Production of health. Folland *et al* Chapter 5

Chris Auld
Economics 317

January 21, 2011

A production function for health

- It is useful to model a person (or a population's) health as a function of the causes of health
- A stylized health production function

$$HS = f(HC, L, E, G) \tag{1}$$

  where HS is health status, L is lifestyle, E is environment, and G is genetics.
- This is just fancytalk to note that health generally changes when, other things being equal, lifestyle, environment, genetic makeup, or care changes.

production function cont

- We should be careful about how we're measuring these determinants (inputs) of health.
- Once we have nailed down the specifics of what we mean, we can think about health status as a produced output much like, say, widgets in micro theory.
- (graphs of total and marginal health products).

What has changed health status over time?

- Health care is not as important a determinant of health as you might think.
- Improvements in health care technology are not as important as you might think in explaining why we're healthier than people in, say, the year 1800.

McKeown Thesis

The enormous gains in population health that occurred over the last 300 years were largely due to better living standards, notably nutrition, not improvements in medical technology nor designed public health interventions.

World population over time

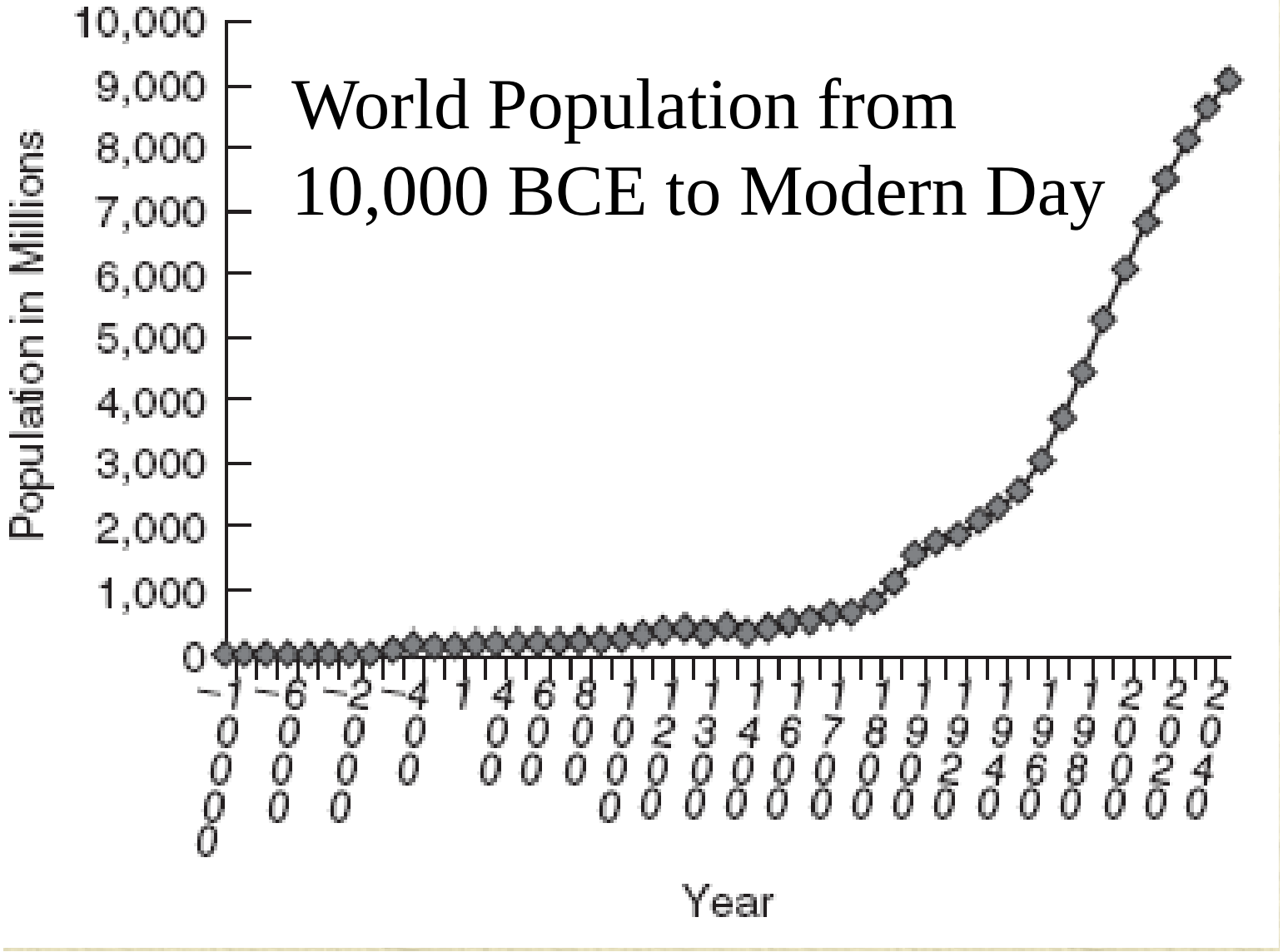
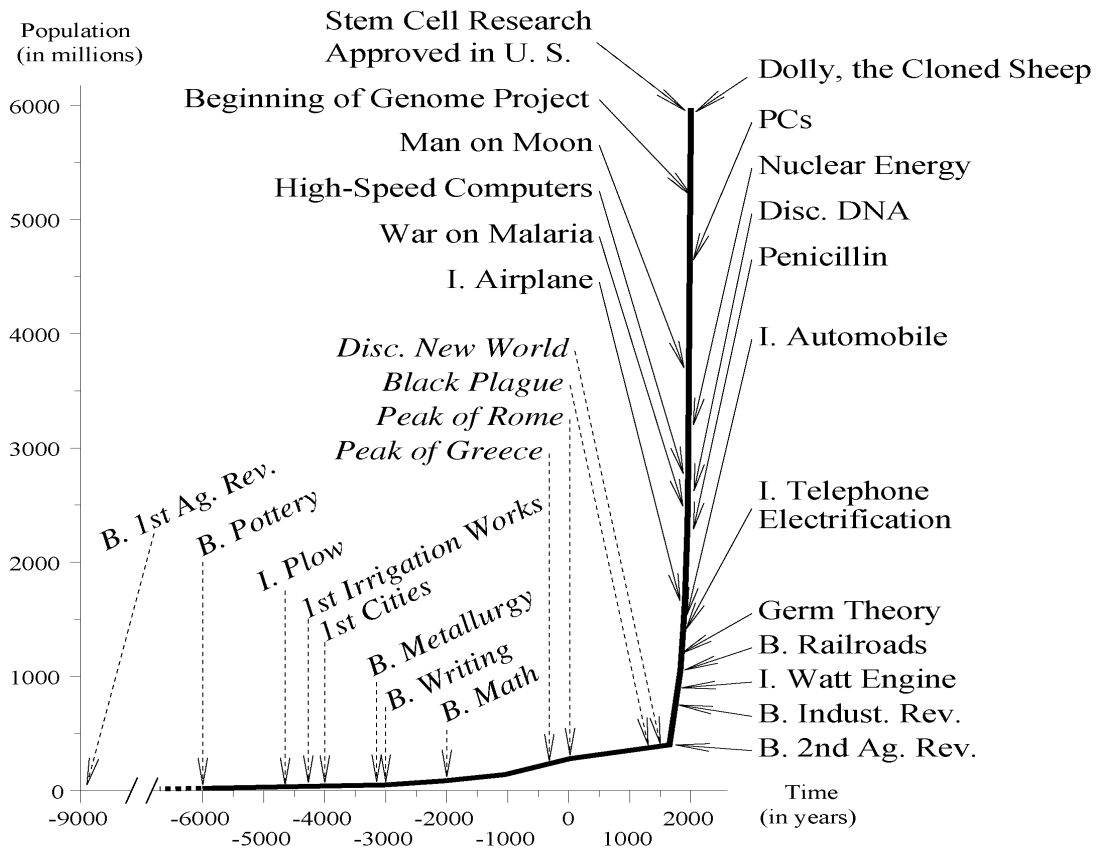


