

Measuring economic growth

Definition of economic progress

How growth is measured

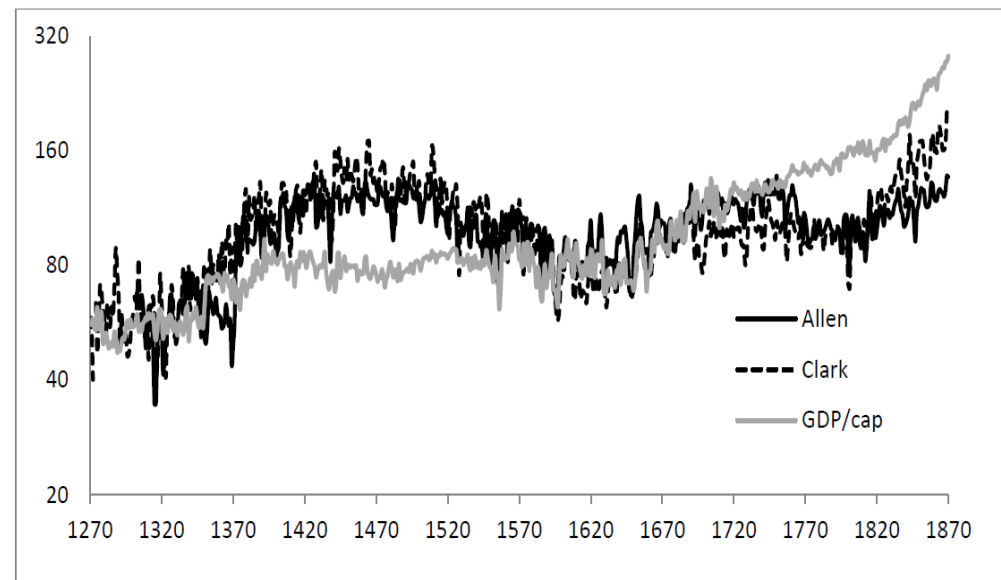
Problems with GDP/capita

Why is it used? Correlates

Growth accounting

Some history of growth

FIGURE 5: Indexed daily real wage rates of unskilled building workers and GDP per capita, (log scale, mean of 1270-1870 = 100)

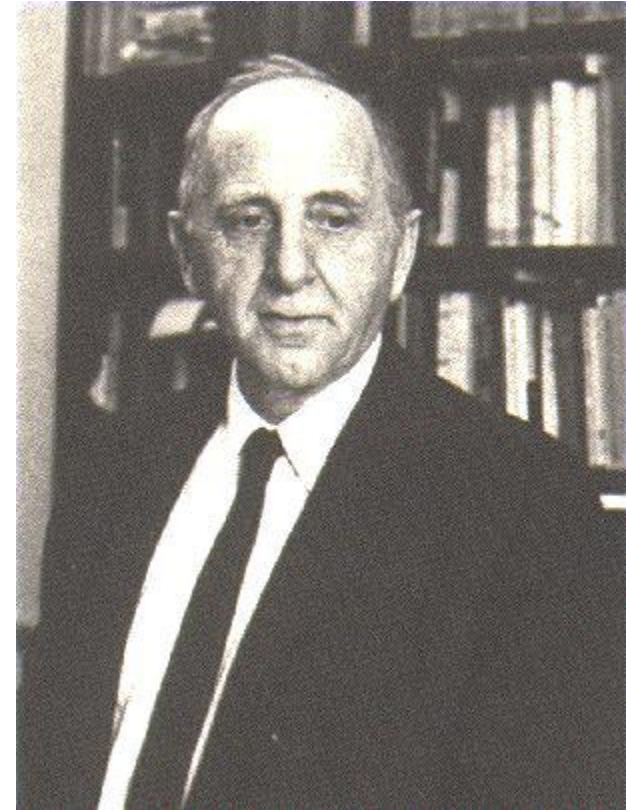


Defining economic progress

- Ideally we'd have a measure of welfare
 - But we don't
 - And if we did, it would pose problems
 - Interpersonal comparisons, aggregation, etc.
- So we use GDP per capita
 - Value of goods & services produced in year and exchanged in markets
 - Devised by Simon Kuznets & others 1931-34

