Aggregate Implications of Credit Market Imperfections

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forthcoming in
NBER Macroeconomics Annual 2007

Prepared for talks at Brown, April 9, 2008 & Boston College, April 10, 2008

Organization of the paper (not this presentation):

1. Introduction
2. A Simple Model of Credit Market Imperfections: A Single Agent's Perspective
3. Partial Equilibrium Models
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    - Heterogeneous Agents: Distributional Implications
    - Heterogeneous Agents: Replacement Effects
4. General Equilibrium with Endogenous Saving: Capital Deepening vs. Net Worth Effects
5. General Equilibrium with Heterogeneous Projects
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    - A Model with Pure Capital and Consumption Projects:
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        - Inefficient Booms and Volatility
        - Hybrid Cases: Asymmetric Cycles & Intermittent Volatility
6. General Equil. with Hetero. Agents (and Capital): Patterns of International Capital Flows
7. General Equil. with Hetero. Agents (with Hetero. Projects): Patterns of International Trade
8. A Model of Polarization
9. Concluding Remarks

What this paper does:

- By using *the same, simple* abstract model of credit market imperfections throughout,

- *synthesize* a diverse set of results within a *unified* framework.

- show how the credit market imperfections can be a key to understanding a wide range of aggregate phenomena, including:

  - ➢Endogenous investment-specific technological changes
  - ➢Development traps and Leapfrogging
  - ➢Persistent recessions and recurrent boom-and-bust cycles
  - ➢Reverse international capital flows
  - ➢Rise and fall of Inequality across nations
  - ➢New sources of comparative advantage and patterns of international trade

- with the hope of offering a coherent picture across many results that are *seemingly conflicting* and/or *seemingly unrelated*.

Recurring themes:

- Properties of equilibrium often respond *non-monotonically* to parameter changes. For example,

  - Improving borrower net worth or credit market may first lead to a higher market rate of return and then to a lower market rate of return
  - Improving credit market may first lead to an increased volatility and then a reduced volatility.
  - Productivity improvement may first lead to a greater inequality and then a reduced inequality.

etc.

- Equilibrium and welfare consequences of the credit market imperfections are *rich and diverse* depending on the general equilibrium feedback mechanisms.

What are the basic messages?

(To the outsider of the field):
This is an exciting field, as credit market imperfections have such rich implications.

(To the insider of the field):

Non-monotonicity, in particular, suggests

- Drawing policy implications by comparing a model with credit market imperfections and a model without can be also dangerous, because the effects of improving the credit market could be very different from those of eliminating the credit market imperfections completely.
- The effects of imperfect credit markets could also be very different from the effects of no credit market.

More generally,
Some cautions for studying the equilibrium implications within *a narrow class or a particular family* of models and extrapolating from it.

"All happy families resemble one another. Each unhappy family is unhappy in its own way."
Leo Tolstoy, *Anna Karenina*

A Single Agent's Problem: serve as the building block in all the equilibrium models to come

Two Periods: $t = 0$ and $t = 1$

A Single Agent (an Entrepreneur or a Firm):

- is endowed with $\omega < 1$ units of the input at period 0.
- consumes only at period 1.

Two Means to Convert the Input into Consumption:

- Run a **non-divisible project**, which converts one unit of the input in period 0 into ***R*** units in **Consumption** in period 1, by **borrowing** $1-\omega$ at the market rate of return equal to ***r*.**
- **Lend** $x \leq \omega$ units of the input in period 0 for rx units of consumption in period 1. (Or, **Storage** with the rate of return equal to r.)

Agent's Utility = Consumption in period 1:

$U = R - r(1-\omega) = R - r + r\omega$, if borrow and run the project,

$U = r\omega$ if lend (or put in storage).

***Profitability Constraint*:** The agent *is willing to* borrow and invest iff

(PC) $R \geq r$

***Borrowing Constraint*:** To borrow from the market, the agent must generate the market rate of return, ***r*,** per unit to the lenders, yet, *for a variety of reasons*, no more than a fraction, λ, of the project output can be used for this purpose. Thus, the agent *can* borrow and invest iff

$$\text{(BC)} \qquad \lambda R \geq r(1-\omega).$$

If $\boldsymbol{\lambda/(1-\omega) < r/R \leq 1}$**,** (PC) holds but not (BC).

- The profitable project fails to be financed, due to the borrowing constraint.
- *Necessary Condition*: $\boldsymbol{\lambda + \omega < 1}$
- A higher ω (as well as a higher λ) can alleviate the problem

Broad Interpretations of the Parameters:

λ: agency problems affecting credit transactions (may vary across projects or industries), institutional quality or the state of financial development (may vary across countries)

ω; entrepreneur's net worth, the firm's balance sheet, the borrower's credit-worthiness (may vary across agents).

We now start endogenizing R, r, and ω (but not λ)

Partial Equilibrium with Homogeneous Agents

Two Departures:

- **A Continuum of Homogeneous Agents with Unit Mass**
- A Project produces R units of **Capital**, used in the production of the Consumption Good, $f(k) = F(k, \zeta)$, where $F(k, \zeta)$ is CRS but $f(k)$ is subject to **Diminishing Returns.** ζ is the hidden factors in fixed supply, owned by those who do not have access to the investment technologies.
- $k = Rn$ is Aggregate Supply of Capital; n is the number of agents running the project.

***Profitability Constraint* (PC):** $Rf'(k) \geq r$

***Borrowing Constraint* (BC):** $\lambda Rf'(k) \geq r(1-\omega)$.

Equilibrium Condition: $\mathbf{Rf'(k)/r = Max\{(1-\omega)/\lambda, 1\}}$

If $\boldsymbol{\lambda + \omega < 1, Rf'(k) = r(1-\omega)/\lambda} > r$; **Under-Investment;**
Net Worth Effect; $\omega \uparrow \rightarrow k \uparrow$

If $\boldsymbol{\lambda + \omega > 1, Rf'(k) = r} > r(1-\omega)/\lambda$; **Optimal Investment;**
No Net Worth Effect.

***Partial Equilibrium with Heterogeneous Agents*:** ω ~ *G(ω)* with the same R.

If Rf′(k) > r; Only those with $\omega \geq \omega_c$ invest.

$$\rightarrow k = R[1 - G(\omega_c)] = R\left[1 - G\left(1 - \frac{\lambda R f'(k)}{r}\right)\right].$$

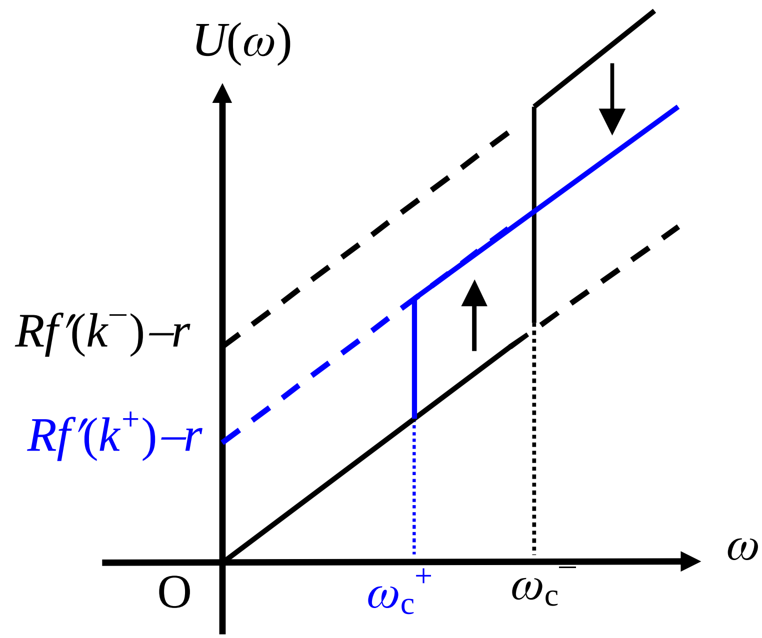
Comparative Statics: $\lambda \uparrow \rightarrow \omega_c \downarrow$, $k \uparrow$

Distributional Impacts of λ ↑:

The Middle Class (and those who own the hidden factors) gain; the Rich lose.

