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Abstract

In order to explain multiple growth regimes, one of the working hypotheses is based on initial conditions. Using a standard optimal growth with the status effect represented by wealth *a la* Friedman (1953), this paper obtains multiple growth regimes based on initial conditions without reliance on other assumptions such as nonlinearities of production or consumption functions and heterogeneous agents/savings behavior. With the status effect, the resulting equilibrium distribution is characterized by a group with a lower level of income and another group with a higher level of income. Globally, a sufficiently strong monetary policy may be an instrument in order for an economy in poverty traps to take off and become wealthy in the long run. Locally, our model sheds light on the relationship between money/inflation and capital in the long run that, given general cash-in-advance constraints on investment relative to consumption, is determined by the curvature of the utilities of wealth and consumption.

Keywords: one-sector growth model, wealth effect, CIA constraint, takeoff.

JEL classification: E13, E52, O11.

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1 Introduction

The notion that an individual might care about wealth has a long history and traditionally viewed possession of wealth as a standard of success and a measure of status in a society. An early exposition of such ideas of status effect was Veblen (1899), but a formal account of wealth was not offered until Friedman (1953) who analyzed individuals' choice and found the resulting distribution effect with a group having a lower level of wealth while the other group having a higher level of wealth. Although Kurz (1968) has formally incorporated the wealth effect in a neoclassical growth model, the implications of the effect of wealth have been neglected neglected in a general-equilibrium framework. Recently, Robson (1992) extended the Friedman model and compared the models with and without the relative standing of wealth in a society.

With the status effect, when the utility of wealth is increasing and concave, as proposed by Friedman (1953) and proved by Robson (1992), there are possibly multiple levels of capital in a steady state. Thus, otherwise identical countries except different levels of initial capital per capita converge to different long-run growth regimes. There were existing studies of multiple growth regimes whose working hypothesis was based on initial history, but they also relied on other assumptions.[1] For example, Azariadis and Drazen (1990) and Galor and Weil (2000) assumed nonlinearities of production or consumption functions at different levels/stages of capital, and Galor (1996) assumed heterogeneous agents/savings behavior. One attractive feature of a standard optimal growth model with the status effect is that multiple growth regimes can arise naturally without relying on nonlinearities of production, heterogeneity of agents or other assumptions.

The purpose of this paper is to study a monetary version of an optimal growth model with the status effect. Our global analysis envisages the role of monetary policy that leads to a big push from poverty traps or causes a big crash in rich clubs. To the best of our knowledge, a global long-run effect of monetary supply on capital has never been analyzed.[2] Our local analysis will shed light on the role of the curvature of utility on the relationship between money/inflation and capital in the long run, an old but ongoing debate made popular by Tobin (1965), Sidrauski (1967), Lucas (1980) and Stockman (1981).

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[1] There are two other different working hypotheses in establishing multiple growth regimes. (*i*) Countries are inherently different in one or more fundamental aggregate features (e.g., Barro and Sala-i-Martin, 1995; Mankiw et al., 1992). (*ii*) Fundamentally identical countries have different expectations (Matsuyama, 1991; Chen and Shimomura, 1998). See survey in Azariadis (1996).

[2] Monetary policy has been found effective in a liquidity trap. In a dynamic general-equilibrium model with a liquidity trap, Auerbach and Obstfeld (2005) found that large-scale open market purchases of domestic government bonds can achieve a substantial welfare improvement.

The status effect has recently received interest in the investigation of various economic issues. Within the context of real models, the issues under study include relative wealth as a social norm effect (Cole, et al., 1992; Corneo and Jeanne, 1997), endogenous growth (Zou, 1994; Futagami and Shibata, 1998), and stock market prices (Bakshi and Chen, 1996). More recently, Gong and Zou (2001) and Chang and Tsai (2003) extended the status effect into a monetary economy via a cash-in-advance (henceforth, CIA) constraint and re-examined the long-run relationship between monetary growth and capital. Gong and Zou (2001) and Chang and Tsai (2003) obtained one steady state and their long-run relationships between money and capital were solely dictated by the CIA constraint on investment relative to consumption.[3]

In this paper we study an optimal growth model with the status effect and with two more extensions. First, as firms hold more cash and consumers use more credit than what one used to assume,[4] we consider the most general CIA constraint on investment relative to that on consumption with their relative degree smaller or larger than unity.[5] Yet, as we will see, even the most general CIA constraint alone cannot dictate the long-run local relationship between money and capital. Second, the wealth is the sum of capital and a fraction of real balances. Under a CIA constraint, money is not used based on the store-of-value motives; an individual holds cash for transaction purposes. Thus, an agent may not perceive real balances completely as wealth, at least for the portion held for purchase of consumption. We capture such a feature by considering a fraction of real balances as wealth. As will be seen, the degree of real balances perceived as wealth affects capital in a way depending on relative risk aversion in wealth.

Our main findings are summarized as follows. First, there are multiple locally stable steady states. Thus, otherwise identical economies except for different initial levels of capital end up in different convergence clubs. Locally, a monetary policy cannot generate an effect to elude poverty traps. Globally, a sufficiently strong monetary policy may be an instrument in

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[3] While Gong and Zou (2001) uncovered a negative relationship when the CIA constraint on investment relative to consumption was one, Chang and Tsai (2003) found a positive relationship when the CIA constraint on investment relative to consumption was sufficiently smaller than one. Neither the curvature of the utility from holding wealth nor that of consumption plays any role. As our findings below indicate, the results in Gong and Zou (2001) and Chang and Tsai (2003) are special cases.

