EE 462 Development Macroeconomics (1 / 2012)

Lecture 7 Growth Evidences

Read 3.2, 3.3 in Charles Jones; Barro; and Mankiw, Romer and Weil (1992)

topic

- Convergence
- Mankiw, Romer and Weil (1992) and conditional convergence
- Econometric issues around growth regression

Convergence

- How well does the neoclassical growth model explain differences in growth rates?
- Early hypothesis by Gerschenkron (1952) about catching up by backward countries. They tend to grow faster than rich countries.
- We did documents the enormous differences in levels of income per person around the world.
- The question of convergence asks whether these big differences are getting smaller over time.

Baumol (1986) showed convergence among some developed countries and the absence among others.

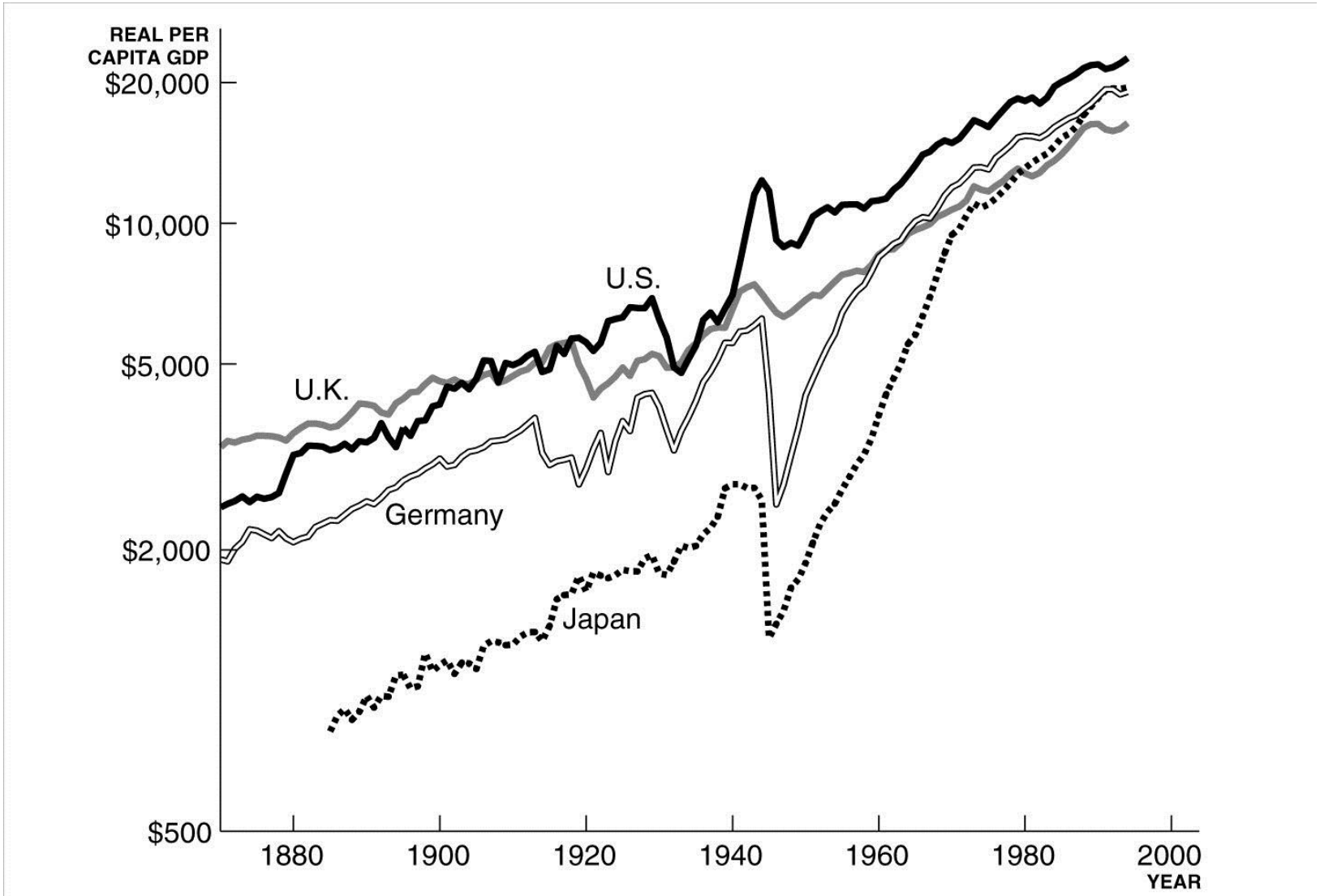

FIGURE 3.3 **PER CAPITA GDP, 1870–1994**

Economic Growth, 2nd Edition

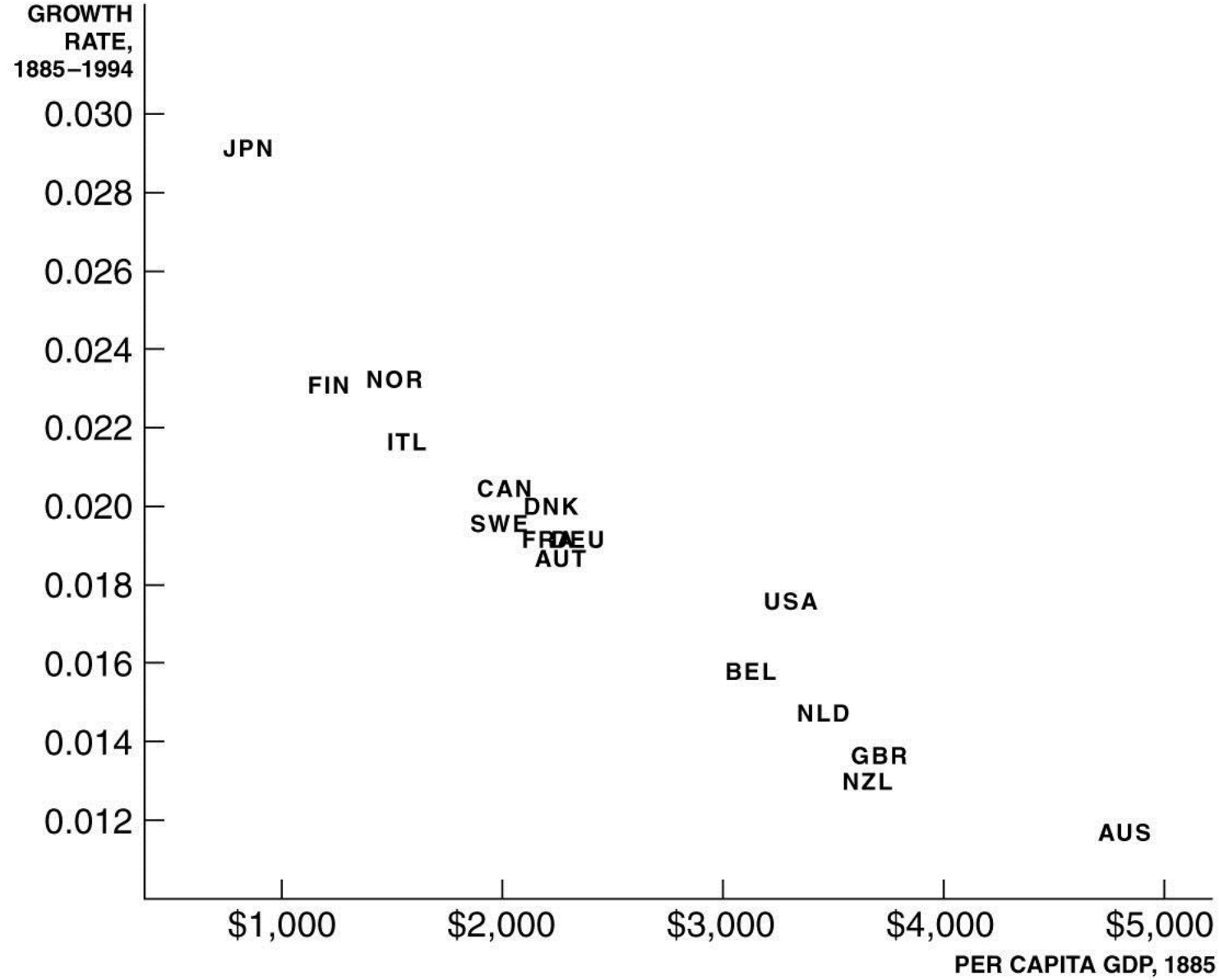

FIGURE 3.4 GROWTH RATE VERSUS INITIAL PER CAPITA GDP, 1885–1994

Economic Growth, 2nd Edition

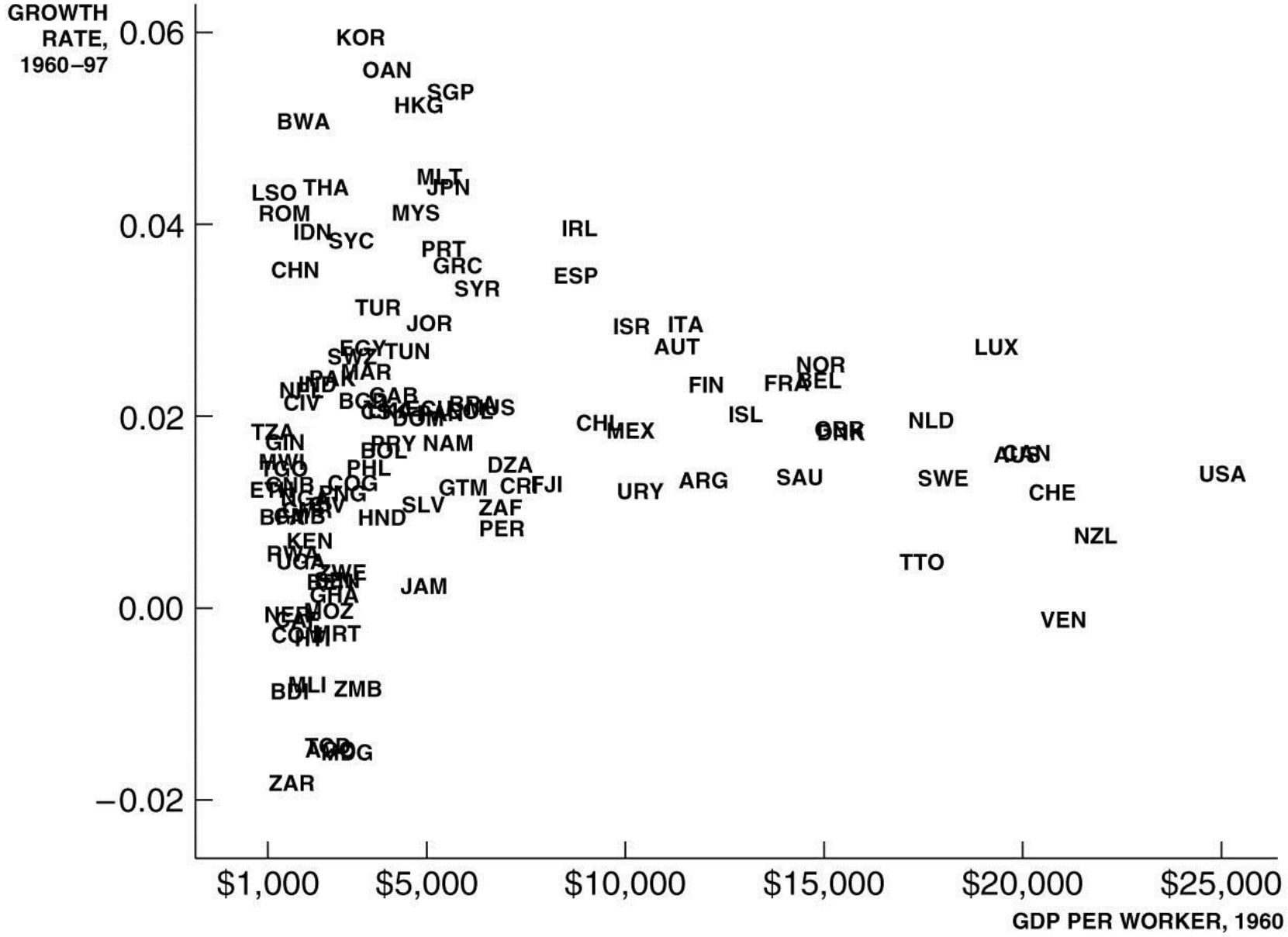

FIGURE 3.6 THE LACK OF CONVERGENCE FOR THE WORLD, 1960–97

- The last figure showed the poor countries are not closing gap in per-capita income..(table in chapter 1 support this fact). WHY?
- The neoclassical growth model prediction is: among countries that have the same steady state, the convergence hypothesis should hold: poor countries should grow faster on average than rich countries.
- In other words, the further economy an economy is below its steady state, the faster the economy should grow.
- This is called “transitional dynamics”.

