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EDUCATION AND GROWTH IN THE PRESENCE OF CAPITAL FLIGHT

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Education and Growth in the Presence of Capital Flight

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Abstract

We study the effect of capital controls on the level of investment in human capital and the resulting growth path of an economy. The economy consists of two groups of agents based on the ownership of factors of production. One type of agents – called workers – own human capital and bequeath education to their offsprings. The other group of agents – called capitalists – own and bequeath physical capital. The workers have the political power to tax capital income. The capitalists, based on the tax rate imposed by the workers and the capital control regime in place, decide to invest part or all of their capital abroad. We characterize the optimal tax behavior of the workers. We find that higher capital controls are beneficial for investment in education whenever there is capital flight in a steady state equilibrium. However, higher capital controls are shown to have no effect on the tax rate on capital income imposed by workers: rather, they act as a disincentive for capital flight by lowering the return from foreign investment. We show that lowering capital controls can lead to higher growth only when there is no capital flight in the steady state. Importantly, to prevent capital flight in the long run, human capital accumulation must not show decreasing returns with respect to education and the economy must be sufficiently developed.

1 Introduction

This paper explores the implications of financial capital flight on redistribution and human capital investments. Our research is motivated by a large corpus of literature studying the association between inequality and growth. This literature examines the effect of income distribution on economic growth by examining the impact of redistributive politics on physical capital investment and/or human capital investment. Extensions of this literature incorporate roles for redistribution, public financing of education, capital market imperfections, non convexities in technologies, etc.

We focus on capital flight particularly since this is an issue that tends to plague countries with relative large inequalities and yet seems not to have received much attention in the literature. We model an economy populated by dynastic agents who have access either to physical capital or human capital. Owners of physical capital have two alternative investment possibilities - investing at home or abroad. Investments abroad provide a secure return while investments at home are subject to redistributive taxation. We examine the optimal degree of taxation under these circumstances and the optimal degree of capital flight. This framework allows us to also revaluate the role of inequality on redistribution.

Beginning with Perotti (1996), the empirical literature has failed to find a robust relationship between inequality and consequent redistribution despite theoretical models continuing to rely on this link. However, these models either tend to assume closed economies (Alesina and Rodrik (1994)) or avoid physical capital altogether (Saint Paul (1993)). While Galor and Moav (2004) incorporate physical capital and human capital accumulation in the process of economic growth, their analysis is also based on a closed economy framework. It does not take much to realize that once one allows the possibility of capital flight, then even workers who do not earn a return from physical capital will not necessarily want to tax at high rates since that would encourage further capital flight and reduce their own wages. Therefore the obvious link between inequality and redistribution breaks down. This suggests the extent of redistribution depending not just on the degree of inequality but also the openness of the economy to capital flows.

While the literature on the interaction between physical capital and human capital and their effects on economic growth is large, there are a few papers that are directly related to our work. Galor and Moav (2004) examine the relative importance of physical capital and human capital at different stages of economic development and looks at implications of inequality on economic growth. They show that in the initial stages of development, physical capital is more important and therefore inequality is beneficial. In later stages as human capital becomes more important, inequality is less beneficial.

While it is not our attempt here to rewrite the various stages of development after incorporating capital flight, it is still useful to consider the implications of capital flight on the stages of development. Our results suggest that a less developed economy can actually end in either poverty traps with absolutely no human capital accumulation or even growth traps with sustained increases in inequality and a declining human capital to physical capital ratio with permanent capital flight. We find that capital controls can be beneficial to under-developed countries for two reasons. First, they keep the level of domestic investment high (and reduce capital flight) which leads to higher domestic wages, domestic income, and investment in education. Second, the endogenous threshold required to jump to a balanced growth path is lowered with higher capital controls. This makes it easier for an under-developed economy to transition to a 'high' growth path.

Our work is also related to Bourguignion and Verdier (2000) and Viaene and Zilcha (2002a,b). For instance, Bourguignion and Verdier (2000) examine the willingness of capital owners to fund public education. Their work, which is a part of a larger literature on the transition from oligarchies to democracies, examines the impact of capital flight on the public funding of education. While in a closed economy, oligarchs (who are assumed to be capitalists) may choose to subsidize education, once the economy opens upto capital flight, the same incentive disappears and hence international financial liberalization is bad for education. In our paper this possibility of a development trap where there are physical capital outflows and zero human capital emerges as a special case. Moreover, we are more concerned with the incentives of the owners of human capital to redistribute in the presence of international capital flows. Hence, the two papers are complementary.

Viaene and Zilcha (2002b) examine the role of government intervention in raising human capital investments in a two country model. Their work focuses on the issue of competition between governments in trying to garner a larger share of output and the role of public education spending in the final outcome. However, Viaene and Zilcha (2002a) - which is more closely related to our work - allows for heterogeneity in income across agents. Viaene and Zilcha (2002a) find that capital market integration does not affect the long run growth rate of an economy (when compared to the autarkic case), and that capital market integration is always preferred by altruistic households even if later generations lose and integration reduces income inequality in the country that experiences outflows. These results are not the same as ours although modeling strategies in both their model and our framework is quite different. In particular, we do not assume public provision of education. Further, income distribution is modeled in terms of it functional distribution with different groups acting strategically. In contrast, Viaene and Zilcha (2002a) assume a continuum of agents.

The paper proceeds as follows. In section 2, we characterize the optimal tax rate and its implications for capital flight. In section 3, we consider the transitional dynamics and derive conditions under which poverty traps and balanced growth obtains. We conclude with section 4.

2 The Model

The aggregate production function of the economy in period t is given by

$$Y_t = A{K_t}^{\gamma}{H_t}^{1-\gamma}, \tag{1}$$

where Y_t denotes output, H_t and K_t denote the aggregate amounts of human capital and physical capital respectively, $A > 0$ denotes a technological shift parameter[1], and $\gamma \in (0, 1)$. The economy consists of two types of agents called capitalists - indexed by K - and workers - indexed by W, of equal measure. The capitalists provide physical capital whereas the workers supply the human capital in the production process. There are competitive markets for both physical and human capital. The wage rate and rental rate are

$$w_t = (1-\gamma)\frac{Y_t}{H_t}, \tag{2}$$

and

$$r_t = \gamma\frac{Y_t}{K_t}, \tag{3}$$

respectively.

