Institution-Induced Productivity Differences and Patterns of International Capital Flows

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1. Introduction.

- Capital often flows "upstream" from poor (South) to rich (North) countries, contrary to the neoclassical prediction. Why?

- **Two departures from the neoclassical paradigm** can explain this: Namely, the lenders would get higher return in North when
  - ➢ the rich North is more productive than the poor South (*Productivity Differences*);
  - ➢ the rich North has superior institution protecting the interest of lenders (*Institutional Differences*);

  if we treat the differences in productivity and institution as *exogenous*.

- One might think that this logic should carry over even if North is more productive due to its superior institution.

- This paper aims to demonstrate that productivity and institutional differences have very different effects on capital flows to the extent that the productivity differences are *induced by* institutional differences.

Features of my model:

- Two periods (can easily be embedded into an OLG model with two-period lives)
- Countries differ in the institutional quality (IQ) of their *domestic* credit markets.
- Saving flows *freely* across borders, equalizing the rate of return.

- In each country, entrepreneurs have access to many projects with **productivity-agency cost trade-off.**
  - ➢Agency cost depends not only on the agency problem inherently associated with each project, but also on the country's IQ.
  - ➢More productive projects, due to their bigger agency problems, are more dependent on the country's IQ.

- Entrepreneurs face the borrowing constraint.
  - ➢Credit goes to the projects that generate the highest return to the lenders (inclusive of agency cost), which are not the most productive.

- IQ affects the productivity-agency cost trade-off, hence the types of projects financed.
  → Productivity differences arise ***endogenously*** as IQ differences affect the composition of the credit.

With the following results:

- Endogenous and exogenous productivity differences have *opposite* effects on investment and capital flows. Higher productivity due to a better IQ leads to
  - a higher output and a higher wage, etc., like the exogenous case.
  - a *lower* investment and a current account *surplus* (i.e., capital *outflow*), unlike the exogenous case

- *Ambiguous effects* of IQ on capital flows, due to the two effects working in the opposite directions.
  1. *Holding productivity constant*, a higher IQ causes to a current account **deficit** (i.e., capital **inflows**), because it makes the country a more attractive place to invest.
  2. *Induced* productivity improvement causes a current account **surplus** (i.e., capital **outflows**), because the country needs less resources.

➔ Suppose that North is more productive than South because it has better IQ. No reason to expect large capital flows in either direction. Or the lack of such capital flows should not be interpreted as the prima facie evidence of the barriers to international capital flows.

- *Non-monotonic effects* of IQ suggested by parametric examples:
  - Better IQ, while monotonically increasing the output, and the wages, leads to a **U-shaped** response of the investment and capital flow.
    - Initially, a *lower* investment & current account *surplus* (i.e., capital *outflow*)
    - Then, a *higher* investment & a current account *deficit*, (i.e., capital *inflow*).
  - If countries inherently differ only in their IQ,
    - Middle-income countries run a current account *surplus* (i.e., capital *outflow*)
    - High and low-income countries run a current account *deficit* (i.e., capital *inflow*)
      - ✓ because high-income countries have better IQ.
      - ✓ because low-income countries are less productive.
  - Starting from a very low IQ, an institutional reform helps a low-income country to experience both *a growth* & *a current account surplus* (i.e., capital *outflow*).

- Cautions for interpreting the empirical evidence.
  - If the rich are more productive *partly* due to their better IQ and *partly* due to other factors, one's failure to separate the two sources of productivity differences could one to overestimate the effects of IQ differences on capital flows.
  - Using the financial frictions (the wedge) as a proxy of IQ can be misleading
  - A False dichotomy between Productivity vs. Institutional Differences

Exogenous versus Endogenous: An Intuition (Preliminary Attempt)

Higher productivity generally has two effects:

1) More output can be produced with *less* investment.
2) Higher rate of return makes the lender willing to finance *more* investment.

Exogenous case: Both effects operate. Under the "reasonable" assumption, 2nd effect dominates the 1st. → *higher investment*.

Endogenous case:

- **Productivity-agency cost trade-off**; more productive projects come with bigger agency problems (country's IQ is given).
- Under the borrowing constraint, credit markets always pick the projects that generate the highest return to the lenders, which are *not* the most productive ones.
- Improving IQ, by changing the trade-off, shifts the composition of credit toward more productive projects, which come with bigger agency problems.
- Productivity goes up, but *not* the rate of return to the lenders (inclusive of the agency cost). *Envelope Theorem!*

Hence, 1st effect dominates the 2nd. → *lower investment*.

Some related work:

Productivity Difference and Reverse Capital Flows:

- Lucas (1990) and others

Domestic Credit Market Imperfections and Reverse Capital Flows:

- *Net Worth Effect*; Gertler-Rogoff (JME 90); Matsuyama (Ecta 04; JEEA 05) and others
- *Institutional quality*; Sakuragawa-Hamada (IER 01), Caballero-Fahri-Gourinchas (AER 08), and others.

Global Imbalance and U-shaped patterns of capital flows:

- Gourinchas-Jeanne (07)'s "Allocation Puzzle"
- Prasad-Rajan-Subramanian (BPEA 07) "Foreign capital detrimental to development"

Impacts of economic reform on capital flows:

- Song-Storesletten-Zilibotti (AER 11), Buera-Shin (2010): Saving channel

Endogenous Productivity through Composition of Credit

- Matsuyama (AER 07); closed economy business cycles with endogenous productivity

Productivity Effects of Institutional Quality:

- Buera-Kaboski-Shin (10) in a two-sector closed economy model.

