Openness, Technology Capital and Development

McGrattan and Prescott

JET, 2009

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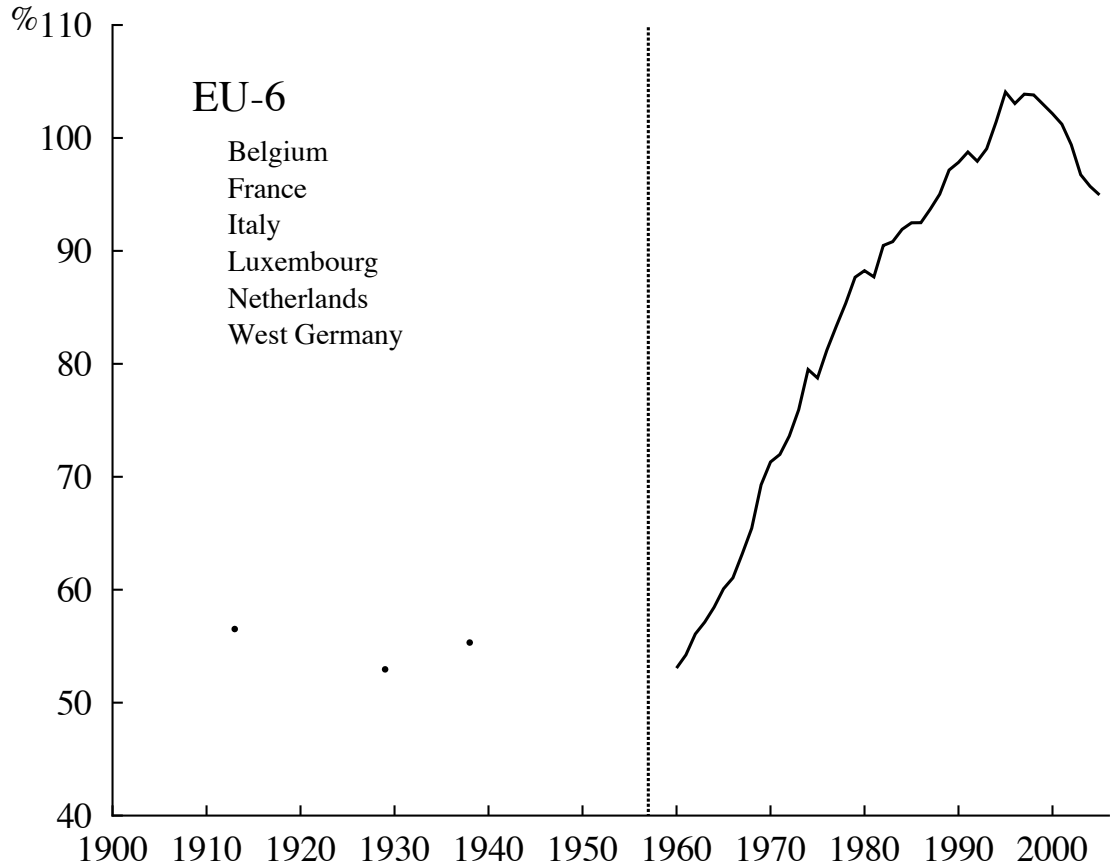
Motivation

- Large gains to openness not related to trade
- Gains stem from exploiting intangible assets in open countries
- Develop a framework to study these gains