Credit Market Imperfections as **Barriers to Entry**

→ Political Economy Implications

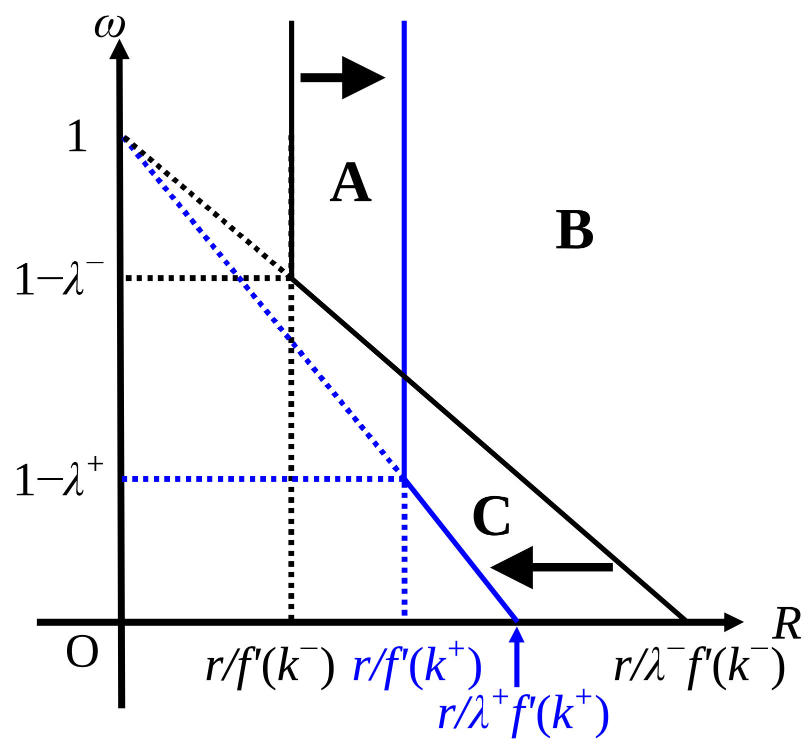


Partial Equilibrium with Heterogeneous Agents: *(ω, R) ~ G(ω, R)*

The investing agents must satisfy both

(PC) $Rf'(k)/r \geq 1$
and
(BC) $\omega \geq \omega_c(k) \equiv 1 - \lambda R f'(k)/r$

$$\rightarrow \quad k = \int_{\frac{r}{f'(k)}}^{\infty} R\left[\int_{\omega_c(k)}^{\infty} g(\omega, R)\, d\omega\right] dR$$



Composition Effects of Improved Credit Market

The rich, but less productive agents in A replaced by the poor, but more productive agents in C.

Also, with a higher λ,

- A fraction of the active firms that are credit-constrained first goes up and then goes down.
- Aggregate Investment may decline, as the credit shifts towards the more productive.

A General Equilibrium Model with Endogenous Saving:

- Go back to the homogeneous case, where every (investing) agent has the same R and ω.
- Add some "savers", with no access to the investment technology, who choose to maximize $U^o = V(C^o{}_0) + C^o{}_1$ subject to $C^o{}_1 = r(\omega^o - C^o{}_0)$.

→ Saving by the Savers: $V'(\omega^o - S^o(r)) \equiv r$ → $S^o(r) \equiv \omega^o - (V')^{-1}(r)$.

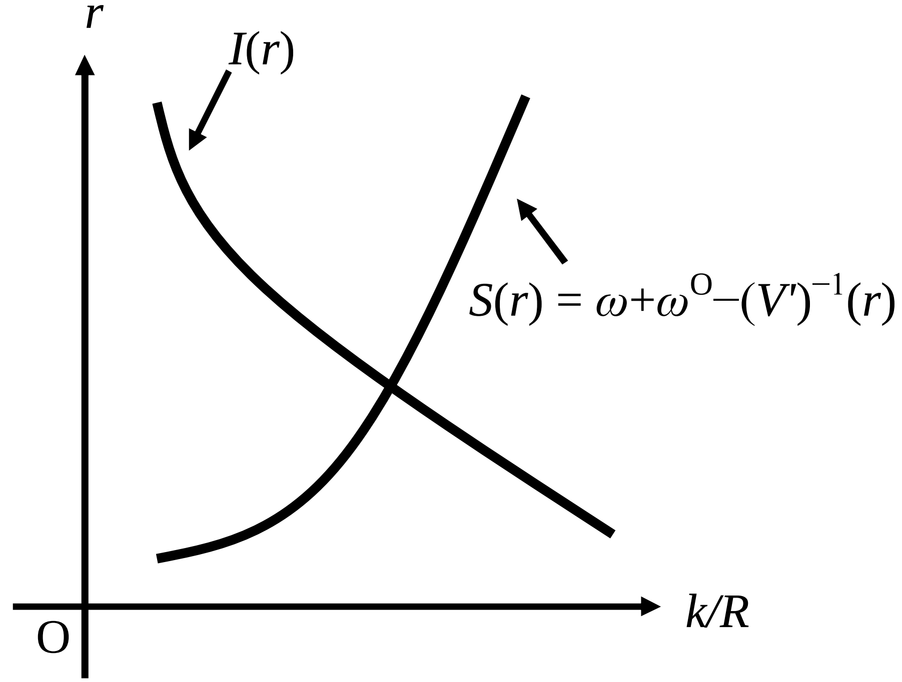
Resource Constraint (RC): $k = R[\omega + S^o(r)] = R[\omega + \omega^o - (V')^{-1}(r)]$.

→ $k/R = S(r) \equiv \omega + \omega^o - (V')^{-1}(r)$.

(PC)+ (BC): $Rf'(k) = \mathrm{Max}\{1, (1-\omega)/\lambda\}r$.

→ $$k/R = I(r) \equiv \frac{1}{R}(f')^{-1}\left(Max\left\{1, \frac{1-\omega}{\lambda}\right\}\frac{r}{R}\right).$$

which jointly determines k and r.

