<Article>Capital Flight, Capital Controls and Self-Fulfilling Expectation

Capital Flight, Capital Controls and Self-fulfilling Expectation

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1. Introduction

As many barriers to the international capital mobility across national boundaries have been dismantled in developed countries since 1970's, the international financial market has been integrated increasingly. Perfect capital mobility across notional boundaries plays more and more important roles in making up the lack of capital and in redistributing world resources. However, as shown in the Mexico Peso crisis (1986) and the Asian currency crisis (1997), the liberalization of capital mobility also generated capital flight in some developing countries. In order to avoid capital flight and to increase domestic investment, China has adopted a policy that the mobility of foreign capital across the boundary is allowed but the mobility of domestic capital across the boundary is prohibited. This paper will analyze why capital flight happens and whether the capital controls policy is effective or not.

MacDougall (1960) proposed a standard economic theory of capital mobility on which the marginal product of capital is equalized across all countries by perfect capital mobility. This theory implies that capital flight does not happen even though capital mobility is not restricted. To explain capital flight and capital mobility, Velasco (1996) used a fiscal externality to explain why investment and the associated capital inflows in developing countries continue to be disappointing and highly uneven over real time in many case after the debt crisis happened; Gertler and Rogoff (1990), Hamada and Sakuragawa (1992) argued that capital flight could be contributed to incomplete information.

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This paper provides a new way to analyze why capital flight happens and to examine whether the capital controls policy adopted by China is effective or not. The essential feature of the paper is to focus on a technological externality associated with the average capital stock in the economy[1]. Since production activities of firms are complementarily related and give labor learning chances, the larger (smaller) the average capital stock in the economy, the larger (smaller) the technology level in the economy. Because of the existing of the technological externality, the curve of the marginal product of capital begins with upward and ends with downward as the average capital stock in the economy increases. This result will yield multiple steady states. Howitt and McAfee (1988), Krugman (1991) and Matsuyama (1991) proposed that history (an initial condition) and expectation both matter in selecting a steady state on which the economy converges when multiple steady states exist. The paper implies that if capital mobility is perfect, capital flight cannot be avoided when a welfare-inferior steady state is selected. On the other hand, even though the mobility of domestic capital across the boundary is prohibited, the agents in the economy will be decreasing their investment over real time when a welfare-inferior steady state is selected.

The paper is organized as follows. Section II provides a static analysis to discuss the relationship between the technological externality and capital flight. Section III provides a dynamic analysis to compare effects of the perfect capital mobility policy and the capital controls policy. Section IV provides some concluding remarks.

2. Technological Externality and Static Analysis

Let us consider a small open economy where many identical firms with the same technology exist. The firms rent services of capital and labor to produce single goods. The production function of a representative firm with constant returns is denoted as follows:

$$y = A(k^{*})f(k), \tag{1}$$

where y is the per capita output of the representative firm, k the per capita capital stock of the representative firm, k^{*} the average capital stock in the economy, and $A(k^{*})$ the

[1] The similar assumption about the production technology please see Romer (1986, 1987), Prescott and Boyd (1987), and Bencivenga and Smith (1991).

technological level. We assume that $A(k^*)$ satisfies the following conditions:

$$A'(k^*) > 0,\ A''(k^*) < 0,\ A(0) = 0,\ A'(0) = \infty,\ A'(\infty) = 0,\ \lim_{k^* \to \infty} A(k^*) = 1. \quad (2)$$

Eq. (2) implies that the marginal technological externality is decreasing as the average capital stock in the economy increases.

We should note that, since many firms exist in the economy, each firm thinks its investment activity don't affect the level of the average capital stock though investment activities of all firms can yield a change of k^*. Since k^* and $A(k^*)$ is given for the representative firm, the marginal product of capital of the representative firm is given by

$$MPK(k) = A(k^*)f'(k). \quad (3)$$

Eq. (3) means that, given k^*, the marginal product of capital is decreasing as the per capita capital stock of the firm. However, since identical firms with the same technology exist, we can obtain $k = k^*$ in the equilibrium of the domestic capital market. As the curve of marginal product of capital of the representative firm shifts to $k = k^*$, the representative firm must adjust its investment level to $k = k^*$. Considering the technological externality, the marginal product of capital of the economy can be given by

$$MPK(k^*) = A(k^*)f'(k^*). \quad (4)$$

Eq. (4) can be depicted in Fig. 1. Eq. (4) means that, the curve of the marginal product of capital begins with upward and ends with downward as the average capital stock in the economy increases.[2]

