Capital Controls: Growth versus Stability

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The big picture

- Response to impaired balance sheets of a sector/country
- Policy
  - Ex-post redistribution
    - .
  - Ex-ante insurance

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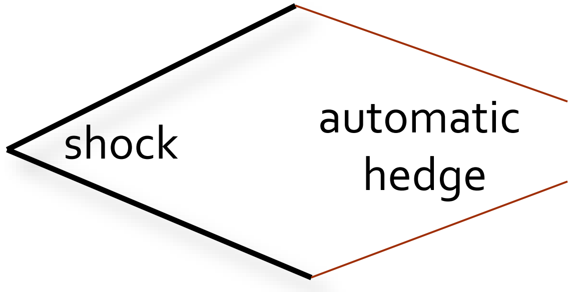
  - 2 sector economy: debt limits
  - International eco.: capital controls

When is credit excessive?

- Constrained inefficiency (in incomplete market setting) due to pecuniary externality
  - Price movement provides "automatic hedge" and
  - Price taking behavior undermines this hedge



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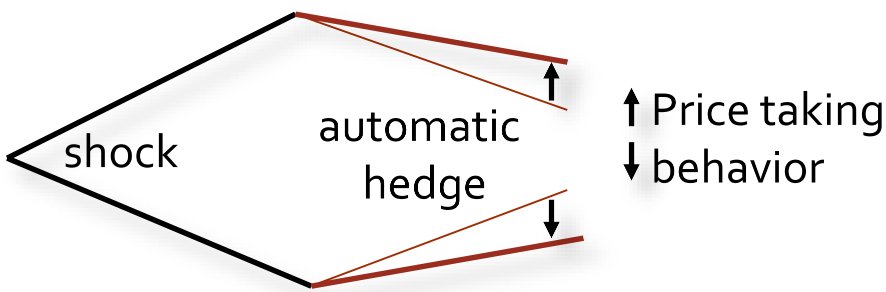

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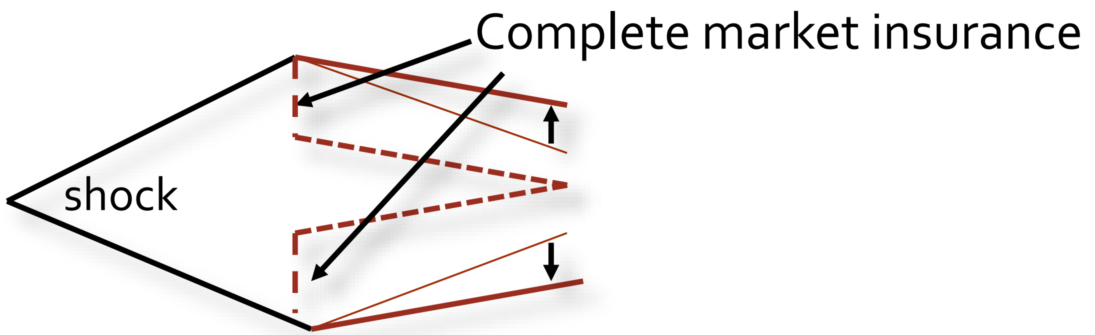

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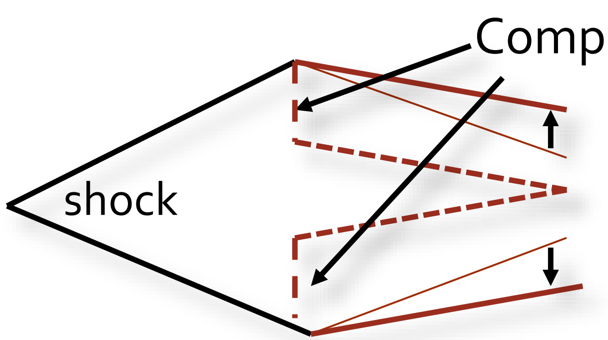

Complete markets
Pecuniary externality has only second order effects

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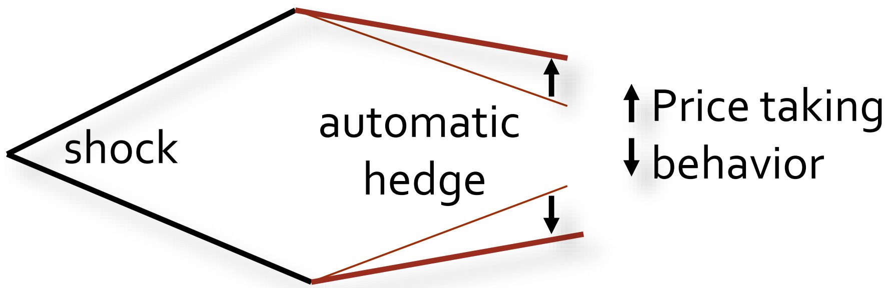

- Impose capital control/borrowing limit to

Price	Intention	Depends on
Output price	Sell output more expensive	Elasticity of substitution, s
Input (capital) price	Buy capital input cheaper	Adjustment cost, $\Phi(\iota)$
Interest rate	Borrow cheaper	Intertemporal preference

Market structures – isolating effects

	Trade		Finance	
Markets	Output y^a, y^b	Physical capital k	Debt	Equity
Complete Markets Full integration/First Best	X	X	X	X
Capital control Across countries	X	X		
No capital control Across countries	X	X	X	
	intratemporal		intertemporal	

So far, extreme debt limits/capital controls

Results (1)

