Economic Development

Wash U presentation

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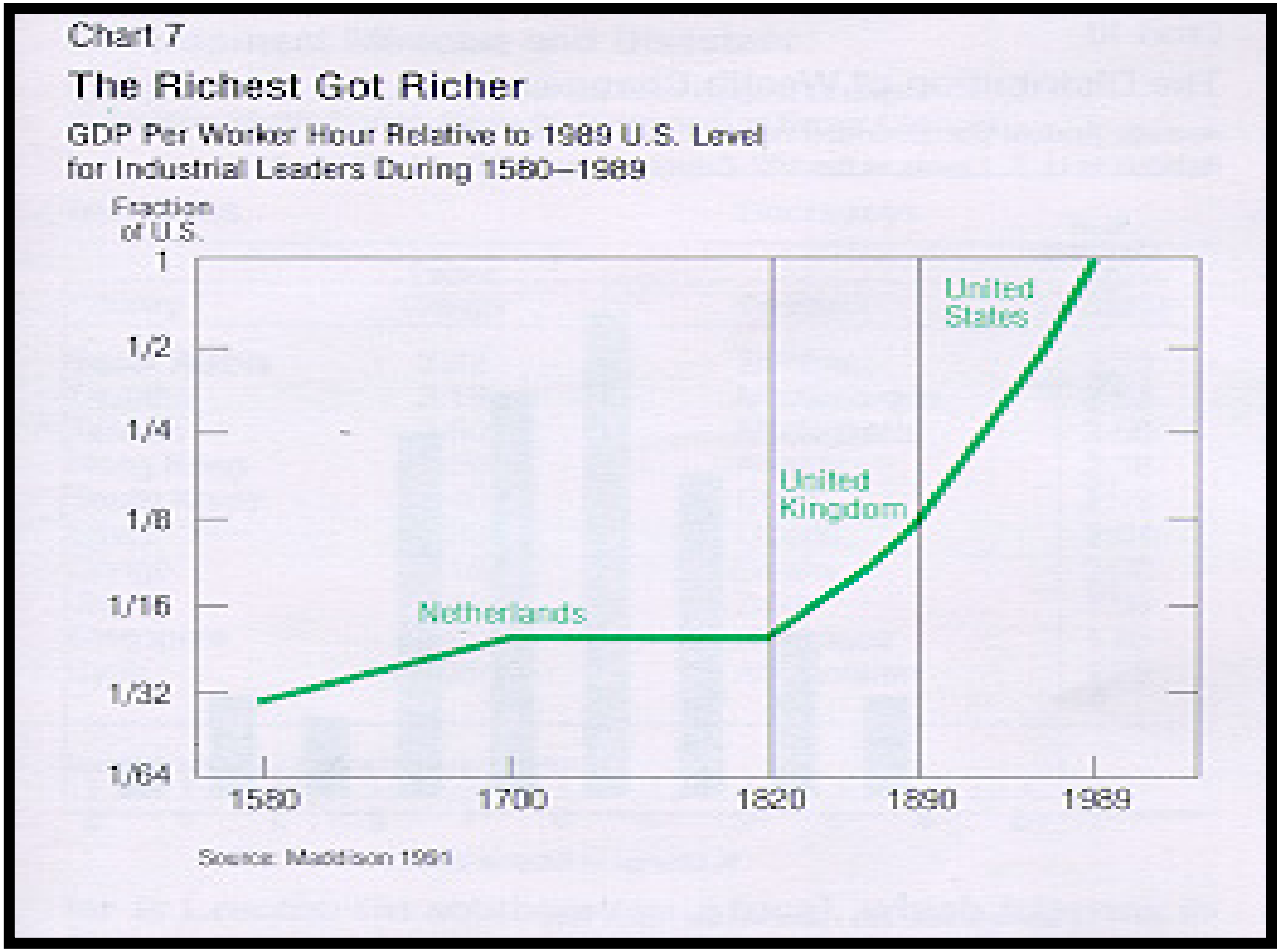
Modern economic growth

- Growth rate of U.S. per capita income over the course of this century ≈ 2% per year.
- Relative to most of human history, 2% growth is exceptionally high!

  Netherlands (1580-1820): 0.2%

  U.K. (1820-1890): 1.2%

Facts: Growth rates



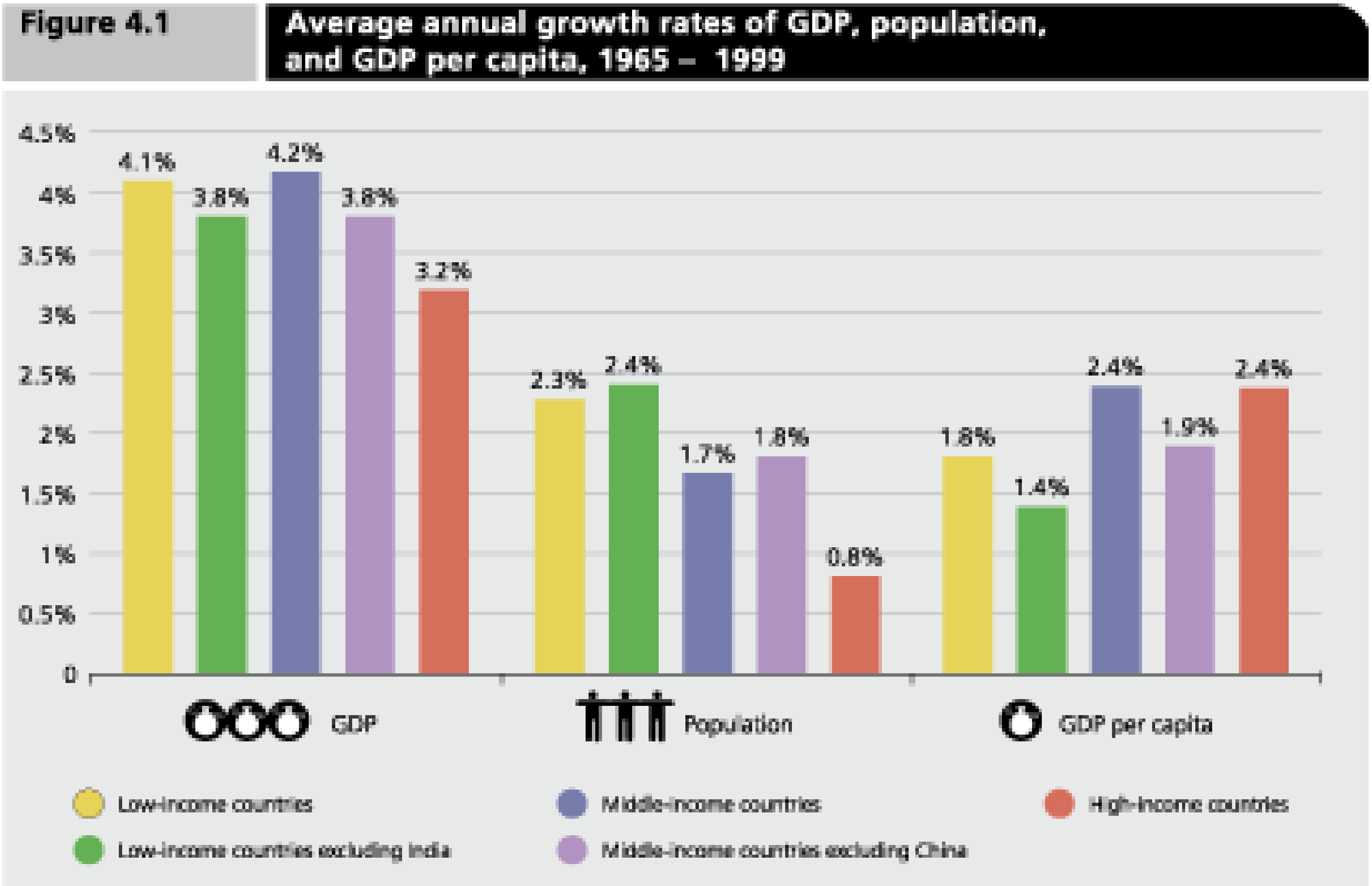
- Between 1870 and 1978, U.S. per capita income has increased by a factor of 7.5, Sweden by a factor of 11, Japan by a factor of 16!
- If the 2% growth rate is sustained, incomes will double every 35 years.

- If the growth rate is γ, how long does it take to double the per capita income?
- Let the number of years be T.

  $y_T = (1+\gamma)^T y_0$ where $y_T = 2y_0$.

