# Capital Flows and Asset Prices

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**Abstract**

We construct a model of small open economy in which it is difficult to enforce debtors to repay debt unless it is secured by the collateral, and assets and projects usable as collateral for international borrowing are more restricted than domestic borrowing. Using this model, we analyse how adjustment to capital account liberalisation depends upon the degree of development of domestic financial institution. It is shown that asset prices affect importantly on the dynamic adjustment of output and TFP during the adjustment process. We also analyse why the economy with underdeveloped financial system may be vulnerable to shocks to the condition of domestic and foreign credits.

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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. Typical examples in recent decades include Latin America in the late 1970s to 1980s, the Nordic countries in the late 1980s to the early 1990s, and East Asia in the mid to late 1990s. The standard theory interprets 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 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 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? How does the value of fixed assets

[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.

interact with domestic and foreign credits and aggregate production?

In order to address these questions theoretically, 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 labour to produce output in the following period. At each date, some entrepreneurs are productive while others are not. Here, the fixed asset plays a dual role: it is factor of production as well as collateral for loan. The borrower's credit limit is affected by the price of fixed asset. At the same time, 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. The extent to which future output becomes collateral depends upon both technology and the quality of institution, which affects the development of domestic financial system. We show that, if the domestic financial system is underdeveloped, the domestic financial system fails to transfer enough purchasing power from savers (typically unproductive entrepreneurs) to investing agents (productive entrepreneurs). Some funds are allocated towards unproductive entrepreneurs, being used with inferior technology, resulting in low total factor productivity (TFP) of the economy. The domestic interest rate remains low - a symptom of financial suppression, and the domestic wage and user cost of fixed asset remain low - symptom of wage suppression.

Moreover, we consider the extent to which assets and projects become collateral for foreign loan is restricted compared to domestic credits, because the foreign creditors generally have more difficulties in enforcing debts in a different country. Thus, the

constraint on international borrowing is tighter than domestic borrowing. If the international borrowing constraint is significantly tighter, 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 fixed asset in production, and the resulting relative severities of financial suppression and wage suppression.

When the domestic financial system is poor, the wage 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 productive and unproductive agents. The initial boom is amplified by the increase in asset price that further loosen 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; the share of production by productive entrepreneurs and TFP will eventually go back to the previous level.

For the intermediate level of domestic financial development, financial suppression is the dominant symptom under autarky, with the domestic interest rate which is lower than the foreign interest rate. After liberalization, there is capital outflow. The asset price falls sharply because the discount factor is higher and because the user cost of the asset is expected to be lower persistently anticipating future stagnation. The initial fall in asset prices hurts the productive agents more than the unproductive agents because

they had outstanding debt obligation. As a result, their share of production drops together with TFP. Aggregate output, employment, wage rate all fall. Despite this initial drop in TFP and aggregate production, eventually productive agents will benefit from cheaper wage and 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 understand why the economy with underdeveloped financial system is vulnerable to shocks to the condition of domestic and foreign credits after capital accounts liberalization, we do two further experiments: One is a shock to domestic finance and the other is shock to foreign interest rate. For the shock of domestic origin, we consider 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. With the reduction of domestic credit, the productive entrepreneurs who face credit constraint shrink their production. Aggregate production and asset prices fall. The fall in asset prices particularly hurts the productive entrepreneurs with leverage, which further reduce aggregate production. The fall in asset price also tighten both domestic and foreign credits, leading to a higher domestic interest rate. The contraction stops because unproductive entrepreneurs will benefit from lower production cost, expanding their production, but TFP decreases endogenously during the recession.

In order to see how the economy reacts to an external shock, we also examine the effect of a unanticipated increase in the foreign interest rate. We find that with fall in collateralizable asset price, both foreign and domestic credit tighten, which push up the domestic interest rate more than the initial increase in the foreign interest rate. The

decrease in asset prices has more negative effects on productive agents so that aggregate production shrinks with endogenously deteriorating TFP.

There is an extensive literature on the implications of credit frictions, both domestic and international, on international capital flows and capital account liberalization. Our paper is 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) consider 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) considers a small open RBC model with collateral constraint to consider the role of asset prices on the Sudden Stops. The mechanism is similar to what we consider in this paper. Fluctuations in asset prices provide a propagation mechanism, as is emphasized by Kiyotaki and Moore (1997). A difference is that in our model changes in TFP are endogenously determined by changes in the allocation of resources among agents with different productivity levels, while in Mendoza (2006) those are caused by exogenous productivity shocks and capacity utilization.

The third strand of literature examine is the relationship between domestic and international financial frictions. Caballero and Krishnamurthy (2004) emphasize the in-

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

teraction between domestic financial constraints and international borrowing constraints for financial crises by constructing a model where firms are subject to liquidity shock. In their model, intact firms act like financial intermediaries, i.e., they borrow against international collateral and lend to distressed firms. Since domestic collateral constraint lowers the domestic rate of return of saving, agents tend to under-save — they hold too little international collateral, which makes the economy more vulnerable to adverse shocks. Another related paper is Kaminsky and Reinhart (1999) who empirically examine the 'twin crisis': banking and balance-of-payment crisis. The paper found that problems in the banking sector typically precede a currency crisis. While our paper does not explicitly model banking sector, it provides a framework to analyze how domestic financial problem interact with international capital flows.

# 2 Model

## 2.1 Framework

We consider a small open economy with one homogeneous goods, land and labour. There are three types of continua of infinitely lived agents: entrepreneurs, workers, and foreigners. Entrepreneurs use land, labour and material goods to produce goods. Workers, who do not have production technology, simply supply labour to finance their consumption. Foreigners lend to and borrow from the entrepreneurs and workers - home residents of the small open economy - at a constant real gross interest rate $r^*$.

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 to use 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 $\kappa$ and $\lambda$ 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 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 agent follows a two

state Markov process[3] :

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

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 indispensable skill, the producer is free to walk away from production before completing the production. Besides the producer, there is a lead creditor who monitors the project throughout, and has some skill to obtain $\theta$ ($< 1$) fraction of maximum amount of output, if she takes over the entrepreneur's production. 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 from production and debt obligation. 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

[3]This transition matrix implies that the fraction of productive entrepreneurs is stationary over time 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 the condition that the productivity of each agent is positively correlated between present and the next periods. We intorduce 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 enternal finance even in the steady state.

$k_t$ 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 $\theta$ fraction of output plus the future value of collateral land[4]:

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

We take $\theta$ as an exogenous parameters 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

[4]If the producer-borrower threatens to walk away from production in order to renegotiate with the creditors before the production is completed, it is efficient for the entrepreneurs to pay some amount to creditors in order to complete the production, (which maximizes output). Assume that the outside creditors are weak against the producer and the lead creditor in the debt renegotiation, the outside creditors will be paid the value of collateral land in order to give up their 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).

Then, the lead creditor and the producer-debtor negotiate payment. Again we assume the lead creditor is weak in bargaining agaist the producer. Thus, after the producer pays as much as $\theta$ fraction of mamimum output and the value of collateral land to the all creditors, the producer is allowed to complete the production to obtain $1-\theta$ fraction of maximum output. The resourse allocation is efficient ex post through the negotiation. But the ex ante resourse 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.

hand side (LHS) of the flow-of-fund constraint is expenditure; consumption $(c_t)$, net purchase of land $(q_t(k_t - k_{t-1}))$, 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 domestic and foreign creditors –, and the external finance of the borrowings from home and foreign creditors.[5]

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 (1) subject to the constraints of technology and finance (2), (4), (5).and (6).

Next, we turn to workers. Unlike 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[6],

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

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

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

[5] 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.