- Complete markets: (full risk sharing benchmark)
  - First best, Pareto optimal allocation
- Capital controls: only international trade, no finance
  - Ex-ante insurance
    - Output price: "terms of trade hedge"
      less powerful than in Cole & Obstfeld 1991, since capital stock
    - Input price: capital price is depressed
  - Ex-post inefficiency – physical capital is misallocated
    - Rebuilding of capital stock through investment rate ι
      (speed depends on Φ'' - no rebuilding with sticky output prices)
- No capital controls on debt: trade + debt market
  - "skin in the game constraint" limits risk sharing …

Results (2)

- No capital control: trade + debt market
  - Maintain full specialization after negative shock
  - Replace lost capital & borrow funds

1. as firms replace physical capital
   - Destroys "Terms of trade hedge"
     - Pecuniary externality: each firm in sector buys capital ignoring that this lowers the price of their output. (constrained inefficiency!)
   - Increase price of capital
   - Improves ex-post physical capital allocation
2. as firms borrow
   - Increase interest rate (borrowing rate)
   - Sector becomes morel levered & exposed to the next adverse shock

- Unanticipated bail-out/debt relief can be Pareto improving

Two country model: Ricardo with capital

- Two output goods y^a and y^b - imperfect substitutes

$$y_t = \left[\frac{1}{2}\left(y_t^a\right)^{\frac{s-1}{s}} + \frac{1}{2}\left(y_t^b\right)^{\frac{s-1}{s}}\right]^{s/(s-1)}$$

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- (Comparative) advantages:

	Good *a*	**Good *b***
Country *A*	ak_t	$\underline{a}k_t$
Country *B*	$\underline{a}k_t$	ak_t

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- (Comparative) advantages:

	Good a	Good b
Country A	ak_t	$\underline{a}k_t$
Country B	$\underline{a}k_t$	ak_t

- World capital shares: $\psi_t^{Aa} + \psi_t^{Ab} + \psi_t^{Ba} + \psi_t^{Bb} = 1$
- World supply of goods:

$$Y_t^a = \left(a\psi_t^{Aa} + \psi_t^{Ba}\underline{a}\right)K_t \qquad Y_t^b = \left(a\psi_t^{Bb} + \psi_t^{Ab}\underline{a}\right)K_t$$

Two country model

- Price of output goods a and b in terms of price of y

$$P_t^a = \frac{1}{2}\left(\frac{Y_t}{Y_t^a}\right)^{1/s} \text{ and } P_t^b = \frac{1}{2}\left(\frac{Y_t}{Y_t^b}\right)^{1/s}$$

- Terms of trade P_t^a / P_t^b

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- Preferences

$$E\left[\int_0^\infty e^{-\rho t}\frac{c_t^{1-\gamma}}{1-\gamma}dt\right]$$

  - Same preference discount rate ρ for all
  - Focus on log utility: $\gamma = 1$

Two country model

- Capital evolutions for $i = a, b$
  - $dk_t = (\Phi(\iota_t) - \delta)k_t dt + \sigma^i k_t dZ_t^i,$ Φ is concave
    - Single type of capital
    - Shocks are technology specific
    - Investment in composite good

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- Optimal investment rate

$$\Phi'(\iota) = 1/q_t$$

  - q_t is a constant for linear Φ adjustment cost function

1. First Best: no frictions

1. Perfect specialization — international trade
2. Perfect risk sharing — international finance

- Planner's problem
  - Full specialization $\psi_t^{Aa} = \psi^{Ba} = 1$
  - Input equalization $k_t^A = k_t^B = K_t/2$
  - Investment rate equalization $\iota_t^A = \iota_t^B$
  - Output equalization $y_t^a = y_t^b$ $\quad Y_t = \frac{a}{2} K_t$
  - $\frac{dZ_t^a + dZ_t^b}{\sqrt{2}} \equiv dZ_t$

1. First Best: Prices (time invariant)

- SDF $m_t = e^{-\rho t}\left(\frac{K_0}{K_t}\right)^{\gamma}$
- $$\frac{dm_t}{m_t} = \underbrace{\left\{-\rho - \gamma\left[\Phi\left(\frac{a}{2}-\zeta\right)-\delta\right] + \frac{\gamma(\gamma+1)\sigma^2}{4}\right\}}_{=E\left[\frac{dm_t}{m_t dt}\right]} dt - \frac{\gamma\sigma}{\sqrt{2}} dZ_t$$
- **Risk-free rate:** $r^F = \rho + \gamma\left[\Phi\left(\frac{a}{2}-\zeta\right)-\delta\right] - \frac{\gamma(\gamma+1)\sigma^2}{4}$

- From $E\left[\frac{dr_t^K m_t}{m_t dt}\right] = 0$, $\underbrace{\mu_t^m}_{-r_t} + \mu_t^{r^K} + \sigma_t^{r^K}\sigma_t^m = 0$
- **Price of capital:** $q = \frac{\zeta}{r_t^F + \frac{\gamma}{2}\sigma^2 - \left[\Phi\left(\frac{a}{2}-\zeta\right)-\delta\right]}$

Discount – growth rate

Gordon Growth Formula

Overview

- First Best Analysis
  - Full specialization
- Closed Capital Account
  - "Terms of trade hedge"
  - Long-run investment distortion
- Open Capital Account for debt
  - Pecuniary externalities – role for policy intervention
  - Specialization through borrowing
  - Growth versus Stability – hot money

Returns on physical capital

- Postulate
  - $dq_t/q_t \;= \mu_t^q dt + \sigma_t^{qa} dZ_t^a + \sigma_t^{qb} dZ_t^b$
- Returns from holding physical capital
  - $dr_t^{Aa} = \left(\frac{aP^a - \iota_t}{q_t} + \mu^q + \Phi(\iota_t) - \delta + \sigma^a \sigma_t^{qa}\right) dt +$
    $+(\sigma^a + \sigma_t^{qa}) dZ_t^a + \sigma_t^{qb} dZ_t^b$
  - $dr_t^{Ab} = \left(\frac{\underline{a}P^a - \iota_t}{q_t} + \mu^q + \Phi(\iota_t) - \delta + \sigma^a \sigma_t^{qb}\right) dt +$
    $+(\sigma^b + \sigma_t^{qb}) dZ_t^b + \sigma_t^{qa} dZ_t^a$
- Aside: Recall Ito product rule
  - $d(X_t Y_t) = dX_t Y_t + X_t dY_t + \sigma_X \sigma_Y dt$

