Capital Flows and Asset Prices

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Abstract

After liberalizing international transaction of financial assets, many countries experience large swings in asset prices, capital flows, and aggregate production. This paper studies how the adjustment to capital account liberalization depends upon the degree of development of domestic financial system, and why the economy with underdeveloped financial system may be vulnerable to shocks to the domestic and foreign finance. We construct a model of small open economy in which it is difficult to enforce debtors to repay their debts unless the debts are secured by collateral, and assets usable as collateral for international borrowing are more restricted than domestic borrowing.

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1 Introduction

After liberalizing international transaction of financial assets, many countries experience large swings in the value of fixed assets, the amounts of foreign and domestic credits, and aggregate economic activities. This is true for both industrial and emerging market countries alike. Notable examples in recent decades include Latin America from the late 1970s, the Nordic countries in the late 1980s to the early 1990s, and East Asia from the mid 1990s. The standard theory interprets the liberalization of international financial transaction (capital accounts liberalization) as liberalization of a particular trade - trade between present goods and claims to future goods -, which should bring similar benefits as liberalization of trade of regular goods. These volatile swings, however, raise concerns about the potential costs of capital account liberalization.

In a recent book, Obstfeld and Taylor (2004) analyze the flows and ebbs of international financial transactions since the late nineteenth century, and show that uneven capital account liberalization in the last four decades brought mixed blessings to different countries. Kose, Prasad, Rogoff and Wei (2006) summarize previous theoretical and empirical studies to conclude that there is no robust relationship between capital account liberalization and economic growth, and that the benefits appear to dominate with strong domestic financial institution, while the costs appear to outweigh the benefits with weak institution.[1]

How does the adjustment to capital account liberalization depend upon the degree of development of domestic financial institution? Why may the economy with under-

[1]Peter Henry (2005) argues that capital account liberalization should have beneficial effects to the level of aggregate output, not to the long-run growth rate, and presents evidence for this prediction.

developed financial system be vulnerable to shocks to foreign and domestic finance?

In order to answer these questions theoretically, we single out the possibility of default as a distinguishing feature of financial transaction - trade between present goods and claims to future returns. For the claims to future returns, we focus on private debt or equity, and will not address important related issues of sovereign debts, and government guarantee of private debts, nor international flow of technology and managerial capital (foreign direct investment). With this focus, we construct a model of small open economy in which it is difficult to enforce debtors to repay their debt unless it is secured by the collateral. Entrepreneurs use fixed asset (land) and working capital to produce output in the following period. At each date, some entrepreneurs are productive while others are not. Here, the fixed asset is factor of production as well as collateral for loan. The borrower's credit limit is affected by the price of fixed asset, while the asset price is affected by credit limits. The interaction between credit limits and the asset price turns out to be a propagation mechanism which may generate large swings in aggregate economics activities.

In addition to fixed asset, some fraction of future output becomes collateral for domestic loans, like project finance, or equity. The extent to which future output becomes collateral depends upon both the technology and the quality of institution, which affects the development of domestic financial system. We show that, if the domestic financial system is underdeveloped, it fails to transfer enough purchasing power from savers (typically unproductive entrepreneurs) to investing agents (productive entrepreneurs). Some funds are allocated to unproductive entrepreneurs, with inferior technology, resulting in low total factor productivity (TFP) of the economy. The domestic interest rate earned

by savers remains low - the symptom of financial suppression, and the domestic wage and user cost of fixed asset remain low - the symptom of cost suppression.

Moreover, we consider the extent to which assets and projects become collateral for foreign loan is restricted compared to domestic loans, because the foreign creditors generally have more difficulties in enforcing debts in a different country. If the collateral constraint on foreign borrowing is significantly tighter than the one on the domestic borrowing, then the domestic credit market can be segmented from the international credit market with distinctively higher domestic interest rate than foreign interest rate.

We show that the adjustment of the economy following capital account liberalization depends upon the degree of development of the domestic financial system and the importance of collateralizable fixed asset in production, and the resulting relative severities of financial suppression and cost suppression.

When the domestic financial system is poor, the cost suppression is severe with low TFP under autarky. Due to low production costs, even the unproductive entrepreneur enjoys high rate of returns on production, which results in relatively high domestic real interest rate. Then, after liberalization there will be capital inflows towards both productive and unproductive entrepreneurs. The initial boom is amplified by the increase in asset price that further loosens the borrowing constraints. But when the domestic financial system is poor, the boom is not sustainable: the initial expansion of borrowing is offset by the eventual rise of production costs, and falls in the share of production of productive entrepreneurs and TFP.

For the intermediate level of domestic financial development, financial suppression is the dominant symptom under autarky, with the domestic interest rate being lower than

the foreign interest rate. After liberalization, there is capital outflow. The asset price falls because of the higher interest rate and anticipation of recession. This hurts the productive entrepreneurs with debt leverage more than the unproductive entrepreneurs, and their share of production drops. The TFP, aggregate output, employment, wage rate all fall. Despite the initial recession, eventually productive entrepreneurs who will benefit from cheaper cost of production will takeover production of unproductive entrepreneurs. In the long-run, the economy will recover with leaner and more efficient production with higher TFP.

In order to address the question of why the economy with underdeveloped financial system is vulnerable to shocks after capital account liberalization, we do two experiments: the first is a shock to domestic finance, an unanticipated fall in the fraction of future output usable as collateral for domestic loans. This is meant to capture an aspect of domestic banking crisis. The second is a shock to external borrowing, an unanticipated increase in the foreign interest rate. We show that both the domestic shock and the external shock generate falls in the asset price, simultaneous contractions of domestic and foreign credit, endogenous falls in TFP, and recession - a twin crises - in the short run. In the long run, however, we find that, only if the domestic financial system takes time to recover, the economy continues to suffer from low TFP and stagnation.

There is an extensive literature on the implications of credit frictions, both domestic and international, on international capital flows and capital account liberalization. While the basic structure of our paper is built upon Aoki et al. (2006) to incorporate the role of asset prices in the adjustment following capital account liberalization, our paper can be related to the following three strands of literature.

The first strand of literature focuses on the direction of capital flow under credit frictions. Gertler and Rogoff (1990) construct a model of North-South lending under moral hazard. In their model, since agency problem becomes less severe as a country's net worth becomes larger, capital can go from the poor South to the richer North.[2].

The second is on the implications of international capital flows on economic volatility. Aghion, Bacchetta and Banerjee (2004) show that countries with intermediate level of financial development are more unstable than very developed or very underdeveloped countries. Mendoza (2006) constructs a small open RBC model with collateral constraint to analyze the role of asset prices on the Sudden Stops. Although the propagation mechanism though the interaction between the asset price and credit limit is similar to ours, as is analyzed by Kiyotaki and Moore (1997), TFP moves exogenously in Mendoza (2006), while endogenously in our framework.

The third strand of literature examines the relationship between domestic and international financial frictions. Caballero and Krishnamurthy (2004) emphasize the interaction between domestic and international collateral constraints for financial crises by constructing a model where firms are subject to liquidity shock. Since domestic collateral constraint lowers the domestic rate of return of saving, agents tend to under-save — they hold too little spare international borrowing capacity, which makes the economy more vulnerable to adverse shocks. Kaminsky and Reinhart (1999) also empirically examine the 'twin crisis': banking and balance-of-payment crisis, and found that problems in the banking sector typically precede a currency crisis. While our paper does not explicitly

[2]See also Lucas (1990). For more recent literature on the direction of capital flow under credit frictions, see, for example, Sakuragawa and Hamada (2001), Caballero, Farhi and Gounrinchas (2006), and Mendoza, Quadrini and Rios-Rull (2007).

model banking sector, it provides a framework to analyze why the difficulties of domestic finance and international finance interact with each other through the asset price.

2 Model

2.1 Framework

We consider a small open economy with one homogeneous goods, land and labour. There are two types of continua of infinitely lived domestic agents, entrepreneurs and workers, in addition to foreigners.

The preference of the entrepreneurs is described by the expected discounted utility:

$$E_t \left[\sum_{s=t}^{\infty} \beta^{s-t} \log c_s \right], \tag{1}$$

where c_s is the consumption at date s, and $\beta \in (0,1)$ is the subjective discount factor, and E_t is the expectations conditional on information at date t.

The entrepreneur has a constant returns to scale production technology combining land (k_t), labour (l_t) and material goods (m_t) as inputs to produce gross output of good (y_{t+1}) with one period production lag as:

$$y_{t+1} \leq a_t \left(\frac{k_t}{\kappa} \right)^{\kappa} \left(\frac{l_t}{\lambda} \right)^{\lambda} \left(\frac{m_t}{1-\kappa-\lambda} \right)^{1-\kappa-\lambda}, \tag{2}$$

where a_t is a productivity parameter, which is known at date t. Parameters κ and λ represent the share of land and labour in production, where $\kappa, \lambda, 1-\kappa-\lambda \in (0,1)$.

Material goods input includes both working capital and reproducible fixed capital - noting our economy has one homogeneous goods -, and gross output includes output and fixed capital after depreciation. At each date, some agents are productive ($a_t = \alpha$), the others are unproductive ($a_t = \gamma$), and the idiosyncratic productivity of each entrepreneur follows a two state Markov process[3] :

$$\text{Prob}\left(a_{t+1} = \gamma \mid a_t = \alpha\right) = \delta, \text{ and Prob}\left(a_{t+1} = \alpha \mid a_t = \gamma\right) = n\delta. \tag{3}$$

Agents can become producers or creditors.[4] We consider an environment in which, because the production technology is specific to the producer, only the entrepreneur who started the production has the skill to obtain maximum output described by the production function. Despite this skill, the producer is free to walk away from the production and the debt obligation before completing the production. Besides the producer, there is a lead creditor who monitors the project throughout, and has some skill to obtain θ (< 1) fraction of maximum output, if she takes over the entrepreneur's production.

[3]Bernard et.al. (2003) use the US Census of Manufactures to show that the labour productivity differs across plans in the range of 1/4 to 4 times the mean productivity, (with the standard deviation of log productivity equals 0.66), even in the same 4-digit industry. The difference is not due to the difference in capital-labour ratios.

This transition implies that the fraction of productive entrepreneurs is stationary and equal to $n/(1+n)$, given that the economy starts with such population distribution. We assume that the probability of the productivity shifts is not too large:

$$\delta + n\delta < 1.$$

This assumption is equivalent to a positive serial correlation of the productivity of each entrepreneur. We introduce this turnover of individual productivity in order to separate the distribution of productivity from the distribution of wealth, so that there are significant needs for external finance even in the steady state.

[4]In equilibrium tipically the unproductive agents will become creditors in the domestic financial markets.

Although the production is divisible, there is only one lead creditor for each production project, and only a home agent can become a lead creditor. All the other (non-lead) outside creditors, home or foreign, cannot recover any amount of output and can take over only land as collateral asset if the producer-borrower walks away. Knowing this possibility in advance, foreign creditors (as outside creditors) would limit the credit so that the debt repayment (b^*_{t+1}) of the debtor-producer does not exceed the value of collateral, i.e., the future value of land, $q_{t+1}k_t$, where q_{t+1} is land price in terms of good at time $t+1$ and k_t is land put in collateral for loan:

$$b^*_{t+1} \leq q_{t+1}k_t. \tag{4}$$

Similarly, the domestic lead creditor restricts her loan (b_{t+1}) so that the total sum of loans does not exceed θ fraction of output plus the future value of collateral land[5]:

$$b_{t+1} + b^*_{t+1} \leq q_{t+1}k_t + \theta y_{t+1}. \tag{5}$$

[5]If the producer-borrower threatens to walk away from production in order to renegotiate with the creditors before completing the production, it is efficient for the producer to pay some to creditors in order to complete the production. We assume the outside creditors are weak against the producer and the lead creditor in the renegotiation. Then the lead creditor pays the outside creditors the value of collateral land in order to acquire the outside creditors' right to the land as senior creditors. (It is efficient to make the outside creditors senior creditors in order to maximize the borrowing from them). After the outside creditors leave, the lead creditor and the producer-debtor negotiate. We assume the producer has all the bargaining power. Then, after the producer pays θ fraction of maximum output and the value of collateral land to the lead creditor, the producer is allowed to complete the production to obtain $1-\theta$ fraction of maximum output. The resource allocation is efficient ex post. But the ex ante resource allocation may not be efficient because of the credit constraint which arises from the possibility of the default and negotiation. We assume there is no reputation to enforce debts, because there is no record keeping of the past defaults. Here, we apply Hart and Moore (1994) and Aghion, Hart and Moore (1992) on default and renegotiation between private parties.

Here "land" represents fixed asset with limited supply which the outside creditors can recover after default, and κ is the share of such asset in gross output. We take θ as an exogenous parameter to represent the degrees of development of the country's financial institution.

The flow-of-funds constraint of the entrepreneur is given by:

$$c_t + q_t\left(k_t - k_{t-1}\right) + w_t l_t + m_t = y_t - b_t - b_t^* + \frac{b_{t+1}}{r_t} + \frac{b_{t+1}^*}{r^*}, \tag{6}$$

where w_t is the real wage rate and r_t is the domestic real gross interest rate. The left hand side (LHS) of the flow-of-fund constraint is expenditure; consumption (c_t), net purchase of land $(q_t\left(k_t - k_{t-1}\right))$, wage bill $(w_t l_t)$ and material goods input (m_t). The right-hand-side (RHS) is financing; the internal finance from the net worth – output minus the debt repayment to home and foreign creditors –, and the external finance of the borrowings from home and foreign creditors.[6] The entrepreneur chooses the quantities $\left(c_t, k_t, l_t, m_t, y_{t+1}, b_{t+1}, b_{t+1}^*\right)$ to maximize the expected discounted utility subject to the constraints of technology and finance (2 - 6).

Next, we turn to workers. Unlike the entrepreneurs, the workers do not have production technology, nor any collateralizable asset in order to borrow either domestically or internationally. They choose consumption c_t, labour supply l_t, and domestic and foreign net borrowings (b_{t+1} and b_{t+1}^*) to maximize the expected discounted utility,

$$E_t\left[\sum_{s=t}^{\infty} \beta^{s-t} u\left(c_s - v(l_s)\right)\right],$$

[6] We assume there is no rental market for land because of potential hold-up problem between landlords and tenants, and that the producer has to buy land.

subject to the flow of funds constraint,

$$c_t = w_t l_t - b_t - b_t^* + \frac{b_{t+1}}{r_t} + \frac{b_{t+1}^*}{r^*},$$

and the borrowing constraints,

$$b_{t+1} \leq 0, \text{ and } b_{t+1}^* \leq 0.$$

We assume $u(\cdot)$ is strictly concave. Let $\overline{L}$ be population size of workers, and $v(l) = l^{1+\frac{1}{\eta}} / \left(1 + \frac{1}{\eta}\right)$ where $\eta > 0$. The choice of labour supply implies $w_t = v'(l_t)$, and the total labour supply becomes

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

Foreigner lend to and borrow from the domestic agents at a constant real gross interest rate r^*. Throughout the analysis, we assume that there is no limitation on domestic lending to foreigners at this interest rate, (because foreigners have enough collateral). We also assume the foreign interest rate is strictly less than the home time preference rate:

$$r^* < 1/\beta. \tag{A1}$$

Let C_t, C_t', and C_t^w be aggregate consumption of productive entrepreneurs, unproductive entrepreneurs, and workers, and let B_t, B_t', and B_t^w be aggregate quantities of the other quantity b_t of productive entrepreneurs, unproductive entrepreneur, and workers. Supply of land is fixed at $\overline{K}$. The market clearing condition for land, labour, goods,

and domestic credit are written as:

$$K_t + K'_t = \overline{K}, \tag{7}$$

$$L_t + L'_t = L^s(w_t) = \overline{L} w_t^{\eta}, \tag{8}$$

$$\begin{aligned} & C_t + C'_t + C^w_t + M_t + M'_t \\ &= Y_t + Y'_t - (B^*_t + B^{*\prime}_t + B^{*w}_t) + \frac{B^*_{t+1} + B^{*\prime}_{t+1} + B^{*w}_{t+1}}{r^*}, \end{aligned} \tag{9}$$

$$B_{t+1} + B'_{t+1} + B^w_{t+1} = 0. \tag{10}$$

In the RHS of equation (9), the last two terms are the net supply of goods by the foreigners to domestic agents. In equation (10), the debt of domestic agents to the other domestic agents should be net out in the aggregate, even though the total debts of the domestic agents need not because of the international borrowing and lending. (Remember that the domestic credit market may be segmented from the international credit market, because the home agents face the international borrowing constraint).