[4] Bates, et al, (2006) documented that firms held much more cash after 1980 with the average ratio of cash to total assets more than doubled in the past 20 years. Moreover, Ludvigson (1999) uncovered that as a fraction of personal income, consumer credit had doubled during the postwar period, with particularly sharp and sustained increases occurring in the past 20 years.

[5] Existing models assumed the CIA constraint on investment relative to the constraint on consumption is either equal to unity (Stockman, 1981; Gong and Zou, 2001) or smaller than unity (Wang and Yip, 1992; Chang and Tsai, 2003. Like ours, Chen and Guo (2007) considered a general CIA constraint, albeit in the analysis of local indeterminacy and in an endogenous growth framework.

order for an economy in a poverty trap to take off and becomes wealthy in the long run. Alternatively, however, a strong monetary policy in an opposite direction may also lead a wealthy economy to a big crash. Existing studies paid no attention to this role of monetary policy.

Second, in our local analysis, the long-run relationship between money/inflation and capital depends on the curvature of the utility of wealth relative to consumption as compared with a threshold that is affected by the CIA constraint on investment relative to consumption. Given a general relative CIA constraint, the curvature of the utility in wealth vis-à-vis consumption governs the local relationship between money and growth. Existing studies paid attention to the relative CIA constraint, but not to the role of the relative curvature of utility.

Finally, a higher degree of real balances perceived as wealth exerts a local effect on capital depending on the relative risk aversion in wealth as compared to a threshold that is affected by the growth rate of money and the relative CIA constraint. Given the threshold, in an economy with larger curvature in the utility of wealth, a higher degree of real balances perceived as wealth has a negative long-run effect on capital.

The remainder of this paper is organized as follows. Section 2 sets up a model and studies the optimization and the equilibrium. Section 3 characterizes the steady-state equilibrium in a local and a global analysis. Finally, some concluding remarks are offered in Section 4.

2 The Model

The basic model is based on Friedman (1953), Kurz (1968) and Stockman (1981). The economy consists of a continuum of identical agents, each supplying labor inelastically. The lifetime utility of the representative agent is

$$U = \int_0^\infty [u(c) + \beta v(w)]\, e^{-\rho t} dt,$$

where c is consumption per capita, w is an agent's perceived wealth per capita, $\rho>0$ is the time preference rate and $\beta\geq 0$ is the degree of wealth on the preference relative to consumption.

Wealth and preference are connected through many reasons. First, a wealthy agent can afford a house in an expensive, good district like Beverly Hill in Los Angels. Moreover, in a capital market with imperfect information, an agent with access to wealth is easier to obtain loans because of collateral (Stiglitz and Weiss, 1983) and is easier to become an entrepreneur who monitors workers (Banerjee and Newman, 1993). Finally, in political economy, wealth can be used to buy either a power in politics or an ownership power in a firm through share holdings (Bowles and Gintis, 1992).

We assume a separable form for the consumption-induced utility and the wealth-induced utility so there is no direct substitution effect on utility between consumption and wealth.[6] The same form was used in Kurz (1968), Gong and Zou (2001), and Chang and Tsai (2003).

In our model, the agent's perceived level of wealth is

$$w=k+\gamma m, \tag{1}$$

which includes his capital, k, and a part of his real balances, m. Parameter $0\leq\gamma\leq1$ is the degree of real balances perceived by an agent as wealth. In our model, an individual chooses to hold real balances only for transactions and not for a store of value. Thus, the agent may not perceive real balances completely as wealth, at least for the portion held in order to purchase consumption. It is reasonable to capture such a feature by assuming a degree of real balances perceived as wealth. Two extreme cases are in order. If $\gamma=0$, real balance is not recognized as wealth, as were in Kurz (1968) and Zou (1994). Alternatively, if $\gamma=1$, all real balance is accepted as wealth, as were in Gong and Zou (2001) and Chang and Tsai (2003).

Felicity u has a standard strictly increasing and concave property; i.e., $u'(c)>0>u''(c)$. Moreover, felicity v is strictly increasing and strictly concave; i.e., $v'(w)>0>v''(w)$. A concave utility of wealth is reasonable according to Robson (1992) who showed that the attitudes to risk in a strictly increasing and concave utility provide a natural explanation of the fundamental phenomenon addressed by Friedman and Savage (1948) that individuals may simultaneously purchase insurance and participate in lotteries.

Let $f(k)$ be an individual's output and thus income per capita, with $f(k)$ strictly increasing and strictly concave in capital per capita; i.e., $f'(k)>0>f''(k)$. The representative agent's budget constraint is

$$\dot{k}+\dot{m}=f(k)-c-\pi m-\delta k+T, \tag{2}$$

where π is the inflation rate, δ is the depreciation rate of capital and T is real transfer per capita from the government. The budget constraint states that income and transfers not spent on consumption are used either to form capital or to hold real balances. Initial capital and nominal money are predetermined. Assume that money grows at a constant rate μ.

Denote I the gross investment per capita. The gross investment net of the depreciation then forms new capital in the way as follows.

$$\dot{k}=I-\delta k. \tag{3}$$

The representative agent faces the following CIA constraint

$$\varphi_c c+\varphi_I I\leq m,\ 0\leq\varphi_c\leq1,\ 0\leq\varphi_I\leq1. \tag{4}$$

[6] As money enters the utility, eliminating the substitutability between consumption and real balances is in favor of the super-neutrality of money, according to Asako (1983).

The CIA constraint includes several special cases. (i) If φ_c=1 and φ_I=0, only consumption is liquidity constrained as assumed in Clower (1967) and Lucas (1980). (ii) If φ_c=φ_I=1, the CIA constraint on investment relative to consumption is one as employed in Stockman (1981) and Abel (1985). (iii) If φ_c=1 and 0<φ_I≤1, the CIA constraint on investment is smaller than that on consumption as utilized in Wang and Yip (1992) and Palivos et al (1993).