Net worth dynamics

- Agent $I \in \{A, B\}$
  - consume at rate $\zeta_t^I = c_t^I / n_t^I$
  - Portfolio weights $(x_t^a, x_t^b, 1 - x_t^a - x_t^b)$
    - x_t^a fraction held in capital that will produce output a
    - x_t^b … b
    - $1 - x_t^a - x_t^b$ fraction held in international debt/bond
    - No equity or derivatives
- Net worth dynamics
  - $dn_t^I / n_t^I = x_t^a dr_t^{Ia} + x_t^b dr_t^{Ib} + \left(1 - x_t^a - x_t^b\right) dr_t^F - \zeta_t^I dt$
  - Solvency constraint: $n_t \geq 0$

    (together form budget constraint)

    No exogenous debt constraint,
    solvency constraint doesn't bind, acts as off-equilibrium threat

Equilibrium characterization

- Equilibrium is a map

Histories of shocks → prices, allocations

$\{Z_s, s \leq t\}$ → $q_t, \psi_t^{Aa}\ldots, \iota_t^A, \iota_t^B, d\zeta_t^A, d\zeta_t^B$

wealth distribution

$$\eta_t = \frac{N_t}{q_t K_t} \in (0,1)$$ A' wealth share

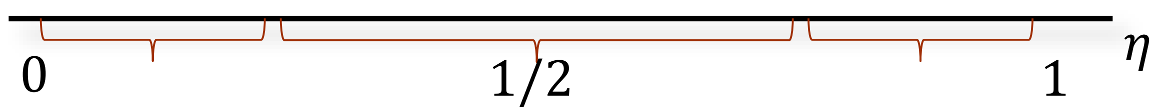
- $\psi_t^{Aa} + \psi_t^{Ab} + \psi_t^{Ba} + \psi_t^{Bb} = 1$ and $C_t^A + C_t^B = Y_t - \iota_t K_t$
- Portfolio weights: $\frac{\psi_t^{Aa}}{n_t}, \frac{\psi_t^{Ab}}{n_t}, 1 - \frac{\psi_t^{Aa} + \psi_t^{Ab}}{n_t}$
- Consumption rates: $\zeta_t^A = C_t^A / N_t \quad \zeta_t^B = C_t^B / (q_t K_t - N_t)$

2. Closed capital account – no debt

- Cole-Obstfeld (1991) with investment & capital

- Proposition 2:
  - Three regions

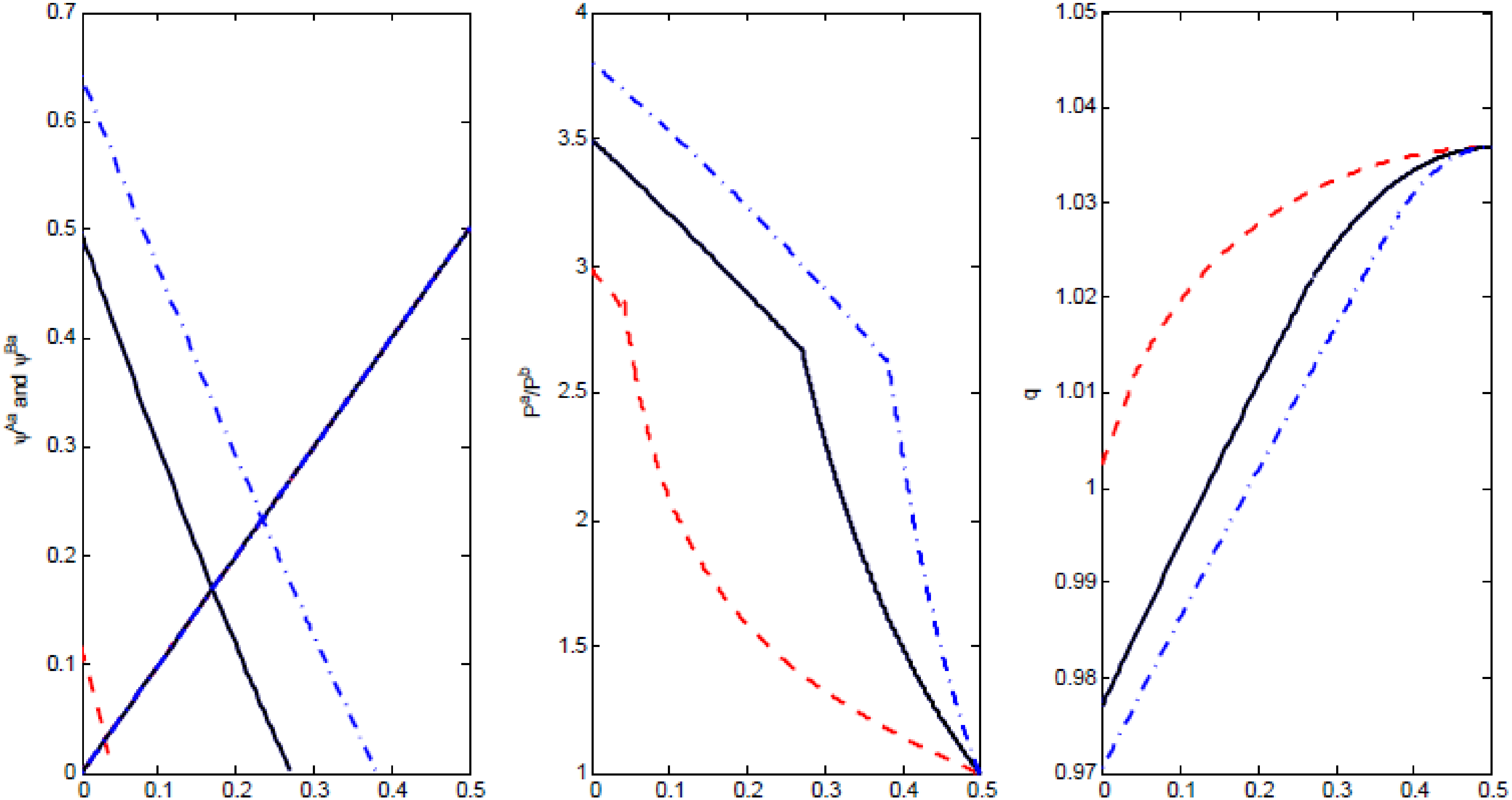
		Full specialization	
A produces	a	a	a, b
B produces	a, b	b	b



