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
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 ↑ quality (picture, energy, etc.)
  - repair costs ↓ by factor 30
  - true price ↓ 4.3%/year versus 1.0 in CPI 1953-83
  - growth underestimated

1950 Zenith TV
Other problems too--examples

• Quantifying value of ↑ life expectancy & health (quality adjusted years of life)
  – US real growth 1900-50 ↑ 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, $s^L = \frac{wL}{Y}$ is labor share
  – $s^K = \frac{rK}{Y}$ 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 $\approx 0.60$ works well for US
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

<table>
<thead>
<tr>
<th>Period</th>
<th>Rate of TFP growth (% / year)</th>
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</thead>
<tbody>
<tr>
<td>1890-1920</td>
<td>0.46</td>
</tr>
<tr>
<td>1920-1970</td>
<td>1.89</td>
</tr>
<tr>
<td>1970-1994</td>
<td>0.57</td>
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<tr>
<td>1994-2004</td>
<td>1.03</td>
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<tr>
<td>2004-2014</td>
<td>0.40</td>
</tr>
</tbody>
</table>

Data (from Gordon) adjusts for education which improves the quality of labor.

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