It is clear that (4) is general in that it includes not only all existing cases but also the case where the CIA constraint on investment relative to consumption is larger than one. Evidence indicates that firms in the U.S. held much more cash after 1980 with the average ratio of cash to total assets more than doubled in the past 20 years (cf. Bates, et al, 2006). The motives of holding so much cash include transaction motives (Mulligan, 1997), precautionary motives (Opler, et al, 1999), agency motives (Jensen, 1986) and/or tax motives (Hartzell et al, 2006). Together with the fact that consumer credit had a sharp increase in the past 20 years (Ludvigson, 1999) it is therefore plausible that the degree of CIA constraints on investment is higher than that on consumption, at least during some periods of time.

2.1 Optimization

The representative agent's optimization problem is to maximize the lifetime utility by choosing between consumption, investment and real balances, all of which are subject to the constraints in (2)-(4). Let λ_k>0 and λ_m>0 be the co-state variables associated with capital and real balances, respectively, and ξ>0 be the Lagrange multiplier of the CIA constraint. The necessary conditions are

$$u'(c) = \lambda_m + \xi\varphi_c, \tag{5a}$$

$$\lambda_k = \lambda_m + \xi\varphi_I, \tag{5b}$$

$$\dot{\lambda}_k = (\rho+\delta)\lambda_k - \lambda_m f'(k) - \beta v'(w), \tag{5c}$$

$$\dot{\lambda}_m = (\rho+\pi)\lambda_m - \beta v'(w)\gamma - \xi, \tag{5d}$$

and the transversality conditions $\lim_{t\to\infty} e^{-\rho t}\lambda_{kt}k_t = 0$ and $\lim_{t\to\infty} e^{-\rho t}\lambda_{mt}m_t = 0$.

In these conditions, (5a) equalizes the marginal utility of consumption to the marginal cost of consumption, the sum of the shadow price of real balances and the shadow price of the CIA constraint on consumption. Next, in (5b) optimal investment requires no arbitrage between capital and real balances. Thus, the shadow price of capital must equal the shadow price of real balances and the shadow price of the CIA constraint on investment. Finally, conditions (5c) and (5d) are the intertemporal no-arbitrage conditions which govern how each of the two Hamiltonian shadow prices changes over time.

2.2 Equilibrium

In equilibrium, government real transfers are financed by the increase in monetary supply; thus, $T=\mu m$. The money and the goods markets are both clear; i.e.,

$$\dot{m} = (\mu - \pi)m, \tag{6a}$$

$$\dot{k} = f(k) - c - \delta k \,. \tag{6b}$$

A perfect-foresight equilibrium is a time path $\{c, m, k, \lambda_k, \lambda_m, \xi, \pi\}$. The path satisfies the agent's optimization, (5a)-(5d), the money and the goods market equilibrium, (6a)-(6b), and the binding CIA constraint (4).[7] Below, we explain how the equilibrium is determined.

First, if we substitute ξ in (5b) into (5a), we obtain

$$\lambda_k = \tfrac{\varphi_I}{\varphi_c} u'(c) + (1 - \tfrac{\varphi_I}{\varphi_c})\lambda_m \equiv \lambda_k(c, \lambda_m). \tag{7a}$$

Next, differentiating (5a) with respect to time, with the use of (5c) and (7a), yields

$$\dot{c} = \tfrac{-1}{u''(c)} \tfrac{\varphi_c}{\varphi_I} [\lambda_m f'(k) + \beta v'(w) - (\rho + \delta)\lambda_k(c, \lambda_m) - (\tfrac{\varphi_I}{\varphi_c} - 1)\dot{\lambda}_m], \tag{7b}$$

which is the Keynes-Ramsey condition.

Moreover, as (3) and (6b) indicate $f(k)=c+I$, the CIA constraint suggests $m=(\varphi_c-\varphi_I)c+\varphi_I f(k)$. If we differentiate this relationship and use (6a), we attain

$$\pi = \mu - \tfrac{(\varphi_c/\varphi_I - 1)\dot{c} + f'(k)\dot{k}}{(\varphi_c/\varphi_I - 1)c + f(k)}.$$

By substituting $\dot{c}$ in (7b) and $\dot{k}$ in (6b), along with $\dot{\lambda}_k$ in (5c) and $\dot{\lambda}_m$ in (5d), the above expression leads to the following relationship

$$\pi = \pi(c, k, \lambda_m). \tag{7c}$$

Finally, substituting ξ in (5b) into (5d), together with (7a) and (7c), yields

$$\dot{\lambda}_m = \lambda_m[\rho + \tfrac{1}{\varphi_I} + \pi(c, k, \lambda_m)] - \tfrac{\lambda_k(c, \lambda_m)}{\varphi_I} - \beta\gamma v'(w). \tag{7d}$$

Thus, the equilibrium system is simplified to three equations, (6b), (7b) and (7d). These equations determine the equilibrium paths of c, k and λ_m. The equilibrium paths of λ_k, ξ, π and m are in turn determined by (7a), (5b), (7c) and (4).

2.3 Steady State

In a steady state, $\dot{c} = \dot{k} = \dot{\lambda}_m = \dot{m} = 0$. Under $\dot{m} = 0$, then (6a) gives inflation as $\pi^*=\mu$.[8]

[7] Following Lucas (1980) and Wang and Yip (1992), we assume the CIA constraint is binding in equilibrium.

[8] An asterisk is used to denote values in a steady state.