  - Symmetric

$$\psi_t^{Aa} = \eta_t$$
$$\psi_t^{Bb} = 1 - \eta_t$$
$$\psi_t^{Ba} = \psi_t^{Ab} = 0$$

2. Closed capital account



Wealth share η

s=.5, 1.01 (Cobb Douglas), 3

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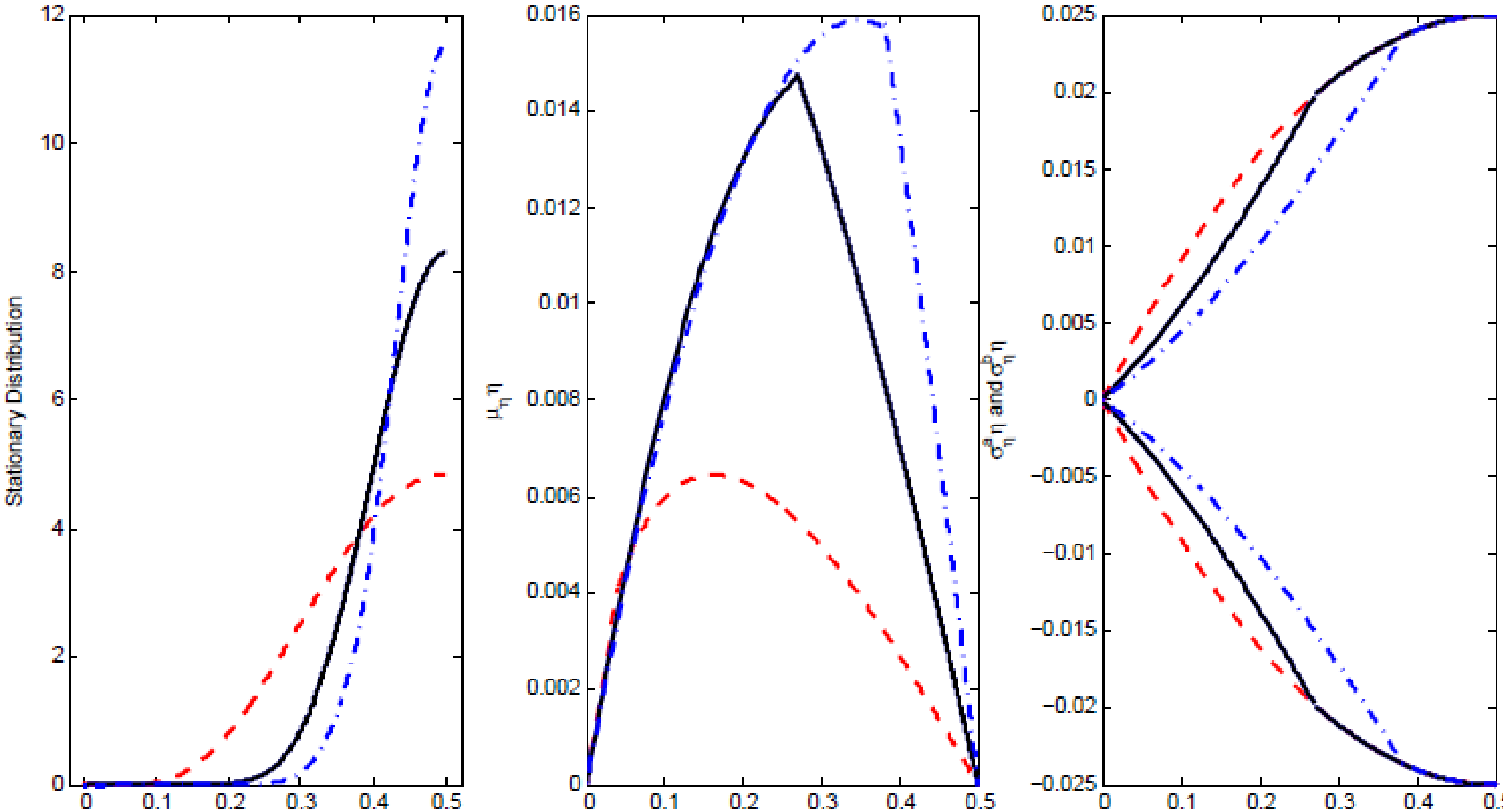

