Credit Cycles and Capital Flows
Hotelling Lecture
at African Econometric Society Meeting

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Introduction

How do shock to technology and wealth distribution generate large fluctuations in aggregate output and asset prices?
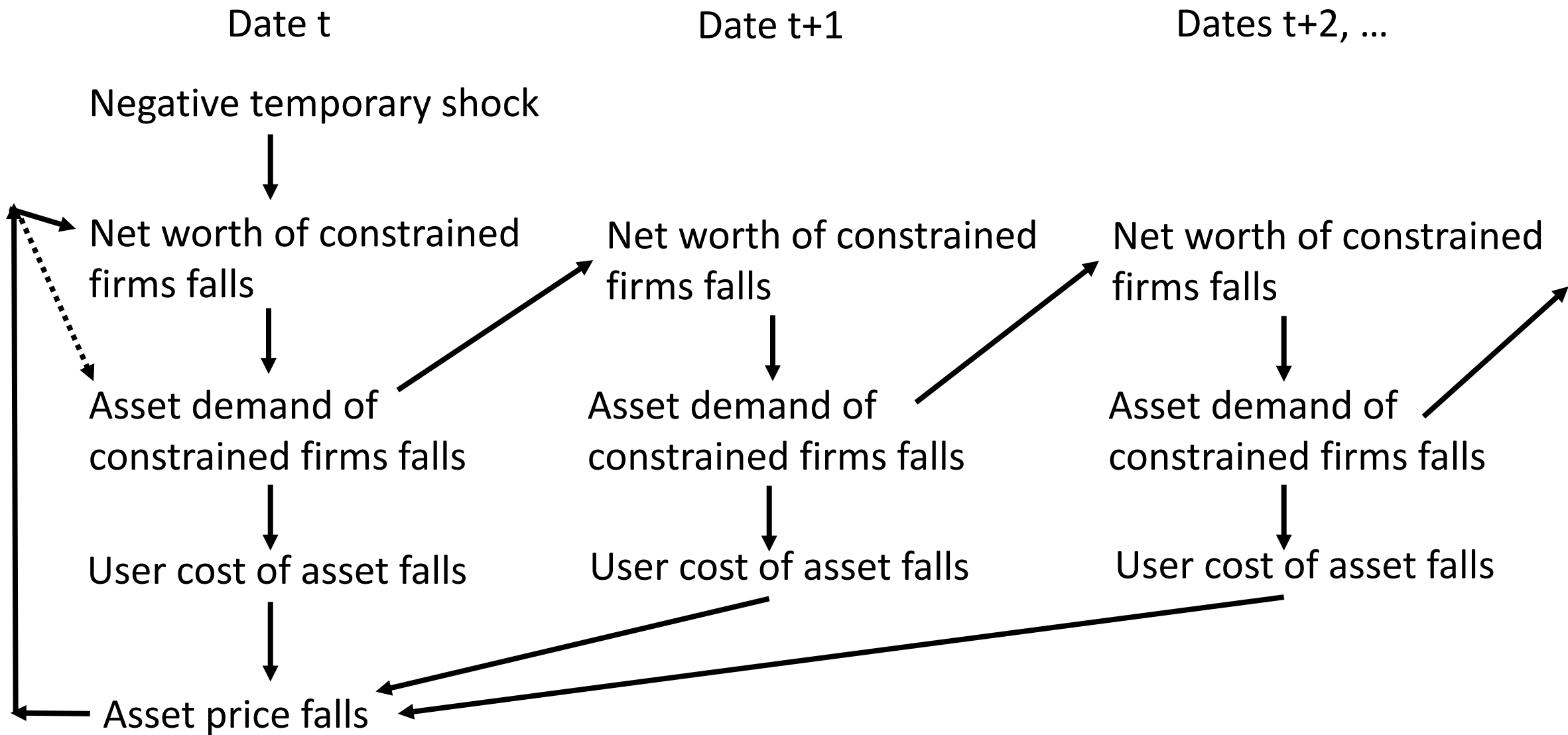
propagation

persistence

co-movement between output and asset value

co-movement across sectors

co-movement between output and productivity

Date t	Date t+1	Dates t+2, ...

Negative temporary shock

Net worth of constrained firms falls

Net worth of constrained firms falls

Net worth of constrained firms falls

Asset demand of constrained firms falls

Asset demand of constrained firms falls

Asset demand of constrained firms falls

User cost of asset falls

User cost of asset falls

User cost of asset falls

Asset price falls

Basic Model

One homogeneous goods and land (fixed supply of $\overline{K}$)

Farmers and gatherers with population size $1:1$

Preference

$$\text{farmer} \; : \; E_0 \left[\Sigma_{t=0}^{\infty} \beta^t x_t \right]$$

$$\text{gatherer} \; : \; E_0 \left[\Sigma_{t=0}^{\infty} R^{-t} \, x_t' \right], \quad 1 < R < \frac{1}{\beta} \qquad \text{(A1)}$$

Output of farmer

$$y_{t+1} \; = \; F(k_t) = (a+c)k_t, \text{ where}$$

$$c \; > \; \left(\frac{1}{\beta} - 1 \right) a \; : \;\; \text{nontradeable} \qquad \text{(A2)}$$

Limited commitment:

only farmer who starts the production can get full output

farmer cannot precommit to finish $\rightarrow$ credit constraint

$$Rb_t \leq q_{t+1}k_t \qquad (1)$$

Flow-of-funds

$$q_t(k_t - k_{t-1}) + Rb_{t-1} + x_t - ck_{t-1} = ak_{t-1} + b_t \qquad (2)$$

$$x_t \geq ck_{t-1} \qquad (3)$$

Gather's production

$$y'_{t+1} = G(k'_t), \text{ where}$$

$$G'(k) > 0, G''(k) < 0, G'(0) > aR > G'(\overline{K})$$

flow-of-funds

$$q_t(k'_t - k'_{t-1}) + Rb'_{t-1} + x'_t = G(k'_{t-1}) + b'_t$$

Equilibrium: Because of $(A1, A2)$, we guess

$$Rb_t = q_{t+1}k_t$$
$$x_t = ck_{t-1}$$

$$q_t(k_t - k_{t-1}) + Rb_{t-1} = ak_{t-1} + \frac{1}{R}q_{t+1}k_t, \text{ or}$$

$$K_t = \frac{1}{q_t - \frac{1}{R}q_{t+1}}[(a + q_t)K_{t-1} - RB_{t-1}] \qquad (4)$$

$$B_t = \frac{1}{R}q_{t+1}K_t \qquad (5)$$

$$u_t = q_t - \frac{1}{R}q_{t+1} = \frac{1}{R}G'\left(\overline{K} - K_t\right) \equiv u(K_t) \qquad (6)$$