Plan of the Paper

1. Introduction
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3. Patterns of International Capital Flows with Exogenous Productivity and IQ

4. Modeling Endogenous Productivity Response to IQ

5. Patterns of International Capital Flows with Endogenous Productivity
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     - Two-Country World
     - Three-Country World
   - A Continuum of Projects Case

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2. The Setup: A Two-Sector, Two-Period Interpretation

Two Periods: $t = 0$ ("today") & $t = 1$ ("future")

In $t = 0$, the endowment is allocated between consumption and investment projects.
In $t = 1$, the projects generate capital, K, which are used to produce the consumption good with $Y = F(K, L) \equiv f(k)L$, where $k \equiv K/L$.

- F is CRS; $f(k)$ satisfies $f'(k) > 0 > f''(k)$ and $f'(0) = \infty$.
- L: fixed labor supply (introducing diminishing returns to capital)

Two Types of Agents: Savers/Workers & Borrower/Entrepreneurs

A continuum of **Savers/Workers** with measure L**,** each of whom

- has ω units of endowment in $t = 0$;
- supplies one unit of labor and earns $w(k) \equiv f(k) - kf'(k)$ in $t = 1$;
- maximize the quasi-linear preferences:

$$U^s = V(C_0^s) + C_1^s; \quad \text{s.t.} \quad C_1^s = r(\omega - C_0^s) + w(k) \qquad\qquad V' > 0 > V''$$

$\rightarrow$ FOC: $V'(C_0^s) = r$ $\qquad\rightarrow\qquad$ Saver's Saving: $S^s(r) \equiv \left[\omega - (V')^{-1}(r)\right]L$

A continuum of **Borrowers/Entrepreneurs** with measure E**:**

- Each may be endowed with small $\omega^b \geq 0$ units in $t = 0$.
- They consume only in $t = 1$, hence save all of ω^b in $t = 0$.
- Each has access to a set of projects, J.
- A type-j ($\in J$) project converts m_j units of the endowment to $R_j m_j$ units of "physical capital," by borrowing $m_j - \omega^b$ at the market rate of return, r.

Entrepreneur's Objective = Consumption in Period 1

$$U^b = \begin{cases} R_j m_j f'(k) - r(m_j - \omega^b) = [R_j f'(k) - r] m_j + r\omega^b & \text{by running a project-}j \\ \\ r\omega^b & \text{by lending (not borrowing)} \end{cases}$$

Each entrepreneur is willing to borrow and run a project-j iff

***Profitability Constraint for a Type-j* (*PC-j*):** $\quad R_j f'(k) \geq r$.

In the perfect credit market,

- The credit goes to only the most productive (the highest R_j).
- All entrepreneurs would be indifferent between running this project and lending

Credit Market Imperfections: The entrepreneur cannot pledge more than a fraction λ_j of the project-*j* revenue for the repayment ($0 < \lambda_j < 1$).

Borrowing Constraint for a Type-j (BC-j): $\lambda_j R_j m_j f'(k) \geq r(m_j - \omega^b)$

To keep it simple, let $\omega^b = 0$, so that (*BC-j*) is always more stringent than (*PC-j*).

Borrowing Constraint for a Type-j (BC-j): $\lambda_j R_j f'(k) \geq r$

Then, competition among entrepreneurs ensures that, in equilibrium, credit goes only to the projects with the highest pledgeable rate of return, $\lambda_j R_j$:

$$r = (\lambda_{j*} R_{j*}) f'(k) = (\lambda_{j*} R_{j*}) f'\left(\frac{R_{j*} I}{L}\right),$$

where

- $j^* \equiv Arg \max_{j \in J} \{\lambda_j R_j\}$
- I is the aggregate investment, i.e., the total amount of the endowment left unconsumed and allocated to the investment projects.

Aggregate Investment Schedule:

$$I(r) \equiv \frac{L}{R_{j^*}}(f')^{-1}\left(\frac{r}{\lambda_{j^*}R_{j^*}}\right)$$

Aggregate Saving Schedule:

$$\begin{aligned} S(r) &\equiv \omega^b E + \left[\omega - (V')^{-1}(r)\right]L \\ &= \left[\omega - (V')^{-1}(r)\right]L \end{aligned}$$

Current Account Schedule:

$$CA(r) \equiv S(r) - I(r)$$

Under Autarky:

$$CA(r^A) \equiv S(r^A) - I(r^A) = 0.$$

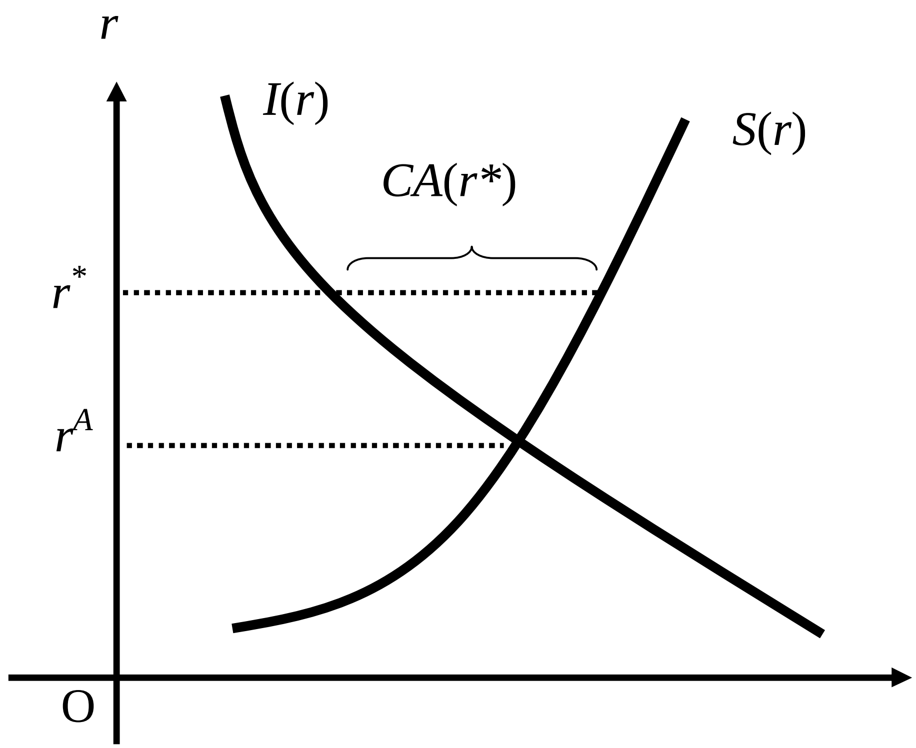


Figure 1: Metzler Diagram

World Economy: Countries indexed by $c \in C$;