GDP/capita is problematic

- Devised for specific purpose
 - Short run comparisons in same economy (USA 1929-32)
 - Not for long run comparisons or across economies
 - Not measure of welfare either (Kuznets)
 - Ignores distribution of income



Simon Kuznets 1901-85

It has other problems too

- How to value public goods
 - Fire and police protection, defense, parks...
- Externalities such as pollution
- Bias against poor economies in comparisons of countries
 - Exchange rates omit non traded goods
 - Example: suits tailored in Hong Kong
 - Solution: purchasing power parity (PPP)
 - With PPP correction Asia's share of world output ↑ from 7% to 18% in 1990

And there are still other problems

- Especially < 1970 (at least USA)
 - GDP/capita understates real growth < 1970
 - It is more accurate > 1986
- These other problems are less obvious
 - Changes in quality of goods: price indexes overstate price increases
 - Underestimates improvements in quality of life
 - Better health, entertainment (radio, TV, Netflix)
 - Non market transactions (leisure time, unpaid housework)

Example of quality of goods:TV

- Spreads more rapidly than any device since
 - 9% households 1950, 65% 1955 in US
- GDP omits $\uparrow$ quality (picture, energy, etc.)
 - repair costs $\downarrow$ by factor 30
 - true price $\downarrow$ 4.3%/year versus 1.0 in CPI 1953-83
 - growth underestimated



1950 Zenith TV

Other problems too--examples

- Quantifying value of $\uparrow$ life expectancy & health (quality adjusted years of life)
 - US real growth 1900-50 $\uparrow$ 2.1% to 4.2%
- Non market transactions in family
 - Household appliances: value of goods produced may underestimate welfare gain
 - Childcare: bias in reverse direction
 - Household economics a solution?
- Discomfort of work: ploughing

Measuring Growth

- Nonetheless we'll use read GDP/capita
 - But keep problems in mind
 - And be skeptical of early figures (especially Maddison)
- Justification: desirable correlates