$$\underset{s \to \infty}{Lim}E_t\left(R^{-s}\,q_{t+s}\right) = 0 \qquad (7)$$

Steady state

$$\frac{R-1}{R}q^* = u^* = a$$

$$\frac{1}{R}G'\left(\overline{K} - K^*\right) \equiv u^*$$

$$B^* = \frac{1}{R}q^*K^*$$
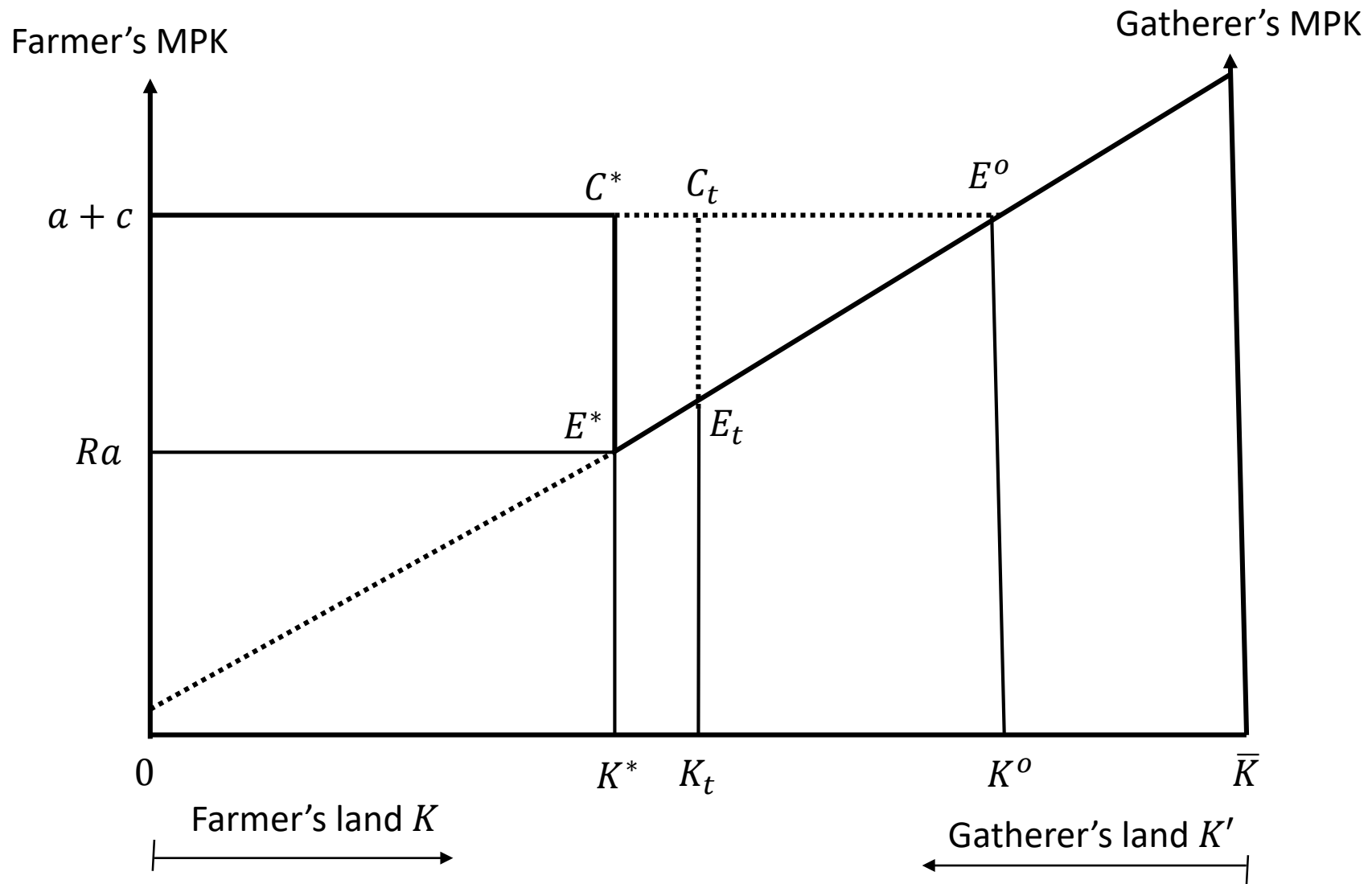
Verify the guess: Three strategies to use a unit fund:

(i) invest now: $U\left(0, \frac{c}{u_t}, \frac{a}{u_t}\frac{c}{u_{t+1}}, \frac{a}{u_t}\frac{a}{u_{t+1}}\frac{c}{u_{t+2}}, \ldots\right) = \frac{\beta}{1-\beta}\frac{c}{a}$

(ii) save&invest: $U\left(0, 0, \frac{Rc}{u_{t+1}}, \frac{Ra}{u_{t+1}}\frac{c}{u_{t+2}}, \frac{Ra}{u_{t+1}}\frac{a}{u_{t+2}}\frac{c}{u_{t+3}}, \ldots\right) = \frac{\beta^2 R}{1-\beta}\frac{c}{a}$

(iii) consume now: $U\left(1, 0, 0, \ldots\right) = 1$

$(A1) \leftrightarrow (i) \succ (ii),\ (A2) \leftrightarrow (i) \succ (iii)$

Land Allocation in Steady State

Economy was at the steady state at date t-1

Unanticipatedly, at date t, $a_t = (1 + \Delta)a$, once for all

$$u(K_t)K_t = [(1 + \Delta)a + q_t - q^*]K^* \qquad (8)$$

$$u(K_{t+s})K_{t+s} = aK_{t+s-1} \text{ for } s \geq 1 \qquad (9)$$

$$q_t = \sum_{s=0}^{\infty} R^{-s} \, u(K_{t+s}) \qquad (10)$$

Asset demand of credit constrained firm depends upon the net worth $\longrightarrow$ history dependent $\longrightarrow$ persistence

Asset market is forward looking $\longrightarrow$ anticipating persistent effect of the shock, the asset price moves significantly

$\longrightarrow$ persistence and amplification re-enforce each other

$+$ Balance sheet of the constrained firms has leverage

$\longrightarrow$ large propagation

Capital Flows and Vulnerability

After liberalizing international transaction of financial assets, many countries experience large swings in capital flows, asset prices, and aggregate production.
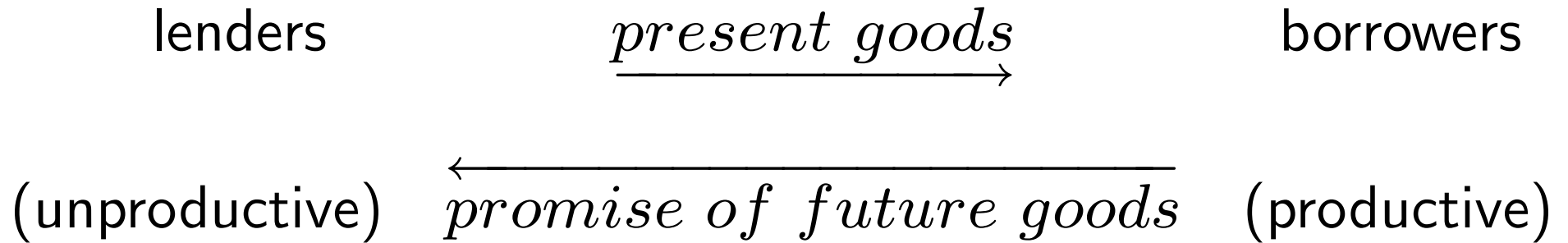
e.g. Latin America since 1970s, Nordic countries in the late 80s and early 90s, East Asia in the 90s

Prasad-Rogoff-Wei-Kose (2003), Obstfeld-Taylor (2004): No robust relationship between liberalization and growth. Benefits with strong institution, and costs bigger with weak institution

How does the adjustment to capital account liberalization depend upon the development of domestic financial system?

Why may the economy with underdeveloped financial system be vulnerable to shocks to foreign and domestic credits?

Approach:

lenders $\xrightarrow{\quad present\ goods \quad}$ borrowers

(unproductive) $\xleftarrow{\quad promise\ of\ future\ goods \quad}$ (productive)

Borrowers may not keep their promises $\Rightarrow$ use collateral

total assets $>$ collateral for domestic loan

$>$ collateral for international loan

value of fixed assets $\rightleftarrows$ domestic and foreign credits

Model: Open Economy Credit Cycles

A small open economy

One homogeneous goods and land

Many entrepreneurs and foreigners

Preference

$$\text{entrepreneur} \ : \ E_0\left[\Sigma_{t=0}^{\infty}\beta^t \ln c_t\right]$$

$$\text{foreigner} \ : \ E_0\left[\Sigma_{t=0}^{\infty}\left(1/r^*\right)^t c_t\right], \ \ 1 < r^* < \frac{1}{\beta}$$

At date t: Entrepreneur A uses k_t land and m_t material goods to start production

Agent B lends and monitors (lead creditor)

Agent C lends and does not monitor (outside creditors)

At date t+1: output $y_{t+1} = a_t \left(\frac{k_t}{\kappa}\right)^{\kappa} \left(\frac{m_t}{1-\kappa}\right)^{1-\kappa} = a_t F(k_t, m_t)$ if A finishes

$$y_{t+1} = \theta a_t F(k_t, m_t), \text{ if B finishes}$$

$$y_{t+1} = 0, \text{ if C finishes}$$

Only single home agent can be the monitor of each segment of project

Productivity of each entrepreneur:

$$a_t = \begin{cases} \alpha, & \text{if the entrepreneur is productive} \\ \gamma, & \text{if he is unproductive} \end{cases}$$

Idiosyncratic productivity transition:

$$\text{Prob}\left(a_{t+1} = \gamma \mid a_t = \alpha\right) = \delta, \ \text{Prob}\left(a_{t+1} = \alpha \mid a_t = \gamma\right) = n\delta$$

In Competitive Economy, the entrepreneur (borrower) can walk away from production and debt. No reputation

$\Rightarrow$ Fixed asset (land) becomes collateral for domestic and foreign resalable credits

θ fraction of output from the present project becomes collateral for domestic bilateral credit

Each entrepreneur takes prices (q_t, r_t, r^*) and initial net worth as given, and chooses quantities $(c_t, k_t, m_t, y_{t+1}, b_{t+1}, b^*_{t+1})$, subject to the flow-of-funds constraint:

$$c_t \;+\; q_t\left(k_t - k_{t-1}\right) + m_t = y_t - b_t - b^*_t \;+\; \frac{b_{t+1}}{r_t} + \frac{b^*_{t+1}}{r^*}$$

and the international and domestic borrowing constraints:

$$b^*_{t+1} \;\leq\; q_{t+1}k_t$$
$$b_{t+1} + b^*_{t+1} \;\leq\; \theta y_{t+1} + q_{t+1}k_t$$