- Period-0 endowment & Period-1 consumption good are both intertemporally tradeable
- Capital stock and labor are not.

For each $c \in C$; define $S^c(r)$, $I^c(r)$, $CA^c(r) \equiv S^c(r) - I^c(r)$, and r^{cA} by

$$CA^c(r^{cA}) \equiv S^c(r^{cA}) - I^c(r^{cA}) = 0.$$

Under Financial Integration: The rate of return is equalized across countries:

$$\sum_{c \in C} S^c(r^*) = \sum_{c \in C} I^c(r^*) \quad \Leftrightarrow \quad \sum_{c \in C} CA^c(r^*) = 0.$$

Since $CA^c(r) \equiv S^c(r) - I^c(r)$ is strictly increasing in r, the autarky rates dictate "**Chain of Comparative Advantages**" in intertemporal trade.

- If $r^{cA} < r^*$, $CA^c(r^*) \equiv S^c(r^*) - I^c(r^*) > 0$; a CA **surplus (**capital **outflow)**.
- If $r^{cA} > r^*$, $CA^c(r^*) \equiv S^c(r^*) - I^c(r^*) < 0$; a CA **deficit** (capital **inflow)**.

3. Patterns of International Capital Flows with Exogenous Productivity and IQ

Consider the case with only one-type of projects.

$$I(r) = \frac{L}{R}\left(f'\right)^{-1}\left(\frac{r}{\lambda R}\right)$$

Effect of Productivity: Two effect of an exogenous increase in *R*:

1) *Less* investment is needed to produce more output;
2) Higher return to the lenders, who become willing to finance *more* investment.

2nd effect dominates the 1st, if $\eta(k) \equiv -kf''(k)/f'(k) < 1$, satisfied by Cobb-Douglas,

$R\uparrow$ → $I(r)\uparrow$ → $r^A\uparrow$ → CA deficit (i.e., Capital Inflow)

Effect of IQ:

$\lambda\uparrow$ → $I(r)\uparrow$ → $r^A\uparrow$ → CA deficit (i.e., Capital Inflow)

4. Modeling Endogenous Response of Productivity to Institutional Quality

Decomposing Pledgeability:

$$\lambda_j^c = [\Lambda(R_j)]^{\theta^c}$$

$0 < \Lambda(R_j) \leq 1;$ project-specific component, common across countries

- Project-specific component, capturing the Agency Problem of each project:
- $\Lambda(\bullet)$ is strictly decreasing → Productivity-Agency Cost Trade-off

$\theta^c > 0;$ country-specific component

- Capturing the degree of credit market imperfections of each country, the inverse measure of Institutional Quality (IQ)
- A bigger θ^c reduces the pledgeability, λ_j^c, by exacerbating the agency problem.

Strict log-submodularity: $\partial \log \lambda_j^c / \partial R_j \partial \theta^c < 0$

- More productive projects, with their bigger agency problems, suffer disproportionately from the credit market imperfections (a bigger θ).

How Institutional Quality (IQ) affects Productivity:

Credit flows to the project to solve $\max_{j \in J}\{\lambda_j R_j\} = \max_{j \in J}\left\{[\Lambda(R_j)]^{\theta} R_j\right\}$.

Denote the solution by ***R*(*θ*)**, *decreasing* in θ, due to log-submodularity.

(With a poor institution, the credit switches towards less productive projects.)

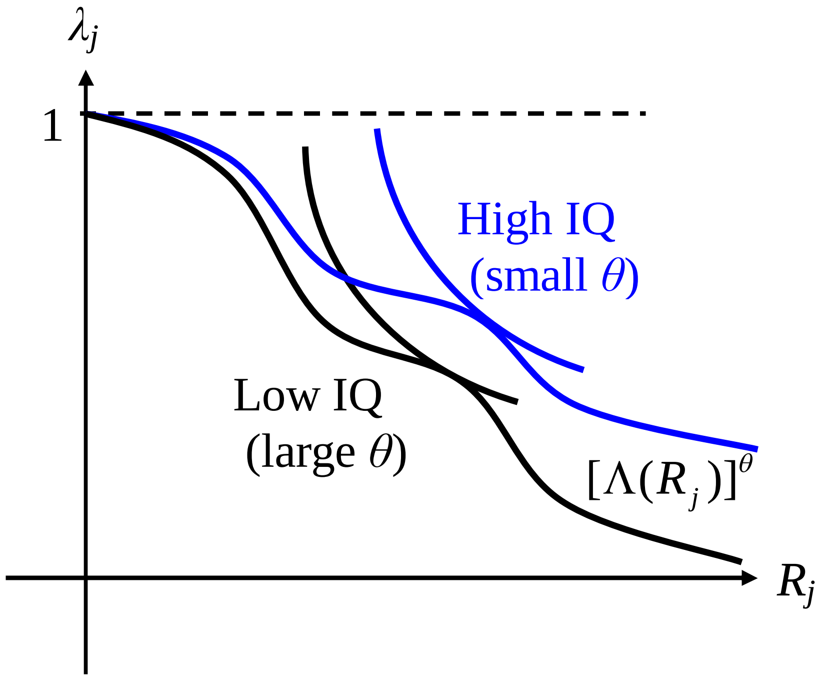


Figure 2

Aggregate Investment Schedule:

$$I(r;\theta) = \frac{L}{R(\theta)}\left(f'\right)^{-1}\left(\frac{r}{[\Lambda(R(\theta))]^{\theta} R(\theta)}\right)$$