The competitive equilibrium is defined as a set of prices (q_t, r_t, w_t) and quantities which is consistent with the choice of all the individual entrepreneurs and workers as well as the clearing conditions of markets for land, labour, goods and domestic credit. Because there is no aggregate shocks, aside from possibly an unanticipated exogenous shock to the initial condition, the agents have perfect foresight of future prices and aggregate quantities in the equilibrium, (even though each entrepreneur faces idiosyncratic

productivity shocks). By Walras' Law, only three out of four market clearing conditions are independent.

2.2 Properties of Equilibrium

We now describe the equilibrium of our economy. For the details of the derivations, please see Appendix. We first observe that the domestic interest rate cannot be lower than the foreign interest rate:

$$r_t \geq r^*.$$

Otherwise, all of domestic savings would go abroad, and domestic use of land and labour would shrink to zero, which would contradict the market clearing.

We start by describing the behavior of entrepreneurs. The international borrowing constraint implies that, when the entrepreneur buys one unit of land at price q_t, he can borrow up to the present value of q_{t+1} with favorable foreign interest rate, and needs to finance only the difference,

$$u_t \equiv q_t - \frac{q_{t+1}}{r^*}, \tag{11}$$

from the other funds. Here u_t is the required downpayment for the entrepreneur to buy a unit of land. We can also think of u_t as the opportunity cost - user cost - of holding land for one period.

When each entrepreneur chooses the factor demand to minimize the cost of production, $u_t k_t + w_t l_t + m_t$ for a given output y_{t+1} subject to production function (2), the

factor demand and the cost function satisfy:

$$\begin{aligned} & k_t : l_t : m_t = \frac{\kappa}{u_t} : \frac{\lambda}{w_t} : 1-\kappa-\lambda, \text{ and} \\ & Min \ \ (u_t k_t + w_t l_t + m_t) = \frac{u_t^{\kappa} w_t^{\lambda}}{a_t} y_{t+1}, \end{aligned} \tag{12}$$

for the entrepreneur with the productivity a_t. Because the ratio of factor demand are common to all the productive and unproductive entrepreneurs, we know:

$$K_t : L_t : M_t = \frac{\kappa}{u_t} : \frac{\lambda}{w_t} : 1-\kappa-\lambda = K_t' : L_t' : M_t'. \tag{13}$$

Let Z_t be the total net worth of all the entrepreneurs:

$$Z_t = Y_t + Y_t' + q_t \left(K_{t-1} + K_{t-1}'\right) - B_t - B_t' - B_t^* - B_t^{*\prime}.$$

Let s_t be the share of net worth of all the productive entrepreneurs:

$$s_t = \left(Y_t + q_t K_{t-1} - B_t - B_t^*\right) / Z_t. \tag{14}$$

The productive entrepreneurs would borrow up to the limits of international and domestic borrowing, if the rate of returns on production $(\alpha/(u_t^{\kappa} w_t^{\lambda}))$ exceeds the domestic interest rate - note that the rate of return is the inverse of unit of cost in (12). Aggregating the flow-of-funds (6) across all the productive entrepreneurs, we have:

$$u_t K_t + w_t L_t + M_t \leq \frac{\beta s_t Z_t}{1 - \frac{\theta}{r_t} \alpha/(u_t^{\kappa} w_t^{\lambda})}, \tag{15}$$

where the equality holds if $\alpha/(u_t^{\kappa} w_t^{\lambda}) > r_t$, and the strictly inequality implies $\alpha/(u_t^{\kappa} w_t^{\lambda}) = r_t$. The numerator of RHS is the aggregate gross saving of the productive entrepreneurs, because they save β fraction of their net worth with logarithmic period utility function. The denominator is the fraction of the costs which has to be financed from own saving, after borrowing θ fraction of future output from domestic creditor at the interest rate r_t. Thus, the productive entrepreneurs use their gross saving in order to finance the gap between the total cost of production and the external finance.

While the productive entrepreneurs have a comparative advantage in production with borrowing, the unproductive entrepreneurs have comparative advantage in providing loan. So the unproductive entrepreneurs either lend to the productive entrepreneurs in domestic credit market and/or produce with borrowing from foreigners - if the rate of returns on production is equal to the domestic interest rate:

$$\frac{\gamma}{u_t^{\kappa} w_t^{\lambda}} \leq r_t. \tag{16}$$

This would hold with equality when the unproductive agents produce. If (16) holds with strict inequality, the unproductive entrepreneurs specialize in providing loan.

Concerning the workers, they will decumulate their financial assets until they consume all, if the domestic real interest rate is strictly less than the time preference rate (i.e., $r_t < 1/\beta$).[7] The aggregate consumption of the workers is equal to the aggregate wages:

$$B_t^w = B_t^{*w} = 0, \text{ and } C_t^w = w_t L^s(w_t). \tag{17}$$

[7] We will later verify this inequality holds in equilibrium.

From the behavior of the workers, the domestic credit market equilibrium condition becomes $B_{t+1} + B'_{t+1} = 0$. Together with the consumption function of the entrepreneurs, the goods market clearing condition (9) can be written as:

$$q_t\overline{K} + w_t L^s(w_t) + M_t + M'_t = \beta Z_t + \frac{B^*_{t+1} + B^{*\prime}_{t+1}}{r^*}, \text{ where}$$
$$Z_t = Y_t + Y'_t + q_t\overline{K} - B^*_t - B^{*\prime}_t. \tag{18}$$

Then, from the international borrowing constraint, we have:

$$u_t\overline{K} + w_t L^s(w_t) + M_t + M'_t \leq \beta Z_t. \tag{19}$$

If domestic interest rate is higher than the foreign interest rate, the equality holds as the international borrowing constraint is binding. If (19) holds with strict inequality (with non-binding international borrowing constraint), then the domestic and foreign interest rates are equal, as domestic credit market is perfectly integrated with the international credit market.

Let x_t be the excess rate of returns of the productive agent over the unproductive agent. Then

$$x_t = \left(\frac{1-\theta}{\frac{u_t^{\kappa} w_t^{\lambda}}{\alpha} - \frac{\theta}{r_t}} - r_t \right) / r_t. \tag{20}$$

The first term in the parenthesis of RHS is the rate of returns on saving of the productive entrepreneurs, when they borrow up the their credit limit. The total net worth of the

domestic agents evolve as:

$$Z_{t+1} = (1 + s_t x_t) r_t \beta Z_t. \tag{21}$$

Because the net worth of productive entrepreneurs earns the excess rate of returns, the growth rate of the total net worth of the domestic agents depends upon the share of productive entrepreneurs' net worth s_t. The share of productive entrepreneurs evolves as:

$$\begin{aligned} s_{t+1} &= \frac{(1-\delta)(1+x_t) r_t \beta s_t Z_t + n\delta r_t \beta (1-s_t) Z_t}{(1+s_t x_t) r_t \beta Z_t} \\ &= \frac{(1-\delta)(1+x_t) s_t + n\delta(1-s_t)}{1+s_t x_t} \equiv f(s_t, x_t). \end{aligned} \tag{22}$$

The denominator of RHS of the first equation is the total net worth in the next period. The numerator is the aggregate net worth of the productive entrepreneurs in the next period, which is the sum of the net worth of whose who continue to be productive with probability $1-\delta$ (from (3)) and the net worth of those who shifts from unproductive to be productive with probability $n\delta$.

The dynamic evolution of the economy is characterized by sequence of $(q_t, u_t, w_t, r_t, K_t, K'_t, L_t, L'_t, M_t, M'_t, Z_t, s_t, x_t, Z_{t+1}, s_{t+1})$ that satisfies (7), (8), (11), (13), (14), (15), (16), (18), (19), (20), (21) and (22) for a given the initial land and debts of the productive entrepreneurs and foreign debt of the unproductive entrepreneurs (K_{t-1}, B_t, B_t^* and $B_t^{*\prime}$) [8].

Note that, after the initial total net worth of the entrepreneurs (Z_t) and the share of productive agents' net worth (s_t) are determined simultaneously with the land price (q_t), the evolution of the aggregate economy at future date τ is described recursively as

[8] Noting (13) has 4 equations, we have 15 equations to determine 15 endogenous variables.

a function of the variables (Z_τ, s_τ) along the perfect foresight equilibrium path.

Finally, in the subsequent analysis it would be of interest to examine the behavior of the total factor productivity (TFP) of the economy. We define TFP as the ratio of total gross output over total input measure:

$$A_t = \frac{Y_{t+1} + Y'_{t+1}}{\left(\frac{\bar{K}}{\kappa}\right)^{\kappa} \left(\frac{L^s_t}{\lambda}\right)^{\lambda} \left(\frac{M_t + M'_t}{1-\kappa-\lambda}\right)^{1-\kappa-\lambda}} \tag{23}$$
$$= \alpha d_t + \gamma(1 - d_t)$$

where $d_t \equiv \frac{K_t}{\bar{K}} = \frac{L_t}{L^s} = \frac{M_t}{M_t + M'_t}$. Equation (23) shows that TFP depends on the fraction of inputs used by the productive agents, d_t.

3 Steady state under autarky

Before looking into how the economy adjusts to capital account liberalization, it is useful to characterize the steady state equilibrium of the economy when there are no financial transactions with foreigners. This analysis enables us to understand how the direction of capital flow after liberalization is affected by the degree of domestic financial development. Here, the home agents are not allowed to borrow from nor lend abroad, i.e., $b^*_t = 0$. Then, because the goods is homogeneous and all land and labour are traded domestically, the economy would become autarky.

In the steady state, all the endogenous variables are constant. The user cost of land is now defined as the difference between land price and the present value of the land

price of the next period as:

$$u = q\left(1 - \frac{1}{r}\right). \tag{24}$$

Let us define $X = sx$, the product of the share of net worth and the extra rate of returns of the productive agents – the importance of extra returns of the productive entrepreneurs. Then, (13) , (19), (21) and (22) can be rewritten as

$$K : L : M = \frac{\kappa}{u} : \frac{\lambda}{w} : 1 - \kappa - \lambda = \overline{K} : \overline{L} w^{\eta} : M + M' \tag{25}$$

$$q\overline{K} + w^{1+\eta}\overline{L} + M + M' = \beta Z, \tag{26}$$

$$1 = \beta(1 + X)r, \tag{27}$$

$$F(X, x) = X^2 + \left[\delta(1 + n) - (1 - \delta)x\right] X - n\delta x = 0, \text{ and } X \geq 0. \tag{28}$$

Together with the other equilibrium conditions (15), (16) and (20), $(r, w, q, u, x, s, X, K, L, M, M', Z)$ are determined endogenously in the steady state autarky equilibrium.[9]

From the domestic credit constraint (5), the tightness of the credit constraint depends upon both the share of collateralizable land in production (κ) and the fraction of future output usable as collateral for domestic loan (θ) - the degree of domestic financial development. In the Appendix, we show that if the degree of domestic financial development θ is below a threshold level $\overline{\theta}(\kappa)$ where $\overline{\theta}'(\kappa) < 0$, then unproductive entrepreneurs with dominated technology continue to produce, and the allocation of the factors of production is inefficient in the steady state autarky equilibrium. Intuitively, if the domestic financial system is underdeveloped (so that the domestic credit constraint

[9] We have 11 equations, as (25) contains 4 equations, in addition to the definition of X.

is tight with limited share of collateralizable fixed land (κ) or future output (θ)), it fails to transfer enough purchasing power from the unproductive entrepreneurs (savers) to the productive entrepreneurs (investing agents), so that the unproductive entrepreneurs end up employing factors of production with their inferior technology.

Figure 1 shows the relationship between domestic real interest rate and the degree of domestic financial development θ under autarky steady state. When the degree of domestic financial development is very high - higher than $\theta^*(\kappa)$, then the economy achieves the first best allocation with no credit constraint binding. In such equilibrium, the domestic real interest rate is equal to the time preference rate, $1/\beta$. For $\theta < \theta^*(\kappa)$, the productive entrepreneurs face binding credit constraint - (5) holds with equality. But, for $\theta \in (\overline{\theta}(\kappa), \theta^*(\kappa))$, only productive entrepreneurs produce (which implies efficient allocation of the factors of production), even though the consumption of the entrepreneurs is no longer smooth. The interest rate is now below the time preference rate - a symptom of financial suppression.

When the domestic financial system is significantly underdeveloped with $\theta < \overline{\theta}(\kappa)$, production allocation is inefficient, the total factor productivity in (23) is low, below the productivity of the productive entrepreneurs α, closer to the productivity of the unproductive entrepreneurs γ. Then in the steady state, the total wealth of the entrepreneurs stays low along with the wage rate and the user cost. The real interest rate is equal to the rate of return on production for the unproductive entrepreneurs, (16) holds with equality. Because TFP, wage rate, user cost and the unit cost of production are all increasing function of θ, the interest rate is decreasing function of θ in the region $\theta < \overline{\theta}(\kappa)$. Intuitively, suppression of TFP and the factor prices dominates the effect of

financial suppression here: the lower θ is, the lower is the unit cost of production for the unproductive entrepreneur, the higher is their rate of return on production, which is equal to the real interest rate in the steady state. *Figure* 1 describes such non-monotone relationship between real interest rate and the degree of domestic financial development[10].

When the economy starts trading financial assets with foreigners after capital account liberalization, whether the economy experiences capital inflow or outflow depends on the degree of domestic financial development, θ, for a given share of land in the production. In *Figure* 2, the world interest rate is also plotted as a horizontal line. Generally, there are three regions. When θ is very low, lower than θ_1, then the domestic real interest rate under autarky is higher than the foreign interest rate. Because of low TFP and low factor prices, even unproductive entrepreneurs earns relatively high rate of return on production, which is equal to the domestic real interest rate. Then, after liberalization, both productive and unproductive entrepreneurs borrow from foreigners, causing capital inflow.

When the degree of domestic financial development is in intermediate region, $\theta \in (\theta_1, \theta_2)$, then the domestic real interest rate under autarky is lower than the foreign interest rate – the effect of financial suppression dominates the suppression of factor prices. After the capital account liberalization, capital outflows to the foreign country.

For high values of θ, $\theta > \theta_2$, the domestic financial system is advanced enough so that only productive entrepreneurs produce and that the interest rate is high with negligible

[10]This property holds also in Aoki et al. (2006). Here on the other hand the threshold values ($\bar{\theta}$ and θ^*) depends upon the share of land out of gross output, κ.

financial suppression under autarky. With a superior domestic financial system, the domestic interest rate under autarky is higher than the foreign interest rate. After liberalization, the domestic productive entrepreneurs will attract foreign funds with their large borrowing capacity.

In what follows, we focus our analysis on the case with $\theta \in (0, \bar{\theta})$, i.e., inefficient production remains under autarky steady state. This case is of particular interest because capital account liberalization can affect TFP.[11]

4 Capital account liberalization

We now examine how the adjustment to capital account liberalization depends on the degree of development of the domestic financial institution, using the equations we derived in Section 2.[12] In order to illustrate the qualitative features of the transition, we employ some numerical examples of our model. The parameter values of the model are reported in *Table* 1.

