

INTERNATIONAL KNOWLEDGE DIFFUSION

Is International knowledge Diffusion Important for Income Growth?

1. Facts

2. The Model

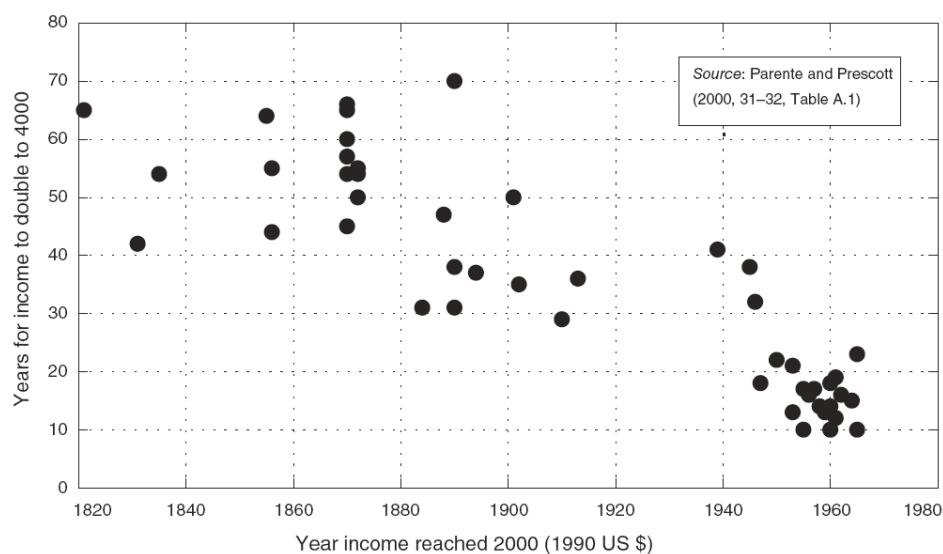
3. Trade and Growth

- Reference: Lucas (2009), “Trade and the Diffusion of the Industrial Revolution,” *American Economic Journal: Macroeconomics*, 1(1), 1-25.

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FACTS

FIGURE: Income Doubling Times



(Lucas (2009), Figure 7.)

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FACTS

- Discussion of the Figure:
 - Once the per-capita income reaches \$2,000, it now takes less time to reach \$4,000.
 - How can we explain this regularity?
 - Theory: Maybe there is an “engine” to adopt the knowledge/technologies accumulated by already advanced economies.
 - Not all countries have started their “engines” yet.
 - But once the engine starts, it works to **catch up** advanced economies.

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FACTS

- International interactions may be important for income growth. (You want to learn from others.)
- How to measure international interactions?
- Not easy.
- We can use a 0-1 criterion of **openness to international trade**.
- Sachs and Warner's (1995) "openness" criterion: 1 vs. 0
 1. Effective protection rates less than 40%
 2. Quotas on less than 40% of imports
 3. No currency controls or black markets in currency
 4. No export marketing boards
 5. No socialistic govt

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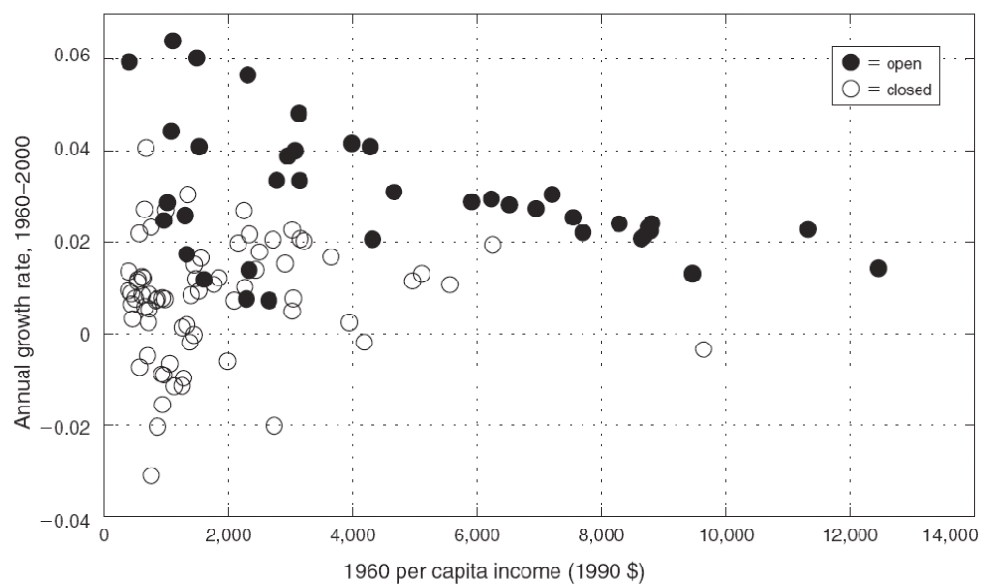
FACTS

- Good: Rare criterion for openness policy
cf. Some economists use $((\text{import}) + (\text{export}))/\text{GDP}$.
- Bad: Arbitrary
(For example, why 40%?)
- **Fact 1:** Open economies converge.