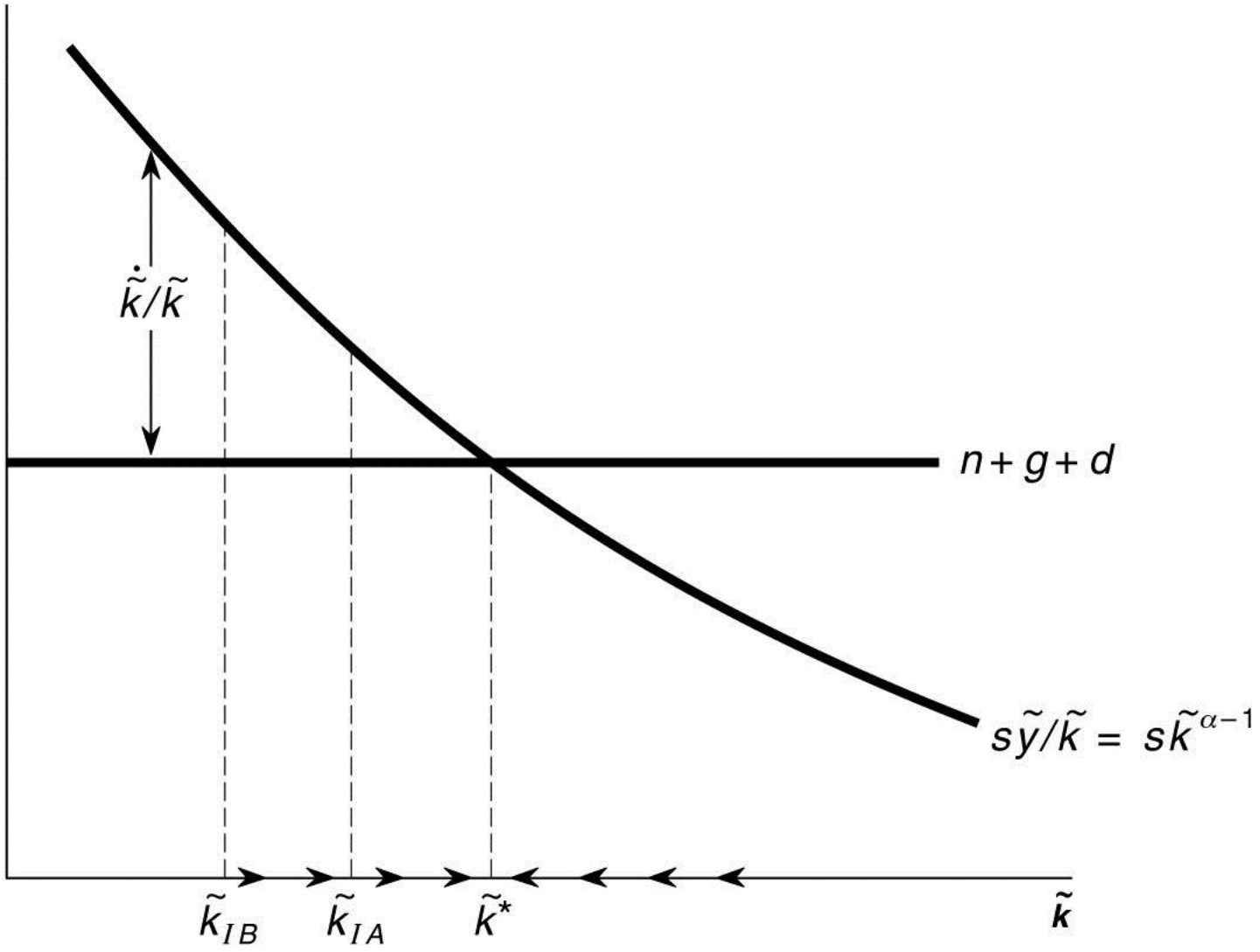

FIGURE 3.7 TRANSITION DYNAMICS IN THE NEOCLASSICAL MODEL

- Mankiw, Romer and Weil (1992) and Barro and Sala-i-Martin (1992) showed that the transitional dynamics of the Neoclassical growth model can explain wide differences in growth rate around the world.
- Among rich countries which have similar technology, investment rate and population growth, they will grow toward the same steady-state target. This is unconditional convergence.
- For others which do not have the same steady states (not the same tech, inv rate or pop growth), they are not expected to grow toward the same steady-state target or to grow at the same rate.

- To show this point, we plot the growth rate of GDP per worker against the deviation of GDP per worker from its steady-state value.
- Although poorer countries do not necessarily grow faster, countries that are poor relative to their own steady states tend to grow more rapidly.
- In 1960, good examples are Korea, Japan, Singapore and HK