GAINS FROM OPENNESS

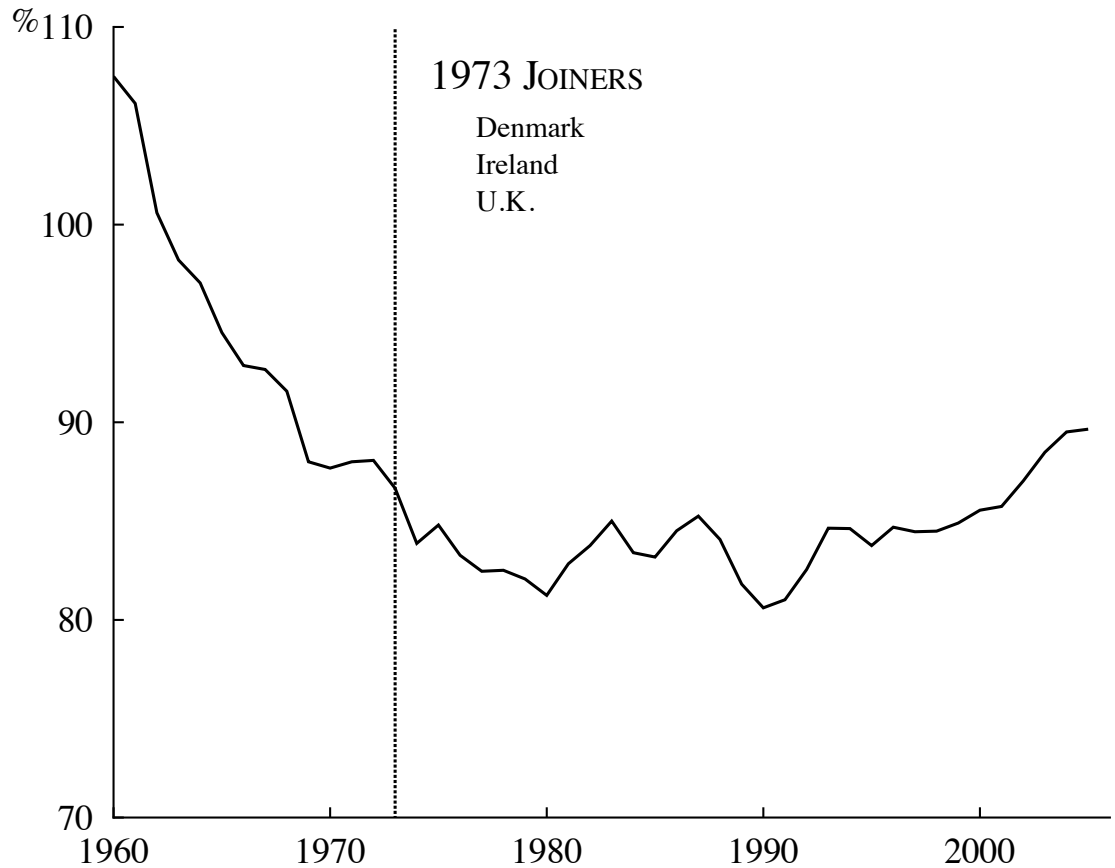
EU-6 Grew Faster than US

Figure 1: EU-6 Labor Productivity as a Percentage of US (1900–2005)



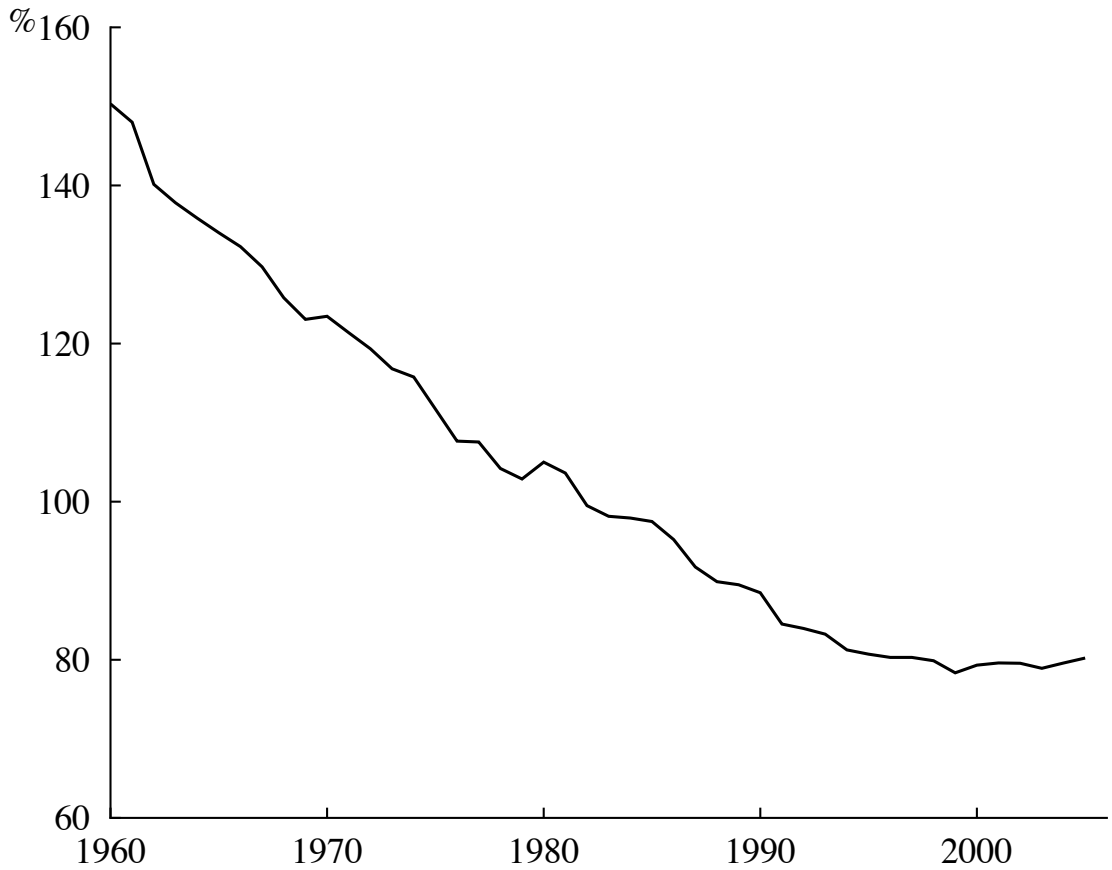
EU-9 Stopped Losing Ground with Openness

Figure 2: 1973 Joiners' Labor Productivity as a Percentage of EU-6 (1960–2005)