The markets clear for goods, land, and domestic and international credits

θ and κ : parameter of domestic financial development

Equilibrium: $\left(q_t, u_t, r_t, K_t, K_t', M_t, M_t', Z_t, s_t, x_t, Z_{t+1}, s_{t+1}\right)$ that satisfies

(1) $u_t = q_t - q_{t+1}/r^*$

(2) $u_t K_t : M_t = \kappa : 1 - \kappa = u_t K_t' : M_t'$: factor demand

(3) $K_t + K_t' = \overline{K}$: land market

(4) $\gamma/u_t^\kappa \leq r_t$: unproductive entrepreneur, $=$ holds if $K_t' > 0$

(5) $u_t K_t + M_t \leq \frac{\beta s_t Z_t}{1-(\theta\alpha/r_t u_t^\kappa)}$, $=$ holds if $\alpha/u_t^\kappa > r_t$

(6) $Z_t = Y_t + Y_t' + q_t \overline{K} - B_t^* - B_t^{*\prime}$: total wealth

(7) s_t : share of net worth of productive

(8) $u_t \overline{K} + M_t + M'_t \leq \beta Z_t,\ =$ holds if $r_t > r^*$

(9) $x_t = \left[\dfrac{1-\theta}{(u_t^\kappa/\alpha)-(\theta/r_t)} - r_t \right] / r_t$: excess rate of return of productive

(10) $Z_{t+1} = r_t \left(1 + x_t s_t \right) \beta Z_t$

(11) $s_{t+1} = \dfrac{(1-\delta)(1+x_t)s_t + n\delta(1-s_t)}{1+s_t x_t} \equiv f\left(s_t, x_t \right)$

- Under financial autarky, if domestic borrowing constraint is tight $\theta < \overline{\theta}(\kappa)$, then the unproductive entrepreneurs produce themselves.

$$\overline{\theta}'(\kappa) < 0$$

- For numerical examples, we use full model with labor:

$$y_{t+1} \leq a_t \left(\frac{k_t}{\kappa}\right)^\kappa \left(\frac{l_t}{\lambda}\right)^\lambda \left(\frac{m_t}{1-\kappa-\lambda}\right)^{1-\kappa-\lambda}$$

$$L_t^s = \overline{L} w_t^\eta$$

$\beta = 0.92$, $\kappa = 0.03$, $\lambda = 0.12$, $\alpha = 1.1$, $\gamma = 1.05$, $\delta = 0.15$, $n = 0.1$, $\eta = 3$

Figure 1: Steady-state interest rate under autarky

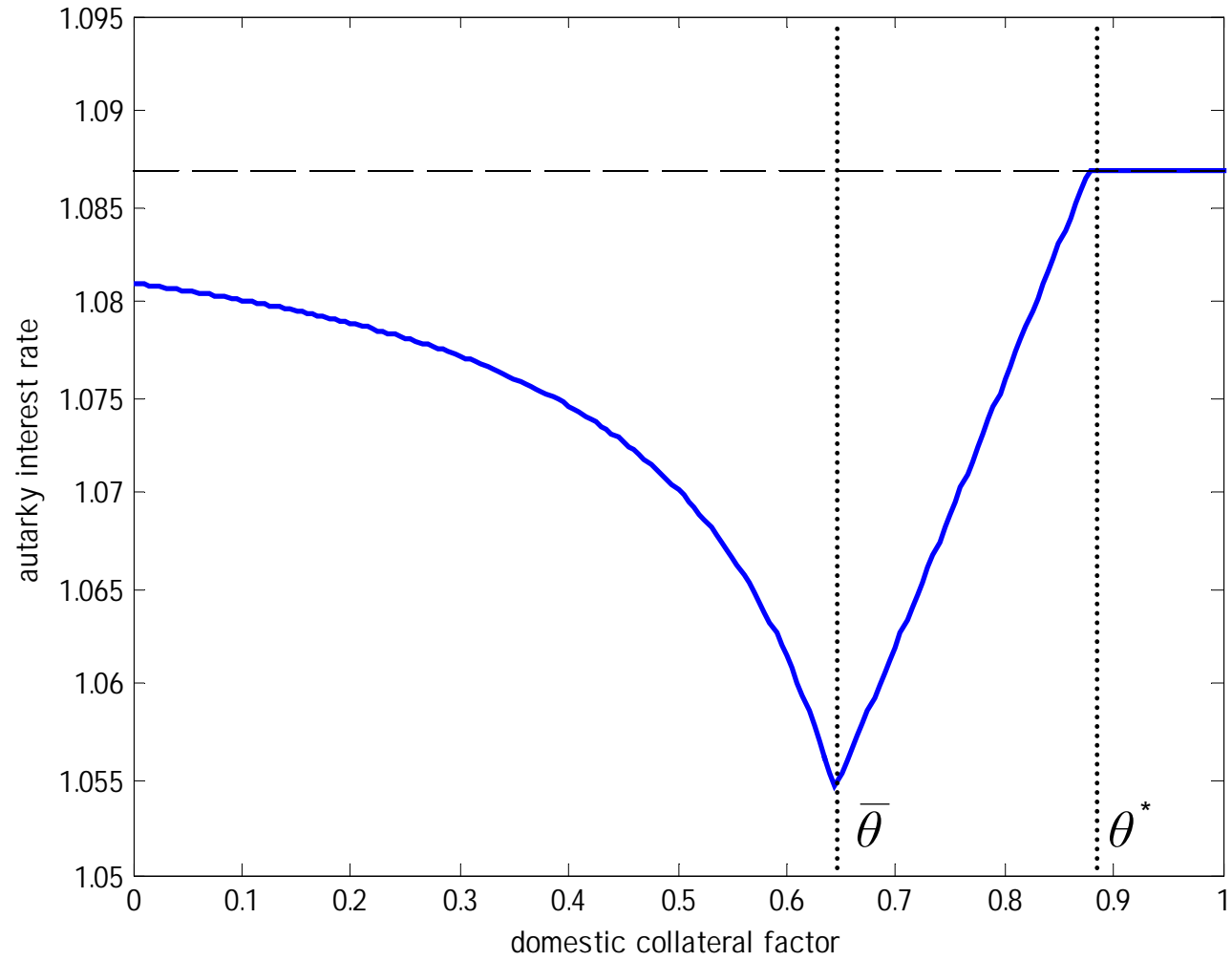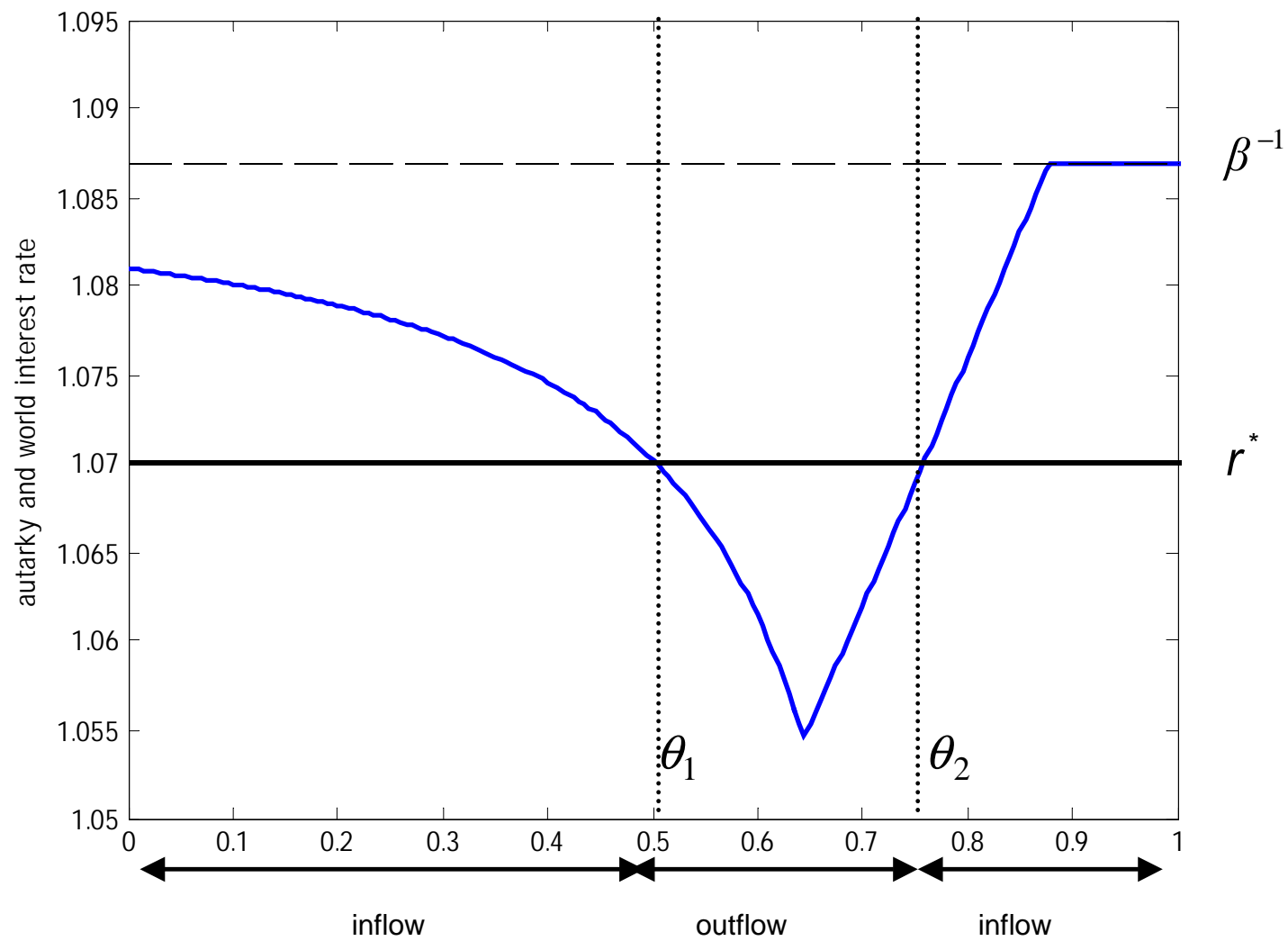# Figure 2: Capital flows after liberalisation