4.1 Capital account liberalization: the role of asset price

Figure 3 shows the dynamics of the economy following capital account liberalization. Before liberalization occurs at time 0, the economy is at the autarky steady state. Here

[11] Thus we verify $r_t < 1/\beta$ in the neighborhood of the autarky steady state as we claim before equation (17). We can show this inequality continues to hold after capital liberalization for $\theta \in (0, \overline{\theta})$. When θ were higher than $\bar{\theta}$, TFP (defined by equation (23)) would be already its maximum value, α before liberalization.

[12] As we derived in Section 2, the dynamics of the economy is given by the sequence of $(q_t, u_t, w_t, r_t, K_t, K'_t,\ L_t, L'_t, M_t, M'_t, Z_t, s_t, x_t, Z_{t+1}, s_{t+1})$ that satisfies (7), (8), (11), (13), (14), (15), (16), (18), (19), (20), (21) and (22) for a given the initial land and debts of the productive entrepreneurs and foreign debt of the unproductive entrepreneurs (K_{t-1}, B_t, B_t^* and $B_t^{*\prime}$)

we assume θ is low ($= 0.2$) and the world interest rate is equal to 1.04. With the relatively underdeveloped domestic financial system (low θ), the autarky interest rate is above the foreign interest rate (due to a severe cost suppression), and capital account liberalization causes capital inflow. The land (asset) price experiences a large upward swing, because both productive and unproductive entrepreneurs can borrow from foreigners at a cheaper interest rate against land, as well as because the agents anticipate that the user cost continues to be higher due to economic expansion. (See $Figure\ 3-1$) As in Mendoza (2006), the asset price serve as amplification mechanism: the higher asset price expands the collateral value and credit limits, which stimulates investment on working capital. At the same time, the larger investment leads to a higher user cost for a while, which results in a higher asset price in the equilibrium. At the beginning, the international borrowing constraint is not binding so that the domestic interest rate drops down to the world interest rate.

In contrast to Mendoza (2006), TFP moves endogenously in our economy. On the one hand, the initial rise in asset price substantially increases the net worth of the productive entrepreneurs, who had outstanding debts against the unproductive agents before the liberalization. On the other hand, the unproductive entrepreneurs expand production by borrowing from foreigners, crowding out the production of productive entrepreneurs. $Figure\ 3-2$ shows that, when θ is low, the crowding-out effect dominates the leverage effect, and the share of investment of productive entrepreneurs falls. Then TFP decreases as seen in (23).

Because of the deterioration of TFP, the initial boom is not sustainable. As the country accumulates net foreign debt, the total net worth of the entrepreneurs decreases.

In the mean time, the international borrowing constraint becomes binding, pushing up the domestic interest rate. Output starts shrinking until it converges to the new steady state value.

In order to understand how the level of financial development interacts with asset prices, *Figure* 4 shows the case $\theta = 0.6$; a little more developed domestic financial system, but still underdeveloped relative to the foreign economy ($\theta = 0.6 < \theta_1$ in *Figure* 1 when $r^* = 1.04$). With a larger θ, the productive entrepreneurs have larger capacity to borrow from domestic lenders. Initially the leverage effect dominates so that, after the liberalization, the productive entrepreneurs expand their production more than the unproductive entrepreneurs, which raises TFP temporally, in contrast to *Figure* 3. Compared with *Figure* 3, the initial boom is longer with this initial increase in TFP, and it takes longer for the international borrowing constraint to become binding. In the long run, the economy stagnates because the production of productive entrepreneurs is crowded out by the unproductive producers as before. *Figures* 3 and 4 show that, under the relatively underdeveloped domestic financial system, even if the liberalization causes the temporary boom in asset price and aggregate production, the liberalization fails to permanently improve the resource allocation and TFP. Thus the economy will stagnate in the long run. While the long-run implications are similar to those described in Aoki et al. (2006), here (i.e. with fixed land used as a collateral) the short-run adjustment is driven by interaction between the leverage effect and the degree of domestic financial depth (see *Figures* 3 and 4).

In *Figure* 5 we set the foreign interest rate to $r^* = 1.07$ and $\theta = 0.6$. (This corresponds to the medium level of financial development in *Figure* 2; $\theta \in (\theta_1, \theta_2)$). Because

the domestic financial system is relatively more developed so that financial suppression relative to the foreign economy is the major symptom of the home economy: under autarky, the interest rate is lower than the foreign counterpart.[13] Then, with the liberalization, the economy experiences capital outflow and temporary recession. The interest rate increases to the level of foreign interest rate. The asset price falls because the interest rate is higher as well as the user cost of the asset is lower persistently due to recession. The initial fall in the asset price hurts the productive agents more than the unproductive agents because they were leveraged. As the result, the share of production of the productive entrepreneurs fall, and TFP drops, which deepens the initial recession. (See $Figure\ 5-2$). However, the decrease in production cost in the subsequent periods helps the production of the productive entrepreneurs to recover. In the end, the productive entrepreneurs absorb all the saving and the unproductive entrepreneurs stop producing. Thus, despite of the initial recession, capital account liberalization leads to long-run efficiency and prosperity, as is shown in Aoki et al. (2006). As before, differently from Aoki et al. (2006), the dynamics of asset prices through the negative leverage effect on productive entrepreneurs causes a temporary drop in TFP.

4.2 Welfare implications of capital account liberalization

A natural question in the debate is to what extent capital account liberalization is beneficial for the country, and how the costs and benefits are distributed among different groups. To answer this question, we examine the welfare effects on various entrepreneurs

[13] When θ=0.2, the steady state gross interest rate under autarky is 1.079 and higher than r^*. Therefore, when $r^* = 1.07$, the direction of capital flow depends on the value of θ — capital inflow with low θ and capital outflow with high θ (but not too high), as in $Figure$ 1.

and workers.[14]

For the entrepreneurs, we measure the welfare effect of capital account liberalization by the average percentage change of steady state autarky consumption that is required in order to make the entrepreneur indifferent between liberalizing capital transactions and staying in autarky. In computing this measure we take into account the effects of the transition dynamics from autarky to the post-liberalization steady state. Formally, for each entrepreneurs i, we define this measure of welfare change - called the consumption equivalent μ^i - as

$$E_0 \sum_{t=0}^{\infty} \beta^t \log\left(c_t^i\right) = E_0 \sum_{t=0}^{\infty} \beta^t \log\left[(1+\mu^i) c_t^{iA}\right] \tag{29}$$

where c_t^i is date t consumption of entrepreneur i after the liberalization at date 0, and c_t^{iA} is his date t consumption if the autarky continued after date 0. We assume that at date -1, the economy is under autarky steady state.

We know consumption c_t^i is proportional to his net worth of date t, z_t^i, as:

$$\begin{aligned} c_t^i &= (1-\beta) z_t^i \\ &= (1-\beta) \beta^t z_0^i r_0^i r_1^i \cdots r_{t-1}^i, \end{aligned}$$

where r_t^i is the gross rate of return on saving of entrepreneur i. The level of r_t^i is equal to r_t when i is unproductive, and is equal to $(1+x_t) r_t$ when i is productive at date

[14] Here we do not address whether the welfare effects of those who gain from capital account liberalization offset the negative consequences of those who lose, because it is not easy to enforce the redistribution in our economy of limited collateral. Also, even if possible, the redistribution would change the allocation systematically.

t. Then, we can decompose the consumption equivalent μ^i into two components: the change in the initial wealth and the change in the subsequent rates of returns between the autarky and the post-liberalization regime:

$$\log\left(1+\mu^i\right) = \log\left(z_0^i / z_0^{iA}\right) + \beta \sum_{t=0}^{\infty} \beta^t \left(P^t R_t\right)_j - \beta \left[\left(I-\beta P\right)^{-1} R^A\right]_j, \tag{30}$$

where z_0^i is the initial wealth immediately after capital account liberalization at $t=0$ and z_0^{iA} is the initial wealth if the autarky continued. $P = \begin{bmatrix} 1-\delta & \delta \\ n\delta & 1-n\delta \end{bmatrix}$ is the transition matrix for the productivity shift, and $R_t = \left[\log\left((1+x_t)r_t\right), \log r_t\right]'$ and $R^A = \left[\log\left((1+x^A)r^A\right), \log r^A\right]$ are the vectors of the log rate of returns for the productive and unproductive entrepreneurs in the liberalization and in the autarky regimes respectively. The sub-index j identifies the type of entrepreneurs ($j=1$ for productive and $j=2$ for unproductive) at $t=0$ when the liberalization occurs. Since entrepreneurs can shift from the productive to the unproductive status, for our welfare analysis of the entrepreneurs, we will need to distinguish four groups depending on the productivity prior and at the liberalization.

For the workers, on the other hand, we can compute the surplus of supplying labour as:

$$c_t - v(l_t) = w_t l_t - \frac{1}{1+\frac{1}{\eta}} l_t^{1+\frac{1}{\eta}} = \frac{1}{1+\eta} w_t^{1+\eta},$$

from the workers' preference, and the resulting consumption and labor supply function. Then, we measure the welfare effect of capital account liberalization on the worker $\left(\mu^W\right)$

as the percentage change of the present value of the surplus of supplying labour as:

$$1+\mu^W=\left[(1-\beta)\sum_{t=0}^{\infty}\beta^t w_t^{1+\eta}\right]/\left(w^A\right)^{1+\eta}, \tag{31}$$

where w^A is the wage rate under autarky.

Table 2 reports the welfare effect of capital account liberalization for the cases corresponding to *Figures* 3, 4 and 5. The headline of productive-productive implies the group of entrepreneurs who was productive at date -1 (prior to the liberalization) and continue to be productive at date 0 (at the liberalization). Similarly productive-unproductive is the group who switches from productive to unproductive from date -1 to date 0. For *Figure* 3 case ($\theta = 0.2$ and $r^* = 1.04$), with relatively underdeveloped domestic financial system, the entrepreneurs and workers gain from the liberalization (in the first and the last rows). All the entrepreneurs gain from wealth revaluation in row (1), while the wealth revaluation gains is particularly large for the entrepreneurs who were productive prior to the liberalization due to their leverage. The effects of the change in the expected rates of returns is negative as in row (2) − (3), but it is dominated by the positive wealth revaluation effect. The workers benefit from the liberalization, because, due to the initial expansion accompanied by capital inflows, wages are higher than autarky during the transition. For *Figure* 4 case ($\theta = 0.6$ and $r^* = 1.04$), productive entrepreneurs prior to liberalization are more leveraged and own the majority of land: therefore, they are the main beneficiaries of the wealth revaluation effect. Thus, the entrepreneurs who were unproductive prior to liberalization loose, because the negative effect coming from the lower rate of returns dominates the positive but smaller wealth

revaluation effect.

When the financial suppression is severe relative to the foreign economy with the medium degree of financial development as in *Figure* 5 ($\theta = 0.6$ and $r^* = 1.07$), the economy experiences an initial recession before becoming productive-efficient in the long-run. The welfare effects of capital account liberalization are mixed. The workers lose since the loss from the lower wages during the initial recession is too large compared to the possible long-run gains in a distant future. For the entrepreneurs that are productive before the liberalization the negative wealth revaluation effect caused by lower asset prices dominates the positive effect of the higher foreign interest rate. On the other hand, the entrepreneurs that are unproductive before the liberalization will gain since the negative wealth effect is smaller for the entrepreneurs who were lenders than the positive effect of higher rates of returns in the subsequent periods.

From these analysis, we learn that the welfare of the workers and the entrepreneurs with leverage (who are productive prior to the liberalization) tend to be more influenced by the short-run movement of the aggregate economy immediately after the liberalization. In contrast, the unproductive entrepreneurs (who are lenders) tend to care more about the subsequent rates of returns on saving, which depends upon the long-run performance of the economy. These welfare effects may explain why the capital account liberalization tends to be unpopular to the workers and the credit constrained entrepreneurs in the country of the medium degree of the domestic financial development.

4.3 Indirect effects of capital account liberalization

Prasad et al. (2006) argue that, far more important than the direct growth effects of access to international capital markets is how capital flows generate a number of what they label as "potential collateral benefits" of financial integration. Indeed, a growing literature shows that financial openness can, among other things, promote development of the domestic financial sector and generate efficiency gains among domestic firms by better corporate governance. In particular Klein and Olivei (2006) find that, in financially integrated economies, the degree of domestic financial sector development is higher than in countries that maintain restrictions on capital account transactions.[15]

In order to capture the idea that, by capital account liberalization, the country can increase the efficiency of the domestic financial system, we will examine the effect of capital account liberalization which improves domestic financial system through an increase in θ.

Figures 6 shows the response of the economy following capital account liberalization which simultaneously increases θ from 0.2 to 0.6, starting from the autarky steady state as in *Figure* 3. The autarky interest rate is above the foreign one due to the cost suppression with low initial θ. Following capital account liberalization and the increase in θ, the economy enters into sustainable boom with improved domestic financial market. The asset price increase substantially and permanently because agents anticipate higher user costs in the long run. As the domestic financial market shifts more purchasing

[15] Klein and Olivei (2001) use indicators of financial intermediary development as measures of financial developement. They find that the deepening of financial markets goes beyond the level of financial convergence. They also show that their results are driven by the inclusion in the cross country sample by OECD-countries: indeed when they restrict their analysis to non OECD developing countries the link between capital account liberalization and financial deepening is weakened.

power from the unproductive entrepreneurs to the productive entrepreneurs, TFP rises permanently. From a welfare perspective the improvement of the domestic collateral factor along with capital account liberalization, generates gains for both entrepreneurs and workers. Once again the positive wealth effect of the increase in asset prices dominates the negative but smaller effect of a reduction in the rates of return for both productive and unproductive entrepreneurs.

Figure 7 considers the same experiment as before but for the economy with significant financial suppression relative to the foreign economy under autarky as in *Figure* 5: the autarky the interest is lower than the foreign one. Now the most of the costs of capital account liberalization associated with the capital outflow is mitigated by the improved domestic financial system. The asset price, output, wage and TFP all rise quickly and permanently. The welfare level of the workers and the most of entrepreneurs increases substantially, (except that a group of the entrepreneurs who switched from unproductive to productive at the time of liberalization suffer in a small amount because the expected rate of returns is lower due to the higher cost of production).

5 Vulnerability to Shocks

5.1 Shock to Domestic Credit

There are series of episodes in which problems in domestic financial market and those in international financial markets interact with each other. For example, Kaminsky and

Reinhart (1999) report that banking crisis and currency crisis are closely related.[16] Calvo and Reinhart (1999) in describing the sudden stop of capital inflows in Latin American and Asian countries in the 1990s point out that the banking sector problems often begin before the sudden stop and that, in their sample, banking crises are often associated with a reversal of capital flow from inflow to outflow.[17]

In order to examine how a domestic finance problem (e.g., domestic banking problem) may propagate to international borrowing and aggregate production in the economy after capital account liberalization, we conduct the following crude exercise: Suppose that there is an unanticipated permanent fall in the fraction of future output which becomes collateral for domestic borrowing (domestic collateral factor θ), starting from the steady state equilibrium under liberalized capital accounts with foreign debt outstanding.

In *Figure* 8, we consider an unanticipated drop in the domestic collateral factor θ from 0.6 to 0.2 at date 0, starting from the new steady state after liberalization in *Figure* 4. Following the drop in θ, the domestic credit to the productive entrepreneurs shrinks together with their investment. The asset price falls, which further decreases the investment of the productive entrepreneurs with the leverage. The drop in asset prices also tightens the international borrowing constraint, which causes an increase in the domestic interest rate. The increase in the domestic interest rate further contracts the production. Therefore, the domestic collateral constraint and international collateral

[16] See, also, Honkapohja et al (2006) for the case of Finland, and Englund (1999) for the case of Sweden. Ozatai and Sak (2002) point out at the fragility of the banking sector as one of the reason behind the 2000-01 crisis in Turkey.