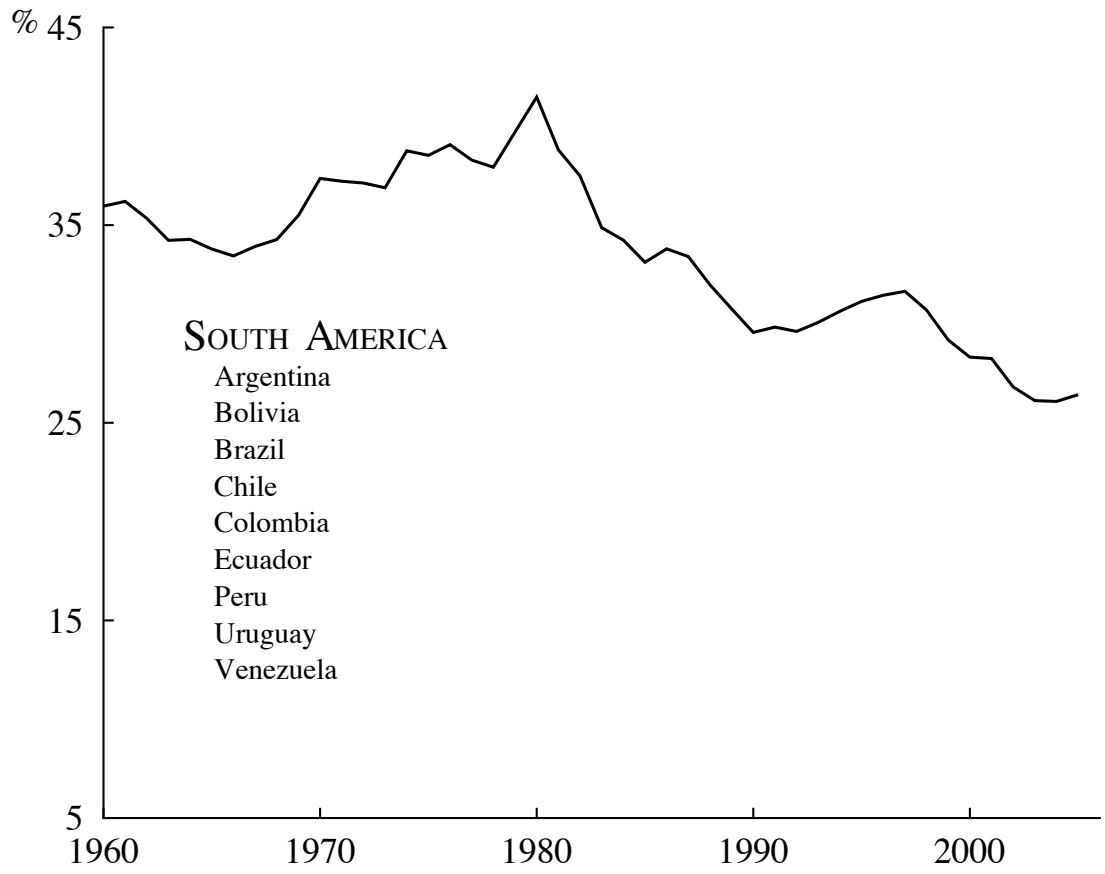
Switzerland Lost Ground

Figure 4: Switzerland's Labor Productivity as a Percentage of EU-6 (1960–2005)



South America is Stuck

Figure 6: South American Labor Productivity as a Percentage of US (1960–2005)



Model

Environment

- There are I countries
- In each country, there are N_i locations ($\propto$ population)
- A firm with presence in country i sells in N_i locations
- Two types of inputs
  - Location specific: tangible capital and labor
  - Firm specific: technology capital

Technologies

- Composite input,
$$z_i = k_i^{\alpha} l_i^{1-\alpha}, \alpha \in (0,1)$$
- Output per unit of technology capital in home country i,
$$y_{ii} = A_i z_i^{1-\phi}, \phi \in (0,1)$$
- Output per unit of technology capital in foreign country j,
$$y_{ij} = \sigma_{ij} A_j z_j^{1-\phi}, \sigma \in [0,1]$$
  - $\sigma_{ij} = 1$: no barrier in country j for country i technology capital
  - $\sigma_{ij} = 0$: country i technology capital cannot be exploited in country j

From Micro Technologies to Macro Technology

M_i: stock of technology capital and $\sigma_{ij} = \sigma_i \; \forall j$

- Output per domestic location:

$$y_{ii} = M_i A_i z_i^{1-\phi}$$

- Output per location in country j:

$$y_{ij} = \sigma_j M_i A_i z_i^{1-\phi}$$

- Maximum output in country i:

$$\max_{\{z_i\}} \left\{ M_i N_i A_i z_i^{1-\phi} + \sigma_i \sum_{j \neq i} M_j N_i A_i z_j^{1-\phi} \right\}$$

$$s.t. \quad N_i M_i z_i + \sum_{j \neq i} N_i M_j z_j \leq Z_i$$

Aggregate Technology

Solution to maximization problem

$$F_i(M_1, \ldots, M_I, Z_i) = A_i N_i^{\phi} \left(M_i + \omega_i \sum_{j \neq i} M_j \right)^{\phi} Z_i^{1-\phi}$$

where $\omega_i = \sigma_i^{\frac{1}{\phi}}$

- Technology is CRS in inputs $Z_i, \{M_i\}$
- However, $F_i(M_1, \ldots, M_I, Z_i) > \sum_i F_i(0, \ldots, 0, M_i, 0, \ldots, Z_i)$