First, under $\dot{k}=0$, (6b) is

$$f(k^*)-\delta k^*-c^*=0, \tag{8a}$$

which is the long-run goods market equilibrium condition.

Next, if we substitute the expression in (7a), $\dot{c}=0$ in (7b) becomes

$$\{(\rho+\delta)[1+\varphi_I(\rho+\mu)]-f'(k^*)\}\lambda_m(c^*,k^*)=\beta v'(w(c^*,k^*))[1+\gamma\varphi_I(\rho+\delta)], \tag{8b}$$

in which, with the use of (4) and (7d) under $\dot{\lambda}_m=0$, $w(c, k)$ and $\lambda_m(c, k)$ are

$$w(c^*,k^*)\equiv k^*+\gamma m^*=k^*+\gamma[\varphi_c c^*+\varphi_I\delta k^*], \tag{9a}$$

$$\lambda_m(c^*,k^*)\equiv u'(c^*)\{1+\varphi_c[\tfrac{\rho+\mu+\gamma(f'(k^*)-(\rho+\delta))}{1+\gamma\varphi_I(\rho+\delta)}]\}^{-1}. \tag{9b}$$

As $v'>0$ and $\lambda_m>0$, consistency in (8b) requires

$$f'(k^*)<(\rho+\delta)[1+\varphi_I(\rho+\mu)].$$

which is a variant of the Brock-Gale condition that requires the marginal product of capital to be dominated by the sum of the time-preference and the discount rates in a steady state.

Equations (8a) and (8b) simultaneously determine the values of k^* and c^* in a steady state. In a (k, c) plane, it is easy to show that the $\dot{k}=0$ locus is positively slopping for all k such that $f'(k)>\delta$ and negatively slopping for all k such that $f'(k)<\delta$.

For the shape of the $\dot{c}=0$ locus, there are three cases in terms of the degree of wealth on the preference relative to consumption.

Case 1. $\beta=0$.

In this case, there is no status effect. Now, $\dot{c}=0$ becomes

$$(\rho+\delta)-f'(k^*)+\varphi_I(\rho+\delta)(\rho+\mu)=0. \tag{10a}$$

Then, the $\dot{c}=0$ locus is a vertical line in the (k, c) plane. Obviously, there is a unique steady state. See E_3 in Figure 1.

[Insert Figure 1 here]

Case 2. $\beta>0$ and $\gamma=0$.

In this case, $\dot{c}=0$ becomes

$$(\rho+\delta)-f'(k^*)+\varphi_I(\rho+\delta)(\rho+\mu)=\tfrac{\beta v'(k^*)}{u'(c^*)}[1+\varphi_c(\rho+\mu)]. \tag{10b}$$

It is easy to show the lefthand side of (10b) is increasing in k, while the righthand side of (10b) is decreasing in k and increasing in c. Thus, the $\dot{c}=0$ locus is positively slopping in the (k, c) plane. As a result, there may be multiple steady states, as illustrated by E_1, E_2 and E_3 in Figure 1

Case 3. β>0 and γ>0.

In this case, $\dot{c} = 0$ is

$$(\rho + \delta) - f'(k^*) + \varphi_I(\rho + \delta)(\rho + \mu) = \tfrac{\beta v'(k^* + \gamma(\varphi_c c^* + \varphi_I \delta k^*))}{u'(c^*)} \Lambda, \quad (10c)$$

where $\Lambda \equiv 1 + \varphi_c(\rho + \mu) + \gamma[\varphi_c f'(k^*) + (\varphi_I - \varphi_c)(\rho + \delta)] > 0.$

It is easy to see that $\dot{c} = 0$ is positively slopping in the (k, c) plane, like the case in (10b). Thus, there may be multiple steady states, as illustrated by E_1, E_2 and E_3 in Figure 1.

For the three steady states in Figure 1, E_2 is a source, while E_1 and E_3 are saddles and are thus locally stable. See an appendix for proof. If the initial level of capital is above k_2, the economy will converge to E_3 in a steady state. The economy becomes a wealthy economy. Alternatively, if the initial level of capital is below k_2, the economy will converge toward E_1 in a steady state, and thus a development trap. There are thus multiple growth regimes and the initial history determines its eventual fate. Otherwise identical economies become poor or wealthy in the long run depending on the initial conditions. There is a set of countries in poverty traps along with another set of countries in rich clubs.

In our model multiple growth regimes naturally arise in a standard optimal growth model with the status effect. Existing working hypotheses in establishing multiple growth regimes may be broadly classified into three types, according to Azariadis (1996). These are (*i*) differences in initial conditions (e.g., Azariadis and Drazen, 1990; Galor and Weil, 2000), (*ii*) differences in one or more fundamental aggregate features (e.g., Barro and Sala-i-Martin, 1995; Mankiw et al., 1992), and (*iii*) differences in expectations (Matsuyama, 1991; Chen and Shimomura, 1998). Our working hypothesis follows the line of thought (*i*). In our paper, a standard growth model with a concave status effect naturally leads to multiple growth regimes without relying on other assumptions made in existing studies. Among the additional assumptions, external effects in technologies were made in some studies (e.g., Krugman, 1987; Azariadis and Drazen, 1990), while heterogeneous agents/savings behavior were assumed in others (e.g., Galor and Ryder, 1989; Galor, 1992, 1996). Some other works assumed imperfect capital market (e.g., Galor and Zeira, 1993; Benabou, 1996), imperfect financial intermediations (Cooper and Ejarque, 1995; Becsi, et al., 1999), and binding subsistence consumption constraint at a low initial level of capital (e.g., Galor and Weil, 2000). Except for Shimomura (2004) and Chen (2007),[9] existing

[9] In a two-good, two-country trade model without capital, Shimomura (2004) obtained multiple steady states based on a negative income effect of the durable good in a range of the shadow price. Chen (2007) obtained two steady states based on habit accumulation in a one-sector model, but it is in an endogenous growth framework.

studies incorporate some forms of market imperfections or heterogeneities, which generate multiple steady states. There is no market imperfection or heterogeneity in our model, yet the resulting equilibrium capital/wealth distribution may be Pareto inefficient.