In each time period $t-1$, where $t = 1, 2, ...\infty$, a new generation of agents are born who live for two periods at the end of which they are replaced by an offspring of their type. Each agent is born with a type of endowment. The

[1] Alternatively one can think of "A" as a parameter which captures the level of development of an economy such as the state of legal institutions, financial markets etc.

capitalists are born with an endowment of capital goods, b_{t-1}^K. Workers are born with an endowment, b_{t-1}^W, which they invest entirely in education, e_t: i.e., $b_{t-1}^W = e_t$. Human capital in period t depends on the level of education according to

$$H_t = e_{t-1}^{\theta}, \tag{4}$$

where $\theta \in [0, 1]$. We assume that both workers and capitalists become economically active in the second period of their life: they only care about second period consumption and leave a bequest for their offspring.[2]

Workers have the political power to extract rents from the capitalists in the form of a tax on capital income.[3] In particular, in period $t-1$, the workers announce a tax rate, τ_t, to be imposed on capital income in period t. Based on the announcement of the tax rate at the end of period $t-1$, the capitalists decide how much of their capital stock to invest at home and abroad. Let $\overline{r}$ denote the world interest rate where $\overline{r} > 1$ which the capitalists take as given. We assume that investment abroad is costly for the capitalists depending on the capital control regime existing in the economy. For each unit of capital invested abroad, the capitalists get a return of $(\overline{r} - \phi)$. The parameter, ϕ, denotes a measure of capital controls in the economy. In particular, $\phi = 0$, corresponds to an economy without capital controls, while, $\phi = \overline{r}$, corresponds to a closed economy.

Our setup implies that the post - tax income of the workers and capitalists is given by

$$y_t^W = w_t H_t + \tau_t r_t K_t = [(1-\gamma) + \tau_t \gamma] A K_t^{\gamma} H_t^{1-\gamma},$$

[2]This makes the setup a warm glow model with one sided altruism.

[3]Later, we consider the case where there is electoral uncertainty where the capitalists can choose the degree of capital controls.

and

$$y_t^K = (1-\tau_t) r_t K_t + (\overline{r} - \phi)(b_{t-1}^K - K_t) \tag{5}$$
$$= (1-\tau_t)\gamma A K_t^{\gamma} H_t^{1-\gamma} + (\overline{r} - \phi)(b_{t-1}^K - K_t),$$

respectively. We now characterize the optimal tax rate set by workers and the resulting domestic investment undertaken by capitalists.

2.1 The Optimal Tax Rate and Capital Flight

The maximization problem faced by a worker born in period $t-1$ is given by

$$\max U^W = \alpha \log c_t^W + (1-\alpha)\log b_t^W,\ \alpha \in (0,1)$$
$$\text{subject to } c_t^W + b_t^W \leq y_t^W,$$

where c_t^W, y_t^W denotes the consumption and income of the worker. The optimal decision rules for the worker are given by

$$c_t^W = \alpha y_t^W,$$

and

$$e_t = (1-\alpha) y_t^W.$$

Log utility implies that workers consume and bequeath a constant proportion of their income.

The capitalist also faces a similar maximization problem as the worker. The only difference with respect to the workers is that capitalists bequeath an endowment of capital for their offspring (as opposed to education). A capitalist born in period $t-1$ solves the following problem:

$$\max U^K = \alpha \log c_t^K + (1-\alpha)\log b_t^K,\ \alpha \in (0,1)$$
$$\text{subject to } \quad c_t^K + b_t^K \leq y_t^K,$$

where c_t^K, y_t^K denotes the consumption and income of the capitalist. The optimal decision rules for the capitalists are given by

$$c_t^K = \alpha y_t^K,$$

and

$$b_t^K = (1-\alpha) y_t^K.$$

Like the worker, the decision rules imply that capitalists also consume and bequeath a constant proportion of their income. Note that as far as utility of an agent is concerned, any policy that maximizes the income of an agent also maximizes her utility. Given any capital income tax rate imposed by the workers, the capitalist's behavior is summarized in the following lemma.

Lemma 1 *Given any tax rate on capital income and domestic rental rate the capitalist will allocate investment home or abroad according to the following criterion:*

$$K_t = \begin{cases} 0 & \text{if } r_t(1-\tau_t) < \overline{r} - \phi \\ \left[\frac{(1-\tau_t)\gamma A}{\overline{r}-\phi}\right]^{\frac{1}{1-\gamma}} H_t & \text{if } r_t(1-\tau_t) = \overline{r} - \phi \\ b_{t-1}^K & \text{if } r_t(1-\tau_t) > \overline{r} - \phi \end{cases} \tag{6}$$

Proof: The capitalists will allocate their investment home or abroad such that their income is maximized. Maximizing equation (5) with respect to K_t gives the expression above.

Lemma 1 characterizes the optimal investment rule by capitalists. Given the domestic return to capital, tax rate, and the world interest rate, the capitalist's entire endowment is invested abroad if $r_t(1-\tau_t) < \overline{r} - \phi$. This implies that there is complete capital flight, and no domestic investment. If $r_t(1-\tau_t) = \overline{r} - \phi$, part of the endowment of capitalists is invested abroad and part of it invested domestically. If $r_t(1-\tau_t) > \overline{r} - \phi$, there is no capital flight, as the domestic after tax return to capital exceeds the world interest rate.

Given the capitalist's decision rule, we can now characterize the worker's optimal tax rate. The marginal product of capital schedule is shown in Figure 1. At any time period t, the pre-tax rental rate is a decreasing function of the domestic investment, K_t. The maximum possible domestic investment is the endowment of the capitalist, b^K_{t-1}. The rental rate of capital at this level of investment is denoted as $\widehat{r}_t$. It will turn out later that $\widehat{r}_t$ plays a crucial role in the optimal tax behavior of the workers. Equation (3) and (4) imply

$$\widehat{r}_t = \gamma A \left(\frac{e^{\theta}_{t-1}}{b^K_{t-1}} \right)^{1-\gamma}. \tag{7}$$

Note that the entire r_t schedule and $\widehat{r}_t$ shifts upwards as the level of human capital increases (see Figure 1). The next proposition characterizes the optimal tax rate for the workers.

INSERT FIGURE 1 HERE.