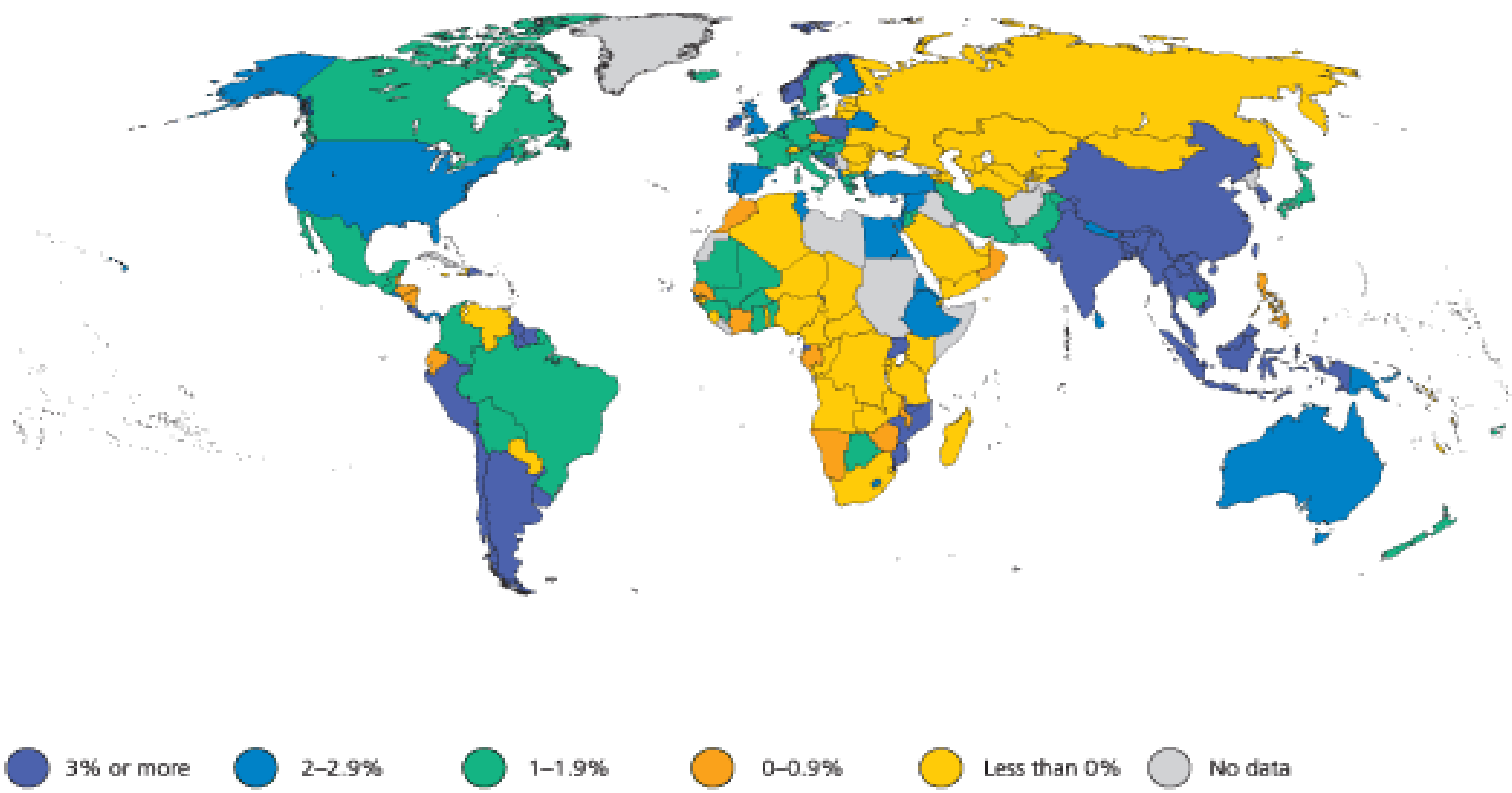
  Then, $\ln(2) = T \ln(1+\gamma)$.
- At a growth rate of 2%, per capita income doubles approximately every 35 years. At a growth rate of 7%, per capita income doubles approximately every 10 years.

… Facts: Growth rates



… Facts: Growth rates

Map 4.1 GDP per capita growth rates, 1990–1999



Convergence?

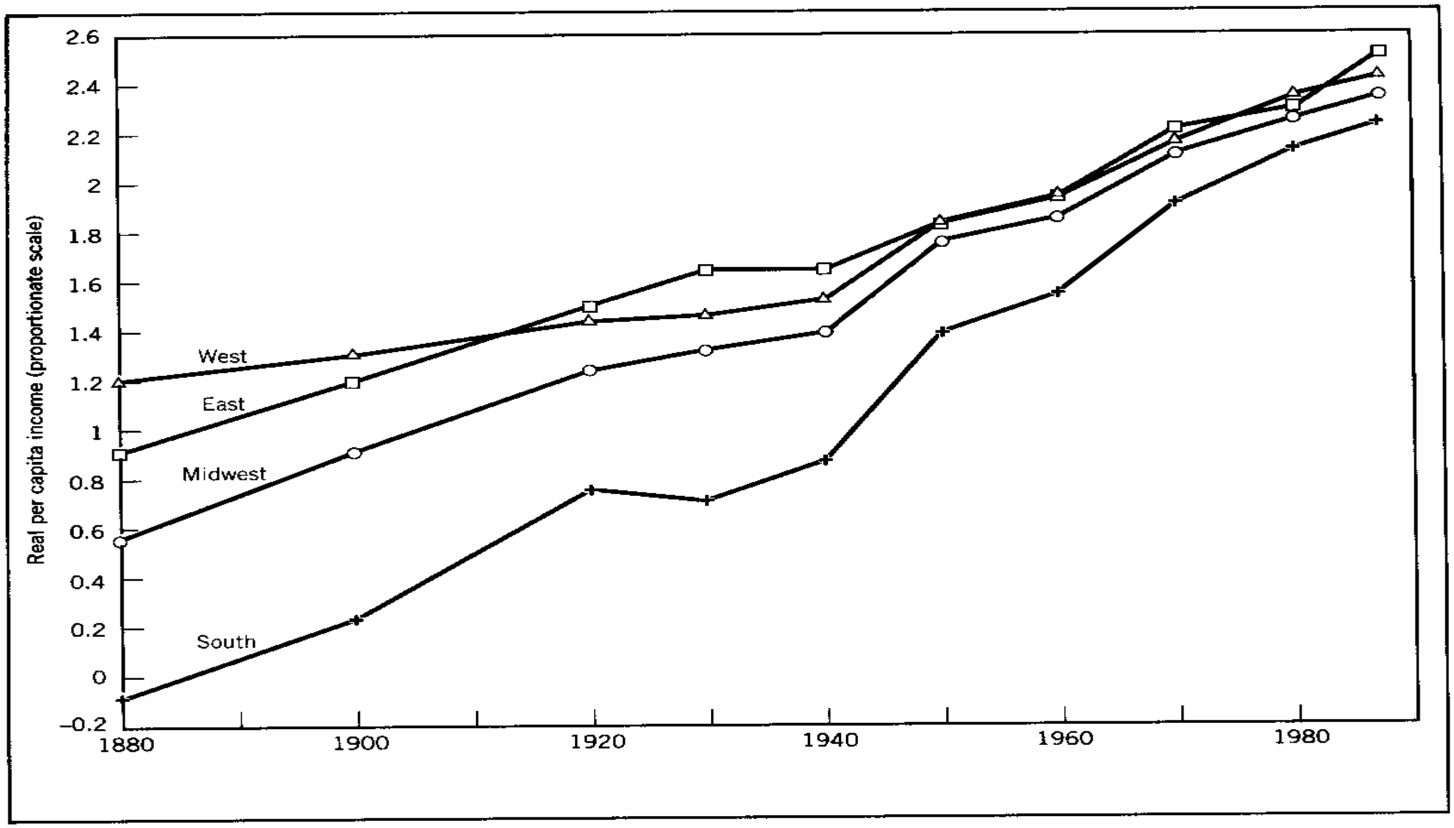


FIGURE 11.7 *Per Capita Income for Four U.S. Regions*
The figure shows the average of per capita personal income for the four regions from 1880 to 1988. The spread across the regions has narrowed substantially over time.

[9]This evidence comes from studies by Robert Barro and Xavier Sala-i-Martin (1991, 1992).

[10]The data refer to personal income exclusive of all transfer payments.

... Convergence?

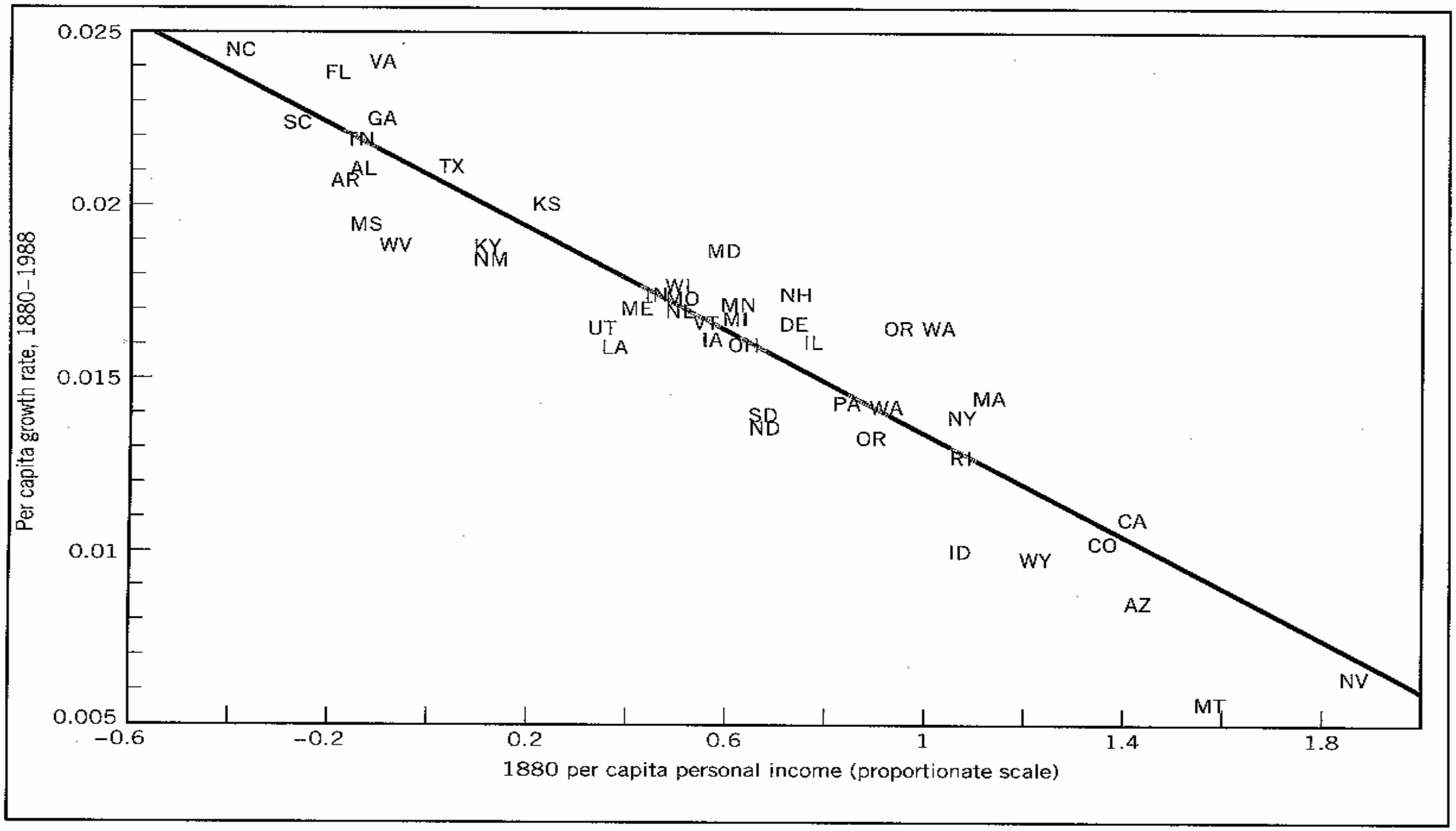


FIGURE 11.6 *Growth of Per Capita Income for U.S. States, 1880–1988*
The average growth rate of per capita personal income, shown on the vertical axis, is inversely related to the initial level of per capita income, shown on the horizontal. (The horizontal axis uses a proportionate scale.)

