

Trade and the Diffusion of the
Industrial Revolution

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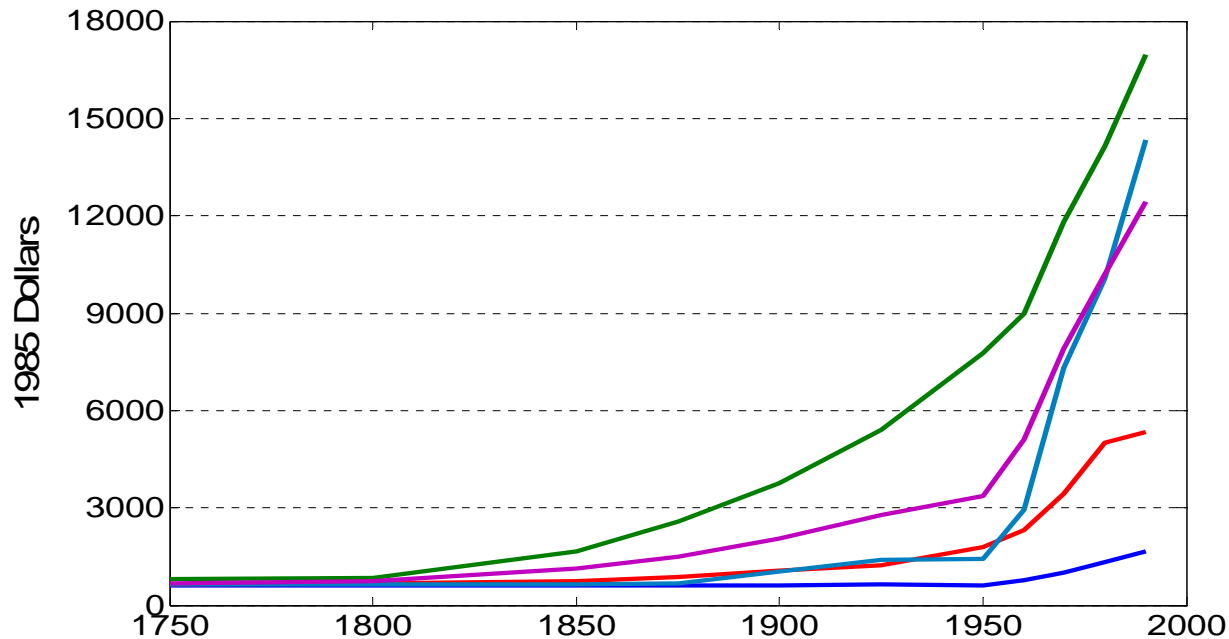
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- Sometime in 18th century, living standards in NW Europe began to grow, at rates rising gradually to about 2% per year. Remained near 2% since 19th century.
- In these successful societies—now many others—normal that real incomes per person multiply by a factor of 7 or 8 every century—factor of 50 in 200 years!
- These developments followed centuries over which the incomes of ordinary working people remained within a range of, say, \$500-\$800 (1990 USD)
- Call these events the “industrial revolution”

GDP per capita, five regions



1990 Population in millions

| | |
|---|------|
| UK, USA, Canada, Australia, New Zealand | 354 |
| Japan | 124 |
| France, Germany, Netherlands, Scandinavia | 184 |
| Rest of Western Europe, Eastern Europe, Latin America | 986 |
| Asia (except Japan), Africa | 3590 |

Consider today the questions:

- What are the main forces that drive economic growth?
- Why have they operated so unequally across different societies?
- What are the conditions under which poor economies can reach U.S./western European/Japanese living standards?
- At what rate will income convergence occur under ideal circumstances?

- Can we find the answers to these questions in writings of Plato, Confucius, Machiavelli, Adam Smith, Karl Marx?
- No
- They did not see these events (the IR), they did not predict them, would not have believed it if someone had told them they would happen
- We have to work out the answers ourselves

- Wide agreement on the main force driving economic growth:
- Ideas. Growth in knowledge. Human capital. Technology.
- Accumulation of physical capital important, too, but secondary
- Fundamental source of productivity improvements is new knowledge
- People had ideas—even scientific ideas—long before 1800. Why didn't IR occur much earlier? Ancient Greece or Rome?
- Great question. Will not address it today

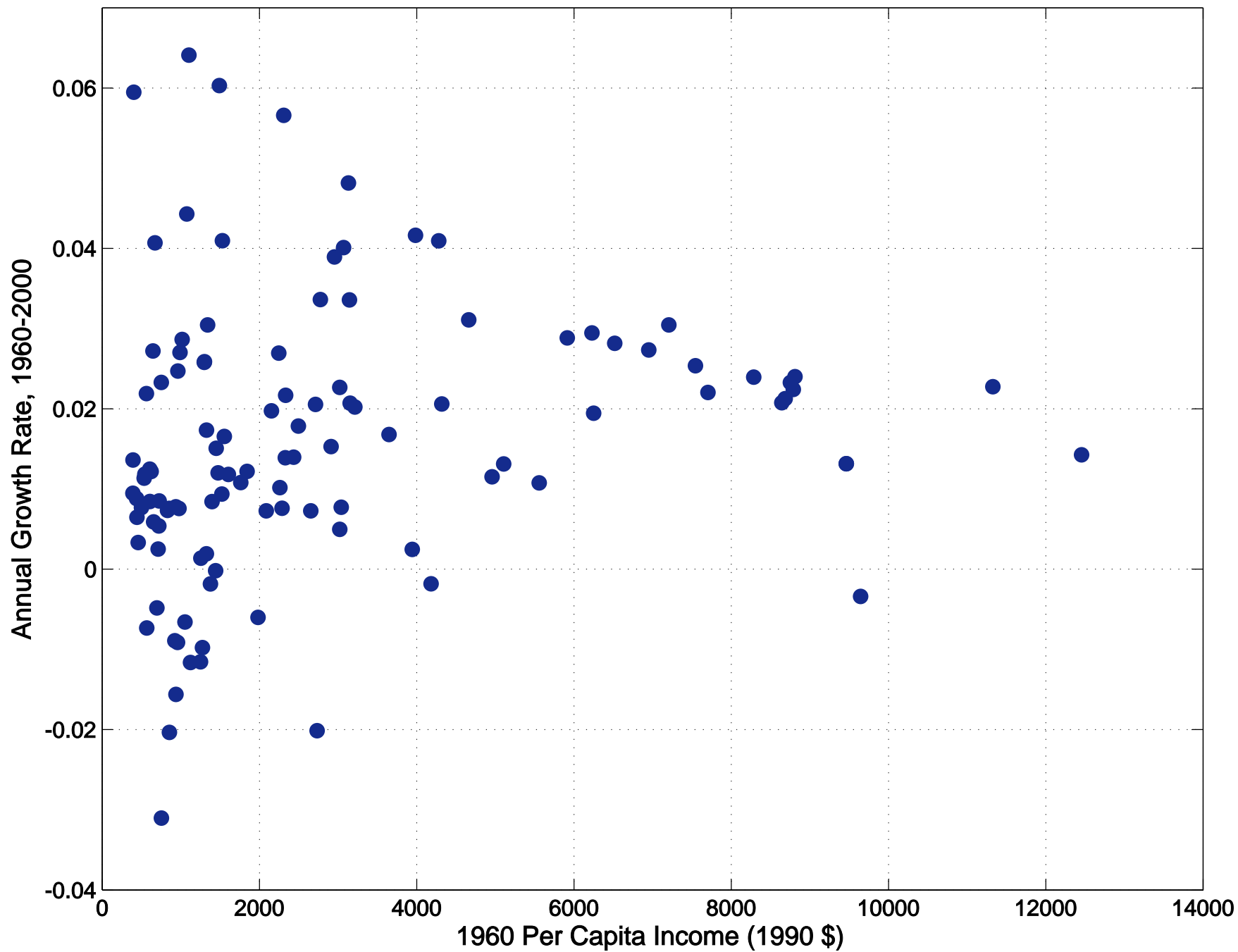
- Take as given that some economies enjoy ongoing income growth
- Others do not have to re-do what UK did in 18th century
- Focus instead on **diffusion** of technology—catch-up growth
- Flows of production-related **ideas** from successful economies to others
- Consider the factors—especially trade—that affect these flows

