A Long Run Perspective on Currency Mismatch, Crises and Growth

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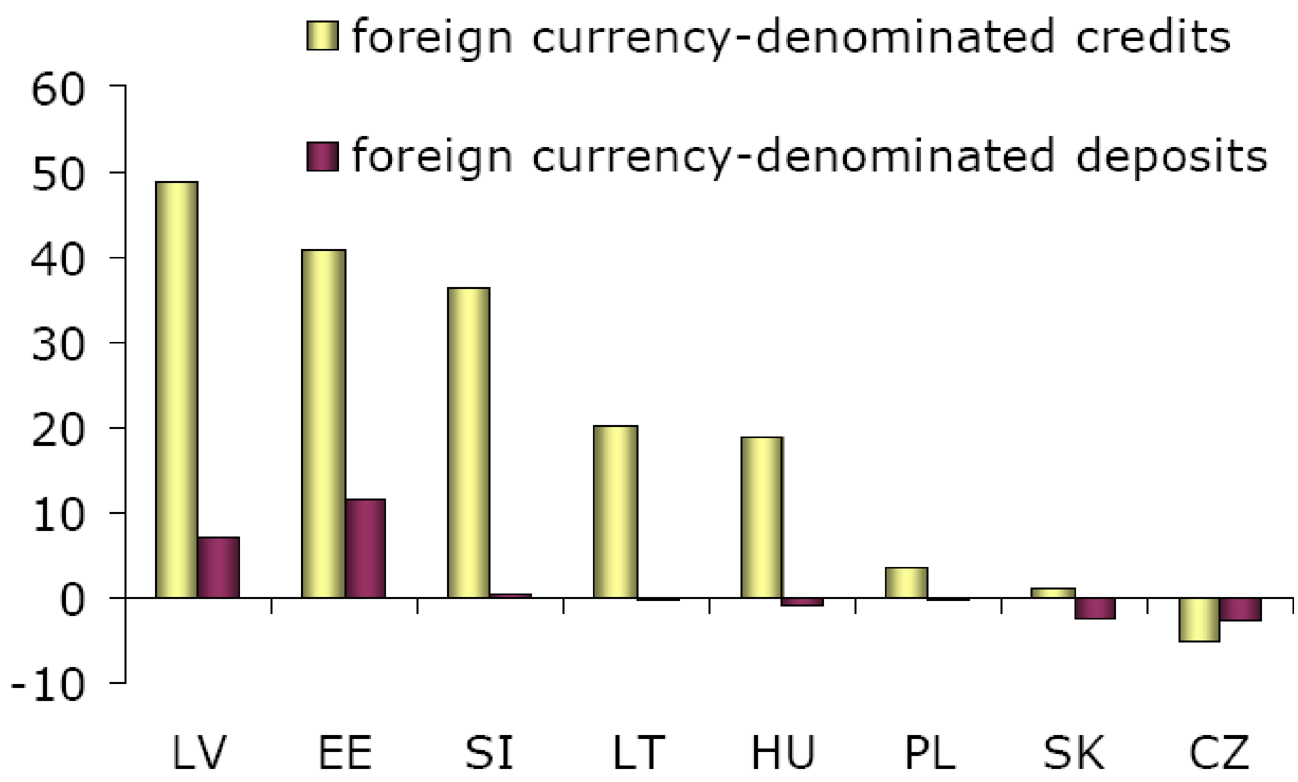
Background

- Lending Booms, Currency Mismatches and Crisis Risk.
- East Asia and Latin America Crises
  - currency mismatch
  - balance sheet effects
    - real depreciations
    - Firesales
    - bankruptcies.
- Most recently: Eastern Europe.

Banks' balanced position masks important shifts in the size and funding of their fx lending

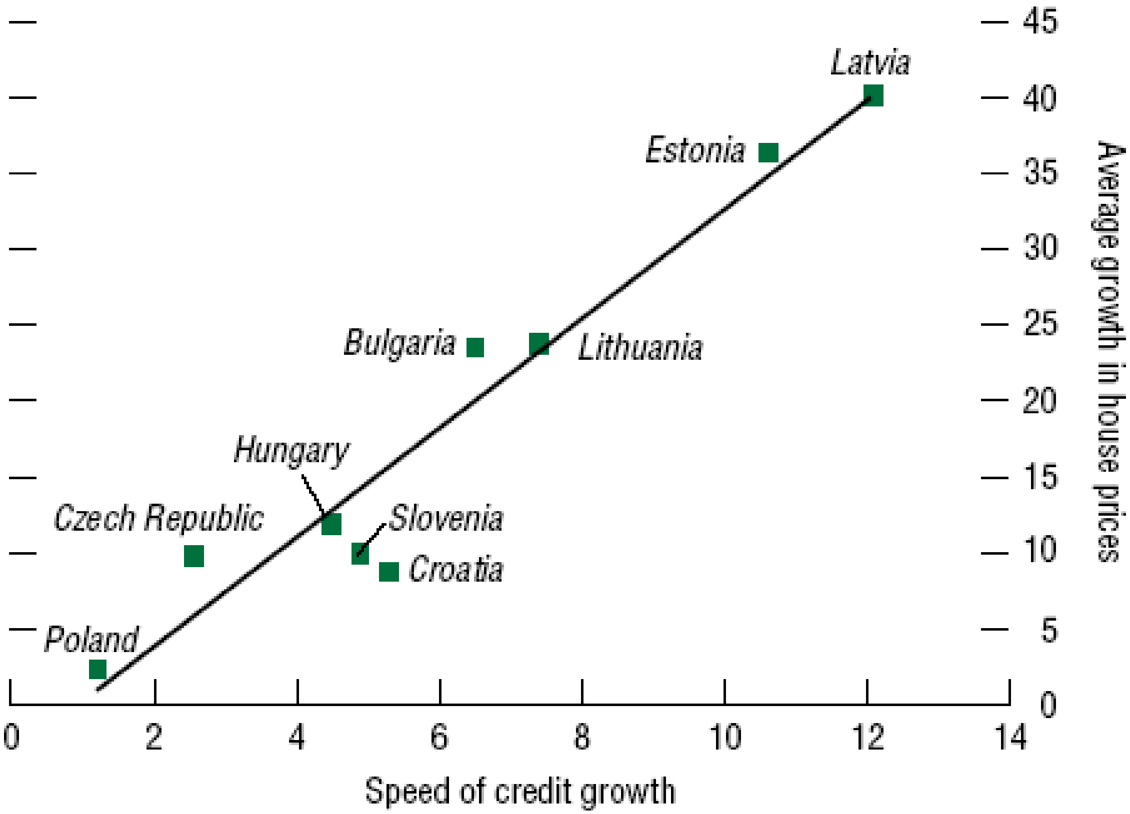
CECs. Change of foreign currency credits and deposits during 2001-05 (in percentage points of GDP)