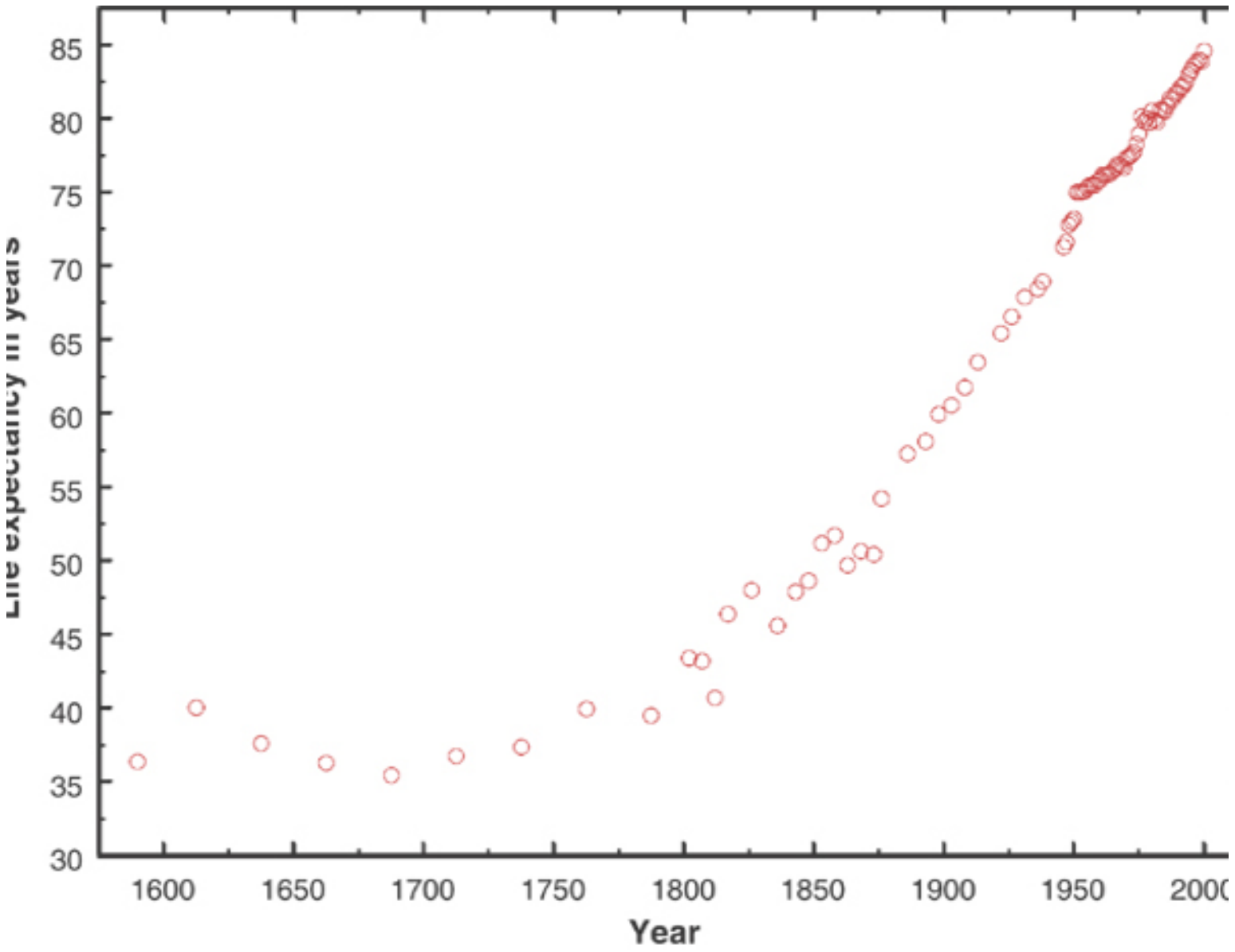
Figure 2
The Growth of World Population and Some Major Events in the History of Technology