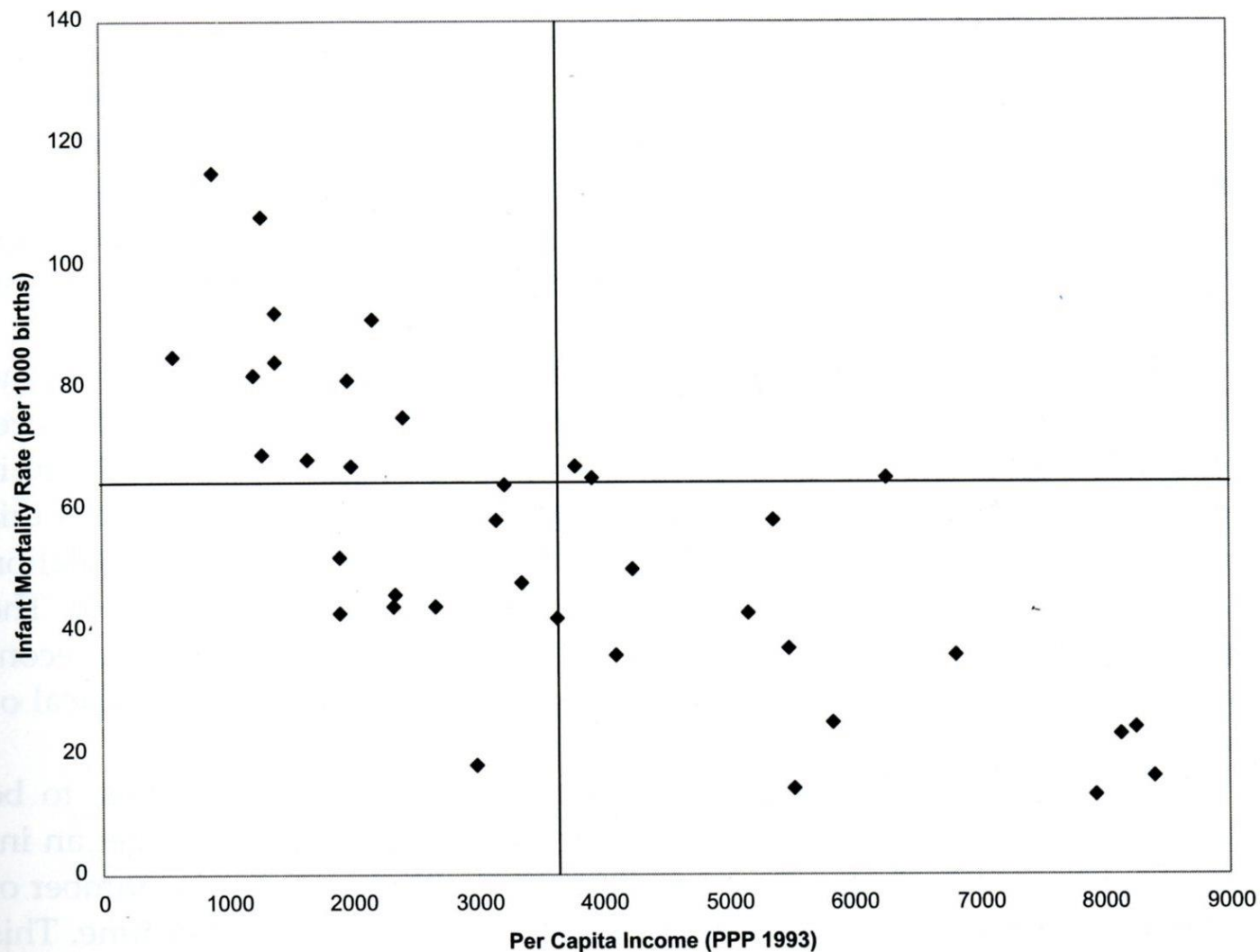


Figure 2.9. Per capita income and infant mortality rates for developing countries. Source: World Development Report (World Bank [1995]) and Human Development Report (United Nations Development Programme [1995]).