[17] Calvo and Reinhart (1999) classify banking crises using events based criterion. Their approach is motivated by the lack of high frequency data that capture when a banking crisis is underway. Using this approach they identifies several episodes of banking crisis.

constraint reenforce with each other through asset prices, which brings a severe recession. On the other hand the unproductive agents will benefit from lower production cost and the higher interest rate (as net lenders). Therefore, TFP endogenously decreases, and the economy fails to recover from recession as long as the problem of domestic finance continues (θ continues to be low).

5.2 Vulnerability to foreign interest rate shock

External factors are often referred as a cause of financial crisis. For example, Russia's default in 1998 caused a large increase in interest rates for many emerging market economies. Calvo and Talvi (2005) report that interest rate spreads for the major Latin American countries rose from 450 basis points prior to the crises to 1600 basis point in the immediate aftermath. Moreover the increase in the spreads was persistent: it took almost five years for the spreads to be back at the level prior to the crisis. In all the major Latin American countries, the increase in the cost of external finance was accompanied by a decline in asset prices and a reduction in private capital flows.[18] A similar shock contributed to the depression of Finland in the early 1990s, as interest rates in Europe increased following German reunification. (See Honkapohja and Koskela (1999)).

Here, we examine qualitatively how an exogenous increase in the foreign interest affects our economy. *Figure* 9 shows the responses of the economy when the foreign interest rate unexpectedly increases permanently from 4 % to 5 % at time 0, starting

[18]For the Chilean experience, interest rates spreads more than tripled and the stock market declined by 37% between the second quarter of 1998 and the fourth quarter of 2002. Following the tightening in credit conditions, Chile experienced also a sudden stop in external financial flows (see again Calvo and Talvi, 2005).

from the post-liberalization steady state with foreign debt position in *Figure* 4.

Following the increase in the foreign interest rate, the asset price drops because the discount factor of future user costs is higher and because the future user costs are expected to be lower anticipating recession. The decrease in asset prices decreases the international collateral and increases the domestic interest rate, leading to drop in output. In response to a 1 % increase in the foreign interest rate, the domestic interest rate initially increases more than 1 %.[19]

The drop in asset prices has contractionary effect on productive agents with leverage more than the unproductive agents. Thus TFP deteriorates, contributing to further decrease in output. In the transition, productive entrepreneurs gradually recover their scale of production, since their domestic borrowing capacity hasn't changed (θ is still the same) and production costs are lower following the initial recession. As long as the domestic financial system is intact, eventually TFP and output recover to the pre-shock level.

6 Conclusions

In this paper we propose a framework to analyze how the economy adjusts to the liberalization of international financial transactions, and how the economy after the liberalization reacts to shocks to domestic and external finance. Differently from Aoki et al. (2006) central to our analysis is the behavior of asset prices since the domestic and

[19] The more than proportional increase in the domestic interest rate depends on the share of land in production. The larger is the share, the larger is the increase in the domestic interest rate.

international credit limits depend endogenously on the value of the fixed asset.

Our model predicts that the adjustment of the economy to capital account liberalization depends upon the depth of the domestic financial system. When the domestic financial system is very underdeveloped, the economy has low TFP and factor prices before the liberalization, and experiences a short-run boom with capital inflow and asset price hike after the liberalization. This boom is not sustainable in the long run, because TFP fails to improve with the underdeveloped domestic financial system.

For the intermediate level of domestic financial development, since the interest rate is lower than the foreign one under financial autarky, capital account liberalization causes capital outflow, falling asset price and a short-run recession. In the long run, the economy will recover with improvement of TFP.

The welfare of workers and productive entrepreneurs with the outstanding debt are more influenced by the short-run fluctuations than the long-run performance of the economy. The welfare of the lenders (unproductive entrepreneurs) depends more on the rate of returns in the long run than the short-run effects. These differences in the welfare effects across different groups of people may partly contribute to the controversy on capital account liberalization. If the economy succeeds in improving the domestic financial system simultaneously with the capital account liberalization, then the economy will prosper persistently with the improvement of welfare widely distributed.

Our model also sheds lights on why the problems of domestic finance and external finance may exacerbate each other through the asset price, causing a twin-crisis style recession after capital account liberalization if the domestic financial system is underdeveloped.

Our conclusions here need to acknowledge that the scope of our analysis is limited to international transaction of private financial assets - private debts and equities - so that we have omitted other important components of capital flows (such as foreign direct investment and sovereign debt flows) that are also relevant in many countries' experiences. Those topics are left for future research.

A Appendix to Section 2

In this Appendix, we describe the details of the entrepreneurs optimization problem and derive equations (15), (20) and (21).

Consider the productive entrepreneurs. From the production function (2) and the minimized cost function (12), we observe that $\alpha/w_t^{\kappa}w_t^{\lambda}$ represents the rate of return of production without borrowing from the domestic lenders. The productive entrepreneurs borrow up to the limits when $r_t < \alpha/w_t^{\kappa}w_t^{\lambda}$. By substituting the binding borrowing constraints (4), (5) and the minimized cost (12) into the flow-of-funds constraint (6), we can express the flow-of-funds constraint of the productive entrepreneurs as

$$c_t + e_t\left(1 - \frac{\theta}{r_t}\frac{\alpha}{u_t^{\kappa}w_t^{\lambda}}\right) = z_t, \tag{A.1}$$

where

$$e_t \equiv u_t k_t + w_t l_t + m_t$$

represents the minimized cost of production and

$$z_t \equiv y_t + q_t k_{t-1} - b_t - b_t^*$$

represents the net worth at the beginning of time t. Also, notice that the binding borrowing constraints (4), (5) imply that z_{t+1} can be rewritten as

$$z_{t+1} = (1-\theta)y_{t+1} = \frac{(1-\theta)}{u_t^{\kappa}w_t^{\lambda}/\alpha}e_t. \tag{A.2}$$

(Here we use (12) to obtain the last expression). By using (A.1) and (A.2), the flow-of-funds constraint is written as

$$z_{t+1} = \frac{(1-\theta)}{u_t^{\kappa} w_t^{\lambda}/\alpha - \theta/r_t}(z_t - c_t). \tag{A.3}$$

Here the term $\frac{(1-\theta)}{u_t^{\kappa} w_t^{\lambda}/\alpha - \theta/r_t}$ represents the rate of return of the productive agents when they borrow up to the borrowing limits. They maximize (1) subject to (A.3). The first order condition is given by

$$\frac{1}{c_t} = \beta \frac{(1-\theta)}{u_t^{\kappa} w_t^{\lambda}/\alpha - \theta/r_t} E_t \frac{1}{c_{t+1}}. \tag{A.4}$$

When the entrepreneurs's utility is logarithmic, it is well-known that the consumption function of this type of optimization problem is given by[20].

$$c_t = (1-\beta) z_t. \tag{A.5}$$

Then, (A.1) and (A.5) imply that when they borrow up to the limits the investment of the productive entrepreneurs is given by

$$e_t \equiv u_t k_t + w_t l_t + m_t = \frac{\beta z_t}{1 - \frac{\theta}{r_t}\frac{\alpha}{u_t^{\kappa} w_t^{\lambda}}}. \tag{A.6}$$

As stated above, this equation holds if $\alpha/u_t^{\kappa} w_t^{\lambda} > r_t$. On the contrary, if the borrowing constraints are not binding (i.e., the right hand side of equation (A.6) is larger

[20] See, for example, Sargent (1987), chapter 1.7

than the left hand side), $\alpha/u_t^{\kappa}w_t^{\lambda} = r_t$ holds. Aggregation of (A.6) over the productive entrepreneurs lead to equation (15). Notice that s_tZ_t in equation (15) represents the aggregate net worth of the productive entrepreneurs. Finally, (A.3) shows that the excess return of the productive entrepreneurs is given by equation (20).

Now turn to the unproductive entrepreneurs. They specialize in lending if (16) holds with strict inequality. On the contrary (16) holds with equality when they produce. Similarly to the case of the productive entrepreneurs, we can express the flow-of-funds constraint of the unproductive entrepreneurs as

$$z'_{t+1} = r_t(z'_t - c'_t), \tag{A.7}$$

where z' and c' respectively represent the net worth and consumption of the unproductive agent. They maximize utility (1) subject to (A.7). Therefore the consumption equation is again given by

$$c'_t = (1-\beta)z'_t. \tag{A.8}$$

Equations (A.5) and (A.8) imply that the aggregate consumption is given by

$$C_t = (1-\beta)Z_t, \tag{A.9}$$

and the aggregate saving is therefore given by βZ_t.

Finally, by aggregating (A.3), (A.7) and using (20), the evolution of the aggregate net worth is given by equation (21).

B Appendix to Section 3

This section derives the two threshold values $\overline{\theta}$ and θ^* discussed in Section 3. (When $\theta < \overline{\theta}$ the unproductive entrepreneurs produce under the autarky steady state. When $\theta > \theta^*$ then the productive entrepreneurs become unconstrained.)

B.1 Derivation of $\overline{\theta}$

For simplicity of notation, express the aggregate investment expenditure as

$$u\overline{K} + w^{1+\eta}\overline{L} + M + M' = E + E',$$

where E and E' respectively denote the aggregate investment expenditure of the productive and unproductive entrepreneurs. From equations (24) and (26), we obtain

$$E + E' = \beta Z - \frac{q}{r}\overline{K}. \tag{B.1}$$

Under the production function (2), cost minimization implies that the expenditure on land uK is given by a fraction κ of the total expenditure (see equation (25)). This implies that

$$\overline{K} = \frac{\kappa}{u}(E + E'). \tag{B.2}$$

Substituting (B.2) into the right hand side of (B.1) and solving for $E + E'$, one obtain

$$E + E' = \frac{\beta Z}{1 + \frac{\kappa}{r-1}}. \tag{B.3}$$

Here we used equation (24) in order to simplify the right hand side of (B.3). From this equation, we observe that when the unproductive entrepreneurs produce ($E' > 0$),

$$E < \frac{\beta Z}{1 + \frac{\kappa}{r-1}}. \tag{B.4}$$

Notice that $r = \gamma/(u^{\kappa} w^{\lambda})$ when $E' > 0$ (see equation (16)). In this case, from equation (15), E is given by

$$E = \frac{\beta s Z}{1 - \theta\alpha/\gamma}. \tag{B.5}$$

Substituting (B.5) into (B.4), we obtain

$$\frac{s}{1 - \theta\alpha/\gamma} < \frac{1}{1 + \frac{\kappa}{r-1}}. \tag{B.6}$$

Notice that s is given by X/x. From (16) and (20) evaluated at the steady state, x is given by

$$x = \frac{\alpha - \gamma}{\gamma - \theta\alpha}, \tag{B.7}$$

and r is given by (27) as

$$r = \frac{1}{\beta(1 + X)}. \tag{B.8}$$

By using (B.7) and (B.8), we can express (B.6) in terms of X as

$$G(X) \equiv \beta(\kappa - 1)X^2 + \left[1 + \beta(\kappa - 1) + \frac{\alpha - \gamma}{\gamma}\beta\right] X - \frac{\alpha - \gamma}{\gamma}(1 - \beta) < 0. \tag{B.9}$$

In addition to this, for q to be finite in the steady state, we need $r > 1$. From (B.8),

this requires

$$X < \beta^{-1} - 1. \tag{B.10}$$

Since function $G(X)$ satisfies $G(\beta^{-1} - 1) > 0$ and $G(0) < 0$, there exists unique $\overline{X}$ such that $0 < \overline{X} < \beta^{-1} - 1$ and $G(\overline{X}) = 0$.

What we have shown so far is that $E' > 0$ implies $G(X) < 0$ in the autarky steady state. Finally, from equation (28), we observe that if $F(\overline{X}, \frac{\alpha-\gamma}{\gamma-\theta\alpha}) > 0$, we have $G(X) < 0$. It is shown that $F(\overline{X}, \frac{\alpha-\gamma}{\gamma-\theta\alpha}) > 0$ holds if

$$\theta < \overline{\theta} \equiv \frac{\gamma}{\alpha} - \frac{\alpha - \gamma}{\alpha} \frac{(1-\delta)\overline{X} + n\delta}{\overline{X}(\overline{X} + \delta(1+n))}. \tag{B.11}$$

Equation (B.11) defines the threshold value $\overline{\theta}$ discussed in Section 3. Equation (B.9) implies that $\frac{d\bar{X}}{d\kappa} < 0$, and (B.11) implies $\frac{d\bar{\theta}}{d\bar{X}} > 0$, therefore $\frac{d\bar{\theta}}{d\kappa} < 0$.

B.2 Derivation of θ^*

In the steady state where the productive entrepreneurs are unconstrained, $r = \alpha/(u^\kappa w^\lambda)$. Then, from equation (20), the excess return $x = 0$ in this steady state. Then (27) and (28) imply that $r = \beta^{-1}$. Together with these facts, the transition equation of s_t implies that $s = \frac{n}{1+n}$, which is equal to the fraction of the number of the productive entrepreneurs (See footnote 3). The productive entrepreneurs are unconstrained when

$$E < \frac{\beta s Z}{1 - \frac{\theta}{r}\frac{\alpha}{u^\kappa w^\lambda}} = \frac{\beta \frac{n}{1+n} Z}{1-\theta}. \tag{B.12}$$

Since $E' = 0$ in this steady state, equation (B.3) becomes

$$E = \frac{\beta Z}{1 + \frac{\kappa}{r-1}} = \frac{\beta Z}{1 + \kappa\beta/(1-\beta)}, \tag{B.13}$$

where we used $r = \beta^{-1}$. By substituting (B.13) into (B.12) and solving for θ, we obtain

$$\theta > \theta^* \equiv 1 - \frac{n}{1+n}\left(1 + \frac{\beta}{1-\beta}\kappa\right). \tag{B.14}$$

This defines θ^* in Section 3.

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κ	λ	η	β	α	γ	n	δ
0.030	0.12	3.0	0.92	1.10	1.05	0.1	0.15

Table 1: parameter values

One period in our model corresponds to a year. Since in our model material good input includes both working capital and fixed capital, we set its share, $1-\kappa-\lambda$, as 0.85. The underlying assumption is the ratio of working capital (intermediate input) to net output is 1, and the ratio of fixed capital to net output is 3. When the capital depreciation rate is assumed to be 0.1, then the implied share of 'material good input' in our model is $(3+1)/(1+0.9*3+1) = 0.85$. The implied ratio of land in net output is then $0.03/(0.03+0.12)=0.2$.

Because of our specification on utility of workers, η represents the Frish elasticity of labour supply. It is set to 3, in line with the RBC literature (eg. King and Rebelo (1999) assume 4.) The results reported are not very sensitive to η.

The discount factor, β, is set 0.92. One may think that this is too high as yearly discount rate. However, in an credit constrained economy, the steady state interest rate is lower than the inverse of time preference rate. Indeed, our model implies that the steady state interest rate with $\beta=0.92$ under autarky ranges from 5.5% to 8.1% depending on the value of θ under which unproductive agents produce.

The four parameters α, γ, n and δ, together with κ, mainly determine how likely the inefficient production remains. We set the gap between the productivity of productive and unproductive agents, $\alpha-\gamma$, as 5 percentage points. Parameters n and δ are set to 0.1 and 0.15, respectively. This implies that in the steady state the fraction of the productive agents is equal to $n/(1+n)$, and the expected time that an agent continues to be productive is $1/\delta = 6.66$ years. Finally, those parameters together imply that the unproductive agents produce in the autarky steady state when θ is less than 0.64.