When the world real interest rate θ is too high to intersect with the curve of marginal product of capital or there is a unique point, it means that capital flight will happen since the returns on investment in the domestic capital market is smaller or not larger than that in the world capital market. Therefore, the domestic economy has no chance to develop. In the paper, we do not consider the two cases. We only analyze the case where two points of intersection between the curve of the marginal product of capital and the world real interest rate exist as shown in Fig. 1.

Fig. 1 indicates that if an initial average capital stock in the economy is slightly below $\overline{k_1^*}$ capital flight will happen. On the other hand, if an initial average capital stock

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[2] If the marginal product of capital is increasing over real time, the marginal product of capital in domestic country is more and more high as international capital flows into the economy. Therefore, all world capital will converge to the economy. This case does not satisfy the assumption that the economy is a small economy.

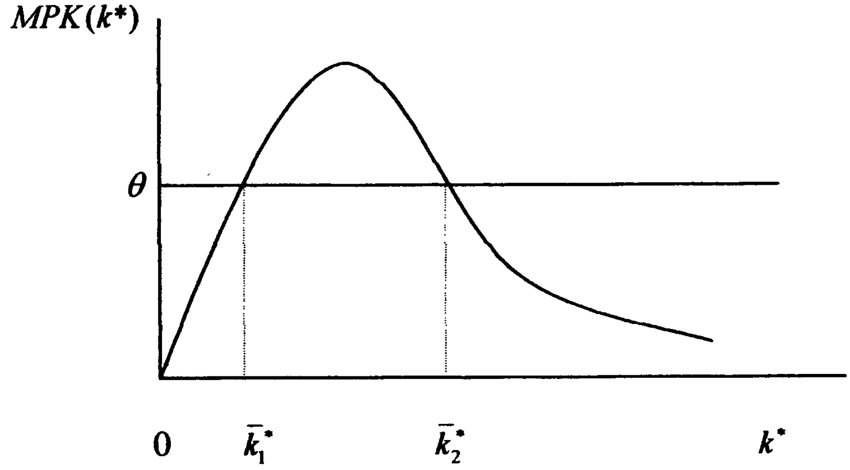

Figure 1

in the economy is slightly above $\overline{k_1^*}$ the economy will converge to $\overline{k_2^*}$. This means that the slight difference at the initial condition will yield completely different consequences. In next section we will use a dynamic model to discuss whether the economy is determined only by the initial condition or not.

3. Dynamic Analysis

In this section, first we provide a basic model to analyze the effect of the perfect capital mobility policy, and then we will modify the basic model to discuss the effect of the above capital controls policy.

3.1 The basic model: Capital mobility across the boundary is free

We assume that all agents have perfect foresight and the rate of population growth is zero in the economy.

Households

Assume that identical and infinitely lived households inhabit in the economy. The optimization problem of a representative household is to maximize

$$\int_0^\infty u(c)exp(-\theta t)dt, \tag{5}$$

$$u(c) = -\frac{1}{\rho}exp(-\rho c),\ \rho > 0$$

where c is the consumption level and θ the rate of preference time.

The flow budget constraint of the representative household is given by

$$\dot{a} = a\theta + w + \pi - c, \quad (6)$$

where a is the wealth held by the representative household, w real wage rate, and π the real net flow transferred from a representative firm.

The first-order conditions for a maximum of Eq. (5) subject to Eq. (6) are given by

$$exp(-\rho c) \equiv \bar{\lambda}, \quad (7a)$$

$$\lim_{t\to\infty} a(t)\bar{\lambda}exp(-\theta t) = 0, \quad (7b)$$

where $\bar{\lambda}$ is the constant Lagrange variable. Therefore, Eq. (7a) means that consumption level is constant. Eq. (7b) is the transversality condition for the representative household.