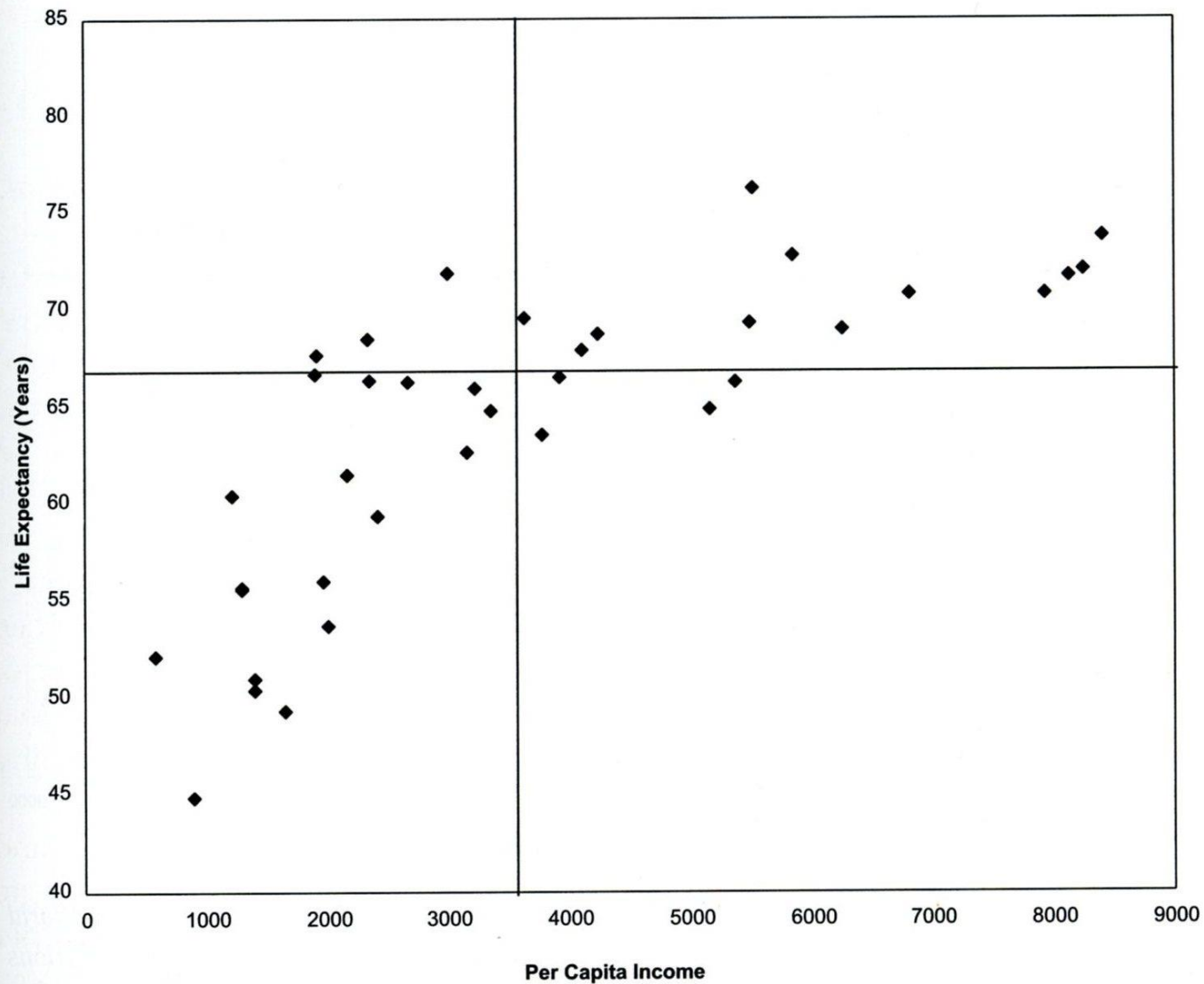


Figure 2.7. *Per capita income and life expectancy for developing countries. Source: World Development Report (World Bank [1995]) and Human Development Report (United Nations Development Programme [1995]).*

What determines GDP?

- Need aggregate output Y
 - Y is value of goods and services produced