Source: National authorities, IMF staff estimates

Figure 1.23. Central and Eastern Europe: Growth in Private Credit and House Prices, 2002–06

(In percent)



Sources: Égert and Mihaljek (2007); and IMF staff estimates.

Note: The speed of credit growth is defined as the annual percentage point increase in the private credit-to-GDP ratio, averaged over 2002–06.

How do currency mismatches endogenously arise?

- Firms with domestic revenues take on exchange rate risk.
- Hedge for investors against future monetary or exchange rate policy change (Jeanne (2004), Tirole (2004))
- Dilution of domestic lenders (Chamon (2004))
- Bailout Expectations and Contract Enforceability (Schneider-Tornell, 2004, Ranciere-Tornell-Westerman (2008))

Currency Mismatch and Sectoral Asymmetries

- Financial Asymmetry: a sector of the economy is more credit constrained than others.
- Non-Tradeables (N) vs. Tradeables Goods (T)
  - Real Exchange Rate Risk
- Housing Sector / High Tech Sector vs Rest of the Economy.
- Sectoral Linkage between N and T

Key tradeoffs our 2-sector model explores

- Currency mismatch
  - Relaxation of borrowing constraints: aggregate investment in N-sector effect.
  - Crisis Risk: aggregate risk of banking crisis and currency crisis.
- Growth perspective
  - How much growth in N-sector spillovers to the rest of the economy
- Welfare perspective.
  - Shall the T-sector finance the bailout?
- Policy issue: shall we discourage currency mismatches?
  - No necessarily.

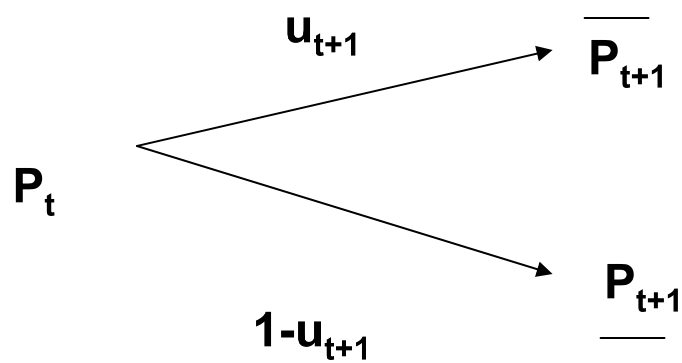
The Model Economy

- Two sectors open economy endogenous growth model
- Tradable and Non-Tradable Sectors
- Three Agents: consumers / entrepreneurs / foreign lenders
- Uncertainty: endogenous real-exchange rate risk
- Asymmetric Financing Opportunities
- Two capital market imperfections:

Contract Enforceability Problems → borrowing constraints
Systemic Bailout Guarantees → risk-taking

uncertainty = endogenous real-exchange rate risk

- P_t = inverse of real exchange rate: price of non-tradables in tradables



- u_{t+1} may be equal either to 1 or $u_{t+1} = u < 1$
- u = sunspot probability
- 1-u → probability of self-fulfilling crisis

Production Structure of the Economy

T	T+1
Non-Tradables Firms ↓	
N-goods (input): →	Non-Tradables Firms
↓ Tradables Firms	
↓ T-goods (consumption good)	

financing conditions

- Tradables Firms and Consumers perfect access to capital markets.
- Non-Tradables Firms and Entrepreneurs :

contract enforceability problems

Borrowing Constraints

Investment capacity

Real-Exchange Rate

- International Investors = lenders
- Standard　N-denominated or T-Denominated one period debts

T-firms:

Produce the T-good using a nontradable input (d_t) and a non-reproducible factor (l_t^T):

$$\max_{\{d_{t+j}, l_{t+j}^T\}_{j=0}^{\infty}} \left[y_{t+j} - p_{t+j} d_{t+j} - v_{t+j}^T l_{t+j}^T \right], \quad (1)$$

$$y_{t+j} = a_{t+j} d_{t+j}^{\alpha} (l_{t+j}^T)^{1-\alpha}, \qquad \alpha \in (0,1) \quad (2)$$

Consumers:

Infinitely lived, consumes only T-goods,

endowed with one unit of the non-reproducible factor, which he supplies inelastically ($l_t^T = 1$).

can buy and sell any amount of the two default-free bonds

$$\begin{aligned} &\max_{\{c_{t+j}\}_{j=0}^{\infty}} E_t \sum_{j=0}^{\infty} \delta^j u(c_{t+j}) \\ &\text{st. } E_t \sum_{j=0}^{\infty} \delta^j [c_{t+j} - v_{t+j}^T + T_{t+j}] \leq 0 \end{aligned}, \quad (3)$$

where $\delta := \frac{1}{1+r}$, T_t is the tax that will finance the bailouts.

N-firms

- Run by overlapping generations of entrepreneurs.