Firms

Under the assumption on firms in section 2, the net flow of the representative firm can be given by

$$\pi = A(k^{*})f(k) - i\left[1 + T(i/k)\right] - w, \quad (8)$$

where i is the per capita investment of the representative firm, and $T(\cdot)$ is the cost associated with the installation of capital and is assumed to satisfy $T(0) = 0$, $T'(\cdot) > 0$ and $2T'(\cdot) + (\cdot)T''(\cdot) > 0$. This assumption means that, the cost is an increasing and convex function of the size of the amount of investment undertaken relative to the existing capital stock of the representative firm.

The optimization problem of the representative firm is to maximize

$$\int_0^\infty \pi(t)exp(-\theta t)dt = \int_0^\infty \left[A(k^{*})f(k) - i[1 + T(i/k)] - w\right]exp(-\theta t)dt, \quad (9)$$

subject to the following constraint

$$\dot{k} = i. \quad (10)$$

Then the optimality conditions of the representative firm are given by[3]

$$q = 1 + T\big(\varphi(q)\big) + \varphi(q)T'\big(\varphi(q)\big), \quad (11a)$$

$$\dot{k} = k\varphi(q), \quad (11b)$$

$$\dot{q} = -A(k^{*})f'(k) - \varphi^2(q)T'[\varphi(q)] + q\theta, \quad (11c)$$

[3] Please see Blanchard and Fisher (1989), pp.62.

$$\lim_{t \to \infty} qk\, exp(-\theta t) = 0, \tag{11d}$$

where q is the Lagrange variable and satisfies $\varphi(1) = 0, \varphi'(q) > 0$. Eq. (11*b*) means is the shadow price of investment. That is, Tobin's q.

Given k^*, the investment level of the representative firm is determined by Eq. (11). Considering the technological externality, the investment level of the representative firm must be adjusted to $k = k^*$. Therefore, Eqs. (11*b*) and (11*c*) can be modified as follows:

$$\dot{k}^* = k^* \varphi(q), \tag{12}$$

$$\dot{q} = -A(k^*)f'(k^*) - \varphi^2(q)T'[\varphi(q)] + q\theta. \tag{13}$$

Steady states and dynamics

In a steady state of the dynamic system characterized with Eqs. (12) and (13), we have

$$\overline{k^*}\varphi(\bar{q}) = 0, \tag{14}$$

$$-A(\overline{k^*})f'(\overline{k^*}) - \varphi^2(\bar{q})T'[\varphi(\bar{q})] + \bar{q}\theta = 0. \tag{15}$$

Eq. (15) is too complex to depict its curve directly. However, since we can simply describe the curves of functions $A(k^*)f'(k^*)$ and $\varphi^2(q)T'[\varphi(q)] - q\theta$, we can compose the curve of Eq. (15) in the third quadrant by depicting the curve of function $A(k^*)f'(k^*)$ in the first quadrant and the curve of function $\varphi^2(q)T'[\varphi(q)] - q\theta$ in the second quadrant. Therefore, we can obtain a possible phase diagram of the dynamic system and three steady states $(1, \overline{k^*})$, $(1, \overline{k_2^*})$ and $(\overline{q_1}, 0)$, and verify a steady state $(1, \overline{k_1^*})$ is a source, steady states $(\overline{q_1}, 0)$ and $(1, \overline{k_2^*})$ are saddle points, where $\overline{q_1}$, $\overline{k_1^*}$ and $\overline{k_2^*}$ satisfy $0 < \overline{q_1} < 1, \overline{k_1^*} < \overline{k_2^*}$[4]. We next use the possible phase diagram to analyze possible dynamic configurations.

When multiple steady states exist, it is difficult to analyze which of multiple steady states the economy will converge on.[5] However, as shown in Appendix, we find that no perfect foresight path in the dynamic configurations is a Jordan curve[6]. This means that no homoclinic and heteroclinic orbits exist in the dynamic configurations.[7] Nevertheless, we can only describe possible dynamic configurations that can occur, but we

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[4] In the steady state $(\overline{q_1}, 0)$, per capita capital and per capita investment is zero. Then the investment-installing function $T(\cdot)$ becomes $T(0/0)$. Although we cannot obtain any value on de L'hospital theorem, it can be interpreted as arbitrary investment adjustment cost.

aren't able to give any condition to verify which of those will occur. If the two eigen values of the eigen matrix in the steady state $(1, \overline{k_1^*})$ are positive, there are three possible dynamic configurations in the dynamic system as shown in Figs. 2~4. If the two eigen values of the eigen matrix in the steady state $(1, \overline{k_1^*})$ are imaginary, there are three possible dynamic configurations in the dynamic system as shown in Figs. 5~7.