Sources: Cipolla 1974; Clark 1961; Fagan 1977; McNeill 1971; Piggott 1965; Derry and Williams 1960; Trewartha 1969. See also Allen 1992, 1994; Slicher van Bath 1963; Wrigley 1987.

Note: There is usually a lag between the invention (I) of a process or a machine and its general application to production. "Beginning" (B) usually means the earliest stage of this diffusion process.

Female life expectancy, England



Source: Oeppen and Vaupel , *Science* 296 (5570) 1029-1031

Aside

Broken Limits to Life Expectancy
Oeppen and Vaupel , *Science* 296 (5570) 1029-1031.

Summary
Is human life expectancy approaching its limit? Many–including individuals planning their retirement and officials responsible for health and social policy–believe it is, but the evidence presented in the Policy Forum suggests otherwise. For 160 years, best-performance life expectancy has steadily increased by a quarter of a year per year, an extraordinary constancy of human achievement. Mortality experts have repeatedly asserted that life expectancy is close to an ultimate ceiling; these experts have repeatedly been proven wrong. The apparent leveling off of life expectancy in various countries is an artifact of laggards catching up and leaders falling behind.

World income over time

Source: Gregory Clark, *A Farewell to Alms: A Brief Economic History of the World*

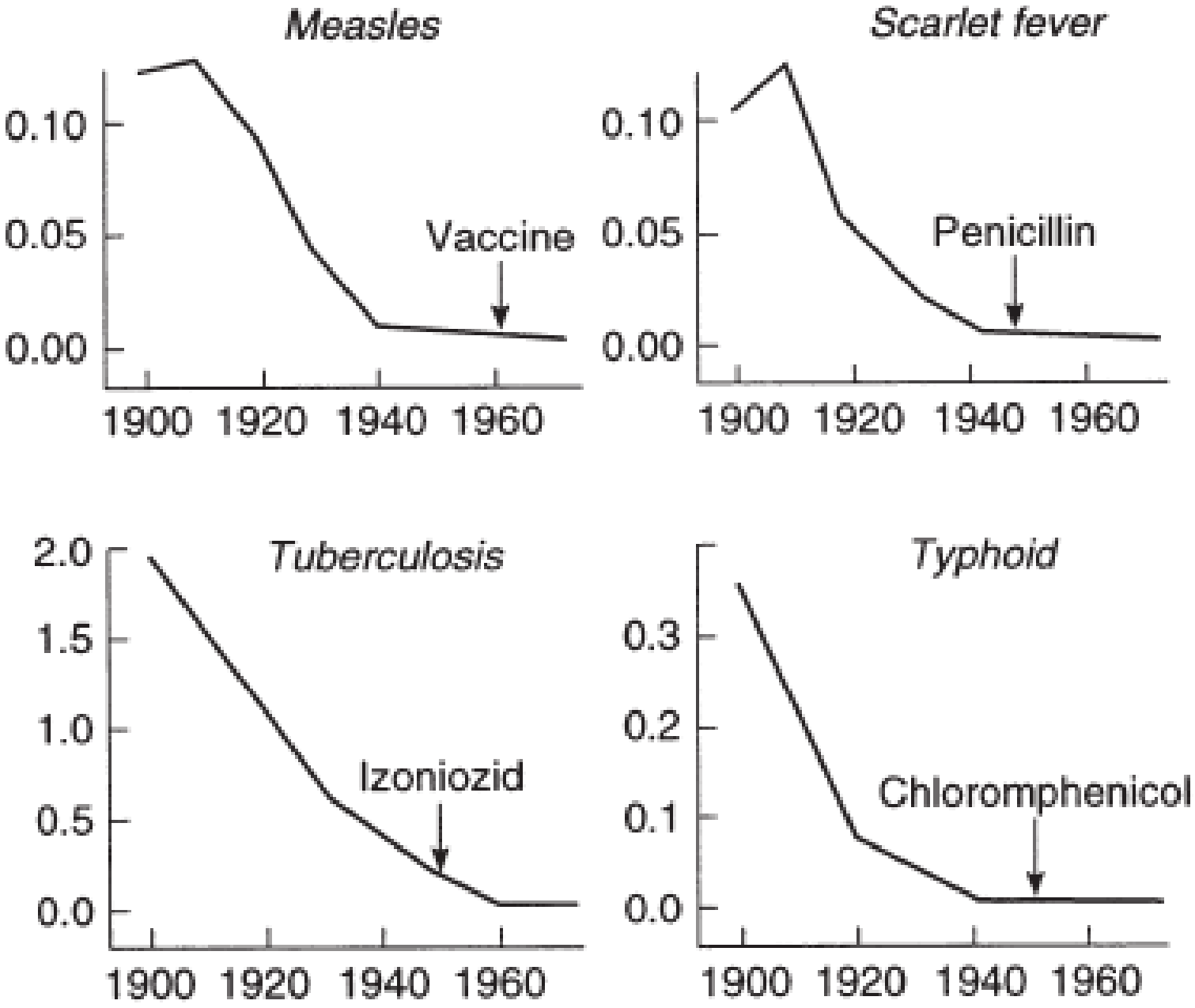
What causes of death have changed?

	1848–1854	1901	1971	Percentage of Reduction (1848–1854 to 1971) Attributable to Each Category	For Each Category, Percentage of Reduction (1848–1854 to 1971) That Occurred Before 1901
I. Conditions attributable to microorganisms:					
1. Airborne diseases	7,259	5,122	619	39	32
2. Water- and foodborne diseases	3,562	1,931	35	21	46
3. Other conditions	2,144	1,415	60	12	35
Total	12,965	8,468	714	72	37
II. Conditions not attributable to microorganisms	8,891	8,490	4,070	28	8
All diseases	21,856	16,958	5,384	100	29

*Standardized to the age/sex distribution of the 1901 population.

Source: Reprinted from McKeown, Thomas, *The Modern Rise of Population.* New York: Academic Press. 1976 (p. 54).

Which disease rates have changed over time?