[6] We assume this form of utility function in order to abstract from the income effect of labour supply.

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

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

Throughout the analysis, we assume that there is no limitation on domestic lending to foreigners at the foreign interest rate. We also assume the foreign interest rate is strictly less than the home time preference rate:

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

Let us denote aggregate consumption of productive entrepreneurs, unproductive entrepreneurs, and workers as $C_t$, $C_t'$, and $C_t^w$. (Similarly 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, etc.)[7]. Supply of land is fixed at $\overline{K}$. The market clearing condition for land, labour, goods, and domestic credit are written as:

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

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

[7]In what follows all aggregate variables are denoted in capital letter.

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

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

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 $(c_t, k_t, l_t, m_t, y_{t+1}, b_{t+1}, b^*_{t+1}, K_t, K'_t, L_t.L'_t, Y_t, Y'_t, C_t, C'_t, C^w_t, M_t, M'_t, B_{t+1}, B'_{t+1}, B^w_{t+1}, B^*_{t+1}, B^{*\prime}_{t+1}, B^{*w}_{t+1})$, 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

In what follows we 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 leading to an inconsistency in the market equilibrium conditions.

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 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 $\beta$ 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 $\theta$ 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 comparable to the domestic interest rate:

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

This would hold with equality when 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., $r_t < 1/\beta$).[8] The aggregate consumption of the workers is equal to the aggregate wages:

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

[8] 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, then the domestic and foreign interest rates are equal, as domestic credit market is completely 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 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 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 value of the land and debts of the productive entrepreneurs and foreign debt of the unproductive entrepreneurs ($K_{t-1}$, $B_t$, $B_t^*$ and $B_t^{*\prime}$) [9].

Note here that after 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 $\tau$ is described recursively as a function of the variables $(Z_\tau, s_\tau)$ along the perfect foresight equilibrium path.

Finally, in the subsequent analysis it would be of interest to examine the behavior

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

of the total factor productivity (TFP) of the economy. We define TFP as the ratio of total gross output over total input measure:

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

where $b_t \equiv \frac{K_t}{\bar{K}} = \frac{L_t}{L^s} = \frac{M_t}{M_t + M'_t}$. Equation (23) shows that TFP depends on the ratio of factor inputs of the productive agents, $b_t$. In particular we are interested in analyzing how TFP is affected by capital account liberalization and interacts with asset price dynamics.

# 3 Steady state under autarky

Before looking into how the economy adjusts to capital account liberalization, it is useful to first 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 nor lend, 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, the equilibrium conditions (7), (8), (13), (15), (16), (19), (20), (21) and (22) can be written as

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

$$uK + wL + M \leq \frac{\beta s Z}{1 - \frac{\theta}{r}\alpha/(u^{\kappa}w^{\lambda})}, \tag{26}$$

$$\frac{\gamma}{u^{\kappa}w^{\lambda}} \leq r, \tag{27}$$

$$q\overline{K} + w^{1+\eta}\overline{L} + M + M' = \beta Z, \tag{28}$$

$$x = \frac{\alpha - ru^{\kappa}w^{\lambda}}{ru^{\kappa}w^{\lambda} - \alpha\theta}, \tag{29}$$

$$1 = \beta(1 + X)r, \tag{30}$$

$$F(X, x) = X^2 + \left[\delta(1 + n) - (1 - \delta)x\right]X - n\delta x = 0, \text{ and } X \geq 0. \tag{31}$$

In the steady state equilibrium of the autarky economy, these equilibrium conditions determine $(r, w, q, u, x, s, X, K, L, M, M', Z)$ endogenously[10]. In particular we are interested in understanding how the autarky equilibrium depends upon the degree of domestic financial development $\theta$ and the share $\kappa$ of land which serves as collateral for loan.

[10] We have 11 equations (24-31) where (25) contains 4 equations, in addition to the definition of $X$.

From the domestic credit constraint (5), the tightness of the credit constraint depends upon both the share of collateralizable land in production ($\kappa$) and the fraction of future output usable as collateral for domestic loan ($\theta$) - the degree of domestic financial development. In Appendix, we show that if the degree of domestic financial development $\theta$ is below a threshold level $\overline{\theta}$, 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. When the domestic financial system is underdeveloped (so that the domestic credit constraint is tight), 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. The threshold value of $\overline{\theta}$ depends critically, among other things, on the share of land $\kappa$, and $\overline{\theta}(\kappa)$ is a decreasing function of $\kappa$. Intuitively, the higher the share of land $\kappa$ is, the more valuable the collateralizable land is, the economy can transfer enough purchasing power to achieve the productive efficiency even if the fraction of future output to become collateral ($\theta$) is low.

Figure 1 shows the relationship between domestic real interest rate and the degree of domestic financial development $\theta$ 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 with 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 $\alpha$, closer to the productivity of the unproductive entrepreneurs $\gamma$. 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, (27) holds with equality. Because TFP, wage rate, user cost and the unit cost of production are all increasing function of $\theta$, the interest rate is decreasing function of $\theta$ in the region $\theta < \overline{\theta}(\kappa)$. Intuitively, suppression of TFP and the factor prices dominates the effect of financial suppression here: the lower $\theta$ is, the lower is the unit cost of production for the unproductive entrepreneur, the higher is the 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.

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, $\theta$. Figure 2 is useful to understand the direction of capital flow following the liberalization as a function of $\theta$, for a given share of land in the production. In that Figure, the world interest rate is also plotted as a horizontal line. Generally, there are three regions. When $\theta$ is very low, lower than $\theta_1$, 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 comparable to the domestic real interest rate. Then, after liberalization, both productive and unproductive entrepreneurs borrow from foreigners. In fact, the unproductive entrepreneurs simultaneously borrow from foreigners and extend loans to the productive entrepreneurs, acting as financial intermediaries.

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, the domestic interest rate is equalized with the foreign interest rate with capital outflow.

For high values of $\theta$, $\theta > \theta_2$, the domestic financial system is advanced enough so that only productive entrepreneurs produce and that the interest rate is high with minimum 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 the next Section, we analyze the dynamics of the economy following capital account liberalization. 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]

[11] When $\theta$ is higher than $\bar{\theta}$, TFP (defined by equation (23)) already reaches its maximum value, $\alpha$.

# 4 Transition dynamics

We now consider various experiments to understand how the adjustment to capital account liberalization depends on the degree of development in the domestic financial institution. Also, we examine how the economy reacts to the shocks to the condition of domestic and foreign credits. Our analysis is based on a calibrated model but our results need to be interpreted in a qualitative way. The parameter values of the model are reported in Table 1.

## 4.1 Capital account liberalization: the role of asset prices

Figure 3 shows the dynamics of the economy following capital account liberalization. Before time 0, the economy is at the autarky steady state, and liberalization occurs at time 0. Here we assume $\theta = 0.2$ and the world interest rate is set to 1.04. In this case the autarky interest rate is above the foreign interest rate, and capital account liberalization causes capital inflow and expansion of output. Immediately after the liberalization the land price, $q_t$, jumps up. Now the agents can borrow from foreigners at a cheaper rate against land. Comparison of equation (11) and (24) imply that the liberalization effectively decreases the discount factor of the asset price equation. The land price jumps up also because the agents anticipate that the future user costs will be higher due to economic expansion. This is why countries often experience large upward swings in asset prices after capital account liberalization.

The dynamic adjustment is characterized by a temporary boom followed by stagnation. Immediately after the liberalization, both productive and unproductive entre-

preneurs can expand production by borrowing from abroad at a cheaper interest rate. The increase in asset prices expands the international borrowing capacity of domestic agents and amplifies the initial boom. Similar to Mendoza (2006), asset prices serve as amplification mechanism.