- Produce N-goods using entrepreneurial labor (l_t), and capital (k_t)

  $q_t = \Theta_t k_t^{\beta} l_t^{1-\beta}, \quad \Theta_t =: \theta \overline{k_t}^{1-\beta}, \;\; k_t = I_{t-1}, \; \beta \in (0,1)$

- Budget constraint: $p_t I_t = w_t + b_t + b_t^n$ (Investment= Cash Flow +Debt Issued)

- The cash flow of the firm equals the entrepreneur's wage: $w_t = v_t$

- $(b_t, b_t^n) = (T - debt, N - debt)$

- Time $t+1$ profits: sales net of wages and debt repayments

  $\pi(p_{t+1}) = p_{t+1} q_{t+1} - v_{t+1} l_{t+1} - L_{t+1} - p_{t+1} L_{t+1}^n$

Contract Enforceability Problems.

Entrepreneurs cannot commit to repay debt: if at time t the entrepreneur incurs a non-pecuniary cost $h[w_t + b_t + b_t^n]$, then at $t+1$ she will be able to divert all the returns provided the firm is solvent.

Bailout Guarantees.

There is a bailout agency that pays lenders the outstanding debts of all defaulting firms if more than 50% of firms become insolvent (i.e., $\pi(p_{t-1}) < 0$).

The guarantee applies to both N- and T-debt.

The bailout agency recuperates a share μ of the insolvent firms' revenues.

The remainder is financed by lump-sum taxes on consumers

$$E_t \sum_{j=0}^{\infty} \delta^j [1-\xi_{t+j}][L_{t+j}+p_{t+j}L_{t+j}^n-\mu p_{t+j}q_{t+j}-T_{t+j}] = 0 \quad (1)$$

$\mu \in [0, \beta], \qquad \xi_{t+1} = 1$ if $\pi(p_{t+1}) \geq 0$

Entrepreneur's Problem:

Choose a plan $P_t = (I_t\ b_t\ , b_t^n, L_t, L_t^n)$ to:

$$\max_{P_t,\eta_t} \ E_t(\xi_{t+1}\{p_{t+1}q_{t+1} \\ -v_{t+1}l_{t+1} - [1-\eta_t][L_{t+1} + p_{t+1}L_{t+1}^n] \\ -h\eta_t[w_t + b_t + b_t^n]\}) \quad \text{s.t. BC}$$

$\xi_{t+1} = 1$ if solvent $\pi(p_{t+1}) \geq 0; \eta_t = 1$ if the entrepreneur has set up a diversion scheme.

Symmetric equilibrium:

- P_t is determined by SE of the credit market game.
- d_t maximizes T-firms profits and c_t maximizes consumers expected utility;
- factor markets clear
- the market for non-tradables clears: $d_t + I_t = q_t$.

Symmetric Equilibrium

1. We take prices (p_t) and the likelihood of crisis ($1 - u_{t+1}$) as given, and derive the equilibrium at a point in time.[Credit Market Game (Tornell-Schneider (RES 2004)]

2. We endogeneize p_t and u_{t+1}.

Proposition 1 (Symmetric Credit Market Equilibria (CME)) *There is investment in the production of N-goods if and only if*

$$R^e_{t+1} := \beta\theta \left[u_{t+1} \frac{\bar{p}_{t+1}}{p_t} + [1 - u_{t+1}] \frac{\underline{p}_{t+1}}{p_t} \right] \geq \frac{1}{\delta} > \frac{h}{u_{t+1}} \tag{6}$$

Suppose (6) holds. Then,

i *There always exists a 'safe' CME in which insolvency risk is hedged ($b_t = 0$). Credit and investment are: $b^n_t = [m^s - 1]w_t$ and $I_t = m^s \frac{w_t}{p_t}$, with $m^s = \frac{1}{1-h\delta}$.*

ii *If in addition $u_{t+1} = u < 1$ and $\frac{\beta\theta \underline{p}_{t+1}}{p_t} < \frac{h}{u}$, there also exists a 'risky' CME in which currency mismatch is optimal ($b^n_t = 0$). Credit and investment are: $b_t = [m^r - 1]w_t$ and $I_t = m^r \frac{w_t}{p_t}$, with $m^r = \frac{1}{1-u^{-1}h\delta}$.*

Equilibrium Dynamics

- Cash flow

$$w_t = \begin{cases} [1-\beta]p_t q_t & \text{if } \pi(p_t) \geq 0 \\ \mu_w p_t q_t & \text{if } \pi(p_t) < 0, \end{cases} \qquad \mu_w \in (0, 1-\beta)$$

- N-sector investment is

$$\begin{aligned} I_t &= \phi_t q_t, \qquad \phi_t = \begin{cases} [1-\beta]m_t & \text{if } \pi(p_t) \geq 0 \\ \mu_w m_t & \text{if } \pi(p_t) < 0 \end{cases} \\ m_t &\in \{m^s, m^r\} \end{aligned}$$

- N-output, prices and T-output

$$\begin{aligned} q_t &= \theta \phi_{t-1} q_{t-1} \\ p_t &= \alpha \left[q_t(1-\phi_t)\right]^{\alpha-1} \\ y_t &= [q_t(1-\phi_t)]^{\alpha} = \frac{1-\phi_t}{\alpha} p_t q_t \end{aligned}$$