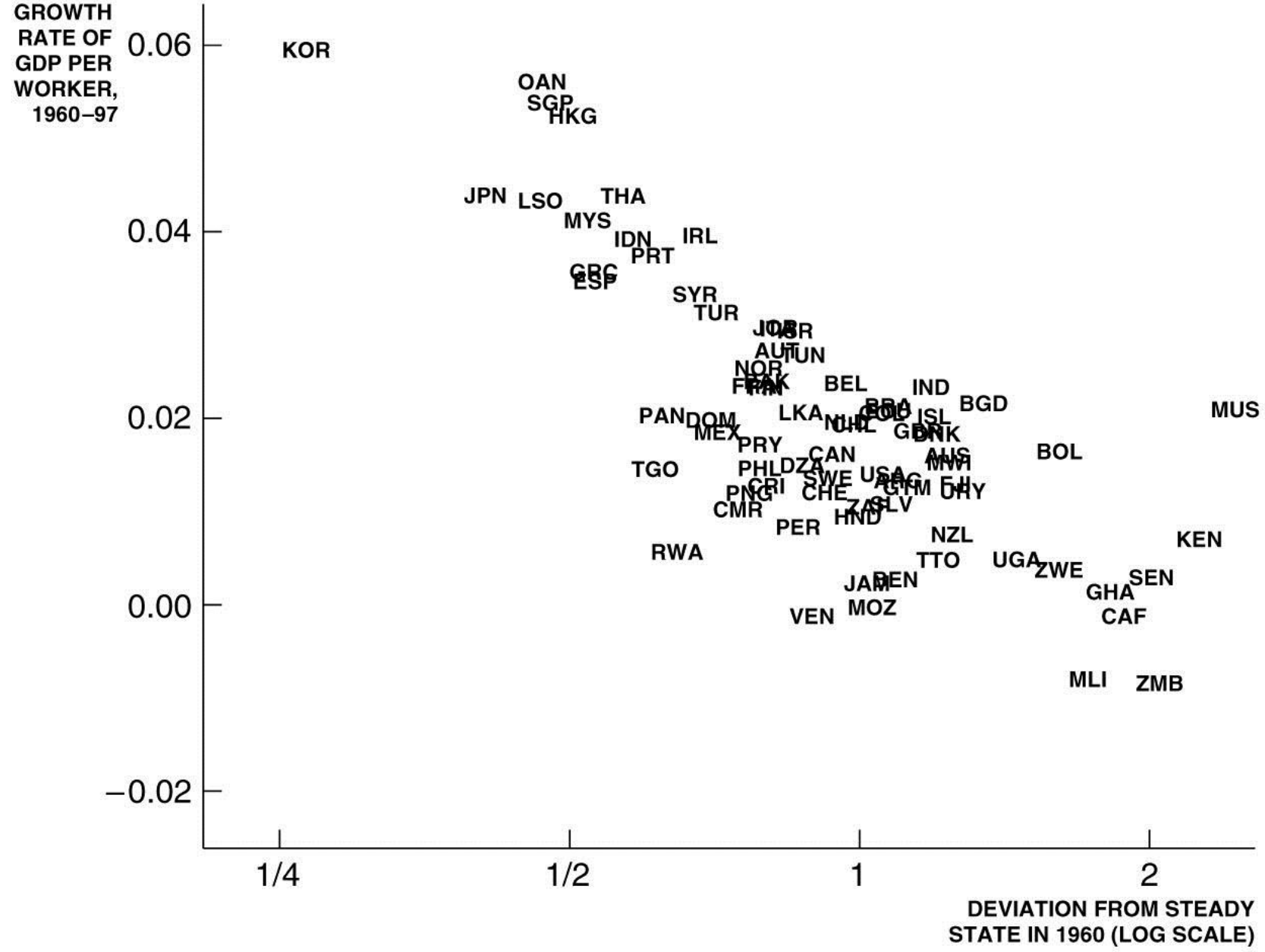

FIGURE 3.8 "CONDITIONAL" CONVERGENCE FOR THE WORLD, 1960–97

Mankiw, Romer and Weil (1992)

- $Y(t)=K(t)^{\alpha}[A(t)L(t)]^{1-\alpha}$
- $L(t)=L(0)e^{nt}$
- $A(t)=A(0)e^{gt}$
- $Kdot=sY - \delta K$
- Define the effective term: $k=K/AL$, $y=Y/AL$
- So, $y = k^{\alpha}$

$$Kdot = sy - (n+g+\delta)k \qquad \text{------(1)}$$

- At steady state, $kdot = 0$
- From (1), $sk^{*\alpha} = (n+g+\delta)k^{*}$

$$k^{*} = [\, s / (n+g+\delta)]^{1/(1-\alpha)}$$

- Substitute in $y^* = k^{*\alpha}$

$$y^* = [\, s / (n+g+\delta) \,]^{\alpha/(1-\alpha)}$$

- To work with cross-country data, we rewrite as

$$Y_i(t) / A_i(t)L_i(t) = [\, s_i / (n_i+g_i+\delta_i) \,]^{\alpha/(1-\alpha)}$$

$$Y_i(t) / L_i(t) = A_i(t) [\, s_i /(n_i+g_i+\delta_i) \,]^{\alpha/(1-\alpha)}$$

- Take log

$$\ln(Y_i(t) / L_i(t))$$

$$= \ln A_i(0) + gt + \alpha/(1-\alpha) [\, \ln s_i - \ln (n_i+g_i+\delta_i) \,]$$

- A(0) reflects resource endowment, climate, institution, etc. which vary across countries.
- Assume advance in Knowledge is not country-specific, so $g_i = g$ and depreciation $\delta_i = \delta$ (no one knows).