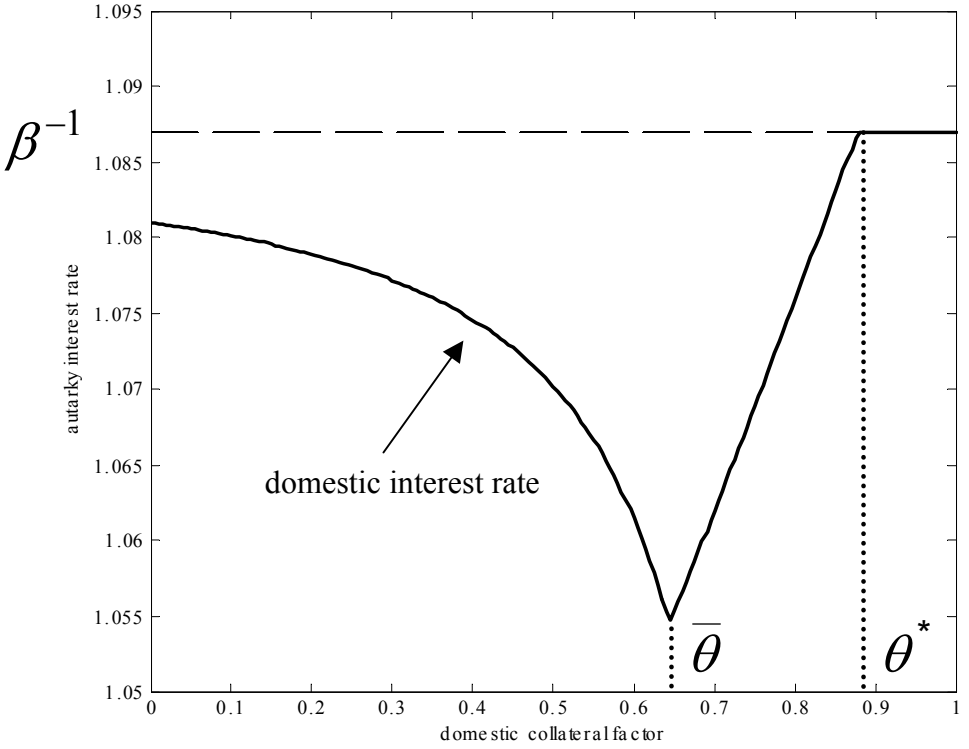

Figure 1. Steady-state interest rate under autarky

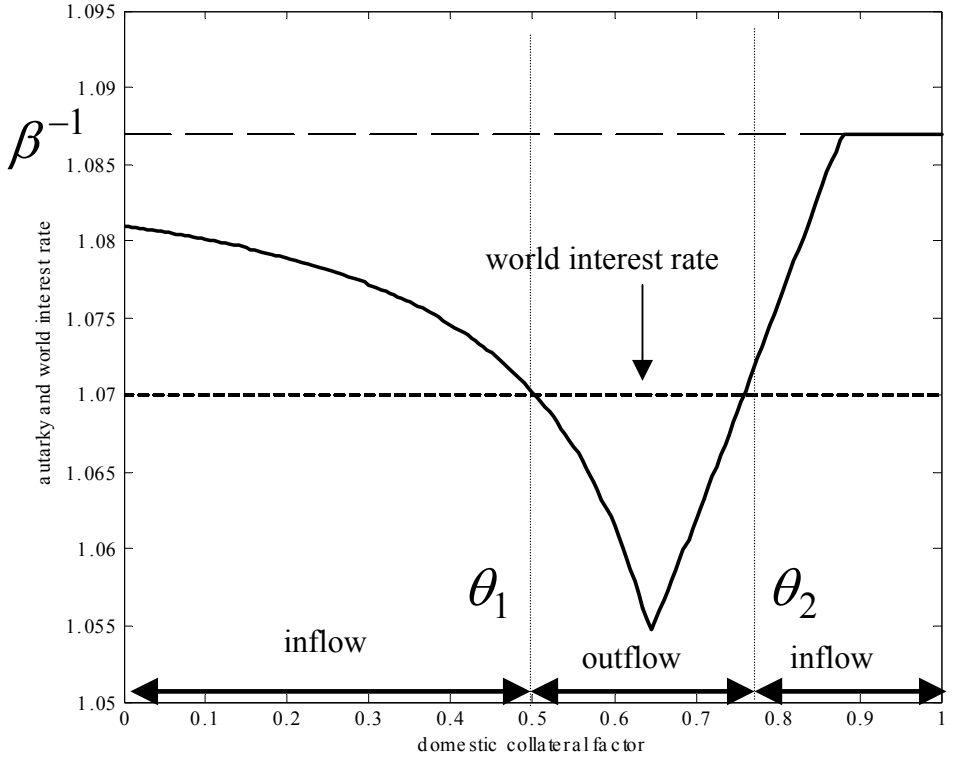

Figure 2. Capital flows after liberalisation

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

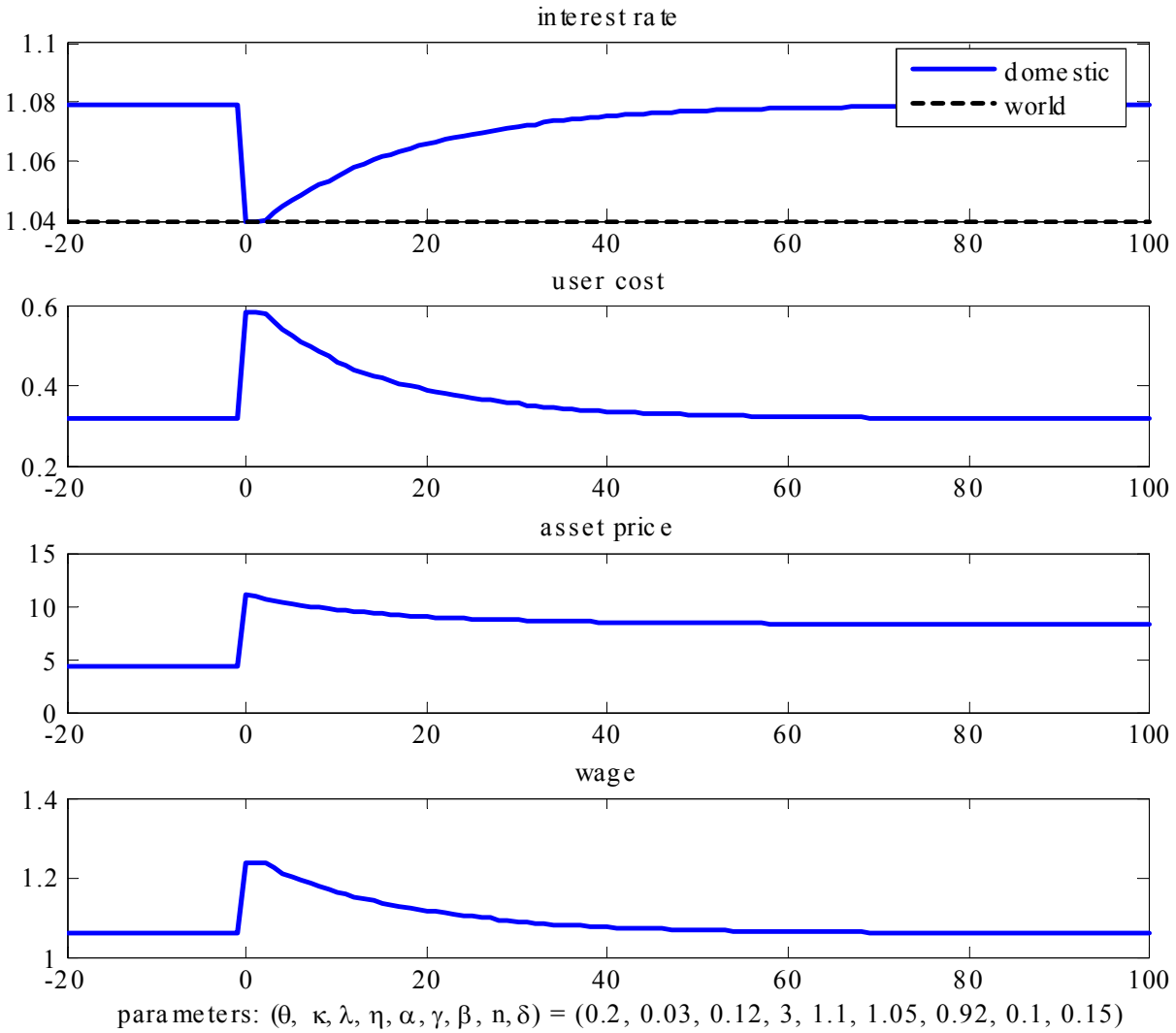

Figure 3-2: dynamics after liberalisation: capital inflow (low theta)

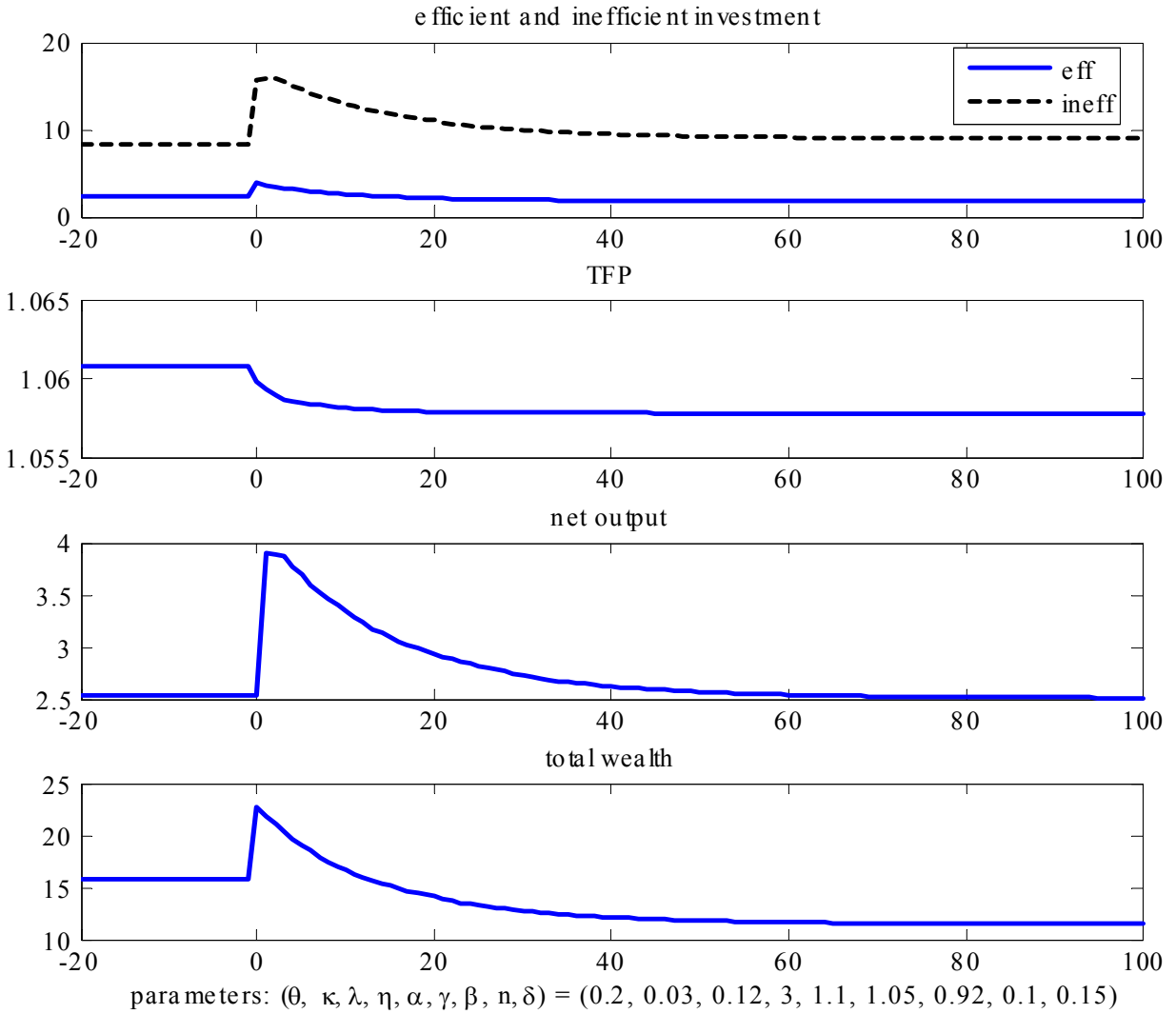

Figure 4-1: dynamics after liberalisation: capital inflow (high theta)

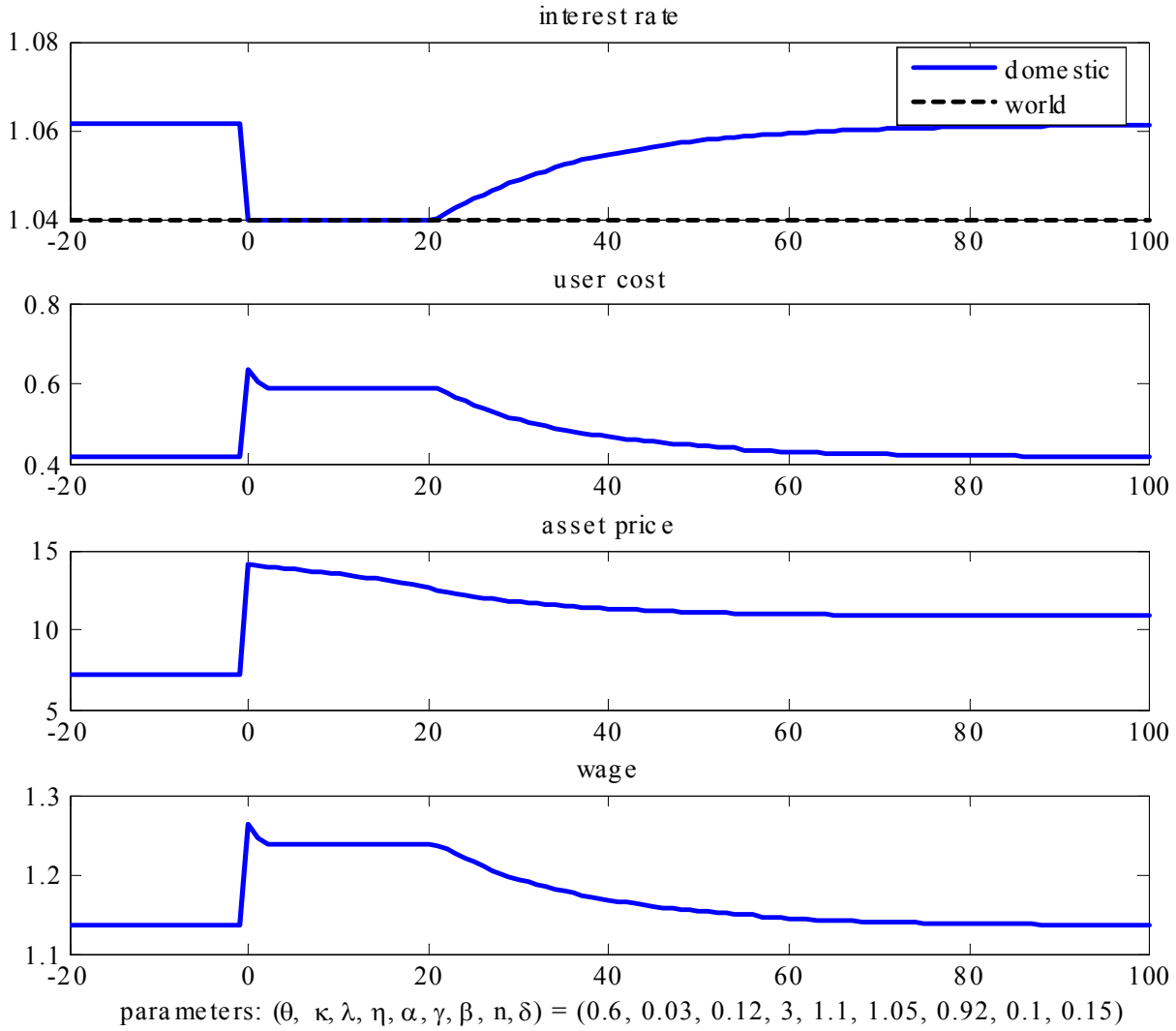

Figure 4-2: dynamics after liberalisation: capital inflow (high theta)