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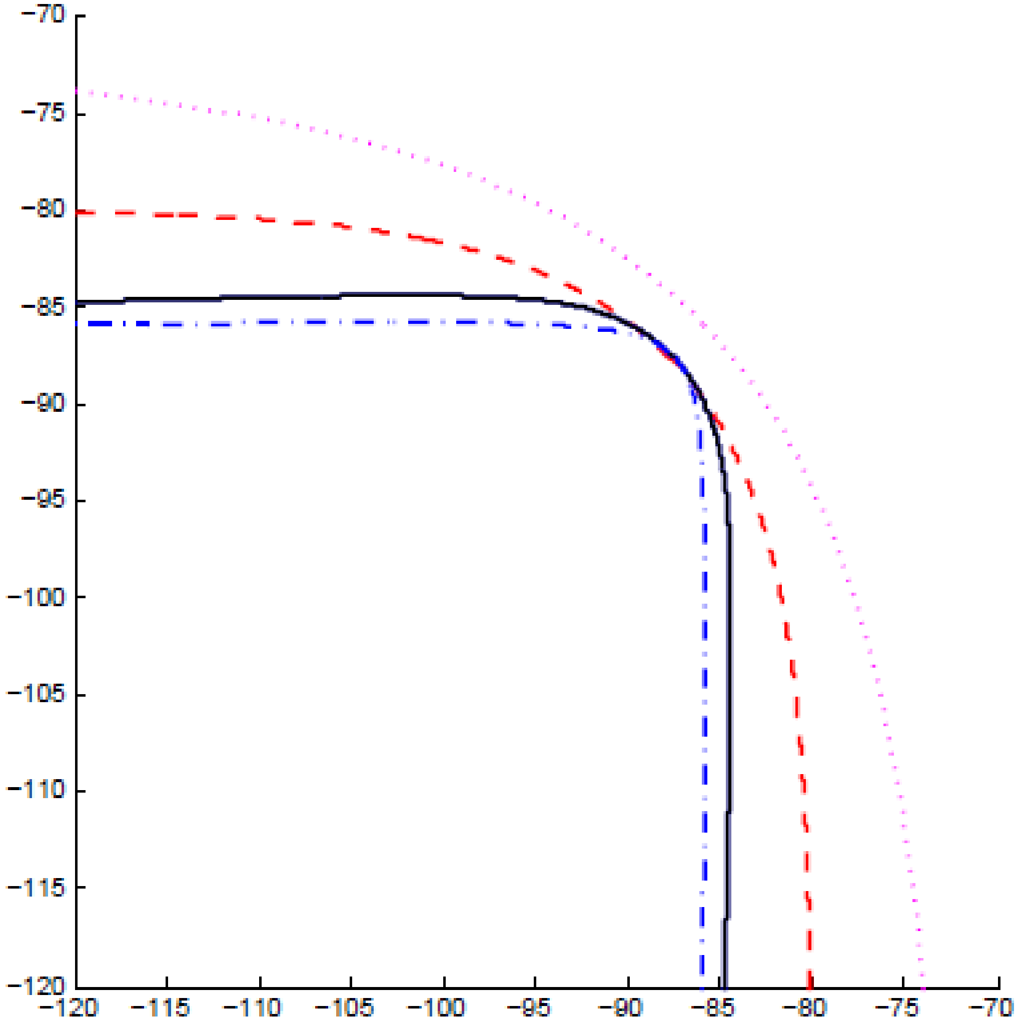

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Catch 22 situation

- Lack of capital mobility
  - Creates ex-ante “terms of trade hedge”
    - Improves ex-ante efficiency – better insurance
  - Physical capital stays misallocated
    - Ex-post inefficiency