- Next, $\ln A_i(0) = a + \varepsilon_i$ (country-specific shock)
- So, $\ln(Y_i(t)/L_i(t))$
  $= a + gt + \alpha/(1-\alpha)[\ln s_i] - \alpha/(1-\alpha)\ln(n_i+g+\delta) + \varepsilon_i$
- To use OLS, assume that s_i is independent from error term or country-specific shock, and population growth n_i is independent from ε_i
- Test if $\alpha/(1-\alpha) = 0.5$ and $-\alpha/(1-\alpha) = -0.5$ for USA $\alpha=1/3$
- Use investment share to proxy saving rate
- Y/L is real GDP in 1985 / working-age population
- $g+\delta = 0.05$; Get $R^2=.59$ imply that cross-country variation in income per capita explained by differences in saving rate and pop growth.
- Implied or estimated capital share is 0.59

Augmented Solow with Human capital

- $Y = K^{\alpha} H^{\beta} [A(t)L(t)]^{1-\alpha-\beta}$; add human capital
- Assume DTS in capital $\alpha+\beta<1$
- At steady-state: $y^* = k^{*\alpha} h^{*\beta}$
- The new regression is

  $\ln(Y_i(t) / L_i(t))$

  $= a + gt + \alpha/(1-\alpha-\beta)[\ln s_{ki}] + \beta/(1-\alpha-\beta)[\ln s_{hi}]$

  $- (\alpha+\beta)/(1-\alpha-\beta) \ln (n_i+g+\delta)] + \varepsilon_i$
- Per capita income depends on accumulation of physical and human capital, and population growth.
- Note that the coefficient is larger

- Rearrange this as

$$\ln(Y_i(t) / L_i(t)) = a + gt + \alpha/(1-\alpha)[\ln s_{ki}] + \beta/(1-\alpha)[\ln h^*_i] - \alpha/(1-\alpha)\ln(n_i+g+\delta)] + \varepsilon_i$$

, where h* is the level of human capital

- So, this implies omitted variable biases in the previous regression.
- Since omitted variable is positively correlated with saving rate and negatively with pop growth, so the estimates are biased upward and downward in the previous one.
- Proxy for H accumulation (s_h) with % of pop with secondary education.
- Get a better implied capital share.

- In summary, the Solow framework is successful in helping us understanding the wide variation in the wealth of nations
- Do this enormous differences in levels of income per capital around the world get smaller over time? This is a question of convergence.
- Next, MRW argues for conditional convergence: convergence only after controlling for their determinants of the SS. That is, income per capita in a given country converges to that country's SS value.
- Calculated rate of convergence is 2% (faster if excluding human capital)

Conditional convergence

- Speed of convergence: $y \rightarrow y^*$

  $d\ln y(t)/dt = \lambda[\ \ln y^* - \ln y(t)\ ] = -\lambda[\ \ln y(t) - \ln y^*]$ ...(13)

  where $\lambda = (n+g+\delta)(1-\alpha-\beta)$.

- For growth rate of $[\ \ln y(t) - \ln y^*] = -\lambda$

  $\ln y(t) - \ln y^* = e^{-\lambda t}[\ln y(0) - \ln y^*]$

  $\ln y(t) - \ln y(0) = -(1-e^{-\lambda t})[\ln y(0) - \ln y^*]$ ……(14) in MRW.

- Substitute $\ln y^*$, we get (16): income growth is a function of the determinants of the SS and initial income:

  $\ln[y(t)/y(0)] = a \ln(s_k) + b \ln(s_h) + c \ln(n_i+g+\delta) + d \ln y(0)$

- Testing for convergence by regressing

$$\ln(y(85)/y(60)) = A + b \ln(y(60))$$

- Found no catching-up, low R^2 ; zero or positive b for poor. But good result for OECD countries, b is significantly negative.
- Testing for conditional convergence: Found better R^2 and significantly negative.
- In sum, they claimed there is substantial convergence in income per capita; and the implied rate of convergence is about the model predicts.
- This result contrasts with Endogenous growth model that predicts no convergence, but divergence. Differences among countries can persist over times even if countries have the same saving and population growth rate.