Proposition 1 *In equilibrium, the workers set a tax rate such that the capitalist is indifferent between investing at home or abroad. The optimal tax rate is given by:*

$$\tau_t = \begin{cases} 0 & \text{if } \widehat{r}_t \leq \overline{r} - \phi \\ 1 - \frac{\overline{r}-\phi}{\widehat{r}_t} & \text{if } \widehat{r}_t > \overline{r} - \phi \end{cases} \tag{8}$$

Proof: The capitalists get a return of $\overline{r} - \phi$ from foreign investment. Suppose $\widehat{r}_t < \overline{r} - \phi$. From (6), the domestic supply of capital is given by $K_t = \left[\frac{(1-\tau_t)\gamma A}{\overline{r}-\phi}\right]^{\frac{1}{1-\gamma}} H_t$. The income of the worker is

$$y^W_t = [(1-\gamma) + \tau_t \gamma] \left[\frac{(1-\tau_t)\gamma}{\overline{r}-\phi} \right]^{\frac{\gamma}{1-\gamma}} A^{\frac{1}{1-\gamma}} H_t.$$

Hence, the tax rate that maximizes $[(1-\gamma)+\tau_t\gamma][(1-\tau_t)\gamma]^{\frac{\gamma}{1-\gamma}}$ will also maximize the worker's income. Maximizing the expression, $[(1-\gamma)+\tau_t\gamma][(1-\tau_t)\gamma]^{\frac{\gamma}{1-\gamma}}$, with respect to τ implies that the optimal tax rate is zero. If $\widehat{r}_t > \overline{r} - \phi$, the workers will set a tax rate up to a point where the capitalist is indifferent between investing at home or abroad. Hence the tax rate that maximizes a worker's income is given by the following condition:

$$\widehat{r}_t(1-\tau_t) = \overline{r} - \phi.$$

Note that Proposition 1 implies that the equilibrium tax rate is given by,

$$\tau_t = \max\{0, 1 - \frac{\overline{r} - \phi}{\widehat{r}_t}\}.$$

with domestic investment given by,

$$K_t = \begin{cases} \left[\frac{\gamma A}{\overline{r}-\phi}\right]^{\frac{1}{1-\gamma}} e^{\theta}_{t-1} & \text{if } \widehat{r}_t \leq \overline{r} - \phi \\ b^K_{t-1} & \text{if } \widehat{r}_t > \overline{r} - \phi \end{cases}.$$

If $\widehat{r}_t \leq \overline{r} - \phi$, the optimal tax for the workers is 0 and we have an interior solution to the capitalist's allocation problem between domestic and foreign investment, i.e., maximization of equation (5) with respect to K_t. If $\widehat{r}_t > \overline{r} - \phi$, we get a corner solution: the workers tax the difference between $\widehat{r}_t$ and $\overline{r} - \phi$. Finally, we rule out the case that $\overline{r} - \phi = 0$. If $\overline{r} - \phi = 0$, then the capitalists have no other option apart from investing at home. Accordingly, workers simply tax capital income entirely, and the economy has zero capital stock from the next period onwards. Since this is an uninteresting case, we assume that, $\overline{r} - \phi > 0$.[4] This fully characterizes the tax rate and the composition of investment in equilibrium.[5]

[4]We later state a regularity condition to ensure that the capitalist's endowment doesn't converge to zero.

[5]We also rule out any kind of capital inflow from the rest of the world. In case of perfect world capital markets, the domestic capital stock will be pinned down by the equality between the domestic return to capital and the world interest rate. In such a scenario, the workers will always choose to impose a zero tax on capital in equilibrium. To make the political

Figure 2 summarizes the tax chosen by the workers and the resulting investment behavior of the capitalists. Figure 2a shows that the amount of capital flight in an interior equilibrium. In Figure 2a, the marginal product of capital schedule intersects the world interest rate $\overline{r} - \phi$ and keeps falling so that $\widehat{r}_t$ is less than $\overline{r} - \phi$. In this case the optimal tax for the workers is zero. The point of intersection between the r_t schedule and $\overline{r} - \phi$ gives us the amount of domestic investment and capital flight.

In Figure 2b, the r_t schedule is decreasing but $\widehat{r}_t$ exceeds the world interest rate, $\overline{r} - \phi$. In this case the workers will tax capital until the capitalists are just indifferent between investing at home or abroad. Ex-post, this implies $r_t(1 - \tau_t) = \overline{r} - \phi$ and there is no capital flight. Note that Figure 2b shows the optimal tax behavior of the worker in the case of a corner equilibrium.

This completely characterizes the tax behavior of the workers and the resulting allocation of capital between home and abroad at any given time period. As to which case occurs depends on the capital-education ratio (which pins down $\widehat{r}$).

INSERT FIGURE 2A AND 2B HERE.

3 The Dynamic Evolution of Education and Capital

In this section, we characterize the transitional dynamics and the steady state behavior of the economy. We show that whether balanced growth obtains depends on whether $\theta = 1$, or $\theta < 1$, respectively. We also derive an endogenous

economy aspect of the model more interesting, we allow for market imperfections in capital inflows. In particular, we make the extreme assumption that there can be no capital inflows. However, this can be relaxed without altering the basic intuition of the model.

threshold relating the technology parameter, "A", to the capital control parameter, ϕ. The endogenous threshold determines whether the worker's income and human capital accumulation matches the growth in income of the capitalists and the accumulation of capital. Importantly, we show that capital controls can lead to a higher growth in education if the economy is at a lower level of development.

3.1 $\theta = 1$

We first consider the case where $\theta = 1$. The capitalist's income in equilibrium is given by $y_t^K = (\overline{r} - \phi)b_{t-1}^K$, irrespective of whether $\widehat{r}_t$ is less than or greater than $\overline{r} - \phi$. This implies that the evolution of the capitalist's endowment is given by,

$$b_t^K = (1-\alpha)(\overline{r} - \phi)b_{t-1}^K. \tag{9}$$

The income of workers is given by,

$$\begin{aligned} y_t^W &= [(1-\gamma) + \tau_t\gamma]AK_t^{\gamma}H_t^{1-\gamma} = [(1-\gamma) + \tau_t\gamma]AK_t^{\gamma}e_{t-1}^{\theta(1-\gamma)} \\ &= [(1-\gamma) + \tau_t\gamma]AK_t^{\gamma}e_{t-1}^{\delta}. \end{aligned}$$

where $\delta = \theta(1-\gamma)$. From Proposition 1, the evolution of education is given by

$$e_t = \begin{cases} (1-\alpha)(1-\gamma)\left[\frac{\gamma}{\overline{r}-\phi}\right]^{\frac{\gamma}{1-\gamma}} A^{\frac{1}{1-\gamma}} e_{t-1}^{\theta} \text{ if } \widehat{r}_t \leq \overline{r} - \phi \\ (1-\alpha)[(1-\gamma) + \tau_t\gamma]A(b_{t-1}^K)^{\gamma}(e_{t-1})^{\delta} \text{ if } \widehat{r}_t > \overline{r} - \phi. \end{cases} \tag{10}$$

It is clear from equation (9) that the dynamics of the evolution of capital does not depend on the parameter θ. However, the evolution of education given by equation (10) depends on the value of the parameter, θ. The capitalist's capital endowment grows at the rate $(1-\alpha)(\overline{r} - \phi)$. To ensure that the capitalist's endowment grows over time, we require the regularity condition: $(1-\alpha)(\overline{r} -$

$\phi) > 1$.[6] This implies that the capitalist's endowment of capital grows at a constant rate if the economy does not have any capital controls in place.