However, differently from Mendoza (2006), asset prices in our model have important implications for the average efficiency of the economy and its effect interacts with the degree of development of domestic financial system ($\theta$). The initial jump in asset price works more in favour of the productive agents, because because they had outstanding debts against the unproductive agents before the liberalization. However, since the unproductive agents were not leveraging prior to the liberalization, they can expand production disproportionately by borrowing from foreign. Figure 3 shows that when $\theta$ is not very high the second effect dominates. TFP decreases even though net output increases.[12]

Because of the initial jump in the asset price, the net worth of the entrepreneurs increases immediately after the liberalization. At the beginning, the international borrowing constraint is not binding so that the domestic interest rate drops down to the world interest rate. As the country accumulates net foreign debt, the total net worth of the agents decreases, and in the mean time, the international borrowing constraint becomes binding. Output starts shrinking and then converges to the new steady state value. The new steady state value of output is only slightly higher than the autarky equilibrium.

In order to understand how the level of financial development interacts with asset

[12] In the next example, we see that the first effect can dominate.

prices, Figure 4 shows the case $\theta = 0.6$; more developed domestic financial system. In this case, immediately after the liberalization the productive entrepreneurs absorb all the savings so that the unproductive production is eliminated temporarily. As before, the initial jump in asset price enables productive agents to expand production. Large $\theta$ means that they have large capacity to borrow from domestic lenders. Contrary to Figure 3, TFP temporarily increases. Compared with Figure 3, the temporary boom is even larger because of this increase in TFP. Another difference from Figure 3 is that it takes longer for the international borrowing constraint to become binding. This occurs because a higher $\theta$ implies high average efficiency of the economy, and thus, higher asset prices. Thus international collateral becomes bigger. Similar to Figure 3, in the long run the economy stagnates. Figures 3 and 4 show that, even though the liberalization and the resulting increase in asset price increases the borrowing capacity of the agents, the resource allocation does not necessarily improve.

In Figure 5 we set the foreign interest rate to $r^* = 1.07$ so that under autarky the interest rate is lower than the foreign counterpart, contrary to Figures 3 and 4.[13] In this case, the economy experiences capital outflow and temporary stagnation. The interest rate jumps to the foreign interest rate. Asset prices also jump down because the discount factor is higher and the user cost of land decreases due to stagnation. The initial decrease in asset prices hurts the productive agents more than the unproductive agents because they were leveraged. As a result, their production shrinks markedly. On

[13]In Figure 5 $\theta$ is set 0.6. When $\theta$=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 $\theta$ — capital inflow with low $\theta$ and capital outflow with high $\theta$ (but not too high). When $\theta$=0.2 and $r^* = 1.07$, the dynamics of the economy is similar to Figure 3.

the other hand, the unproductive agents will initially benefit from the drop in production costs and increase their production (they also suffer from the surprise decrease in net worth but the positive effect caused by lower production costs is bigger). Thus TFP drops and it contributes to the decrease in net output further. However, the decrease in production cost in the following periods is in favour of the productive agents, and they start increasing their production size. In the end, the productive agents can absorb all the saving and unproductive production disappears. Thus, capital account liberalization causes temporary recession but increases long-run efficiency, as is shown in Aoki et al. (2006). Differently from Aoki et al. (2006), the dynamics of asset prices causes temporary drop in TFP as well as output.

## 4.2 Shock to Domestic Credit

Anecdotal evidences suggest that 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 related with each other.[14].

In order to examine this issue, we conduct the following crude exercise. We consider a drop in the domestic collateral factor $\theta$ from 0.6 to 0.2. The dynamics of the economy in this case in Figure 6. In Figure 6, it is assumed that before time 0 the economy is at its steady state under open capital account with foreign debt outstanding, and $\theta$ drops at time 0. The purpose of this exercise is to examine the propagation mechanism

[14]See, also, Honkapohja et al (2006) for the case of Finland, and Englund (1999) for the case of Sweden.

of a domestic financial problem (for example, domestic banking crises) to international borrowing and its implication for the open economy.

Following the drop in $\theta$, the economy experiences a sudden drop in asset prices. This occurs because a decrease in $\theta$ represents the decrease in borrowing capacity of agents in the domestic financial market, thus aggregate output and the user cost decrease. The drop in asset price further decreases the productive production because of its negative effect on the productive agents' net worth. 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 decreases further the production. Therefore, the domestic collateral constraint and international collateral constraint reenforce with each other through asset prices, and this fact serves as yet another amplification mechanism. On the other hand the unproductive agents will benefit from lower production cost and increase their size. Therefore, TFP endogenously decreases, which is yet another factor that contributes to decrease in asset prices.

## 4.3 Vulnerability to foreign interest rate shock

External factors are often referred as a cause of financial crisis.[15] We examine how an exogenous increase in the foreign interest affects our economy. Figure 7 shows the responses of the economy when the foreign interest rate increases from 4 % to 5 % at time 0. Before time 0, it is assumed that the economy is at the steady state under open capital account with foreign debt position.

[15] See, Honkapohja and Koskela (1999) for how high interest rates in Europe after German unification contributed to the Finnish depression in the 1990s.

In response to a 1 % increase in the foreign interest rate, the domestic interest rate initially increases more than 1 %. This is again due to the contraction through the asset price fall. Following the increase in the foreign interest rate, asset prices drop 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.

As in the other cases, the drop in asset prices has negative effect on productive agents with leverage more than the unproductive agents. As the result, their production decreases more than that of the unproductive agents. Thus TFP deteriorates, contributing to further decrease in output.[16]

# 5 Conclusions

[to be added]

[16] On the contrary, net TFP improves because the production cost decreases. This effect dominates the negative effect of the expansion of the unproductive agents.

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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

The model is calibrated yearly. Since in our model material good input includes both working capital and fixed capital, we set its share, 1-κ- λ, 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 β=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, α-γ, 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/δ = 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.