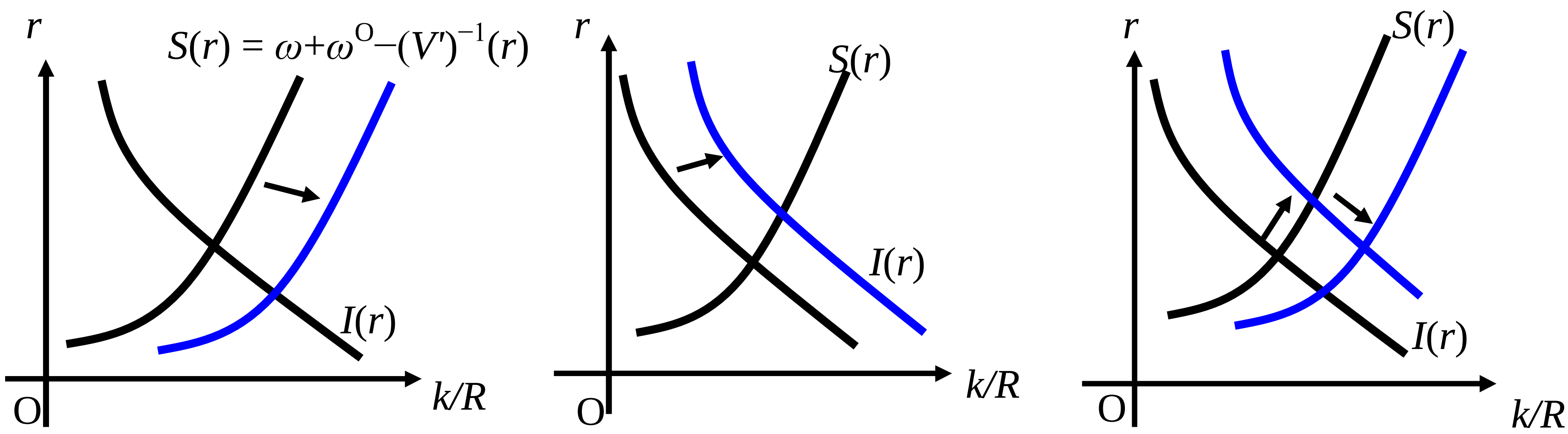


- $S(r)$ depends on $\omega + \omega^o$;
- $I(r)$ depends only on ω.

Capital Deepening Effect:
$\Delta\omega^0 > 0$

Net Worth Effect:
$\Delta\omega = -\Delta\omega^0 > 0$ (and $\Delta\lambda > 0$)
when $\lambda + \omega < 1$.

Combined Effects:
$\Delta\omega > 0$
when $\lambda + \omega < 1$.



The equilibrium rate of return is *non-monotonic in* λ (and ω);

A Two-Country Model: Patterns of International Capital Flows

Two Countries**: North and South** of the kind described above

North and South share the same f(k) and R, but may differ in λ, ω, and ω^o.

Further Assumptions:

- The Input and the Consumption Good are *tradeable*. → This allows the agents to lend and borrow and make the repayment across the borders.
- Physical Capital and the "hidden inputs" is *nontradeable*. We later relax this assumption.
- Only the agents in North (South) can produce Physical Capital in North (South), effectively ruling out FDI. We later relax this assumption.

Experiment:

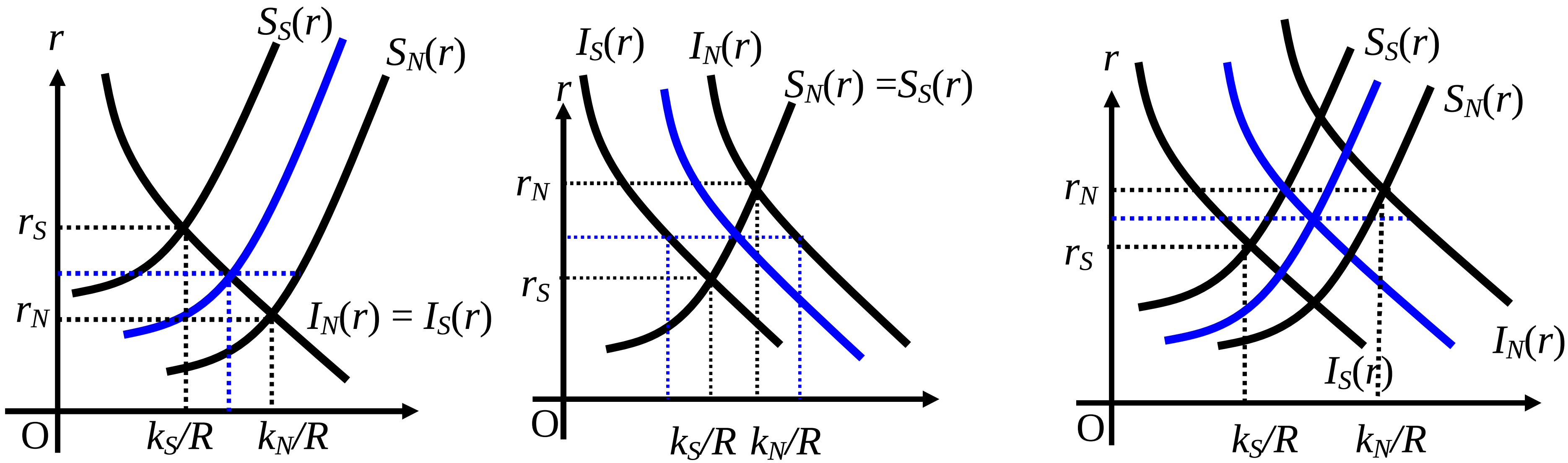
Suppose the agents in North can pledge $\varphi\lambda_N$ to the lenders in the South, and the agents in South can pledge $\varphi\lambda_S$ to the lenders in the North.

Now let φ change from $\varphi = 0$ (Financial Autarky) to $\varphi = 1$ (Full Financial Integration).

Neoclassical View
$\lambda_N = \lambda_S,\ \omega_N=\omega_S,\ \omega^o_N > \omega^o_S$;

Capital Flight:
$\lambda_N > \lambda_S,\ \omega_N=\omega_S,\ \omega^o_N =\omega^o_S$; or
$\lambda_N=\lambda_S,\ \omega_N-\omega_S = \omega^o_S-\omega^o_N > 0$.

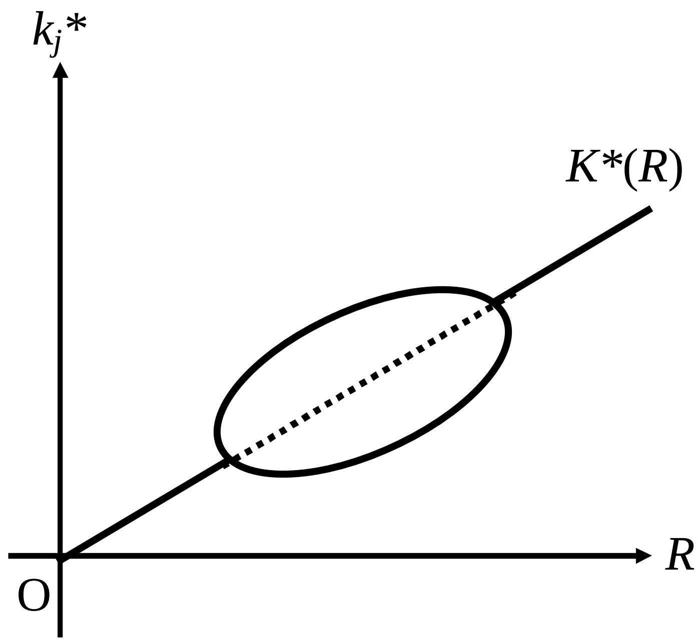
Capital Flight:
$\lambda_N=\lambda_S,\ \omega_N>\omega_S\ \ \omega^o_N=\omega^o_S$.



