ECO 330: Economics of Development

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Growth Accounting Recap

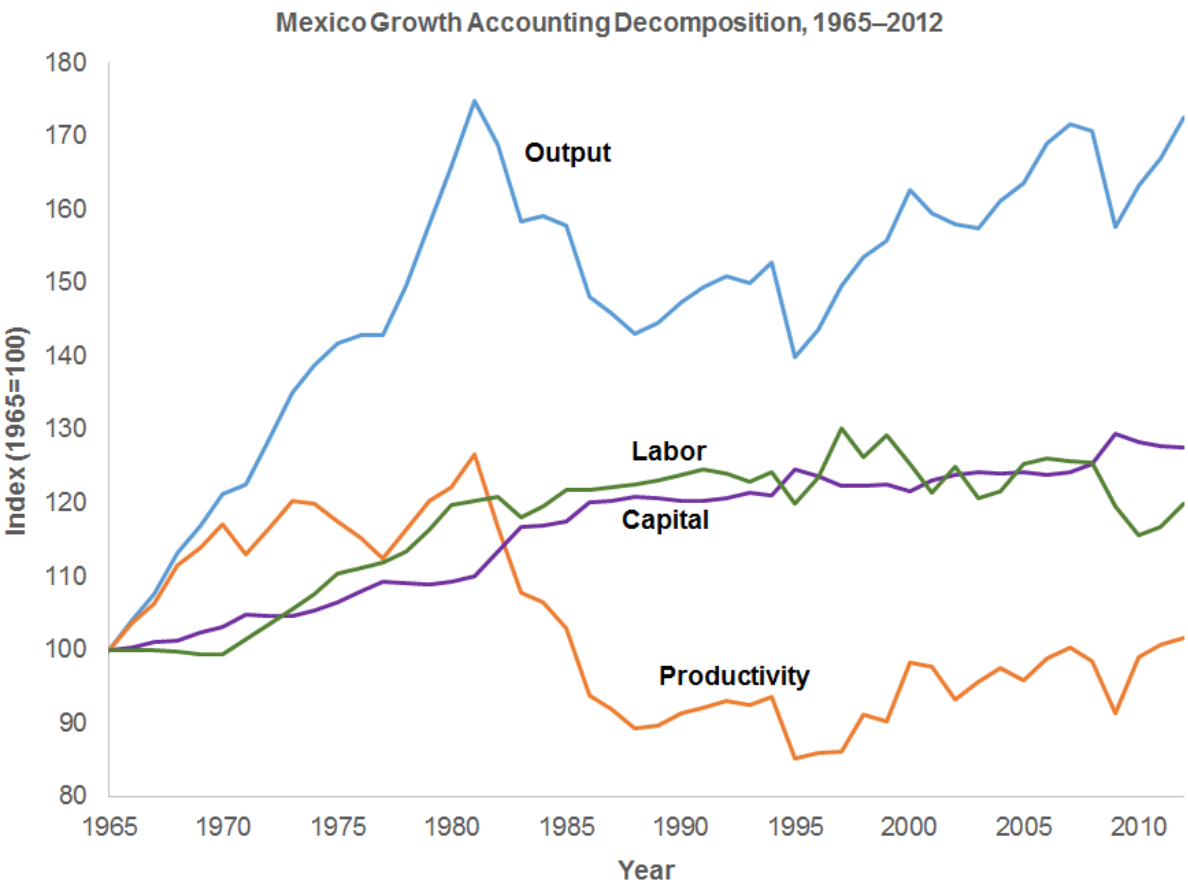
Decomposed Output per Worker into three components

