Theories of Economic Growth - Development in Open Economies

Guzmán Ourens

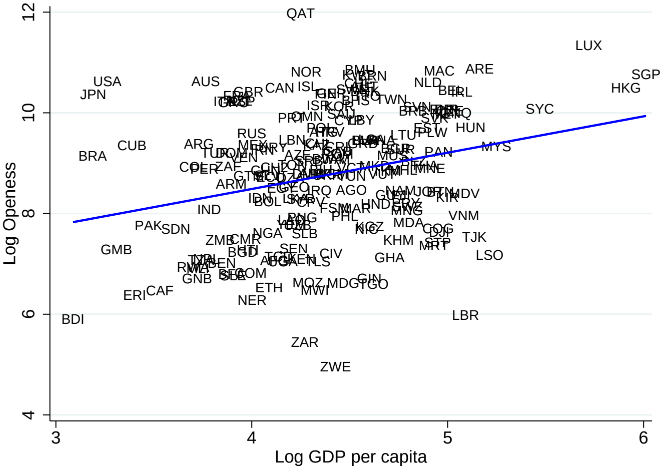
Tilburg University

Intro

- So far we have considered closed economies.
- Now we consider world equilibria with international trade in:
  - financial assets
  - commodities
  - We don't consider: technological spillovers.
- Main message: growth in one country cannot be analyzed in isolation from the growth experiences of other nations in the world.

Intro

Relationship between openness and income per capita:



Intro

Introducing financial linkages between economies we can address:

- Why does capital not flow from Rich to Poor countries?
  - Lucas Paradox (Lucas, 1990)
  - Consider a world economy in which countries have = technology.
    The only reason one country would be richer is higher K/L.
    The rate of return to capital will be lower in the richer economy.
    There will be incentives for capital to flow from rich to poor countries.

Introducing trade between countries we can address:

- Can trade spur growth?
- How?

Growth and Financial Capital Flows

Allowing for international capital flows

- relaxes domestic consumption and savings constraint
  - we will show that international capital flows change transitional dynamics in the basic neoclassical growth model.
- brings about interdependencies between economies:
  - we expect capital to flow toward areas where its rate of return is higher

The Setup

Consider a world economy consisting of J (small) countries, indexed $j = 1, ..., J$, each with:

- Aggregate production function for producing a unique final good:

$$Y_j(t) = F(K_j(t), A_j(t)L_j(t))$$

  where F satisfies Inada conditions.

- Define variables in intensive terms:
  - $\tilde{c}_j(t) = C_j(t)/[A_j(t)L_j(t)]$ $\qquad (c_j(t) = C_j(t)/L_j(t) = \tilde{c}_j(t)A(t))$
  - $k_j(t) = K_j(t)/[A_j(t)L_j(t)]$

  $\Rightarrow Y_j(t)/[A_j(t)L_j(t)] = F(k_j(t), 1) = f(k_j(t))$

  $\Rightarrow y_j(t) = Y_j(t)/L_j(t) = A_j(t)f(k_j(t))$

- Tech. change at constant rate g across countries: $A_j(t) = A_j(0)e^{gt}$
- $A_j(0)$ are given

The Setup

- Let $B_j(t) \in \mathbb{R}$ be the net borrowing of j ($b_j(t)$ in intensive terms)
- Let $r(t) \in \mathbb{R}$ be the world interest rate.
- Resource constraint at j:

$$\dot{k}_j(t) = f(k_j(t)) - \tilde{c}_j(t) + b_j(t) - (n + g + \delta)k_j(t)$$

- Let $\mathcal{A}_j(t)$ denote the international asset position of j at time t.
- Flow budget constraint for country j at time t:

$$\dot{\mathcal{A}}_j(t) = r(t)\mathcal{A}_j(t) - B_j(t) \tag{1}$$

- No-Ponzi game condition:

$$\lim_{t\to\infty} \mathcal{A}_j(t).e^{-\int_0^t r(s)ds} = 0 \tag{2}$$

The Setup

- In intensive terms: $\mathbf{a}_j(t) = \mathcal{A}_j(t)/(A_j(t).L_j(t))$

  $\Rightarrow$ (1) becomes:

$$\dot{\mathbf{a}}_j(t) = (r(t) - g - n)\mathbf{a}_j(t) - b_j(t) \tag{3}$$

  $\Rightarrow$ (2) becomes:

$$\lim_{t\to\infty} \mathbf{a}_j(t).e^{-\int_0^t [r(s)-g-n]ds} = 0 \tag{4}$$

- Borrowing in the world must balance:

$$\sum_{j=1}^{J} B_j(t) = 0 \tag{5}$$

The Setup-Consumers

- CRRA preferences: $u(c(t)) = \frac{c(t)^{1-\sigma}-1}{1-\sigma}$
- exogenous population growth rate: n
- $L_j(0) = 1 \forall j \Rightarrow L_j(t) = L(t) = e^{nt}$
- inelastic labour supply: $L_j(t) = \bar{L}_j(t)$
- exogenous discount factor: ρ

$$\max \quad \int_0^\infty e^{-(\rho-n)t} u(\tilde{c}_j(t)A(t))dt$$

$$\begin{aligned} s.t. \quad & \dot{\mathbf{a}}_j(t) = (r(t) - g - n)\mathbf{a}_j(t) - b_j(t) \\ & \dot{k}_j(t) = f(k_j(t)) - \tilde{c}_j(t) + b_j(t) - (n + g + \delta)k_j(t) \\ & \lim_{t\to\infty} \mathbf{a}_j(t).e^{-\int_0^t [r(s)-g-n]ds} = 0 \end{aligned}$$

Equilibrium

- World equilibrium:
  - $\left[\{k_j(t), \tilde{c}_j(t), \mathbf{a}_j(t)\}_{j\geq 1}^{J}, r(t)\right]_{t\geq 0}$: each country's allocation maximizes the utility of the representative household in each country, and the world financial market clears.

- Steady-state world equilibrium:
  - world equilibrium in which $k_j(t)$ and $\tilde{c}_j(t)$ are constant and output in each country grows at a constant rate.

World Equilibrium

In equilibrium we have:

- $k_j(t) = k(t) = f'^{-1}(r(t) + \delta)\forall j$
- $\frac{\dot{\tilde{c}}_j(t)}{\tilde{c}_j(t)} = \frac{1}{\sigma}[r(t) - \rho - g\sigma]$

Steady State

At the unique SS world equilibrium we have:

- $r = \rho + \sigma g$, so its constant
- output, capital, and consumption in intensive terms are constant in all countries

Steady State

At the unique SS world equilibrium we have:

- $r = \rho + \sigma g$, so its constant
- output, capital, and consumption in intensive terms are constant in all countries
- output, capital, and consumption per capita grow at the rate g in all countries
- $k_j^* = k^* = f'^{-1}(r + \delta) \forall j$
- $\lim_{t \to \infty} \dot{\mathbf{a}}_j(t) = 0 \forall j$

Transitional dynamics

- For the world equilibrium $\exists$ a unique path for $k, c, \mathbf{a}$ that converges to the SS.
- There are no transitional dynamics for each economy j individually.

Lucas Paradox

Why does capital not flow from Rich to Poor countries?

- With perfect international capital markets, capital flows equalize effective capital-labor ratios. But this does not imply equalization of capital-labor ratios. The more productive countries should have higher capital-labor ratios.

- There might be imperfections in capital markets
  - frictions to international capital movements
  - perceived risk of default
  - frictions to capital movements within countries

- Evidence shows
  - at the macro level: no huge differences in returns
  - at the micro level: differences are more sizeable
  - positive correlation between rate of savings and investing.

Economic Growth in a Heckscher-Ohlin World

Now we move to evaluate how trade in goods affect growth.

- We focus on a Heckscher-Ohlin setting, but results can be different in other settings.

The Setup

- J countries
- 2 factors (K_j and L_j) used to produce inputs.
- 2 inputs: one K-intensive and one L-intensive.
- there is free international trade (only) in these inputs
  - we call $X_j^i(t)$ the usage of input i in country j
  - we call $Y_j^i(t)$ the production of input i in country j
- countries have the same technologies:

$$Y_j(t) = F(X_j^K(t), X_j^L(t))$$

  where F satisfies Inada conditions
- production of inputs follow: $Y_j^K(t) = K_j(t)$ and $Y_j^L(t) = A_j L_j(t)$
- no tech progress.

The Setup

- Free international trade $\rightarrow$ domestic and international prices of traded goods are equal: $p^K(t)$ and $p^L(t)$
- Price of final good set to 1.
- Competitive factor markets $\rightarrow$ $w_j(t) = A_j p^L(t)$, and $R_j(t) = p^K(t)$.
  $\Rightarrow$ Conditional factor price equalization
- There is positive depreciation: $r_j(t) = R_j(t) - \delta = p^K(t) - \delta = r(t)$
- Trade balance equation:

$$p^K(t)[X_j^K(t) - Y_j^K(t)] + p^L(t)[X_j^L(t) - Y_j^L(t)] = 0$$

- Resource constraint: $\dot{K}_j(t) = F(X_j^K(t), X_j^L(t)) - C_j(t) - \delta K_j(t)$
- World market clearing: $\sum_{j=1}^J X_j^i(t) = \sum_{j=1}^J Y_j^i(t) \ \forall i = K, L$