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FACTS

FIGURE: Income and Growth Rates, 112 Economics (1960-2000)

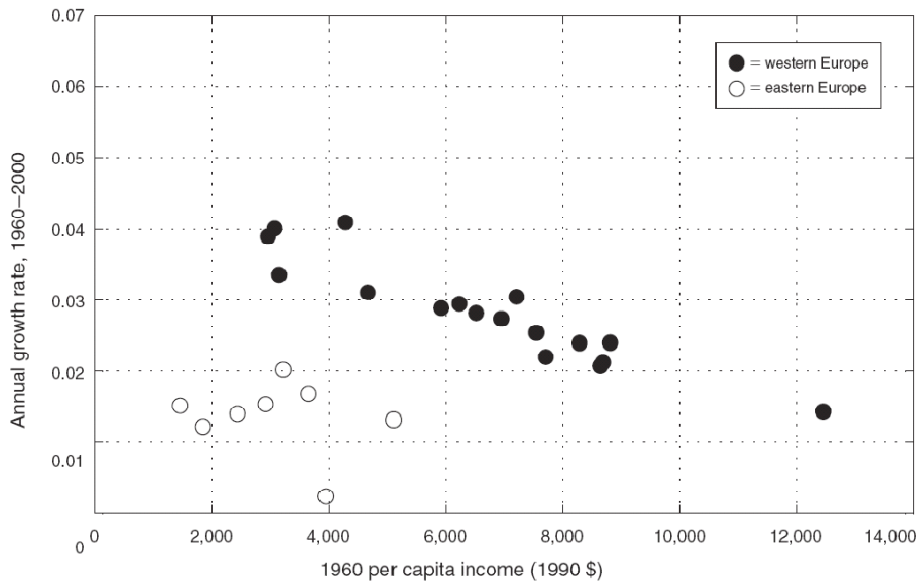


(Lucas (2009), Figure 2.)

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FACTS

FIGURE: 25 European Economics (1960-2000)

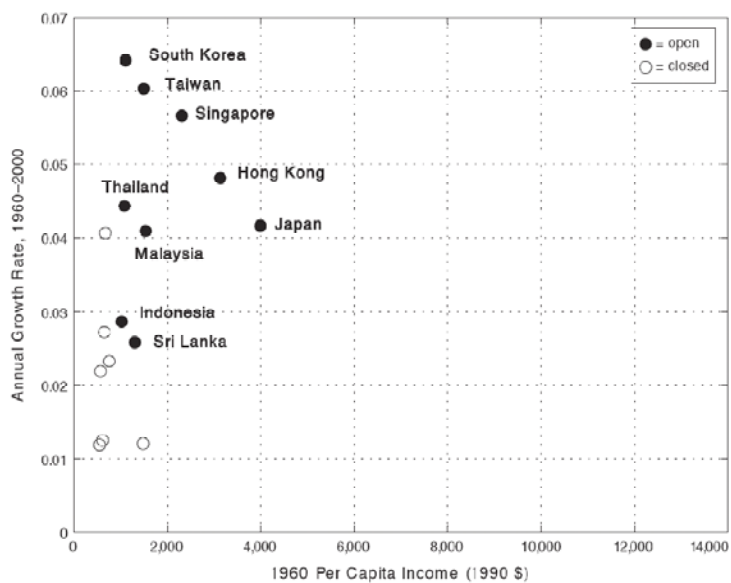


(Lucas (2009), Figure 3.)

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FACTS

FIGURE: 16 Asian Economics (1960-2000)



(Lucas (2009), Figure 3.)

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THE MODEL

- **Leader** (Economy 1):

- $Y_{1t}/L_{1t} = A_{1t}$
(subscript “1t” means “Economy 1 in year t”)
- $A_{1,t+1} = (1 + g_A)A_{1t}$
(constant productivity growth at g_A)
- There is no K. No h. Everything is productivity, $\{A_{1t}\}$
(or one may interpret it as human capital).

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THE MODEL

- **Follower** (Economy 2):

- $Y_{2t}/L_{2t} = A_{2t}$
(subscript “2t” means “Economy 2 in year t”)
- $A_{2,t+1} = (1 + g_A)(A_{1t})^\theta (A_{2t})^{1-\theta}$,
 $0 < \theta < 1$ (θ is called “theta”.)
- Cf. For Economy 1, it was $A_{1,t+1} = (1 + g_A)A_{1t}$. Notice that g_A is the same between the two economies.
- So Economy 2’s productivity in year $t + 1$ depends on year t ’s productivities in *both* economies.
- Economy 2 learns from Economy 1. If A_{1t} is higher, $A_{2,t+1}$ grows faster.
- No strong theory. A mechanical model.