- Look at evidence: post-1960 GDP data for 112 countries, post-1820 GDP data for 50 countries
- Great contribution of Kuznets, Stone, others is adaptation of methods of financial accounting to create **national accounts**
- Now have comparable measures of real GDP over countries and time
- Great source is Angus Maddison, OECD: Economic history of the world in one Excel file
- Try to use these data to measure forces that affect technology, growth

Post-1960 evidence

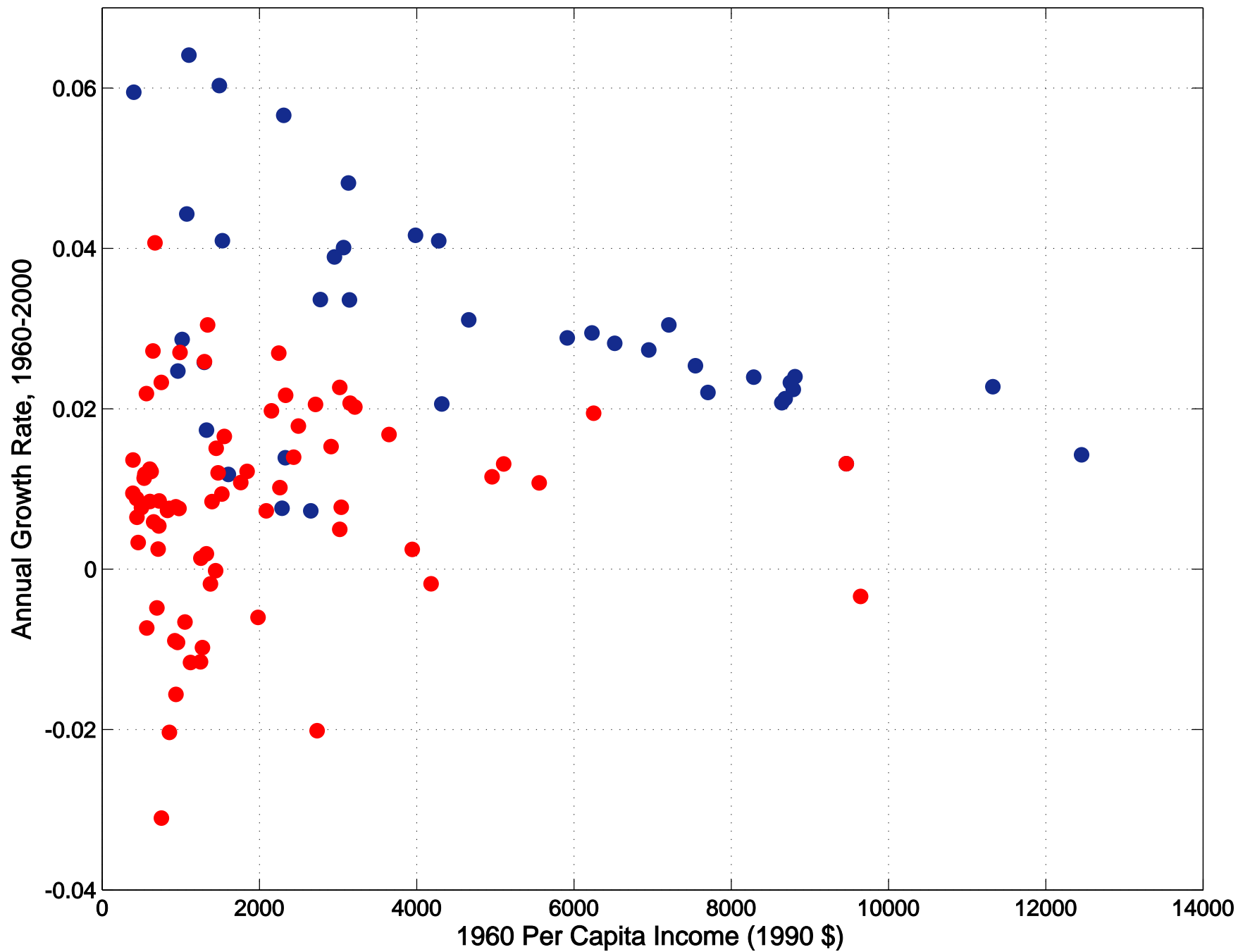
- Income levels and growth rates, 1960-2000
- Look at cross-country plots of
 - annual growth rates of GDP per capita, 1960-2000
 - against 1960 levels (1990 US \$) of per capita GDP
- Maddison, OECD, 2003
- 112 countries with populations over 1 million