Rest of the Model

- Preferences

$$\sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$$

- Feasibility

$$Y_t = C_t + X_{kt} + X_{mt} + NX_t$$

- Laws of motion

$$K_{t+1} = (1 - \delta_k)K_t + X_{kt}$$
$$M_{t+1} = (1 - \delta_m)M_t + X_{mt}$$

Solving the Model

Denote $M = (M_1, \ldots, M_I)$

- Domestic return on domestic technology capital

$$\frac{\partial F_i(M, Z_i)}{\partial M_i} = \kappa N_i \left(M_i + \omega_i \sum_{j \neq i} M_j \right)^{\theta}$$

  where $\theta = (\alpha - 1)(1 - \phi)/(1 - \alpha(1 - \phi)) < 0$

- Return of country i' technology capital in country $j \neq i$

$$\frac{\partial F_j(M, Z_i)}{\partial M_i} = \omega_j \kappa N_j \left(M_i + \omega_i \sum_{k \neq i} M_k \right)^{\theta}$$

Solving the Model

- FOC

$$r_{mi,t}(M) = \sum_{j=1}^{I} \frac{\partial F_j(M, Z_i)}{\partial M_i}$$

- Steady state

$$r_{mi,t} = \frac{1}{\beta} - 1 + \delta_m$$

GAINS FROM OPENNESS

Steady State

- If closed, larger is better

$$\sigma_i = 0 \ \ \forall i \Rightarrow y_i \propto N_i^{\phi/[(1-\phi)(1-\alpha)]}$$

- Large gains of forming a union of identical countries

$$y_i(I) \propto (1 + (I-1)\omega_i)^{\phi/[(1-\phi)(1-\alpha)]}$$

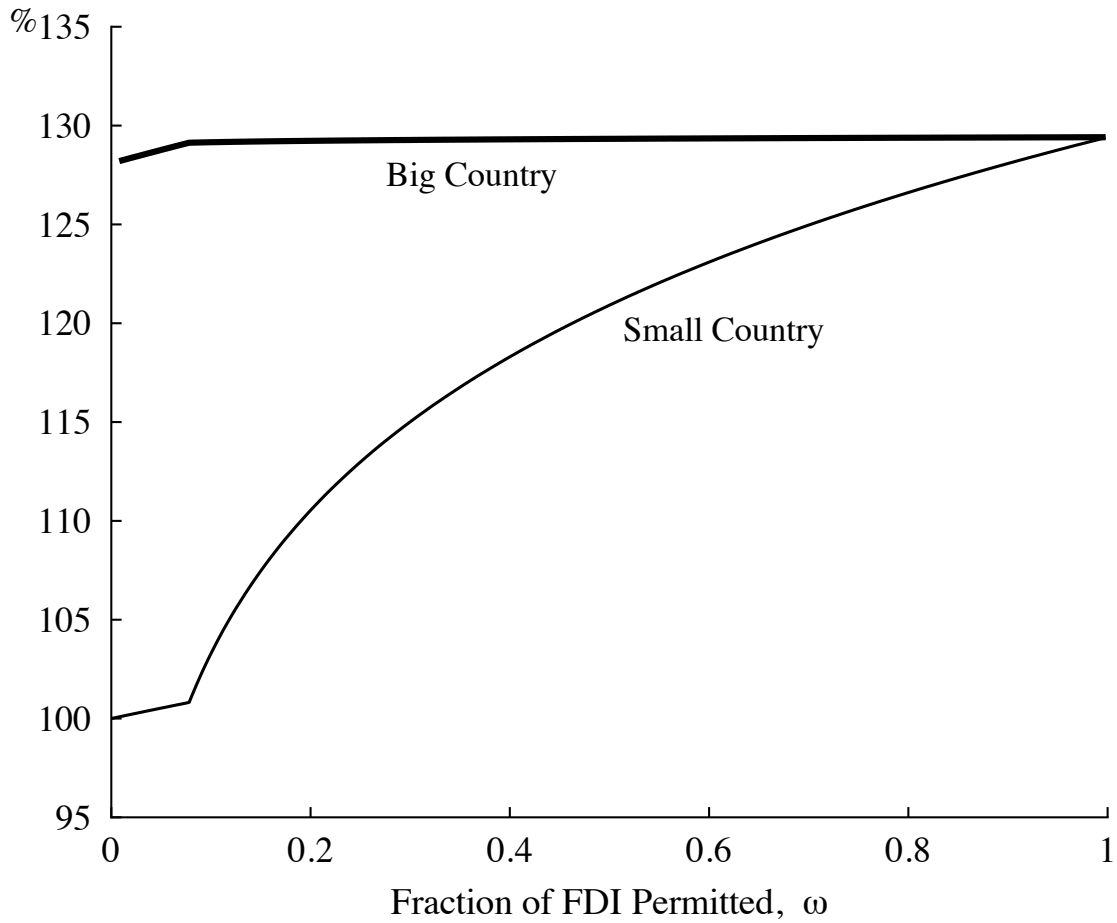
- Large gains from opening unilaterally
  - Openness gives access to world technology capital