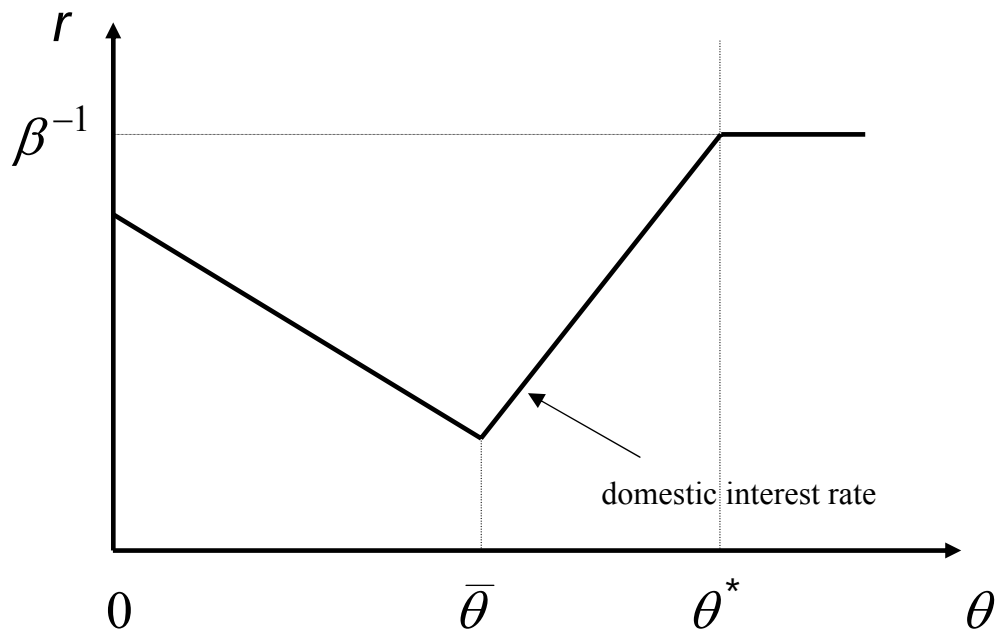



Figure 1: Steady-state interest rate under autarky

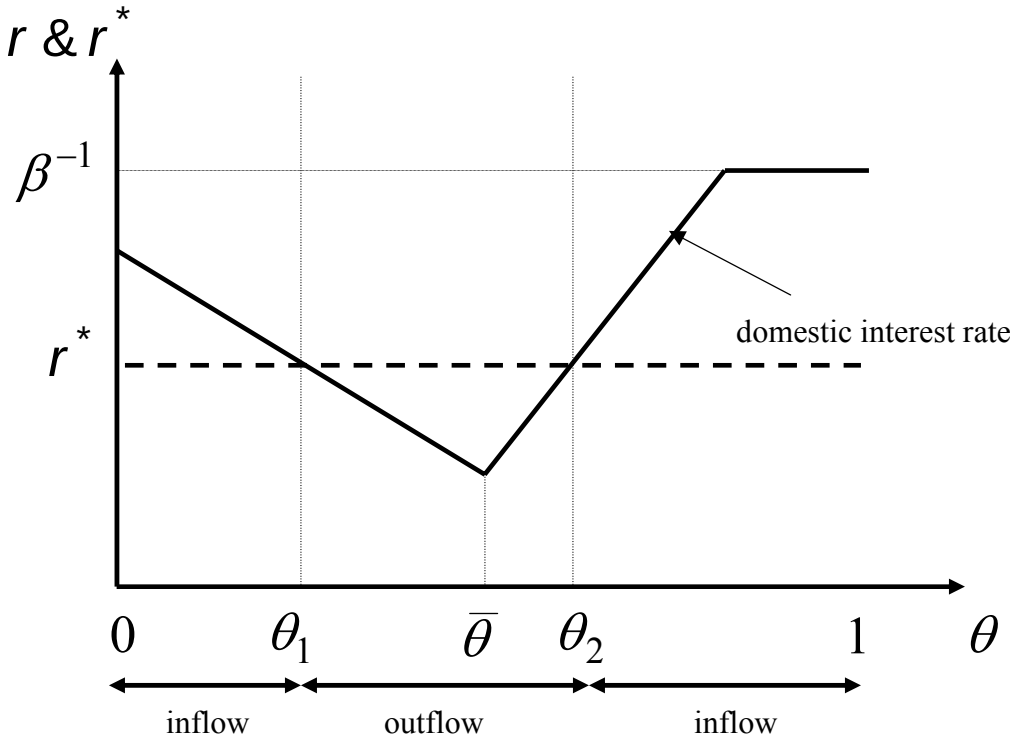



Figure 2: Capital flow after liberalisation

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

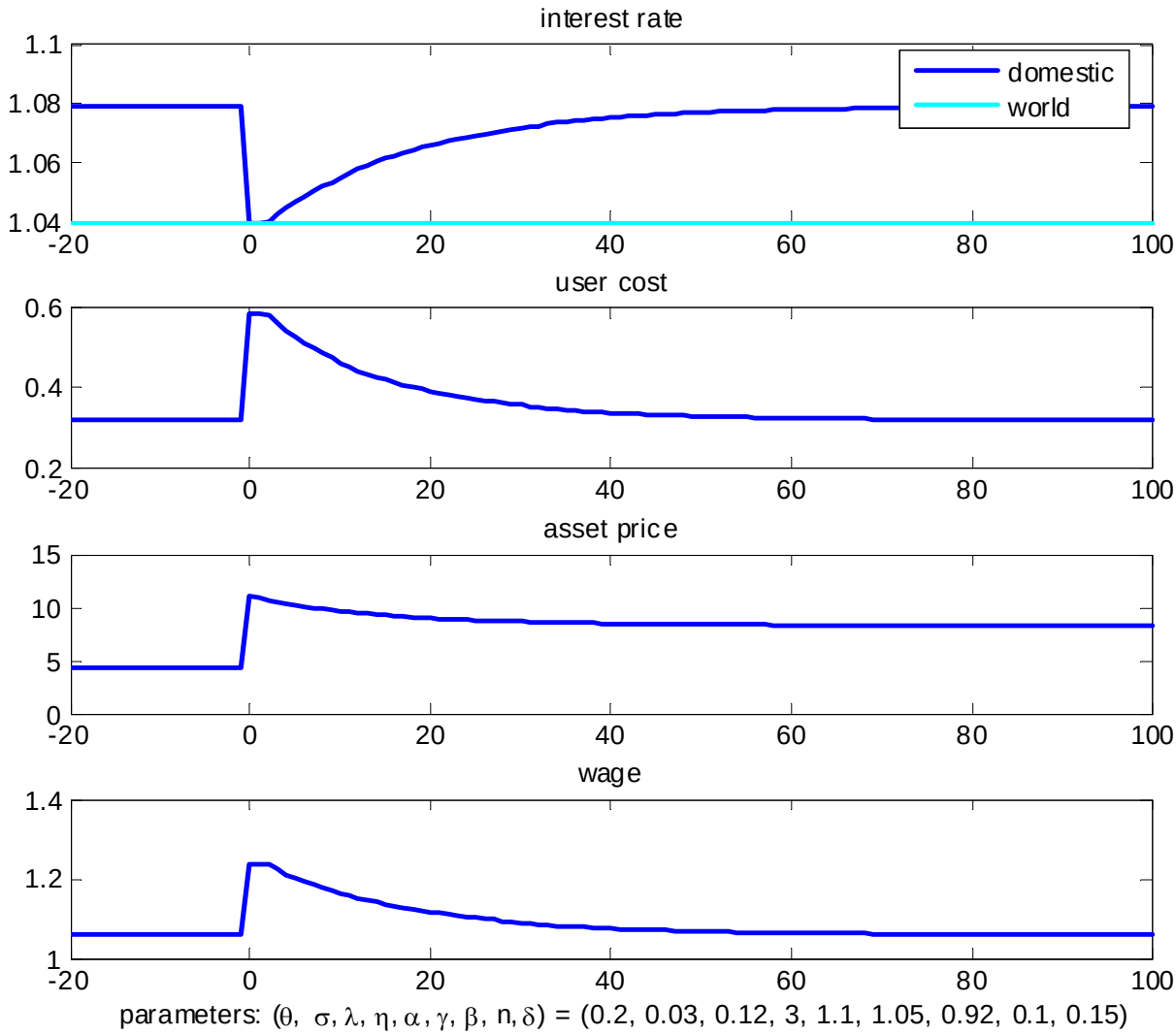


Figure 3-2: dynamics after liberalisation: capital inflow (low theta)