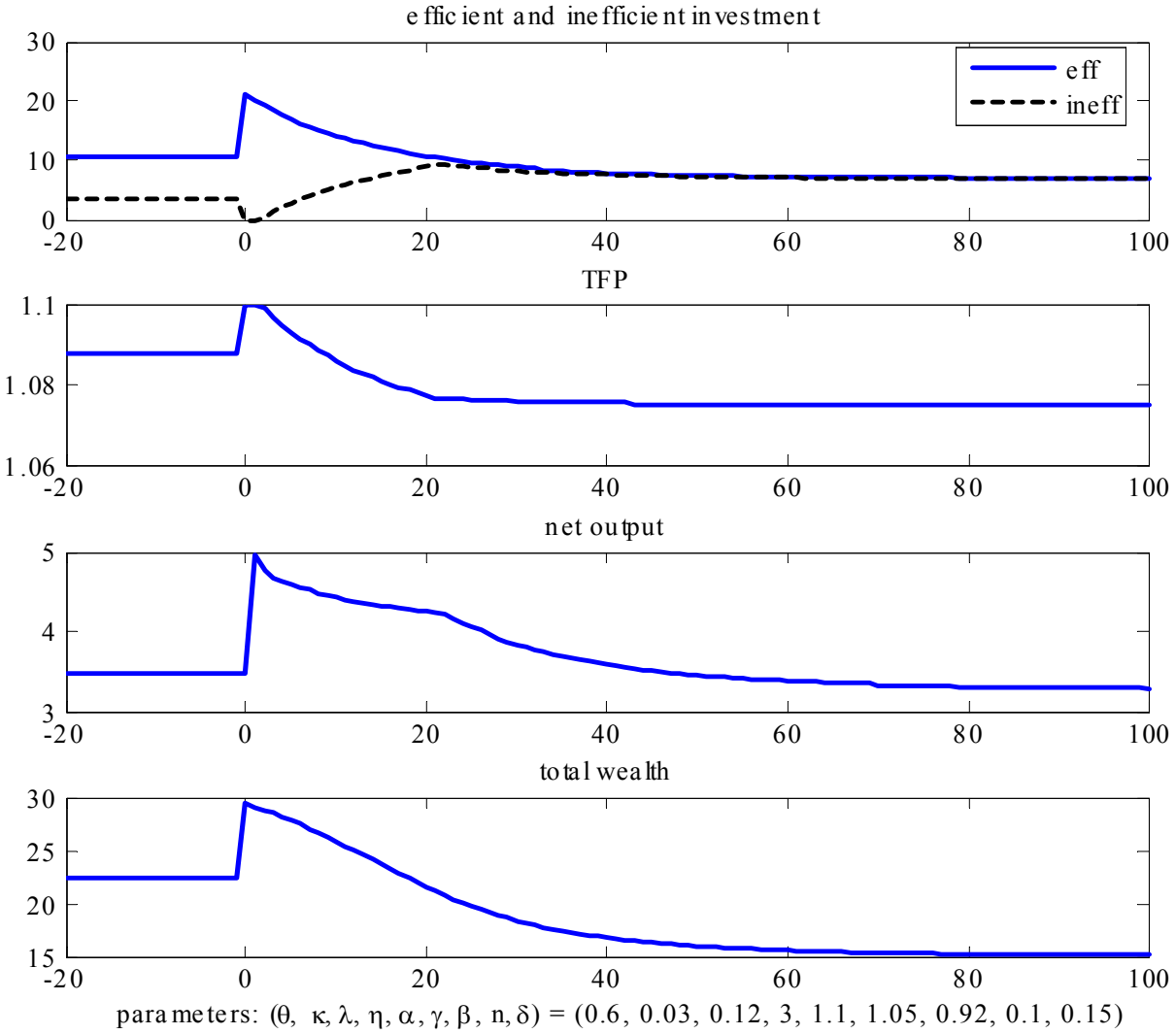

Figure 5-1: dynamics after liberalisation: capital outflow

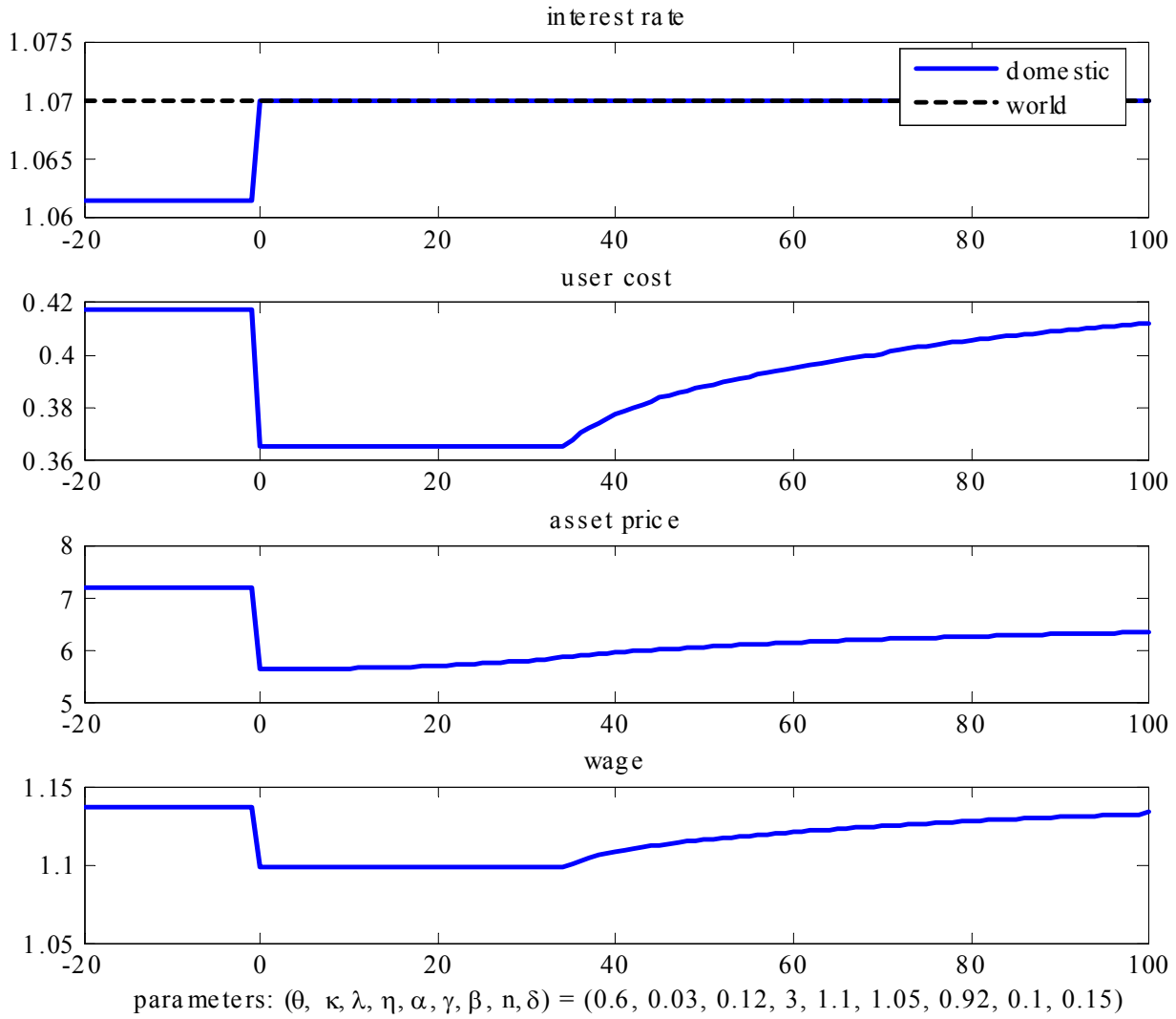

Figure 5-2: dynamics after liberalisation: capital outlow

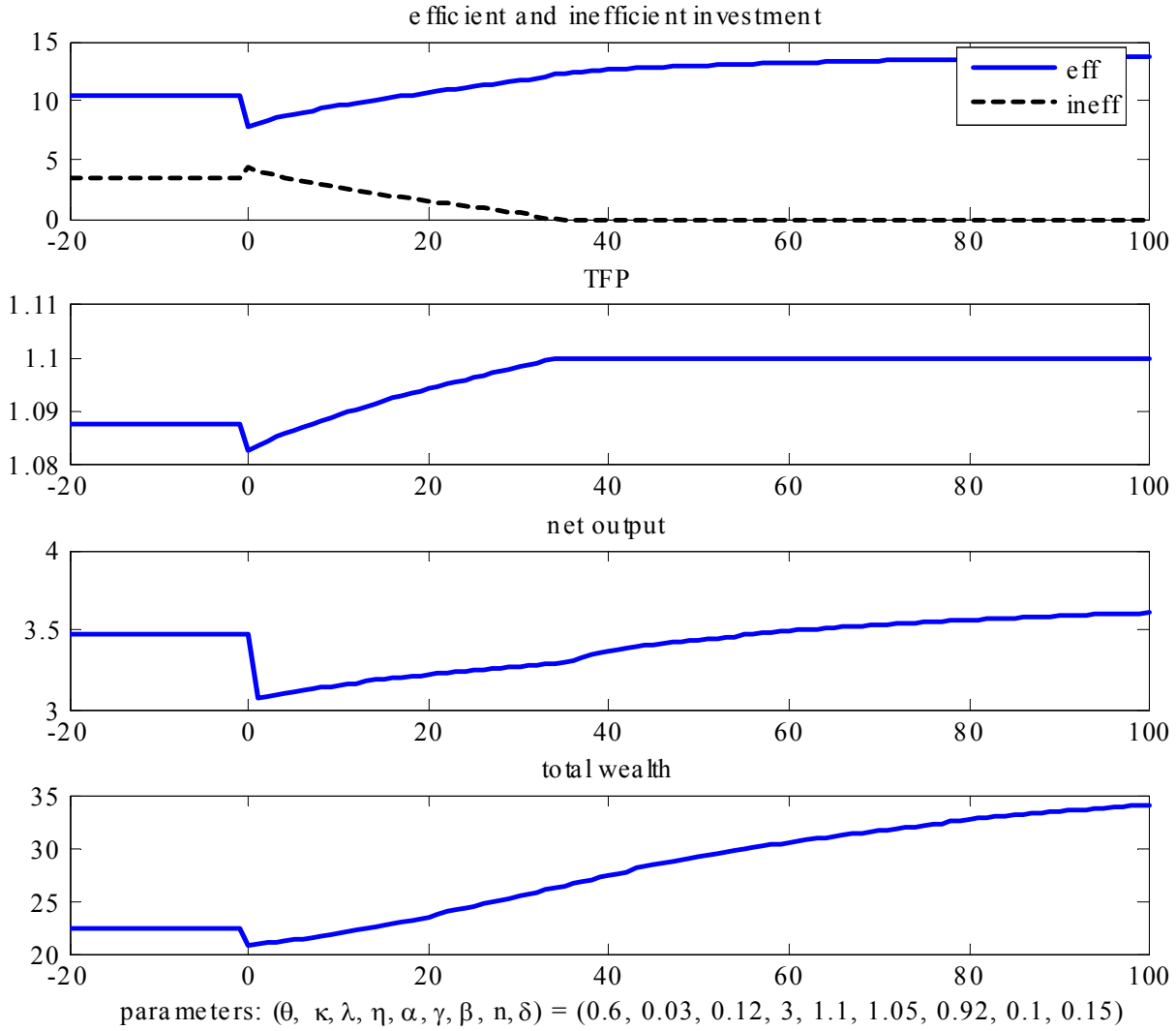

Figure 6-1: dynamics after liberalisation: capital inflow
theta increases from 0.2 to 0.6

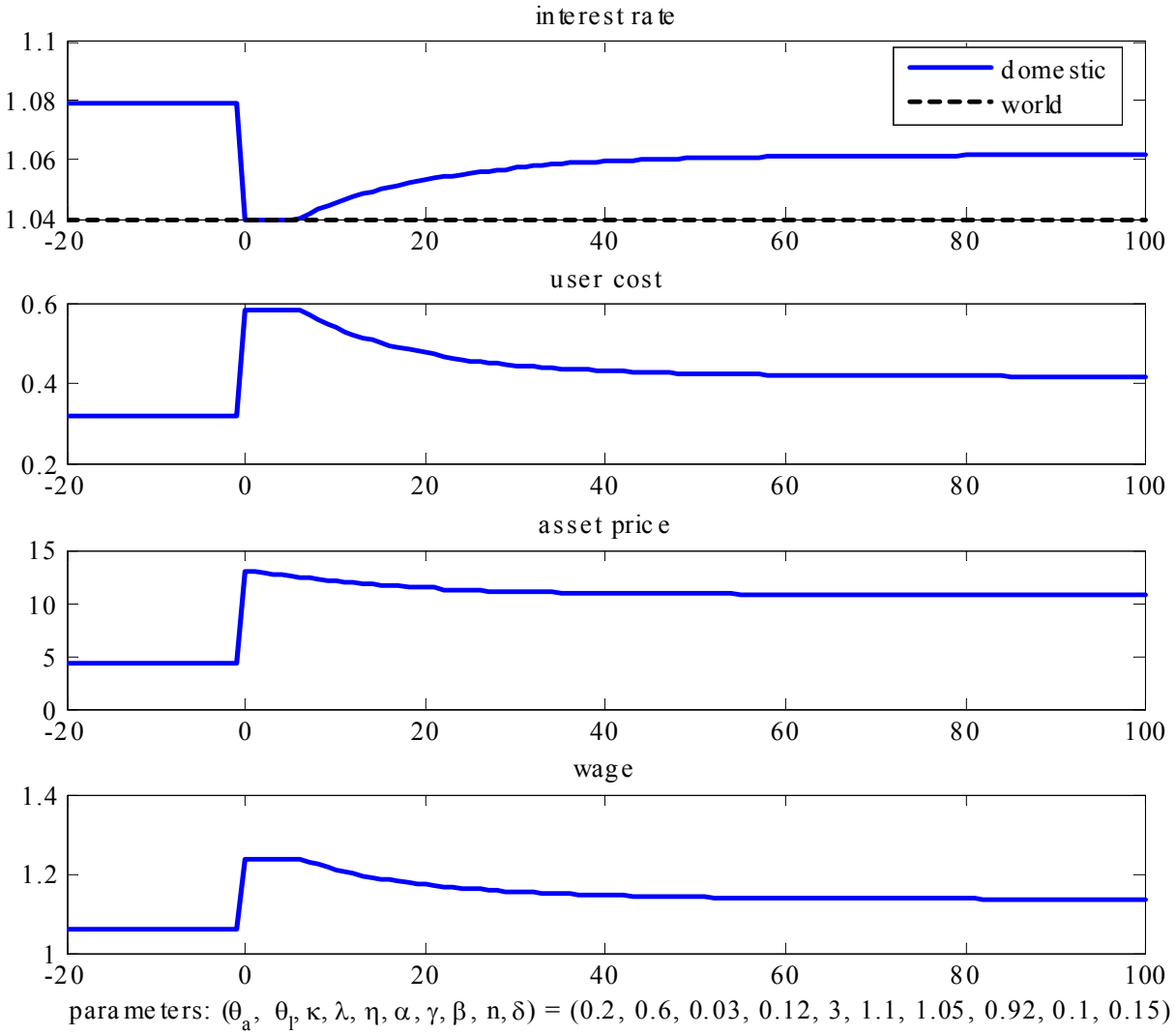

Figure 6-2: dynamics after liberalisation: capital inflow
theta increases from 0.2 to 0.6