Market structures – isolating effects

Markets	Output y^a, y^b	Physical capital k	Debt	Equity
	Trade		Finance	
Complete Markets Full integration/First Best	X	X	X	X
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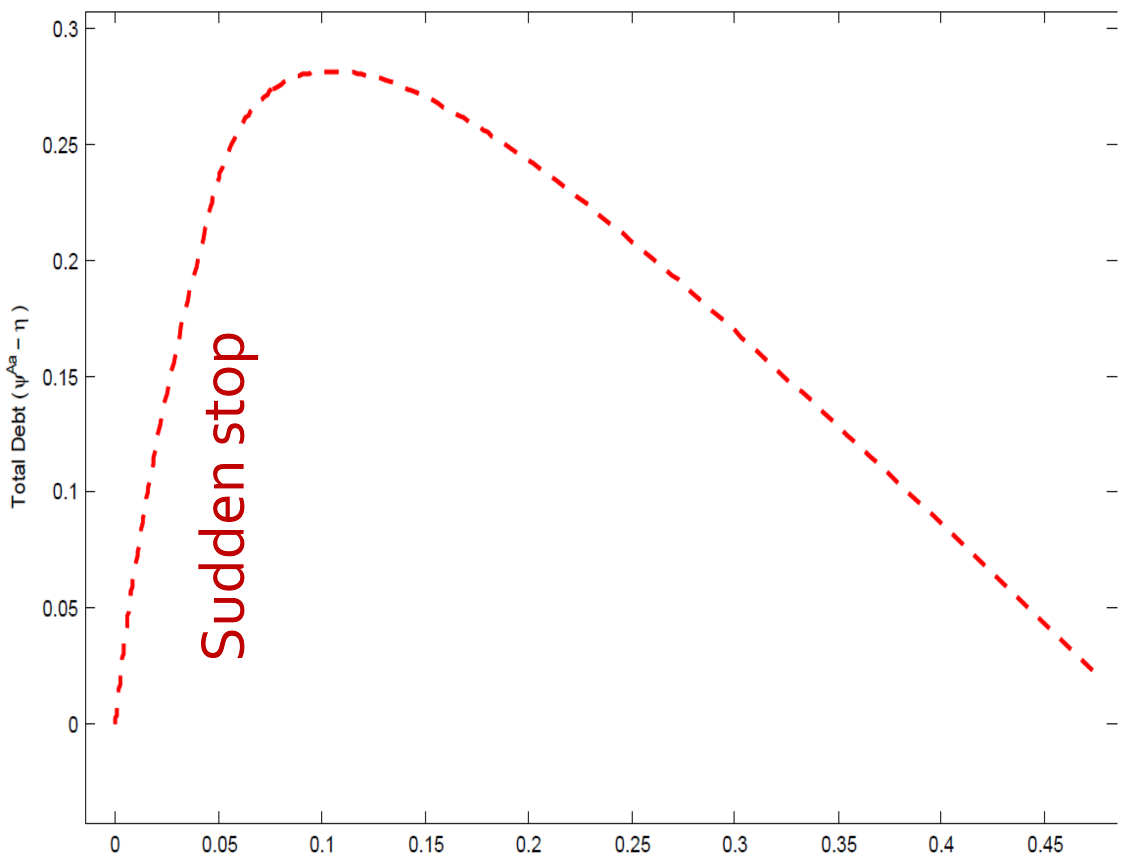
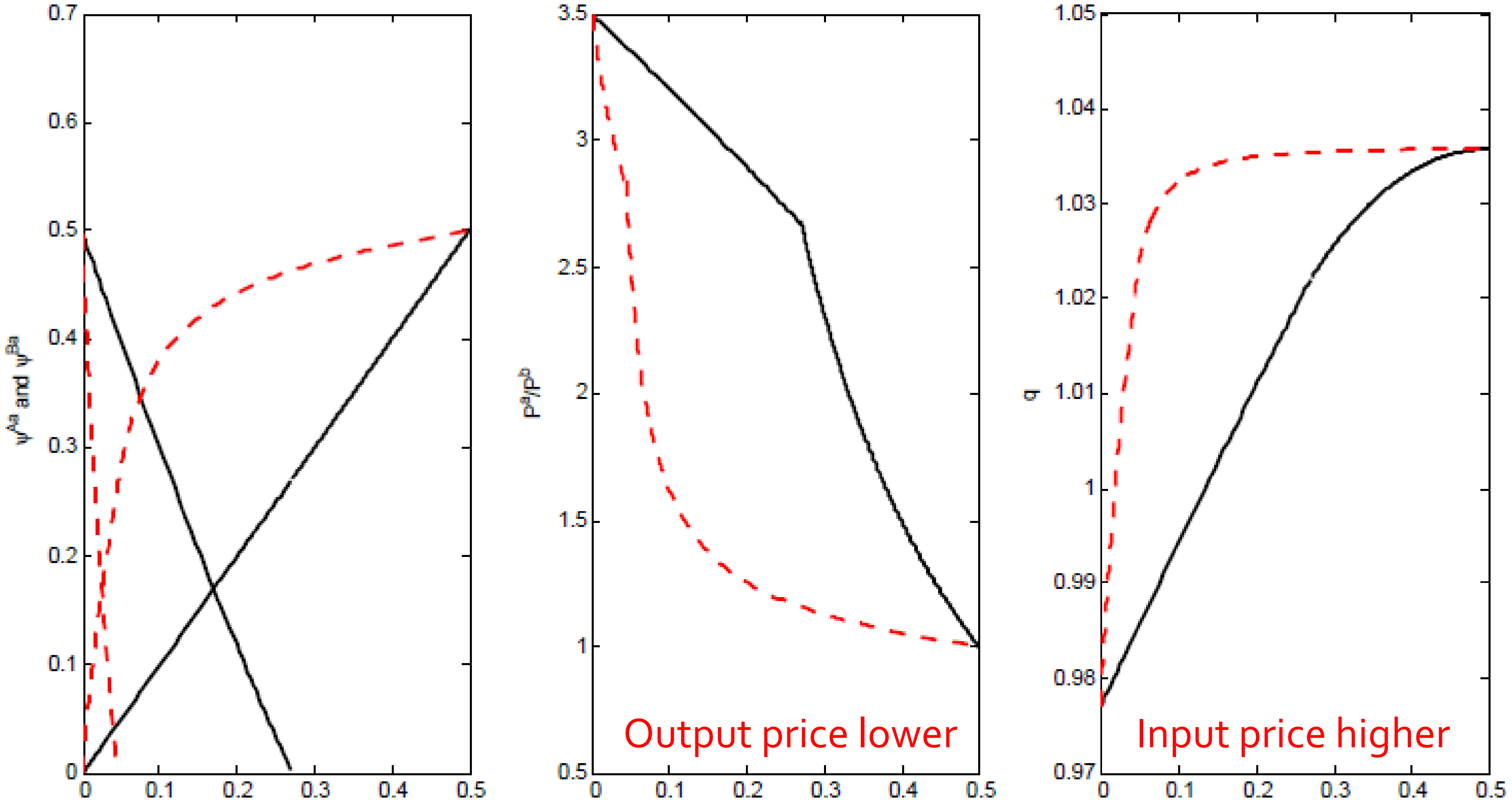
- Not perfect risk sharing due to skin in game constraint

Equilibrium credit flow



3. Capital account: open vs. closed

- $r = 5\%, a = 14\%, \underline{a} = 4\%, \delta = 5\%, \kappa = 2, \sigma^A = \sigma^B = 10\%,$
- $s = 1.01$ (Cobb-Douglas)