 - Function of labor L and capital K , $Y = F(K, L)$
 - F assumed homogenous (constant returns)
- Let subscripts denote partial derivatives
- If costs minimized,
 - $F_K(K, L) = r$ and $F_L(K, L) = w$
 - r is price of capital, w is wage
 - implicitly good price = 1

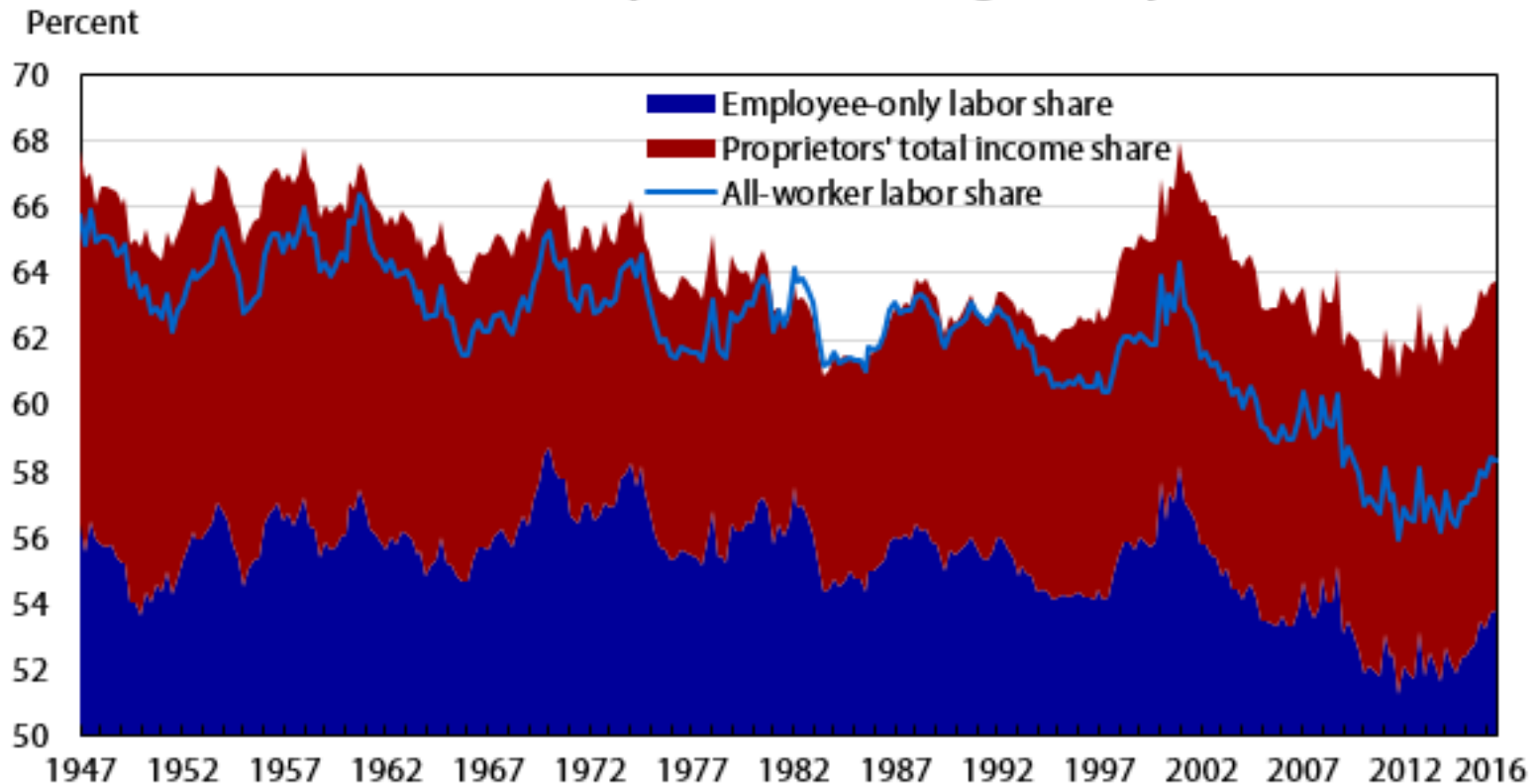
What can we say about F ?