Capital Account Liberalization

- Region I, $\theta < \theta_1$: Factor price suppression

Before liberalization, $r^A > r^*$ $\Rightarrow$ liberalization causes capital inflow

$$\text{unproductive} \quad \rightarrow \quad \text{productive}$$

$$\uparrow \qquad \nearrow$$

$$\text{foreigners}$$

$\Rightarrow$ initial boom with land price hike and credit expansion

$\Rightarrow$ boom is not sustainable

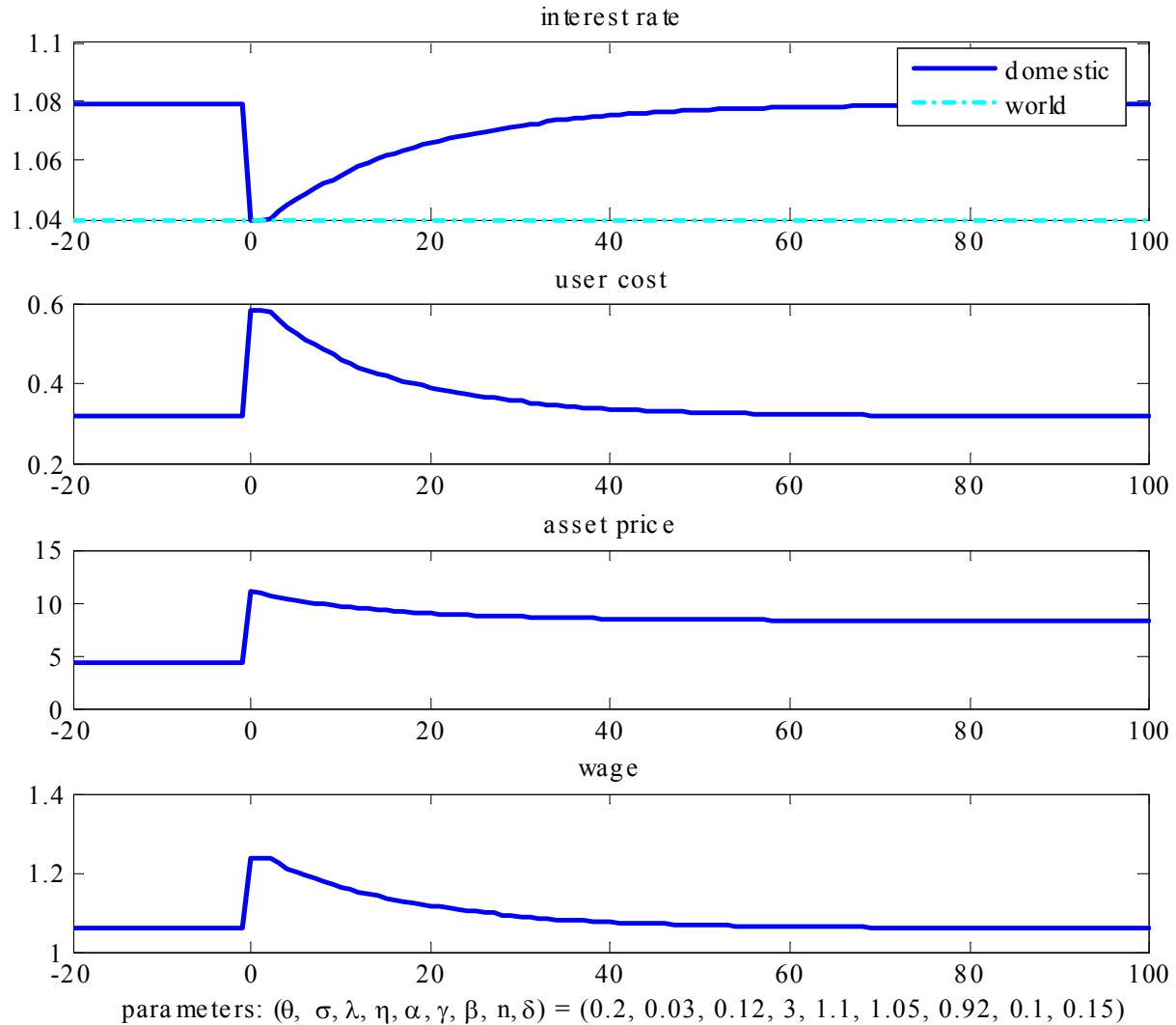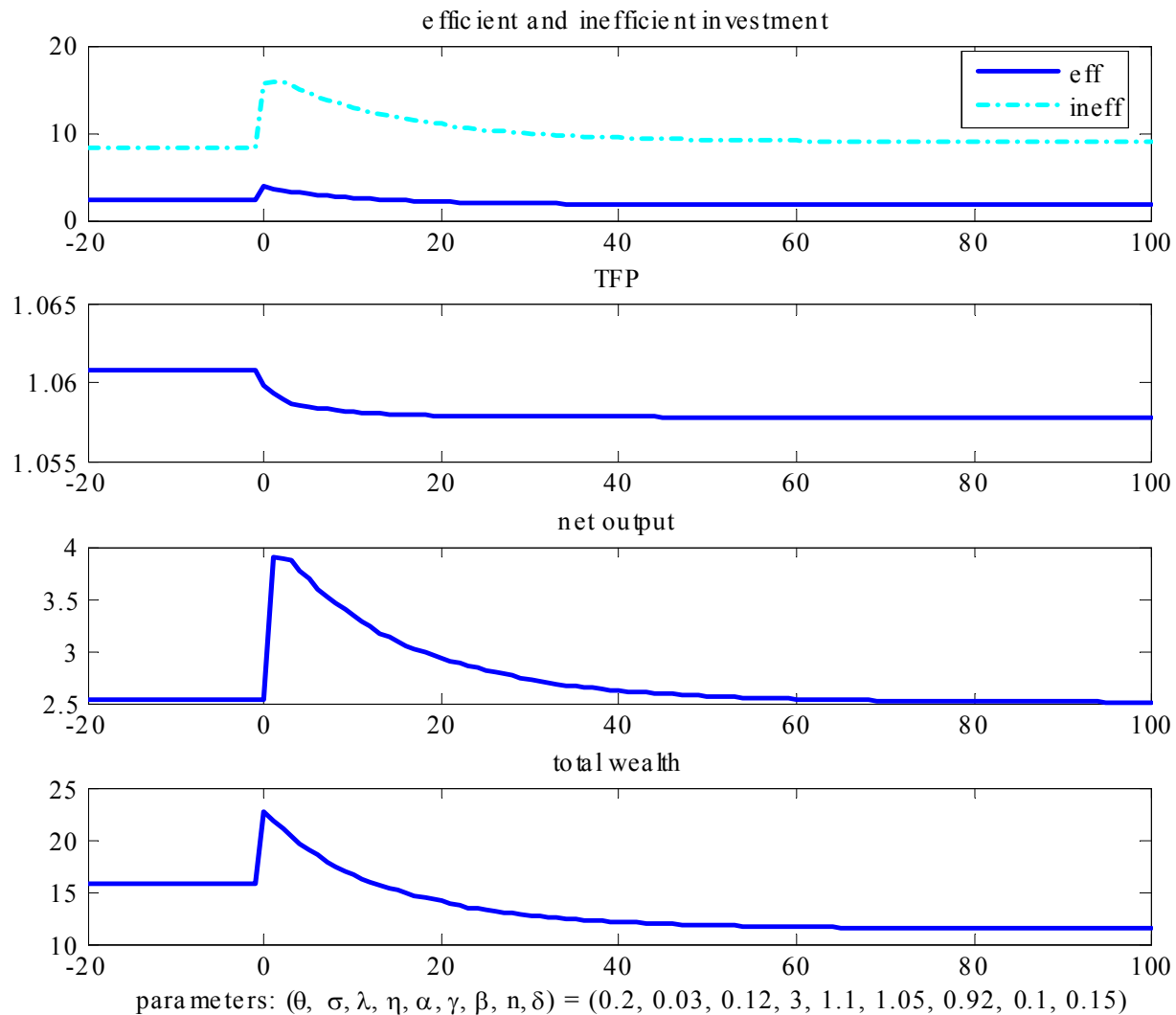Figure 3-1: dynamics after liberalisation: capital inflow (low theta)