Since $\theta = 1$, from (10), the evolution of education is given by,

$$e_t = \begin{cases} (1-\alpha)(1-\gamma)\left[\frac{\gamma}{\overline{r}-\phi}\right]^{\frac{\gamma}{1-\gamma}} A^{\frac{1}{1-\gamma}} e_{t-1} \text{ if } \widehat{r}_t \leq \overline{r}-\phi \\ (1-\alpha)[(1-\gamma)+\tau_t\gamma]A(b^K_{t-1})^{\gamma}(e_{t-1})^{1-\gamma} \text{ if } \widehat{r}_t > \overline{r}-\phi. \end{cases} \tag{11}$$

The next proposition summarizes the steady state equilibrium growth rate of education in comparison to the growth rate of capital.

Proposition 2 *Let g_e and g_K denote the growth rates of education and capital, respectively. Define $\underline{A}(\phi)$ as*

$$\underline{A}(\phi) = \frac{\overline{r}-\phi}{(1-\gamma)^{1-\gamma}\gamma^{\gamma}}.$$

If $A \geq \underline{A}(\phi)$ there exists a unique balanced growth equilibrium where $g_e = g_K = (1-\alpha)(\overline{r}-\phi)$. If $A < \underline{A}(\phi)$ then in the steady state, $g_K > g_e$.

Proof: Define the critical value of the capital-education ratio that yields an interior solution as $\widehat{\frac{b^K}{e}} = (\frac{\gamma A}{\overline{r}-\phi})^{\frac{1}{1-\gamma}}$. Note that if $\frac{b^K_t}{e} \leq \widehat{\frac{b^K}{e}}$, a corner solution obtains. For a corner equilibrium, from Proposition 1 and equation (11), we know that the growth rate of education is given by,

$$g_e = \frac{e_t}{e_{t-1}} = (1-\alpha)[1 - \frac{\overline{r}-\phi}{\gamma A(\frac{b^K_{t-1}}{e_{t-1}})^{\gamma-1}}\gamma]A(\frac{b^K_{t-1}}{e_{t-1}})^{\gamma}$$
$$g_e = (1-\alpha)[A(\frac{b^K_{t-1}}{e_{t-1}})^{\gamma} - (\overline{r}-\phi)(\frac{b^K_{t-1}}{e_{t-1}})].$$

Since the $argmax_{(\frac{b^K}{e})} g_e = \widehat{\frac{b^K}{e}}$, this implies that the maximum growth rate with a corner solution for g_e^* is given by:

$$g_e^* = (1-\alpha)(1-\gamma)A^{\frac{1}{1-\gamma}}(\frac{\gamma}{\overline{r}-\phi})^{\frac{\gamma}{1-\gamma}}$$

[6] We can also think of this as an upper bound on the extent of capital controls, i.e., $\phi \leq \overline{r} - (1-\alpha)^{-1}$.

Now we look at the case of an interior equilibrium. If $\frac{b_t^K}{e} > \widehat{\frac{b^K}{e}}$, equation (11) implies that the growth rate of education is given by, $g_e^* = (1-\alpha)(1-\gamma)\left[\frac{\gamma}{\overline{r}-\phi}\right]^{\frac{\gamma}{1-\gamma}} A^{\frac{1}{1-\gamma}}$. From equation (9), $g_K = (1-\alpha)(\overline{r}-\phi)$. Let $\underline{A}(\phi)$ be the level of technological parameter where this condition, $g_e^* = g_K$, holds with equality, i.e.,

$$\underline{A}(\phi) = \frac{\overline{r}-\phi}{(1-\gamma)^{1-\gamma}\gamma^{\gamma}}.$$

In the steady state, if $A < \underline{A}(\phi)$, $g_e < g_K$: i.e., there will always be capital flight and the growth rate of education will be strictly less than the growth rate of capital. However, if $A \geq \underline{A}(\phi)$, there exists a unique $(\frac{b^K}{e})$ ratio such that $g_e = g_K = (1-\alpha)(\overline{r}-\phi)$: i.e., in the steady state, there will be no capital flight.

Insert Figure 3a and Figure 3b Here.

These cases are depicted in Figures 3a and 3b. In particular, Figure 3a shows the steady state equilibrium when $A > \underline{A}(\phi)$. The growth rate of education is an increasing function of capital-education ratio. It reaches a maximum at $\widehat{\frac{b}{e}}$ after which it becomes constant as we have capital flight. The growth rate of capital is always equal to: $(1-\alpha)(\overline{r}-\phi)$. When $A > \underline{A}(\phi)$, these two curves intersect at a unique capital-education ratio, $\overline{\frac{b}{e}}$. If the initial ratio, $\frac{b_0}{e_0} < \overline{\frac{b}{e}}$, then the capital-education ratio, $\frac{b}{e}$, will increase. If $\frac{b_0}{e_0} > \overline{\frac{b}{e}}$, then the capital-education ratio, $\frac{b}{e}$, falls. This implies that the steady state equilibrium is unique and stable with both capital and education growing at the same rate. In the steady state, we always have a corner solution with no capital flight.

Figure 3b shows the steady state equilibrium when $A < \underline{A}(\phi)$. Here, irrespective the initial capital - education ratio, $\frac{b_0}{e_0}$, the growth rate of education never catches up with the growth rate of the capital stock. Eventually the domestic rental rate falls to a point where there is capital flight. This leads to unbalanced growth: i.e., to a situation in which $g_K > g_e$ in the steady state. If we interpret the $\frac{b}{e}$ ratio as a measure of inequality, then in steady state inequality keeps increasing. The income of the capitalists in comparison to the income of the workers also keeps increasing forever.