1. Productivity

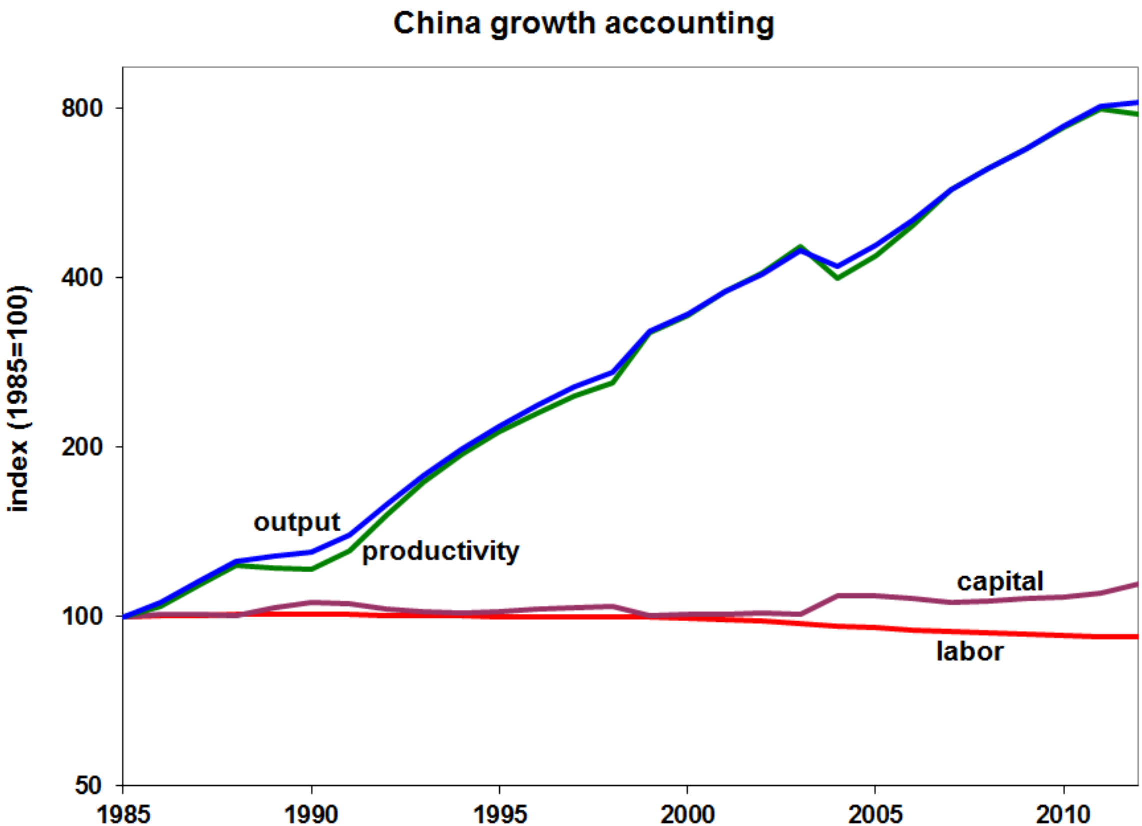
2. Capital-Output Ratio

3. Labor Supplied per Worker

Mexico Growth Accounting: 1965-2012



China Growth Accounting: 1985-2010



Growth Accounting Recap

Long term growth mostly driven by changes in TFP

- TFP is computed as a residual (what's not explained by quantity of Capital and Labor inputs alone)
- TFP absorbs things such as human capital

TFP is exogenous in Solow Growth Model

- Need a new model to think about TFP growth

Human Capital

Human Capital is investment people make to improve their skills and abilities

- Main component is education.
- Can also include things such as on the job training, but harder to get cross-country data

Human Capital vs TFP

Human Capital may be important component of TFP

- Extend growth accounting framework to disentangle Human Capital from other factors entering TFP

$$Y_t = A_t K_t^{\alpha} (h_t L_t)^{1-a}$$

- h_t is human capital. Makes labor more productive, but doesn't effect capital productivity.

Human Capital vs TFP: Results

Human capital (average years of schooling) does better than savings rates and traditional capital in explaining cross-country variation in income.

- Causality is unclear (educated because rich, or rich because educated?)
- Most growth still driven by TFP growth

Table 4.1: Decomposition of Labor Productivity

		Contribution from		
Country	Y/L	$(K/Y)^{\alpha/(1-\alpha)}$	H/L	A
United States	1.000	1.000	1.000	1.000
Canada	0.941	1.002	0.908	1.034
France	0.818	1.091	0.666	1.126
United Kingdom	0.727	0.891	0.808	1.011
India	0.086	0.709	0.454	0.267
China	0.060	0.891	0.632	0.106
Kenya	0.056	0.747	0.457	0.165
Average, 127 Countries	0.296	0.853	0.565	0.516

Decompose Labor Productivity (Y/L) into three factors

- Capital-Output Ratio (K/Y), Human Capital (H/L), TFP (A)
- Report values of each factor relative to U.S. (1.00=U.S.)