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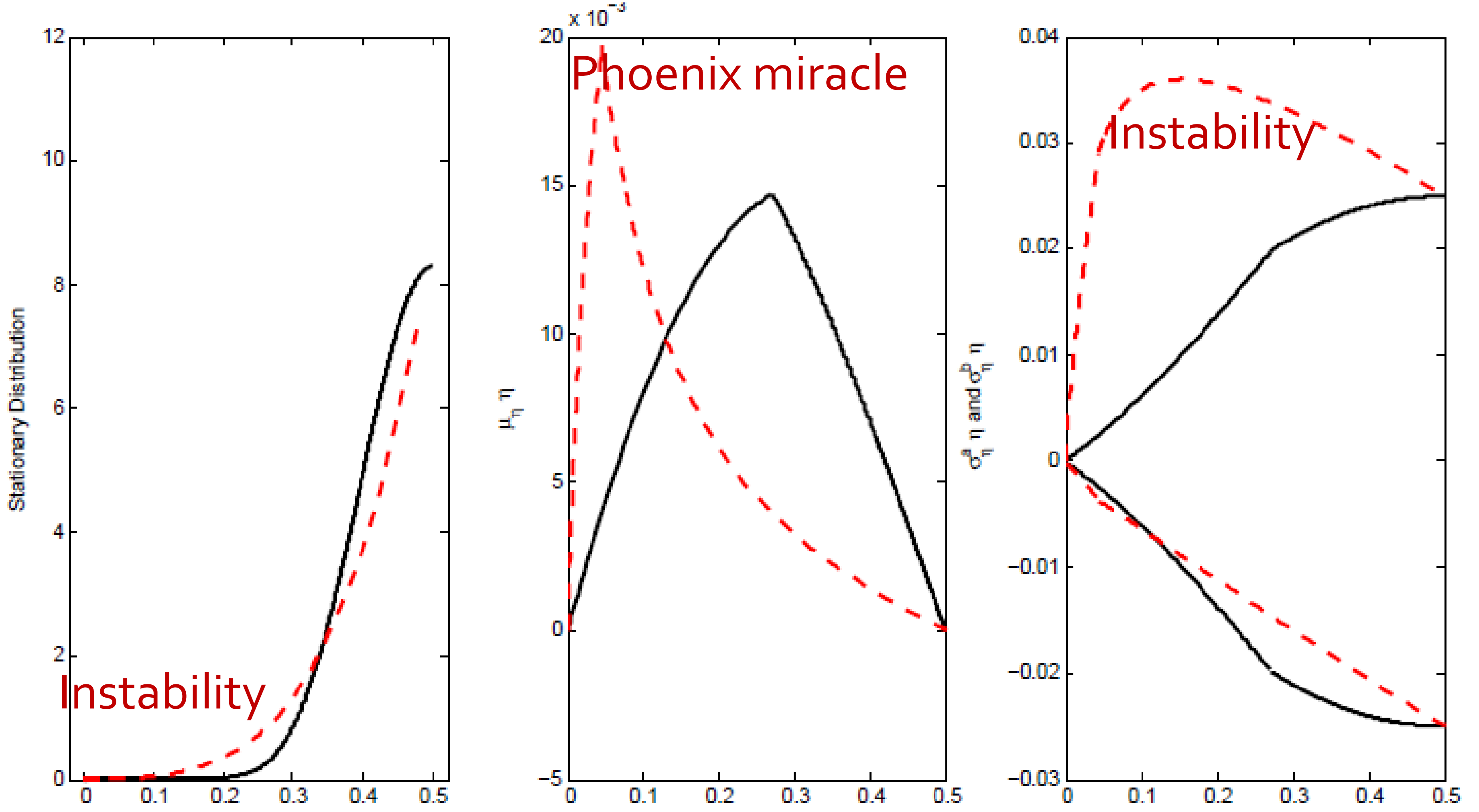

Welfare comparison

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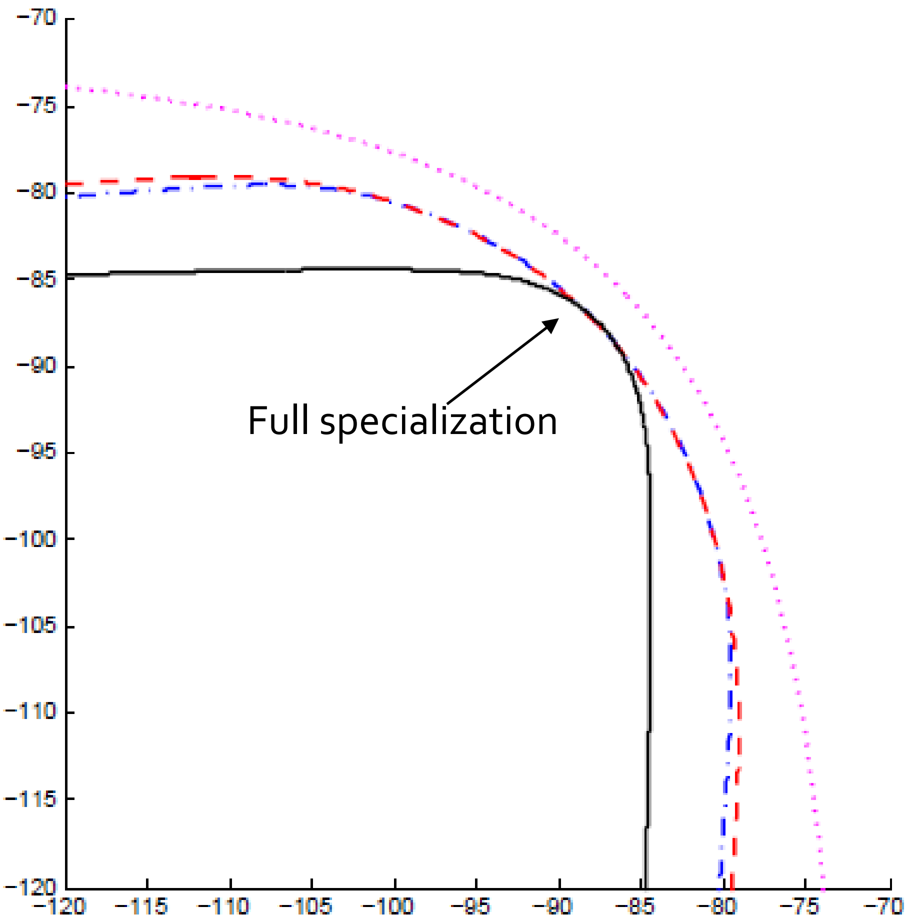