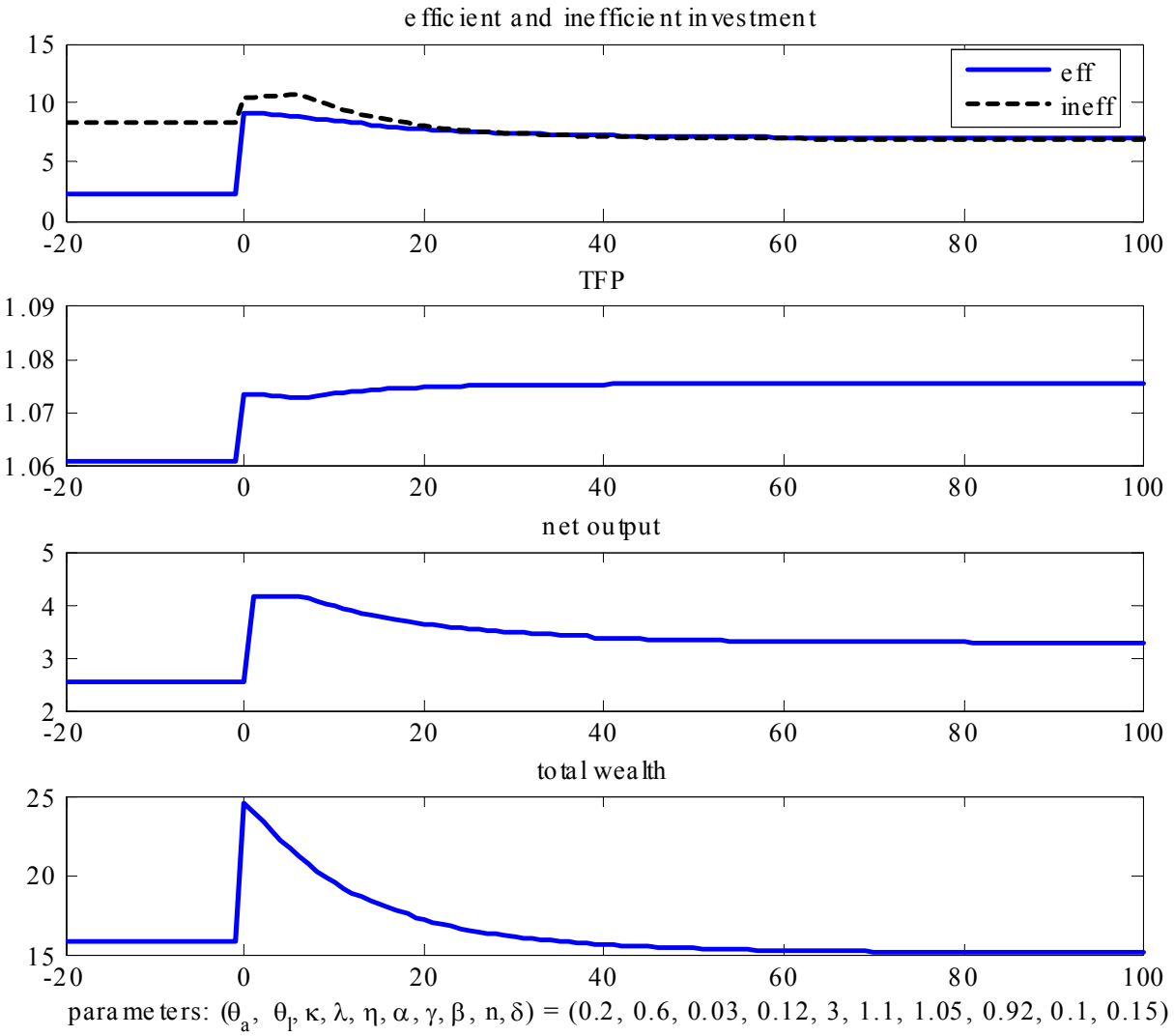

Figure 7-1: dynamics after liberalisation: capital outflow
theta increases from 0.6 to 0.76
(When theta = 0.76, interest rate under autarky is 1.07)

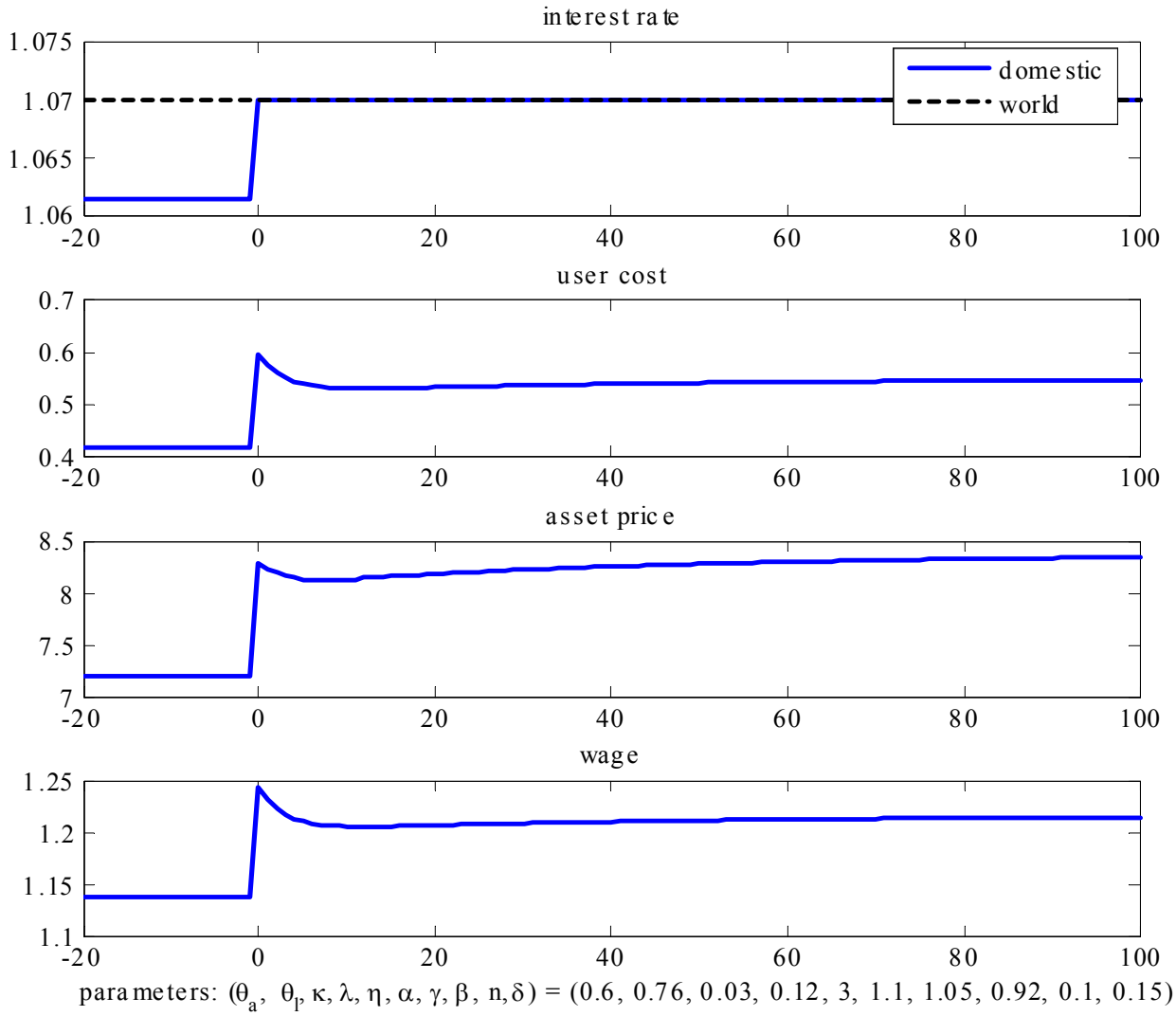

Figure 7-2: dynamics after liberalisation: capital outflow
theta increases from 0.6 to 0.76
(When theta = 0.76, interest rate under autarky is 1.07)