Dynamic Implications:

- Let us introduce a dynamic feedback from k_N to ω_N (and from k_S to ω_S).
- We can do this by embedding the above structure into an OG framework; so that a higher investment by the current generation leads to a higher demand for the endowment of the next generation, which leads to a higher net worth, ω.
- This could lead to Endogenous Inequality across countries from an intermediate value of R.
- Going from a low value of R to a higher value of R could generate Inverted U-curve patterns of Endogenous Inequality.

Schematically…



Some Other Extensions:

- Allowing the agents in the North to run the project in the South with reduced productivity could lead to Two-Way Flow of Financial Capital and FDI.
  - ➢Savers in the South lends to Firms in the North, which invest in the South.
  - ➢FDI can be used to bypass the external capital market in the South.

- Introducing Trade in Inputs, which are subject to some trade costs.
  - ➢This could lead to positive spillovers in neighboring countries; Regional contagions (East Asian booms and Latin American stagnations)

- Endogenous Investment Technologies

  - ➢Two-Way Causality between Productivity Differences vs. Credit Market Imperfections
  - ➢Financial Capital may flow into countries with worse credit markets; A solution to the allocation puzzle??

General Equilibrium Model with Heterogeneous Projects (with Homogeneous Agents)

- **A Continuum of Homogeneous Agents with Unit Mass (No Savers)**
- Each Agent can choose one (and only one) of J non-divisible projects**.**

	Period 0	*Period 1*
Type-j Project:	m_j units of the input	m_jR_j units in capital & m_jB_j units in consumption

m_j: the (fixed) set-up cost,
R_j: project productivity in capital
B_j: project productivity in final good

Profitability Constraint (PC-j): $R_jf'(k) + B_j \geq r$
Borrowing Constraint (BC-j): $m_j[\lambda_jR_jf'(k) + \mu_jB_j] \geq r(m_j - \omega)$,

λ_j: pledgeability of capital produced by project-j
μ_j: pledgeability of the final good produced by project-j

Equilibrium Conditions;

(1) $\omega = \sum_j(m_j n_j)$.

(2) $k = \sum_j(m_j R_j n_j)$.

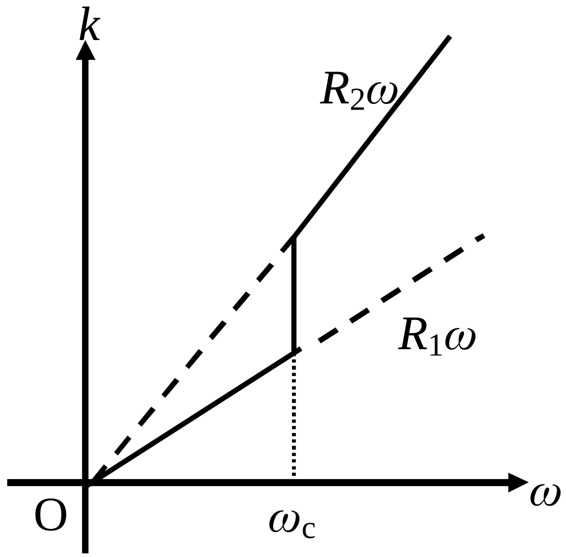
(3) $$r \geq Min\left\{\frac{\lambda_j R_j f'(k) + \mu_j B_j}{1-\omega/m_j}, R_j f'(k) + B_j\right\}; n_j \geq 0 \ \ (j = 1, 2, \ldots J)$$

where n_j is the measure of type-j projects initiated.

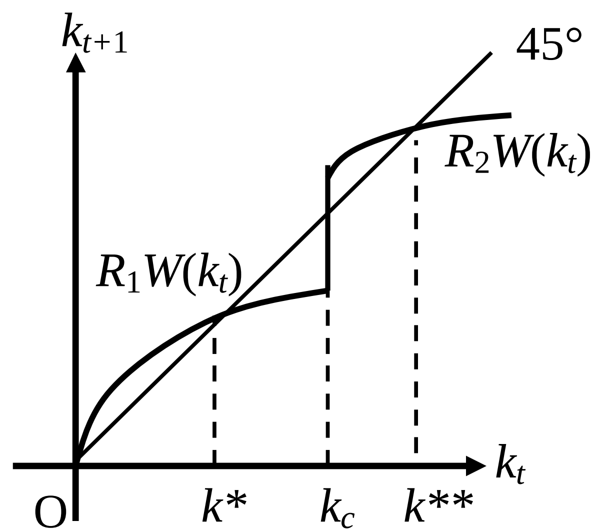
Example 1: J =2; $R_2 > R_1 > \lambda_1 R_1 > \lambda_2 R_2$. $B_1 = B_2 = 0$.

Key Trade-offs: Productivity vs. Agency Problems;

Project-2 is more productive, but comes with bigger agency problems than Project-1.



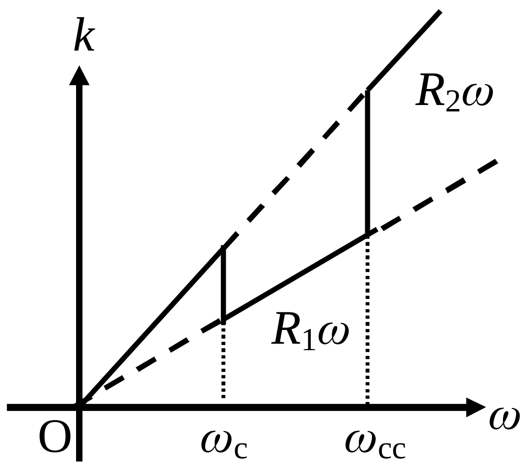
Procyclical Investment Specific Tech Change



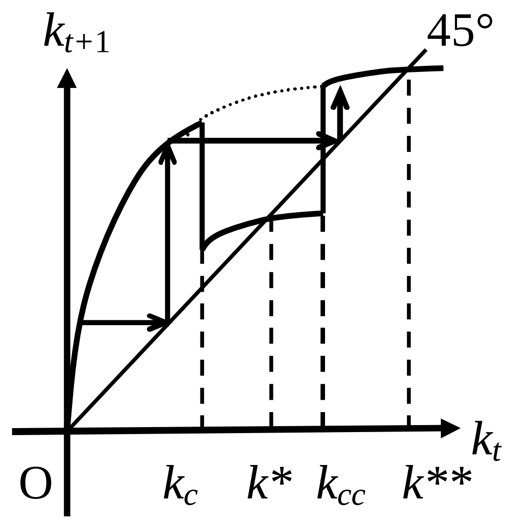
Dynamic Implications: Credit Traps

Example 2: $J = 2$ and $R_2 > R_1 > \lambda_2 R_2 > \lambda_1 R_1$, $m_2/m_1 > (1-\lambda_1)/(1-\lambda_2 R_2/R_1) > 1$. $B_1 = B_2 = 0$.

