Development Economics

Lecture 4: Population Growth and Development

Professor Anant Nyshadham
EC 2273

This lecture

1. Malthus models of population growth
    1. Move step by step though building a model in economics (including some back-steps!)
2. Does Malthus fit observed facts
    1. Yes, and no
3. Population and development

The Dismal Science

- Economics got its nickname from Thomas Malthus because of his gloomy predictions
- 1798 Essay on the Principal of Population
  - Population grows at an exponential rate, unless checked by limited food supplies
  - Some factor of production (land) is in fixed supply, and marginal returns to additional labor are diminishing.
  - As population grows, land becomes more and more scarce, so the marginal product of each person declines, so population driven to subsistence.
- Technology improvements create not better living standards, but a higher population.

Building a model

- Start with observation:
  - Population grows at an exponential rate
    - Fits bacteria in a Petri dish pretty well (at least initially)
- Express observation in a formula.
- Check whether implications of observation are consistent with the world
- If not, modify model
- If yes, does model help explain other important factors?

Building a model

- Exponential increase in population?

Initial population P_0

Population at P_1

$$P_1 = P_0 + g\,P_0 = (1+g)\,P_0$$

$$P_t = (1+g)^t\,P_0$$, where g is growth rate

Predictions: if $g > 0$ and $P_0 > 0$,

then as t gets large, P gets large

Only stable population $g = 0$ or $P_0 = 0$

Building a model

- Population until 1800 did not seem to increase without bound (and even now does not)
- Something must limit population growth—Build a better model
- Malthus big idea: Perhaps g is not constant but varies with available food

Building a model

- How should g vary?.... g(Y/P)

Pop growth depends on income per person (Y/P)

expect g(Y/P) to be high with large Y/P

low with low Y/P

One way to write: $g(Y/P) = a\ Y/P$ (linear)

When will population be stable i.e., $P_{t+1} = P_t$

$P_{t+1} = (1+g(Y/P))\ P_t \quad \rightarrow \quad P_{t+1} = P_t + g(Y/P)\ P_t$

… so only stable when Y/P=0

... reasonable?

Building a model

- Other possible ways to model g(Y/P)

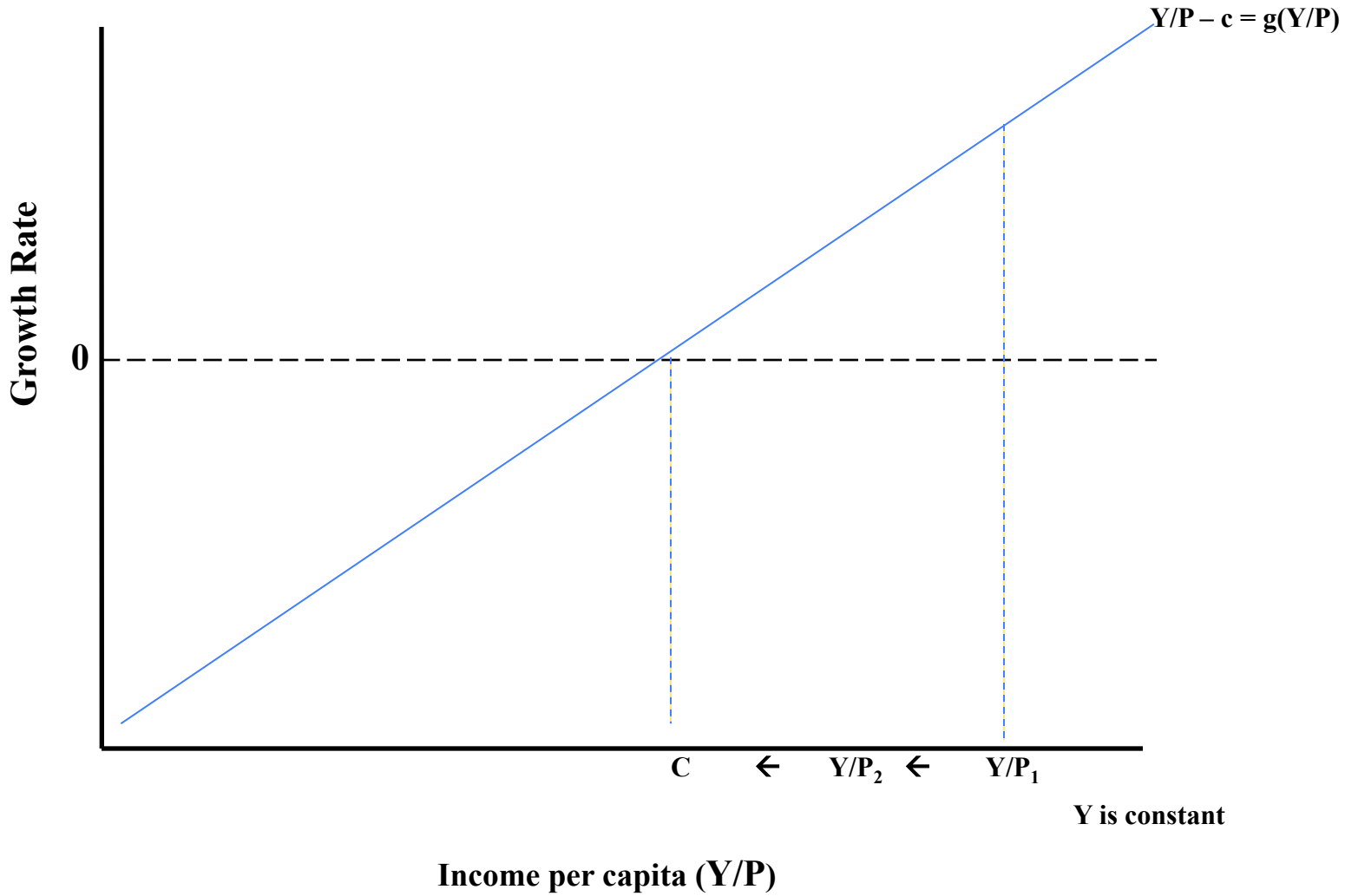
$$g(Y/P) = Y/P - c \qquad \text{(still linear)}$$