Huge Gains for Small Countries (SS)

- 2 Countries, $N_1 = 1, N_2 = 10$
- Comparison of 2 steady states
  - Closed economies ($\omega_1 = \omega_{20} = 0$)
  - Open economies ($\omega_1 = \omega_{20} = \omega \in (0, 1]$)
- Will show
  - Small productivity gains for large country
  - Large productivity gains for small country (up to 30%)

Huge Gains for Small Countries (SS)

Figure 8: Steady-State Productivities as a Function of ω



Tangible vs Technology Capital Accumulation

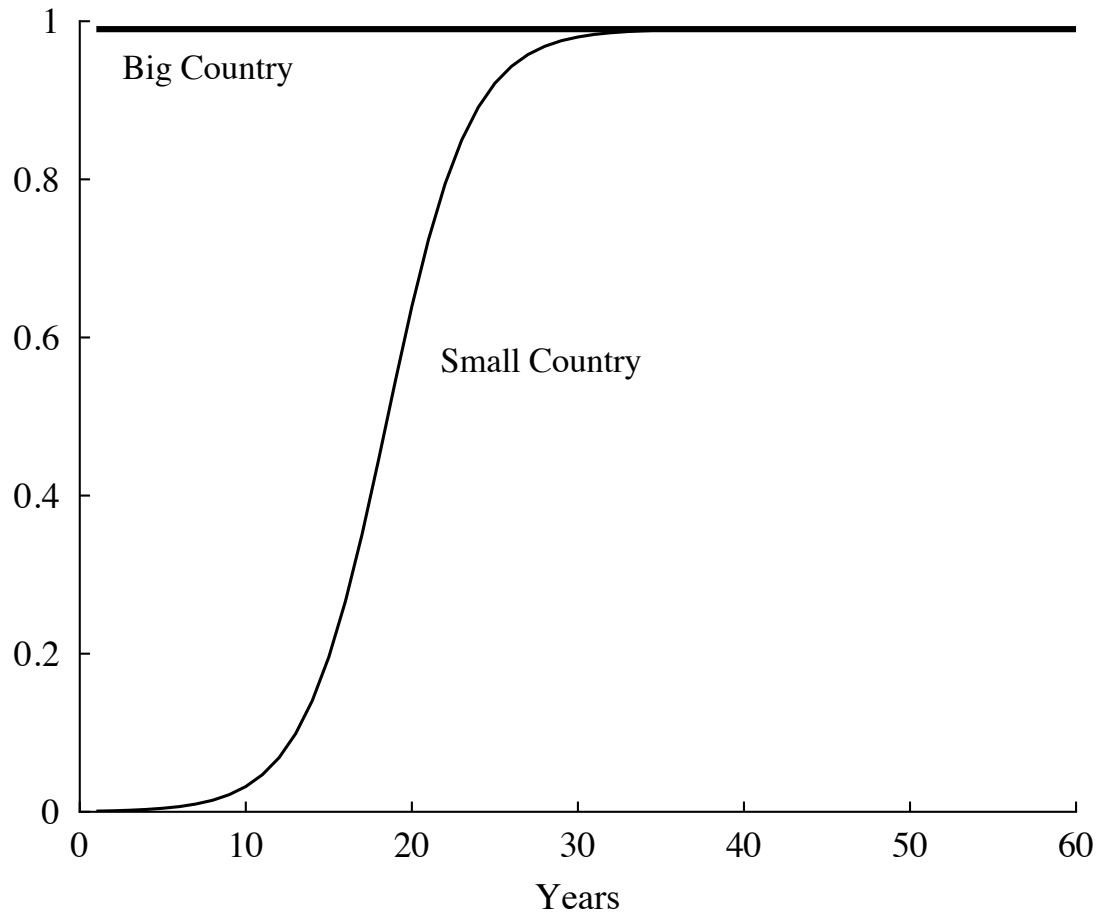
- Country 2 opening increases the marginal return to M_1
  - Incentives to accumulate technology capital
- Country 1 opening increases the marginal return to K_1
  - FDI acts as a productivity shock
- The small country may deplete its technology capital
  - If M_2/M_1 is too large, $X_{1m} = 0$

Transition - Joining a Large Open Economy

- 2 countries: $N_1 = 1, N_2 = 10$
- Countries are closed in period 0 ($\sigma_{10} = \sigma_{20} = 0$)
- Country 1 opens in period 1 ($\sigma_{11} = 0.99, \sigma_{21} = 0$)
- Country 2 opens gradually