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THE MODEL

- Another way to understand Follower’s (Economy 2’s) productivity growth is

- $A_{2,t+1} = (1 + g_A)(A_{1t})^\theta (A_{2t})^{1-\theta}$.
 - So $\frac{A_{2,t+1}}{A_{2t}} = (1 + g_A)(A_{1t})^\theta \frac{(A_{2t})^{1-\theta}}{A_{2t}}$.
 - So $\frac{A_{2,t+1}}{A_{2t}} = (1 + g_A)(A_{1t})^\theta (A_{2t})^{-\theta}$.
 - So $\frac{A_{2,t+1}}{A_{2t}} = (1 + g_A) \left(\frac{A_{1t}}{A_{2t}}\right)^\theta$.
 - LHS: Economy 2’s productivity growth
 - ... becomes higher if $\frac{A_{1t}}{A_{2t}}$ is higher
- So there is a catch-up. (Draw possible evolutions of $\{A_{1t}\}$ and $\{A_{2t}\}$.)

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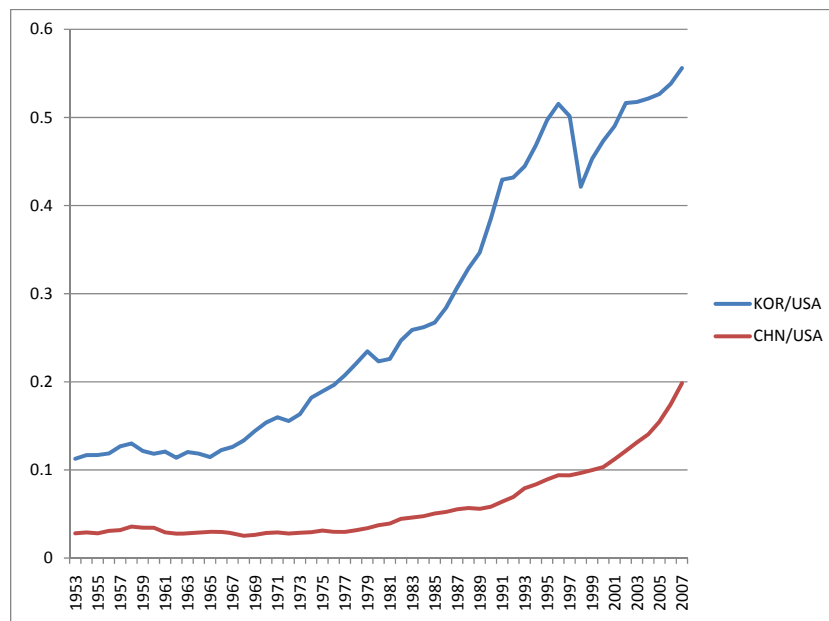
THE MODEL

- So what?
- We want to understand a given economy with this model.
- For example, take South Korea. (But you can take any other economy – Brazil, China, ...)
- Leader (Economy 1): U.S. 🇺🇸
- Follower (Economy 2): South Korea 🇰🇷 / China 🇨🇳
- Download PWT data from http://pwt.econ.upenn.edu/php_site/pwt63/pwt63_form.php.
- Step 1: Choose USA, KOR and CHN.
- Step 3: “rgdpl” (Real GDP per capita)
- Step 4: All years.