When is $g(Y/P) = 0$? When $Y/P = c$

when $Y/P > c$, $g(Y/P) > 0$

when $Y/P < c$, $g(Y/P) < 0$

Building a model



Building a model

- Where does Y come from?

  Production function

  combine population P and land T (terra)

  $Y = f(P,T)$, f describes how these combine

  expect Y to increase when increase P and/or T

  $df/dP > 0 \quad df/dT > 0$

Building a model

- Possible ways to model $Y=f(T, P)$

  $Y = T + P \rightarrow Y/P = T/P + 1$

  as P goes up Y/P falls

  Other functions $Y = T^{a}P^{1-a}$ (Cobb-Douglas)

  Most functions used in economics

  f(T,P)/P falls as P rises

Building a model

- Use math to understand implications of the model. How does P and Y/P change over time?

$$P_{t+1} = (1 + g(Y_t/P_t))\, P_t$$

$$Y_t/P_t = f(T,P_t)/P_t$$

So a stable population occurs when $g(f(T,P_t)/P_t) = 0$

Building a model

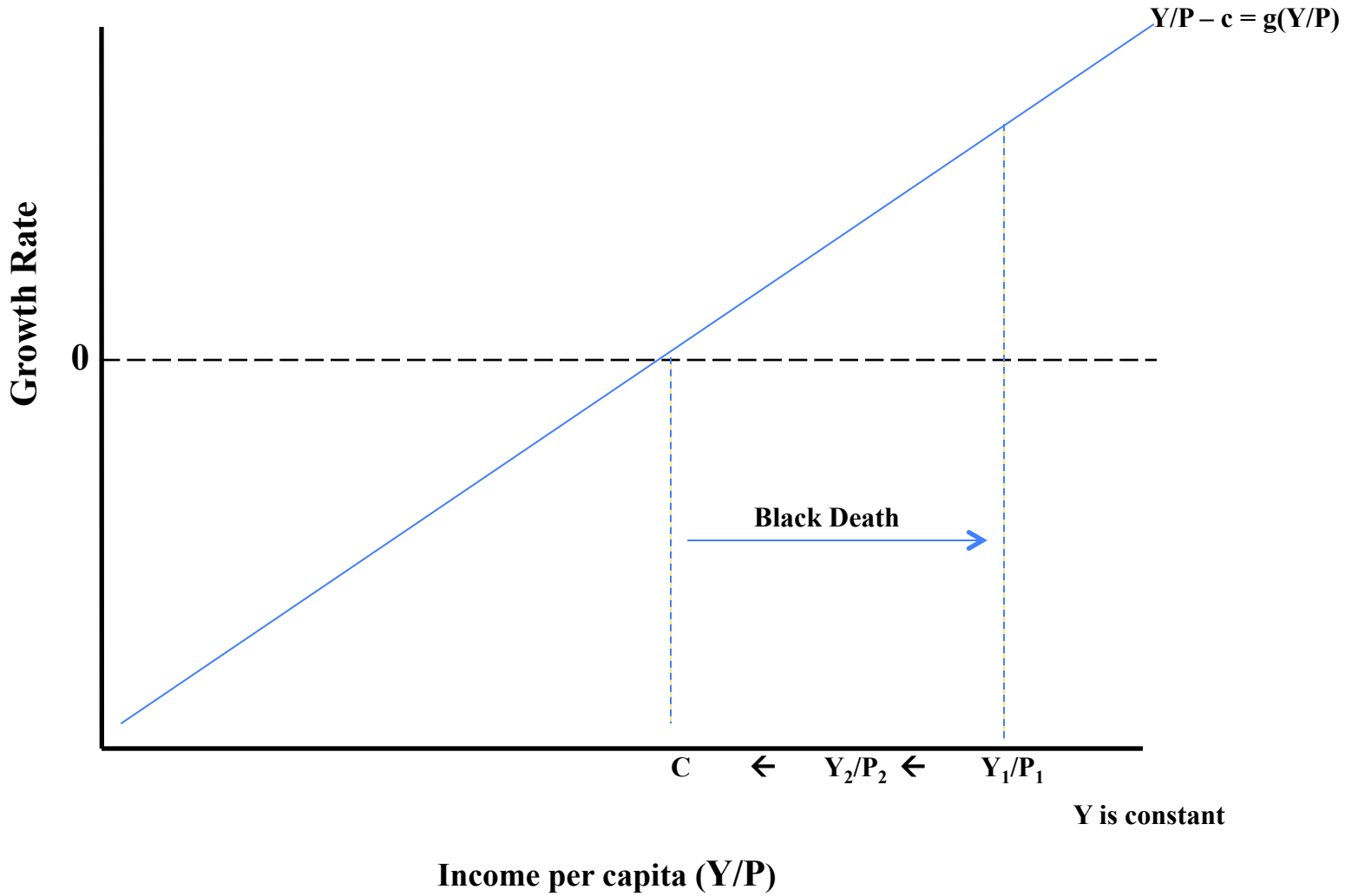
- How does P and Y/P change over time?

$$g(f(T,P_t)/P_t) = 0$$

$$g(Y/P) = Y_t/P_t - c = 0 \rightarrow Y/P = c$$

find $(T + P_t) / P_t = c \rightarrow$ stable population

Building a model



Building a model

- Model fits Malthus description:
  - Population grows at an exponential rate, unless checked by limited food supplies
  - Production (per person) diminishing with number of people (because of fixed supply of an input).
  - Population driven to subsistence.
- Stable population at subsistence.
- Seems to fit the world up until Malthus.

Building a model

- What happens when there is technological change?

Original: $Y/P = T/P + 1$ Improved: $Y/P = 2T/P + 1$

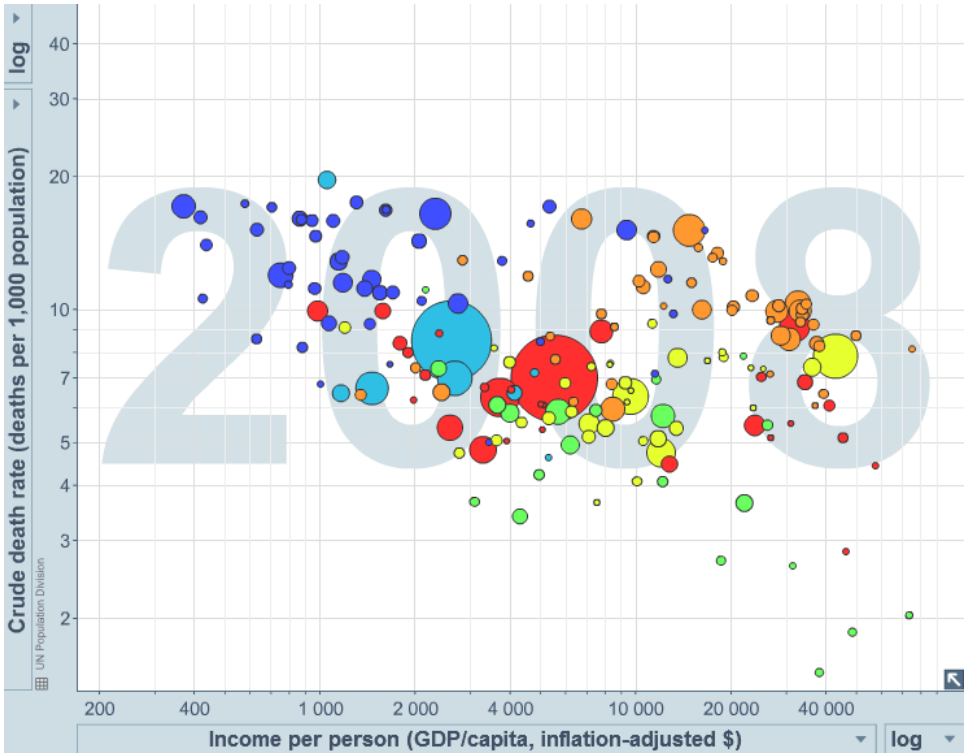
$g(Y/P) = Y/P - c \rightarrow$ stable population still when $Y/P = c$