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Human Capital correlated with cross-country differences in Labor Productivity for developed countries

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Human capital alone can't explain gap between developed and developing countries. TFP does better.

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Capital-Output ratios do little to explain differences in labor productivity across countries

Brief Overview of Romer Model of TFP Growth

Romer Growth Model allows TFP growth through R&D

- Labor can be used either for Production or Research

$$\underbrace{L_t}_{\text{Total Labor Supply}} = \underbrace{L_t^{\text{Prod}}}_{\text{Labor used for Production}} + \underbrace{L_t^{\text{R\&D}}}_{\text{Labor used for Research}}$$

- Production function uses only labor used for production

$$Y_t = A_t K_t^{\alpha} \left(L_t^{\text{Prod}}\right)^{1-\alpha}$$

Labor used for Research and TFP

Labor allocated towards research increases TFP (A_t)

- Assume TFP growth depends on TFP and R&D Labor

$$\overbrace{\Delta \mathrm{A_t}}^{\text{TFP growth}} = \overbrace{\mathrm{A_{t-1}}}^{\text{Past TFP}} \; \overbrace{\gamma}^{\text{R\&D Efficiency}} \; \overbrace{L_t^{\mathrm{R\&D}}}^{\text{R\&D Labor}}$$

Where $\Delta A_t \equiv A_t - A_{t-1}$ ($\equiv$ indicates "is defined as") is TFP growth in levels

- R&D produces TFP (Knowledge) as an output

R&D and TFP Growth

Idea is that TFP represents “current stock of knowledge”

- More you know, the easier it is to discover new things
- Unlike human capital, stock of knowledge not embodied in individuals. Transmitted across people and time. This means there are knowledge spillovers.
- Knowledge is unbounded. There is always more to learn.

Knowledge as a Good

Knowledge has several unique properties

- Non-Rival: use of knowledge does not prevent others from using knowledge.

Example:

- A **cookie recipe** is a non-rival good (we can both use it)
- A **cookie** itself is rival good (if I eat it, you cannot eat it)

Knowledge as a Good

Knowledge has several unique properties

- Excludable: Despite being non-rival, owner of knowledge may be able to prevent others from using it

Examples:

- **Patents** and **copyrights** prevent use of knowledge
- Can try to hide knowledge (**secret recipes**)

There are limits to excludability (patents expire and not all knowledge can be patented)

Excludability of Knowledge

In this model, without excludability, no incentive for R&D

- R&D produces Knowledge as output
- If can't sell Knowledge (because freely available), then won't produce Knowledge
- This is basic reason why governments enforce patents

Monopoly Rents for Knowledge

When you own access to knowledge, can charge rents

- Price of knowledge no longer equal to zero. Therefore will now produce knowledge in equilibrium
- Keep in mind, Monopoly Rents are still inefficient
- This is because knowledge has positive externalities.

Positive Externalities for Knowledge

Using Knowledge allows everybody to develop new Knowledge easier.