interest rate

domestic
world

user cost

asset price

wage

parameters: $(\theta, \sigma, \lambda, \eta, \alpha, \gamma, \beta, n, \delta) = (0.2, 0.03, 0.12, 3, 1.1, 1.05, 0.92, 0.1, 0.15)$

Figure 3-2: dynamics after liberalisation: capital inflow (low theta)

efficient and inefficient investment

TFP

net output

total wealth

parameters: $(\theta, \sigma, \lambda, \eta, \alpha, \gamma, \beta, n, \delta) = (0.2, 0.03, 0.12, 3, 1.1, 1.05, 0.92, 0.1, 0.15)$

- Region II, $\theta_1 < \theta < \theta_2$: Interest rate suppression

Before liberalization, $r^A < r^* \Rightarrow$ liberalization causes capital outflow

$$\text{unproductive} \quad \longrightarrow \quad \text{productive}$$

$$\searrow$$

$$\text{foreigners}$$

$\Rightarrow$ land price, credit, TFP and output decrease initially

$\Rightarrow$ international capital market act as "catalyst"

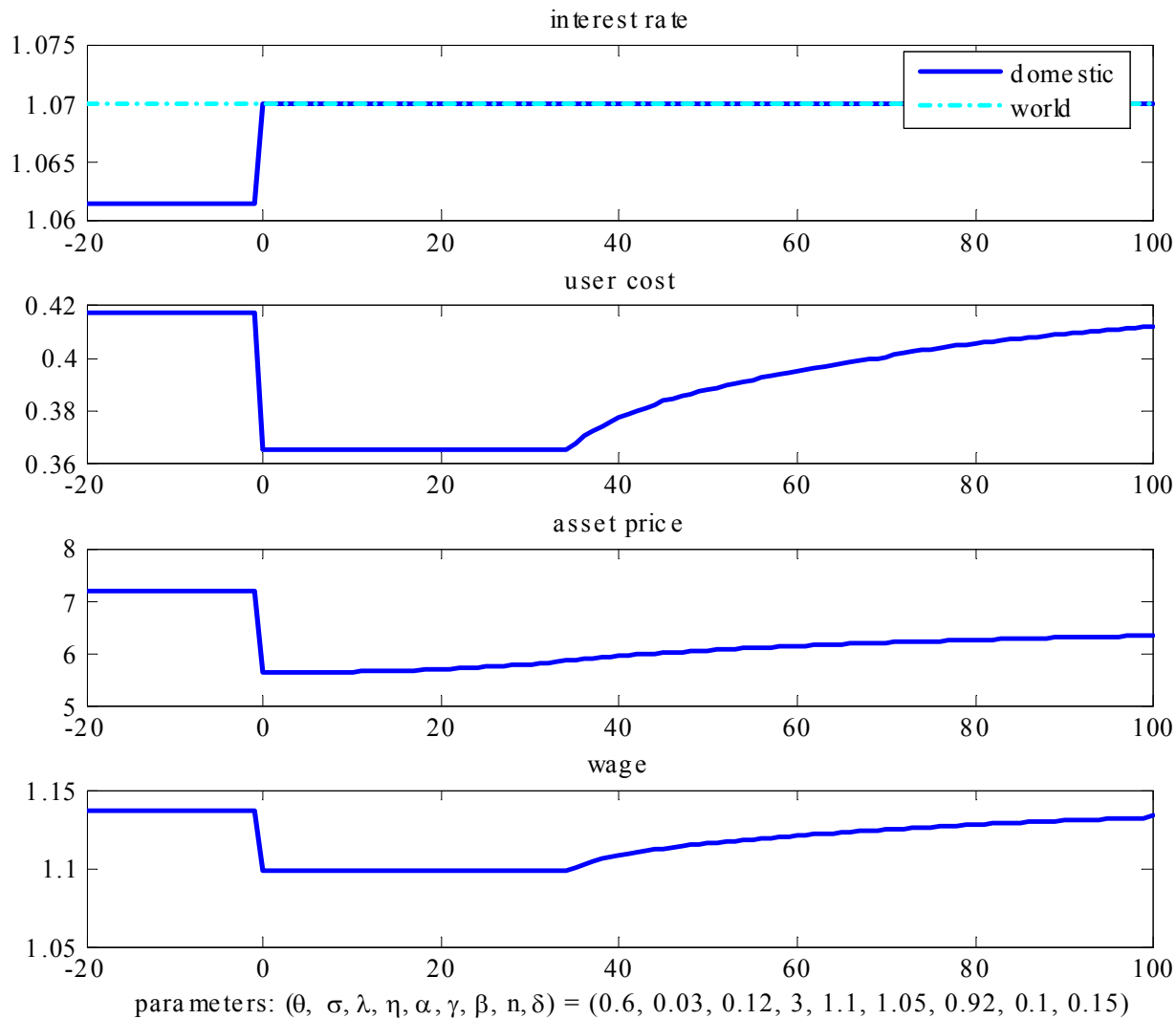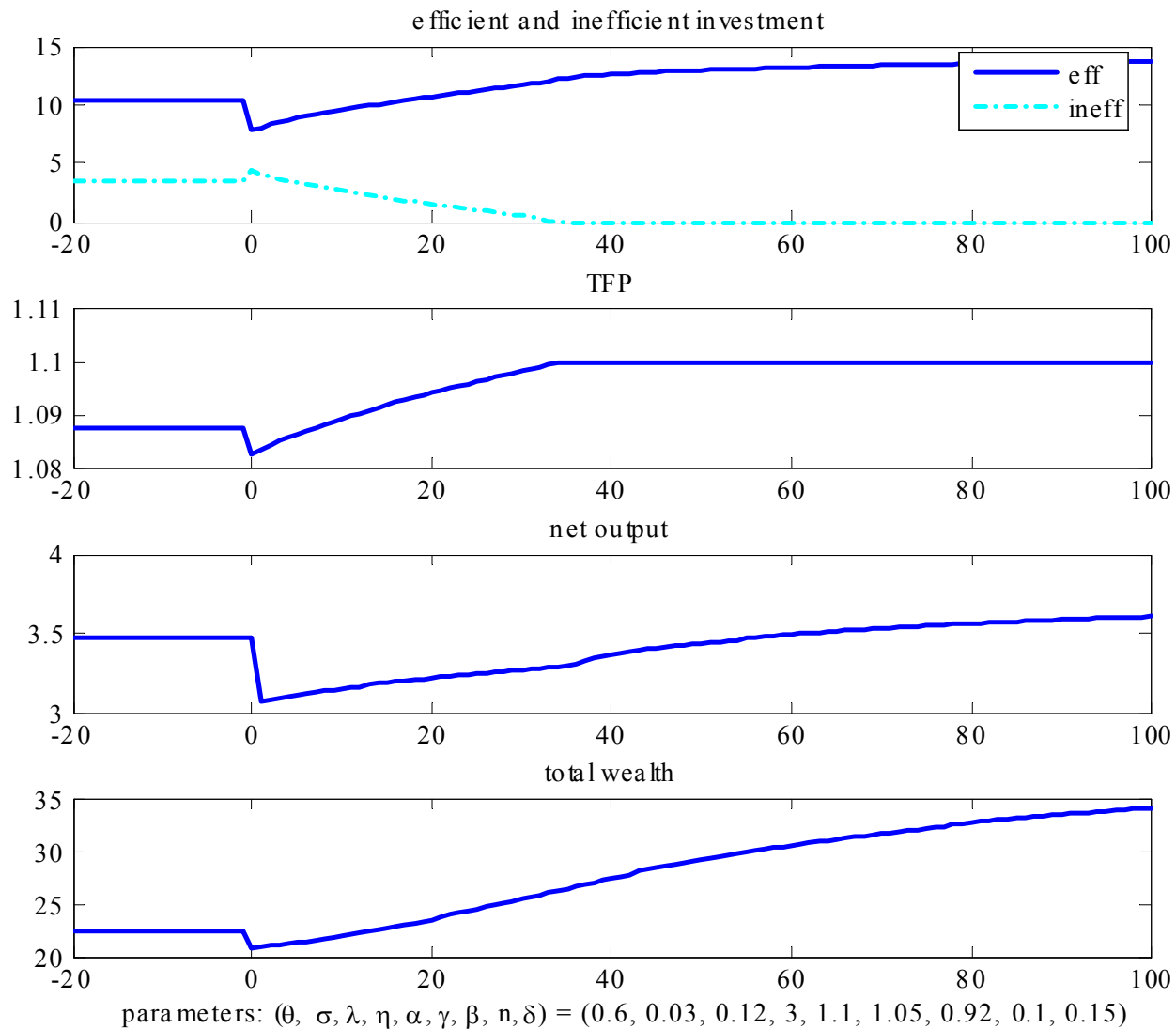Figure 5-1: dynamics after liberalisation: capital outflow