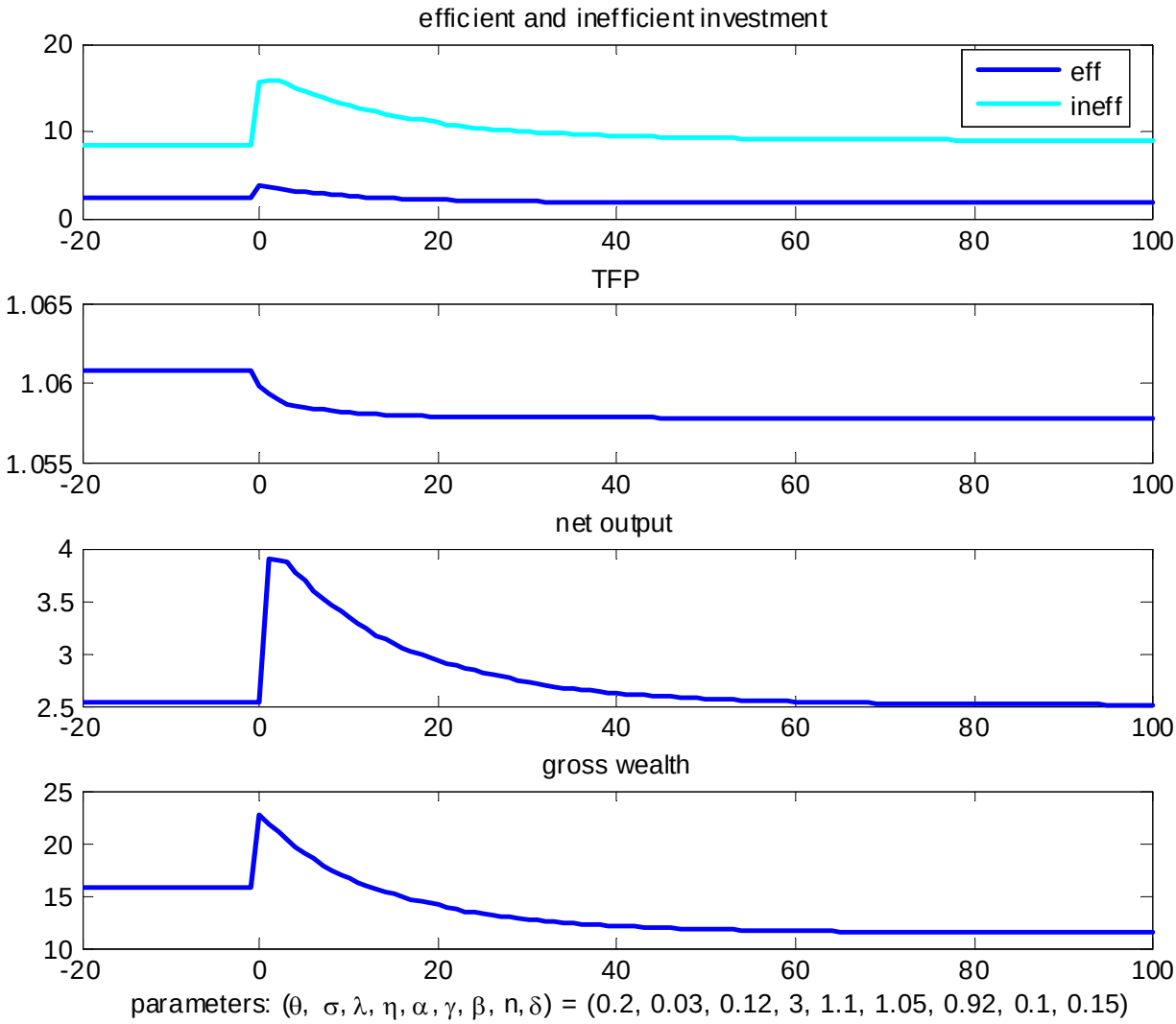


Figure 4-1: dynamics after liberalisation: capital inflow (high theta)

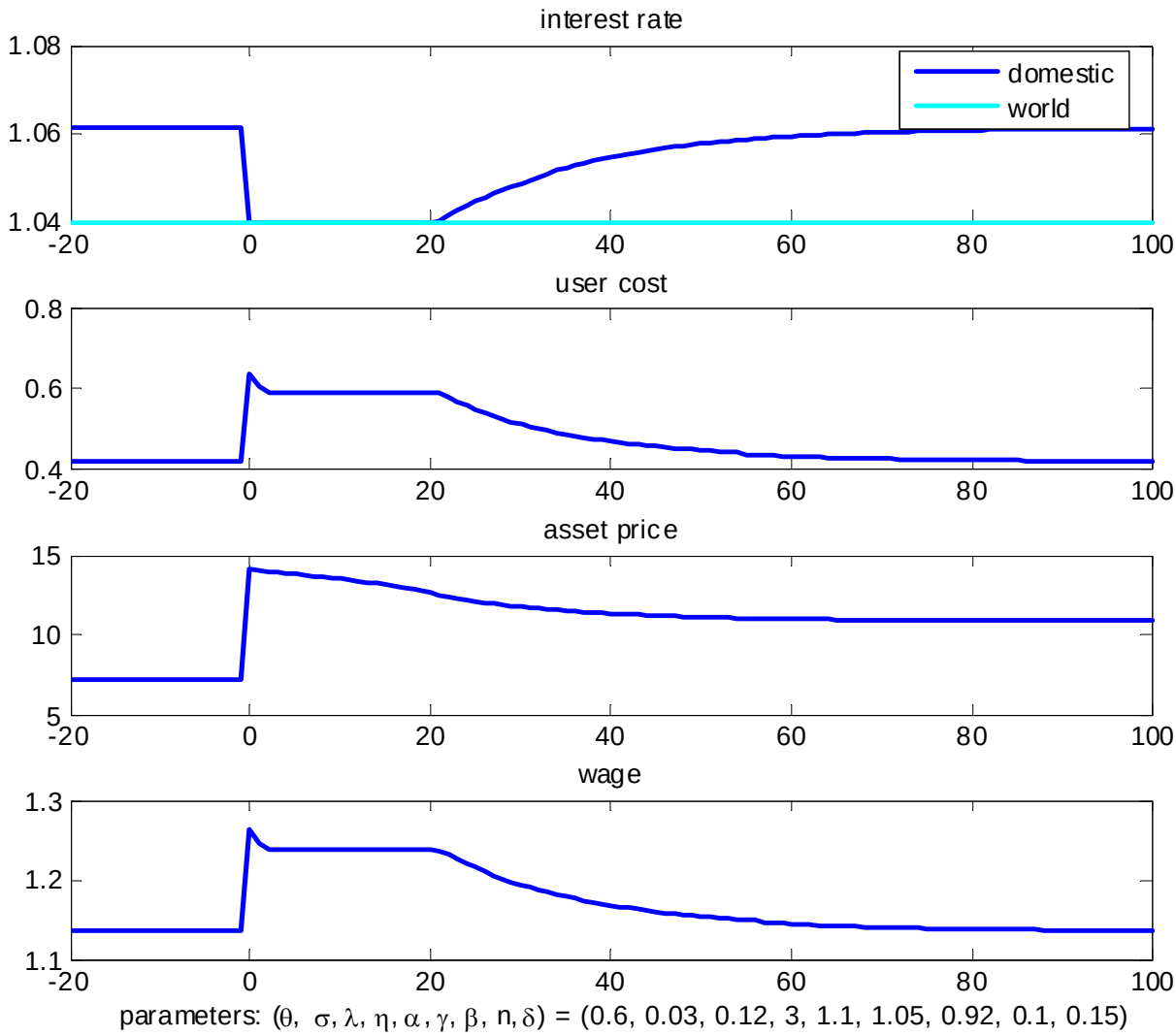


Figure 4-2: dynamics after liberalisation: capital inflow (high theta)