The mechanism for multiple growth regimes here is the *internal* status effect in a concave utility with the risk attitudes about wealth that is consistent with the phenomenon of simultaneous purchases of insurance and lotteries described by Friedman and Savage (1948). Intuitively, the representative agent obtains utility form holding wealth in a concave fashion in a similar way to what consumption gives utility. On optimality in the Keynes-Ramsey condition, a higher level of consumption comes with a higher level of wealth. If an agent chooses to accumulate more capital, the marginal utility of wealth is diminishing. This increases the growth rate of the shadow prices of both capital and real balances in terms of consumption (cf. (5c) and (5d)). The representative agent needs to increase the level of consumption so the shadow prices of both capital and real balances in terms of consumption decrease to a constant in a steady state (cf. (5a) and (5b)). As a result, when an agent optimally chooses to hold more capital, he will choose to consume more.

With the emergence of a poverty trap like E_1 in Figure 1, it is interesting to investigate policies in order to help the economy out of the trap and take off. Although monetary policies have been found to be effective in a liquidity trap in Auerbach and Obstfeld (2005), attention has never been paid to their role as a mechanism for a takeoff from a development trap. We investigate such a possibility in the next section.

3. Characterization of Equilibrium

Suppose that the steady-state equilibrium is at E_1 in Figure 1. Implicitly we assume that the initially endowed capital per capita is below the level of k_2 in Figure 1. As a result, the economy ends up in a poverty trap at E_1. We analyze the effects of monetary growth on capital accumulation in the long run. We start by a local analysis, followed by a global analysis.

3.1 Local Analysis

When the monetary growth rate is increased (i.e., a higher μ) and thus inflation is increased, the $\dot{k}=0$ locus is not affected. However, holding c constant, the $\dot{c}=0$ locus is shifted in the direction of k direction of k as follows.

$$\left.\frac{\partial k}{\partial \mu}\right|_{\dot{c}=0} = \frac{1}{\Omega}[\varphi_I(\rho+\delta) - \varphi_c \frac{\beta v'}{u'}] \begin{matrix}\leq \\ \geq\end{matrix} 0 \ \ if \ \frac{v'}{u'} \begin{matrix}\leq \\ \geq\end{matrix} \frac{\varphi_I}{\varphi_c}\frac{\rho+\delta}{\beta} \equiv \hat{\xi}, \tag{11}$$

where $\Omega \equiv f''(1+\gamma\varphi_c \frac{\beta v'}{u'}) + \frac{\beta v''}{u'}(1+\gamma\varphi_I f')\{1+\varphi_c(\rho+\mu)+\gamma[\varphi_c f'(k)+(\varphi_I-\varphi_c)(\rho+\delta)]\} < 0.$

Obviously, the $\dot{c}=0$ locus may shift leftward or rightward. If the $\dot{c}=0$ locus shifts leftward, capital decreases in the long run (see E_1' in Figure 2). Alternatively, if the $\dot{c}=0$ locus shifts rightward, capital increases in the long run (see E_1'' in Figure 2).

[Insert Figure 2 here]

Whether the $\dot{c}=0$ locus shifts leftward or rightward depends on the ratio of the marginal utility of wealth to the marginal utility of consumption, $\frac{v'}{u'}$, as compared to a threshold, $\hat{\xi}$. Thus, given the threshold, the curvature of the utility induced by wealth relative to the curvature of the utility generated by consumption is crucial in the determination of the long-run effect of monetary supply on capital.

In the situation where the marginal utility of wealth is sufficiently large relative to the marginal utility of consumption, a higher monetary growth rate leads the agent to substitute away from consumption toward investment. As a result, the level of capital is larger in the long run. Intuitively, when the marginal utility of wealth is sufficiently large relative to the marginal utility of consumption, in response to higher monetary growth rates and thus lower real balances the representative agent will reduce consumption and increase investment in order to decrease the marginal utility of wealth. Alternatively, under the condition where the marginal utility of wealth is sufficiently small relative to the marginal utility of consumption, the agent increases consumption and reduces investment in response to a higher growth rate of monetary supply. Thus, capital is reduced in the long run.

In characterizing the threshold, it is decreasing in the degree of wealth on the preference relative to consumption and increasing in the liquidity constrains on investment relative to consumption. For a given positive degree of wealth on the preference relative to consumption (i.e., $\beta>0$), a higher CIA constraint on investment relative to consumption (i.e., higher φ_I/φ_c) increases the threshold and thus reduces the likelihood of a positive effect of money on capital accumulation. A lower CIA constraint on investment relative to consumption (i.e., lower φ_I/φ_c) decreases the threshold, and thus increases the likelihood of a positive effect of money on capital accumulation. There are some special cases.

1 $\varphi_c=1$, $\varphi_I=0$: (Lucas, 1980) then (11) becomes $-\beta v'/(\Omega u')\geq 0$ if $v'\geq 0$.

2 $\varphi_c=1$, $\varphi_I=1$: (Stockman, 1981) then (11) becomes $(\rho+\delta-\beta v'/u')/\Omega\leq(\geq)0$ if $v'\leq 0(v'/u'\geq(\rho+\delta)/\beta)$.