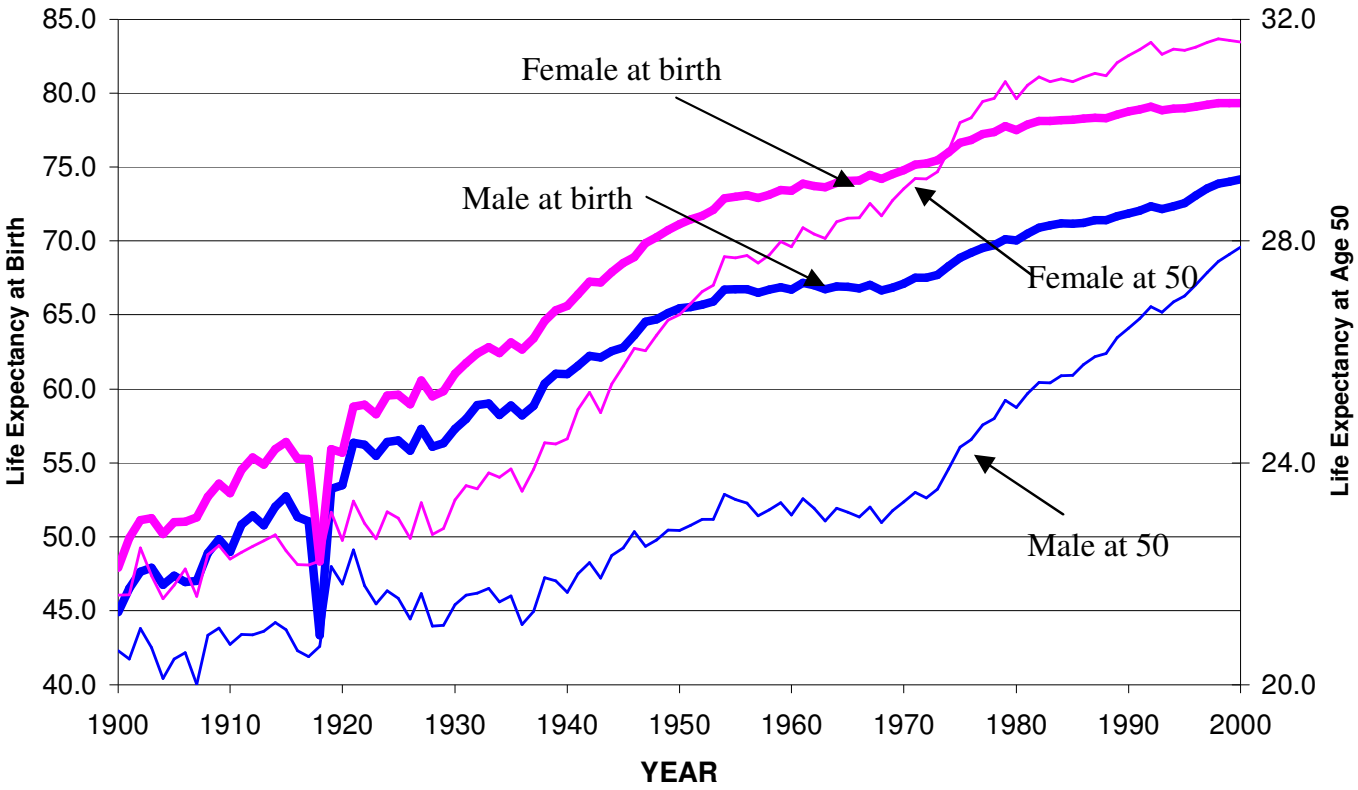
What are the major reasons we're healthier today?

- **Not** improvements in health care technology or health care access.
- Increases in living standards, notably, nutrition. But sanitation and other public health interventions probably also very important.
- Cutler and Miller (2005): Benefit/Costs of water filtration $= 23$.
- An important reason: $\uparrow$ nutrition $\rightarrow \uparrow$ disease resistence
- Reductions in harm from childhood and in utero disease play out even late in life (Fogel 2004)
- Indirect causes: increases in economic well-being, education, literacy

Contribution of medical research.

- Nonetheless, health care technology improvements do improve health.
- Murphy and Topel (2005) estimate the economic value of improvements to health in the U.S. since 1970 amount to roughly $3.2 TRILLION per year.
- If improvements in health were included in GDP, increment in GDP since 1970 would be almost 50% higher.
- These changes could have been largely due to factors other than health technology, but even if health technology is only a small contributor, probably worth the expense.

Recent changes in life expectancy



Contribution of medical research cont.

- We ought to be skeptical regarding the effectiveness of a given medical practice.
- We also ought to be skeptical regarding the marginal effectiveness of health care expenditures, as we will see.
- The contribution of public health (clean water, etc) may have more relevance in the lesser developed world.

The production of health in the modern developed world.