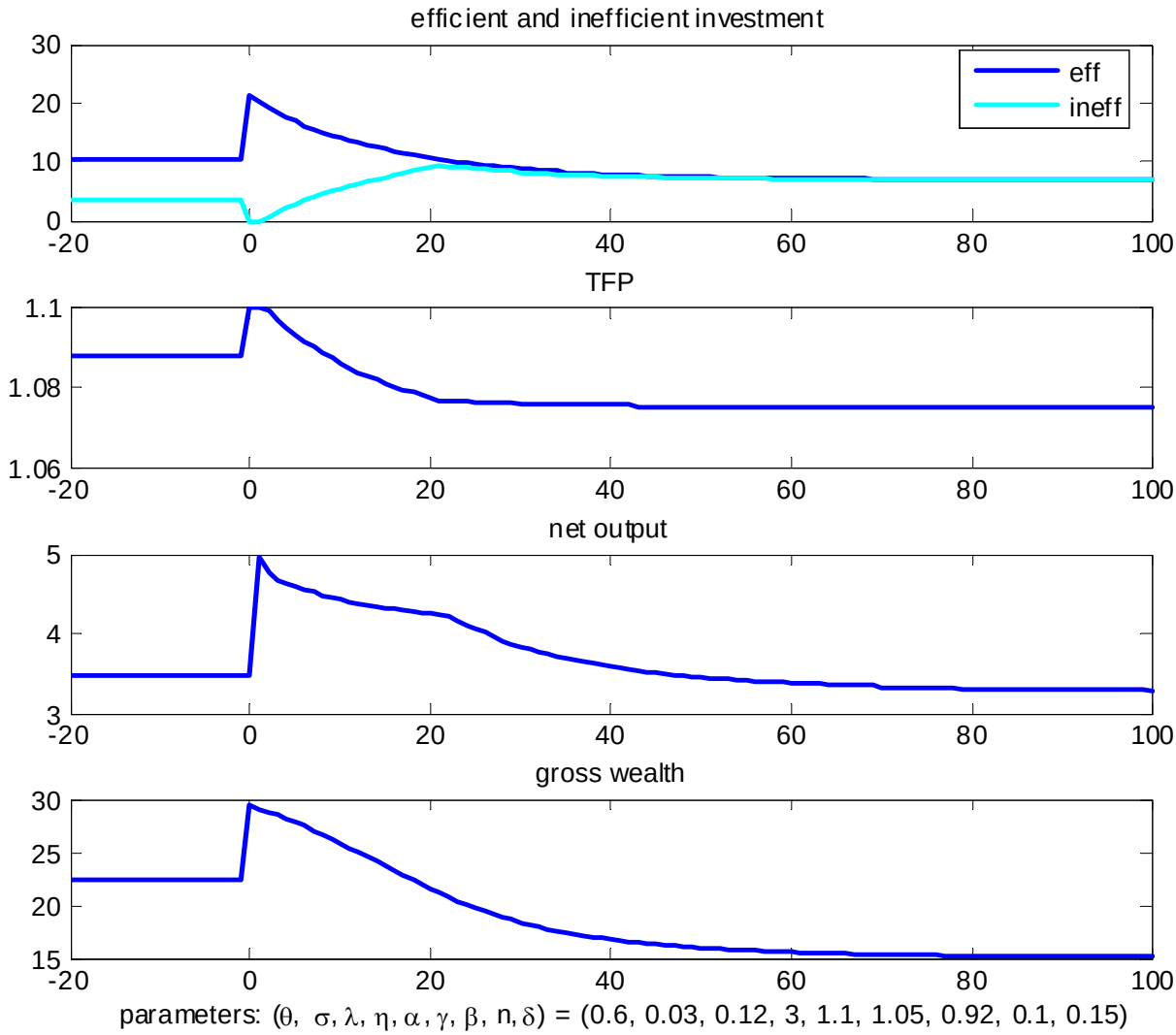


Figure 5-1: dynamics after liberalisation: capital outflow

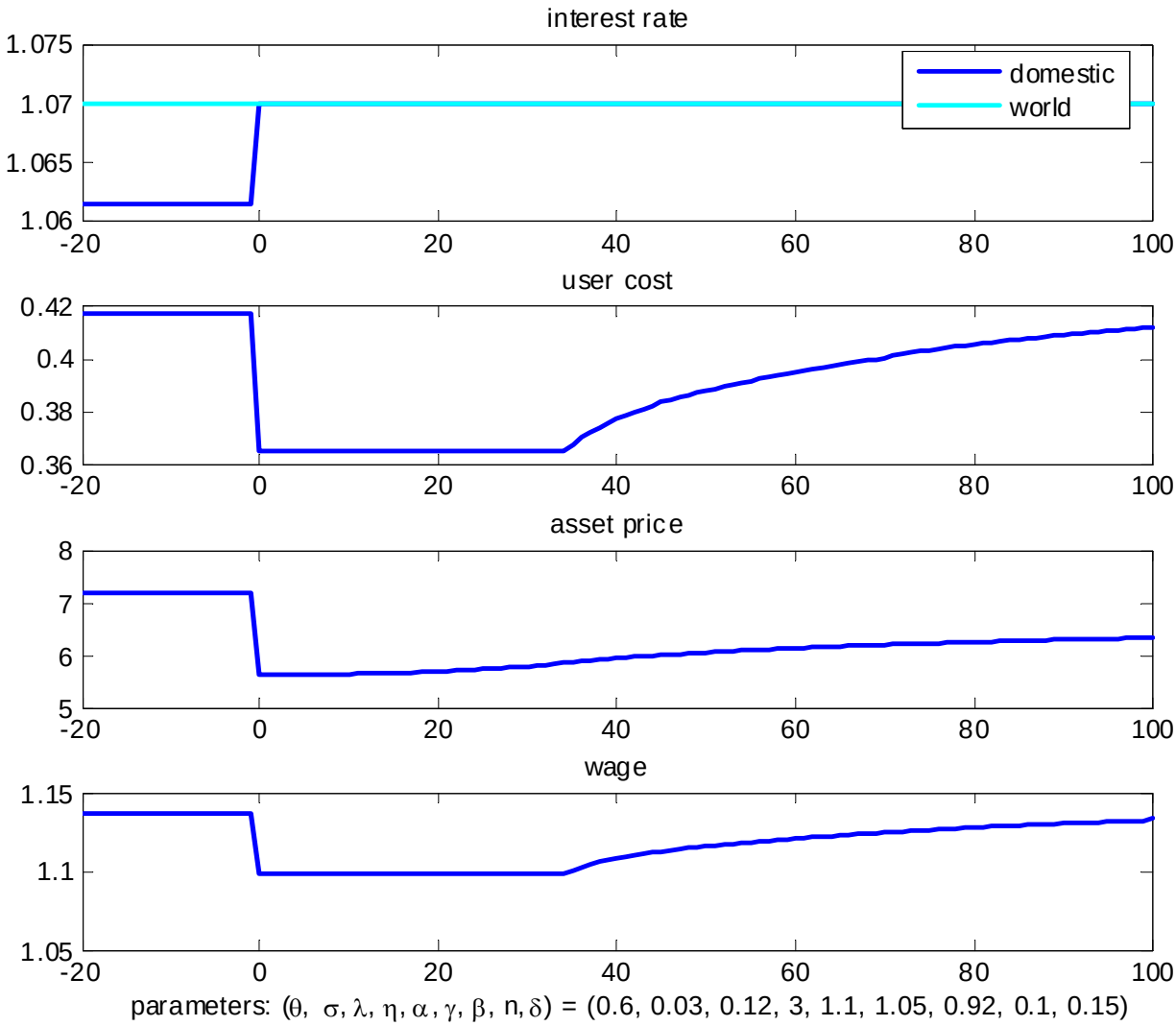


Figure 5-2: dynamics after liberalisation: capital outlow