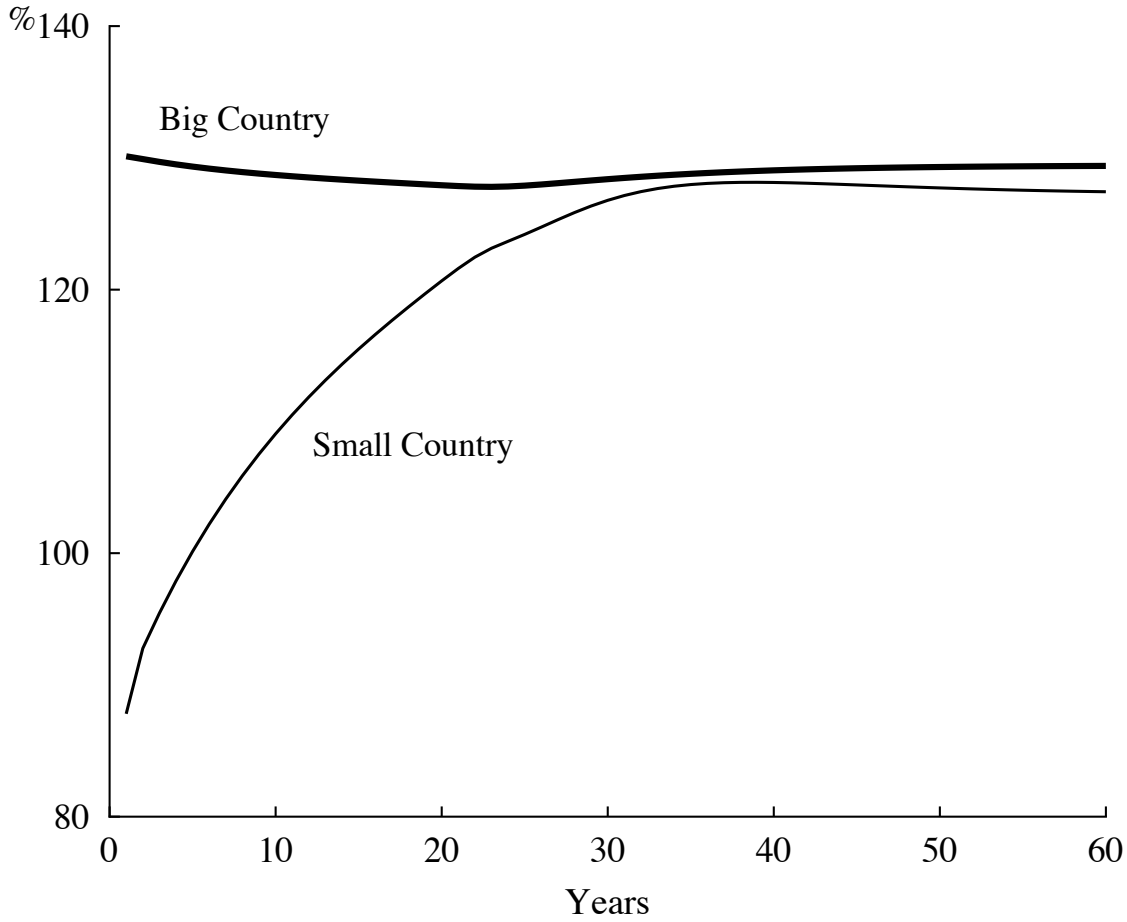
Gradual Openness

Figure 9: Openness Parameters Path (Example 5)