- Likewise, everybody benefits from new Knowledge

Positive Externalities for Knowledge

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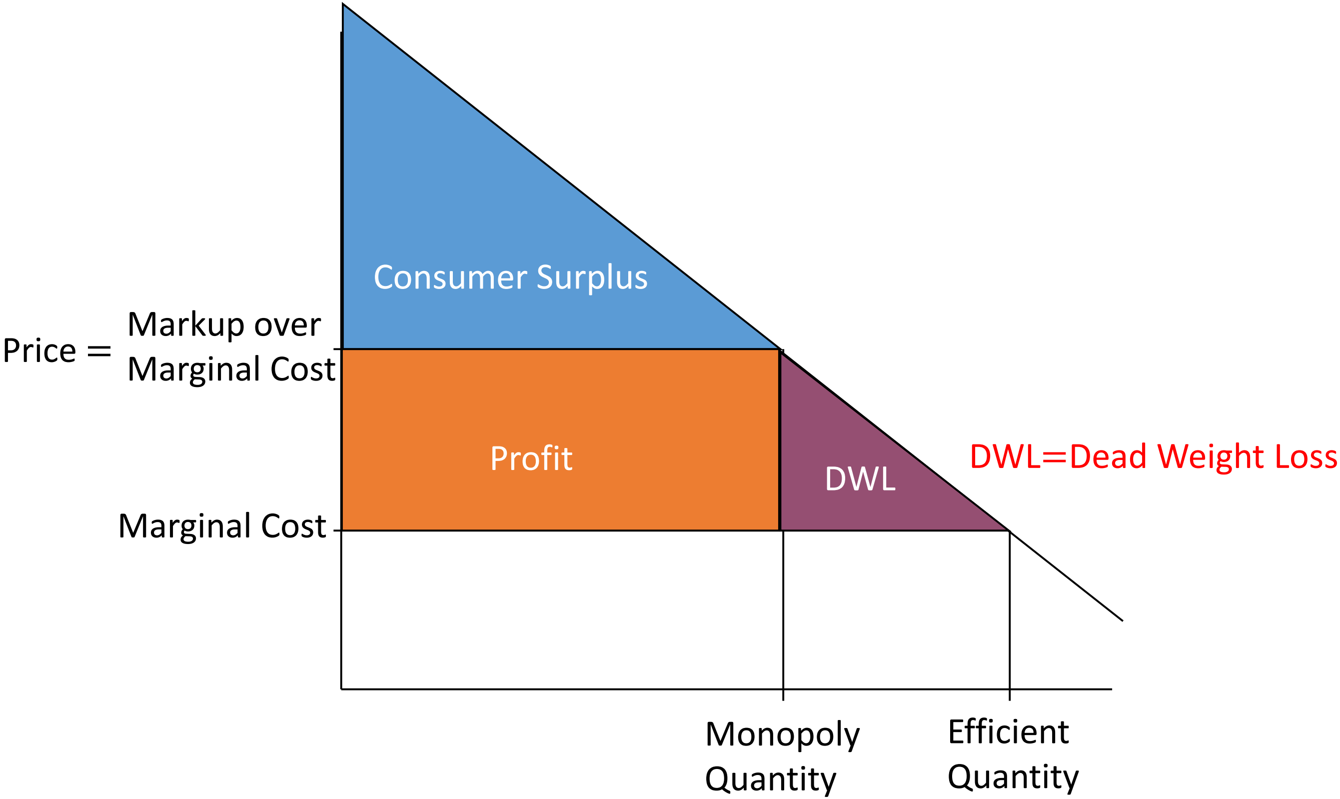
- Likewise, everybody benefits from new Knowledge

In model R&D producers do not care about externality

- Care only about what they can sell their knowledge for.

Example: Pharmaceutical company might care only about profits, not the good a drug could do for the world

Graphical Analysis of Monopoly Power



Note: Knowledge freely available without patents ⇒ price = 0 without Monopoly Power
⇒ Quantity under Perfect Competition is 0. Monopoly better than perfect competition here.

Solving Romer Model

Won’t discuss how to solve model fully

- Need to find labor allocated for production vs R&D.

- Determined by Marginal Revenue = Marginal Cost

$$\begin{matrix}\text{Cost of producing 1} \\ \text{more unit of Knowledge}\end{matrix} = \begin{matrix}\text{What you can sell 1} \\ \text{more unit of Knowledge for}\end{matrix}$$

- We assume monopolistic competition in R&D sector

TFP Growth Rate

- Growth rate (%) of TFP at time T is

$$g_{A_t} \equiv 100 \times \frac{A_t - A_{t-1}}{A_{t-1}}$$

- Then growth rate of TFP depends on R&D efficiency and Labor allocated towards R&D

$$g_{A_t} = 100 \times \gamma L_t^{\mathrm{R\&D}}$$

Implications of Romer Model

- Grow faster the more labor you allocate towards R&D
- Bigger countries have more labor ⇒ more people working on R&D ⇒ Grow Faster
- This is due to positive externalities of Knowledge

Implications of Romer Model

- Unlike Malthus and Solow Growth Model, do not reach steady state value of wealth
- Balanced Growth in equilibrium. Output per Capita, Capital Stock, and TFP grow at a constant rate.
- No limits to how rich countries can be
- Predicts countries should not converge (larger countries catch up, but then smaller countries will be left behind)