Comments to MRW's paper

- 1. Investment rates are not constant.
- 2. Population and depreciation rate vary across countries, so does the rate of convergence.
- 3. Not really find catching-up among poor.
- 4. "A" should be treated as a regressor. Otherwise, we have omitted variable bias.
- 5. We can proxy A by panel data and treat A as a fixed effect (not vary over time).
- 6. MRW differs from Barro's regression which is ad hoc. In ad hoc regression, we do not know whether our additional variable affect the LR growth, SS level, or both. Normally, they claim that Z, extra growth determinants, function as proxy for differences in g (rate of technical progress), which MRW assumed to be constant.

Econometric issues: Model uncertainty

- How to specify Z or control variables in growth regression
- The problem is the absence of any consensus on which growth determinants to be included in the model or we have model uncertainty or open-ended model
- One way to resolve this is to identify variables whose empirical importance is robust (as defined by Levine and Renelt (1992) use of extreme bound analysis)
- a given regressor robustly affects growth if the sign of the coefficient is constant and the estimate is statistical significant across all model specification.
- Levine and Renelt tested initial income, investment share, secondary school enrolment rates, and population growth.
- Only robust determinants found are initial income and investment share, inflation volatility and exchange rate distortion.
- Fragile if their statistical significance disappears when a different group of right-hand-side variables is selected

Parameter heterogeneity

- Data for very different countries cannot be seen as realizations from a common data generating process.
- Harberger (1987): What do Thailand,…, ...have in common that merits their being put in the same regression analysis?
- Several papers found evidence for widespread heterogeneity. If parameters vary across countries, what shall we do? (with the fact that we have short time series data)
- Interpret what we know as an average
- New methods: robust estimation, regression trees, sample splits....

Econometric issues: Data

1. *Time series approach*.

- Small data set, Little time variation
- Observed outputs are poor for potential output, contaminated by business cycle dynamics.
- Possible long deviation from trend due to crises or slumps

2. *Endogeneity problem*

- Possible from Growth and investment, Political instability and growth
- Reverse causality leads to inconsistent estimates of the causal effect due to a correlation between an explanatory variable and the error term
- Similar when we have omitted variables and measurement error problem.

- Given the endogeneity problem, we can use the partial correlation to rule of some hypothesis (not to imply causal effect)
- Growth is negatively related to corruption
- Not saying that lower corruption will raise growth.
- But we can rule out that corruption is good for growth.
- Using IV to solve the problem.
- Valid if not correlate with error terms, not a direct growth determinant itself.
- Easier being said than done since most will use judgment
- Or we can use panel data and use lags of endogenous variables as instruments. Sometime predetermined variable is not a good instrument

3. *Small data need careful investigation*

- Outliers (using Cook's distance statistics, or robust estimator)

4. *Measurement error*: One error makes all parameter estimates to be biased. For example, Capital stocks.

5. *Heteroskedasticity:* Non constant variance

- Still unbiased but inefficient OLS
- White's heteroskedasticity correction.

Critiques Summary

- Error term is added in an ah hoc fashion: e(i) interchangeable across observations
- Done without enough attention to the historical and institutional context.
- Much works cannot identify the channels of causation but the partial correlation.
- Could have reverse causality or joint caused by third factor. For example, oil price affects inflation, we found inflation affects growth.
- Endogeneity problem when error related to Z.
- No good for policy recommendation without causality relationship and magnitude are not accurate.

Future researches to growth Econometrics

- Three questions (Pritchett 2000)
- 1. What are conditions that initiate an acceleration of growth or the conditions that set off sustained decline?
- 2. What happens to growth when policies (trade, macro, investment) or politics change dramatically in episodes of reform?
- 3. Why have some countries absorbed and overcome shocks with little impact on growth, while other seem to have been overwhelmed by adverse shock?