3 $\varphi_c=1$, $\varphi_I<1$: (Wang and Yip, 1992) then (11) becomes $[\varphi_I(\rho+\delta)-\beta v'/u']/\Omega\leq(\geq)0$ if $v'\leq 0(v'/u'\geq [\varphi_I(\rho+\delta)/\beta])$.

4 $\varphi_c=0$, $\varphi_I=1$: then (11) becomes $\varphi_I(\rho+\delta)/\Omega<0$.

Only when consumption is not cash constrained such that φ_I/φ_c approaches infinity, there is no role for the status effect and the long-run relationship between money and capital is ambiguously negative. With the status effects, our results suggest neither the outcome of a neutral relationship between monetary growth and capital when φ_I/φ_c is 0, as conceived by Lucas (1980), nor the outcome of a positive relationship between monetary growth and capital when φ_I/φ_c is very small and close to 0, as posited by Gong and Zou (2001), nor the conclusion of a negative relationship between monetary growth and capital when φ_I/φ_c is 1 or close to 1, as put forward by Stockman (1981), Wang and Yip (1992) and Chang and Tsai (2001). The curvature of utilities between wealth and consumption needs to be taken into account in the determination of the long-run relationship between money and capital when there is a status effect.

Given a threshold, the relationship between the long-run effect of monetary growth on capital and the ratio of the marginal utility of wealth to the marginal utility of consumption is thus positive (Figure 3). The relationship shifts upward if β is higher and downward if φ_I/φ_c is larger.

[Insert Figure 3 here]

The above results seemingly indicate that the degree of real balances perceived as wealth has no effects on capital accumulation in the long run. As we will see below, the degree to which real balances are perceived as wealth does affect capital accumulation in the long run.

Specifically, when the degree of real balances perceived as wealth increases, the $\dot{k}=0$ locus is not affected. The $\dot{c}=0$ locus shifts as follows.

$$\left.\frac{\partial k}{\partial \gamma}\right|_{\dot{c}=0} = \frac{1}{\Omega}\frac{-\beta}{u'}\{m^* v''(w^*)\Lambda + v'(w^*)[\varphi_c f'(k) + (\varphi_I - \varphi_c)(\rho+\delta)]\} \begin{matrix}\le\\ \ge\end{matrix} 0$$
$$if\ \varepsilon \equiv \frac{-v'' w^*}{v'} \begin{matrix}\ge\\ \le\end{matrix} \frac{\varphi_c f'(k) + (\varphi_I - \varphi_c)(\rho+\delta)}{1+\varphi_c(\rho+\mu)+\gamma[\varphi_c f'(k^*) + (\varphi_I-\varphi_c)(\rho+\delta)]}\left(\frac{k^*}{m^*}+\gamma\right) \equiv \hat{\varepsilon}. \tag{12}$$

The above expression asserts that in response to a larger degree of real balances perceived as wealth, the $\dot{c}=0$ locus may shift leftward so capital decreases or shift rightward so capital increases in the long run. The direction of such shifts depends on the coefficient of the relative risk aversion in the utility of wealth, ε, as compared to a threshold, $\hat{\varepsilon}$. Here, and different from the effects of monetary growth, the curvature in the utility of consumption produces no effects. Only the attitude to risk, or the curvature in the utility of wealth, is relevant to the effect. Specifically, when the relative risk aversion in the utility of wealth is larger than the threshold, there is a strong diminishing marginal utility of wealth. In this situation, when there is a larger degree of real balances perceived as wealth, real balances can substitute for capital, thereby leading to lower capital holdings. Alternatively, if the relative risk aversion in the wealth-induced utility is smaller than the threshold, the agent accumulates more capital.

Characterizing the threshold, it is straightforward to show that the threshold decreases in both the growth rate of monetary supply and the ratio of real balances to capital and increases in the ratio of CIA constraint on investment relative to consumption. Thus, given the coefficient of risk aversion in wealth, a smaller growth rate of monetary supply, a smaller ratio of real balances to capital, and a larger ratio of CIA constraint on investment relative to consumption reduce the likelihood that a larger degree of real balances perceived as wealth exerts a negative effect on capital accumulation in the long run.

For a given threshold, the relationship between the effect of the degree of real balances perceived as wealth on capital accumulation in the long run and the coefficient of risk aversion in wealth-induced utility is thus negative. See an illustration of the relationship in Figure 4. The relationship shifts downward if u and m/k are higher and upward if φ_I/φ_c is higher.

[Insert Figure 4 here]

3.2 Global Analysis

In the former subsection, the effect of a monetary policy is local. As a result, starting from a poverty trap and with a monetary policy, the economy remains in the trap. However, a monetary policy could boost a global effect as analyzed below.

Suppose that in the neighborhood of a poverty trap (E_1 in Figure 5), the marginal utility of wealth relative to the marginal utility of consumption is larger than threshold $\hat{\xi}$. Now, suppose that the monetary growth rate is increased. If the growth rate of money is increased sufficiently strong the $\dot{c}=0$ locus may shift rightward so much so that the only steady state is at E_3'. The economy eventually joins the rich-country club. Intuitively, because of high inflation, real balances are reduced sufficiently and are substituted away from consumption and toward capital sufficiently. The equilibrium then moves gradually from E_1 and eventually toward E_3'. The economy under study therefore takes off from a poverty trap and becomes prosperous.