Population Growth vs Economic Growth

Have three models for thinking about whether Population Growth is good or bad for development

Malthusian Model:

- Natural resources are main determinant of wealth
- More people ⇒ Less resources per person ⇒ less output per person
- Population growth is bad for growth in Malthusian Model

Population Growth vs Economic Growth

Have three models for thinking about whether Population Growth is good or bad for development

Solow Growth Model:

- Capital stock is main determinant of wealth
- More people $\Rightarrow$ Invest in more capital $\Rightarrow$ same capital per person $\Rightarrow$ same output per person
- Population growth does not affect growth in Solow Model

Population Growth vs Economic Growth

Have three models for thinking about whether Population Growth is good or bad for development

Romer Growth Model:

- Knowledge stock is main determinant of wealth
- More people ⇒ Invest in more in R&D ⇒ more Knowledge per person (non-Rival good) ⇒ higher output per person
- Population growth is good for growth in Romer Model

Population Growth vs Economic Growth

What model is closest to reality?

- Malthusian model can't explain growth in developed countries since industrial revolution
- Solow model does a poor job matching facts on convergence and cross-country differences in income
- Romer model does better in matching growth, but predicts strong scale effects for growth

Scale Effects in Growth Models

Scale effects means larger populations imply higher economic growth rates

- Not clear whether scale effects exist. Most think not.
- US Population 4x higher in 2000 than in 1900, but growth rate still ~2% per year
- Have not observed divergence between United States and small countries such as Canada and U.K.

Scale Effects in Growth Models

Not all evidence is against Scale Effects however

- Anecdotal evidence that technological innovations occur disproportionately in densely populated areas

- Some evidence of scale effects over past 1000 years

- Spillover and Agglomeration effects often observed in certain industries. **Example:** Silicon Valley