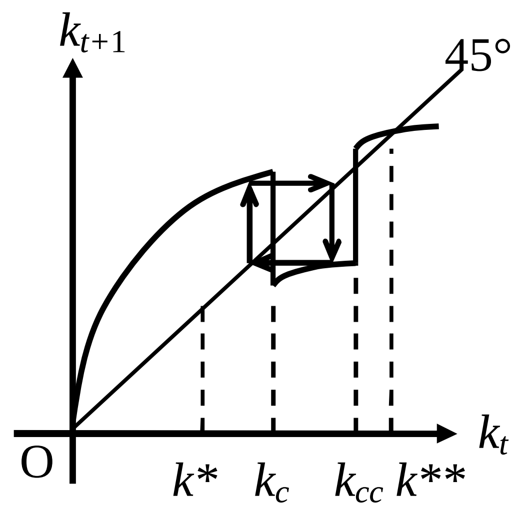
The less productive and less “secure” project-1 have advantage of smaller set-up costs



Counter-cyclical ISTC



Dynamic Implications:
Leapfrogging

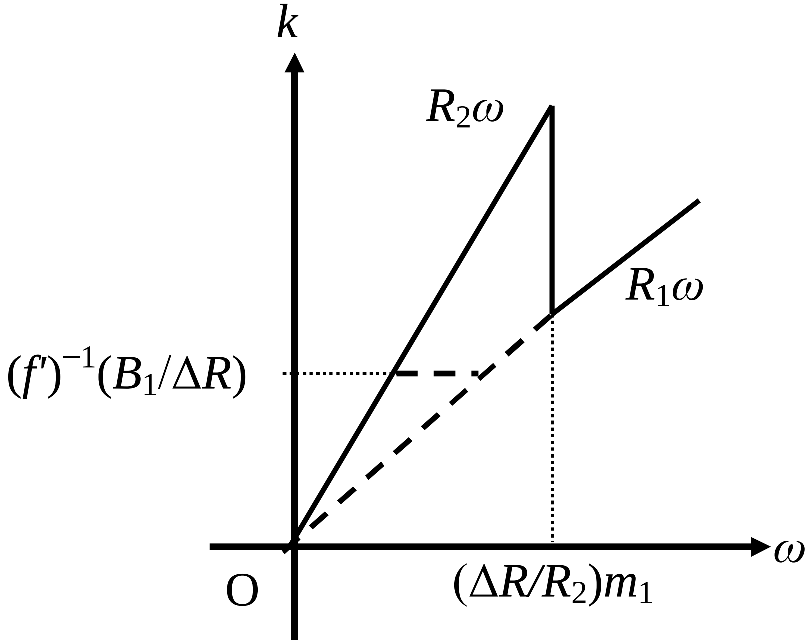


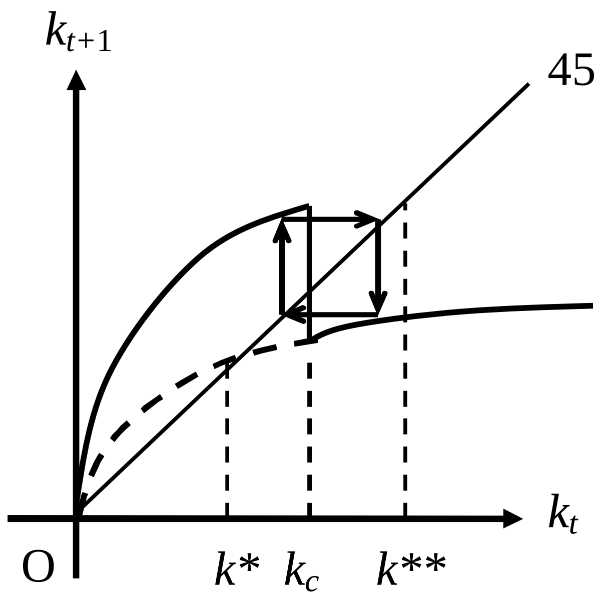
Dynamic Implications:
Credit Cycles as a Trap

Example 3: J = 2; $\lambda_1 = \lambda_2 = 1$, $\mu_1 = \mu_2 = 0$, $\Delta R \equiv R_2 - R_1 > 0$, $B_1 > B_2 = 0$

Project-1 is less "socially productive" but hgenerates more "private benefits" or "personal satisfaction" than Project-2.

- Project-1 cannot be financed if $\omega < (\Delta R/R_2)m_1$.
- If $B_1 > \Delta R f'(R_1(\Delta R/R_2)m_1)$, the agents invest to Project-1 whenever $\omega > (\Delta R/R_2)m_1$.





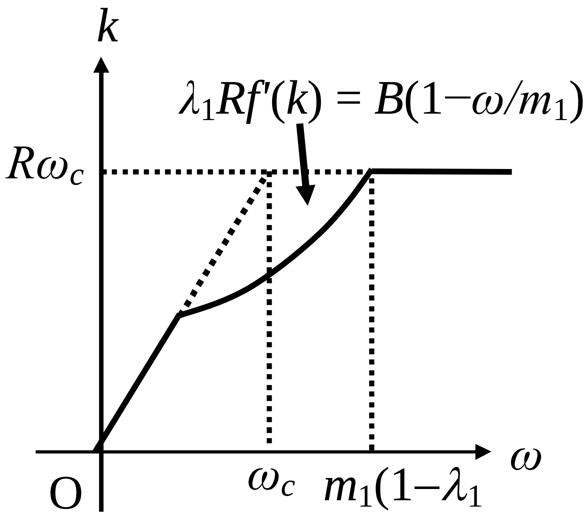
- In boom, the entrepreneurs can finance the self-indulgent project.
- In recession, they cannot.

Along these cycles, the booms occur due to the *misallocation* of the credit.

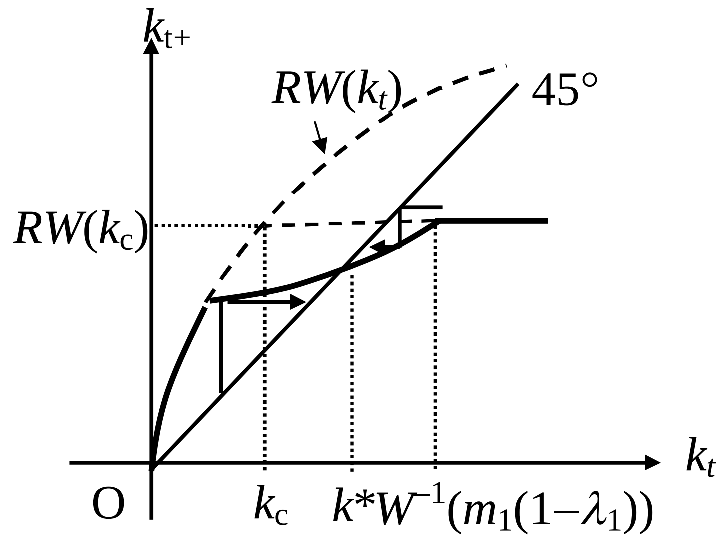
Example 4: $J = 2$; $R_1 > R_2 = 0$, $B_1 = 0 < B_2$ and $\lambda_1 < 1$, $\mu_2 = 1$,