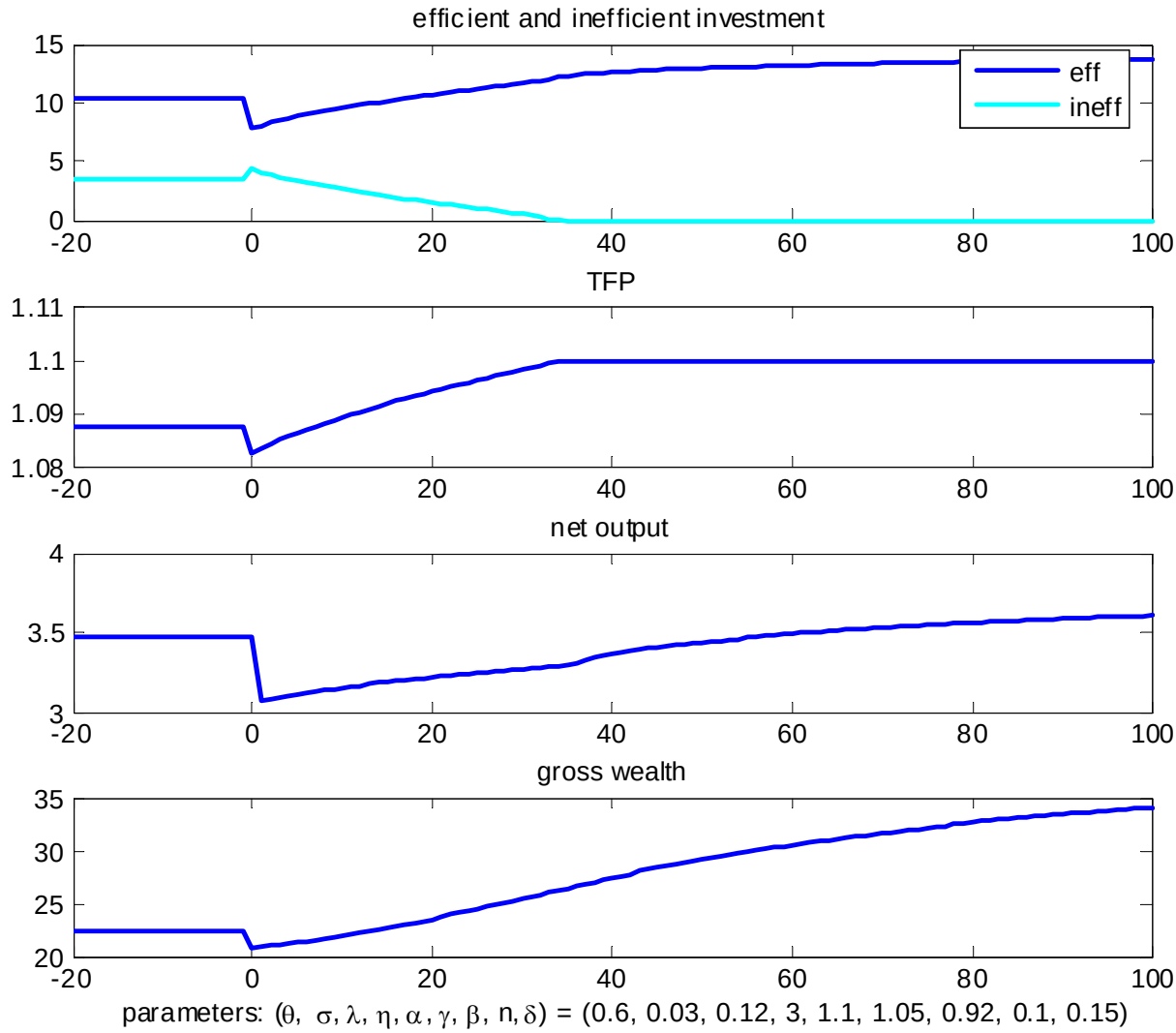


Figure 6-1: dynamics after shock to theta

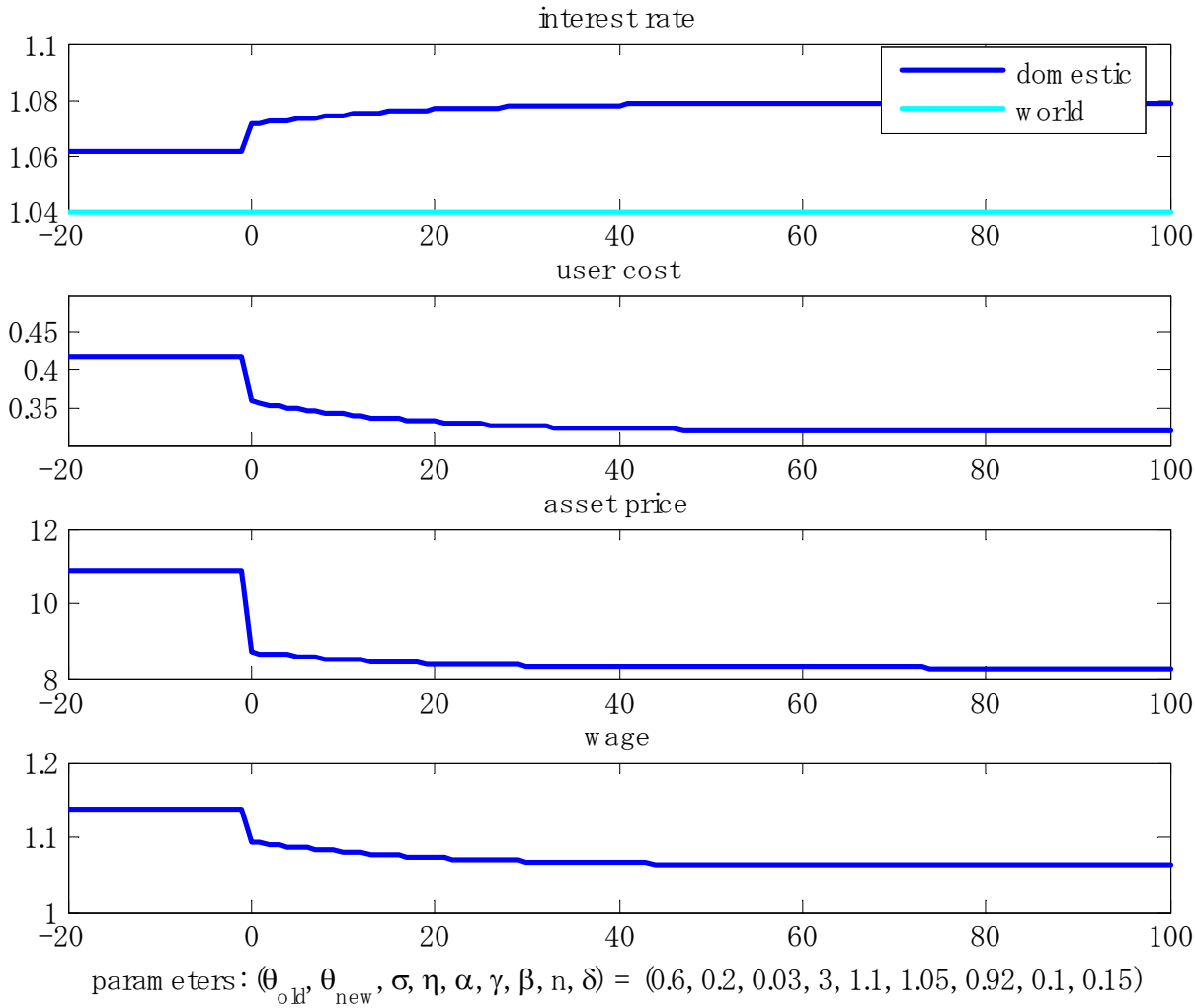


Figure 6-2: dynamics after shock to theta