Fig. 3 implies that history matters in selecting the long-run position of the economy. If an initial average capital stock is slightly below (above) $\overline{k_1^*}$, the economy will select the steady state $(\overline{q_1}, 0)$ $((1, \overline{k_2^*}))$. The slight diffrence at the initial yields completely different consequences. On the other hand, a common feature from Fig. 3 through Fig. 7 is with overgrapping locus. In those cases, the realized steady state is determined not only by history but also by what expectation all agents have for the future investment in the economy. It is conceivable that if everyone believes that the economy will end up in the steady state $(\overline{q_1}, 0)$, then it will; and that if everyone instead believes that it will end up in the steady state $(1, \overline{k_2^*})$, then it will. The possibility of the existing of self-fulfilling expectation cannot be ruled out. Therefore, even though an initial average capital is above (below) $\overline{k_1^*}$, it is possible that the economy will end up in the steady state $(\overline{q_1}, 0)$ $((1, \overline{k_2^*}))$.

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[5] Howitt and McAfee (1988) discussed the possibility of local dynamic analysis and Krugman (1991) and Matsuyama (1991) considered the possibility of global perfect foresight dynamic analysis. However, Local dynamics is not enough, because demonstrating the uniqueness of a perfect foresight path in a neighborhood of a stationary state does not necessarily rule out the existing of other prefect foresight path in the large.

[6] Jordan curve is a closed curve that does not intersect itself.

[7] Homoclinic orbit is a Jordan curve that connects a stationary point; Heteroclinic orbits is a Jordan curve that connects distinct stationary points.