Persistence of Inefficient Recessions: Financial Accelerator Models

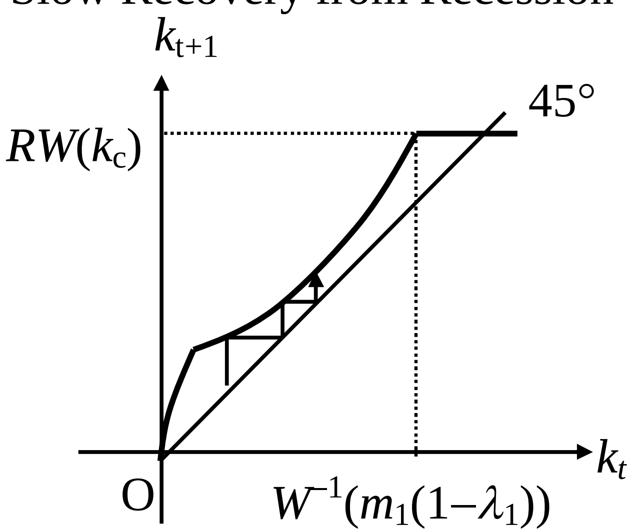
Under-investment of Capital-Generating Project



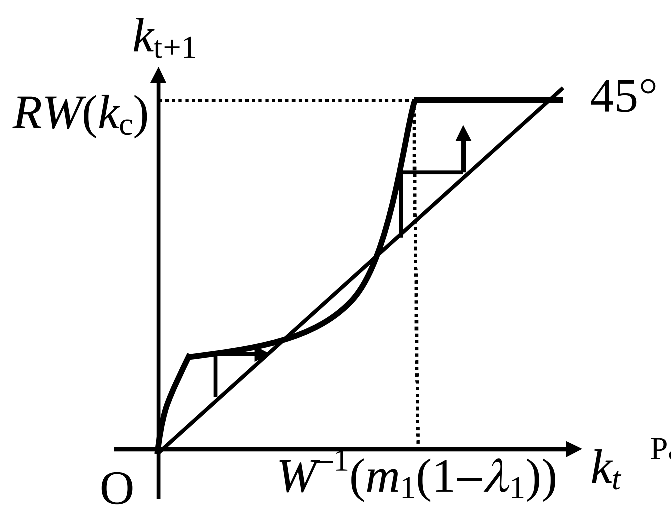
A Temporary Shock has an Echo Effect



Slow Recovery from Recession

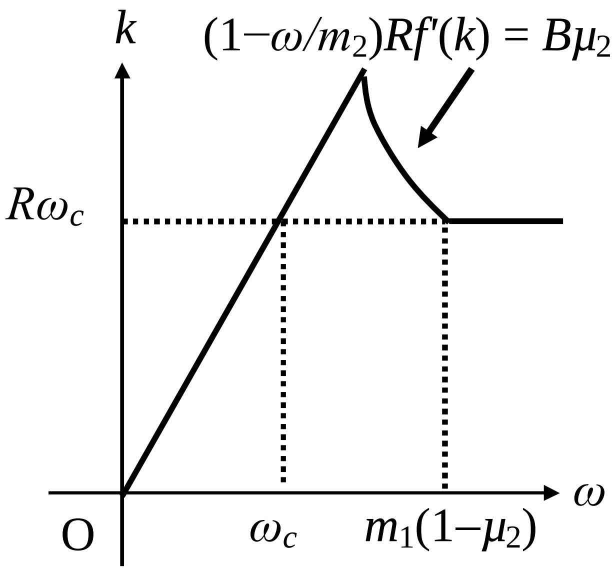


Permanent Recession

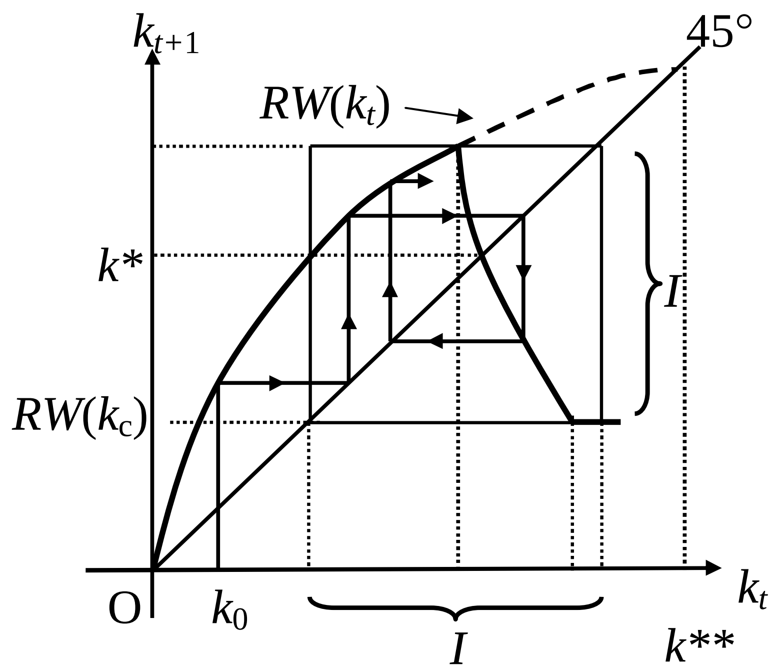


Example 5: $J = 2$; $R_1 > R_2 = 0$, $B_1 = 0 < B_2$ and $\lambda_1 = 1$, $\mu_2 < 1$,
Inefficient Booms and Volatility:

Over-Investment to Capital-Generating Project



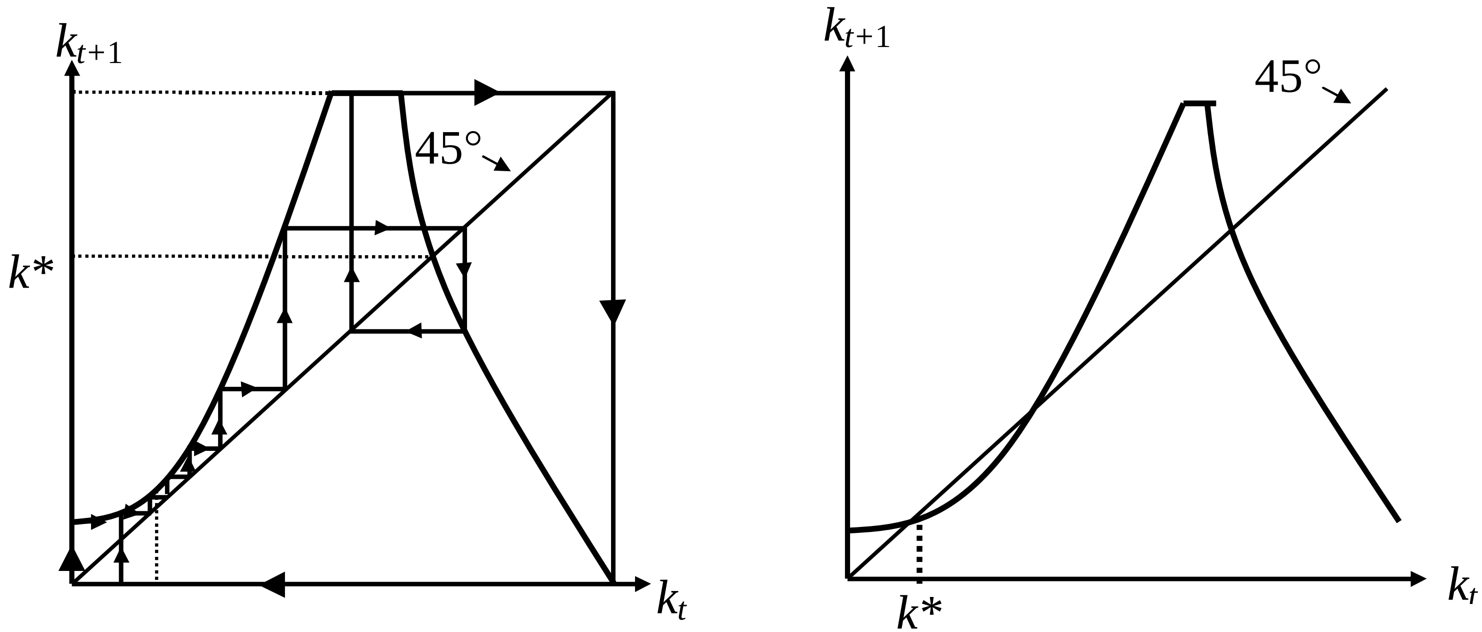
Dynamic Implications:
Endogenous Cycles



Again, non-monotonicity; Endogenous Fluctuations Occur for an intermediate value of μ_2

Example 6: Hybrid of “Persistence of Inefficient Recessions”& “Inefficient Booms and Volatility” Models

Asymmetric Cycles and Intermittent Volatility



A Two-Country Model: Patterns of International Trade:

Two Countries: **North and South (j = N or S)**

A Continuum of Tradeable Consumption Goods, $z \in [0,1]$

Symmetric Cobb-Douglas preferences.

Homogeneous Agents with Unit Mass, each endowed with $\omega < 1$ units of the Input (**Labor)**

Tradeable Consumption Goods produced by the projects run by agents

- Each agent can run at most one project.
- Each project in sector z converts one unit of labor to R units of good z.

→ To run the project, one must hire $1-\omega$ units of labor at the market wage rate, w, from those who don't run the project.

Profitability Constraint* (*PC-z*)*: $p(z)R \geq w$

***Borrowing Constraint* (*BC-z*):** $\lambda\Lambda(z)p(z)R \geq w(1-\omega)$,

$0 \leq \lambda \leq 1$: country-specific factors

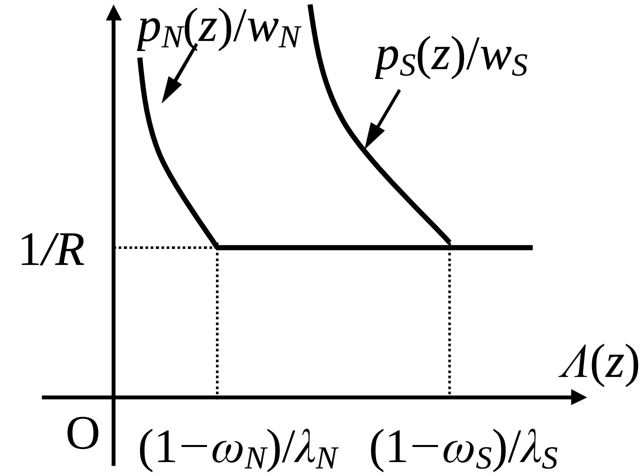
$0 \leq \Lambda(z) \leq 1$: sector-specific factors, continuous and increasing in z.

Under $\omega_N > \omega_S$ and/or $\lambda_N > \lambda_S$.

Autarky Equilibrium:

- (PC-z) is binding for $\Lambda(z) > (1-\omega)/\lambda$.
- (BC-z) is binding for $\Lambda(z) < (1-\omega)/\lambda$.

  - The credit market imperfection restricts entry to the low-indexed sectors.
  - The rent created by the limited entry makes the lenders happy to finance the firms in these sectors.

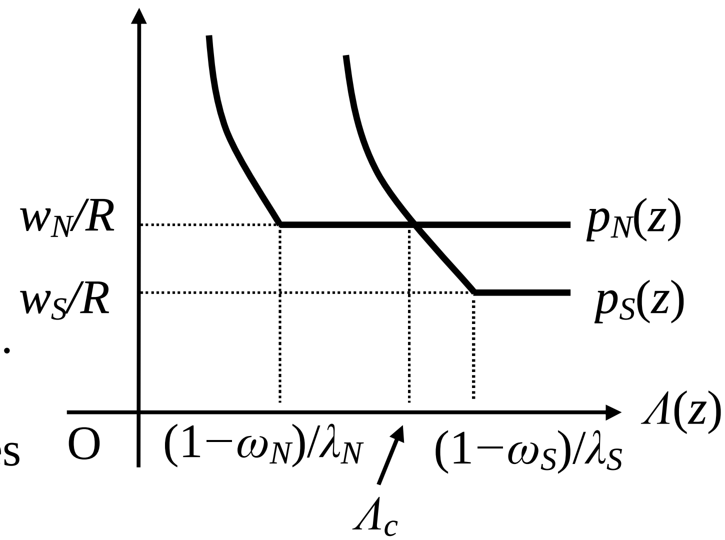


→ North has *absolute* advantage.

World Equilibrium: A higher wage in North.

- North's *comparative* advantage in low-indexed sectors.
- South's *comparative* advantage in high-indexed sectors.

North, with the better contractual environment, specializes in the sectors that are more subject to agency problems.



A Model of Polarization:

Two Periods: 0 and 1

A Continuum of Agents with Unit Mass:

- The input endowment at period 0, ω, is distributed as $\omega \sim G(\boldsymbol{\omega})$.
- Consumes only at period 1.

Two Ways to Convert the Input into Consumption.

- Can run **an investment project** with **the variable scale** $I \geq m$, which converts I units of the input into RI units in consumption in period 1, by borrowing $I-\omega$ at the rate equal to r. **(**m is **the minimum investment requirement,** i.e., investing $I < m$ generates nothing.**)**
- **Lending** $x \leq \omega$ units of the endowment in period 0 for rx units of consumption in period 1.

Agent's Utility = Objective Function = Consumption in Period 1:

$U = RI - r(I-\omega) = (R - r)I + r\omega$, if borrow and run the project,

$U = r\omega$ if lend (or put in storage).

If $r > R$, the agent does not want to invest.

If $r = R$, the agent is indifferent.

If $r < R$, the agent ***wants to*** borrow and invest **as much as possible**.

***Borrowing Constraint*:** The agent *can* borrow and invest iff

(BC) $\lambda RI \geq r(I-\omega)$.

If $r \leq \lambda R < R$, the agent could borrow and invest by infinite amount. Never happens in equilibrium!

For $\lambda R < r < R$, the agent borrows as much as possible and invest, if it can satisfies the minimum investment requirement.