- Consider factor shares—share of income earned by workers and owners of capital
 - Since Y is income, $s^L = wL/Y$ is labor share
 - $s^K = rK/Y$ is capital share
- Homogeneity $\rightarrow s_L + s_K = 1$
 - Why? Differentiate $F(uL, uK) = uF(L, K)$ with respect to u
 - Then use chain rule and definition of shares

So what is F ?

- A good candidate
 - $F(K, L) = AL^a K^{1-a}$
- Why? Homogenous and
 - It has constant factor shares
 - a is labor share, $1-a$ is capital share
 - As do real economies (see next slide)
 - If factor shares are constant, it must be of this form (Cobb-Douglas)
- Labor share ≈ 0.60 works well for US

Figure 2. All-worker labor share, employee-only labor share, and proprietors' total income share, first quarter 1947 through third quarter 2016



Source: U.S. Bureau of Labor Statistics.

Labor share does not vary much (in short run)

Growth Accounting

- Suppose $Y = F(K, L, t)$ shifts over time as economy grows more efficient or knowledge grows
- How much of output growth is due to shift and how much to changes in L and K ?
- Shift means more output without more labor or capital
 - It will be what increases GDP/capita, but it is often embodied in innovative new capital

Chain rule lets us figure out

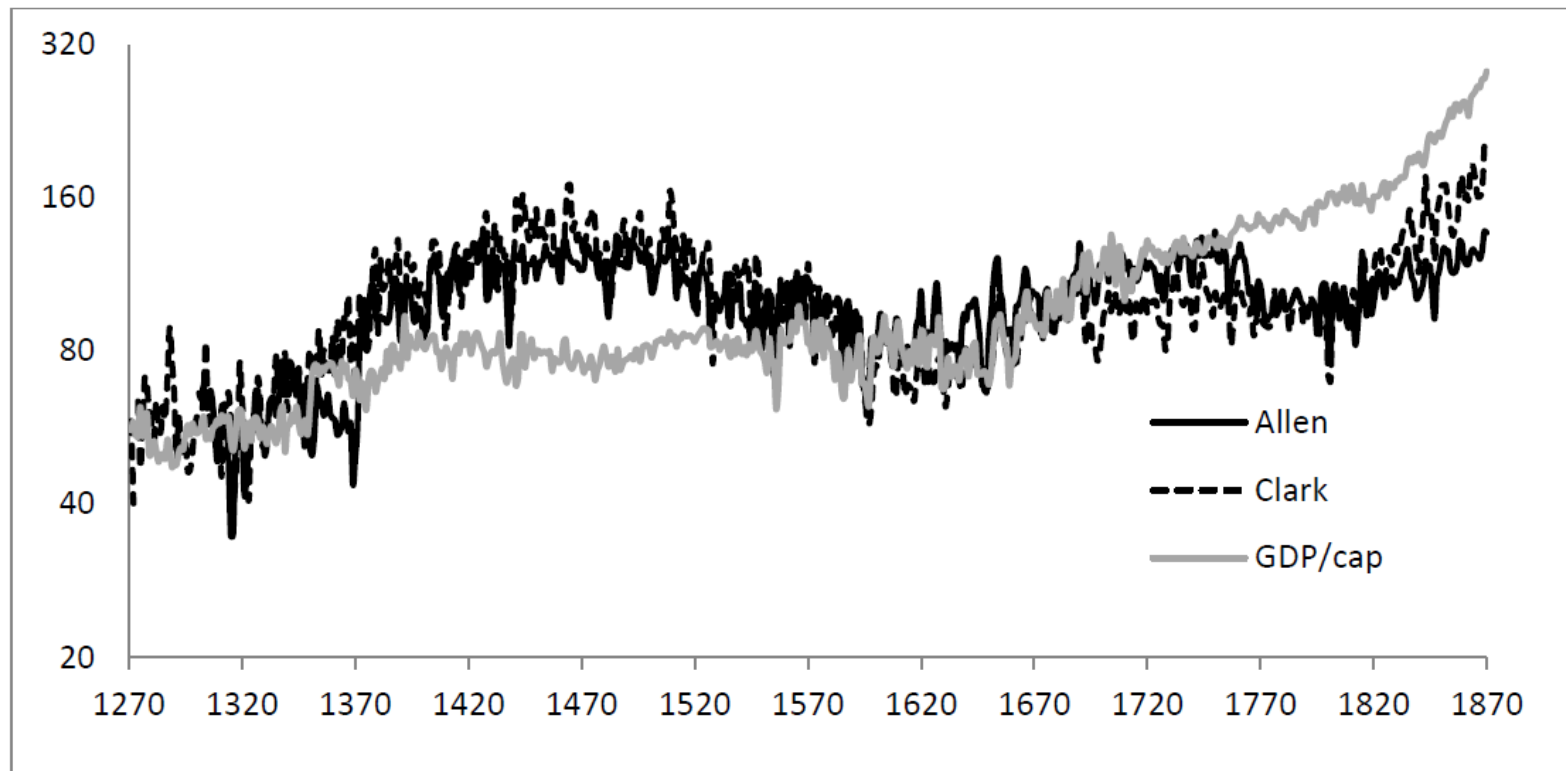
- $\frac{dY}{dt} = F_K \frac{dK}{dt} + F_L \frac{dL}{dt} + F_t = r \frac{dK}{dt} + w \frac{dL}{dt} + F_t$
- If we divide both sides by Y and use the definition of factor shares we get
- $\frac{d \ln(Y)}{dt} = S^K \frac{d \ln(K)}{dt} + S^L \frac{d \ln(L)}{dt} + \frac{\partial \ln(Y)}{\partial t}$
- We can measure everything here except the last term & rates of change are %/year
 - Last term “residual” is total factor productivity growth (TFP) measure of technical change

Historical examples of TFP growth

- Preindustrial societies $< 0.1\%$ per year
- French agriculture 1500-1800: -0.1 to 0.1% per year (biggest sector of economy)
 - 0.0 to 0.2 in 1700s
- Britain during Industrial Revolution
 - 0.3% 1700-60, 0.5% 1800-31
 - 1.9% in cotton textiles 1780-1860! Sector with enormous technical change

Long run growth in Britain: real wages and GDP/capita

FIGURE 5: Indexed daily real wage rates of unskilled building workers and GDP per capita, (log scale, mean of 1270-1870 = 100)



TFP growth in US with rapid technical change

	Period	Rate of TFP growth (% / year)
Data (from Gordon) adjusts for education which improves the quality of labor	1890-1920	0.46
	1920-1970	1.89
	1970-1994	0.57
	1994-2004	1.03
	2004-2014	0.40

Technical change since 1870 has been rapid
but since 1970 it has slowed down!

So what have we done?

- Defined economic progress
- Explained how growth is measured—GDP/capita
- Gone over problems with using GDP/capita
 - externalities, public goods, international comparisons, quality of goods, non market transactions, etc.
- Explained why it is used? Correlates
- Explained growth accounting and TFP, our measure of technical change
- Used TFP and GDP per capital to cover some history of growth