[Insert Figure 5 here]

Alternatively, suppose that the marginal utility of wealth relative to the marginal utility of consumption is smaller than threshold $\hat{\xi}$. Now, the marginal utility of wealth is relatively smaller than the marginal utility of consumption. Thus, if the growth rate of money is reduced sufficiently, the $\dot{c}=0$ locus may shift rightward. Then, the only steady state is E_3'. As a result, the level of capital increases from initial k_1 toward k_3'.

Similar takeoff results may be obtained in combination with changes in the degree of real balances perceived as wealth. For example, suppose that the attitude to risk in the utility of wealth is larger than the threshold $\hat{\varepsilon}$ (like F in Figure 4). Then, if the degree of real balances perceived by the representative agent is decreased sufficiently, the equilibrium may move from E_1

gradually toward $E_3^{'}$ (Figure 5). This situation often emerges in an economy where credit markets are imperfect and new currencies are issued to stop hyperinflation.[10]

To illustrate, successful takeoffs have been made in several East Asian economies where the "four tigers" (Hong Kong, Singapore, S. Korea and Taiwan) have joined the rich-country club and now so too with China. One example was the experiences of Taiwan during 1945-1952 when Taiwan was poverty stricken. During this period the monetary supply was used as the inflationary taxes with over 70% of the revenue remitted to the government or its enterprises. As a result, the monthly inflation rate of whole sale prices was over 16.5%, or equivalently over 500% per annum.[11] Several actions were taken in order to stabilize the economy at the end of 1949. In particular, the old currency was replaced by a new currency and the growth of monetary supply was strictly controlled. Thus, if the curvature of utility in the Taiwan economy is akin to point B in Figure 3 and point D in Figure 4, then by tightening the monetary growth rate sufficiently the locus $\dot{c}=0$ shifts rightward. Moreover, by issuing new currencies, people are more willing to hold currency, and the degree to which real balances are perceived as wealth is higher. As a result of these policies, people in Taiwan held currency for longer periods and were more willing to deposit their money in banks.[12] In the decades that followed, the Taiwan economy stabilized, grew rapidly by the 1960s and became industrialized in the 2000s.

On the contrary, expansionary monetary policy has driven an initially rich country to a big crash as experienced in some Latin American countries in the post-WWII era. This outcome is especially obvious in Argentine which experienced an unprecedented boom since the turn of the twentieth century but was persistently retardated after WWII.[13] Along with other policies, Argentina had a high growth rate of money supply that led to high inflation for long periods. The annual inflation rate was 30.3% in 1950-59, 23.3% in 1960-69, 132.3% in 1970-79 and

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[10] The effect of inflation/deflation on the big push is more credible in economies with imperfect credit markets. This justifies the wealth-status effect as some forms of wealth are good collateral when a household or firm wants to borrow. Our examples illustrated below are about some developing economies whose credit markets were imperfect.

[11] See Tsiang (1980) and Makinen and Woodward (1989) for accounts of hyperinflation in Taiwan. Korea had a similar experience during 1945-48, with an average monthly inflation rate over 11.1%, or equivalently over 250% per annum. See Campbell and Tullock (1957) and Kim and Kim (1996) for accounts of South Korean hyperinflation.

[12] These were accompanied by the policy of a "Preferential Interest Rate" (at 7% per month or 125% per annum) established for time deposits and the outward-looking, export-expansion policy.

[13] According to Taylor (1994, Table 1), Argentina used to have more than 75% of average GDP per capita of 28 OECD countries before WWII, but declined to 65% by 1950 and further to 32% by 1987.

750.4% in 1980-89.[14] Such high rates of inflation lead the economy originally at equilibrium with high income at E_3 to move to E_1' (in Figure 5). An irreversible downturn, and even a big crash, thus emerges. Capital is de-accumulated and the economy is in poverty traps.

3.3 A Numerical Example

We now offer a numerical example to illustrate our results. We take $u(c)=[c^{(1-\sigma)}-1]/(1-\sigma)$ and $v(w)=w^{\theta}/\theta$. The utility has a constant intertemporal elasticity of consumption that is consistent with economic growth. The technology takes the Cobb-Douglas form, $f(k)=Ak^{\eta}$.

We set ρ=0.04, σ=1.5, θ=1, β=0.7, A=0.3, η=0.4, δ=0.065, $\varphi_c=\varphi_I=1$, γ=0.1, and μ=5. Under this set of parameter values, there are three steady states: k_1=0.1027, k_2=1.3955 and k_3=3.7099. Moreover, k_1 and k_3 are locally stable and k_2 is a source. If the central bank increases the growth rate of money to μ=6, the two saddle points corresponding to k_1 and k_3 are decreased locally. Alternatively, if the growth rate of money is decreased to μ=4, capital per capita is increased locally.[15] See Table 1. In Table 1, we also quantify the effects of changes in other parameters.

Now, suppose that the government changes monetary supply sufficiently strong by reducing the growth rate of money from μ=5 to μ=1.[16] Then, there is only one steady state with k_3=5.2348. If the growth rate of money is tightened to μ=.2, then capital is increased further to k_3=6.1714. Sufficiently tight monetary policy thus causes a big push.

Alternatively, suppose that the central bank changes the growth rate of monetary supply sufficiently by increasing the growth rate of money from μ=5 to μ=10.[17] In this case, there is only a steady state with k_1=0.0286. If the economy is originally at k_3, then loosening money supply too much brings about a big crash.

4 Concluding Remarks

In order to explain why many countries are in poverty traps and there are multiple growth regimes, several working hypotheses are proposed in the literature. Among these is the one

[14] These numbers are taken from Cavallo (1996), a former minister of Economy and Public Works, Republic of Argentina. The monetary policy came with the inward-looking, import-substitution policy and nationalist government before 1970 and the external debt policy in 1979-1982. See detailed accounts in Diaz-Alejandro (1984) for Latin American debt.