Proposition 2 suggests that capital controls are good for an economy when the level of technology is very low. However, when technology reaches a certain threshold capital controls can be harmful for growth. To see this intuitively, consider the case where $A > \underline{A}(\phi)$, under which the worker's optimal tax is a corner equilibrium (in terms of Figure 2b). When ϕ rises (capital controls rise) the worker's optimal tax on capital income increases. This lowers the after-tax income of capitalists in the next period and leads to lower domestic investment, K, as well as a reduction in the growth rate of capital, g_K. This reduces steady state wages and the income of workers, leading to lower investment in education. Therefore, a rise in ϕ leads to a lower capital-education ratio as well as lower equilibrium growth rates of education and capital. As such, a reduction in ϕ as long as $A > \underline{A}(\phi)$ facilitates the transition to the high equilibrium growth rate. This is because the level of technology is sufficient to sustain balanced growth, implying that developed countries do not require capital controls.

When $A < \underline{A}(\phi)$, an interior equilibrium obtains and the optimal tax set by workers is zero. A rise in ϕ has two effects: first, it reduces capital flight which increases the domestic capital stock and wages, leading to higher income for the workers. This leads to more investment in education as well as a higher growth rate of education, g_e (even though $g_e < g_K$). Figure 4 shows the effect of a change in ϕ on the g_K and g_e curves. Note that $\underline{A}(\phi)$ is falling in ϕ. This implies that a rise in ϕ reduces the threshold required to jump to the balanced growth equilibrium. In this sense, increasing capital controls when a country is underdeveloped may be good, as it relaxes the constraint required to achieve the high growth equilibrium.

Insert Figure 4 Here.

Interestingly, in an interior equilibrium, the channel through which capital controls affects growth is not through the equilibrium tax rate. This is because the optimal taxes for workers are zero. A change in ϕ only affects the proportion of the capitalist's endowment invested domestically and abroad. This affects the wages of workers and their income which leads to changes in investment in education. Importantly, the channels through which changes in ϕ affect equilibrium growth depends on whether a corner or interior equilibrium obtains in steady state.

3.2 $\theta < 1$

We now consider the case where human capital is concave with respect to investment in education i.e., $\theta < 1$. The results are summarized by the following lemma.

Lemma 2 *Given any initial endowment of capital, b_0^K, and education, e_0, there exists a time period t' such that $\widehat{r}_t < \overline{r} - \phi$ for all $t \geq t'$.*

Proof: We show that in the steady state there is some capital flight even if the economy starts off from a point where the domestic pre-tax rental rate exceeds the return from foreign investment for the capitalists. From equation (10), the evolution of education is given by

$$e_t = (1-\alpha)[(1-\gamma) + \tau_t \gamma] A (b_{t-1}^K)^\gamma (e_{t-1})^\delta \qquad \text{if } \widehat{r}_t > \overline{r} - \phi.$$

From Proposition 1, we know that the optimal tax rate on rental income is given by, $\tau_t = 1 - \frac{\overline{r}-\phi}{\widehat{r}_t}$. Using (7) and (10), we can write the evolution of education as

$$e_t = (1-\alpha)[A(b_{t-1}^K)^\gamma (e_{t-1})^\delta - (\overline{r} - \phi) b_{t-1}^K].$$

Accordingly, the growth rate of education is given by

$$g_e = \frac{e_t}{e_{t-1}} = (1-\alpha)[A(\frac{b^K_{t-1}}{e_{t-1}})^\gamma e_{t-1}^{(\theta-1)(1-\gamma)} - (\overline{r}-\phi)(\frac{b^K_{t-1}}{e_{t-1}})].$$

When the growth rate of education, g_e, exceeds growth rate of domestic capital, $(1-\alpha)(\overline{r}-\phi)$, the capital-education ratio, $\frac{b^K}{e}$, falls in the next period. In addition, the term $e_{t-1}^{(\theta-1)(1-\gamma)} \rightarrow 0$ if $g_e > (1-\alpha)(\overline{r}-\phi)$. Hence, in the steady state, $g_e < (1-\alpha)(\overline{r}-\phi)$, which implies, $\widehat{r}_t = \gamma\left(\frac{e^\theta_{t-1}}{b^K_{t-1}}\right)^{1-\gamma}$, is monotonically decreasing over time. Hence, there exits a t' such that $\widehat{r}_t < \overline{r}-\phi$ for all $t \geq t'$.

Lemma 2 says that irrespective of whether the initial world interest rate is less or greater than the initial domestic interest rate, an interior equilibrium obtains in the steady state in which optimal taxes are zero. Hence, when human capital is concave with respect to investment in education, an interior equilibrium obtains with a unique constant steady state level of education. In the next proposition, we characterize the unique steady state level of investment in education.

Proposition 3 *In the steady state, the unique constant steady state level of education is given by,*

$$e^* = \left\{(1-\alpha)(1-\gamma)A^{\frac{1}{1-\gamma}}\left[\frac{\gamma}{\overline{r}-\phi}\right]^{\frac{\gamma}{1-\gamma}}\right\}^{\frac{1}{1-\theta}},$$

and is independent of the initial endowments.

Proof: From Lemma 2, it follows that the economy eventually reaches a point when $\widehat{r}_t < \overline{r}-\phi$. From (10), the evolution of education is given by

$$e_t = (1-\alpha)(1-\gamma)A^{\frac{1}{1-\gamma}}\left[\frac{\gamma}{\overline{r}-\phi}\right]^{\frac{\gamma}{1-\gamma}} e^\theta_{t-1}.$$

Education in period t is a monotonically increasing concave function of the previous period's education. In the steady state, $e_t = e_{t-1} = e^*$. Hence, the steady state level of education is

$$e^* = \left\{(1-\alpha)(1-\gamma)A^{\frac{1}{1-\gamma}}\left[\frac{\gamma}{\overline{r}-\phi}\right]^{\frac{\gamma}{1-\gamma}}\right\}^{\frac{1}{1-\theta}}.$$

The intuition behind Proposition 3 operates similar to the case where $\theta = 1$ and $A < \underline{A}(\phi)$ where a rise in ϕ induces a growth effect on the growth rate of education. Here a rise in ϕ has a level effect with the steady state equilibrium growth rate being zero. To see this, suppose there is an increase in ϕ. Since the unique steady state equilibrium level of income is at an interior point, this implies that the optimal tax for workers is zero.[7] Therefore, a rise in ϕ raises domestic investment, K, by the capitalists, and induces lesser capital flight. Since the domestic stock of capital increases, workers wage incomes increase leading to more investment in education. Hence, a higher ϕ - or more capital controls - lead to greater investment in education. Figure (5) depicts this. Starting at e^*, a higher ϕ moves the steady state to e^{**}.

INSERT FIGURE 5 HERE.