- Recall our framework:

$$\text{Health} = f(\text{health care}, \text{lifestyle}, \text{environment}, \text{genetics}) \tag{2}$$

- How can we measure the the marginal product of health care, or the marginal effect of other inputs?

Challenges to estimating the effects of health inputs on health

- First, we have to decide how to measure "health" and how to measure the inputs.
- (What do we mean by "health," anyways?)
- Life expectancy or mortality are often used for pragmatic reasons.
- Other dimensions of health are more difficult to observe. Sometimes use disease rates, disability, self-reported health status, physiological measurements.
- Similar problems for inputs: e.g., what aspect of "lifestyle" do we have in mind?

Correlations vs causation

- We usually have to work with observational data rather than data from researcher–controlled experiments.
- That implies the correlations we observe between inputs and health may reflect causation or it may not.
- e.g. Correlation between health care use and health status.
- Generally: $Corr(x, y) \neq 0$ could be because: x causes y, or y causes x, or some third factor causes both x and y.
- Attempt to deal with this problem econometrically to recover causal effects of interest.

Example.

- **"The U.S. spends more on health care than Canada does, but life expectancies are about the same or higher in Canada. Therefore, Canada's health care system is more efficient."**
- The conclusion may be true, but it does not follow from that evidence.

Effect of health care expenditures on health outcomes

- Suppose we try to estimate the elasticity of health to health expenditures.
- Here by "health" we mean some measure of population health and expenditures are aggregate expenditures on medical inputs.
- The elasticity is

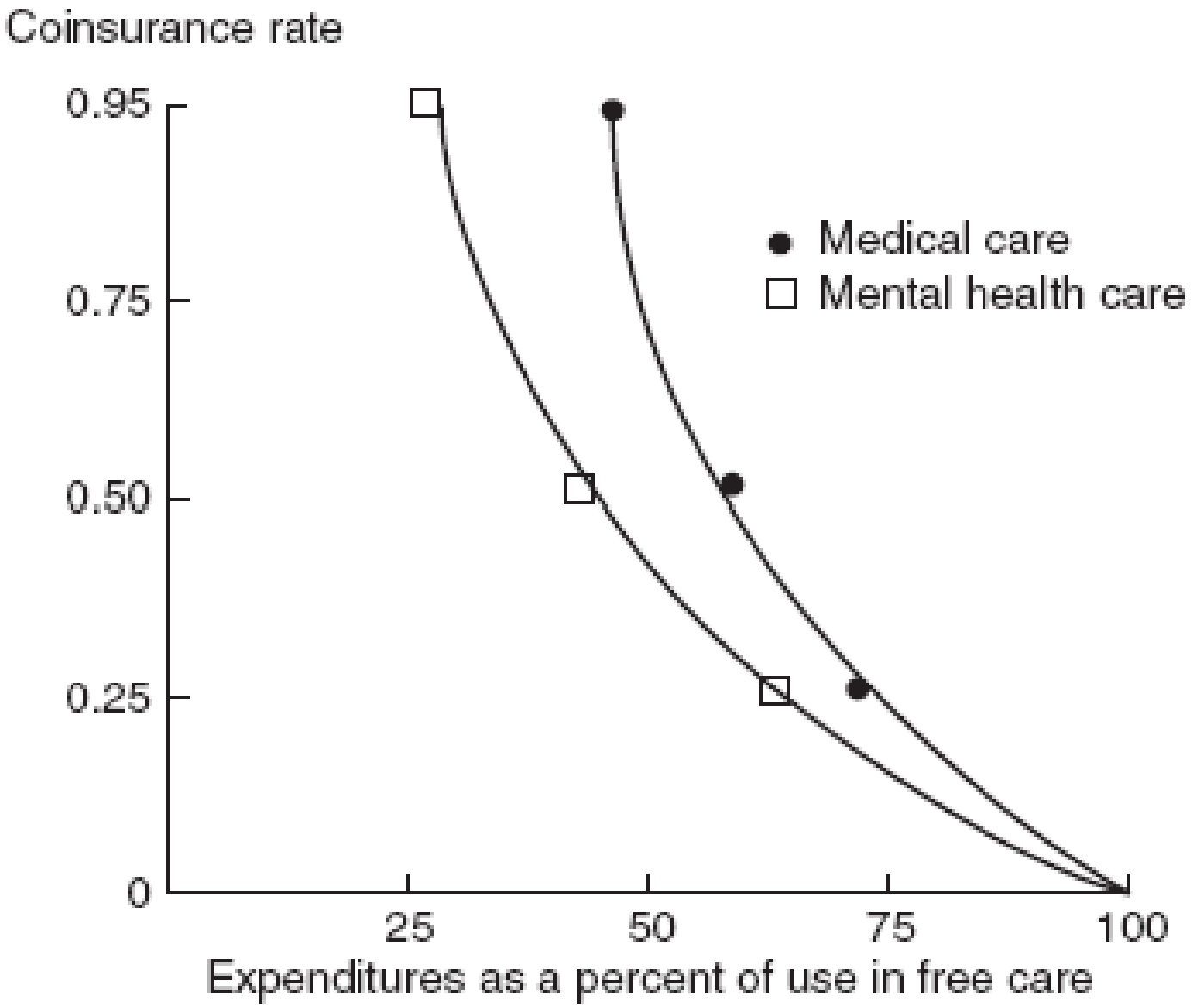
$$\text{elasticity} = \frac{\%\text{ change in health}}{\%\text{ change in expenditures}} \tag{3}$$