interest rate

— domestic
—·— world

user cost

asset price

wage

parameters: (θ, σ, λ, η, α, γ, β, n, δ) = (0.6, 0.03, 0.12, 3, 1.1, 1.05, 0.92, 0.1, 0.15)

Figure 5-2: dynamics after liberalisation: capital outlow

efficient and inefficient investment

TFP

net output

total wealth

parameters: $(\theta, \sigma, \lambda, \eta, \alpha, \gamma, \beta, n, \delta) = (0.6, 0.03, 0.12, 3, 1.1, 1.05, 0.92, 0.1, 0.15)$

- Region III, $\theta > \theta_2$: More advanced financial system

Before liberalization, $r^A > r^*$ $\Rightarrow$ liberalization causes capital inflow

$$\text{unproductive} \quad \longrightarrow \quad \text{productive}$$

$$\nearrow$$

$$\text{foreigners}$$

$\Rightarrow$ boom with land price hike and credit expansion

$\Rightarrow$ boom is sustainable

- Welfare

$$c_t \;=\; (1-\beta)z_t = (1-\beta)\beta^{t-1}\tilde{r}_0\tilde{r}_1\cdots\tilde{r}_{t-1}z_0$$

$$\text{entrepreneurs} \;:\quad E_0\left[\Sigma_{t=0}^{\infty}\beta^t \ln c_t\right]$$

$$\text{workers} \;:\quad E_0\left[\Sigma_{t=0}^{\infty}\beta^t(c_t - v(l_t))\right]$$

	P's z	P's $\tilde{r}$	P's EU	U's z	U's $\tilde{r}$	U's EU	Worker
Region I	0.53	-0.27	0.27	0.32	-0.27	0.05	5.14
Region II	-0.30	0.09	-0.20	-0.02	0.09	0.07	-0.12

Shocks to foreign and domestic credits in Region I

- Foreign interest rate rises

$\Rightarrow$ land price falls

$\Rightarrow$ domestic and foreign credit contract

$\Rightarrow$ domestic interest rate rises more than foreign rate

$\Rightarrow$ TFP and output decrease initially

$\Longrightarrow$ share of net worth of productive agents will recover

$\Longrightarrow$ TFP and output will recover, while land price will not

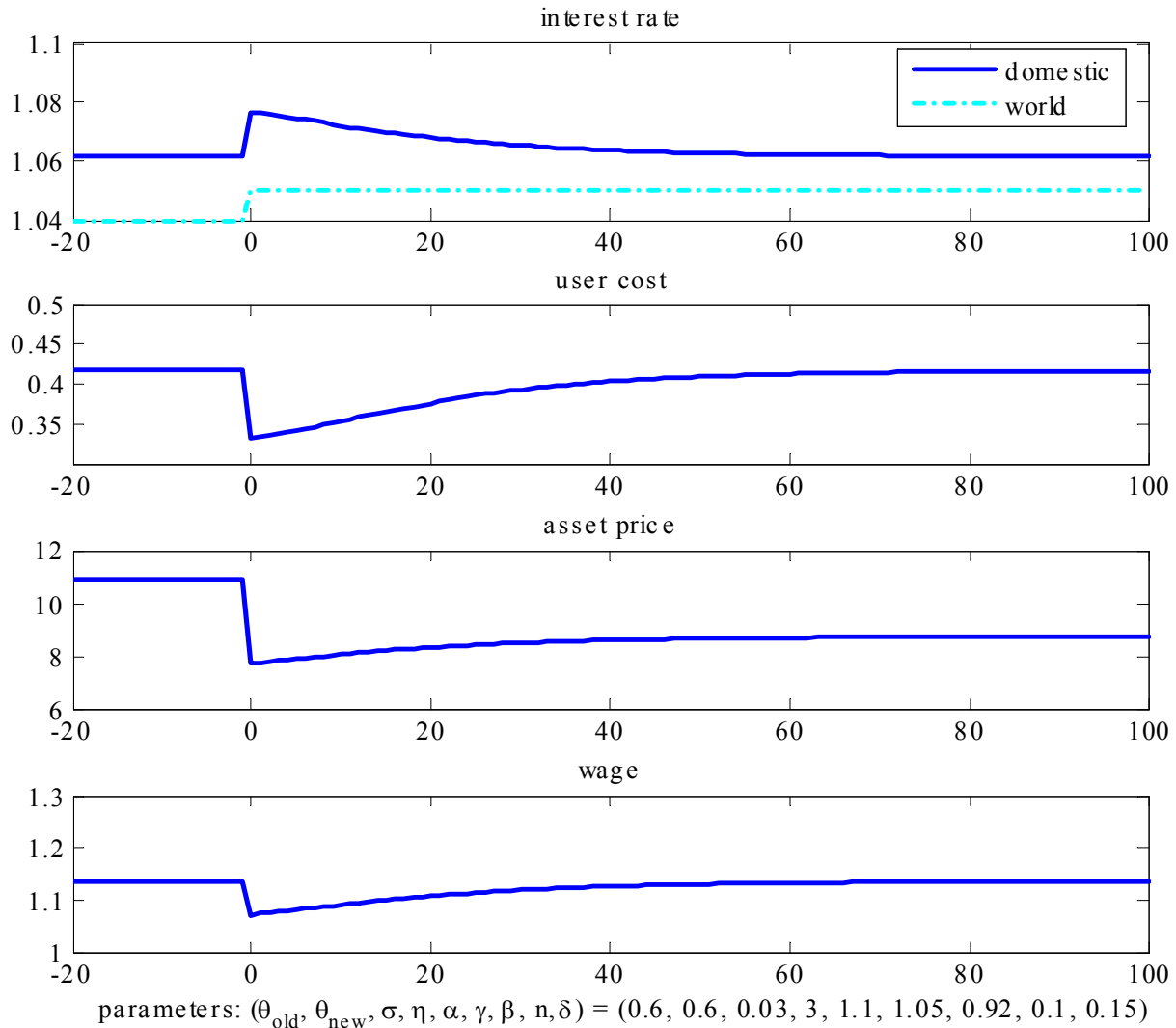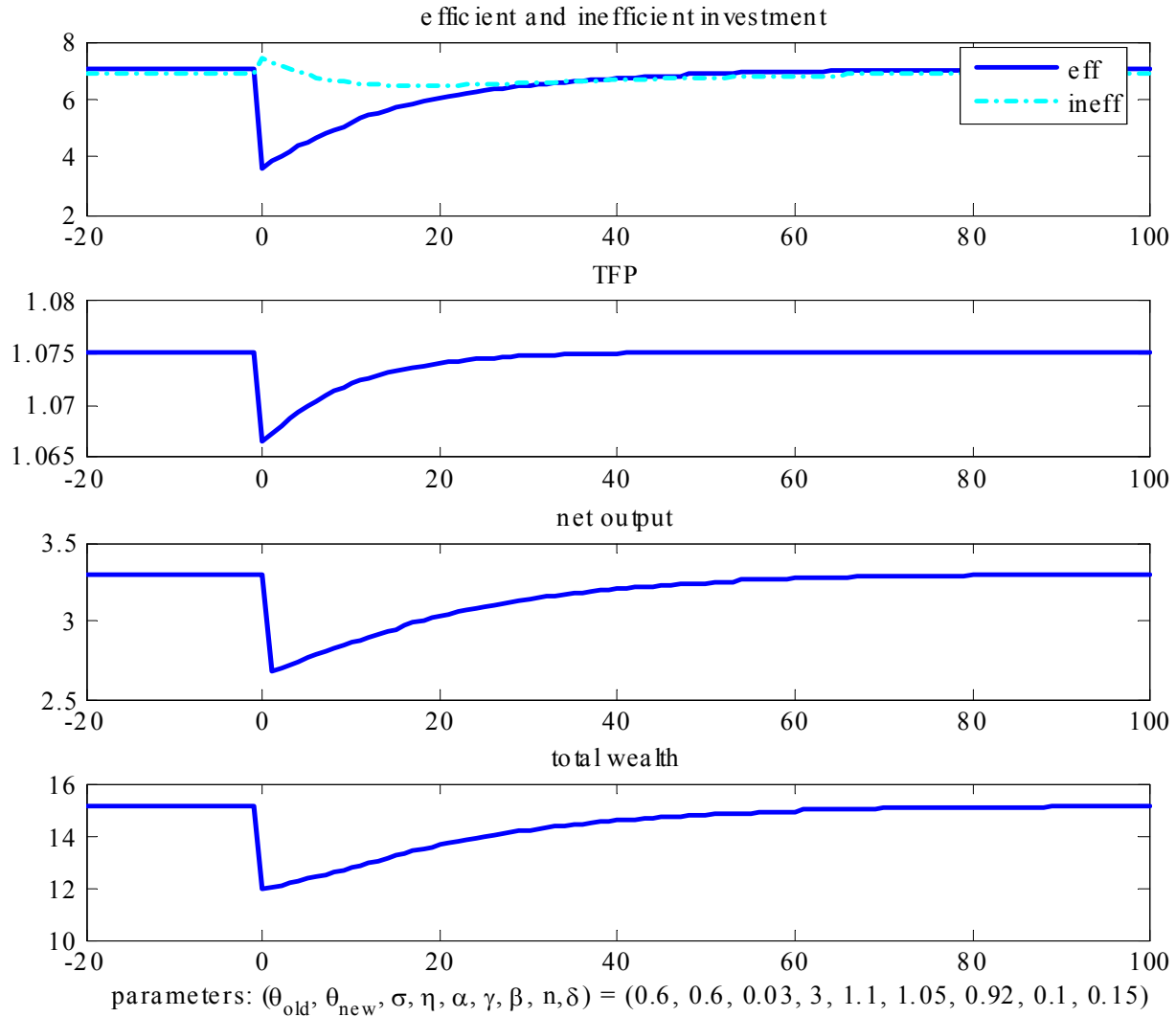Figure 7-1: dynamics after shock to world interest rate