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THE MODEL

FIGURE: KOR and CHN's Per-Capita GDPs, as a fraction of USA level



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THE MODEL

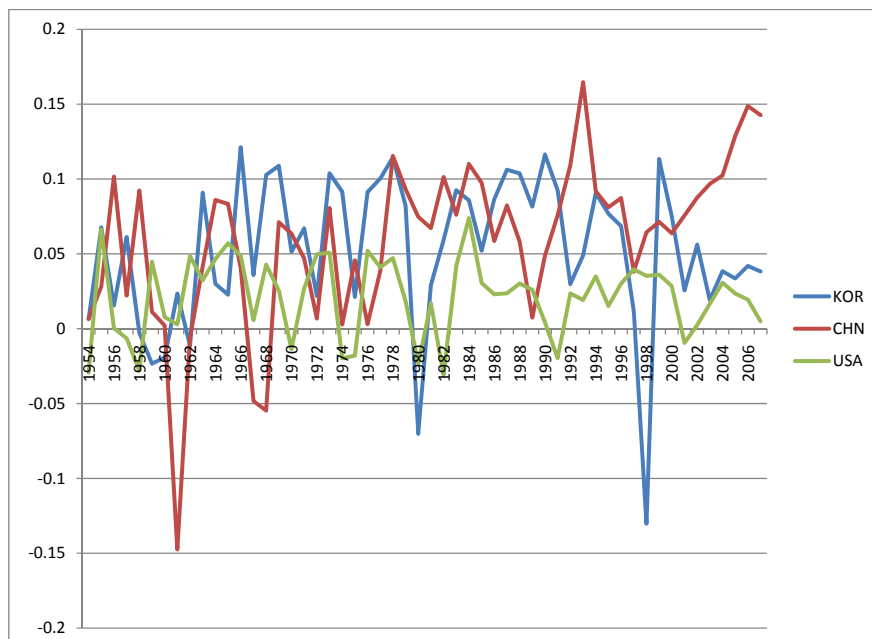
- Discussion of the Figure

- KOR's kick-off was in 1965 or so.
- CHN's kick-off was in 1985 or so. Accelerated in 1995 or so.

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THE MODEL

FIGURE: Per-Capita GDP Growth, KOR, CHN and USA



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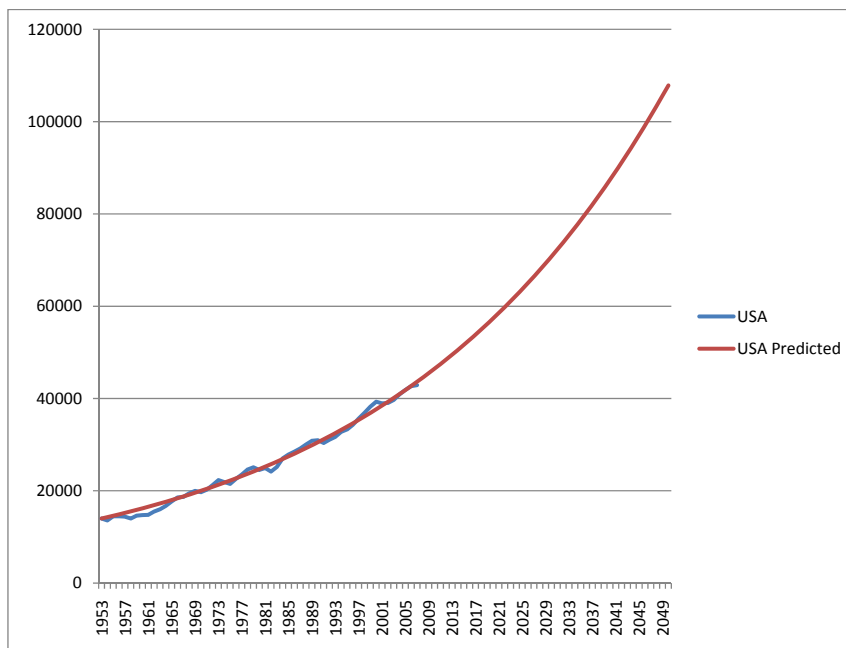
THE MODEL

- Now we look at the model.
- U.S. 🇺🇸 as Leader (Economy 1):
 - Recall: $\frac{Y_{1t}}{L_{1t}} = A_{1t}$ and $A_{1,t+1} = (1 + g_A)A_{1t}$
 - g_A is constant growth of Y/L.
 - Let's average the 1954-2007 growths of Y/L.
 - $g_A = 2.1\%$.
 - Done!

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THE MODEL

FIGURE: Per-Capita GDP, Data and Forecasts: USA 🇺🇸



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THE MODEL

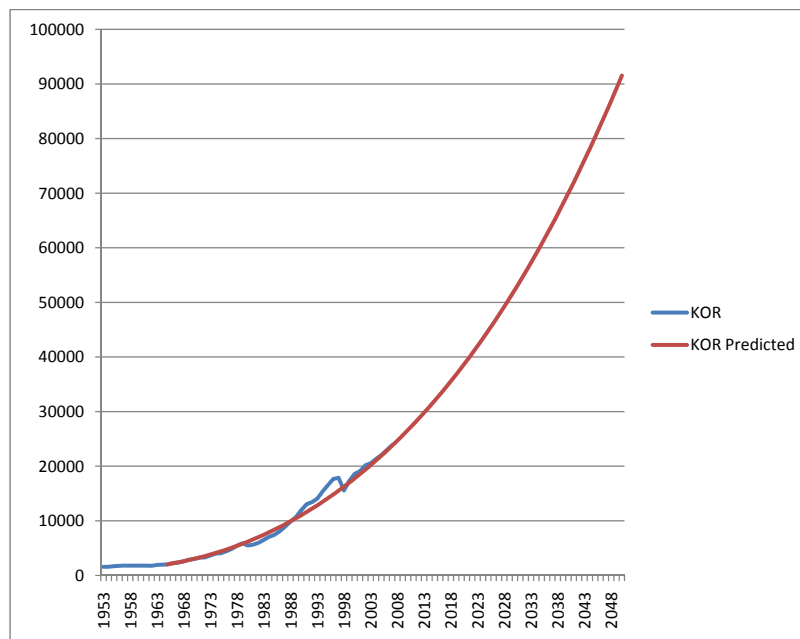
- South Korea 🇰🇷 as Follower (Economy 2):