Effect of expenditures cont.

- Lots of studies try to estimate this effect.
- Surprisingly difficult to find any effect at all!
- A reasonable guess for the U.S. is that the elasticity is perhaps around 0.10 (a 10% increase in expenditures causes a 1% increase in life expectancy).
- Lots of uncertainty.
- Notice this is a **marginal** effect we're trying to estimate.
- Some evidence suggests pharmaceuticals, and improvements in pharmaceuticals, have substantial effects.

Evidence from the RAND health insurance experiment.

- Recall the experiment randomized co-insurance rates and health care use was sensitive to the co-insurance rate.
- If it is the true that, at the margin, more health care causes more health, we should see people randomized to low care prices in better health.
- We don't!



Other inputs.

- If at the margin health care has small effects on health, what does determine differences in health across people, across time, and across regions?
- Lifestyle is important (smoking, exercise, diet, sleep, and so on).
- What determines lifestyle, very broadly defined.
- "Social determinants of health," basically the arguments in our production function other than genetics and health care.

Social capital.

- Nebulous concept, but roughly means the amount of interaction a person has with their family, friends, and community.
- Social capital may directly cause health if it reduces stress.
- More capital may also provide information on effective health–promotion strategies.
- More capital may lead a person to reevaluate health–damaging behaviors.
- Difficult to determine causation.

Social interactions.

- Economists have long studied how people interact in markets, but non–market interactions may be much more important in determining health.
- Social interactions may also directly and indirectly affect health.
- e.g., whether you smoke depends on how many people around you smoke.

Income and health.

- It is well–established that higher income is **correlated** with better health, but not clear whether higher income **causes** better health.
- (graph)

Income and health cont.

- In some cases we can see people's income changing for essentially random reasons (e.g., winning the lottery) and we do not see that random changes in income lead to an improvement in health.
- Changes in the tax structure or level of social support do not seem to cause large changes in health.
- The reasonably persuasive correlational evidence suggests that very low levels of income are bad for health.
- Hard to estimate the causal effect of incremental income at high levels of income.

Income distribution and health

- If the marginal effect of income on health is diminishing, income redistribution increases average health (holding mean income constant).
- (graph)
- Holding an individual's income constant, is there still an effect of income dispersion on the individual's health?
- There is good evidence that, in the U.S., holding an individual's income constant, more income dispersion is **correlated** with lower health, but....
- Health economists generally skeptical relationship is causal.