INCOME LEVELS AND GROWTH RATES, 112 COUNTRIES

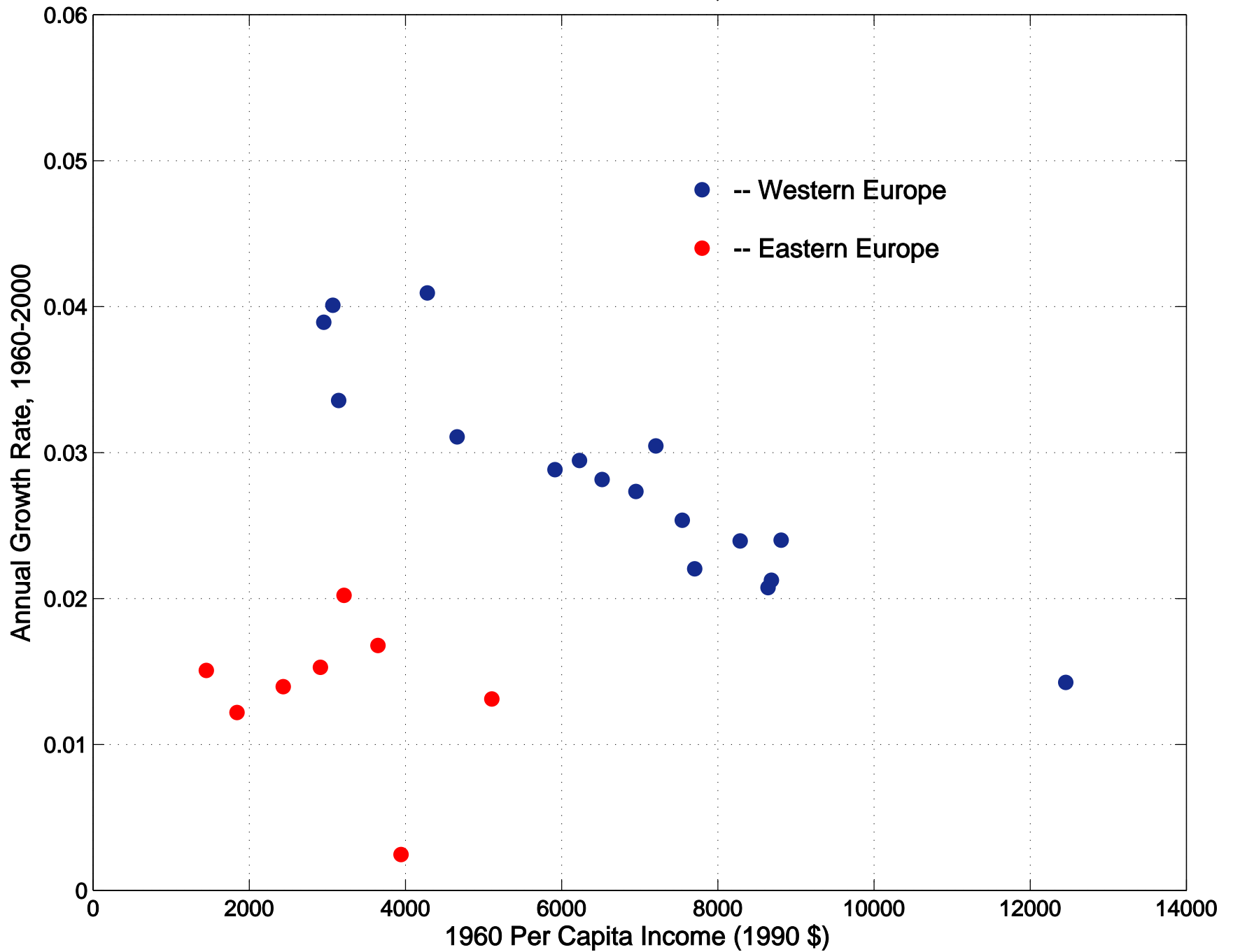


- Sachs and Warner, Brookings, 1995, classify these countries as “open” or “closed”, for period 1970-1989.
- To be “open” a country must pass **all** of five tests:
 - effective protection rates less than 40%
 - quotas on less than 40% of imports
 - no currency controls, black markets in currency
 - no export marketing boards
 - not be socialist

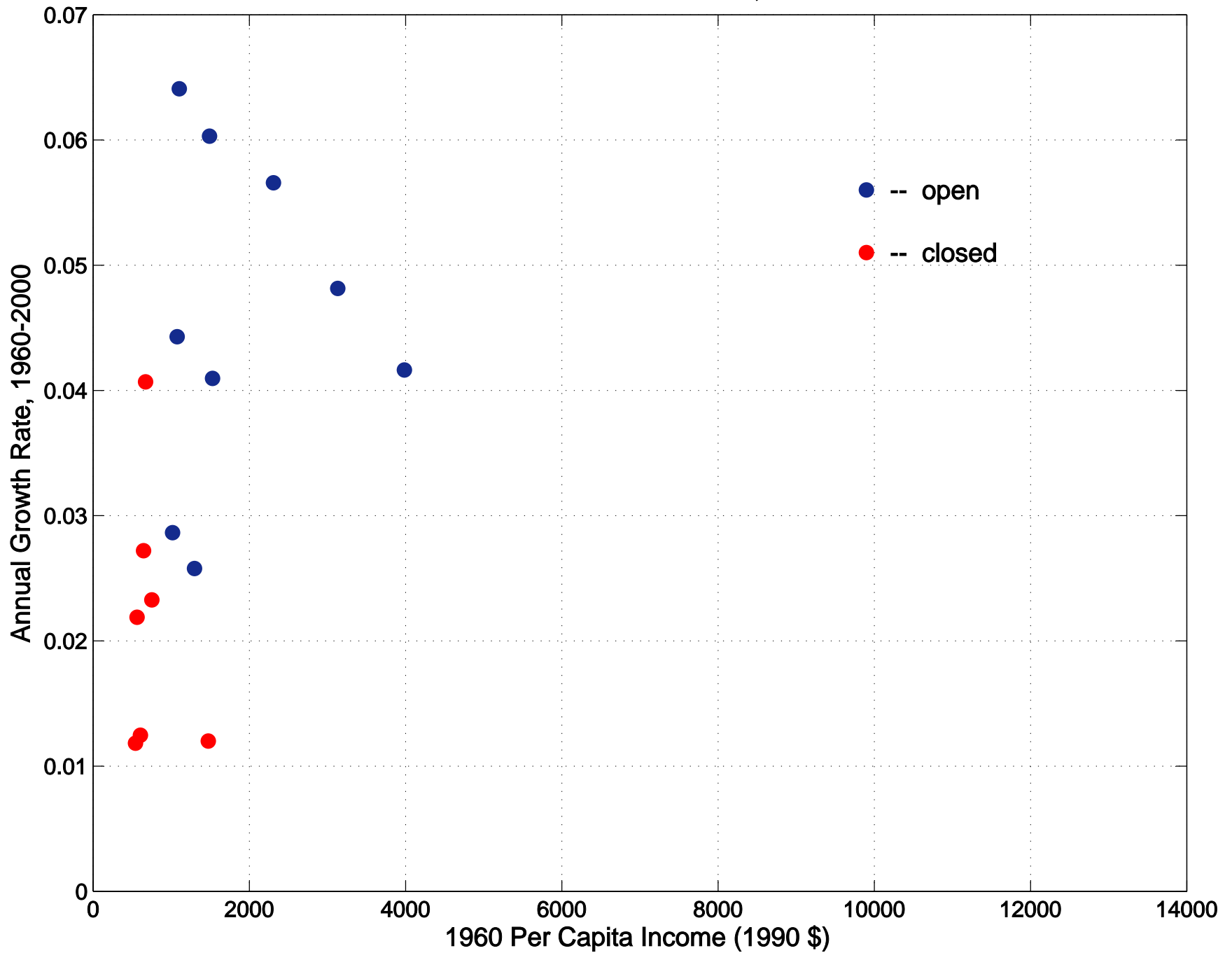
INCOME LEVELS AND GROWTH RATES, 112 COUNTRIES



INCOME LEVELS AND GROWTH RATES, 25 EUROPEAN COUNTRIES



INCOME LEVELS AND GROWTH RATES, 16 ASIAN COUNTRIES



- Excellent country-by-country appendix in SW paper
- Note that classification is for entire 20 year period
- ...extended by me to 40 year period
- Wazciarg and Welch (2003), interesting follow-up paper
- Exploits panel character of data set to examine within-period reforms

- A model of catch-up growth
- Take country's per capita GDP to be proportional to knowledge level
- Consider country with knowledge level h ; leader (US) has level $H > h$
- Assume

$$\frac{1}{H} \frac{dH}{dt} = \mu \quad (\text{a constant})$$

$$\frac{1}{h} \frac{dh}{dt} = \mu \left(\frac{H}{h} \right)^\theta$$

- Call $\theta \in [0, 1]$ a **spillover parameter**: measure of rate of idea flows