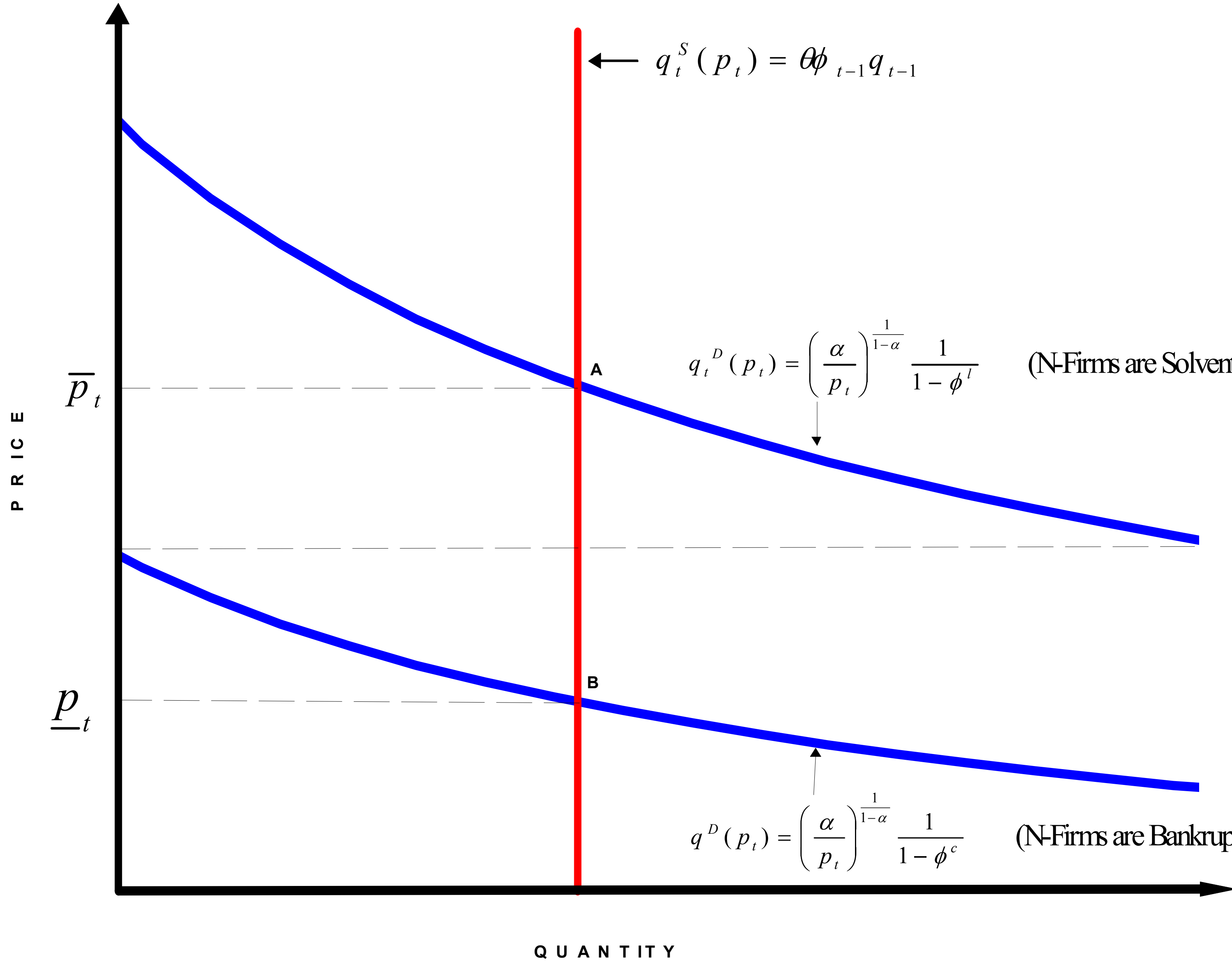
Self-fulfilling Twin Crises

T

- CME: anticipated real exchange rate risk => T debt
- T-debt => solvency of the N-sector will depend on the price of N-good