- Recall: $\frac{Y_{2t}}{L_{2t}} = A_{2t}$ and $\frac{A_{2,t+1}}{A_{2t}} = (1 + g_A) \left(\frac{A_{1t}}{A_{2t}}\right)^\theta$.
- We know $g_A = 2.1\%$. We need θ .
- **Trial and error.** Match 1965 and 2007.
- $\theta = 0.03$ looks fairly well.

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THE MODEL

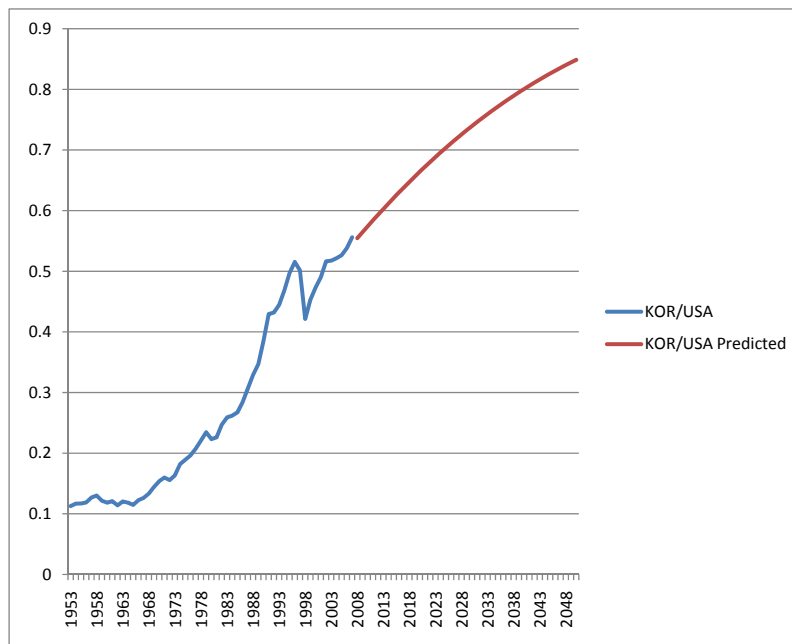
FIGURE: Per-Capita GDP, Data and Forecasts: KOR 🇰🇷



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THE MODEL

FIGURE: Per-Capita GDP as a fraction of USA: KOR 🇰🇷



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THE MODEL

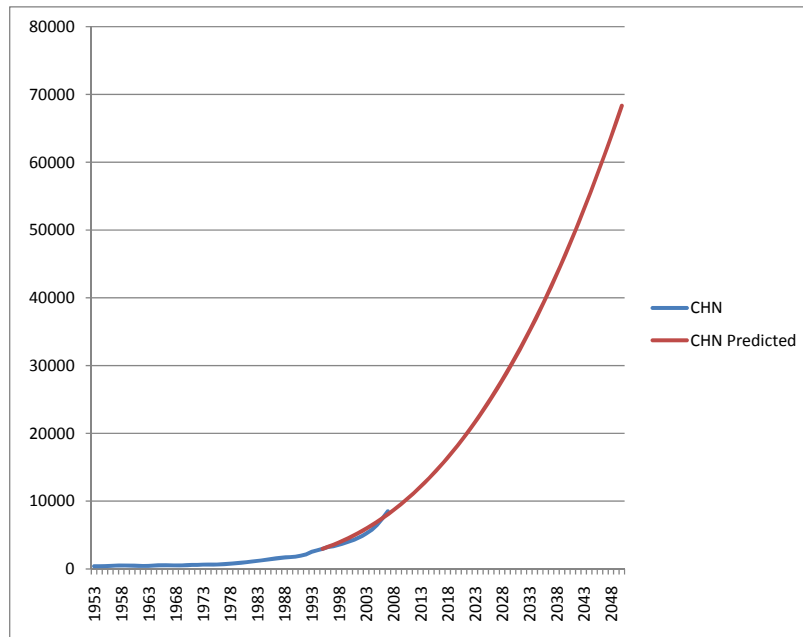
- China 🇨🇳 as Follower (Economy 2):

- Recall: $\frac{Y_{2t}}{L_{2t}} = A_{2t}$ and $\frac{A_{2,t+1}}{A_{2t}} = (1 + g_A) \left(\frac{A_{1t}}{A_{2t}}\right)^\theta$.
- We know $g_A = 2.1\%$. We need θ .
- For Korea, it was $\theta = 0.03$. Use the same number.