"Reverse" causation from health to income

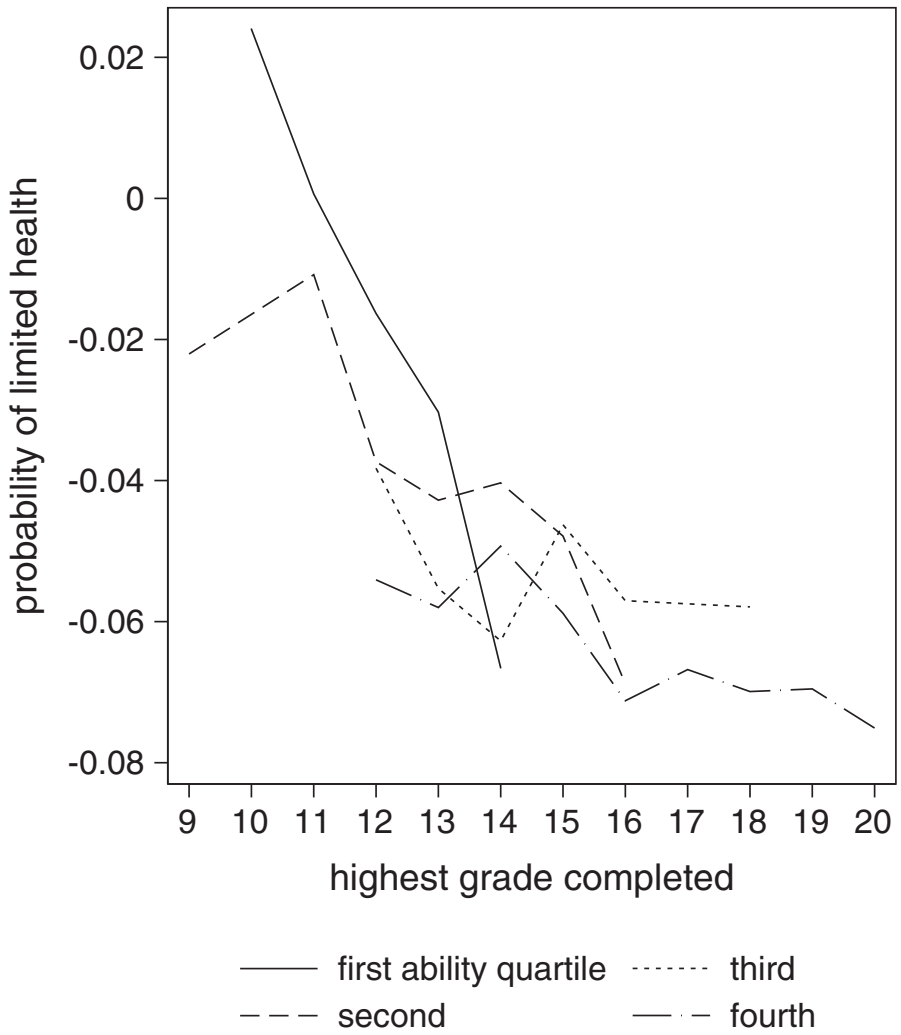
- Plausible that higher individual income causes better health, and perhaps changes in income distribution cause health, but also plausible that health causes income.
- Negative health shocks (e.g., disease, accidents) may cause lower productivity and lower labor supply, either of which decreases income.
- Can attempt to estimate causal effect of health on income by studying essentially random things that affect health, e.g., auto accidents. Evidence suggests strong effects.
- Then we may see health and income are positivity correlated not (only) because higher income causes better health, but also vice versa.

"Third variables" in the health/income relationship

- Other personal or contextual effects may cause both health and income, so the correlation between health and income may not reflect causality from health to income nor from income to health.
- e.g., people who place little value on the future ("high rate of time preference") may not invest in their health or their human capital, so they may be both unhealthy and low income (e.g., smokers).
- Can statistically hold some variables which affect both income and health constant (e.g., education), but there will always be things we can't observe which may enter the relationship.

Education and health.

- Very well-established that there is a positive correlation between health and education.
- Plausible that education causes health:
  - Education increases income and income increases health (indirect effect).
  - Education allows more efficient production of health through increased information.
  - Education increases intelligence and more intelligent people are better at producing health.
  - Education leads to healthier behaviors because: different social environments, change in time preference, different social networks.



Note: Marginal effects from probit models also including cohort dummies, time-invariant characteristics and time-varying characteristics as described in Table 1. Baseline category is respondents in the first ability quartile with a grade 9 education

Figure 1. Estimates of effect of semiparametric schooling and ability on health

Other explanations for the correlation between education and health

- Plausible that education causes health, but health and education could also be correlated because people in poor health choose to obtain less education ("reverse" causality) or because "third variables" lead to both lower education and health.
- e.g., again, people who place little value on the future may choose to get less education and invest less in their health.
- e.g., people with lower intelligence may be less effective at producing health and choose to obtain less education.

Statistical evidence on effect of education on health

- Use essentially random changes in schooling to infer causation.
- e.g., change in compulsory schooling from 14 to 15 years. It is as if some people have been randomly assigned to get an extra year of schooling.
- Result: additional year of education reduces probability of death by 3.6%.
- Evidence from these studies suggests the effect of schooling on health is positive but much lower than the correlational evidence would suggest.

Education and health cont.

- That result implies that, while education does cause health, it is also the case some other factor causes people to both choose higher levels of schooling and to be in better health.

Environmental pollution and health.

- Pollution: bad.

Further reading.

Fuchs, V. (2004) "Reflections on the socio-economic correlates of health," Journal of Health Economics, v23, 653-661.
Murphy, K. and R. Topel (2006) "The Value Of Health And Longevity," Journal of Political Economy, 2006, v114, 871-904.
Deaton, A. (2003) "Health, Income, and Inequality," NBER Reporter.
http://www.nber.org/reporter/spring03/health.html