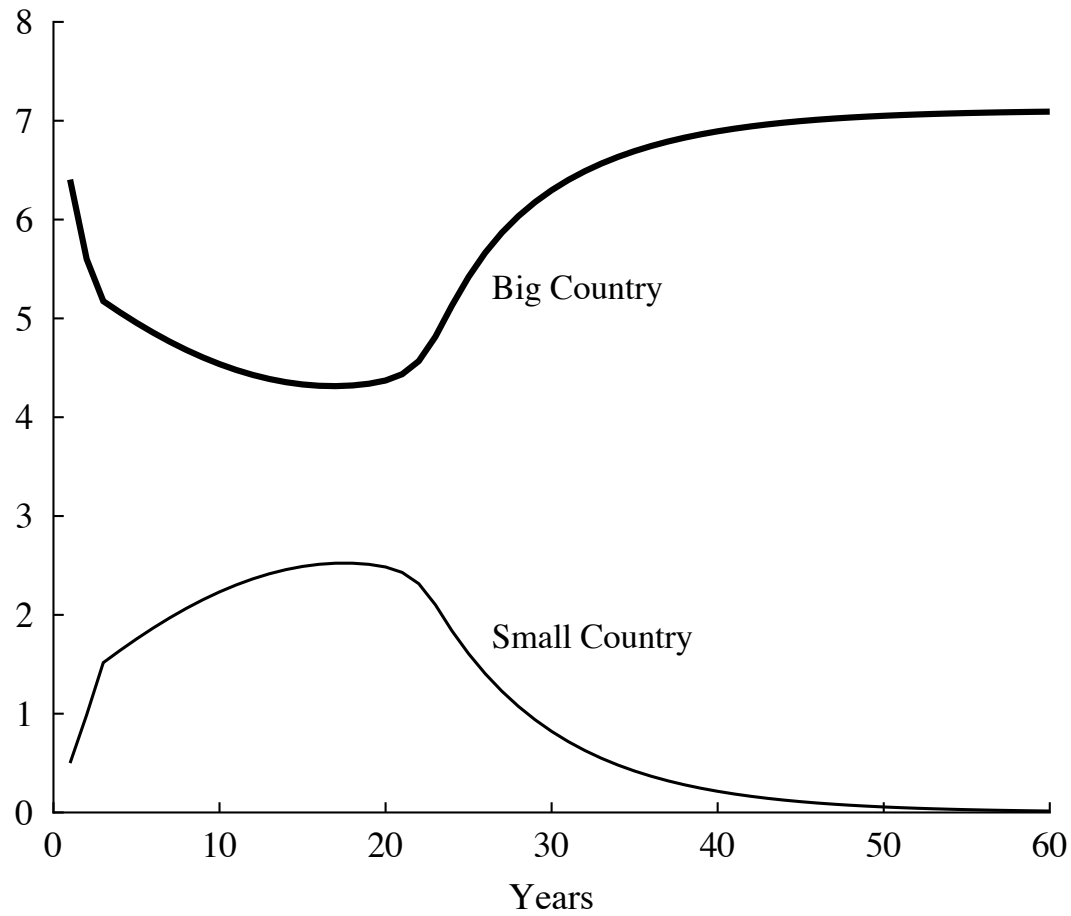
Consumption

Figure 10: Per Capita Consumption Relative to $c_{2,0}(1+\gamma_y)^t$ (Example 5)



Technology Capital

Figure 11: Technology Capital Relative to $Y_{2,0}(1+\gamma_Y)^t$ (Example 5)



Measured vs. Unmeasured Productivity

- Productivity path is similar to consumption path
- Measured productivity excludes investment in technology capital
- Large unmeasured gains when small country accumulates M