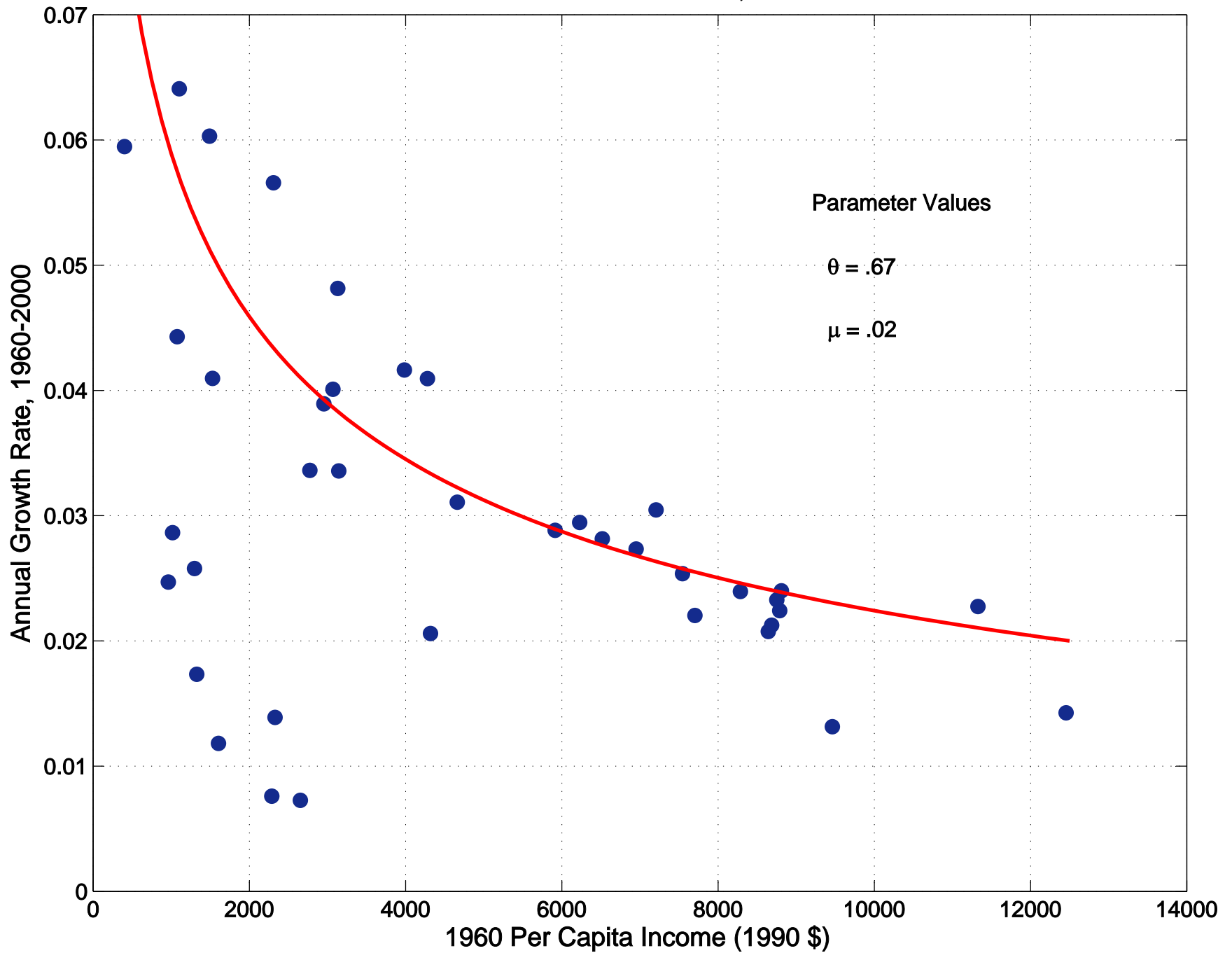
- Example: U.S. growth about $\mu = .02$
- Poland's GDP about $0.27 \times$ US GDP (per capita, Maddison, 2000)
- Then Poland's growth rate should be about

$$\frac{1}{h} \frac{dh}{dt} = (.02)(3.7)^\theta$$

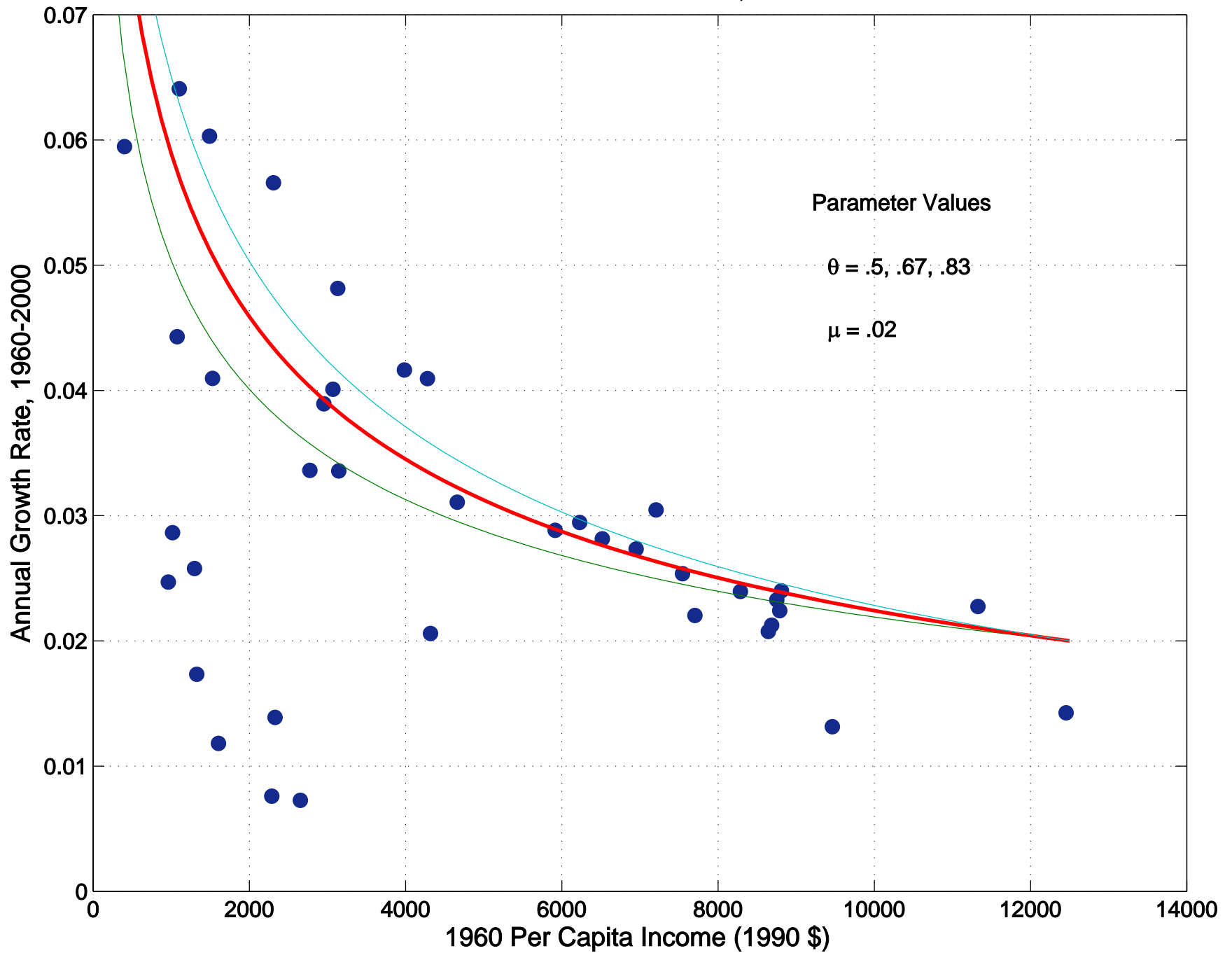
- If $\theta = 0$, growth is .02 : Poland will never catch up!
- If $\theta = 1$, growth is .07: Polish income converges to US level **fast**

- How good is this model? What is value of θ ? Is it really constant?
- Apply model to **open** economies only
- Work out predictions for Sachs-Warner plots (solve DE)
- Plot curve against data.
- Which θ gives best fit?