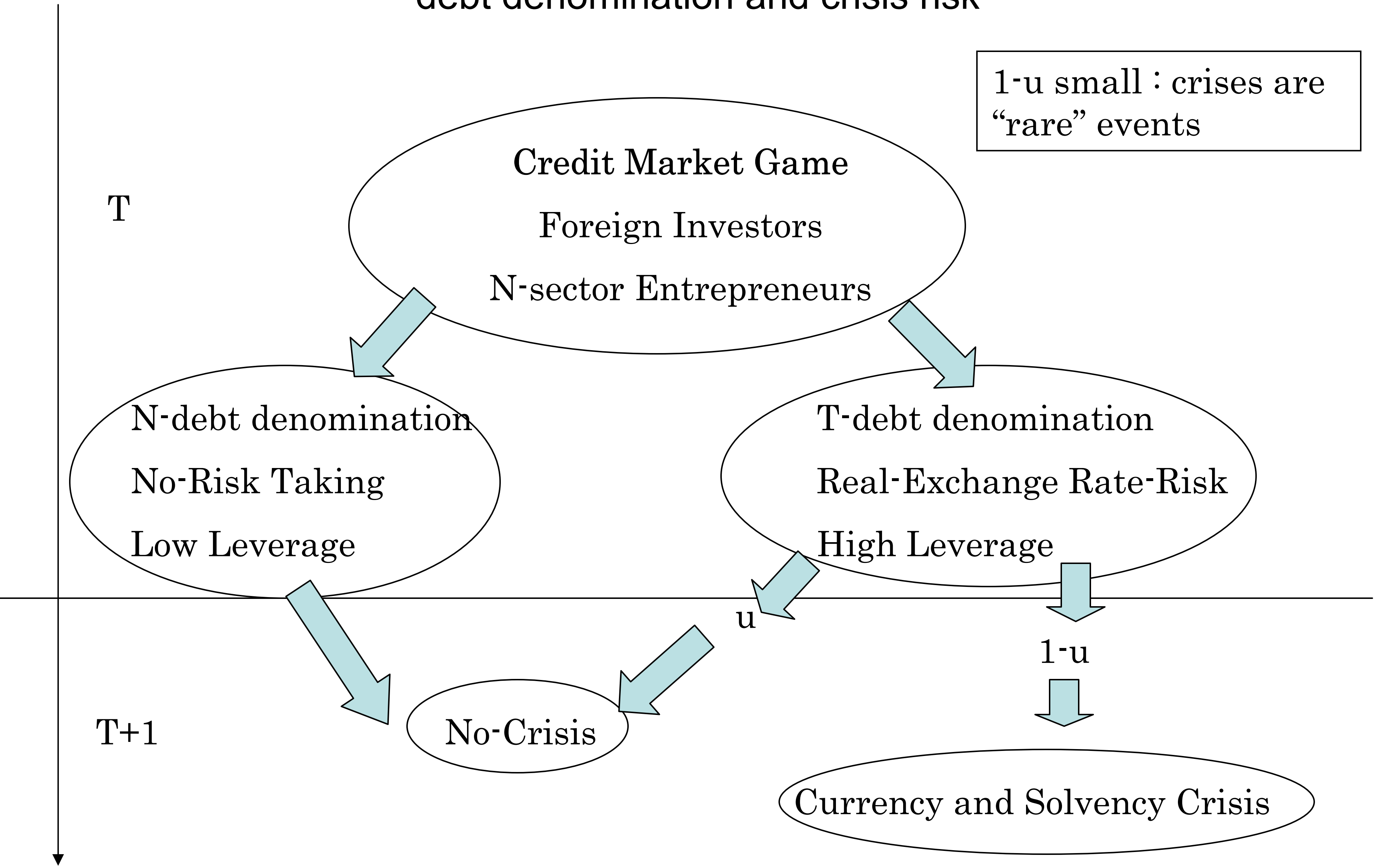
T+1

- The price of N-goods depends N-sector investment
- N-sector investment depends N-sector financial position
- N-sector financial position depends on the price of N-goods
- Multiple Clearing Prices=> validates expectations



$q_t^S(p_t) = \theta\phi_{t-1}q_{t-1}$
A
$\overline{p}_t$
P R I C E
$q_t^D(p_t) = \left(\frac{\alpha}{p_t}\right)^{\frac{1}{1-\alpha}} \frac{1}{1-\phi^l}$
(N-Firms are Solvent)
B
$\underline{p}_t$
$q^D(p_t) = \left(\frac{\alpha}{p_t}\right)^{\frac{1}{1-\alpha}} \frac{1}{1-\phi^c}$
(N-Firms are Bankrupt)
Q U A N T I T Y

debt denomination and crisis risk



Proposition 2 (Safe Symmetric Equilibrium (SSE)) *There exists an SSE if and only if the degree of contract enforceability h is low enough and N-sector productivity θ is large enough. In an SSE there is no currency mismatch* $(b_t = 0)$ *and crises never occur* $(u_{t+1} = 1)$. *Thus, the N-sector investment share is* $\phi^s = \frac{1-\beta}{1-h\delta}$.

Proposition 3 (Risky Symmetric Equilibrium (RSE)) *There exists an RSE if and only if the probability of crisis is small enough, N-sector productivity is large enough, and contract enforceability problems are severe, but not too severe.*

1. *Multiple crises can occur during which all N-sector firms default and there is a sharp real depreciation. However, two crises cannot occur in consecutive periods.*

2. *Firms choose risky plans in no-crisis times and safe plans in crisis times. The probability of a crisis and the N-sector's investment share satisfy:*

$$1 - u_{t+1} = \begin{cases} 1 - u & \text{if } t \neq \tau_i \\ 0 & \text{if } t = \tau_i \end{cases} \tag{7}$$

$$\phi_t = \begin{cases} \phi^l := \frac{1-\beta}{1-h\delta u^{-1}} & \text{if } t \neq \tau_i \\ \phi^c := \frac{\mu_w}{1-h\delta} & \text{if } t = \tau_i \end{cases} \tag{8}$$

where τ_i denotes a crisis time.

GDP Growth

$$gdp_t = p_t \phi_t q_t + y_t$$

Growth in a Safe Economy

$$1 + \gamma^s = \left(\theta \tfrac{1-\beta}{1-h\delta}\right)^\alpha = (\theta\phi^s)^\alpha$$

Growth in a Risky Economy

Lucky Path

$$1 + \gamma^l = \left(\theta \frac{1-\beta}{1-h\delta u^{-1}}\right)^\alpha = \left(\theta\phi^l\right)^\alpha$$

Crisis Episode

$$1 + \gamma^{cr} = \underbrace{\left(\left(\theta\phi^l\right)^\alpha \frac{Z(\phi^c)}{Z(\phi^l)}\right)^{1/2}}_{\text{crisis period}} \underbrace{\left((\theta\phi^c)^\alpha \frac{Z(\phi^l)}{Z(\phi^c)}\right)^{1/2}}_{\text{post-crisis period}}$$

$$1 + \gamma^{cr} = \left(\theta(\phi^l\phi^c)^{\frac{1}{2}}\right)^\alpha$$

Growth Limit Distribution

- GDP growth process

$$\Gamma = \begin{pmatrix} (\theta\phi^l)^\alpha \\ (\theta\phi^l)^\alpha \frac{Z(\phi^c)}{Z(\phi^l)} \\ (\theta\phi^c)^\alpha \frac{Z(\phi^l)}{Z(\phi^c)} \end{pmatrix}, \qquad T = \begin{pmatrix} u & 1-u & 0 \\ 0 & 0 & 1 \\ u & 1-u & 0 \end{pmatrix}$$

- the growth process converges to a unique limit distribution over the three states that solves $T'\Pi = \Pi$.

$$\Pi = \left(\frac{u}{2-u}, \frac{1-u}{2-u}, \frac{1-u}{2-u}\right)$$

- The mean long run GDP growth rate is

$$\begin{aligned} E(1+\gamma^r) &= (1+\gamma^l)^\omega (1+\gamma^{cr})^{1-\omega} \\ \text{where } \omega &= \frac{u}{2-u} \end{aligned}$$