… Conditional convergence

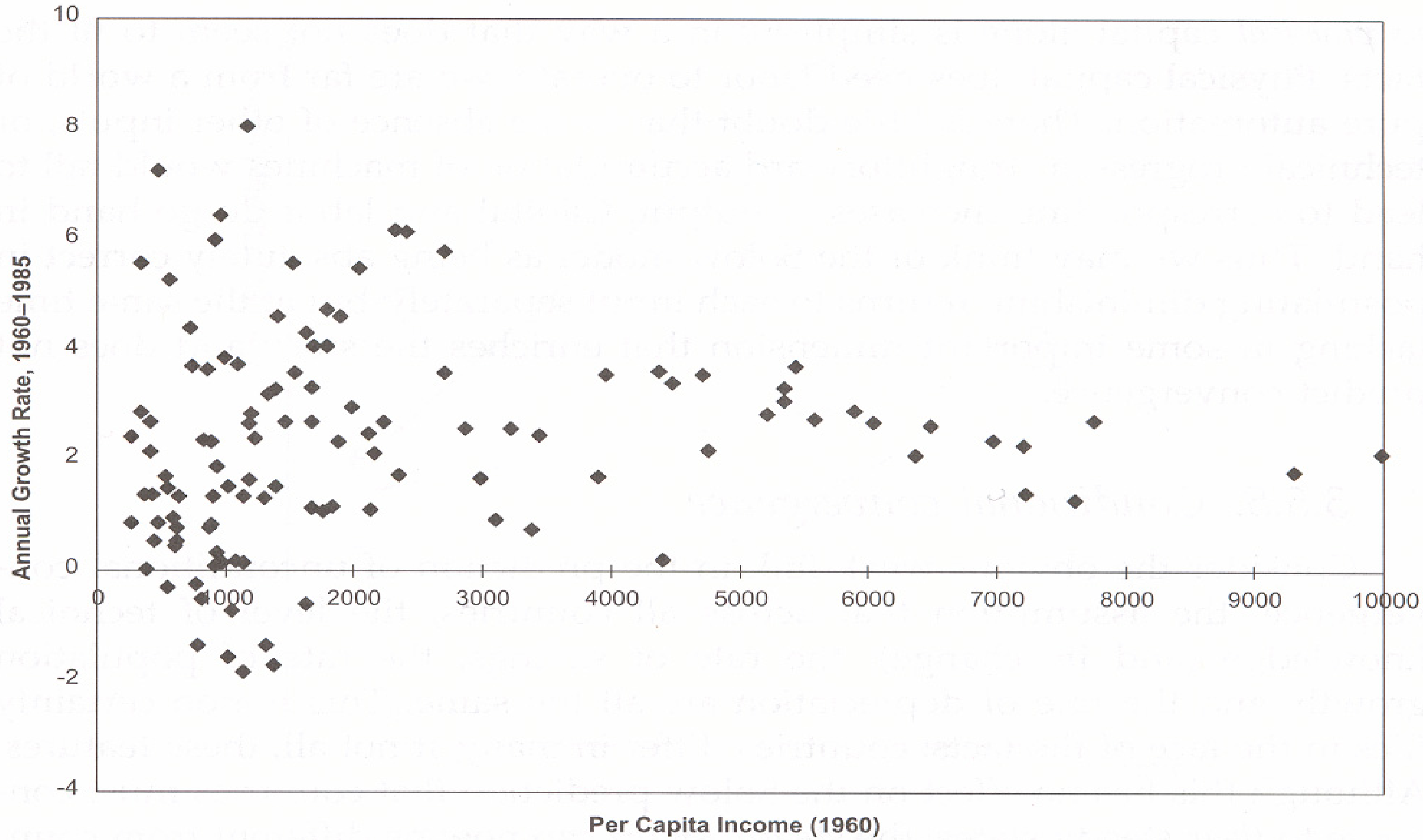


Figure 3.10. Per capita GDP (1960) against average annual growth rate, 1960–85. Source: Penn World Tables Mark II.