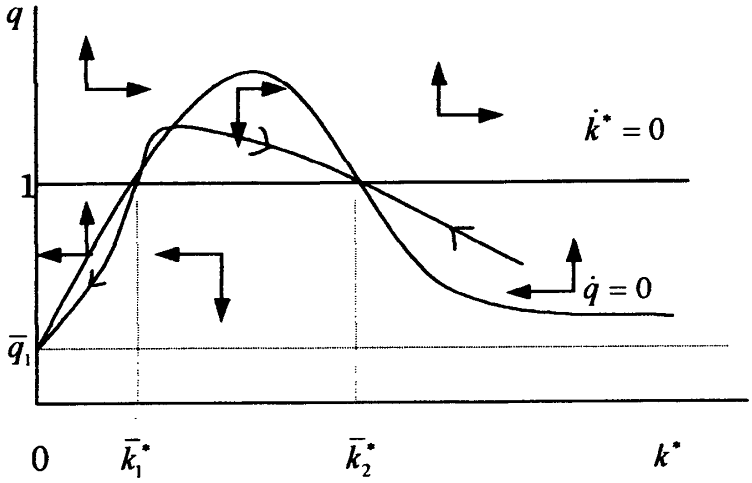

Figure 2

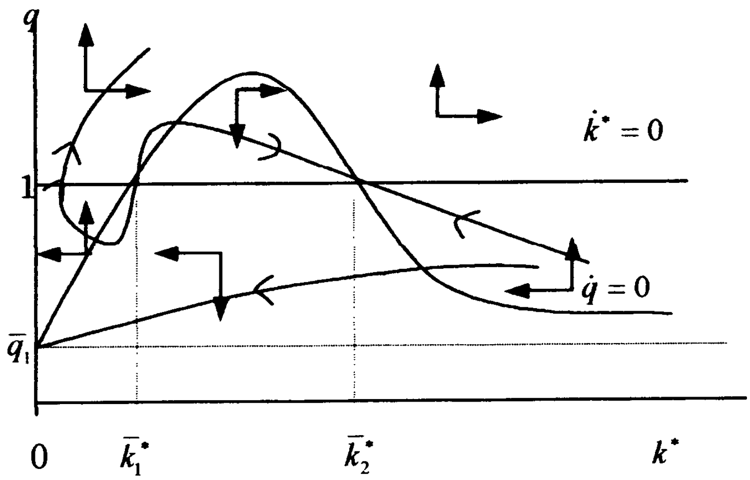

Figure 3

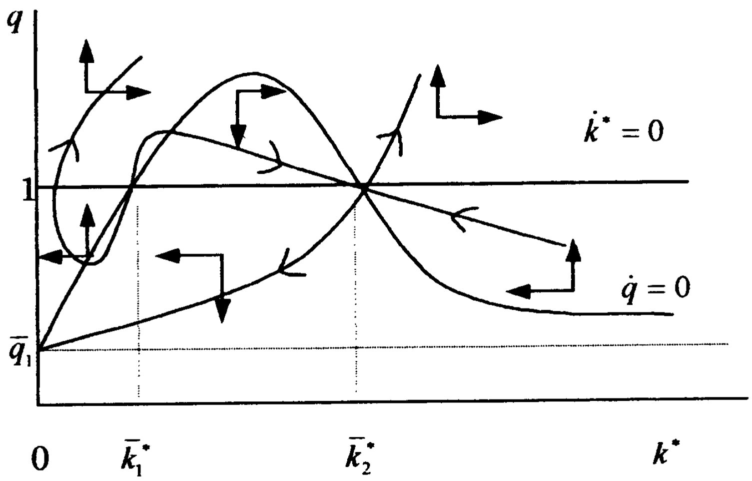

Figure 4

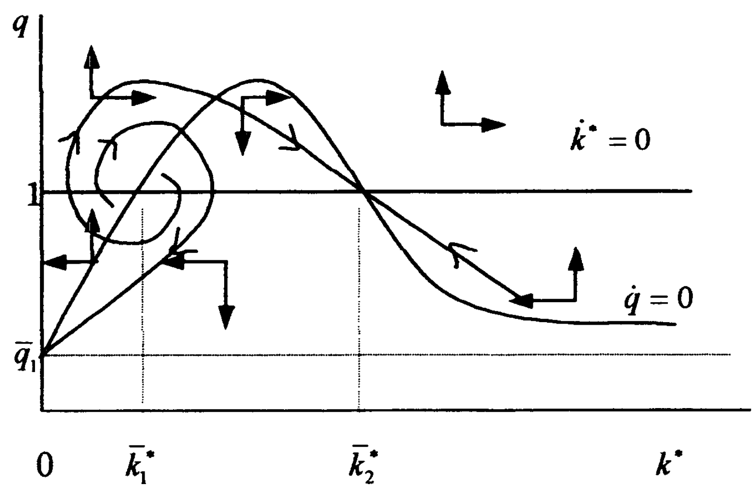

Figure 5

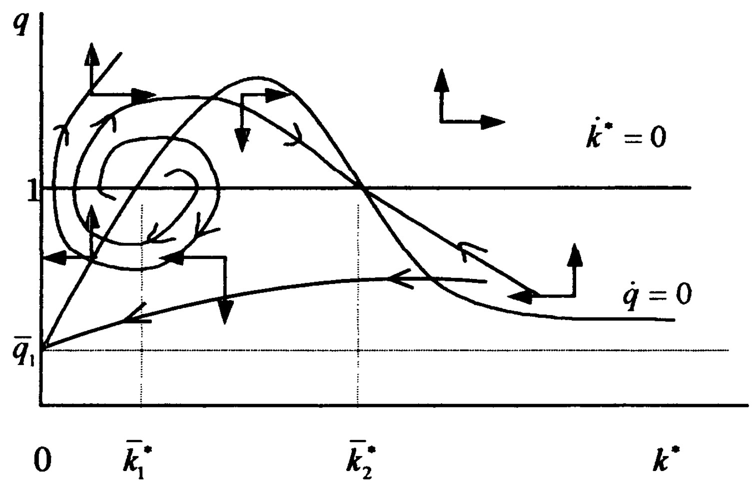

Figure 6

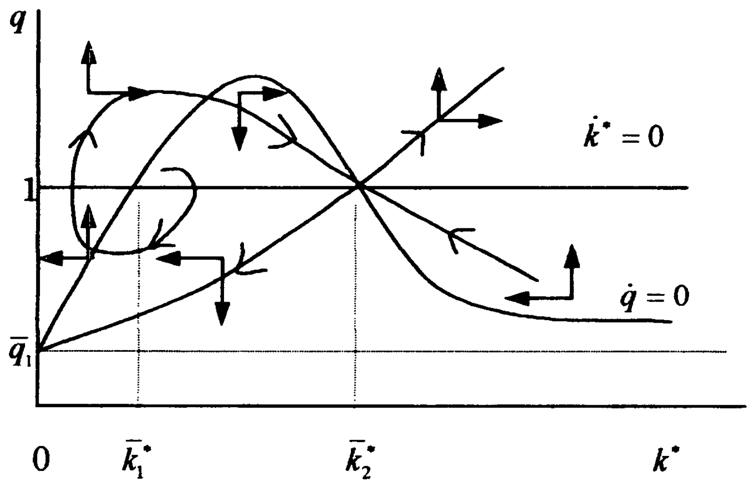

Figure 7

The above analysis means that the realizing of the welfare-inferior steady state $(\overline{q_1}, 0)$ cannot be excluded. If all agents in the economy select the welfare-inferior steady state, capital flight will happen. Therefore capital flight may be inevitable when capital mobility is perfect. In adition, form Eq. (8) we can obtain the intertemporal budget constraint of the representative household as follows:

$$\bar{c} = \theta a_0 + \theta \int_0^{\infty} (w+\pi) exp(-\theta t) dt. \tag{15}$$

Eq. (15) means that the constant consumption flow is equal to a constant proportion of the sum of the initial stock of wealth a_0 and the human wealth that is equal to the present value of labor income. Since the human wealth is an increasing function of the average capital stock in the economy, the human wealth in the welfare-inferior steady state $(\overline{q_1}, 0)$ will be less than that in the welfare-superior steady state $(1, \overline{k_2^*})$. Therefore, if all agents select the welfare-inferior steady state $(\overline{q_1}, 0)$, their consumption in the welfare-inferior steady state $(\overline{q_1}, 0)$ will less than in the welfare-superior steady state $(1, \overline{k_2^*})$.

Why do all agents in the economy bear the low consumption level in the welfare-inferior steady state $(\overline{q_1}, 0)$ and why do they not pursue high consumption level in the welfare-superior steady state $(1, \overline{k_2^*})$? The answer to the problem is that, except for the case in which history matters as shown in Fig. 3, the expectation of all agents plays an important role in selecting a steady state on which the economy converges. If all agents are pessimistic for investing in domestic country over real time, the capital stock in the economy will fall as capital outflows. Consequently, the technology in the economy is falling over real time. Therefore, the economy will end up in the welfare-inferior steady state, and the households in the economy have to bear the low consumption level duo to the existing of the technology externality.