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THE MODEL

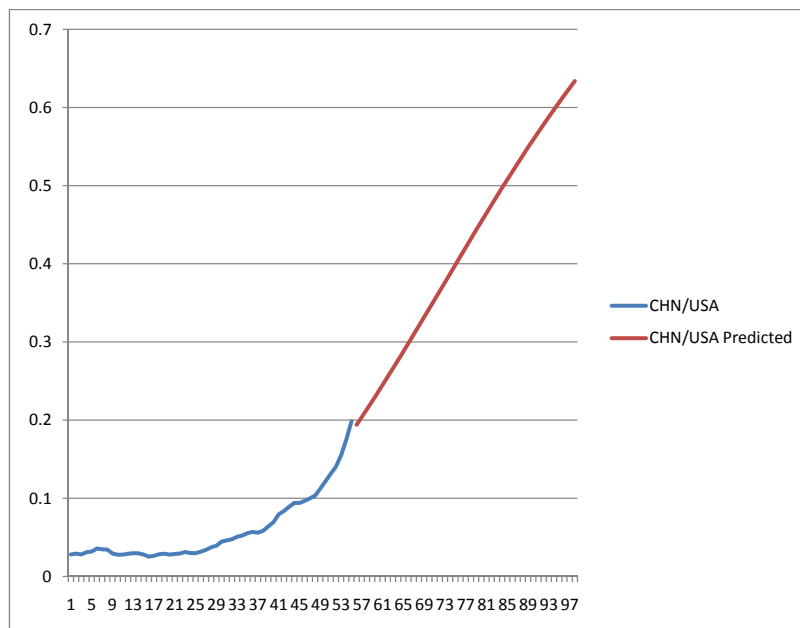
FIGURE: Per-Capita GDP, Data and Forecasts: CHN 



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THE MODEL

FIGURE: Per-Capita GDP as a fraction of USA: CHN 



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THE MODEL

- If you don't like the CHN forecasts, try a different θ .
- We complete the simplest forecasts on 2050!
- Some institutions release their own forecasts, but we discussed all basic features. (K, h, A, ...)
- Example: Goldman Sachs report.
- Dominic Wilson and Anna Stupnytska, "The N-11: More Than an Acronym," Global Economics Paper, 153.
- <http://www.chicagobooth.edu/alumni/clubs/pakistan/docs/next11dream-march%20'07-goldmansachs.pdf>
- P.11 has their own view.
- Now you can do it.

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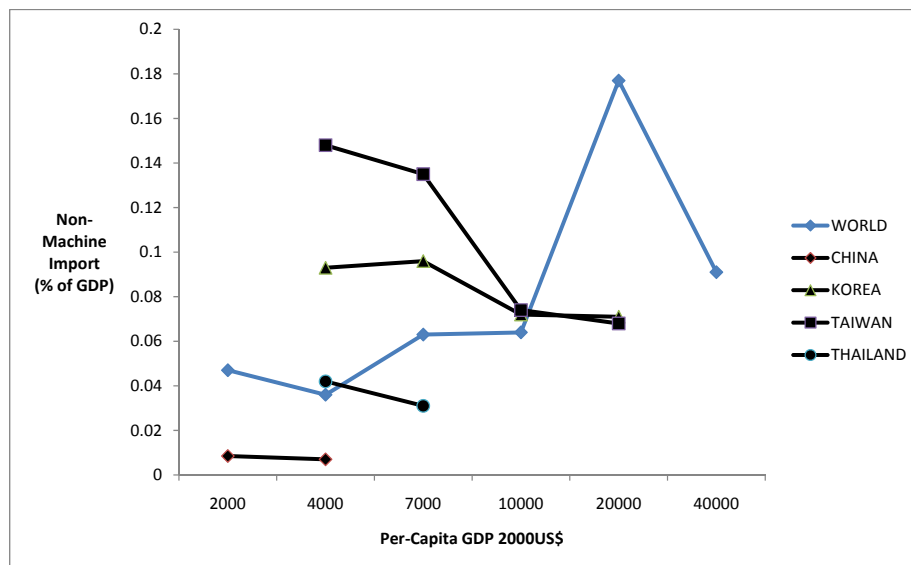
TRADE AND GROWTH

- We have seen that **open** economies converge in income levels.
- Trade consists of
 - (a) Non-machine import
 - (b) Non-machine export
 - (c) Machine import
 - (d) Machine export
- We look at these four in detail.