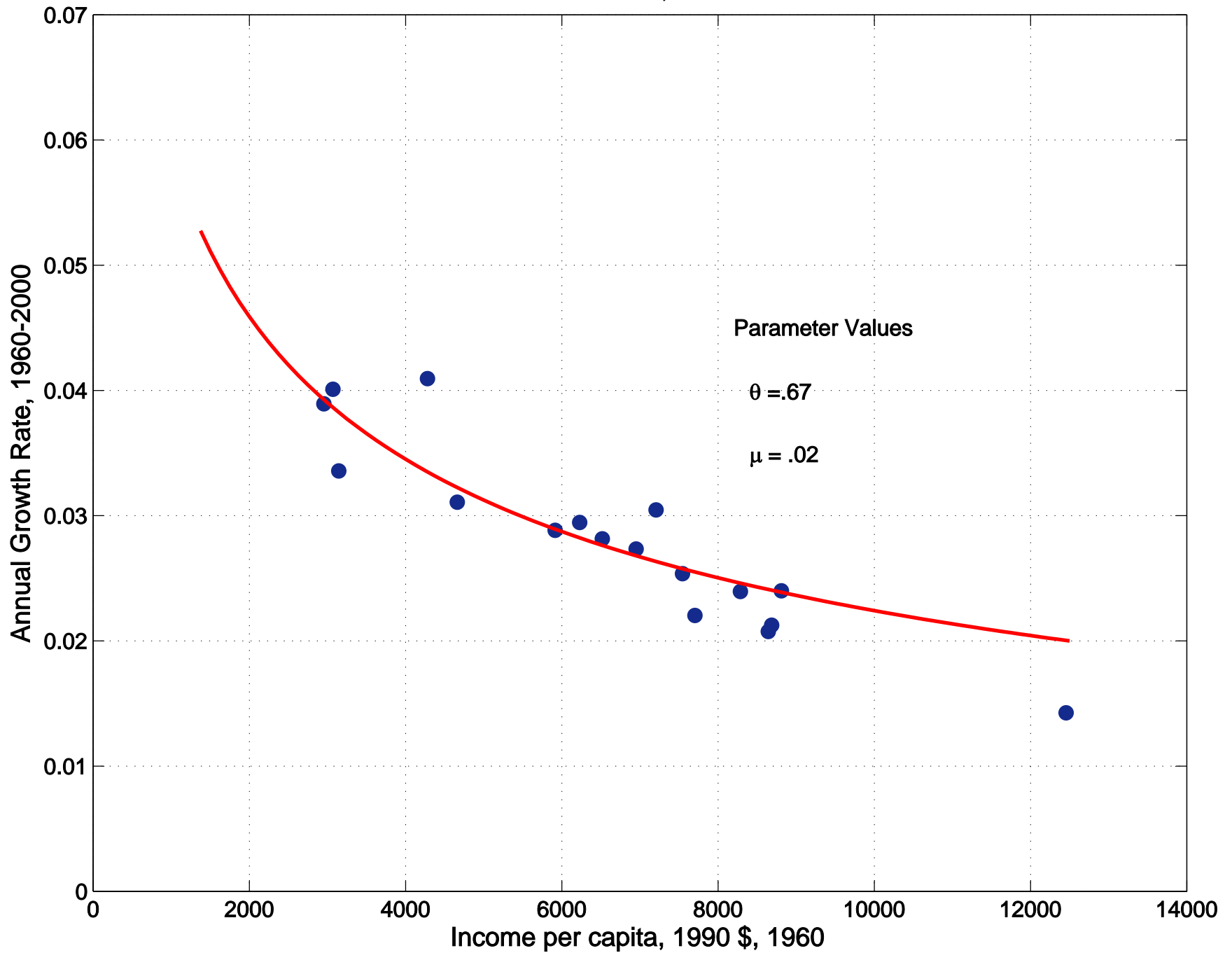
INCOME LEVELS AND GROWTH RATES, 39 OPEN ECONOMIES



INCOME LEVELS AND GROWTH RATES, 39 OPEN ECONOMIES



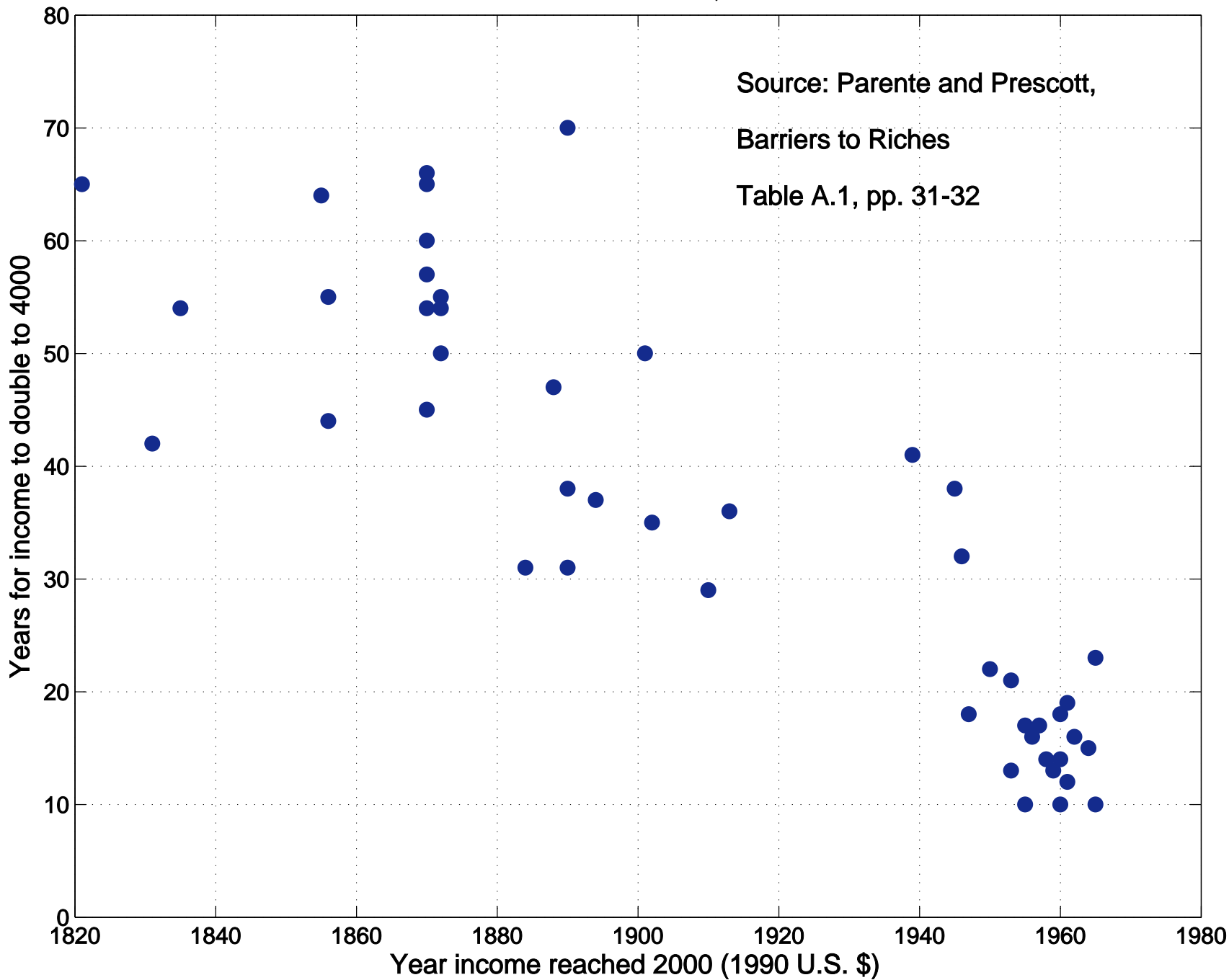
INCOME LEVELS AND GROWTH RATES, 17 OPEN EUROPEAN ECONOMIES



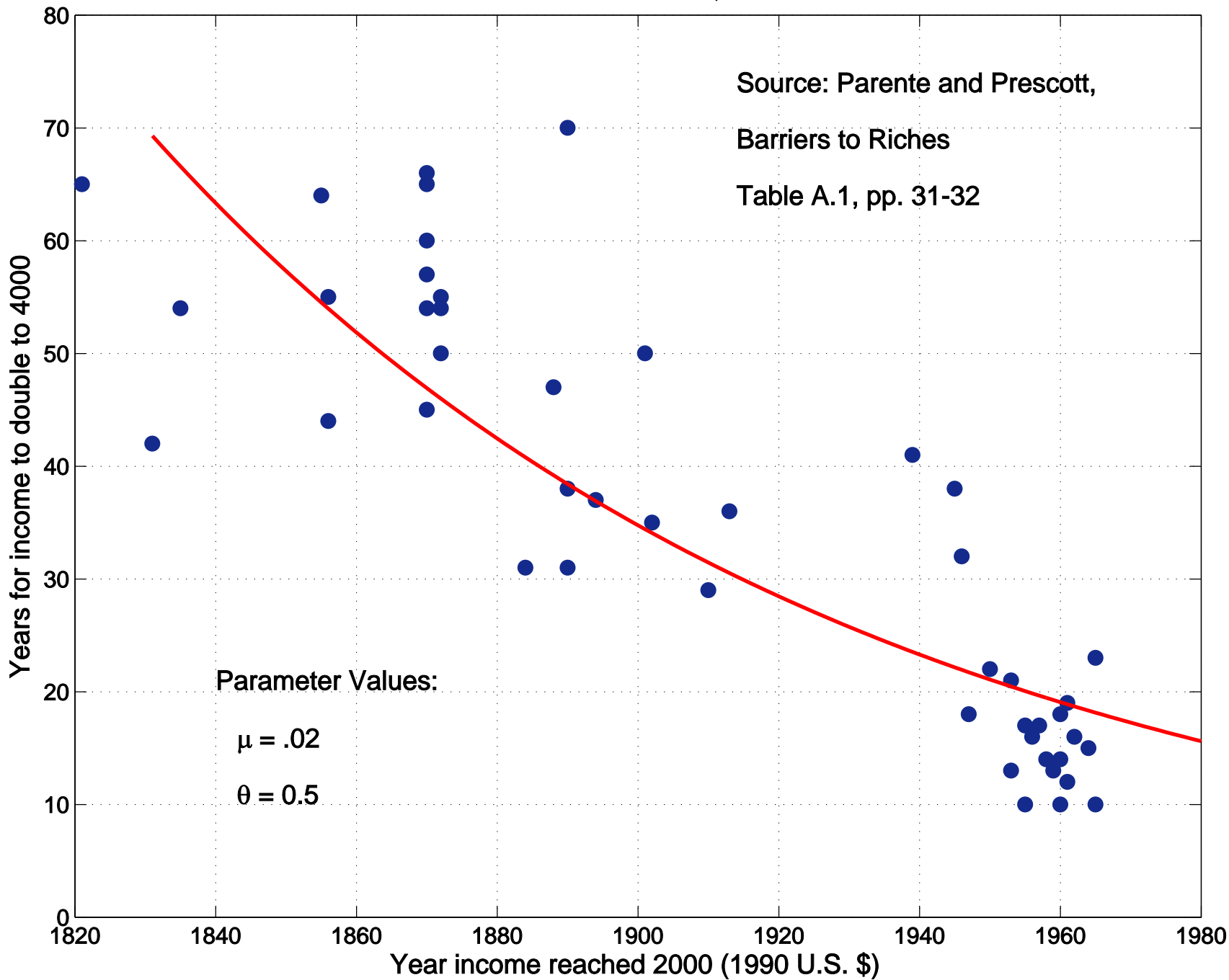
Post-1820 evidence

- Parente and Prescott, *Barriers to Riches*, 2002
- Source: Maddison, OECD
- Plot of years country took for income to grow from 2000 to 4000 (1990 USD) against date country reached 2000
- Same catch-up model implies curve for these data