How Aggregate Investment responds to Endogenous Productivity:

$$I(r;\theta) = \frac{L}{R(\theta)}\left(f'\right)^{-1}\left(\frac{r}{[\Lambda(R(\theta))]^{\theta} R(\theta)}\right)$$

When $R(\theta)$ changes due to a change in θ,

- 1st effect (less investment needed) is **of the first order**.
- 2nd effect (higher return to the lenders) is **of the second order**.

Intuition: The market always chooses the project to maximize the rate of return to the lenders, so that a change in $R(\theta)$ has no additional effect. **Envelope Theorem**

1st effect always dominates. → a higher $R(\theta)$ *reduces* I.

Notes:

1) The logic here does not depend on J, $\Lambda(\bullet)$, nor
   - $f(k)$, unlike the case of exogenous changes.
   - Strict log-submodularity, which determines the shape of $R(\theta)$.
2) The direct effect of a better IQ (a lower θ) increases I. The combined effect of a lower θ on I is *ambiguous*, so we need to look at some specific examples.
3) A better IQ ($\theta\downarrow$) → $[\Lambda(R(\theta))]^{\theta} R(\theta)\uparrow$ → $k\uparrow$, $y = f(k)\uparrow$, and $w = f(k) - kf'(k)\uparrow$.

5. Patterns of International Capital Flows with Endogenous Productivity

A Two-Projects Case: $J = \{0,1\}$; Let $R_0 < R_1$; $1 \geq \Lambda_0 > \Lambda_1$.

Type-1 is more productive than type-0, but more subject to the agency problem. Hence, its pledgeable rate of return declines faster with θ.

- Type-0 is financed if $\theta > \hat{\theta}$
- Type-1 is financed if $\theta \leq \hat{\theta}$.

Fig 3a

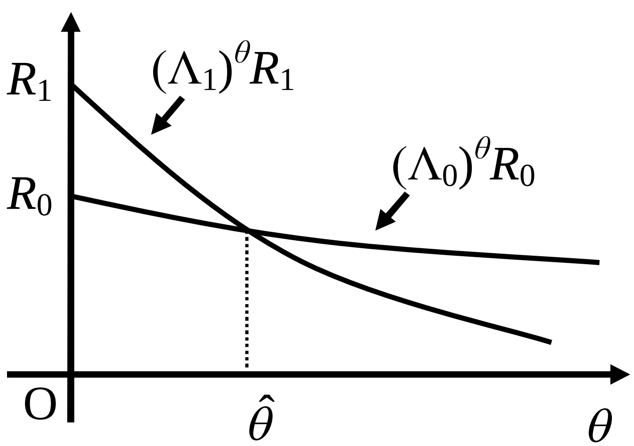
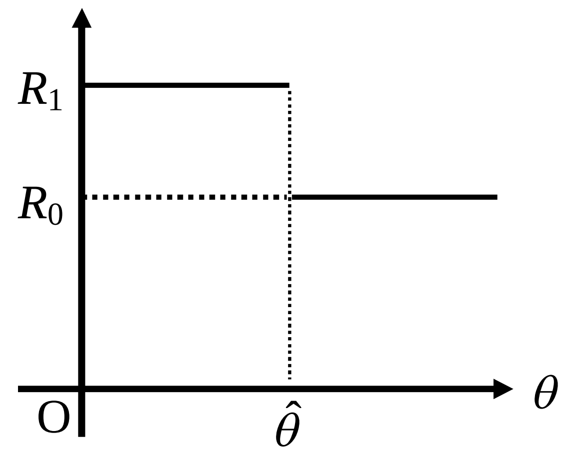


Fig 3b



Note: At $\theta = \hat{\theta}$, productivity jumps, but the pledgeable rate of return doesn't.

→ As IQ improves ($\theta\downarrow$), $I(r;\theta)$ drops discretely at $\theta = \hat{\theta}$.

$$I(r) = \begin{cases} \dfrac{L}{R_0}(f')^{-1}\left[\dfrac{r}{(\Lambda_0)^\theta R_0}\right] & \text{if } \theta > \hat{\theta} \\[2ex] \dfrac{L}{R_1}(f')^{-1}\left[\dfrac{r}{(\Lambda_1)^\theta R_1}\right] & \text{if } \theta \le \hat{\theta}. \end{cases}$$

This translates into a "U-shaped" response of r^A to a change in θ.

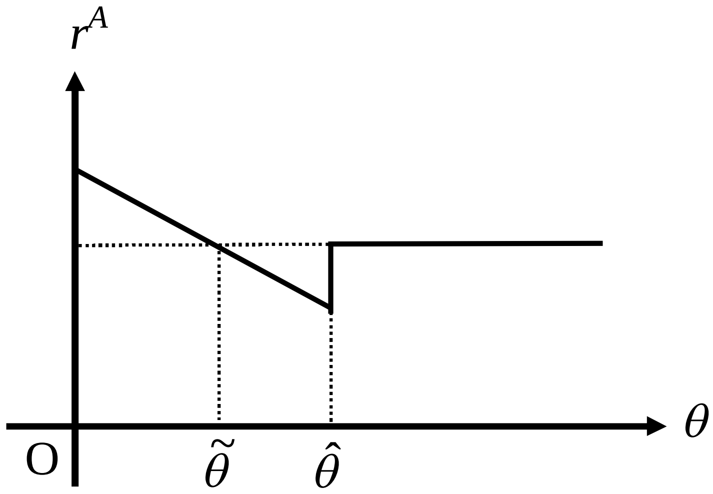


Figure 3c

The graph assumes:

- $\eta(k) \equiv -kf''(k)/f'(k) < 1$ (Thus, exogenous and endogenous productivity go in the opposite direction.)
- $\Lambda_0 = 1$.