3.3 Extensions and Discussion

Our model can easily be extended to allow for the possibility of regime changes between the capitalists and workers. Consider the case where the workers have already set a tax rate, and a capitalist government comes to power. Suppose the capitalist government can change the capital control regime: i.e., set ϕ, given τ. From equation (9), we know that the workers set the tax rate such that the capitalist's make a return just equal to $\overline{r} - \phi$. This means that the capitalists are always better off by liberalizing the capital account: that is, set $\phi = 0$. From Figure 5, we know that as ϕ falls, there is a sudden decline in investment in education, and the economy converges to a lower steady state equilibrium. This holds for both the case where $\theta < 1$ as well as $\theta = 1$ with $A < \underline{A}(\phi)$. Even in the case $\theta = 1$ with $A < \underline{A}(\phi)$, a sufficiently large reduction in ϕ - because

[7] In the steady state, the expression for worker's income is given by $y^W = wh = (1 - \gamma)\left[\frac{\gamma}{\overline{r}-\phi}\right]^{\frac{\gamma}{1-\gamma}} e^{*\theta}$.

$\underline{A}(\phi)$ is decreasing in ϕ - would move the economy to an unbalanced growth equilibrium. Capital account liberalization yields the high growth equilibrium provided that the economy is sufficiently developed.

Finally, suppose the workers have the option of engaging in some subsistence production activity, like home production. In the case where the returns from final good production are sufficiently high, the workers will never engage in subsistence production. The workers invest their entire bequest in education, and the model is identical to the analysis outlined above. If the returns from subsistence production are sufficiently high, then the workers would not invest in education. Capitalists would not invest at home. And the economy is in a low productivity equilibrium where only home production occurs.

4 Conclusion

This paper constructs a heterogenous agent model to study the effect of the capital controls on the level of investment in human capital and the resulting growth path of an economy. Our analysis leads to several interesting implications. First, after characterizing the optimal tax rate, we find that higher capital controls are beneficial for investment in education whenever there is capital flight in a steady state equilibrium. This is because higher capital controls increase the proportion of investment undertaken domestically (relative to capital flight), thereby raising domestic wages, income, and investment in education. We derive an endogenous threshold relating the technology parameter to the degree of capital controls. A sufficiently developed economy – associated with a high level of technological progress – induces a steady state balanced growth path in which education and capital growth at the same rate. However, an under-developed economy can jump to the balanced growth path for a suitably chosen value for the capital control parameter, as higher capital controls reduce the requisite exogenous technological progress required to induce a balanced growth path. This is because higher capital controls increase domestic wages and income inducing higher investment in education. This diminishes the relative contribution required by exogenous increases in technological progress to raise income and investment in education. Accordingly, capital controls can be beneficial to economies that are not developed. Finally, we also show that to prevent capital flight in the long run, human capital accumulation must not show decreasing returns with respect to education and the economy must be sufficiently developed.

References

[1] Alesina, Alberto and Dani Rodrik, 1994, Distributive Politics and Economic Growth, Quarterly Journal of Economics, vol 109 (2), May, 465-90 .

[2] Bourguignon, Francois and Thierry Verdier, 2000, Is Financial Openness Bad for Education? A Political Economy Perspective on Development, European Economic Review, Vol 44, 891-903.

[3] Galor, Oded and Omer Moav, 2004, From Physical to Human Capital Accumulation: Inequality in the Process of Development, Review of Economic Studies, Vol 71, 1001-1026

[4] Perotti, Roberto, 1996, Growth, Income Distribution, and Democracy: What the Data Say, Journal of Economic Growth, vol 1(2), June, 149-87 .

[5] Saint-Paul, Gilles and Thierry Verdier, 1993, Education, Democracy and Growth, Journal of Development Economics, vol 42 (2), December, 399-407

[6] Viaene, Jean Marie and Itzhak Zilcha, 2002(a), Capital Markets Integration, Growth and Income Distribution, European Economic Review, Vol 46, 301-327.

[7] Viaene, Jean Marie and Itzhak Zilcha, 2002(b), Public Education Under Capital Mobility, Journal of Economic Dynamics and Control, Vol 26, 2005-2036.

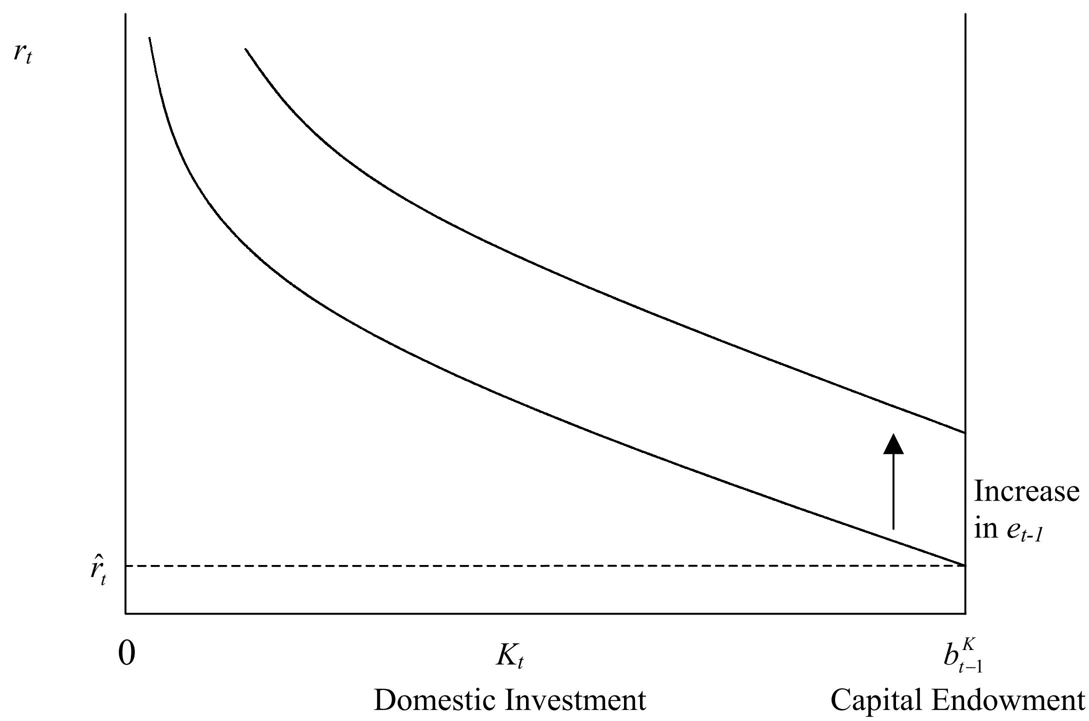


Figure 1: Pre-tax rental rate and $\hat{r}_t$

$$r_t = \gamma A\left(\frac{e_{t-1}{}^{\theta}}{K_t}\right)^{1-\gamma}$$

$$\hat{r}_t = \gamma A\left(\frac{e_{t-1}{}^{\theta}}{b^K_{t-1}}\right)^{1-\gamma}$$