Safe vs. Risky Equilibrium

Safe Equilibrium

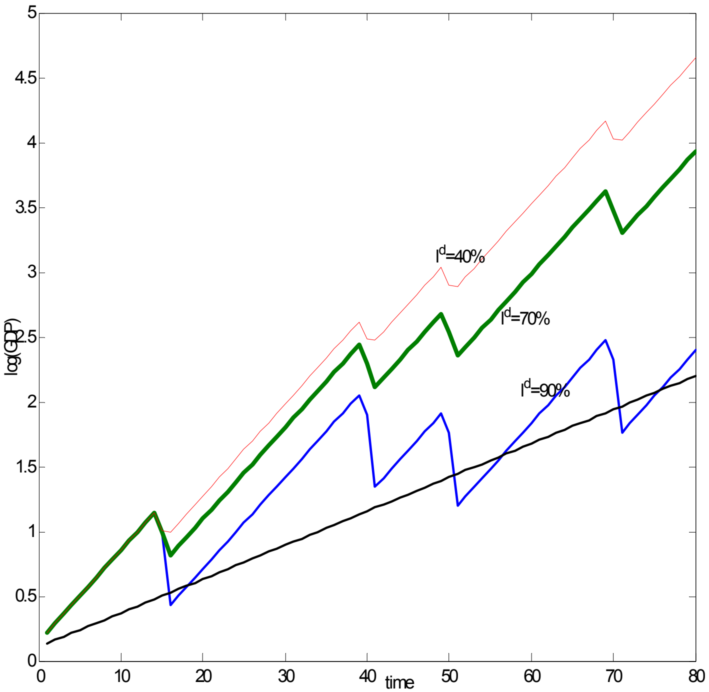
1. No-Crisis
2. Low Leverage
3. Low Investment
4. Low Growth

Risky Equilibrium

1. Boom-Bust Cycles
2. High Growth Phase
   1. high leverage
   2. high investment
3. Crisis Episode
   1. Credit Crunch
   2. Bailout Foreign Investors

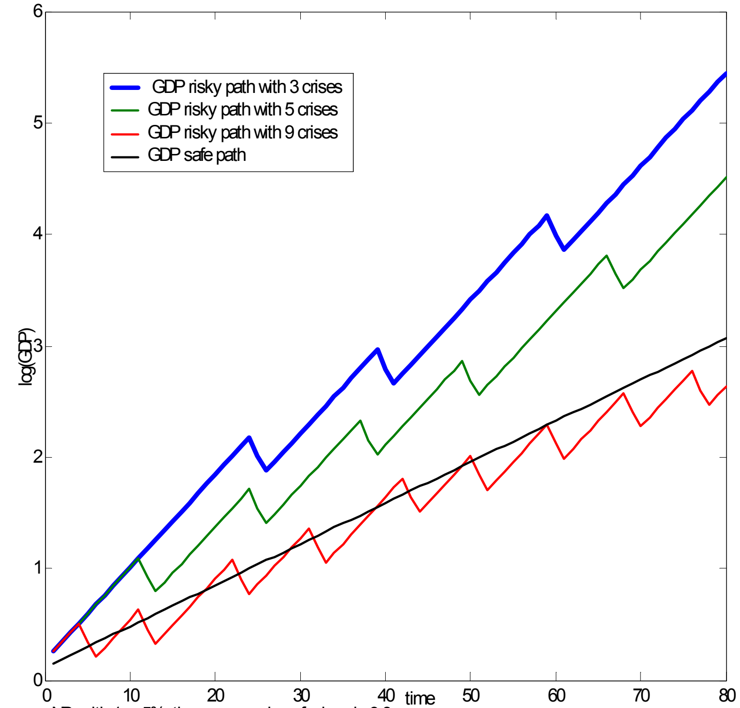
Output in Safe vs. Risky Economy

For different financial distress costs



parameters : $\theta = 1.65 \quad \alpha = 0.35 \quad h = 0.76 \quad 1-\beta = 0.2 \quad 1-u = 5\%$

For different risky paths



NB: with 1-u=5%, the mean number of crises is 3.8

parameters : $\theta = 1.65 \quad \alpha = 0.35 \quad h = 0.76 \quad 1-\beta = 0.2 \quad l^d = 70\% \quad 1-u = 5\%$

<u>proposition</u> : with intermediate contract enforceability problems and financial distress costs not too large:

Mean Growth Risky Equilibrium >Growth Safe Equilibrium

Pareto Optimality

$$\max_{\{c_t, c_t^e, \phi_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \delta^t \left[[1-\nu] u(c_t) + \nu c_t^e \right], \quad \text{s.t.}$$
$$\sum_{t=0}^{\infty} \delta^t \left[c_t + c_t^e - y_t \right] \leq 0$$
$$y_t = [1-\phi_t]^\alpha q_t^\alpha, \qquad q_{t+1} = \theta \phi_t q_t \tag{11}$$

Pareto optimality implies efficient accumulation of N-inputs to maximize the present value of T-production: $\sum_{t=0}^{\infty} \delta^t y_t$.

$$\phi^{po} = (\theta^\alpha \delta)^{\frac{1}{1-\alpha}}, \qquad \text{if } \alpha < \log(\delta^{-1}) / \log(\theta) \tag{12}$$

Proposition 4 *N-sector investment in a safe economy is below the Pareto optimal level (i e., there is a 'bottleneck') if there is low contract enforceability:* $h < (1-(1-\beta)\theta\,(\theta\delta)^{-\frac{1}{1-\alpha}})\delta^{-1}$.

Social Welfare

$$W = E_0\left(\sum_{t=0}^{\infty}\delta^t(c_t + c_t^e)\right) \tag{13}$$

$$= E_0\left(\sum_{t=0}^{\infty}\delta^t[(1-\alpha)y_t + \pi_t - T_t]\right) \tag{14}$$

Safe economy

$$W^s = \sum_{t=0}^{\infty}\delta^t y_t^s = \frac{1}{1-\delta(\theta\phi^s)^\alpha} y_o^s \tag{15}$$

$$= \frac{(1-\phi^s)^\alpha}{1-\delta\left(\theta\phi^s\right)^\alpha} q_o^\alpha \tag{16}$$

$$\text{if } \delta(\theta\phi^s)^\alpha < 1 \tag{17}$$

Risky economy

Crises can occur with probability u.

A crisis involves two deadweight losses:

(i) the revenues dissipated in bankruptcy procedures: $[\beta - \mu]p_\mathcal{T} q_\mathcal{T}$; and

(ii) the fall in N-sector investment due to its weakened financial position: $[(1-\beta)-\mu_w]p_\mathcal{T} q_\mathcal{T}$.