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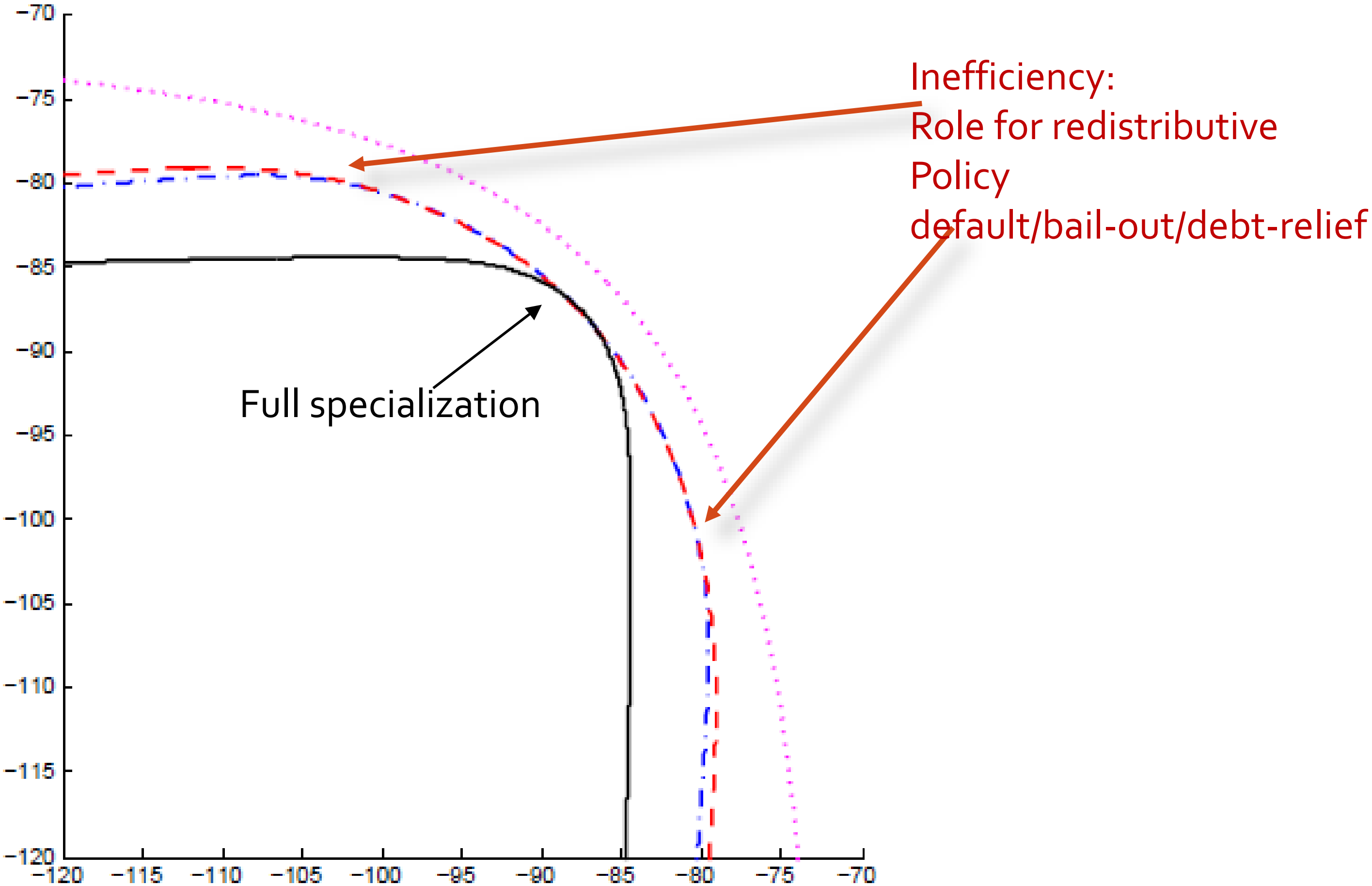

Literature

- Macro, Money with financial frictions
  - BGG, Kiyotaki & Moore 1997/2008, Gertler-Kiyotaki, Mendoza, Bianchi, …
  - Brunnermeier & Sannikov 2012/13, He & Krishnamurthy 2013, Basak & Cuoco 1998
- "terms of trade hedge"
  - Cole & Obstfeld 1991, Martin 2010
- Constrained inefficiency, pecuniary/firesale externalities
  - Incomplete markets:
    - Stiglitz 1982, Geanakoplos & Polemarchakis 1986
  - Debt collateral constraint (that depends on price)
    - Lorenzoni 2005, Jeanne & Korinek 2012, Stein 2012, …
- Hot money financing
  - "Liquidity mismatch" (short-term funding vs. technological illiquidity Φ")

Conclusion

- Two country model with different expertise
- Capital goods market + borrowing allows specialization for larger range of state space
- Undermines "terms of trade hedge", capital price, interest rate
  - Pecuniary externality
  - Constrained inefficiency a la Stiglitz 1982, Geanakoplos & Polemarchakis 1986
- Leverage ups risk for undercapitalized sector
  - Cut back later much more severely – fire sale externality
- Pareto Inefficiency – redistribution might be desirable?
  - Bailout/default/debt relief
  - monetary/fiscal policy? - see "redistributive monetary policy"