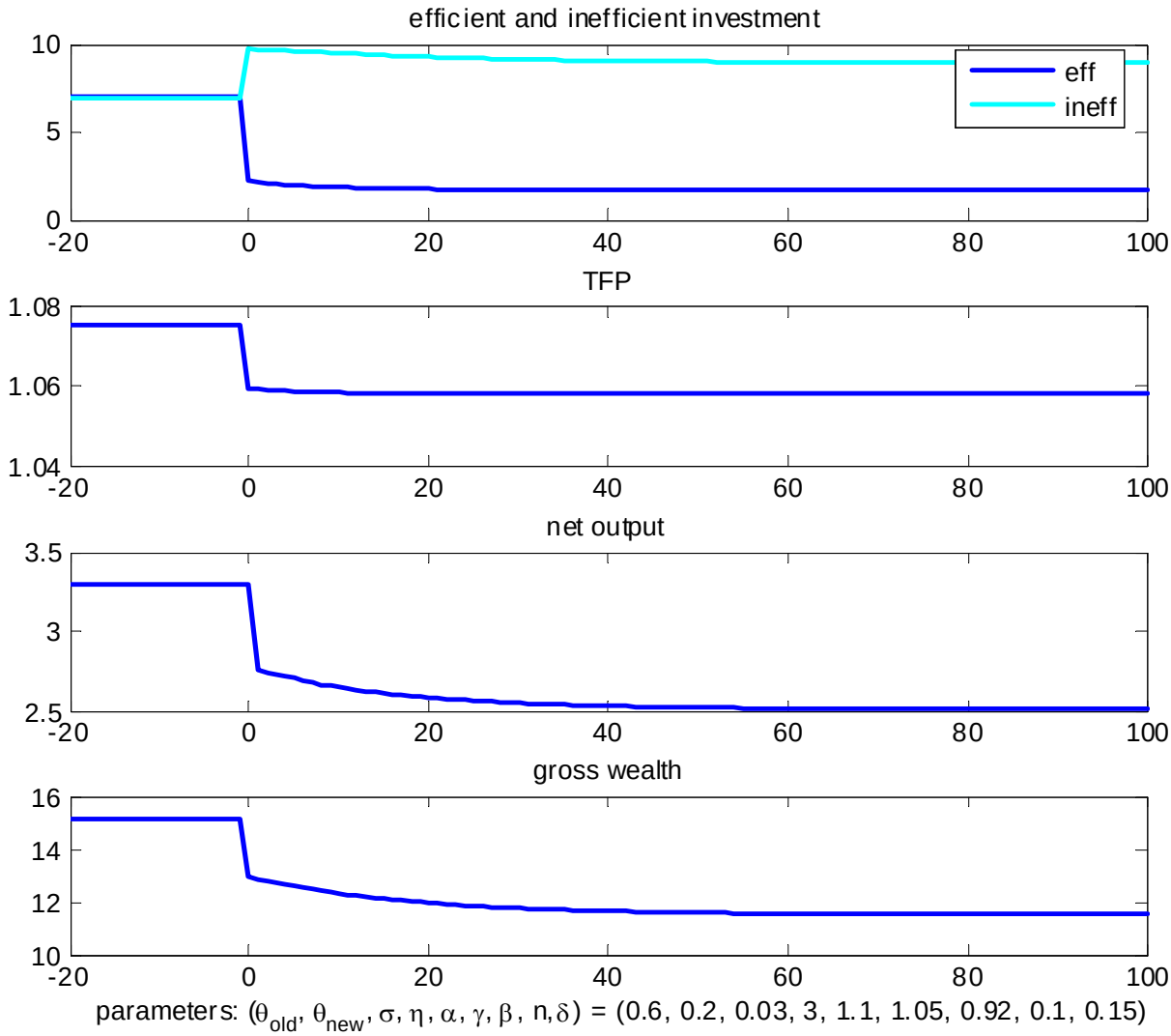


Figure 7-1: dynamics after shock to world interest rate

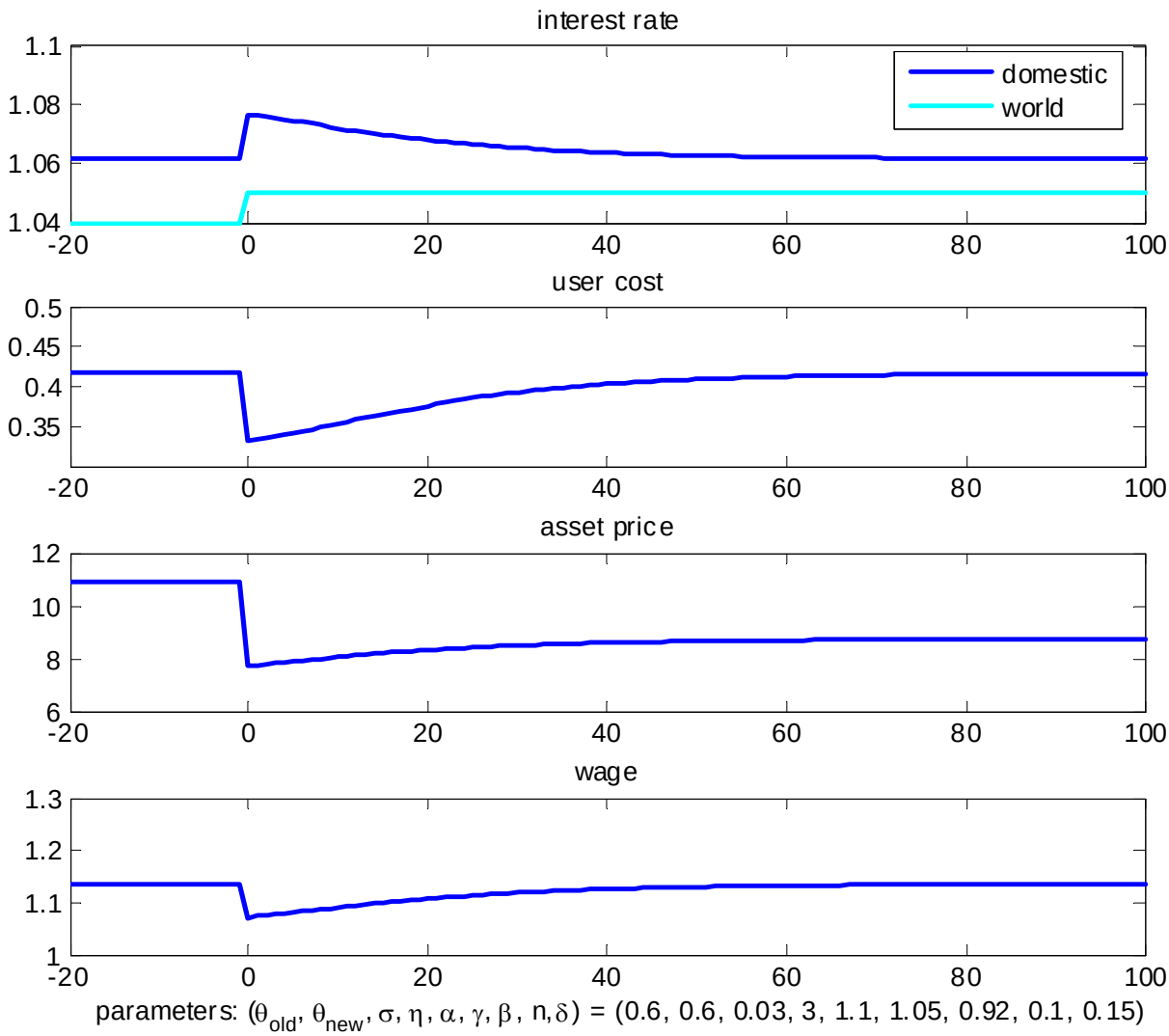


Figure 7-2: dynamics after shock to world interest rate