3.2 Modified model: Domestic capital mobility across the boundary is prohibited.

Based on the above analysis, we find that capital flight cannot avoid when capital mobility is perfect. In order to avoid capital flight and to increase domestic investment, China has adopted a policy that the mobility of foreign capital across the boundary is allowed, but the mobility of domestic capital across the boundary is prohibited. We will modify the basic model to analyze whether the policy really make domestic investment increase or not.

Since the domestic capital mobility across the boundary is prohibited, domestic agents can only borrow and lend in the domestic capital market. Therefore, the domestic real interest rate becomes endogenous. The flow budget constraint condition of the representative household is modified as

$$\dot{b} = br + w + \pi - c, \tag{17}$$

where b is the domestic assets held by the representative household and r the domestic real interest rate.

The first-order conditions for maximum of Eq. (5) subject to Eq. (17) can be modified as follows:

$$\dot{c} = -(\theta - r)/\rho. \tag{18}$$

The modified optimization problem of the representative firm is to maximize

$$\int_0^\infty \pi(t) exp\left(-\int_0^t rdv\right)dt$$
$$= \int_0^\infty \left[A(k^*)f(k) - i\left[1 + T(i/k)\right] - w\right] exp\left(-\int_0^t rdv\right)dt. \tag{19}$$

The optimization conditions for maximum of Eq. (19) subject to (10) are modified as follows:

$$\dot{q} = -A(k^*)f'(k) - \varphi^2(q)T'[\varphi(q)] + qr, \tag{20a}$$

$$\lim_{t\to\infty} q(t)k(t)exp\left[-\int_0^t r(v)dv\right] = 0. \tag{20b}$$

As discussed above, Eq. (20a) implies how the representative firm determines its investment given k^*. Considering the technological externality, Eq. (20a) is modified as

$$\dot{q} = -A(k^*)f'(k^*) - \varphi^2(q)T'[\varphi(q)] + qr. \tag{21}$$

Since $b = 0$ in the equilibrium of the domestic capital market, from Eq. (17) the consumption level can be given by

$$c = w + \pi = A(k^*)f(k^*) - k^*\varphi(q)\left[1 + T\big(\varphi(q)\big)\right]. \tag{22}$$