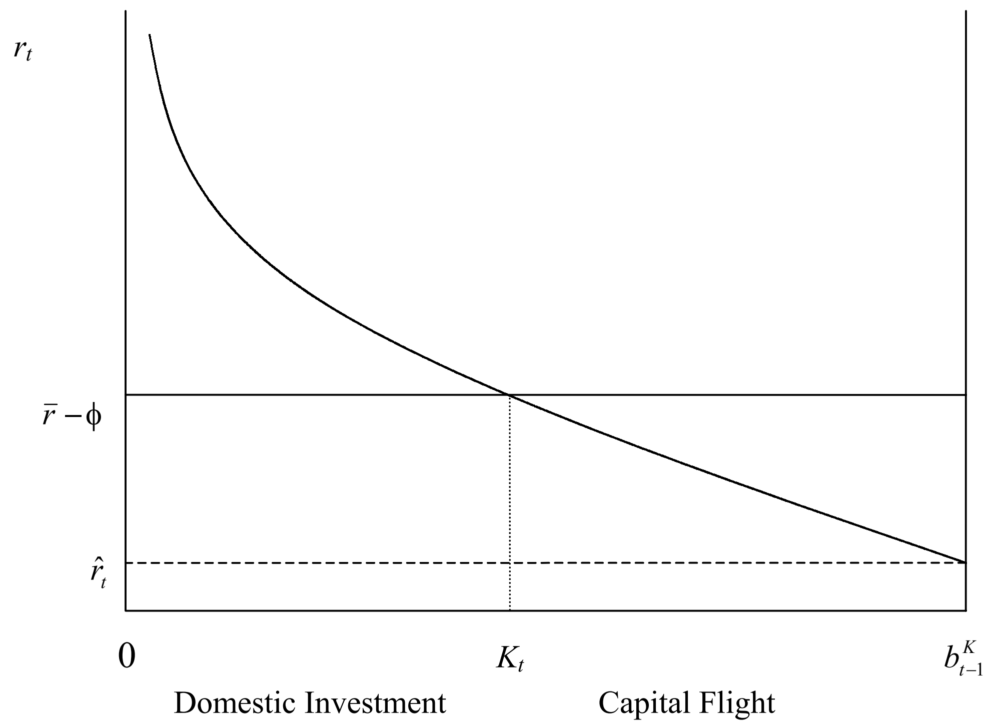
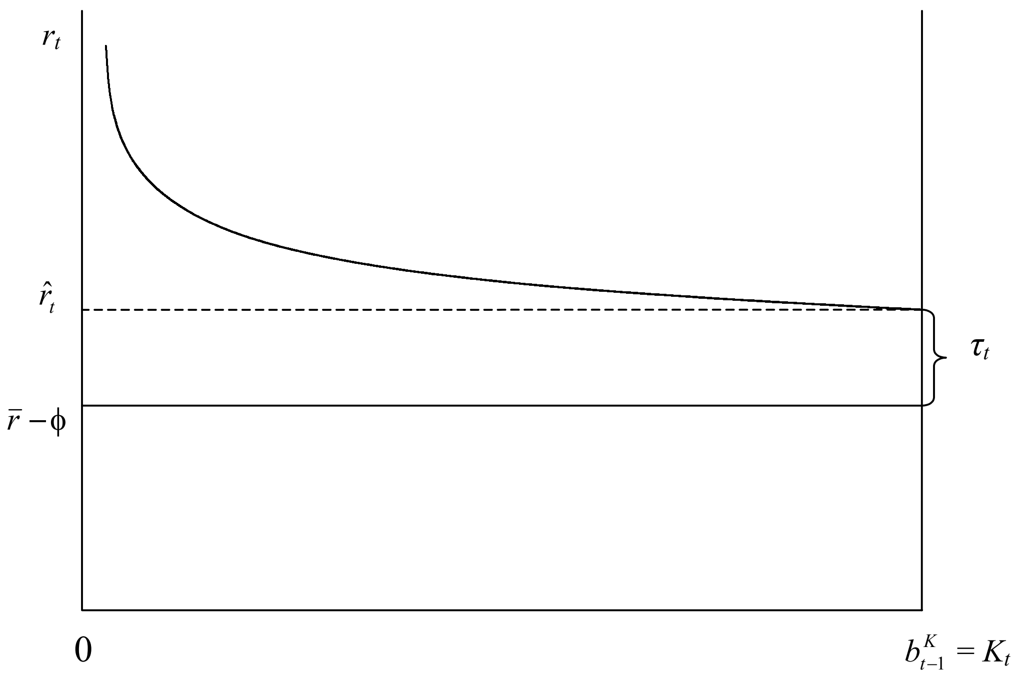