Facts: Income levels

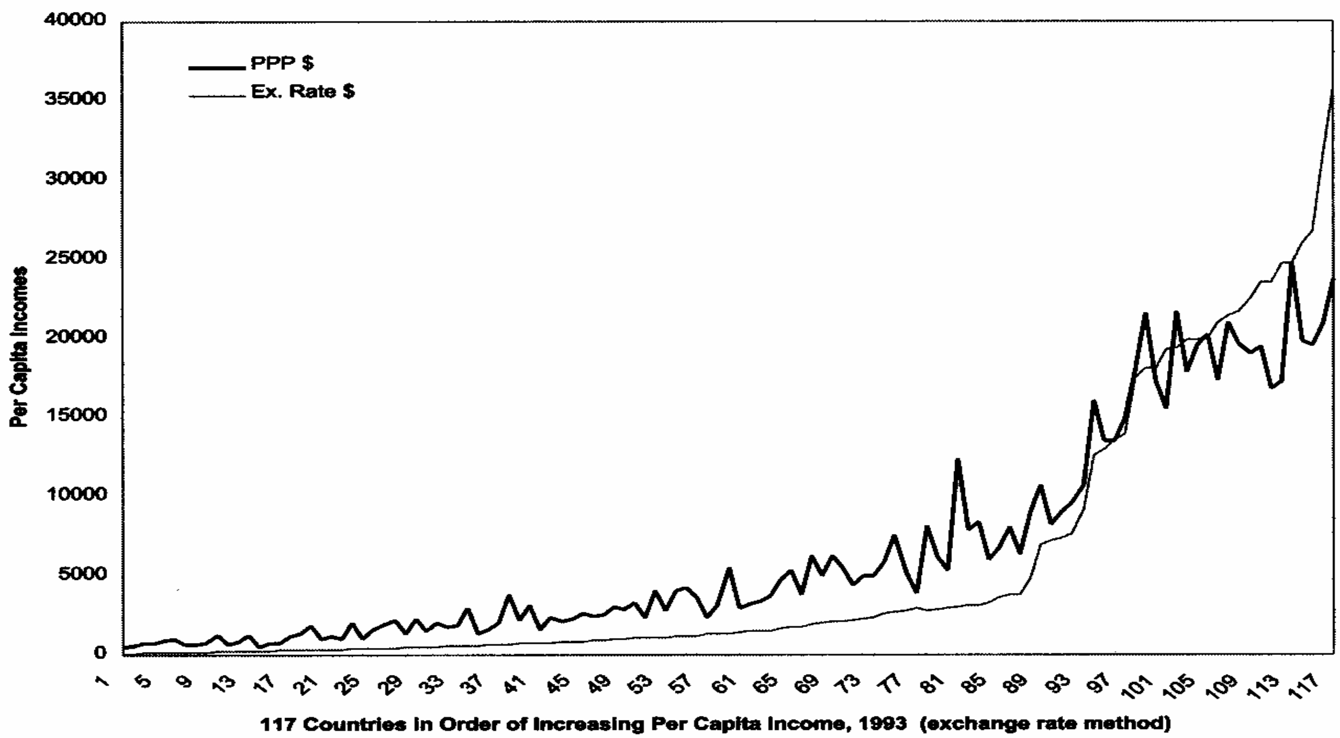
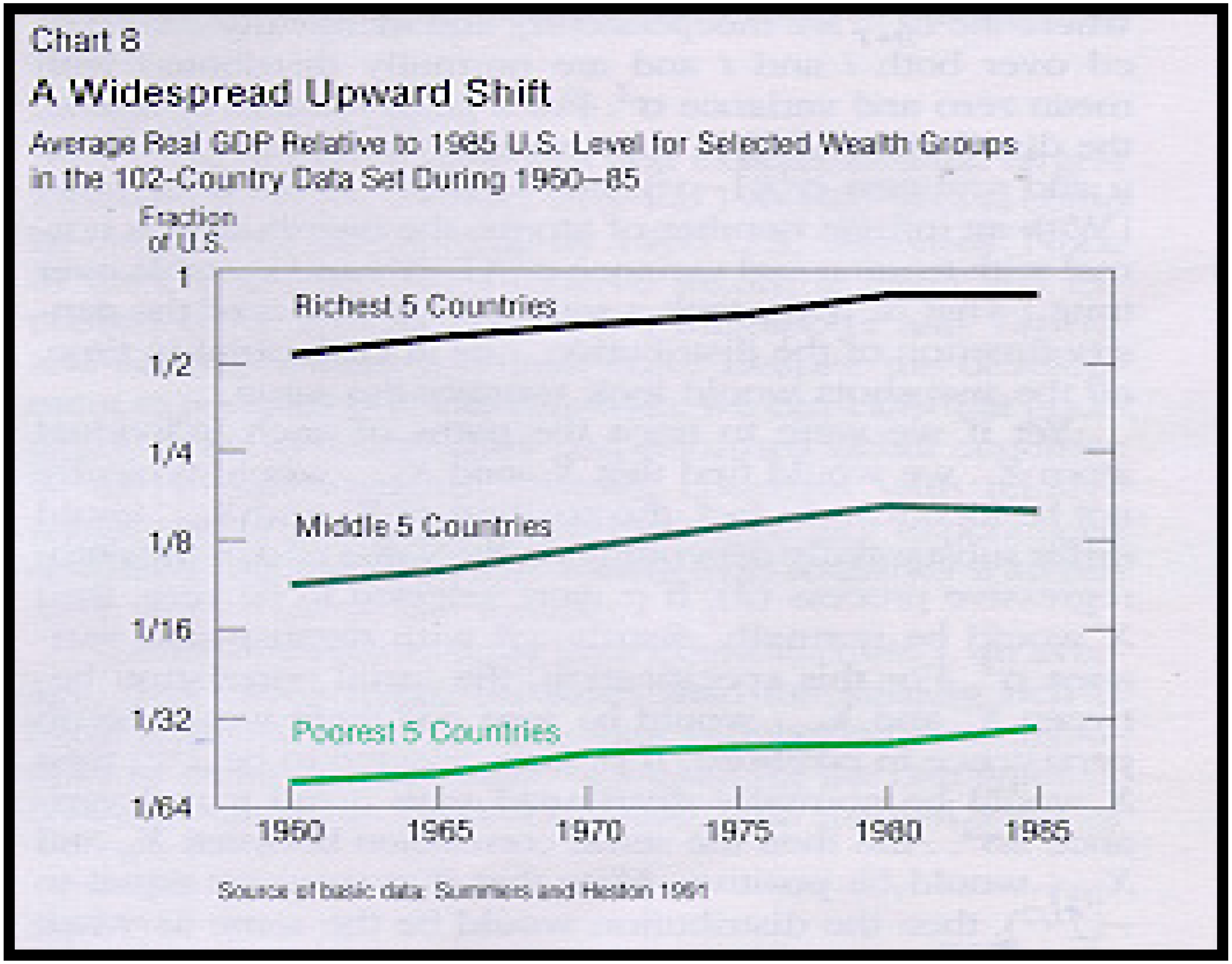
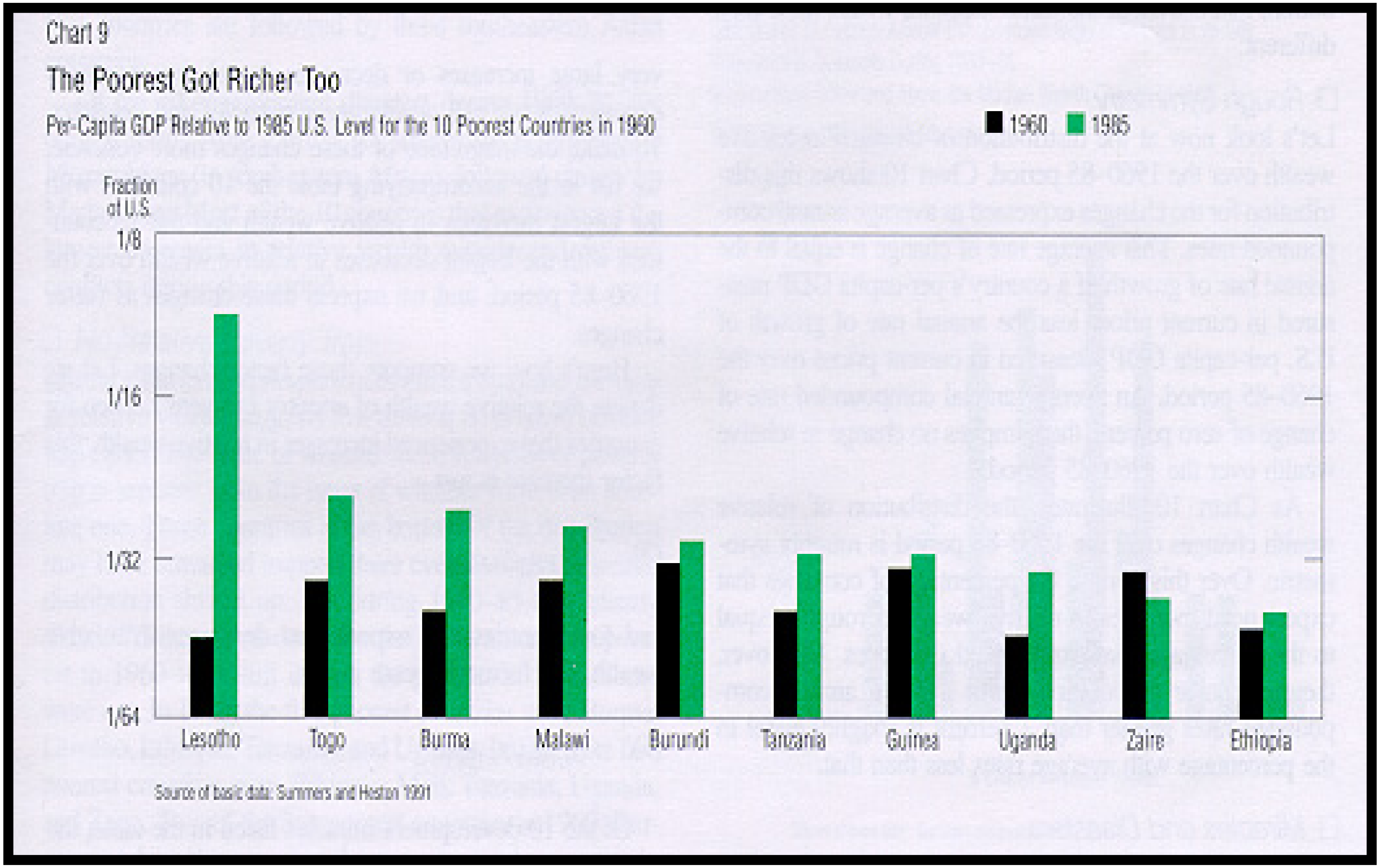


Figure 2.3. PPP versus exchange rate measures of GDP for ninety-four countries, 1993. Source: World Development Report (World Bank [1995]).