A Two-Country World: C = {*N*, *S*}; $\theta^N < \theta^S$. *N* for the rich North; *S* for the poor South. Assume that the countries are identical in all other dimensions.

Case 1: $(\theta^N < \theta^S < \hat{\theta}) \rightarrow CA^N < 0 < CA^S$.
Capital flows from *S* to *N*.

- Both countries use the same technologies.
- *N*'s superior institution causes the capital flows.

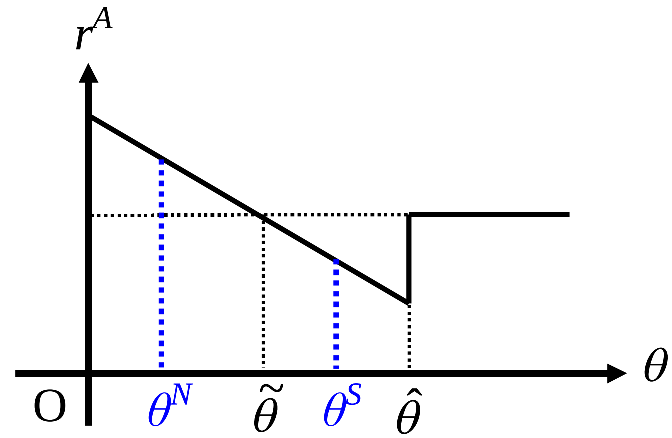


Fig 4a

Case 2: $(\theta^N < \tilde{\theta} < \hat{\theta} < \theta^S) \rightarrow CA^N < 0 < CA^S$.
Capital flows from *S* to *N*.

- Institutional difference is the real cause.
- *N* is more productive, but it is *false* to attribute the patterns of capital flows to the productivity difference, which in fact partially offset the effects of institutional difference on the capital flows.

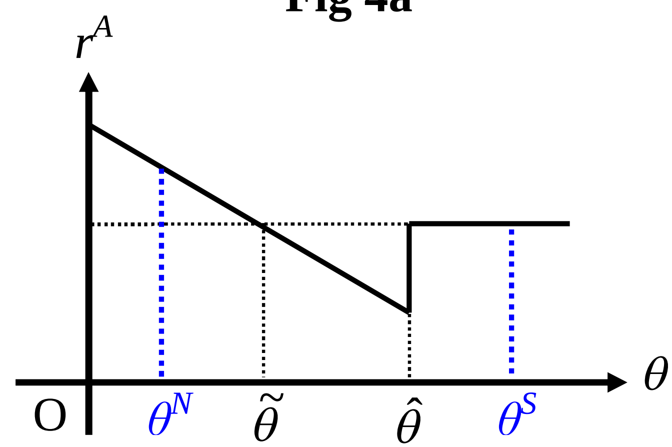


Fig 4b

Case 3: $(\tilde{\theta} < \theta^N < \hat{\theta} < \theta^S) \rightarrow CA^N > 0 > CA^S$.
Capital flows from *N* to *S*.

- Not because of the neoclassical reason.
- *S* is stuck with the less productive technology due to its inferior institution, and hence needs to invest more.
- It is *false* to interpret that "foreign capital" somehow undermines South's development.

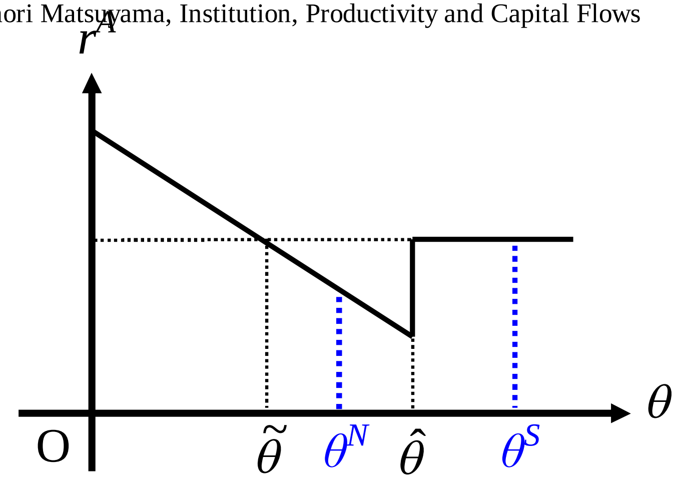


Fig 4c

A Thought Experiment:
Imagine that, starting from Case 3, *S* improves its institution, as shown in the Figure.