The Setup-Consumers

- CRRA preferences: $u(c_j(t)) = \frac{c_j(t)^{1-\sigma}-1}{1-\sigma}$ with $c = C/L$
- exogenous population growth rate: n
- $L_j(0) = L \forall j \Rightarrow L_j(t) = L(t) = Le^{nt}$
- exogenous discount factor: ρ

The Setup-Consumers

- CRRA preferences: $u(c_j(t)) = \frac{c_j(t)^{1-\sigma}-1}{1-\sigma}$ with $c = C/L$
- exogenous population growth rate: n
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- exogenous discount factor: ρ

Consumers' problem:

$$\max \quad \int_0^{\infty} e^{-(\rho-n)t} u(c_j(t)) dt$$

$$s.t. \quad \dot{K}_j(t) = F(X_j^K(t), X_j^L(t)) - C_j(t) - \delta K_j(t)$$

$$\sum_{j=1}^{J} X_j^i(t) = \sum_{j=1}^{J} Y_j^i(t) \forall j$$

FOC: $\Rightarrow$ Euler equation: $\frac{\dot{c}(t)}{c(t)} = \frac{1}{\sigma}[r(t) - \rho]$

The Setup

Define:

- $x_j(t) = X_j^K(t)/X_j^L(t) \Rightarrow$

  $$Y_j(t) = F(X_j^K(t), X_j^L(t)) = X_j^L(t)F(X_j^K(t)/X_j^L(t), 1) = X_j^L(t)f(x_j(t))$$

- $k_j(t) = K_j(t)/L(t)$

Equilibrium

- World equilibrium:
  - $\left[\{k_j(t), c_j(t), x_j(t)\}_{j\geq 1}^{J}, p^K(t), p^L(t)\right]_{t\geq 0}$: each country's allocation maximizes the utility of the representative household in each country, and the world financial market clears.
- Steady-state world equilibrium:
  - world equilibrium in which all of the above are constant.

Equilibrium

The world equilibrium is characterized by

- $x_j(t) = x_{j'}(t) = \frac{\sum_{j=1}^{J} k_j(t)}{\sum_{j=1}^{J} A_j}$ for any j and j' and any t.
- Define $H(t) = \frac{1}{J}\sum_{J}^{j=1} H_j(t)$ for $H = c, k, A$, then:
  - $\frac{\dot{c}(t)}{c(t)} = \frac{1}{\sigma}\left[f'\left(\frac{k(t)}{A}\right) - \delta - \rho\right]$
  - $\dot{k}(t) = Af\left(\frac{k(t)}{A}\right) - c(t) - (n+\delta)k(t)$

Equilibrium

The **unique** Steady State world equilibrium is characterized by

- $f'(x^*) = f'\left(\frac{k^*}{A}\right) = \rho + \delta \; \forall j$

  where $x_j^* = x^* = \frac{\sum_J^{j=1} K_j(t)}{L(t)\sum_J^{j=1} A_j}$ and $k^* = \frac{\sum_J^{j=1} K_j(t)}{JL(t)}$
- $r^* = p^{K*} - \delta = \rho$
- Global saddle-path stability

Transitional dynamics

- No transitional dynamics at the country level.

Results

- Technology is:
  - neoclassical at the world level
  - AK at the country level.
- Capital accumulation at the country level gives sustained growth, but leads to a SS at the world level.
- Long-term dynamics are similar for countries. But short-term dynamics can be very different.
  - Assume all J economies are small and at SS, but j=1 experiences a reduction in its ρ towards $\rho' < \rho$. Then $\exists T > 0 : \forall t < T$ we have: $g_1 = \frac{\dot{c}_1}{c_1} = \frac{\rho - \rho'}{\sigma}$
- This model can fit (temporary) episodes of rapid economic growth for countries changing their policies.

More on this

- Different models have different effects: see Section 19.4.
- Effects of trade on growth:
    - canonical: Grossman and Helpman (1990, 1991), Rivera-Batiz and Romer (1991x2), Young (1991)
    - modern (with heterogeneous firms): Baldwin and Robert-Nicoud (2007), Sampson (2016), Alvarez, Buera an Lucas (2016)
- Effects of trade on welfare in long-run: Atkeson and Burstein (2010), Buera and Oberfield (2014), Perla, Tonetti and Waugh (2015), Ourens (2016).
- Effects of trade on productivity: Caliendo and Parro (2015)
- Effects of trade on resource allocation:
    - technological side: Redding (1999), Rodrik (2016)
    - preference side: Matsuyama (1992), Boppart (2014), Caron, Fally and Markusen (2014)
- Effects of uneven growth in an international context: Acemoglu and Ventura (2002), Corsetti, Martin and Pesenti (2013), Ourens (2018).