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TRADE AND GROWTH

FIGURE: (a) Non-Machine Import (% of GDP)

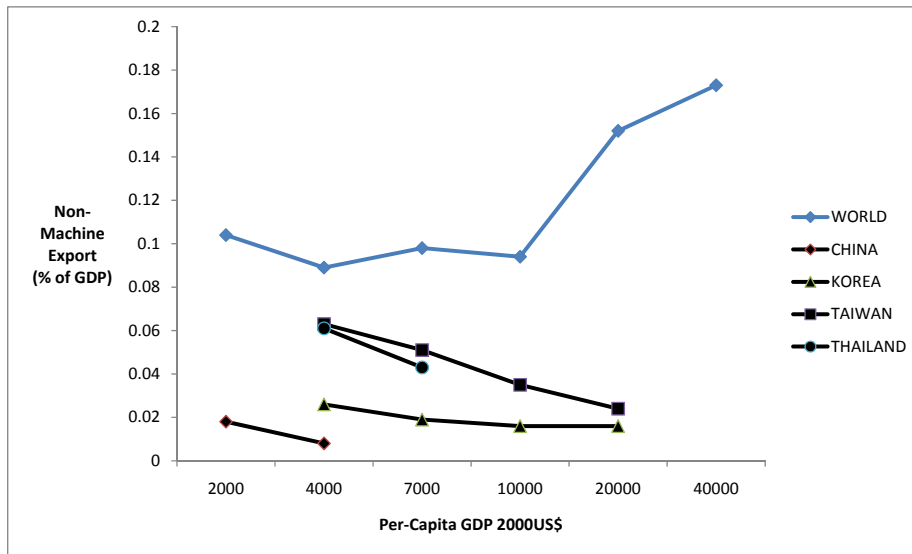


(Data Source: UN Comtrade)

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TRADE AND GROWTH

FIGURE: (b) Non-Machine Export (% of GDP)

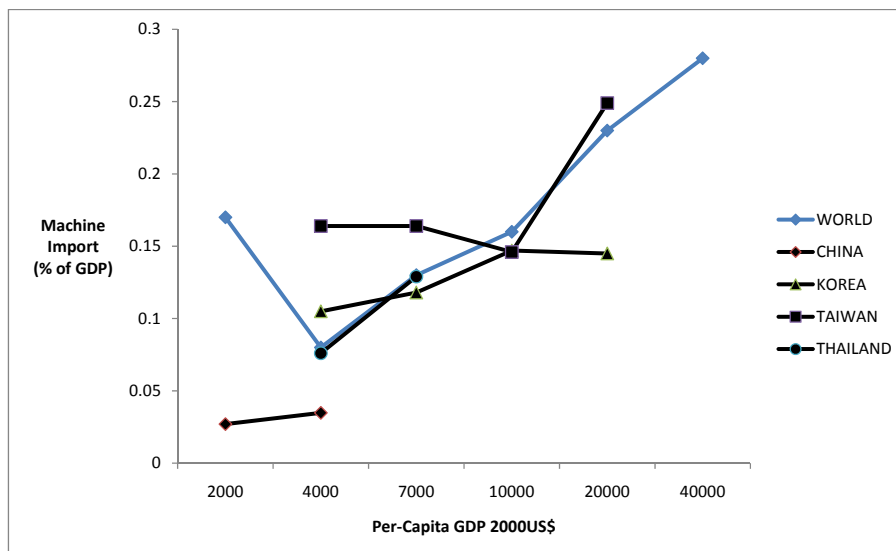


(Data Source: UN Comtrade)

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TRADE AND GROWTH

FIGURE: (c) Machine Import (% of GDP)

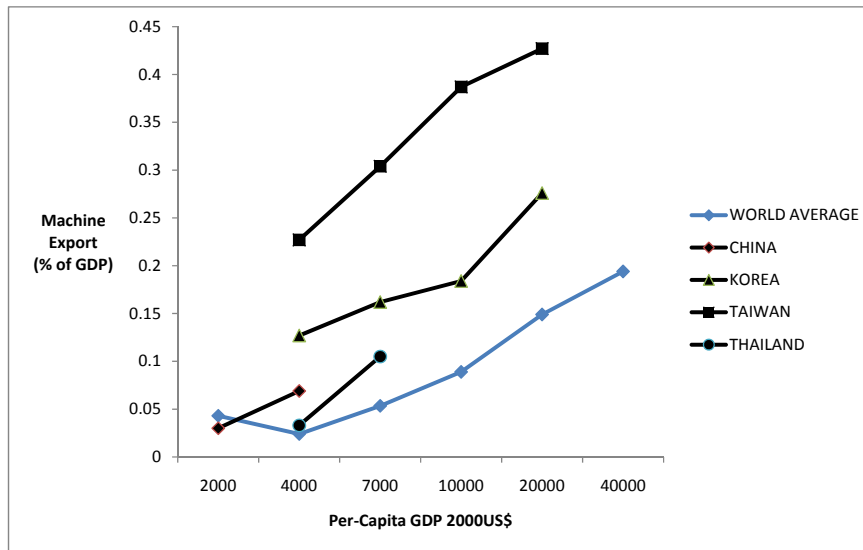


(Data Source: UN Comtrade)