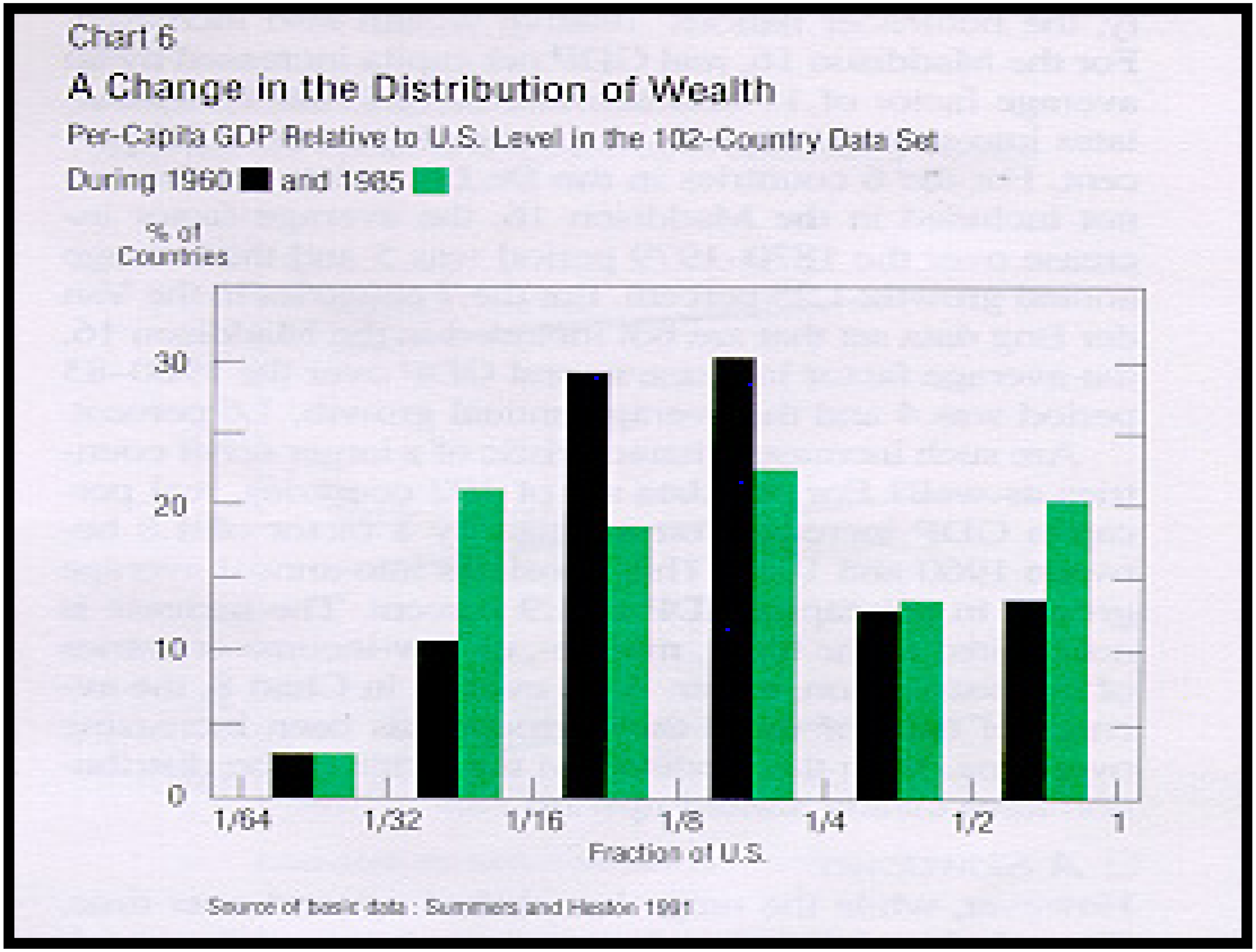
… Facts: Growth rates



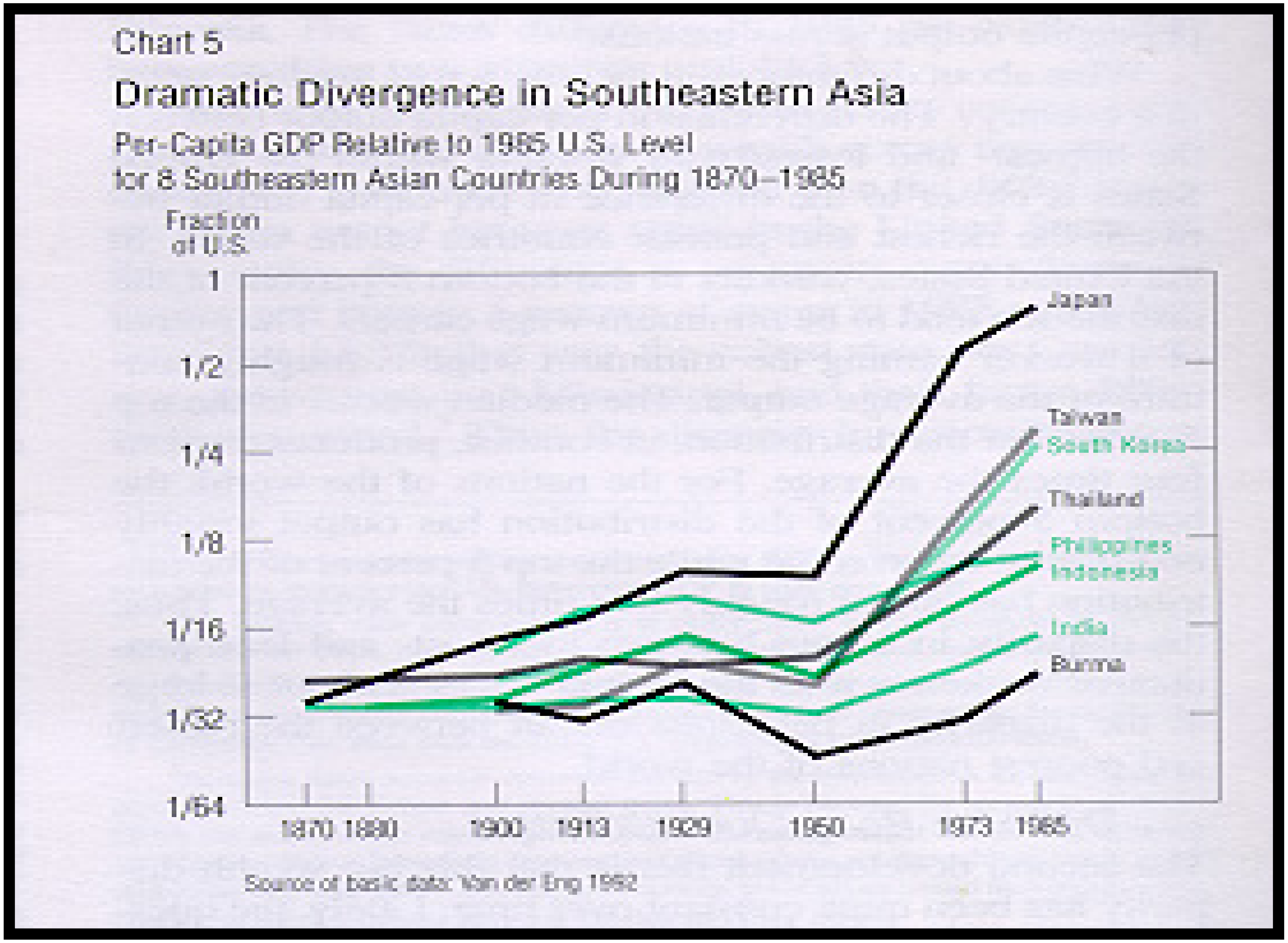
… Facts: Growth rates



… Facts: Income levels



... Facts: Income levels



1 Introduction

- Large differences in living standards across countries over the last 40 years. Measured by GDP per capita, the ratio of rich to poor is more than 30.

- Accounting based on the Solow growth model implies that the income differences are largely due to TFP differences.

- A rough calculation based on exogenous TFP differences in the Solow model
  - $y_t = A(1+\gamma)^{t(1-\theta)} k_t^{\theta}$, where γ is labor-augmenting technical progress and θ is capital share.
  - $k_{t+1}(1+n) = (1-\delta)k_t + sy_t$.
  - Balanced growth implies $k_{t+1} = (1+\gamma)k_t$, so

$$k_t(1+n+\gamma+n\gamma) = (1-\delta)k_t + sy_t$$

- Approximately,

$$\frac{k_t}{y_t} = \frac{s}{n + \gamma + \delta}.$$

- Substitute into the production function to get

$$y_t = A^{\frac{1}{1-\theta}}(1 + \gamma)^t \left(\frac{s}{n + \gamma + \delta}\right)^{\frac{\theta}{1-\theta}}$$

- Alternatively,

$$
\begin{aligned}
y_t &= A(1+\gamma)^{t(1-\theta)} k_t^{\theta} \\
y_t^{1-\theta} &= A(1+\gamma)^{t(1-\theta)} \left(\frac{k_t}{y_t}\right)^{\theta}
\end{aligned}
$$

- Hence,

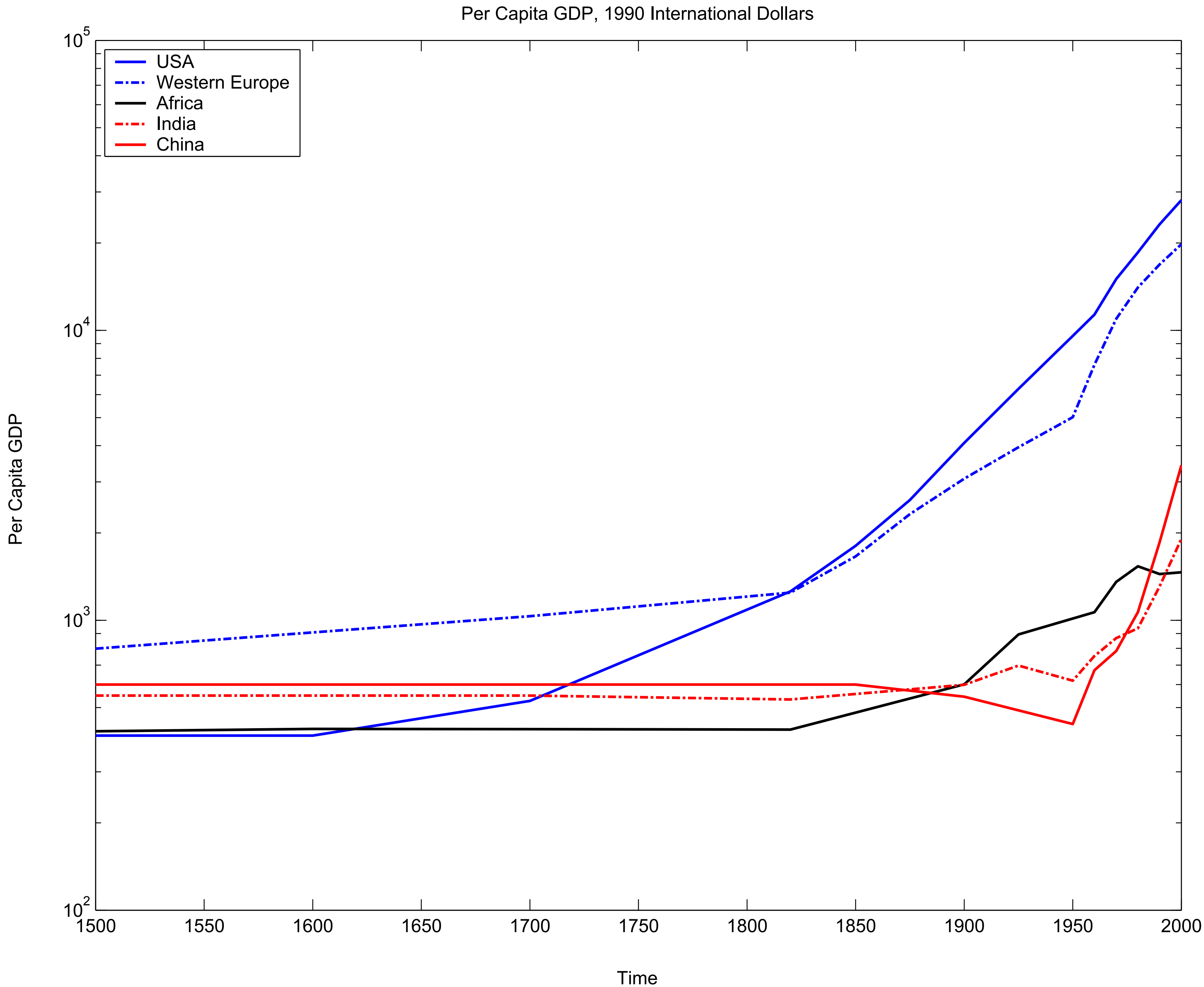
$$
y_t = A^{\frac{1}{1-\theta}} (1+\gamma)^t \left(\frac{k_t}{y_t}\right)^{\frac{\theta}{1-\theta}}
$$

- Ratio of $\frac{k}{y}$rich to $\frac{k}{y}$poor equals 2.7 (Hall and Jones, 1999, estimate the ratio to be 3.6).
  - Suppose that the rate of exogenous technical progress is the same across countries i.e., $\gamma_{\text{rich}} = \gamma_{\text{poor}}$.
  - With $\theta = 0.4$, if the TFP ratio A_{rich} to A_{poor} is 3, the income difference is a factor of 12.