Tech growth: leads in short term to increase Y/P

but long-term driven to c with a larger P

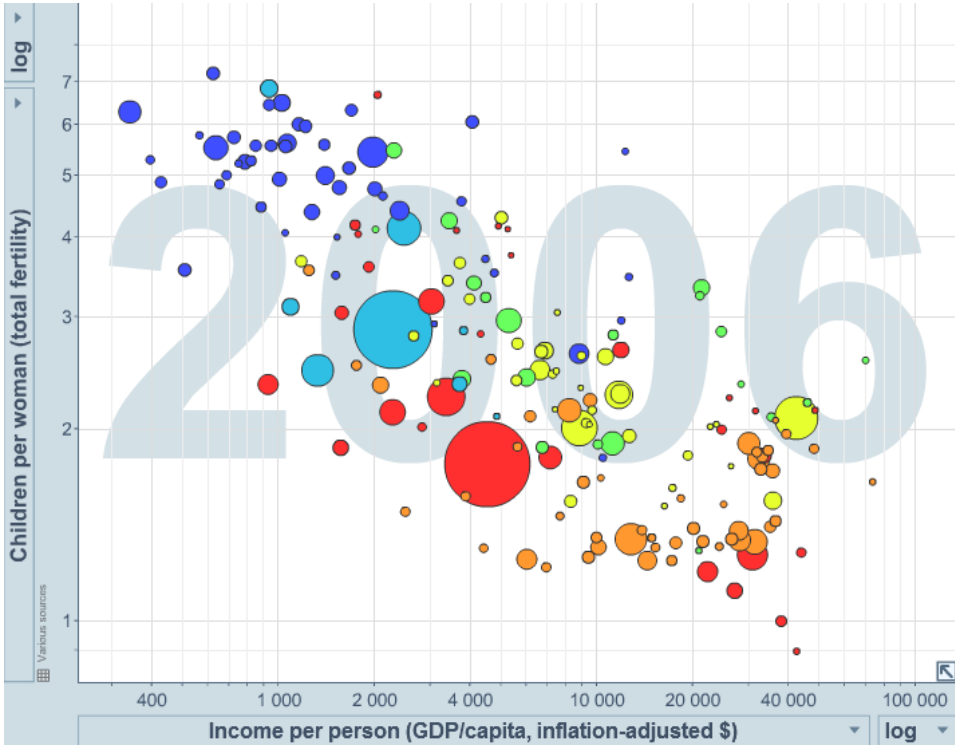
Fertility, mortality and income

Crude Death Rate and Income



Death Rate Drops with Income

Children per woman and Income



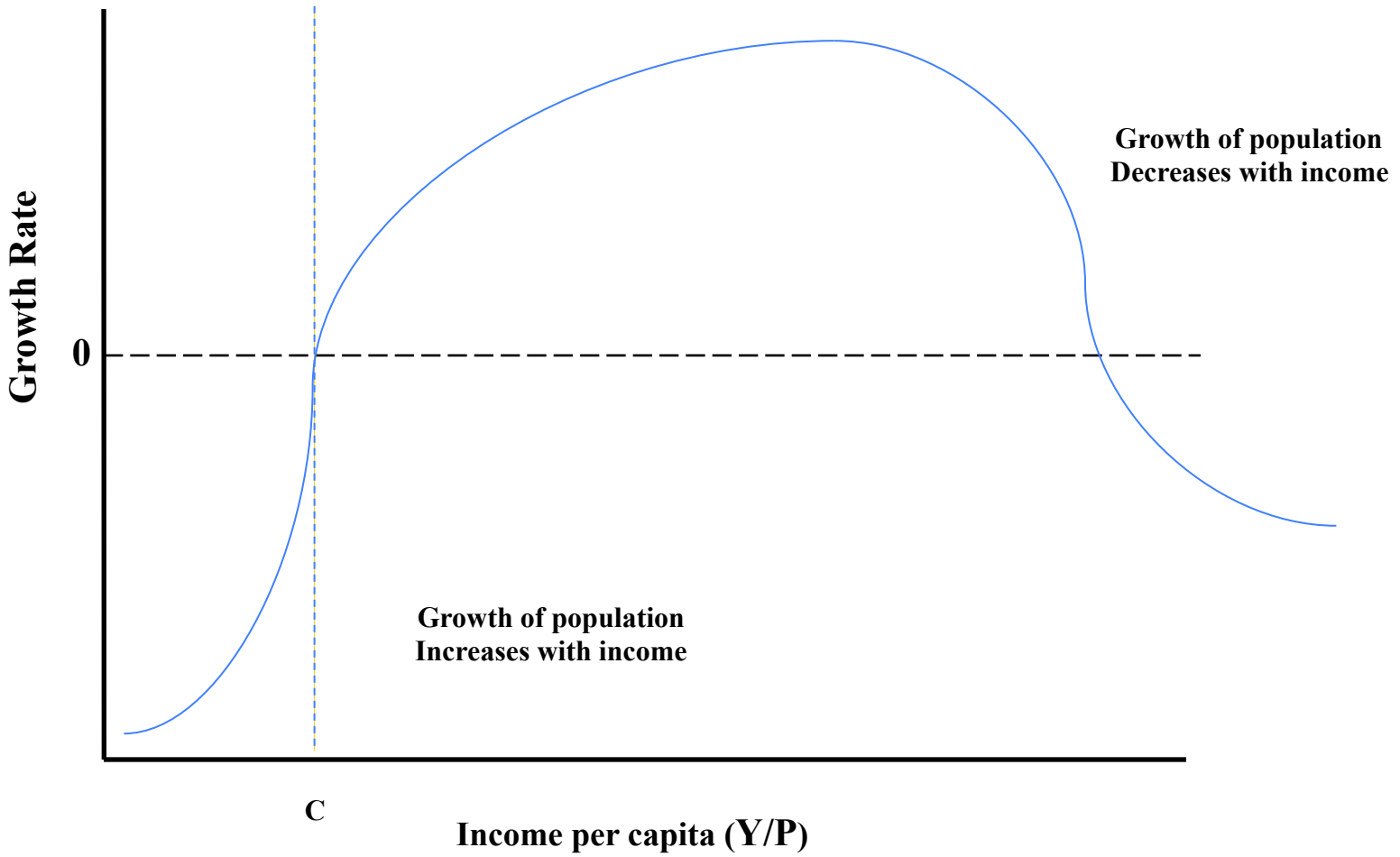
…So does Birth Rate, but not as much

So population growth rate still positive even with high Y/P

Malthus does not describe world today

- Population still increasing, but so is Y/P.
- But maybe extend model: “extended Malthus”
- Perhaps population growth increases with food at low levels of Y/P (as get over disease)
- Then population growth falls at high levels of Y/P (keeping Y/P from collapsing).

Malthus Model as Poverty Trap



… **Then 2 different stable population equilibriums, 1 at low Y/P=c and 1 at high Y/P**

Criticisms of Malthus

- Does not take into account technological progress
  - Response:
    - Yes it does. For "West" technological progress has outstripped population growth, allowing higher population and higher income per capita.
    - For "Rest" technological progress and population growth offsetting, leaving much higher populations, and only slightly higher income per capita.

Criticisms of Malthus

- Macro relationship of population growth and levels of per capita income that is not backed up
  - Response:
    - In pre-industrial times, population and income per capita responded much the way Malthus would predict. Black death, better food crops . . .
    - Relationship has inverted since then, so need a better model (extended Malthus) in which population growth falls with income per capita, or maybe income growth increases with population
- Conclusion: (basic) Malthus model describes world up to 1800 very well. Less well after.

Education and population

- Education seems to be a primary driver
- Better educated women have fewer children
  - Increases the opportunity costs for women
  - Increases the value and availability of education for children, so families tend to have fewer higher "quality" children
  - Higher education better able to use birth control methods
- Empirically mother's education seems to be almost the entire determinant at a micro level of fertility

Conflicting opinions

- **Different policy responses!** The answer matters.
  - Population growth (and implied overpopulation) responsible for many (most) of the world's problems
  - Population growth is a result of problems of underdevelopment (low education), and comes mostly from low death rates (a good thing). Fertility is falling all over the world to catch up with low death rates, so population not a problem.
- Reality probably between:
  - Population puts pressure on resources which may not be sustainable.
  - Among rich countries, population decline is the problem
  - Among poor countries population growth seems to be as much of a problem of underdevelopment as a cause