parameters: $(\theta_{old}, \theta_{new}, \sigma, \eta, \alpha, \gamma, \beta, n, \delta) = (0.6, 0.6, 0.03, 3, 1.1, 1.05, 0.92, 0.1, 0.15)$

Figure 7-2: dynamics after shock to world interest rate

efficient and inefficient investment

TFP

net output

total wealth

parameters: $(\theta_{old}, \theta_{new}, \sigma, \eta, \alpha, \gamma, \beta, n, \delta) = (0.6, 0.6, 0.03, 3, 1.1, 1.05, 0.92, 0.1, 0.15)$

- Domestic collateral tightened

$\Rightarrow$ land price falls

$\Rightarrow$ foreign credit tightened (capital outflow)

$\Rightarrow$ TFP and output decrease

$\Longrightarrow$ share of net worth of productive agents will not recover

$\Longrightarrow$ land price, TFP and output continue to stagnate
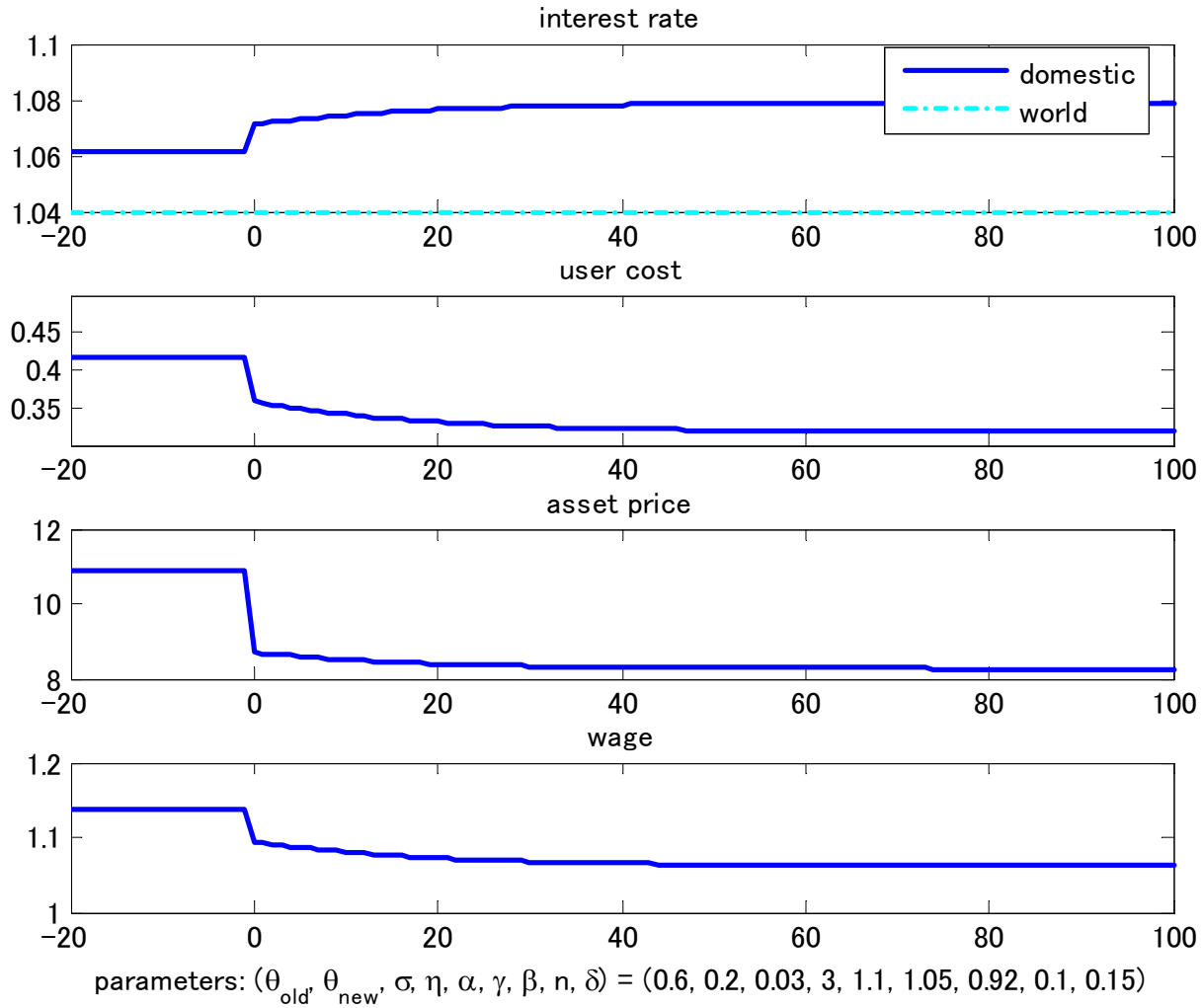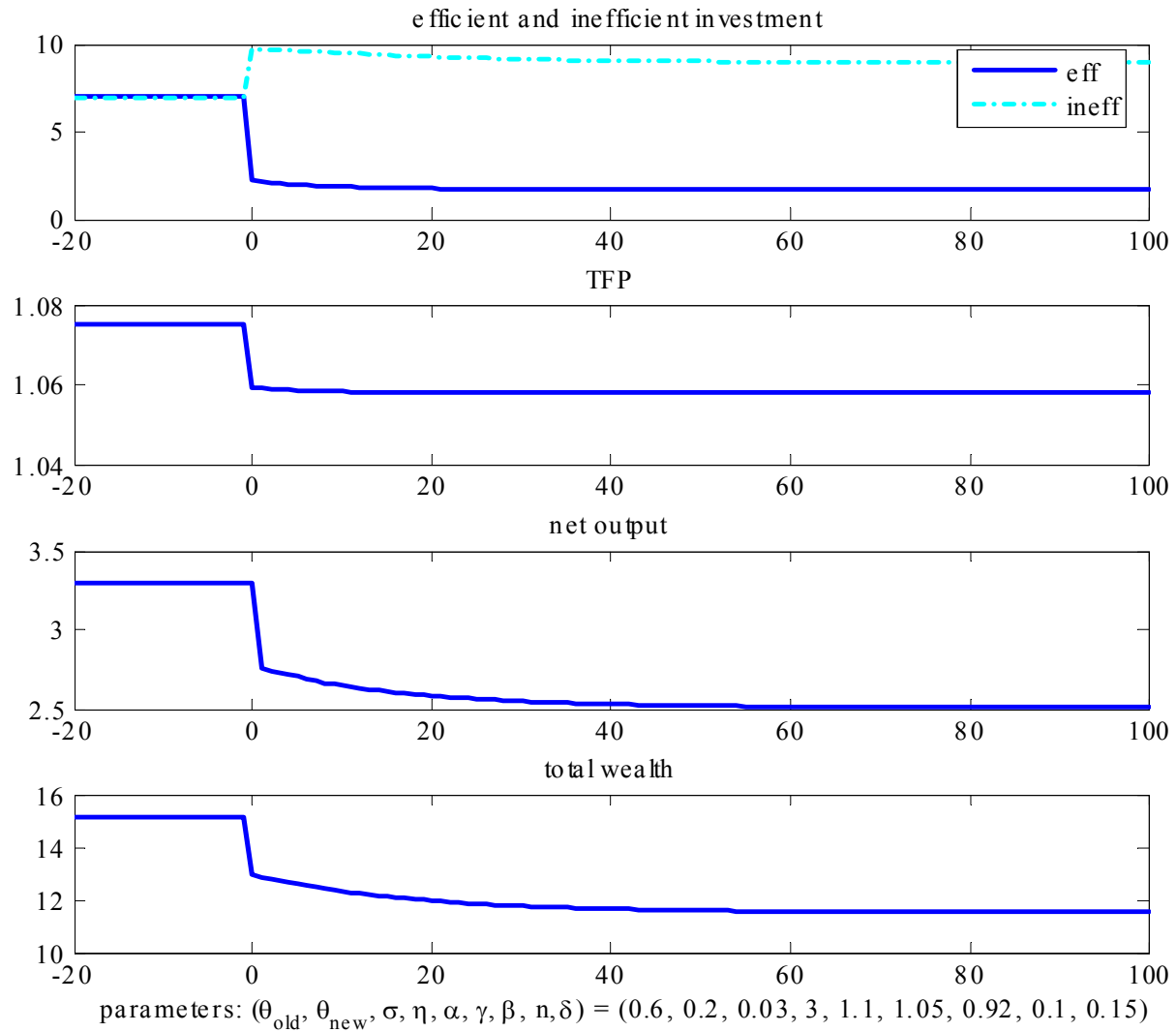
Figure 6-1: dynamics after shock to theta