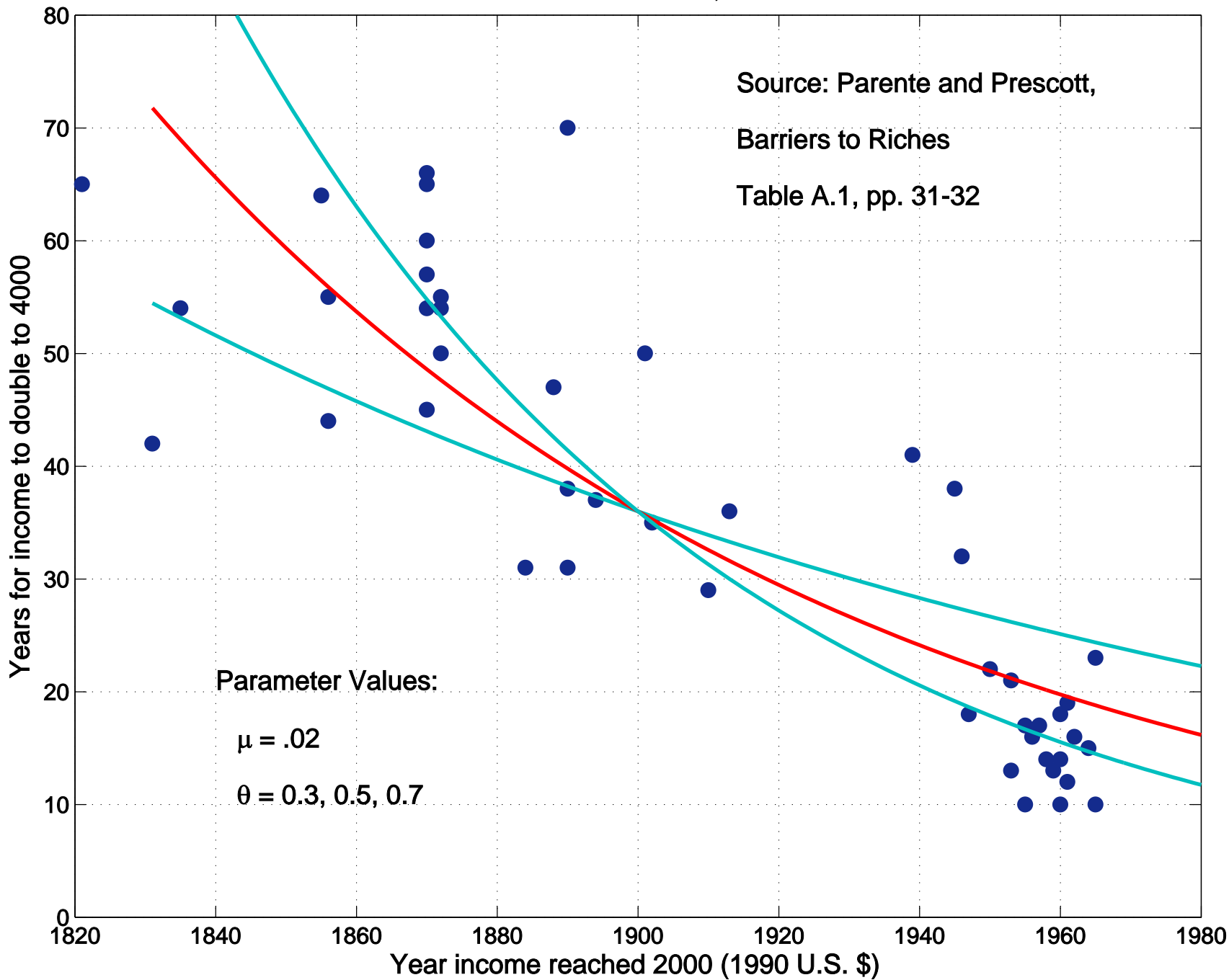
INCOME DOUBLING TIMES, 50 COUNTRIES



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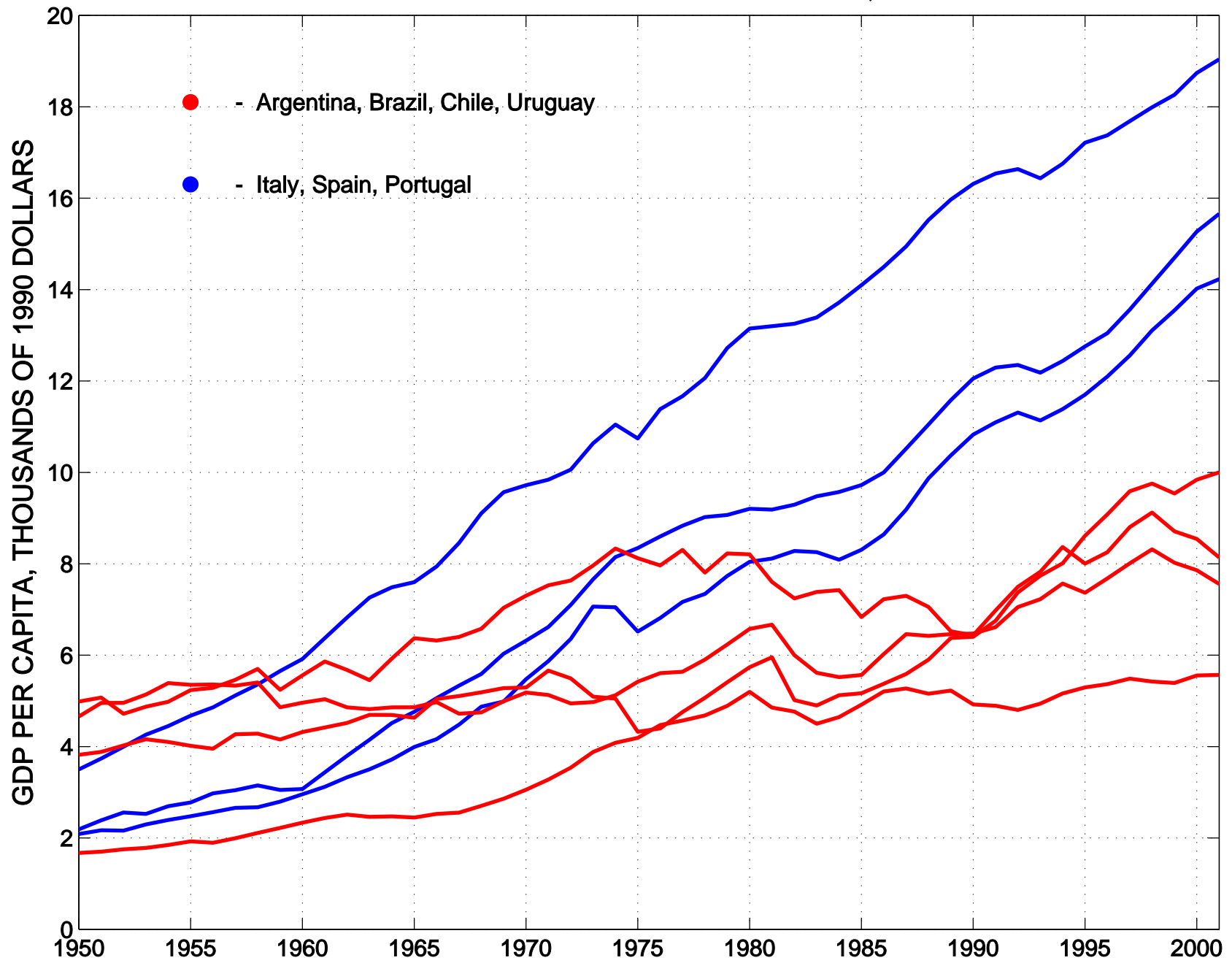
- Sum up evidence.
- Same model fits successful economies pretty well, throughout IR
- Estimate spillover parameter at $\theta = .65 \pm .15$
- Implies potential growth for Poland (using Maddison, 2000, for GDPs)
$$(.02) (3.7)^{.65} = 4.7\%$$
- For China,
$$(.02) (7.8)^{.65} = 7.6\%$$
- For Germany or France, 2.5%

Questions about the model

- Theory implies that all economies lying below the curve
....are falling short of potential, due to bad policies. Plausible?
- Consider 4 groups of countries in turn
 - Latin America
 - eastern Europe
 - Africa
 - Asia

- Latin America ?
- Compare post-1950 growth of
 - Argentina, Uruguay, Chile, Brazil to...
 - Italy, Spain, Portugal
- Similar cultures, similar 1950 income levels
- Europeans open, Americans closed