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TRADE AND GROWTH

FIGURE: (d) Machine Export (% of GDP)



(Data Source: UN Comtrade)

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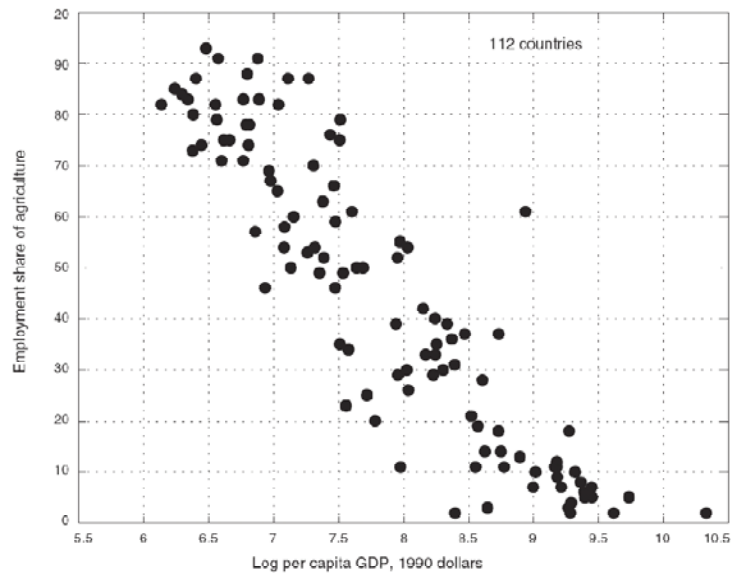
TRADE AND GROWTH

- Discussion of the figures
 - We focused on 4 economies.
 - **Fact 2:** As an economy's income grows, its **machine export** share out of GDP is clearly growing.
 - An explanation is that it is important for economic growth to learn how to produce **manufacturing products** to compete in an international market.
- **Fact 3:** Agriculture appears to decrease as a share of GDP, as an economy grows its income.
 - Look at the following figures.

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TRADE AND GROWTH

FIGURE: Agricultural Employment Shares: XS (1980)

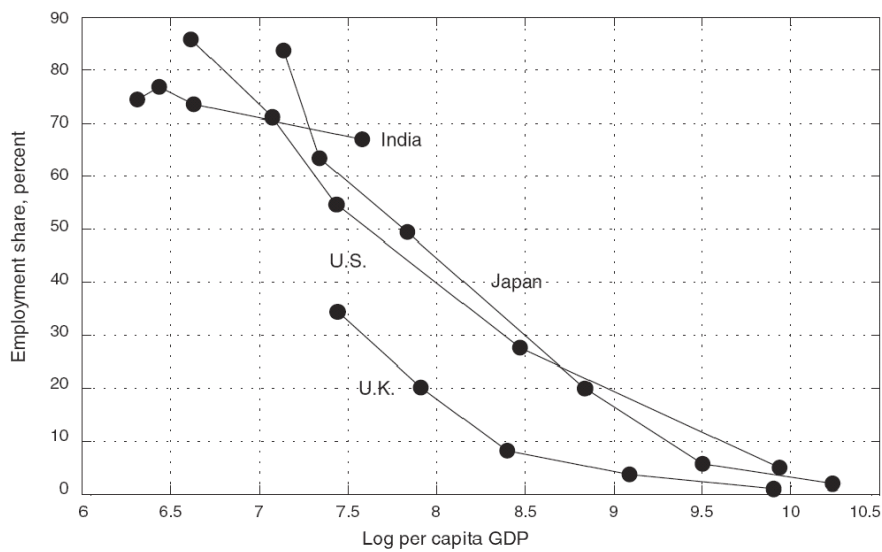


(Lucas (2009), Figure 11.)

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TRADE AND GROWTH

FIGURE: Agricultural Employment Shares: TS (1980)



(Lucas (2009), Figure 13.)

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TRADE AND GROWTH

- **Question:** How does International Trade Affect Economic Growth?
- **Positive Effects**
 - *Competition:* Producers learn how to produce better from more severe international competitions.
 - *Imitation:* Producers are exposed to foreign products. They may imitate to improve their products.
 - *Imports of foreign technologies and capital goods:* For an isolated economy to develop its own technologies to invent a computer will take a long time. It is cheaper to learn the technologies or import capital goods from developed economies.

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TRADE AND GROWTH

- **Negative Effects**
 - *Disadvantage in Learning by Doing:* High-income economies tend to have more advanced technologies. They are more likely to specialize in more sophisticated goods, for example, computer chips and satellites. Low-income economies may continue to export **agricultural** products. (**Learning by doing** in agriculture appears to be smaller.)

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