parameters: $(\theta_{old}, \theta_{new}, \sigma, \eta, \alpha, \gamma, \beta, n, \delta) = (0.6, 0.2, 0.03, 3, 1.1, 1.05, 0.92, 0.1, 0.15)$

Figure 6-2: dynamics after shock to theta

parameters: (θ_{old}, θ_{new}, σ, η, α, γ, β, n, δ) = (0.6, 0.2, 0.03, 3, 1.1, 1.05, 0.92, 0.1, 0.15)

Policy Implications

Before liberalization:

With underdeveloped domestic financial system, unproductive agents produce $\Rightarrow$ low TFP

$\Rightarrow$ low factor price

$\Rightarrow$ low interest rate of savers

After capital account liberalization:

Adjustment depends upon the degree of development of domestic institution relative to the rest of the world

Effect of capital account liberalization on output

	Short-run	Long-run
Domestic collateral\		
Low	*Expansionary*	*Mixed*
Medium	*Contractionary*	*Expansionary*
High	*Expansionary*	*Expansionary*

The economy with low domestic collateral is vulnerable to shocks to domestic and foreign credit

	Short-run	Long-run
foreign interest rate $\Uparrow$	*Contractionary*	*Recovery*
domestic collateral $\Downarrow$	*Contractionary*	*Contractionary*

Empirical Relevance: Integration of Euro Area

Productivity of Souther European countries deteriorated with large capital inflow

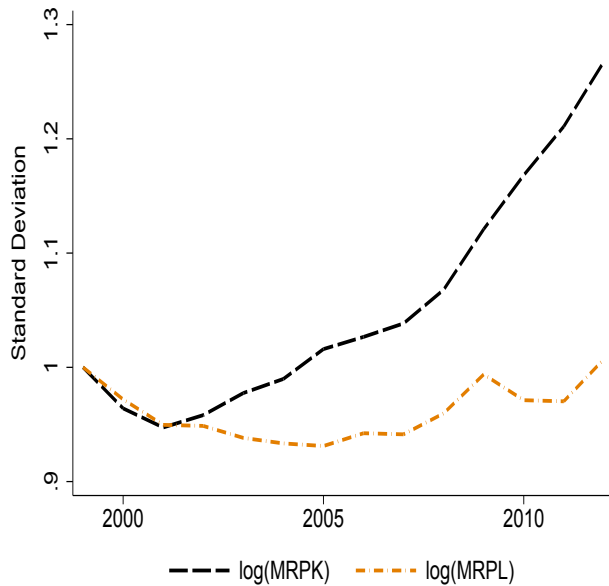 dispersion of marginal revenue productivity of capital expands

  dispersion of total factor revenue productivity (TFPR) expands

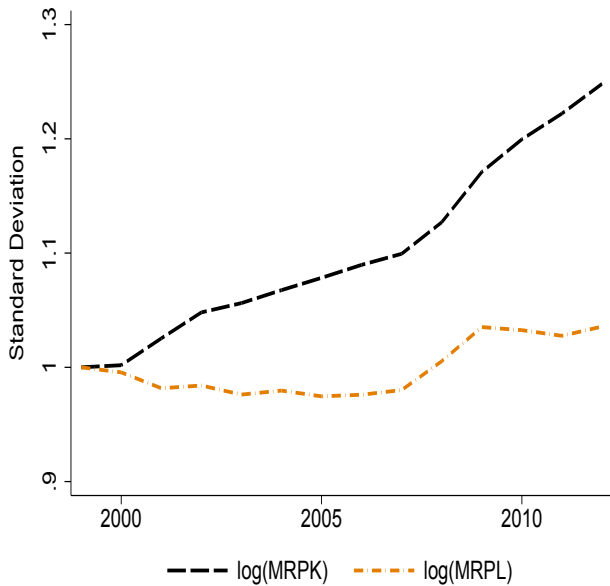 low TFPR firms tend to have larger capital/labor ratio

  $\rightarrow$ aggregate TFP falls relative to efficient level of TFP

Real exchange rates appreciates by 12% during 2000-2007

$\rightarrow$ loose competitiveness

(a) Permanent Sample

(b) Full Sample

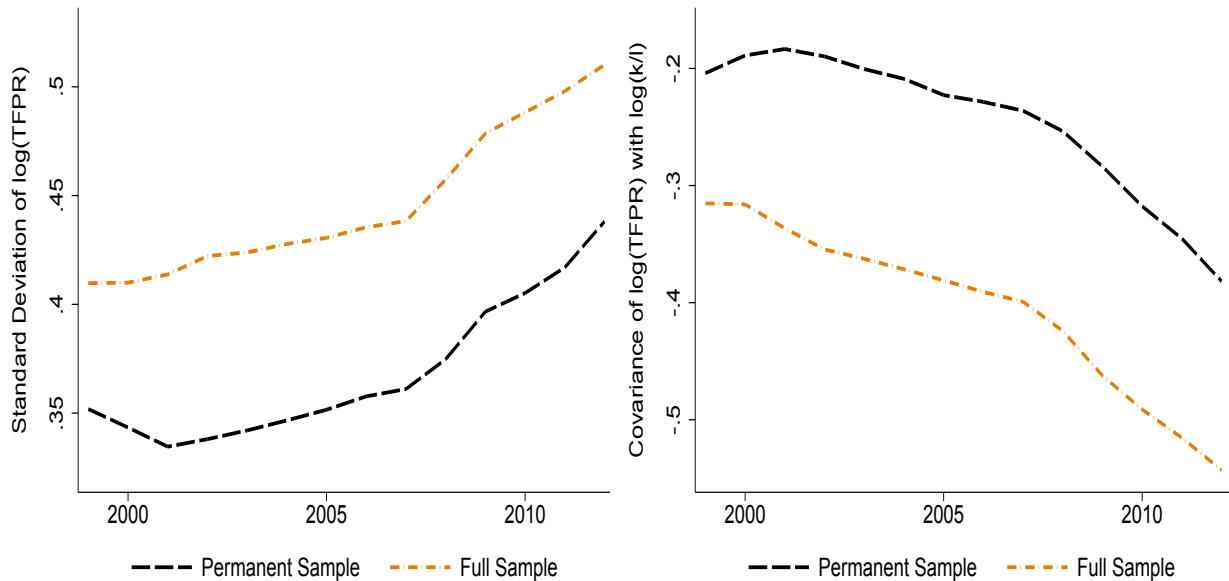Figure 2: Evolution of MRPK and MRPL Dispersion

Figure 3: TFPR Moments