Capital flows are reversed. *S*'s current account turns from a deficit to a surplus. (Capital starts flowing out of *S*, instead of flowing in.)
→Institutional reform in *S* causes *a growth miracle & CA Surplus in S. a CA Deficit in N.*

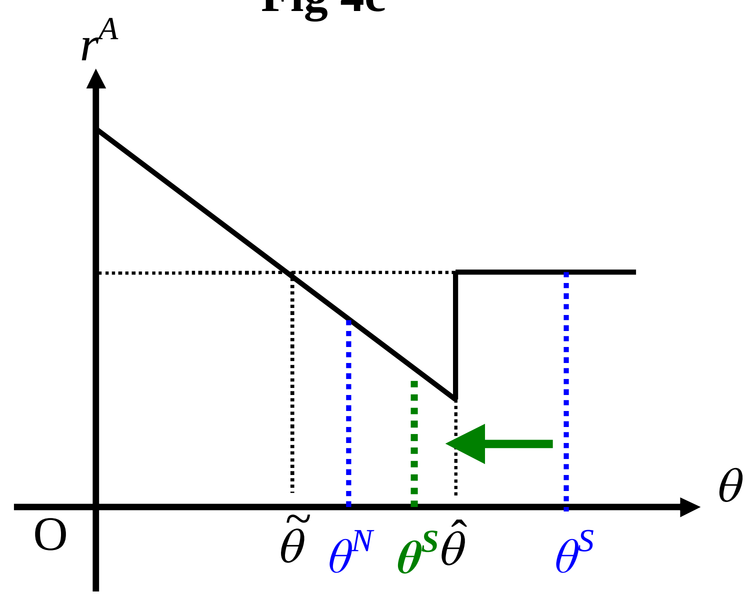


Fig 4d

A Three-Country World: C = {N, M, S} with $\theta^N < \theta^M < \theta^S$.
Assume that they are identical in other dimensions.

Case 1: $\theta^N < \tilde{\theta} < \theta^M < \hat{\theta} < \theta^S \rightarrow CA^N < 0 < CA^M$;
Capital flows into N and out of M.

Among developing countries, capital flows from the more successful M to the less successful S.

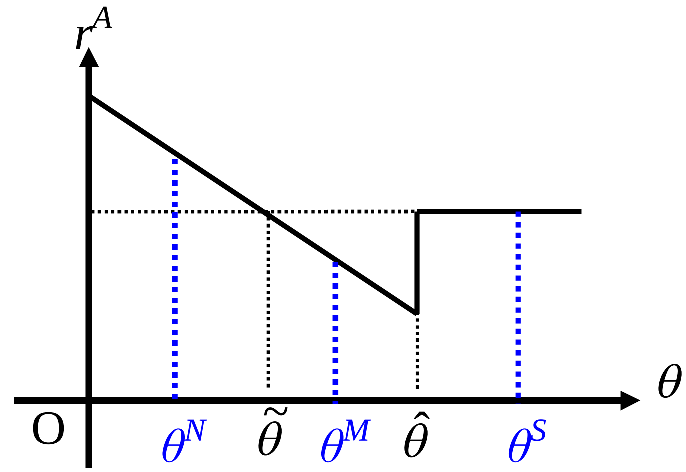


Fig 5a

Case 2: $\tilde{\theta} < \theta^N < \hat{\theta} < \theta^M < \theta^S \rightarrow CA^N > 0 > CA^M, CA^S$
Capital flows from N to M and S.

This is *because* the most developed N is more productive in investment.

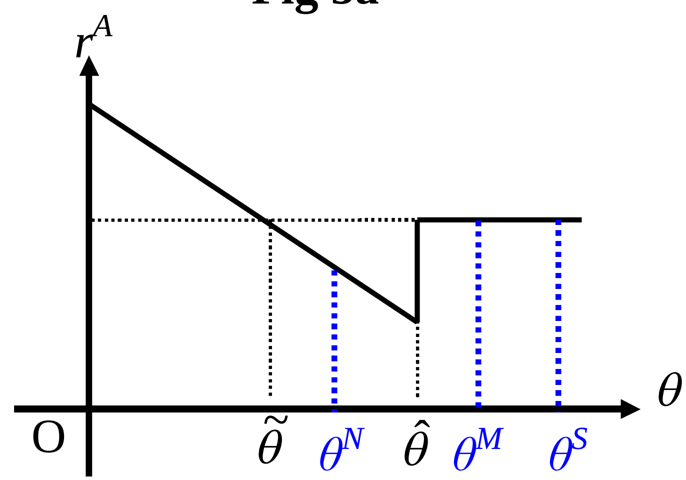


Fig. 5b

Case 3: $\tilde{\theta} < \theta^N < \theta^M < \hat{\theta} < \theta^S \rightarrow CA^N?;\ CA^M > 0 > CA^S$
Capital flows into *S* and out of *M.*

Again, among developing countries, capital flows from the more successful to the less successful.

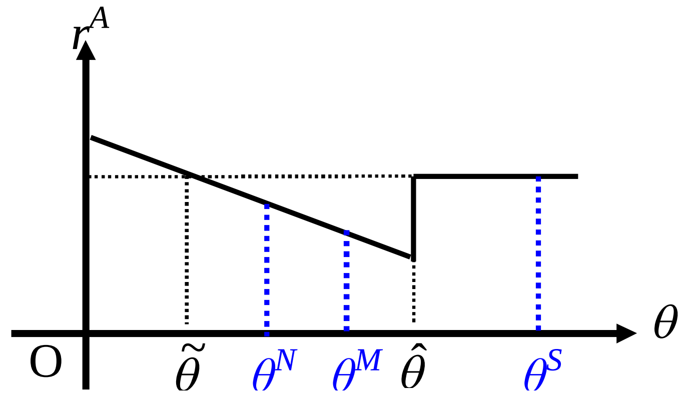


Fig. 5c

A Thought Experiment:

Imagine that *M*'s institution improves so that the situation changes from Case 2 to Case 3.