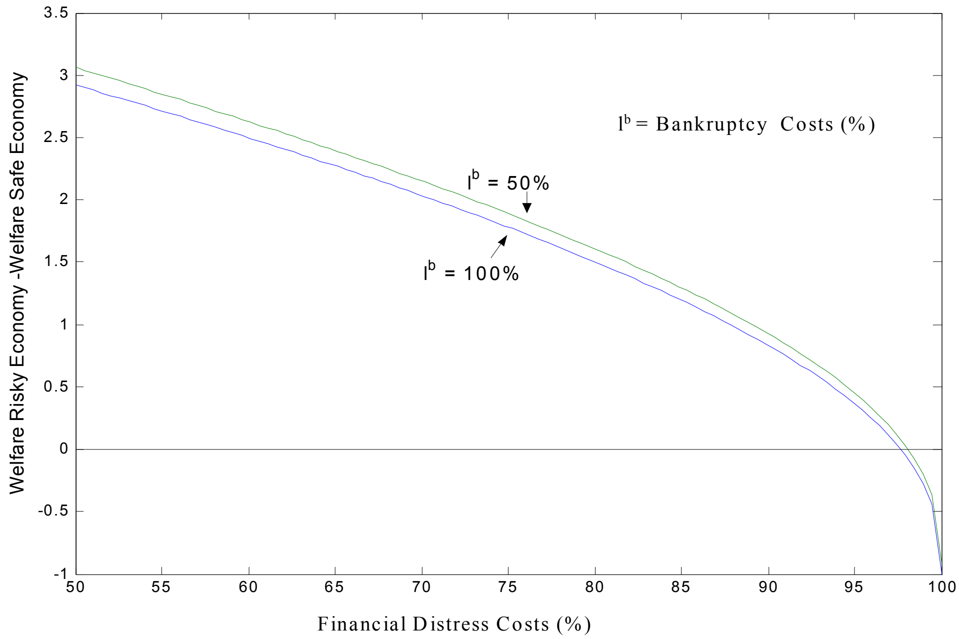
Using the market clearing condition $\alpha y_t = [1-\phi_t]p_t q_t$:

$$W^r = E_0 \sum_{t=0}^{\infty} \delta^t k_t y_t, \;\; k_t = \begin{cases} k^c := 1 - \frac{\alpha[1-\mu-\mu_w]}{1-\phi^c} & \text{if } t = \tau_i \\ 1 & \text{otherwise,} \end{cases} \tag{18}$$

Computing the limit distribution of $k_t y_t$, we have

$$W^r = \frac{1+\delta(1-u)\left[\theta\phi^l \frac{1-\phi^c}{1-\phi^l}\right]^\alpha k^c}{1-\left[\theta\phi^l\right]^\alpha \delta u - \left[\theta^2\phi^l\phi^c\right]^\alpha \delta^2(1-u)}[(1-\phi^l)q_0]^\alpha \tag{19}$$

Figure 1: Social Welfare and Crisis Costs



parameters : $\theta = 1.65$ $\alpha = 0.35$ $h = 0.76$ $1 - \beta = 0.2$ $1 - u = 5\%$

Proposition 5 (Social Welfare) *If crises are rare events and the costs of crises* (β/μ, $(1-\beta)/\mu_w$) *are small, then ex-ante social welfare in a risky economy is greater than in a safe economy if and only if there is a bottleneck* ($\phi^s < \phi^{po}$).

Welfare Analysis

- N-sector investment <Pareto Optimal Level of Investment => *Bottleneck*

- Welfare: Expected discounted sum of consumptions of consumers and risk-neutral entrepreneurs

$$E(W^r) - W^s - E(bailout\_\cos ts)$$

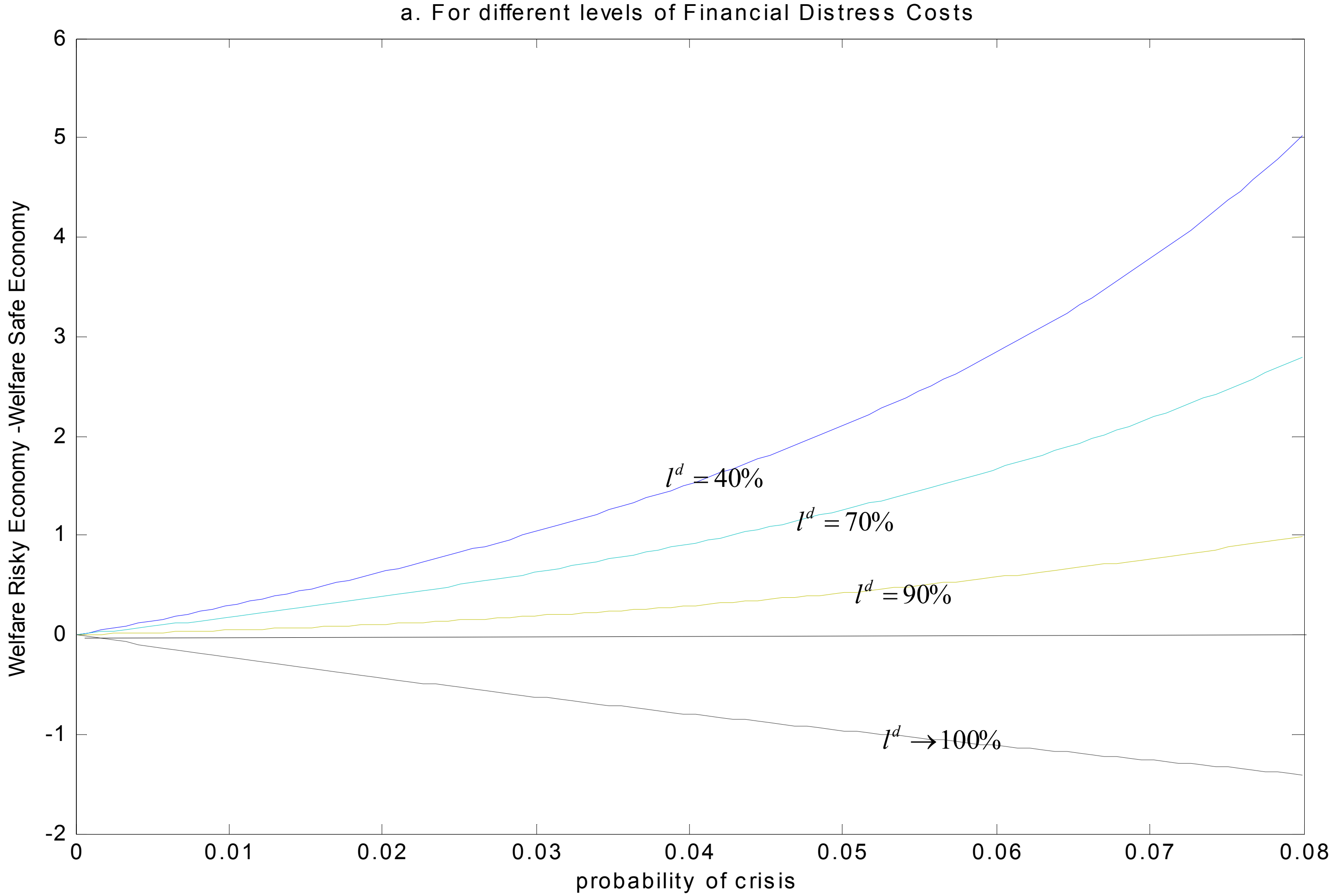
- proposition :If crisis are rare events and crises cost are not too large there are social welfare gains if and only if there is a bottleneck