Agent's Investment Demand for $\lambda R < r < R$,**:**

$$I(\omega) = \left(1-\frac{\lambda R}{r}\right)^{-1}\omega \text{ if } \omega \geq m\left(1-\frac{\lambda R}{r}\right); \qquad I(\omega) = 0;\ \text{otherwise.}$$

Credit Market Equilibrium:

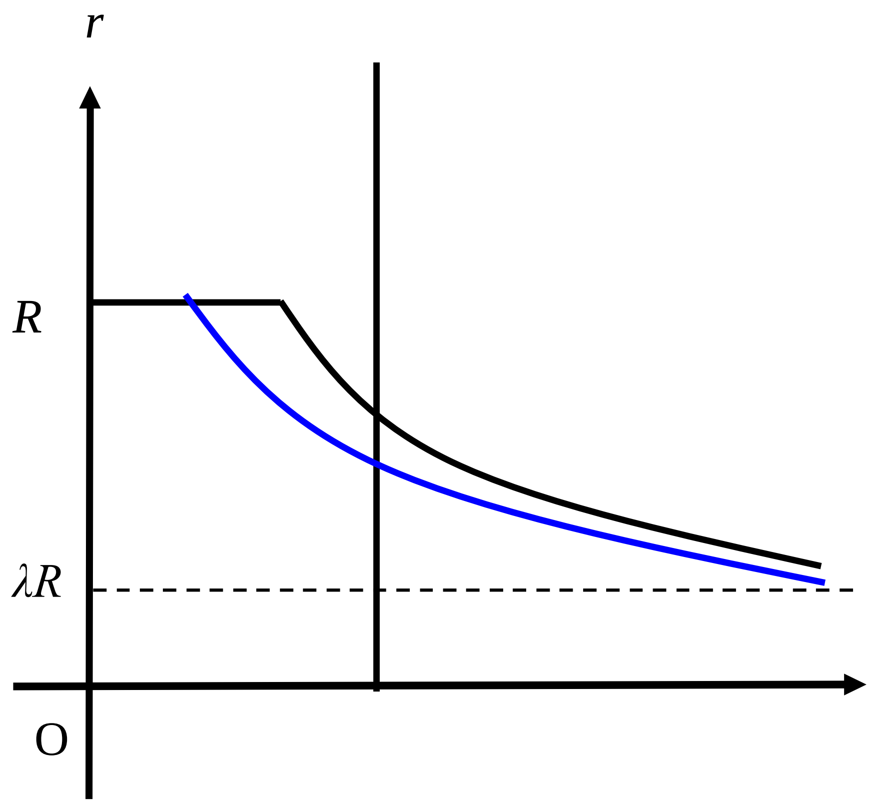
Total Supply = $\int_o^\infty \omega dG(\omega) = \left(1 - \frac{\lambda R}{r}\right)^{-1} \int_{m(1-\lambda R/r)}^\infty \omega dG(\omega)$ = Total Demand

$\lambda R < r < R$

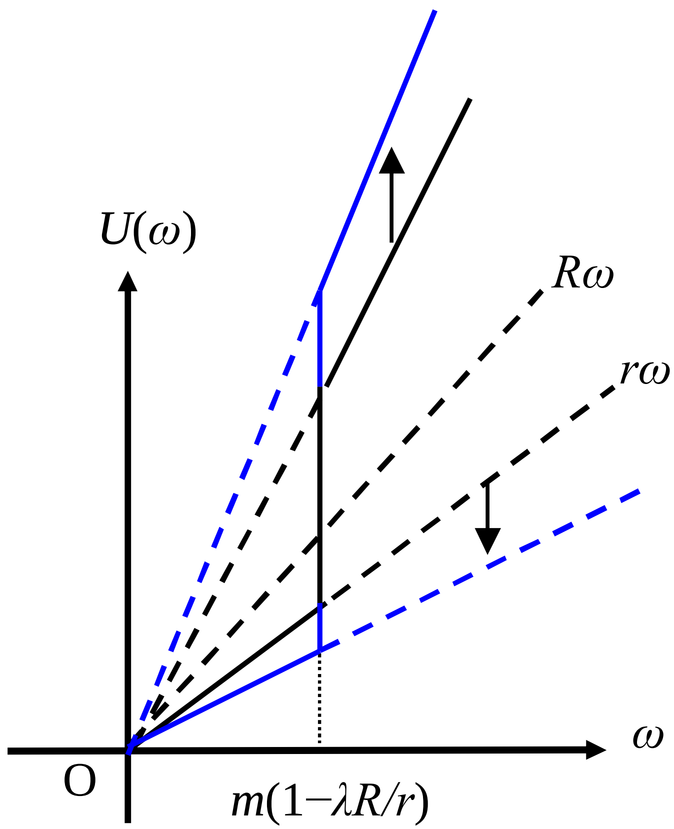
if $\frac{\int_o^{m(1-\lambda)} \omega dG(\omega)}{\int_o^\infty \omega dG(\omega)} > \lambda$.

In this range,

a lower λ reduces r, keeping λ/r constant.



$$U(\omega) = \begin{cases} \dfrac{1-\lambda}{1-\lambda R/r} R\omega & \text{if } \omega \geq m\left(1-\dfrac{\lambda R}{r}\right) \\ r\omega & \text{if } \omega < m\left(1-\dfrac{\lambda R}{r}\right). \end{cases}$$



Note that $r < R < \dfrac{1-\lambda}{1-\lambda R/r} R$.

The marginal value of having an additional unit of the input is strictly

- lower than R for the poor, unless it would push them above the threshold.
- higher than R for the rich, because it would enable them to invest more by borrowing more at the market rate strictly lower than the project return R. (**The Leverage Effect)**

In this model,

- credit market imperfections have no effect on the quantity, or any aggregate variables.
- For any wealth distribution, the *relatively* rich become investors, and the *relatively* poor are prevented from investing.
- A lower λ makes, by reducing r, enrich the rich who borrow to invest, and impoverish the poor who has no choice but to lend.

→ **A Polarization!** (not necessarily a greater inequality)

Dynamic Implications: What if we allow for some feedback from $U(\omega)$ to ω?

- The Poor may benefit from the credit demand by the rich (Trickle Down Effect)
- Endogenous Inequality

Interactions between the Rich and the Poor may also take place through Labor Markets.

A proper discussion of this requires entirely a whole new paper.

Concluding Remarks:

- Credit Market Imperfections are *rich and diverse* in the aggregate implications.

  - ➢It is so rich that they are useful for understanding a wide range of important issues.
  - ➢It is so diverse that properties of equilibrium often respond *non-monotonically* to parameter changes, suggesting some cautions for studying the aggregate implications of within a narrow class or a particular family of models

- Although this paper synthesizes a diverse set of results with a unified framework, it is far from comprehensive. A large number of issues have not been discussed.

  - ➢ Multi-stage financing and liquidity implications
  - ➢ Net worth revaluation through asset price changes,
  - ➢ Endogenous net worth accumulation by borrowers
  - ➢ Endogenous growth, financial intermediation, development of financial markets
  - ➢ Asset pricing and monetary policy implications
  - ➢ Political economy implications
  - ➢ Interacting with other sources of inefficiency such as product market imperfections

→ This is merely the tip of the iceberg: more work needs to be done.