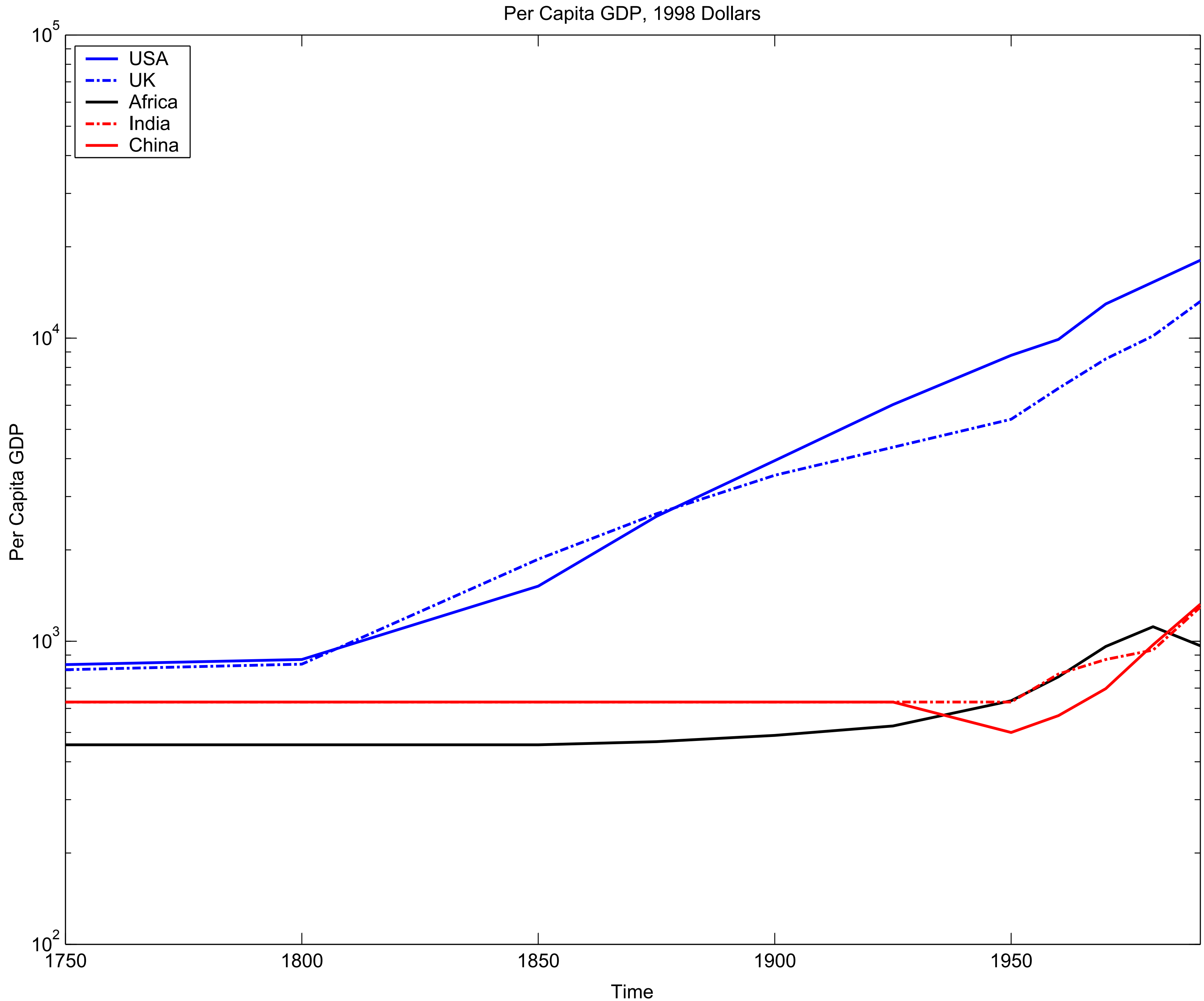
- Quantitative explanations for cross-country income differences
  - Small differences in TFP, but large non-linear effects on factor allocation.
  - Observed income differences do not translate into welfare differences e.g., Home production models.
  - Barriers to technology adoption, capital accumulation

- Point of departure: The observed income differences over the last 40 years are not steady state differences.

- Objective: To quantitatively account for the observed *long run* differences between rich and poor countries in
  - Income
  - Savings rate



Per Capita GDP, 1990 International Dollars
USA
Western Europe
Africa
India
China
Per Capita GDP
Time
10^5
10^4
10^3
10^2
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000


Per Capita GDP, 1998 Dollars
USA
UK
Africa
India
China
10^5
10^4
10^3
10^2
Per Capita GDP
1750
1800
1850
1900
1950
Time

... Introduction

- This paper contributes to the quantitative theory of *evolution* of inequality. It relies on initial endowment differences.

- Factor accumulation plays a key role in the evolution of income inequality.

- TFP is endogenous.

2 Economic Environment

2.1 Technology

$$y_1 = a_1 k_1; \qquad y_2 = \widetilde{a}_2 k_2$$

$$k_1' = (1-\delta)k_1 + i_1$$

$$k_2' = (1-\delta)k_2 + i_2$$

$$c + i_1 + i_2 = y_1 + y_2.$$

$$\widetilde{a}_2 \text{ is i.i.d.}; \quad E\widetilde{a}_2 > a_1 \geq \delta.$$

2.2 Preferences

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{(c_t - \underline{c})^{1-\sigma}}{1-\sigma}$$

- The utility function is quasi-homothetic. The intertemporal elasticity of substitution varies with wealth when $\underline{c} > 0$. When wealth is sufficiently large, the effect of $\underline{c}$ is negligible.

- $\underline{c}$ is not subsistence consumption.

2.3 Endowments

The representative agent is initially endowed with k_{10} and k_{20}. The endowments are sufficiently large to finance the minimum consumption forever.

2.4 Optimization

The respresentative household's problem, given initial endowments, is to

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{(c_t - \underline{c})^{1-\sigma}}{1-\sigma}$$

$$\text{s.t.} \quad c_t + i_{1t} + i_{2t} = y_{1t} + y_{2t},$$

$$k_{1t+1} = (1-\delta)k_{1t} + i_{1t},$$

$$k_{2t+1} = (1-\delta)k_{2t} + i_{2t}.$$

A transformation of the household's problem:

- Define $r_1 = a_1 - \delta$ and $\widetilde{r}_{2t} = \widetilde{a}_{2t} - \delta$. (In equilibrium, r_1 and $\widetilde{r}_2$ will be the rental rates on riskless and risky capital, respectively.)

- Define *discretionary* consumption as $\widehat{c} = c - \underline{c}$ and *discretionary* riskless capital stock as $\widehat{k}_1 = k_1 - \frac{\underline{c}}{r_1}$.

The respresentative household's problem becomes

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{\widehat{c}_t^{1-\sigma}}{1-\sigma}$$

$$\text{s.t.} \quad \widehat{c}_t + \widehat{k}_{1t+1} + k_{2t+1} = (1 + r_1)\widehat{k}_{1t} + (1 + \widetilde{r}_{2t})k_{2t}.$$

- The transformed problem is similar to the optimal consumption and savings problem in Hakansson (1970).

- Step 1: Solve the portfolio problem – allocate a *unit* of wealth between risky and (discretionary) riskless assets.

- Step 2: Solve the consumption-savings problem in each period – decide how much to consume from the beginning-of-period wealth in each period.

- The portfolio weight does not change over time, so the portfolio problem has to be solved only once.

3 Results: Decision Rules

- The optimal portfolio weight ϕ^* solves

$$\max \frac{1}{1-\sigma} E\left\{(1+\widetilde{r}_2)\,\phi + (1+r_1)\,(1-\phi)\right\}^{1-\sigma}.$$

Denote the maximized value of this objective function as ρ^*.

- Denote the wealth at the beginning of period t as

$$\widetilde{\omega}_t \equiv (1+\widetilde{r}_{2t})k_{2t} + (1+r_1)\widehat{k}_{1t}.$$

- Then the decision rules are

$$\widehat{c}_t = (1 - \{\beta(1-\sigma)\rho^*\}^{1/\sigma})\widetilde{\omega}_t,$$

$$\widehat{k}_{1t+1} = \{\beta(1-\sigma)\rho^*\}^{1/\sigma}(1-\phi^*)\widetilde{\omega}_t,$$

$$k_{2t+1} = \{\beta(1-\sigma)\rho^*\}^{1/\sigma}\phi^*\widetilde{\omega}_t.$$

4 Calibration

- Suppose that the model period is 1 year and that there are 100 closed economies. The only difference between these economies is the initial level of wealth.

- Atkeson and Ogaki (1996) and Rosenzweig and Wolpin (1993):

$$\underline{c} = 177$$

$$\beta = 0.95$$

$$\sigma = 0.964$$

$$r_1 = 0.0536.$$

- The random variable $\widetilde{r}_2 \in \{x_L, x_H\}$ with probabilities π and $1 - \pi$.