- Consequences of two CMIs: Imperfect Contract Enfoceability Systemic Bailout Guarantees

- Will the non constrained T-sector be willing to pay the fiscal cost bailout? yes if the share of N-goods in T-production is large enough.

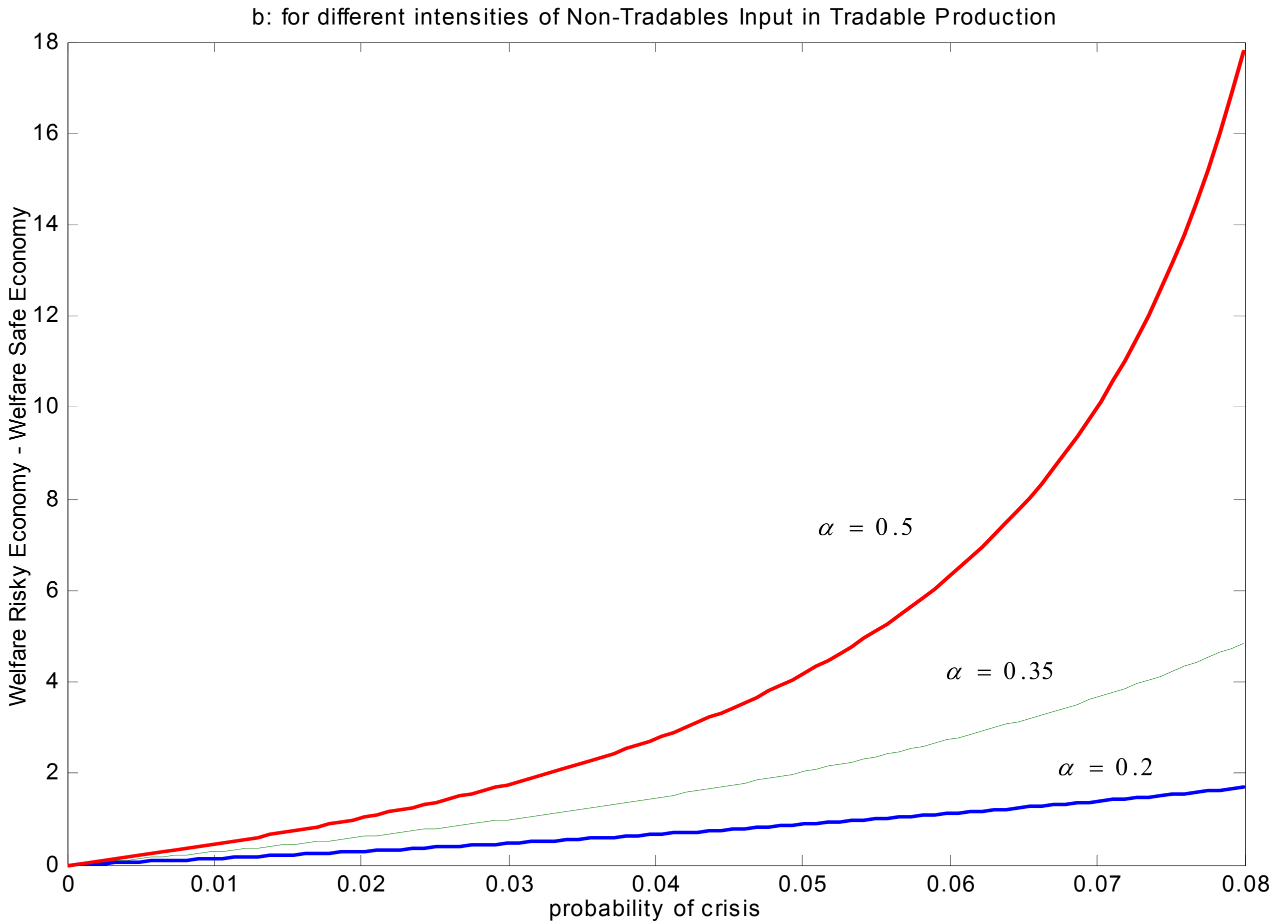
- Bail-Out => a *redistribution* from the unconstrained to the constrained sector for their mutual benefits

Social Welfare Gains and Credit Risk (I)



$$parameters \quad : \theta = 1.65 \quad \alpha = 0.35 \quad h = 0.76 \quad 1 - \beta = 0.2 \quad l^b = 70\%$$

Social Welfare Gains and Credit Risk (II)



$parameters \quad : \theta = 1.65 \quad h = 0.76 \quad 1 - \beta = 0.2 \quad l^d = l^b = 70\%$