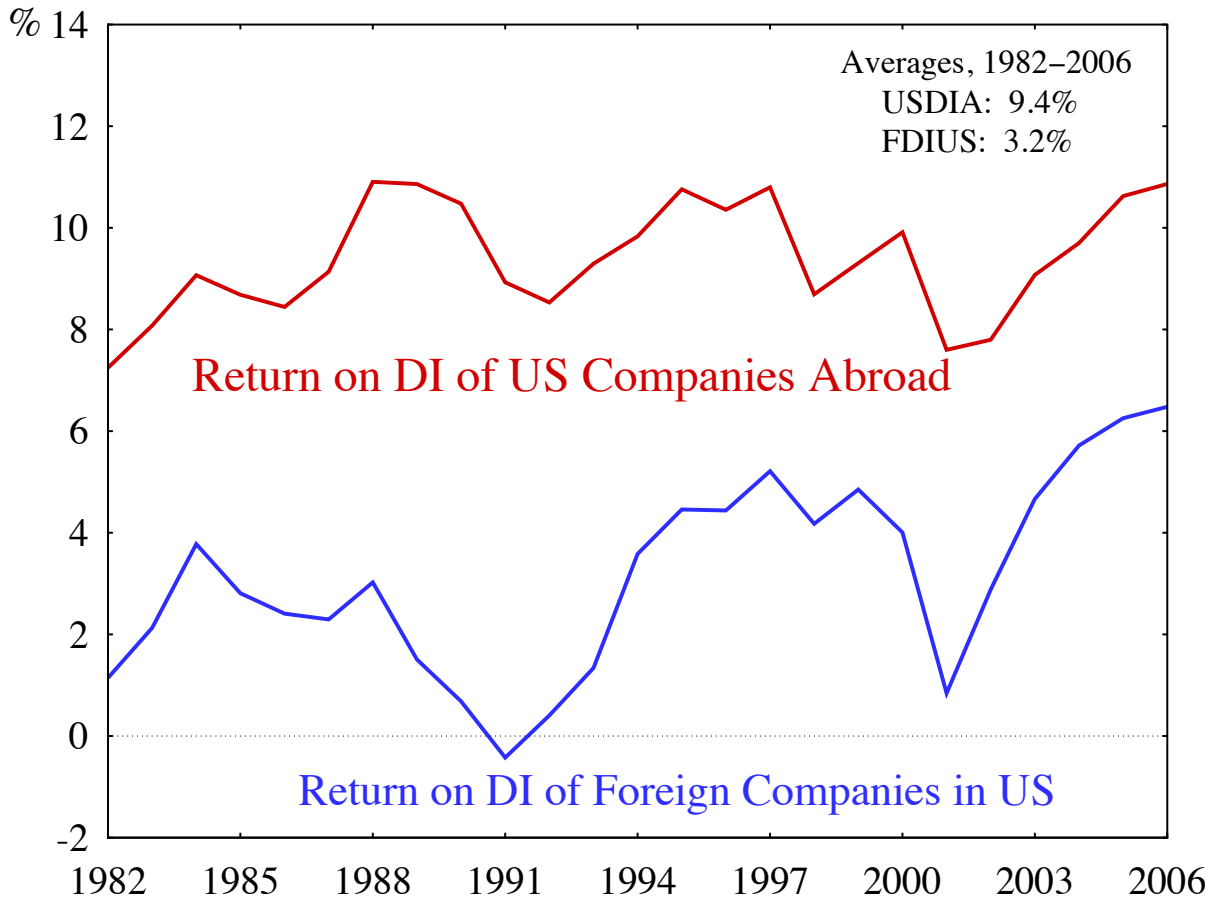
An Application

Technology Capital and the US Current Account

McGrattan and Prescott, AER, 2010

- European return on investment is higher than American
- Why do Europeans invest in America?

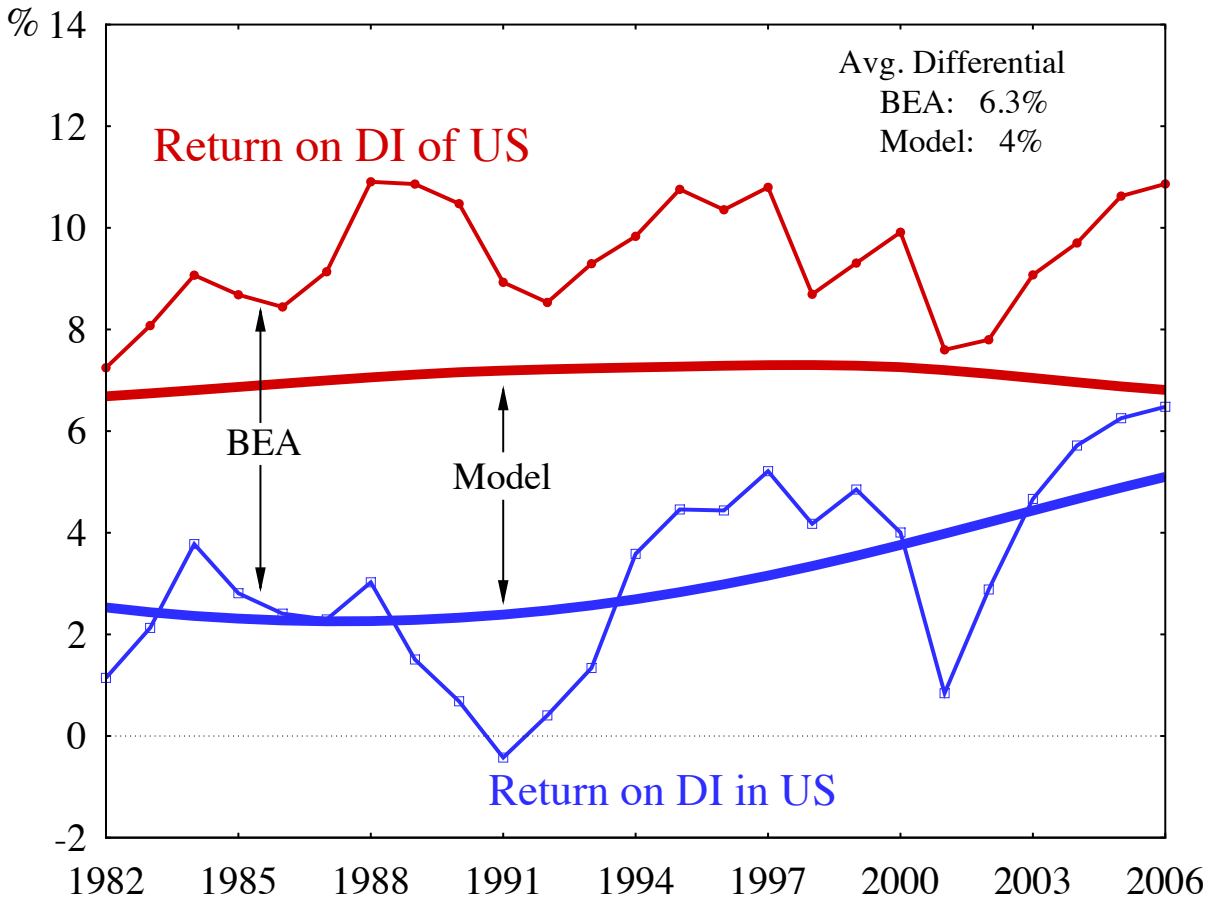
Technology Capital



Answer

- In early periods, large intangible (unmeasured) gains
  - Organizational capital
  - Establishing brand-names
- Americans started investing in Europe much earlier
  - Return in Europe is tangible
  - Return in America is intangible (unmeasured)
- Paper uses model to account for this puzzle

Intangibles Account for 2/3 of the Differential



Conclusion

- Large gains from openness that we are not measuring
- We can use this framework to account for intangibles