Figure 2a: $\hat{r}_t < \bar{r} - \phi$



No Capital Flight

Figure 2b: $\hat{r}_t > \bar{r} - \phi$

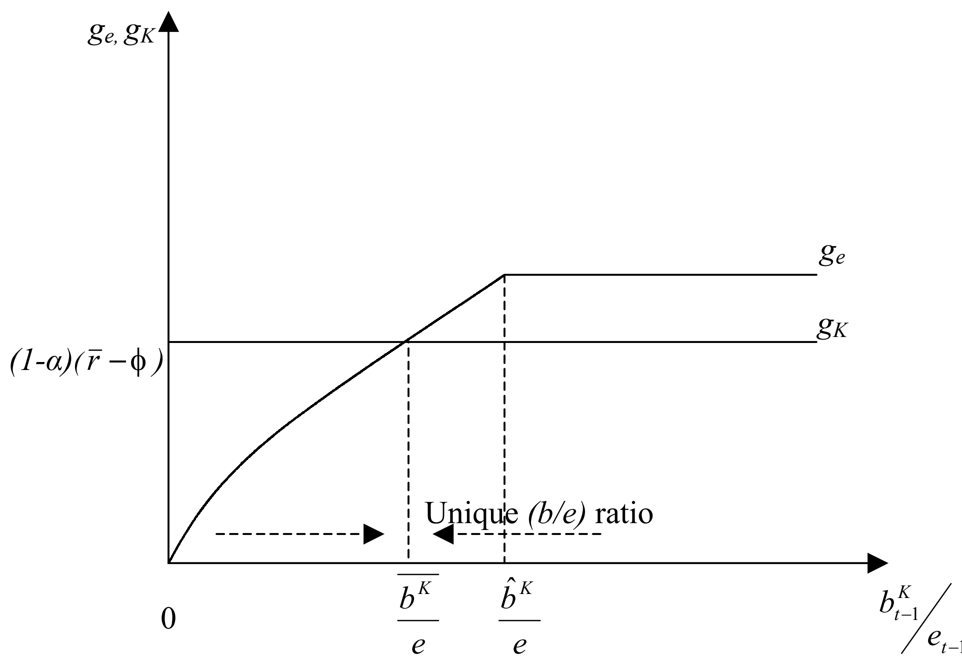


Figure 3a: Steady State with $\theta = 1$
$A > \underline{A}(\phi)$

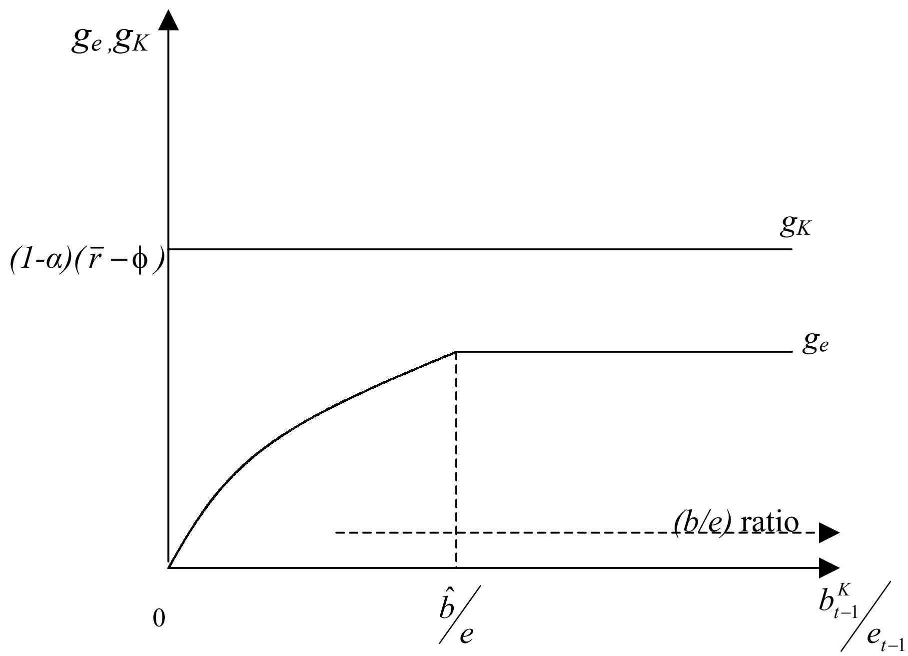


Figure 3b: Steady State with $\theta = 1$
$A < \underline{A}(\phi)$

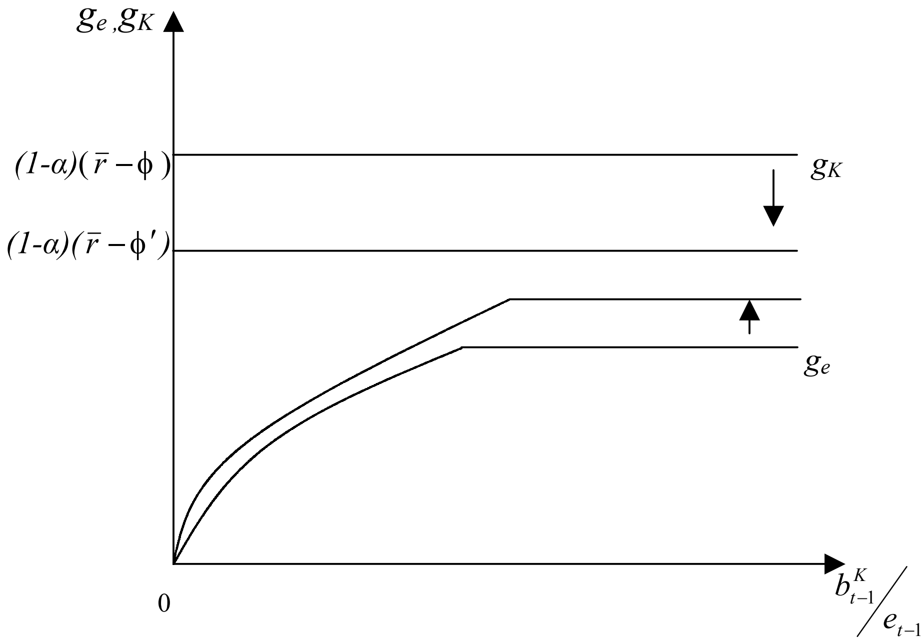


Figure 4: Change in Capital Controls $\phi' > \phi$
$A < \underline{A}(\phi)$

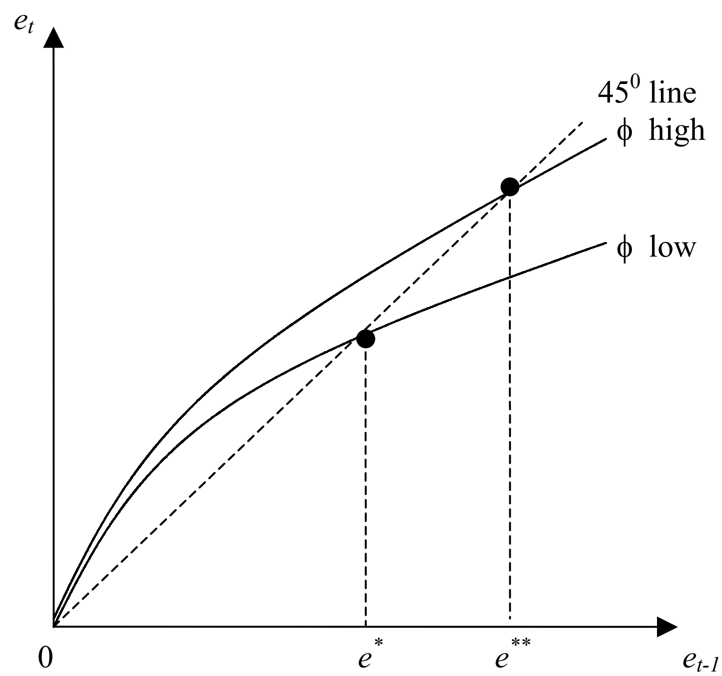


Figure 5: Steady State with $\theta < 1$