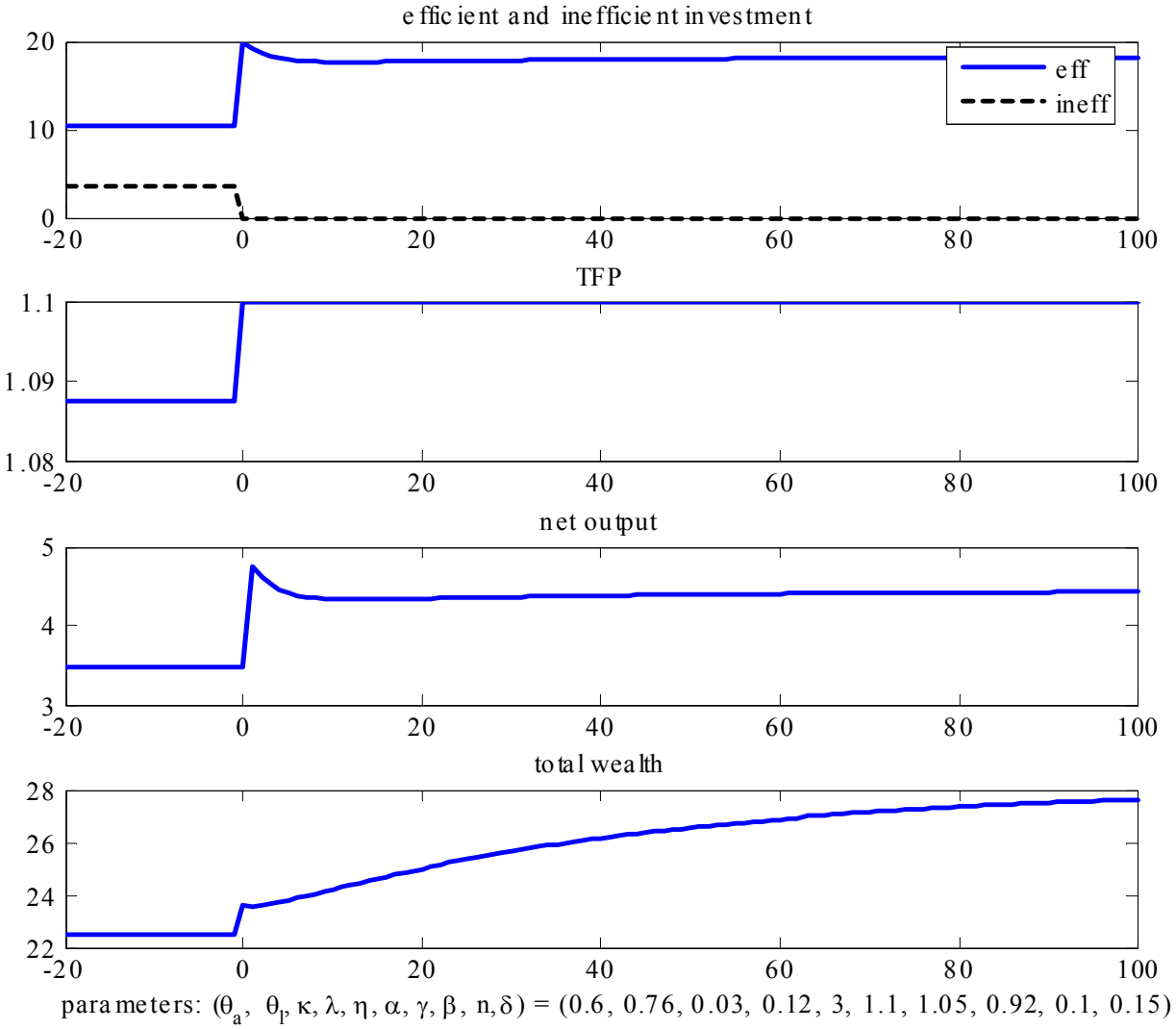

Figure 8-1: dynamics after shock to theta

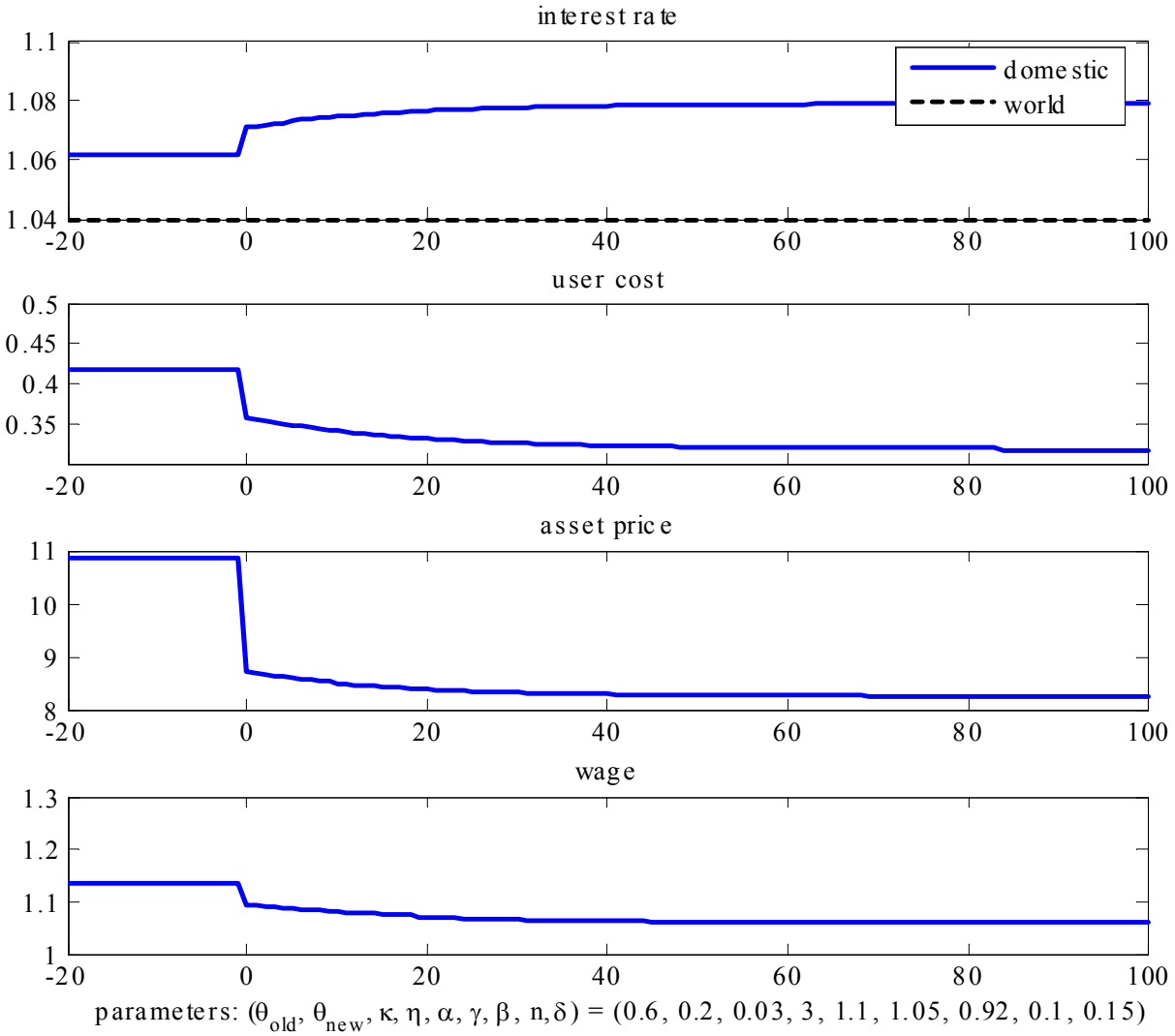

Figure 8-2: dynamics after shock to theta

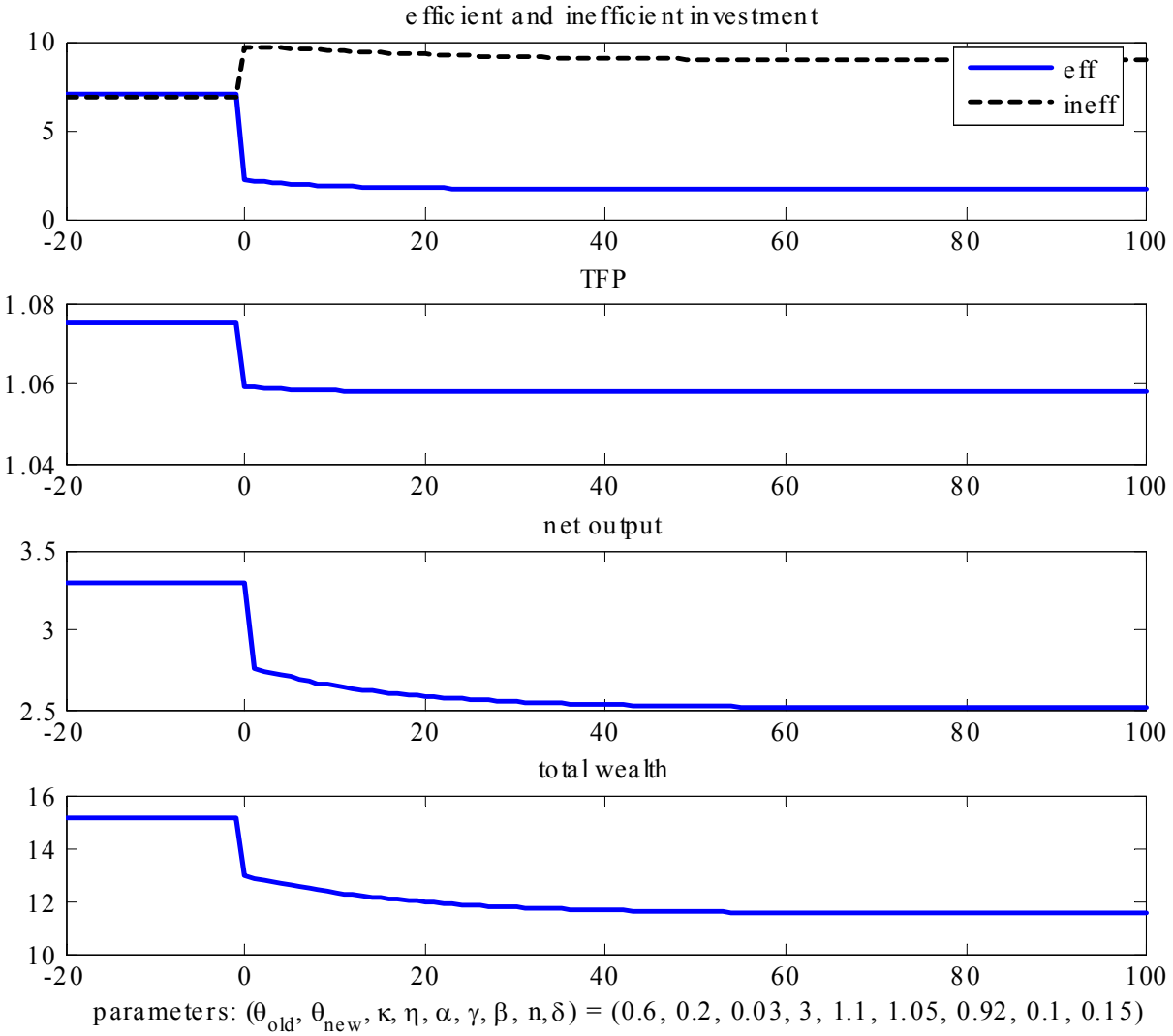

Figure 9-1: dynamics after shock to world interest rate

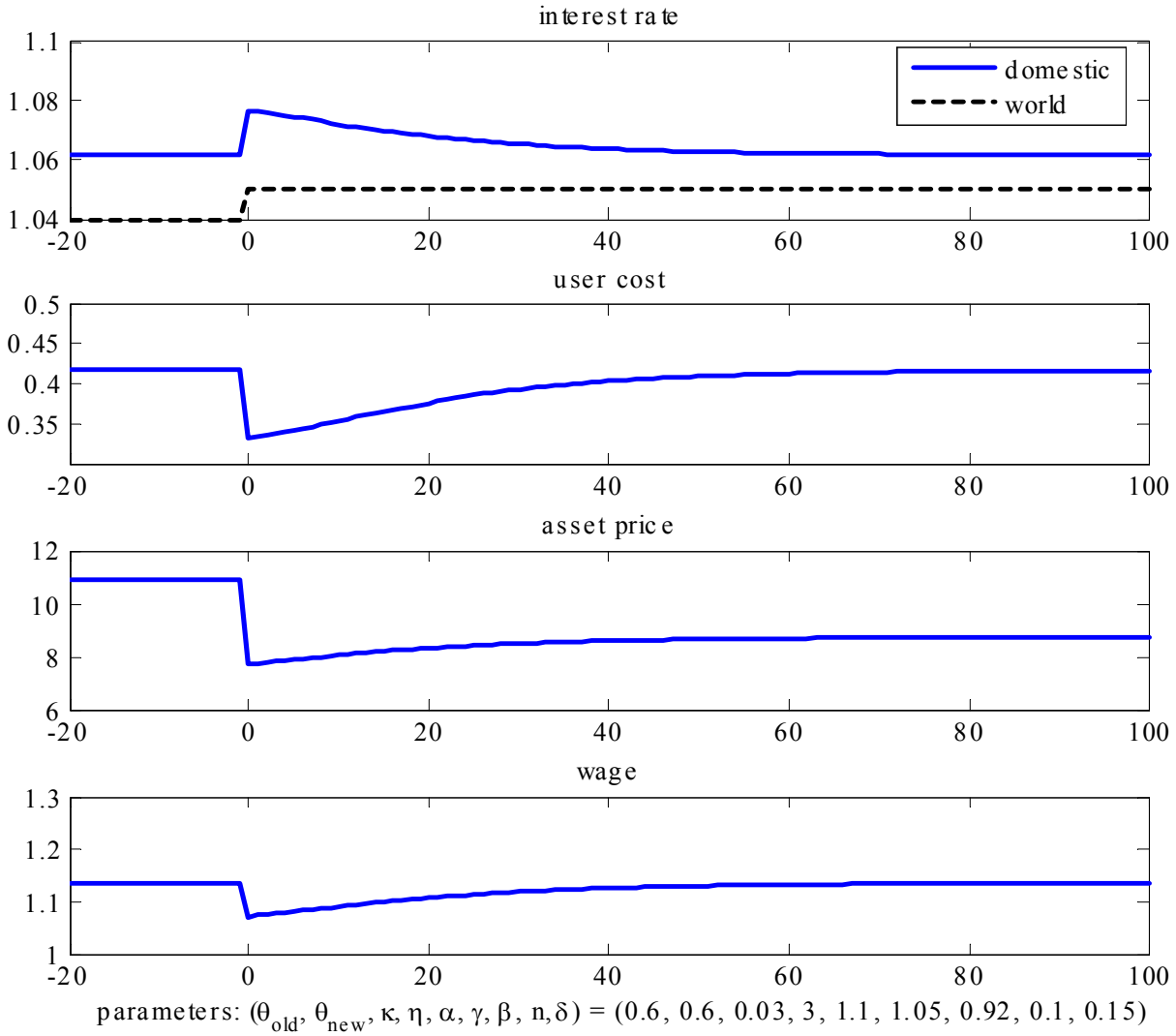

Figure 9-2: dynamics after shock to world interest rate

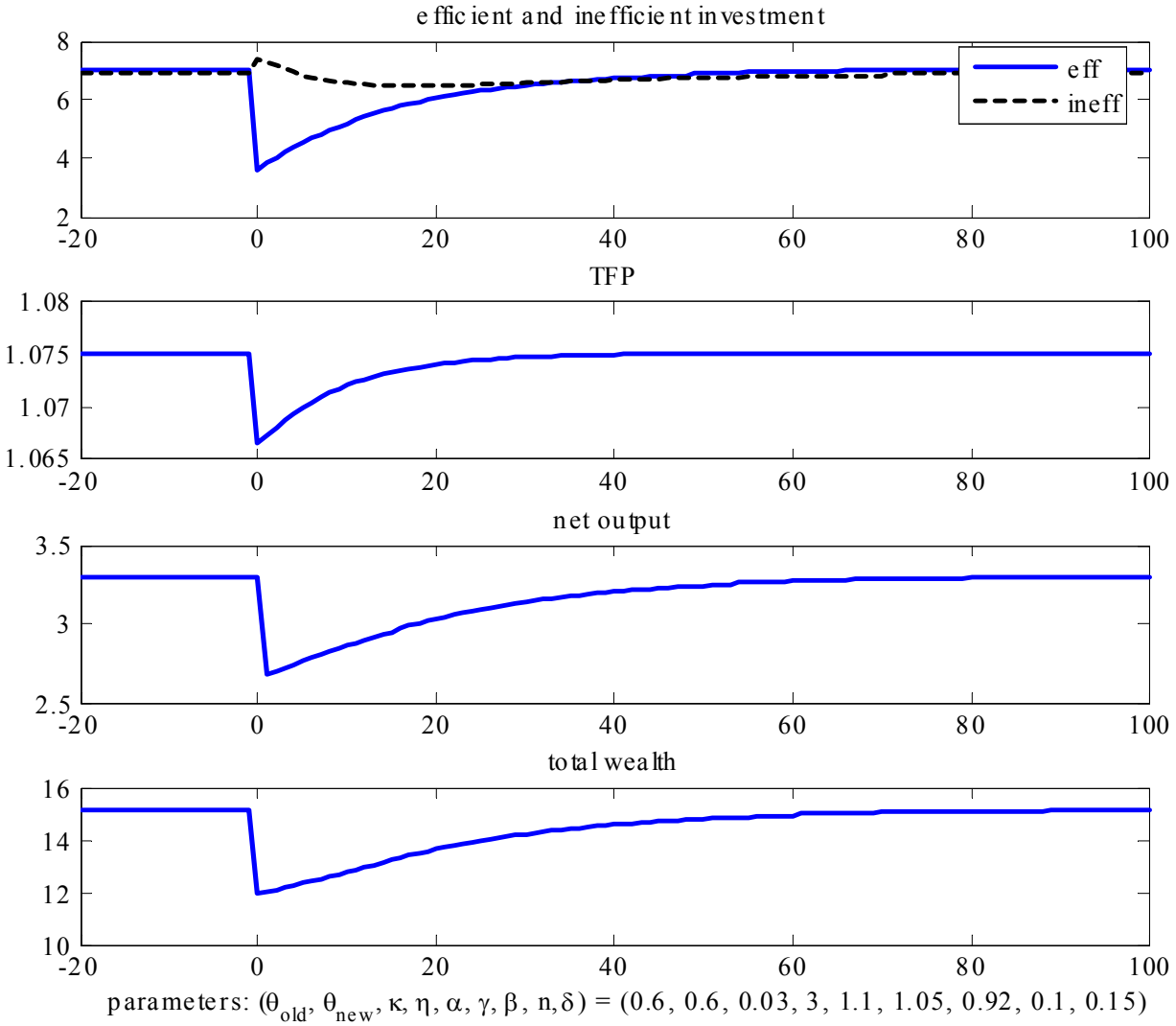

Table 2. Welfare analysis (For notations, see Note at the end of this table)

2-1. theta=0.2, rs=1.04 : capital inflow (*Figure 3*)				
entrepreneurs	productive-productive	productive-unproductive	unproductive-productiv	unproductive-unproductive
welfare gain (mu^i)	0.2931	0.2931	0.0493	0.0493
decomposition				
(1) log wealth change	0.53229	0.53229	0.32342	0.32342
(2) log rates of return (liberalisation)	0.87044	0.63827	0.87044	0.63827
(3) log rates of return (autarky)	1.1457	0.91355	1.1457	0.91355
(2) - (3)	-0.27528	-0.27528	-0.27528	-0.27528

workers	welfare gain (mu^w): (5)/(4)-1	(5) surplus (liberalisation)	(4) surplus (autarky)
	0.51370	0.48125	0.31793

2-2. theta=0.6, rs=1.04 : capital inflow (*Figure 4*)				
entrepreneurs	productive-productive	productive-unproductive	unproductive-productiv	unproductive-unproductive
welfare gain (mu^i)	0.6761	0.7024	-0.13239	-0.11877
decomposition				
(1) log wealth change	0.75067	0.75067	0.092208	0.092208
(2) log rates of return (liberalisation)	1.013	0.54983	1.013	0.54983
(3) log rates of return (autarky)	1.2472	0.76847	1.2472	0.76847
(2) - (3)	-0.23422	-0.21864	-0.23422	-0.21864

workers	welfare gain (mu^w): (5)/(4)-1	(4) surplus (liberalisation)	(5) surplus (autarky)
	0.37307	0.57294	0.41727

2-3. theta=0.6, rs=1.07: capital outflow (*Figure 5*)				
entrepreneurs	productive-productive	productive-unproductive	unproductive-productiv	unproductive-unproductive
welfare gain (mu^i)	-0.18723	-0.18723	0.0717	0.0717
decomposition				
(1) log wealth change	-0.29909	-0.29909	-0.022579	-0.022579
(2) log rates of return (liberalisation)	1.339	0.86026	1.339	0.86026
(3) log rates of return (autarky)	1.2472	0.76847	1.2472	0.76847
(2) - (3)	0.091784	0.091786	0.091784	0.091786

workers	welfare gain (mu^w): (5)/(4)-1	(4) surplus (liberalisation)	(5) surplus (autarky)
	-0.12289	0.36599	0.41727

Table 2 (continued)

2-4. theta increases from 0.2 to 0.6 following liberalization, rs=1.04 (*Figure 6*)				
entrepreneurs	productive-productive	productive-unproductive	unproductive-productive	unproductive-unproductive
welfare gain (mu^i)	0.77164	0.38446	0.38768	0.084408
decomposition				
(1) log wealth change	0.6435	0.6435	0.39922	0.39922
(2) log rates of return (liberalisation	1.0741	0.59536	1.0741	0.59536
(3) log rates of return (autarky)	1.1457	0.91355	1.1457	0.91355
(2) - (3)	-0.071591	-0.31819	-0.071591	-0.31819

workers	welfare gain (mu^w): (5)/(4)-1	(4) surplus (liberalisation)	(5) surplus (autarky)
	0.69566	0.5391	0.31793

2-5. theta increases from 0.6 to 0.76 following liberalization, rs=1.07 (*Figure 7*)				
entrepreneurs	productive-productive	productive-unproductive	unproductive-productive	unproductive-unproductive
welfare gain (mu^i)	0.12446	0.2717	-0.027941	0.099349
decomposition				
(1) log wealth change	0.16057	0.16057	0.014931	0.014931
(2) log rates of return (liberalisation	1.204	0.84826	1.204	0.84826
(3) log rates of return (autarky)	1.2472	0.76847	1.2472	0.76847
(2) - (3)	-0.04327	0.079787	-0.04327	0.079787

workers	welfare gain (mu^w): (5)/(4)-1	(4) surplus (liberalisation)	(5) surplus (autarky)
	0.30302	0.54371	0.41727

Note:

- **Welfare gain of an entrepreneur** (mu^i) represents the permanent increase or decrease in consumption that makes the agent indifferent between liberalisation and autarky. For example, welfare gain of 0.2931 in Table 2-1 means that welfare benefit of moving to liberalization from autarky is equivalent to the permanent increase in consumption of 29.31%. See equation (29).
- **Types of the entrepreneurs**: 'productive-productive' represents an agent who is productive just before liberalization (thus he is a borrower) and remains productive at the time of liberalization'. 'unproductive-productive' represents an agent who is unproductive just before liberalization (thus he is a lender) and switches to productive at the time of liberalization. The other two types are similarly defined.
- 'log wealth change' refers to the first term of the right hand side of equation (30) in the paper.
- 'log rates of return (liberalization)' refers to the second term of equation (30), and 'log rates of return (autarky)' refers to the third term.
- **Workers**: 'surplus (autarky)' refers to the second term of the right hand side of equation (31), and 'surplus (liberalization)' refers to the first term. Welfare gain of the workers is defined as the percentage change in the present value of surplus before and after the liberalization.