Kremer (1993): World Population vs Growth Rate

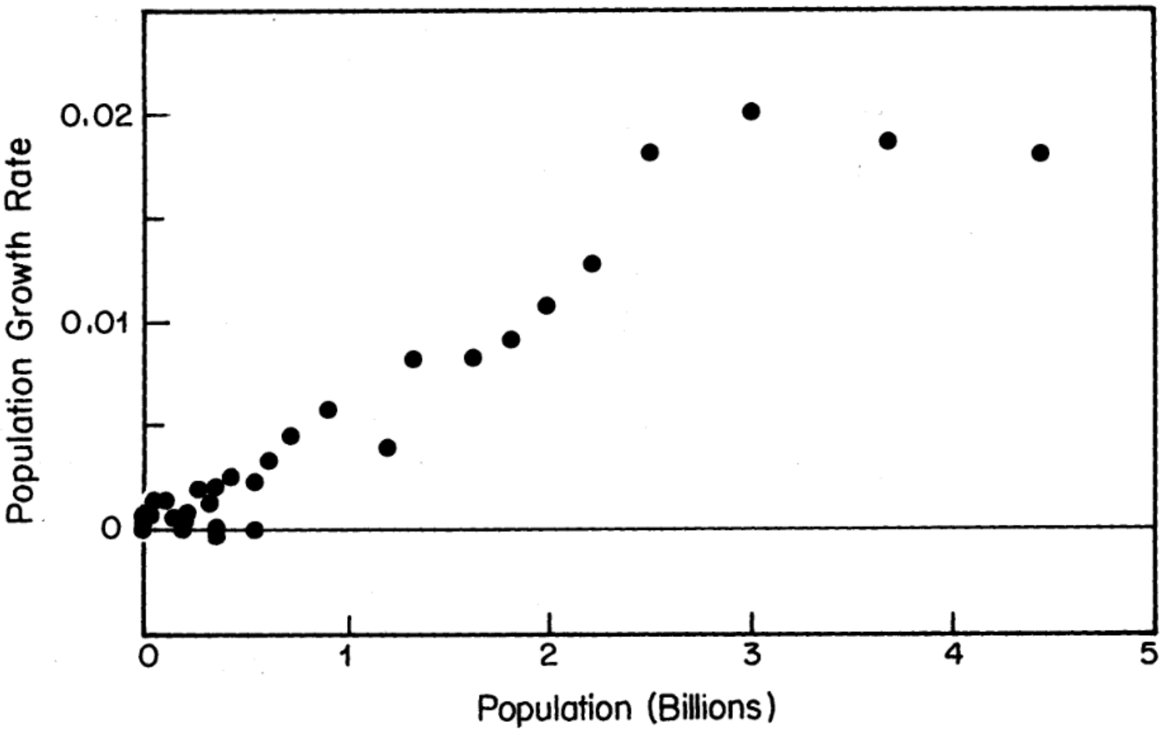


FIGURE I
Population Growth Versus Population

Population and Growth Rates by Time

Not all evidence is against Scale Effects however

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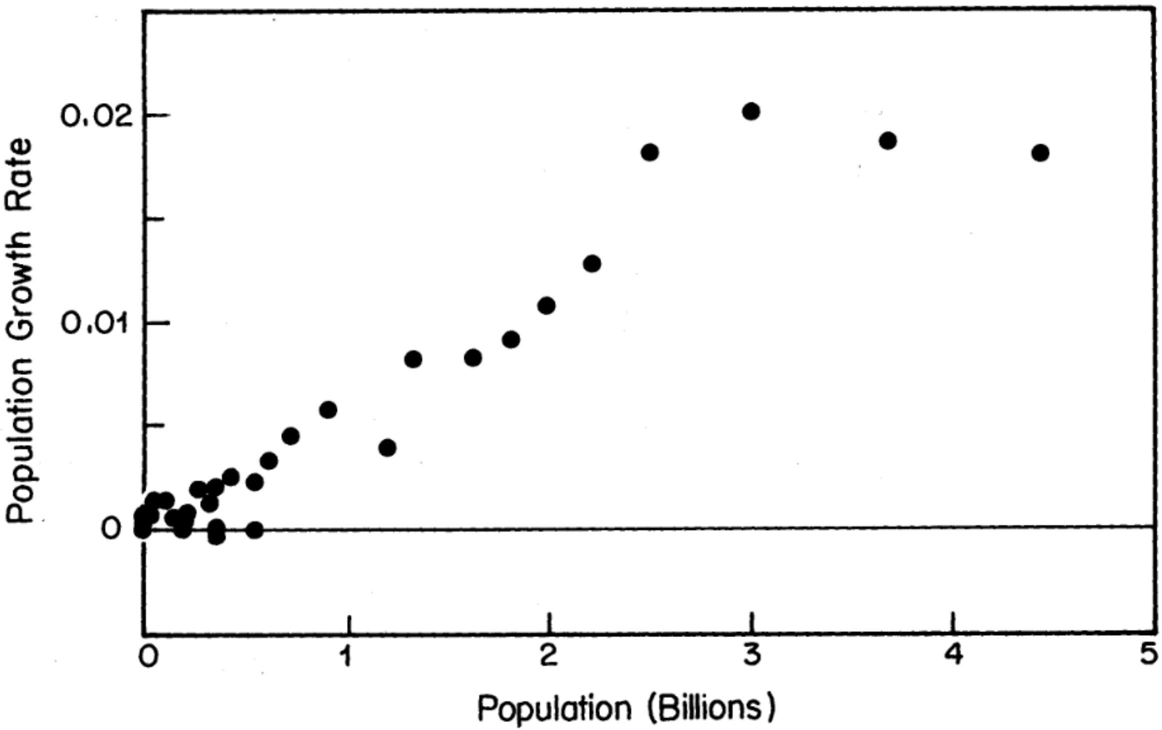

FIGURE I
Population Growth Versus Population

Extensions of Romer Model

Romer model endogenizes TFP, but still overly simple

- In practice, still can't explain development gap

Extensions to model that may be important

- Creative Destruction
- Spillovers across countries

Creative Destruction

Often referred to as Schumpeterian Growth

- Models that innovation often has winners and lowers
- New tech displaces old tech
- Observe this often in the world
- Might explain why countries diverge. One country wins while another loses (Finland and Nokia hurt by Iphone)

Creative Destruction: Mobile Phone Market

Source: storify.com

Technological Spillovers

Not clear what a “Country” is in Romer model

- Group of people between which knowledge is shared
- Should knowledge flow across borders? Languages?
- Likely important for explaining rapid growth of China and other countries that develop in short periods of time