the standard Malthusian economy without endogenous technological change can not match the data

Kremer (1993) Model

- **Kremer model works for most of history. However,**:
  - The positive relationship between population size and population growth rates breaks down in the second half of the 20th century
  - We need to adapt the model to capture the endogenous response to population to higher output per worker that ensures world ends up with constant technological change (as in endogenous growth models)
- This is done introducing a more refined function of population growth, where population growth does not continuously increase with income

Institutions and Growth

- **Solow model**: investment rates main driver of economic growth
- **Endogenous growth models**: skill accumulation (learning) as key driver of growth.
- The key questions are:
  - Why do countries differ in their investment rates?
  - And why do countries differ in their investments in human capital and their learning abilities?
  - What determines the adoption/ discovery of new technologies and the level of investment in innovation?
- **Role of institutions:** government policies and Social infrastructure.

Institutions and Growth

- Countries with **better institutions, secure property rights and less distortionary policies:**
  - Those countries will invest more in both physical and human capital because
  - they can make long run investments as the rules will not likely change arbitrarily
- Examples: South and North Korea, or West and East Germany

Institutions and Growth

- The mechanisms leading a country to invest in both physical capital and in technology are similar to those leading a company to undertake an **investment project**
- A firm will undertake an investment project if its present discounted value of the profits Φ associated to such investment is greater than the fixed set-up costs (F)
  - If $\Pi > F$ the firm invest
  - If $\Pi < F$ then do not invest
- The key question is what determines Π and F?

Institutions and Growth

- **Determinants of F**
- **Costs of set-up a business: regulations, corruption, risk of expropriation**
  - Hernando de Soto (1989) found that in Peru the cost of starting a small business was about 32 times the monthly minimum living wage
  - Huge differences in such costs between advanced (where they are often minor) and developing countries
- "To invest in a Russian company, a foreigner must bribe every agency involved in foreign investment, including the foreign investment office, the relevant industrial ministry, the finance ministry, the executive branch of the local government, the legislative branch, the central bank, the state property bureau, and so on. The obvious result is that foreigners do not invest in Russia. Such competing bureaucracies, each of which can stop a project from proceeding, hamper investment and growth around the world, but especially in countries with weak governments." (Shleifer and Vishny 1993)

Institutions and Growth

- **Determinants of F**
- **Costs of set-up a business: regulations, corruption, risk of expropriation**
    - License fees
    - Bribes
    - Protection money
    - Rights to market in some area
    - Taxes

Institutions and Growth

- **Determinants of F**

- World Bank collects data on how long it takes to set up businesses, and cost in terms of licenses, fees, etc..
  - U.S.: six days and equivalent 1.4% of average income
  - India: 29 days and equivalent 50% of average income
  - Nigeria: 34 days and equivalent 70% of average income
  - Honduras: 14 days and equivalent 63% of average income

- It is not trivial to start new firms, invest in new equipment, adopt a new technology in most poor countries.

Institutions and Growth

- **Determinants of profits Π**
- Institutions also affect the scale of profits.
  - Larger markets (more L) means more profits
  - Barriers to trade limit market sizes, reduce profits
  - Lower profits means less innovation
- Rich places:
  - U.S.: Can sell in any state with minimal or no additional requirements
  - E.U.: Joins many small countries together into one big market

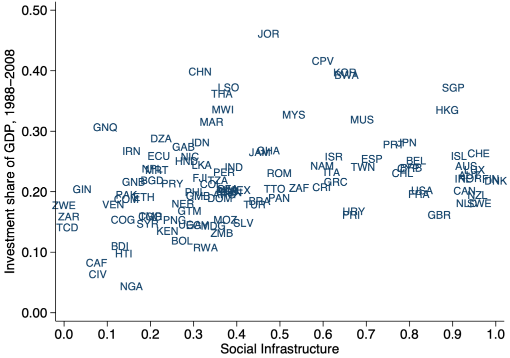
Institutions and Growth

- How do you measure institutions?
  - You don't, not directly
  - Surveys of business conditions
  - Evaluations by agencies of costs of doing business
  - Very rough rankings of countries

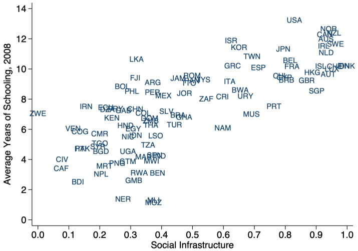
Institutions and Growth

- How do you measure institutions?
- We use a measure of **"social infrastructure"** that captures six dimensions of governance from the World Bank
  - Accountability of politicians
  - Political stability
  - Government effectiveness
  - Regulatory quality
  - Rule of law
  - Control of corruption
- Overall index runs from 0 (worst) to 1 (best)
- Interesting statistics on the institutional barriers to growth are available at the country-levels on:
- http://www.doingbusiness.org/data

Investment in capital and institutions

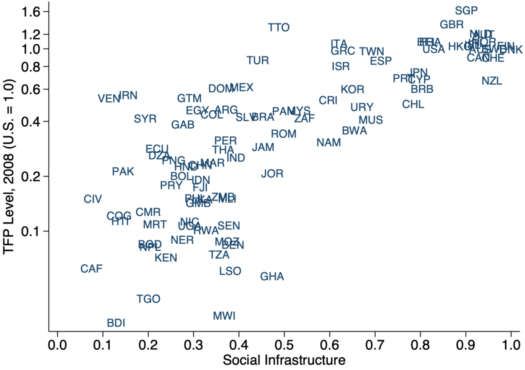


Human capital and institutions



- The effect of social infrastructure on skill accumulation seems to be even stronger than the effect found for physical investments

TFP and institutions



Social infrastructure and TFP

- A key issue is whether social infrastructure affects TFP differences across countries, i.e. the different efficiency in using physical and human capital input
- Including social infrastructure as a factor determining TFP, we could re-write the production function as

$$Y = K^{\alpha}(hI)^{1-\alpha} \tag{14}$$

- with **I denoting the impact of social infrastructure** on the productivity of inputs
- With this specification, two economies with the same K, h, may still have different Y,
- because of **differences in the economic environment where they produce**
- social infrastructure is likely to influence the (mis)allocation of resources (and productivity)

Social infrastructure and TFP

- Having identified a sizable effect of social infrastructure on per capita income growth, the key question is why countries have so different social infrastructures?
- Hard question
- Historical factors and political economy factors