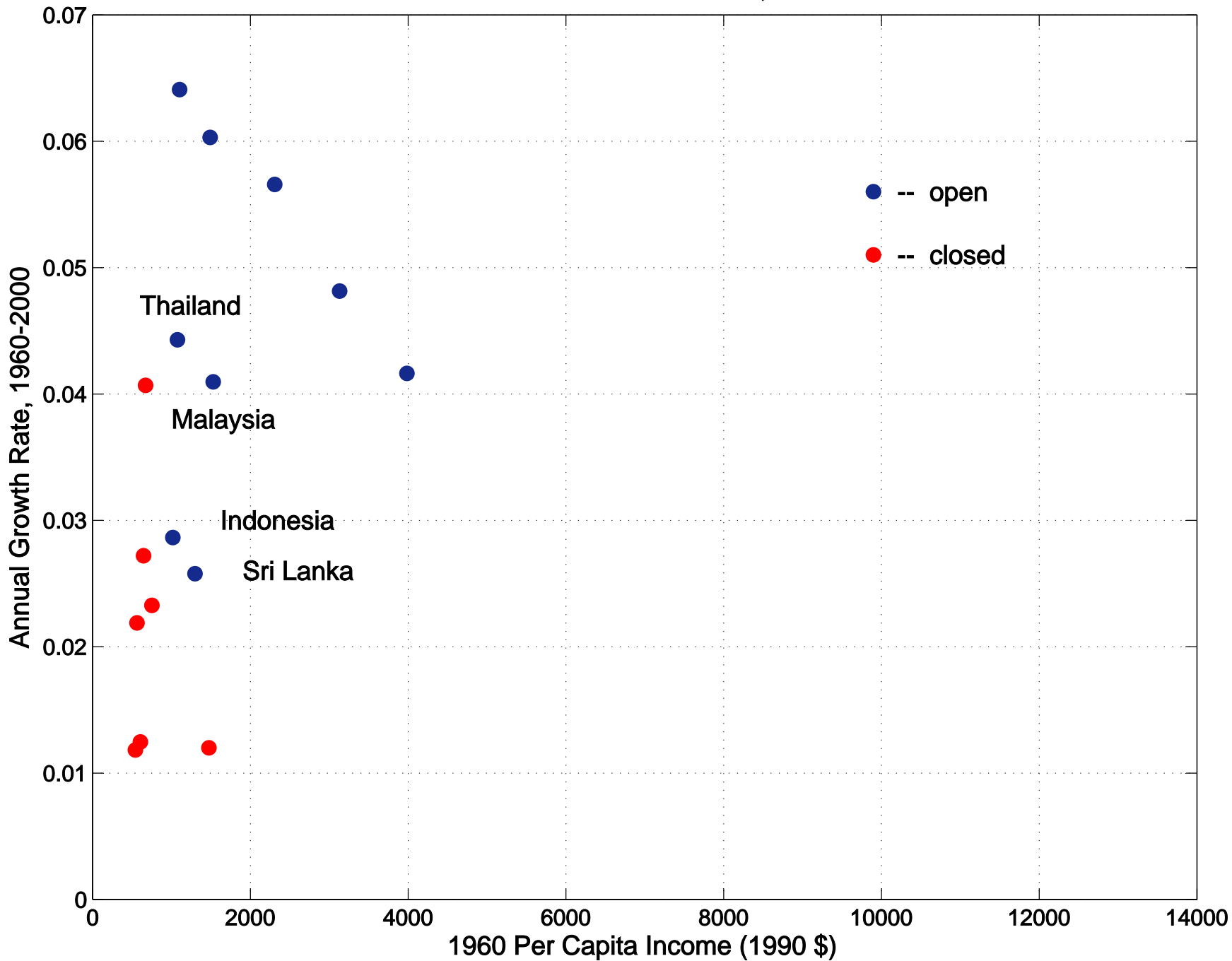
SOUTHERN CONE AND SOUTHERN EUROPE, 1950-2001



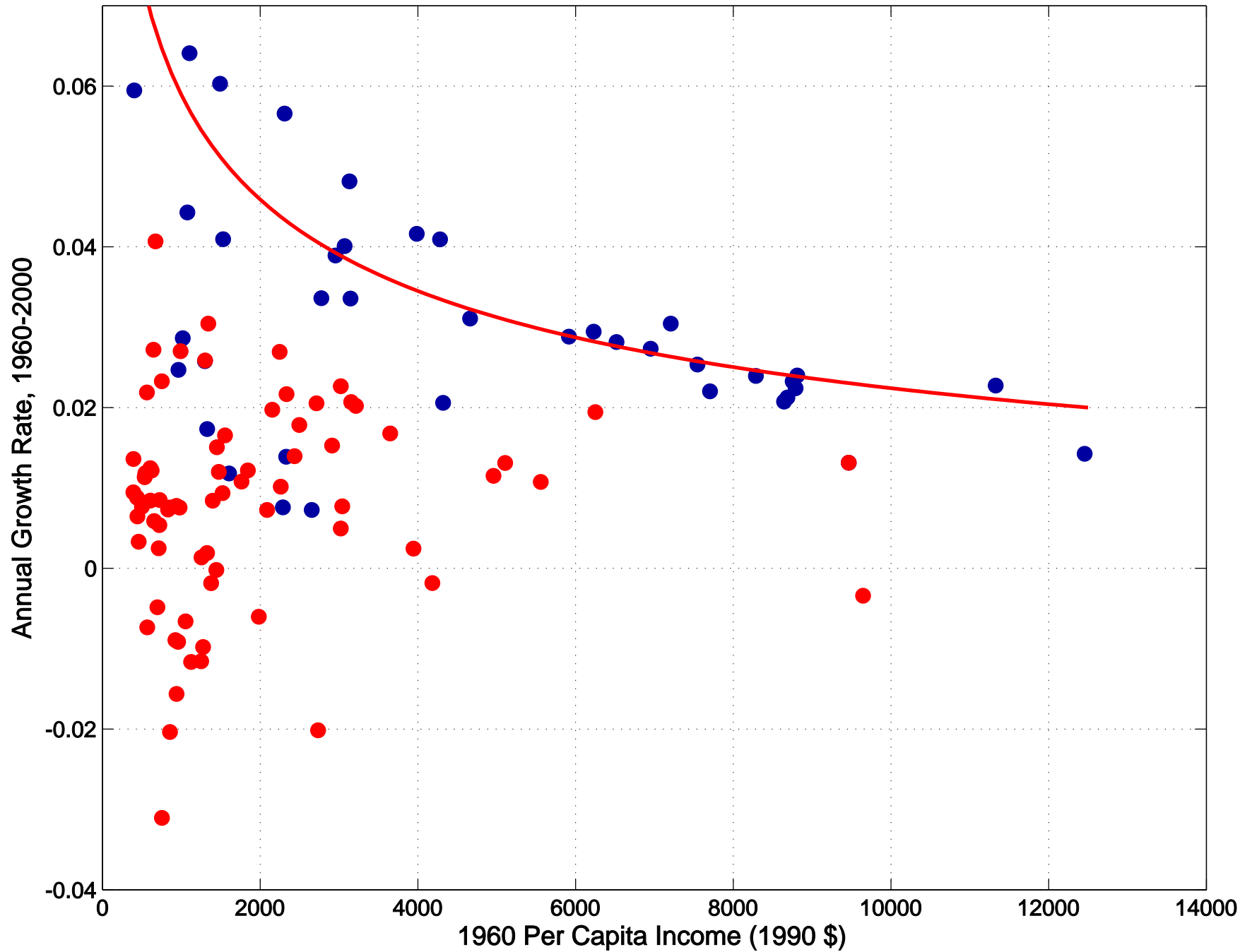
- Eastern Europe?
- Africa ?
- Not places to look for “ideal circumstances”

- Asia ?
- Japan, Hong Kong, Singapore: right on curve
- Some others closed: India, Bangladesh, Pakistan
- But there are important open exceptions: Thailand, Indonesia
- Average growth rates well below “potential”

INCOME LEVELS AND GROWTH RATES, 16 ASIAN COUNTRIES



INCOME LEVELS AND GROWTH RATES, 112 COUNTRIES



- Indonesia 1960-2000 growth rate: 3%
- But 1960 GDP, relative to US, was 1/12. Implied 1960 potential:

$$(.02)(12)^{.65} = 10\%$$

- Implied 1960 potential for open China was 13%
- For open Bangladesh, 15%
- All these numbers seem much too high

- For poorest economies, theory needs modification
- For the rest ($>$ \$2000 per year) simple model is consistent with evidence on comparative performance
- Implies that open economies will grow faster than US, Europe, Japan

$$\frac{1}{h} \frac{dh}{dt} = (.02) \left(\frac{H}{h} \right)^{.65}$$

- Will ultimately reach (approximately) U.S. levels, grow at same rate
- Those that stay closed? Continued backwardness