M's current account turns from a deficit to a surplus. (Capital starts flowing out, instead of flowing in.)
→ *a growth miracle & a capital outflow in M*

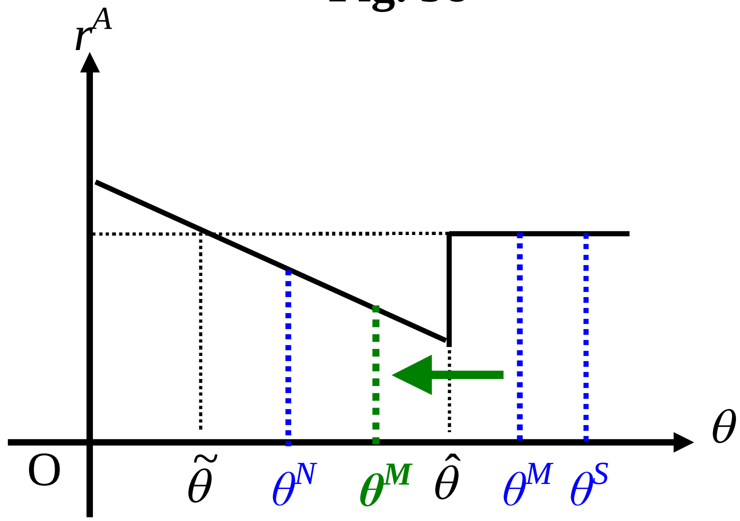


Fig. 5d

In order to see that these results are driven neither by the discreteness nor boundedness of the available technologies,

A Continuum of Projects Case: $j \in J = [0,\infty)$; $R_j \in [R_0,\infty)$ is increasing in j;

$$\lambda_j = [\Lambda(R_j)]^{\theta}, \text{ where } \Lambda(R_j) = \exp\left[\frac{1}{\gamma} - \frac{1}{\gamma}\left(\frac{R_j}{R_0}\right)^{\gamma}\right] \text{ with } \gamma > 0.$$

- $\Lambda(R_0) = 1$; $0 < \Lambda(R_j) < 1$ for $R_j > R_0$; $\Lambda(R_j)$ is decreasing in R_j.
  → Trade-off between productivity and the agency problem.

- For $0 < \theta < 1$, $\lambda_j R_j = [\Lambda(R_j)]^{\theta} R_j$ is maximized at $R(\theta) = R_0/\theta^{1/\gamma} > R_0$ and attains $e^{(\theta-1)/\gamma} R(\theta) = R_0 \left(e^{(\theta-1)}/\theta\right)^{1/\gamma}$. Both are decreasing in θ, and $\lim_{\theta\to 0} R(\theta) = \infty$.
  → As IQ deteriorates, credit flows into less productive projects, which leads to a lower pledgeable.

- For $\theta > 1$, $\lambda_j R_j = [\Lambda(R_j)]^{\theta} R_j$ is maximized at R_0 and attains R_0. Credit flows to the least productive but fully pledgeable project.

Aggregate Investment Demand:

$$e^{(\theta-1)/\gamma}R(\theta)f'\left(\frac{R(\theta)I}{L}\right)=r \;\rightarrow\; \eta\frac{d\log I}{d\theta}=\frac{1}{\gamma}\left(1+\frac{\eta-1}{\theta}\right),\ \text{where } \eta(k)\equiv-\frac{kf''(k)}{f'(k)}.$$

- If $\eta > 1$, $I(r;\theta)$ and hence r^A are increasing in θ. Capital flows from the rich to the poor, simply because the more efficient rich needs less investment.
  (Not an interesting case; nothing to do with the endogeneity of productivity).
- If $\eta < 1$, $I(r;\theta)$ and hence r^A are increasing in $\theta > 1-\eta$, decreasing in $\theta < 1-\eta$.

Cobb-Douglas Case: For $f(k)=k^{\alpha}$, $\eta = 1-\alpha$.

$$\log I(r;\theta)=\begin{cases}\Omega(r)+\theta-1-\alpha\log\theta & \text{for } \theta<1,\\ \Omega(r) & \text{for } \theta>1,\end{cases}$$

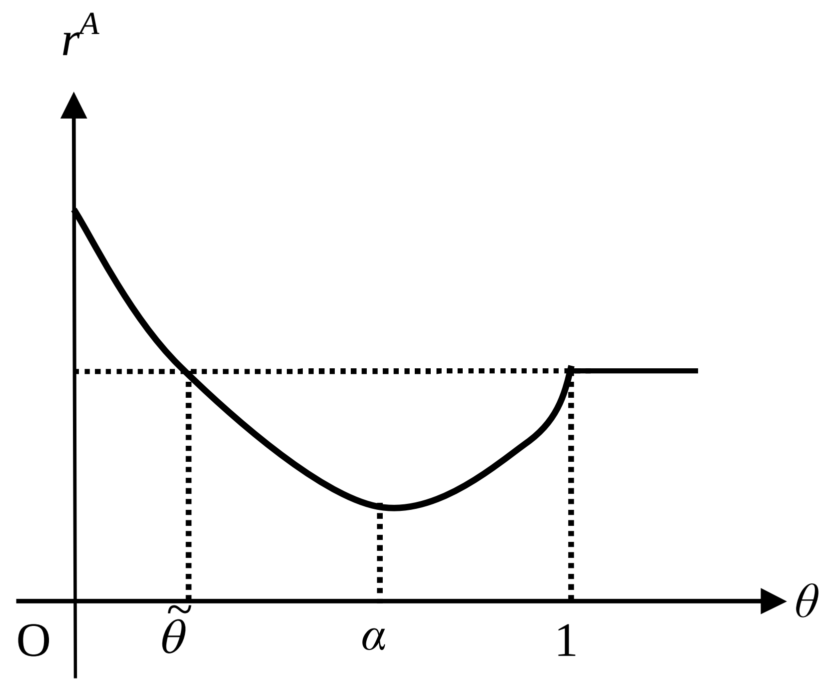
where $\Omega(r)$ is independent of θ.

- $I(r;\theta)$ is decreasing in $\theta < \alpha$ and increasing in $\alpha < \theta < 1$.