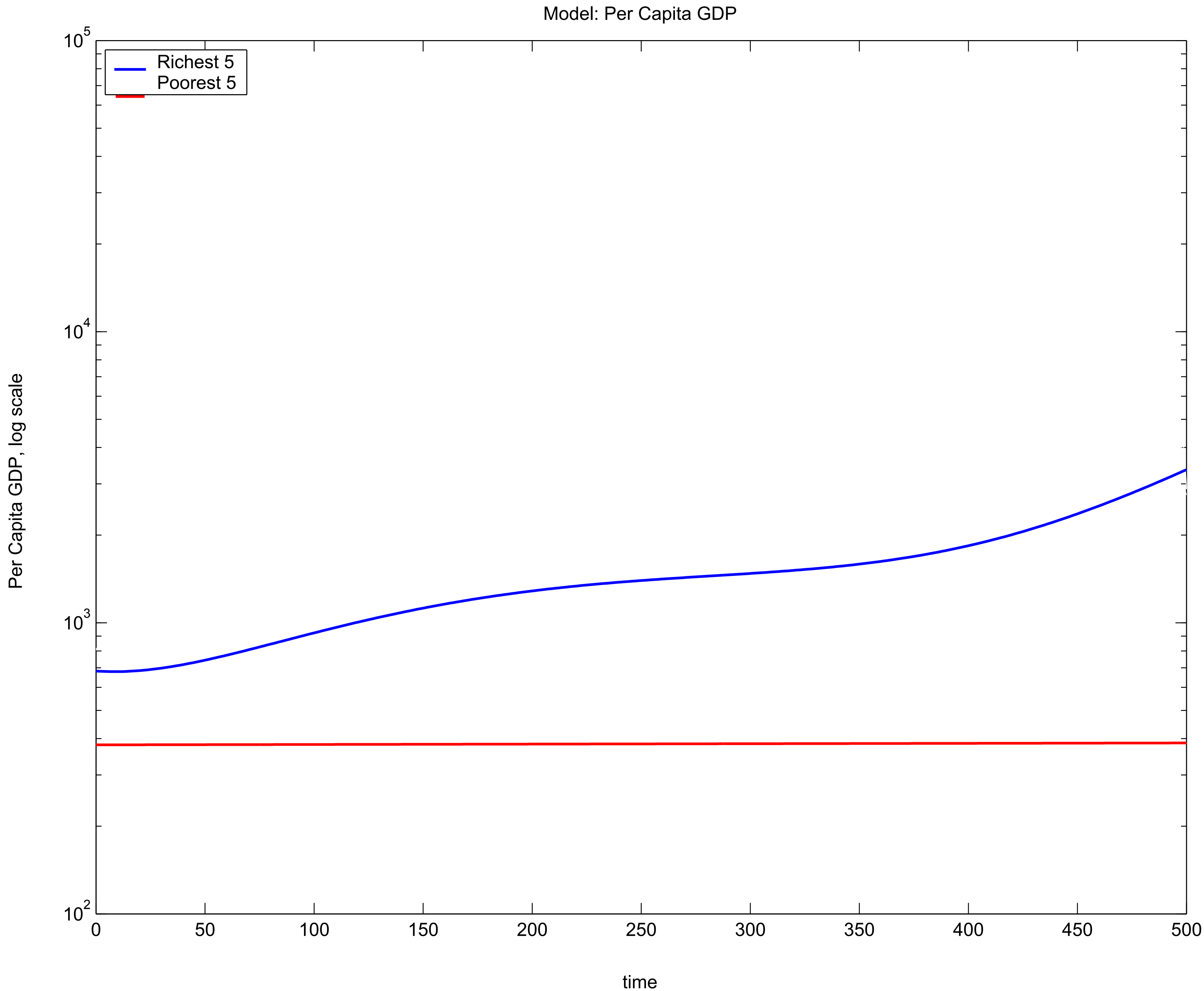
- The distribution of $\widetilde{r}_2$ and the initial wealth levels are chosen to deliver the following:

  - initial GDP for the poor country is roughly equal to its value in the year 1500,

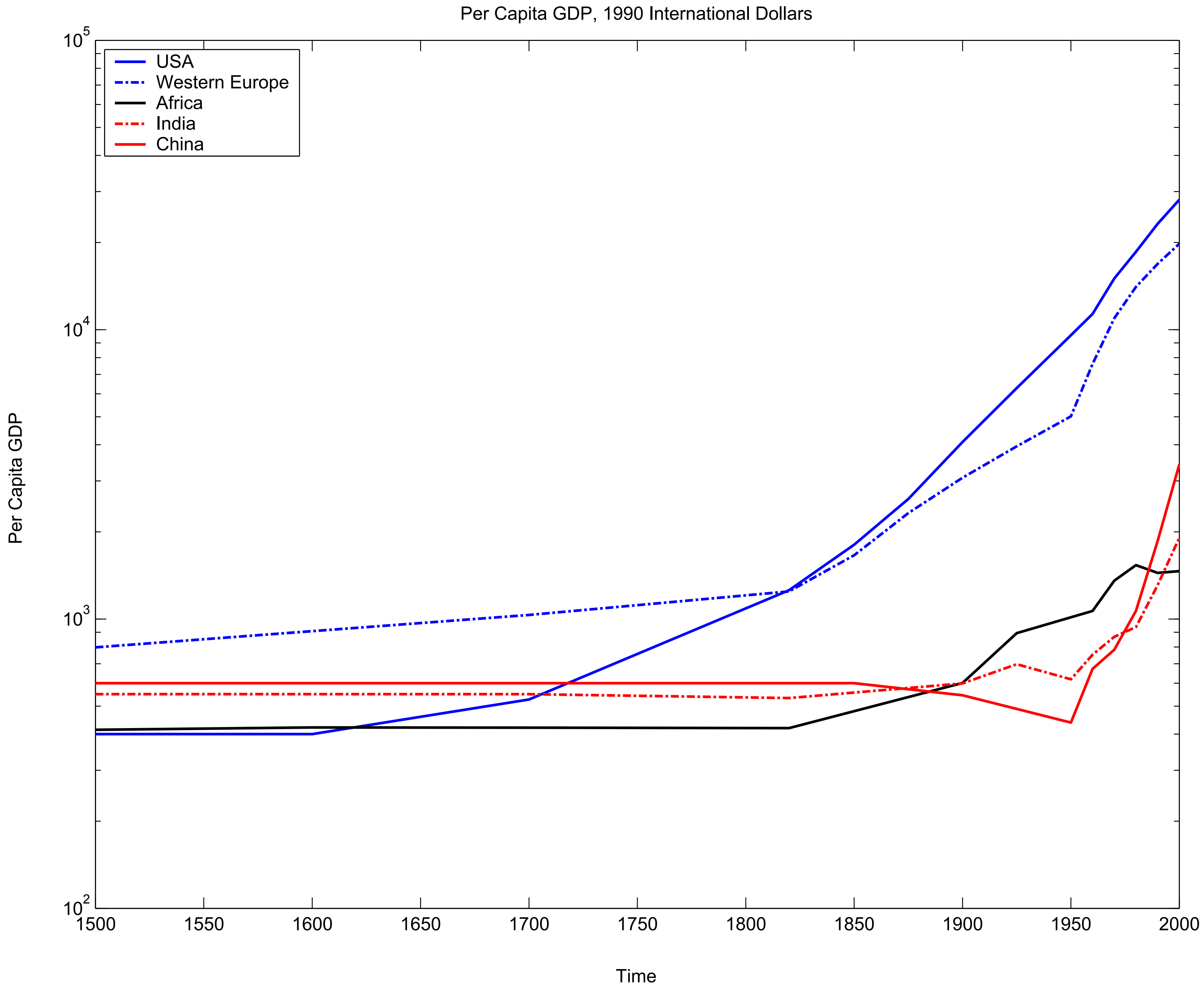
  - initial GDP of the rich country is twice as high as that of the poor country in the year 1500,

  - the poor country's growth rate remains low around 0.1%.