Substituting Eqs. (18) and (22) into Eq. (21), we can obtain

$$\dot{q} = \frac{1}{1+\rho q^2\varphi'(q)k^*}\{-A(k^*)f'(k^*) - \varphi^2(q)T'[\varphi(q)] +$$
$$\rho\left[A'(k^*)f(k^*) + A(k^*)f'(k^*) - \varphi(q)\left[1 + T(\varphi(q)\right]\right]q\varphi(q)k^* + \theta q \tag{23}$$

The dynamic system is represented by Eqs. (12) and (23). We can also obtain three identical steady states $(\overline{q_1}, 0)$, $(1, \overline{k_1^*})$ and $(1, \overline{k_2^*})$. However, since Eq. (23) is too complex to describe phase diagrams of the dynamic system, we cannot describe dynamic configurations of the dynamic system. Furthermore, we cannot judge whether a Jordan's curve exists in the dynamic system or not. We only know that, since multiple steady states exist, history and expectation both matter in selecting a steady state on which the economy converges. Therefore, it cannot be excluded that the welfare-inferior steady state $(\overline{q_1}, 0)$ is selected. If the welfare-inferior steady state is selected, we have $\overline{k^*} = 0$. From Eq. (22), we can obtain

$$\bar{c} = 0. \tag{24}$$

The analysis means that, although capital flight can be avoided by the capital controls policy, all agents will be decreasing their investment in the economy over real time when the welfare-inferior steady state $(0, \overline{q_1})$ is selected. Consequently, all agents will have nothing for sustaining their life in the welfare-inferior steady state.

Based on the analysis in the section, we can find that, in spite of whether capital mobility is restricted or not, multiple steady states exist due to the existing of the technological externality. History and expectation both matter in selecting a steady state on which the economy converges. Capital flight may not be avoided when capital mobility across the boundary is perfect. On the other hand, although capital flight can be avoided by the capital controls policy, the policy cannot certainly make the domestic investment increase. Furthermore, the capital controls policy may yield an zero consumption level in the economy when the welfare-inferior steady state is selected.

4. Conclusions

The paper used the technological externality to explain why capital flight will happen and to examine whether the capital controls policy adopted by China is effective or not. Since the technological externality exists, the curve of the marginal product of capital begins with upward and ends with downward as the average capital stock in the economy is increasing. Consequently, in spite of whether capital mobility is restricted or not, multiple steady states exist. History and expectation both matter in selecting a steady state on which the economy converges. Consequently, we can find that capital flight may be inevitable when capital mobility is perfect. On the other hand, when the mobility of domestic capital across the boundary is prohibited, although capital flight can be avoided, the capital controls policy cannot certainly make domestic investment increase. Furthermore, the capital controls policy may make the consumption level in the economy become zero.

The above conclusion is dependent on the assumption of the existing of the technological externality. It may seem to be too strict. However, the existencing of the technological externality in an economy cannot be ruled out. The paper implies that, if the aim of a government is to make agents increase their investment in the economy, the government must adopt a policy that can give the domestic agents a strong incentive to investment in the economy rather than the capital controls policy.

Appendix

From Eqs. (12) and (13), we can obtain

$$k^{*}\varphi(q)dq = [-A(k^{*})f'(k^{*})-\varphi^{2}(q)T'[\varphi(q)]+q\theta]dk^{*}.$$

According to Green's theorem, we have

$$\begin{aligned} F(k^{*}, q) &= \oint_{\Omega}\{k^{*}\varphi(q)dq-\left[-A(k^{*})f'(k^{*})-\varphi^{2}(q)T'[\varphi(q)]+q\theta\right]dk^{*}\} \\ &= -\iint_{Z}\theta dk^{*}dq \neq 0, \end{aligned}$$

where Ω indicates the range of definition of line integral, and Z the range of definition of double integral. Therefore, no Jordan curve exists in any locus of the dynamic system composed by Eqs. (12) and (13).

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