- $I(r;\theta) > I(r;1)$ if $\theta < \tilde{\theta}$ and $I(r;\theta) < I(r;1)$ if $\tilde{\theta} < \theta < 1$, where $\tilde{\theta} \neq 1$ is the second solution to $h(\theta) \equiv \theta - 1 - \alpha \log\theta = 0$, and satisfies $0 < \tilde{\theta} < \alpha$.

This translates into ***U-shaped*** patterns of the (autarky) rate of return.

Figure 6



Note:
$R(\theta)$ does not jump. Yet, the implications on the patterns of capital flows are similar to discrete project cases.

6. **Alternative Interpretations**

6.1 A One-Sector Interpretation

Instead of thinking that entrepreneurs run the project that produces tangible "physical capital" to be rented out to the C-goods sector, imagine

- An entrepreneur may invest m_j units in $t = 0$ to set up a type-j firm.
- A type-j firm produces the C-good in $t = 1$, using the labor input, n, with a concave function, $y_j = \varphi_j(n)$.
- Each firm hires labor competitively, so that $\varphi_j'(n_j) = w$, and makes the profit equal to $\pi_j \equiv \max\{\varphi_j(n) - wn\} = \varphi_j(n_j) - \varphi_j'(n_j)n_j$.

Let $\varphi_j(n) \equiv F(R_j m_j, n)$, where R_j is a parameter. Then,

$$n_j = R_j m_j / k \quad \& \qquad \pi_j = (R_j m_j) f'(k) \quad \text{where } w = f(k) - kf'(k).$$

A type-j firm can pledge up to $\lambda_j \pi_j / m_j = \lambda_j R_j f'(k)$ per unit of investment, so that the credit flows only to those firms with the highest $\lambda_j R_j$.

Let R_{j*} denote R_j of the firms financed, each of which employs its $n_{j*} = R_{j*}m_{j*}/k$. Hence, by adding up all firms, the labor market equilibrium condition is given by:

$$L = R_{j*}I/k \quad \rightarrow \quad r = \lambda_{j*}R_{j*}f'(k) = \lambda_{j*}R_{j*}f'(R_{j*}I/L)$$

where I is the aggregate investment. The same equation, the same prediction.

According to this interpretation,

- $R(\theta)$: **Realized productivity parameter in the C-goods sector;** For $f(k) = k^{\alpha}$, $R(\theta)^{\alpha}$ may be viewed as the TFP of C-goods sector firms. No need for a two-sector interpretation
- k: **Organizational capital** per worker, embodied in the firms when set up by the entrepreneurs. Nontradedness is more natural according to this interpretation.

6.2 An Infinite-Period Interpretation in an OLG framework

One may find the 2-period model too restrictive, as $CA_0 = CA(r) > 0$ in $t = 0$ implies $CA_1 = -CA(r) < 0$ in t = 1. But, this can be fixed as follows.

Infinite Periods: t = 0, 1, 2, …

- In period t, **savers/workers** of mass L_t, measured in and **entrepreneurs** of mass E_t are born and live for two periods. They interact with each other just as described above.
  - ➢ In their 1st period (i.e. period t), the workers finance the entrepreneurs' projects.
  - ➢ In their 2nd period (period t+1), the workers work with capital generated by the projects, financed in period t.
- In this setup, there is no interaction across different generations.

Investment by generation-t:,

$$I_t = \frac{L_t}{R(\theta)}\left(f'\right)^{-1}\left(\frac{r_{t+1}}{\left[\Lambda(R(\theta))\right]^{\theta} R(\theta)}\right) \equiv L_t I(r_{t+1};\theta)$$

Saving by generation-t in period t: $S_t^t = L_t\left\lfloor \omega - \left(V'\right)^{-1}(r_{t+1})\right\rfloor \equiv L_t S(r_{t+1})$

Current Account by generation-t in period t: $CA_t^t \equiv L_t CA(r_{t+1};\theta)$

Current Account by generation-(t–1) in period t: $CA_t^{t-1} \equiv -L_{t-1}CA(r_t;\theta)$

Current Account in period t: $CA_t \equiv CA_t^{t-1} + CA_t^t = -L_{t-1}CA(r_t;\theta) + L_t CA(r_{t+1};\theta)$

Let $L_t \equiv (1+g)L_{t-1}$. Then, in per capita term:

$$ca_t \equiv \frac{CA_t}{L_{t-1}} = -CA(r_t;\theta) + (1+g)CA(r_{t+1};\theta).$$

In Autarky: $r_t = r^A$ where $ca_t = gCA(r^A;\theta) = 0$

In Open economy: $r_t = r^*$:

$ca_t = gCA(r^*;\theta) > 0$ if $r^* > r^A$; $ca_t = gCA(r^*;\theta) < 0$ if $r^* < r^A$

- The country experiences a current surplus (deficit) and capital outflow (inflow) if its autarky rate is lower (higher) than the world rate, **every period.**
- All the results on the effects of IQ differences discussed in the two-period setup can thus be restated in this infinite period setup.

7. Concluding Remarks

- A stylized model to study how the cross-country IQ differences shape the patterns of international capital flows when such IQ differences also cause productivity differences
- Institution-induced productivity differences have effects on the investment & capital flows opposite of productivity differences due to other factors.
- *U*-shaped responses to IQ on the investment and capital flows
- No reason to expect capital inflows when a country is more productive and has better institution protesting the interest of lenders
- Starting from a very low IQ, a country could experience both a growth and a capital inflow after a successful institutional reform
- Capital flows out from the middle-income countries and flows into both low-income and high-income countries.
- Cautions when interpreting the empirical evidence on the role of productivity differences and institutional differences on capital flows.
- Cautions for using the financial frictions (the wedge) as a proxy for IQ
- Some features of the model, such as poor IQ preventing productive technologies from being adopted, institutional changes causing productivity change, etc., might have wider applications besides capital flows.