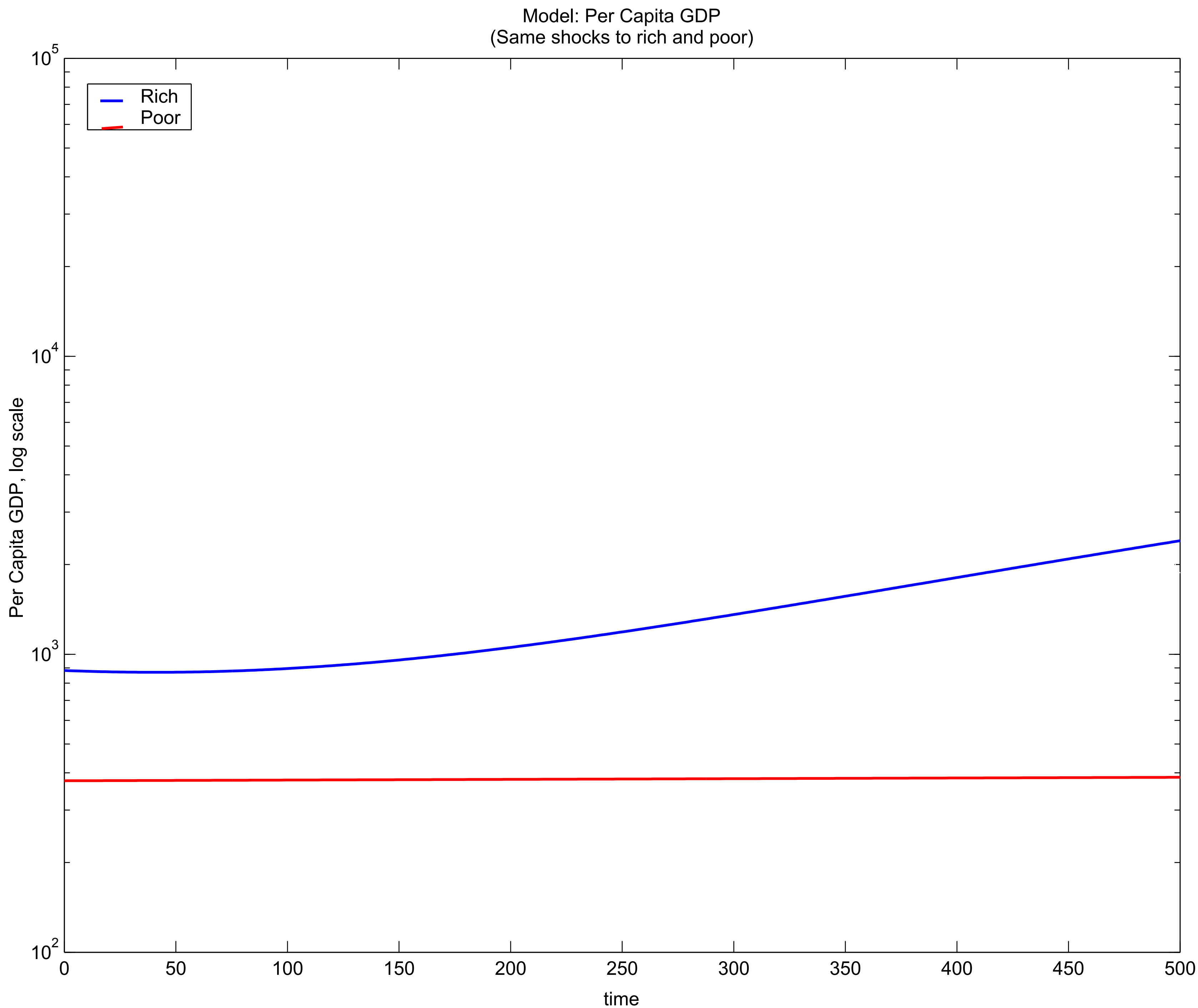
5 Quantitative implications



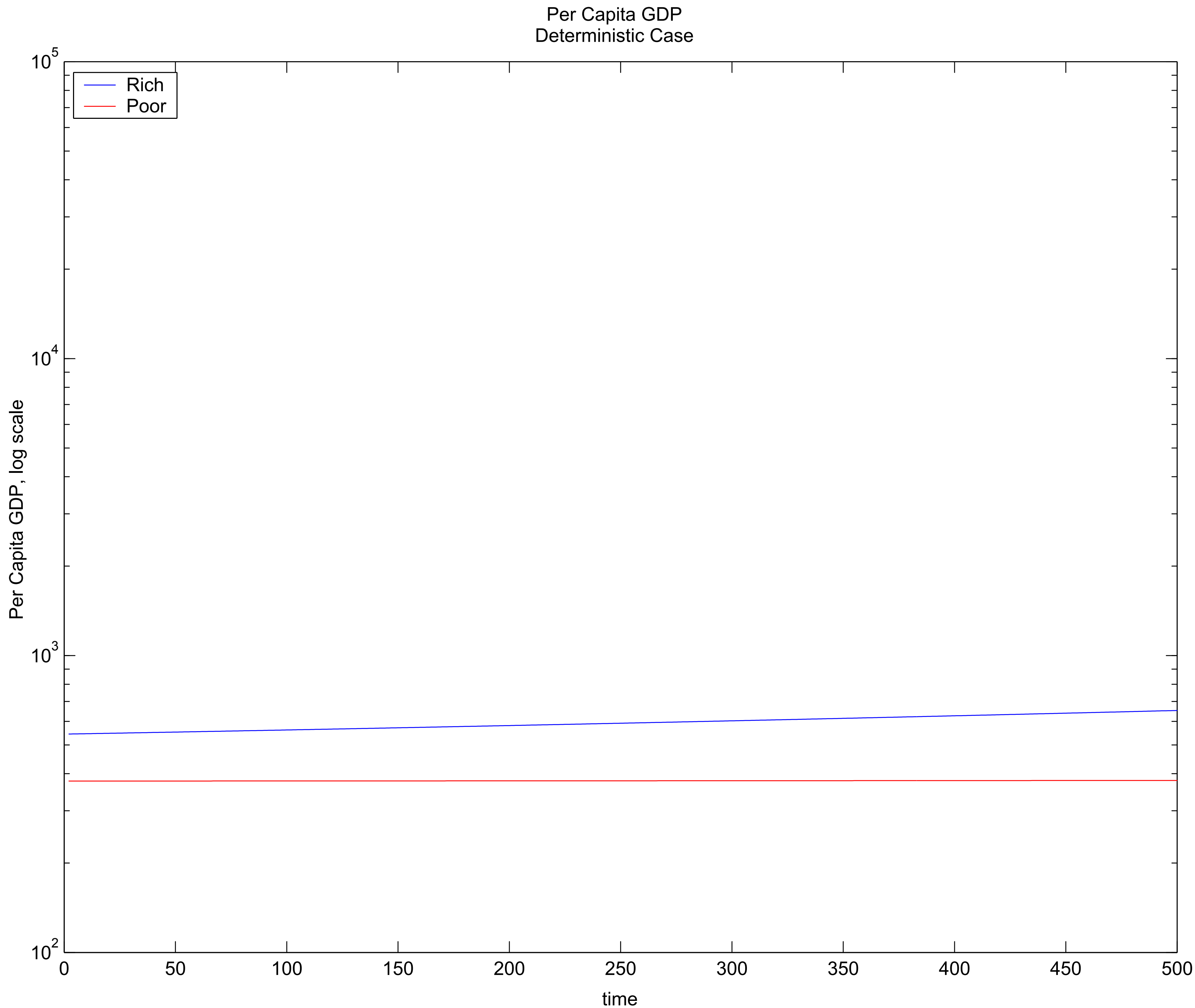
Model: Per Capita GDP
Richest 5
Poorest 5
Per Capita GDP, log scale
time
10^5
10^4
10^3
10^2
0
50
100
150
200
250
300
350
400
450
500



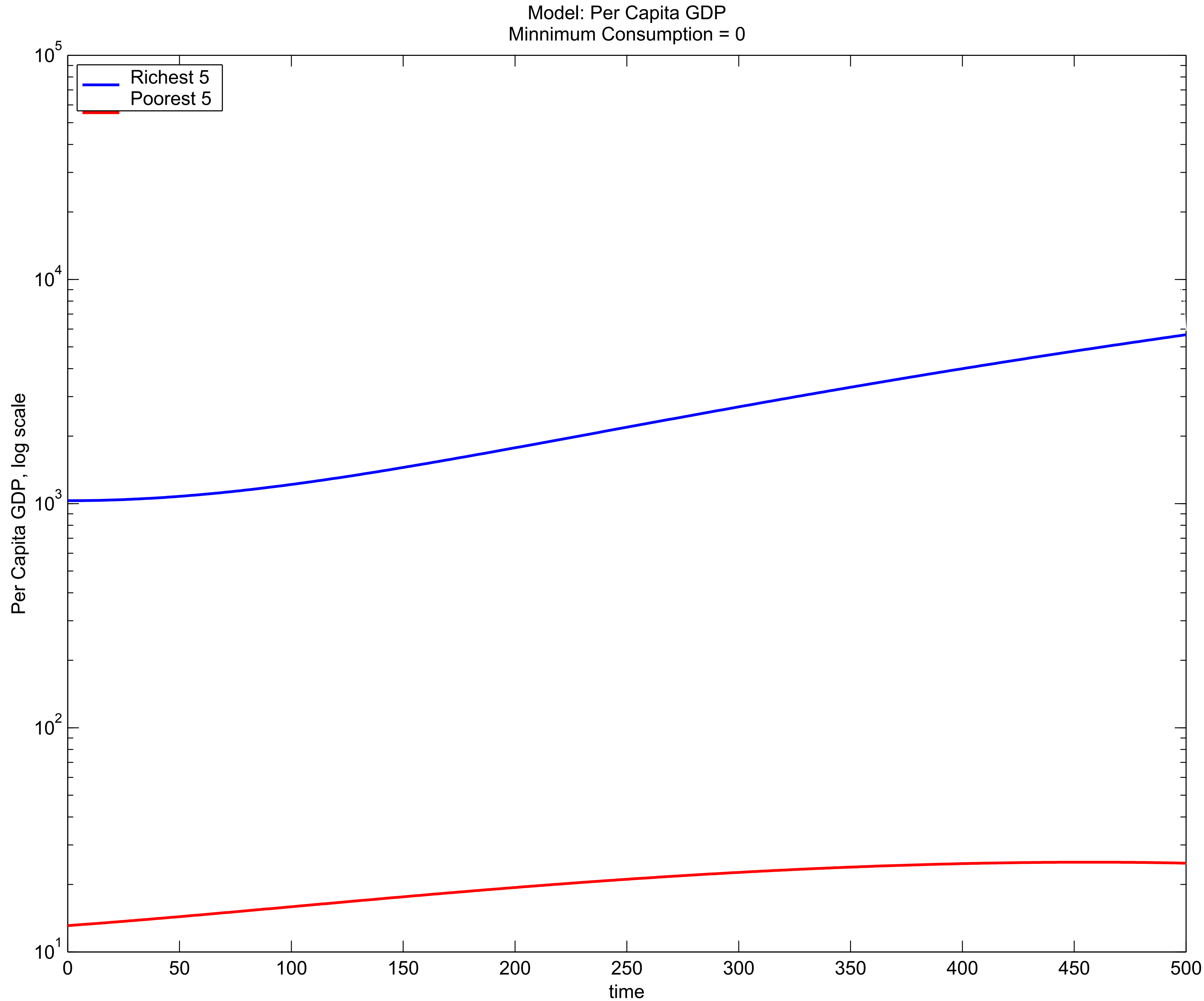
Per Capita GDP, 1990 International Dollars
USA
Western Europe
Africa
India
China
Per Capita GDP
Time
10^5
10^4
10^3
10^2
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000



Model: Per Capita GDP
(Same shocks to rich and poor)
Rich
Poor
Per Capita GDP, log scale
time
10^5
10^4
10^3
10^2
0
50
100
150
200
250
300
350
400
450
500



Per Capita GDP
Deterministic Case
Rich
Poor
Per Capita GDP, log scale
time
10^5
10^4
10^3
10^2
0
50
100
150
200
250
300
350
400
450
500



Model: Per Capita GDP
Minnimum Consumption = 0
Richest 5
Poorest 5
Per Capita GDP, log scale
time

References

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- R. E. Lucas Jr. "Lectures on economic growth." Harvard University Press, 2002.
- Parente, S. and E. C. Prescott. "Barriers to Riches." MIT Press, 2002.