[15] Capital per capita increases to k_2=1.630911 under μ=6 and decreases to k_2=1.0955847 under μ=4. Yet, k_2 is unstable and thus the equilibrium will diverge from it.

[16] The threshold is μ=3.04, at and below which there is only a steady state.

[17] The threshold is μ=9.58, at and above which there is only a steady state.

based upon initial conditions. Existing studies whose working hypotheses are initial conditions also rely on other assumptions such as nonlinearities of production or consumption functions at different levels/stages of capital and heterogeneous agents/savings behavior. Using a standard optimal growth, this paper obtains insights on multiple growth regimes based on initial conditions without dependence on these additional assumptions.

Our model departs by considering the status effect represented by wealth. The status effect has been used to analyze individuals' choice and dates back to Friedman (1953). With the status effect, the resulting equilibrium distribution is characterized by a group with a lower level of income and another group with a higher level of income. Thus, otherwise identical economies end up in different convergence clubs if the initial levels of capital are different.

We characterize monetary policies as an instrument for a takeoff. Locally, monetary policies only have a small effect and countries in poverty traps remain poor. Globally, a sufficiently strong monetary policy may be used as an instrument in order for an economy in poverty traps to take off and becomes wealthy in the long run. Alternatively, however, a strong monetary policy in a contrary direction may also lead a wealthy economy to a big crash. We offered experiences in Taiwan that have taken off using a sufficiently tightening monetary supply in the late 1940s and the early 1950s. We also provided experiences in Argentina that had big crashes in the post WWII era, especially after 1970, because of too loose monetary policies.

Our model also sheds light on the local relationship between money/inflation and capital in the long run. Although very general CIA constraints on investment relative to consumption are considered, the local relationship between money/inflation and capital in the long run is not determined by the relative CIA constraint and thus different from the findings offered by Lucas (1980), Stockman (1981), Wang and Yip (1991), Gong and Zou (2001) and Chang and Tsai (2003). Given a CIA constraint on investment relative to consumption, the local relationship between money/inflation and capital is determined by the curvature of utility between wealth and consumption.

Finally, our model has some limitations. We only consider money as an instrument for a big push or a big crash. As we mention earlier, experiences of big pushes or big crashes are combined with monetary policies and other outward- versus inward-looking trade policies. Also important are the attitudes toward foreign direct investment. These differences in experiences may provide different mechanisms in explaining multiple growth regimes and instruments for big pushes or big crashes. Extensions of our model to formally take into account of trade policies and the policies of foreign direct investment are possible directions in further research.

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Appendix: The local stability property of the model is proved as follows.

The equilibrium dynamic system, (6b), (7b), and (7d), involves one variable whose initial value is predetermined and two control variables which may adjust instantaneously. A steady state is a saddle and thus, the dynamic equilibrium path toward the steady state is unique, if the characteristic function associated the equilibrium dynamic system has only one negative eigenvalue; the dynamic equilibrium path diverges from the steady state if there is no negative eigenvalue.

If we take Taylor's expansion of the dynamic system (6b), (7b), and (7d) in the neighborhood of a steady state, we obtain

$$\begin{bmatrix} \dot{c} \\ \dot{k} \\ \dot{\lambda}_m \end{bmatrix} = \begin{bmatrix} J_{11} & J_{12} & J_{13} \\ -1 & J_{22} & 0 \\ J_{31} & J_{32} & J_{33} \end{bmatrix} \begin{bmatrix} c-c^* \\ k-k^* \\ \lambda_m - \lambda_m^* \end{bmatrix}, \tag{A1}$$

where $J_{11} = \frac{1}{u''(c^*)}(1-\frac{\varphi_c}{\varphi_I})J_{31} + \rho + \delta - \frac{\beta v''(w^*)\gamma\varphi_c(\varphi_c-\varphi_I)}{u''(c^*)\varphi_I}$,

$J_{12} = \frac{1}{u''(c^*)}[(1-\frac{\varphi_c}{\varphi_I})J_{32} - \frac{\varphi_c}{\varphi_I}\lambda_m f''(k^*) - \frac{\varphi_c}{\varphi_I}\beta v''(k^*)(1+\gamma\varphi_I f'(k^*))]$,

$J_{13} = \frac{1}{u''(c^*)}[(1-\frac{\varphi_c}{\varphi_I})J_{33} + \frac{(\rho+\delta)(\varphi_c-\varphi_I)}{\varphi_I} - \frac{\varphi_c}{\varphi_I}f'(k^*)]$,

$J_{22} = f'(k^*) - \delta$,

$J_{31} = -[1+\frac{\lambda_m^*(\varphi_c-\varphi_I)^2}{x^*u''(c^*)\varphi_I}][\frac{u''(c^*)}{\varphi_c} + \beta\gamma^2 v''(w^*)(\varphi_c-\varphi_I)] - \frac{\lambda_m^*(\varphi_c-\varphi_I)(\rho+\delta)}{x^*} + \frac{\lambda_m^*(\varphi_c-\varphi_I)^2\varphi_c\beta\gamma v''(w^*)}{x^*u''(c^*)\varphi_I} + \frac{\lambda_m^*\varphi_I f'(k^*)}{x^*}$,

$$J_{32}=-[1+\frac{\lambda_m^*(\varphi_c-\varphi_I)^2}{x^*u''(c^*)\varphi_I}]\beta\gamma v''(w^*)[1+\gamma\varphi_I f'(k^*)]+\frac{\lambda_m^*(\varphi_c-\varphi_I)\varphi_c\{f''(k^*)\lambda_m^*+\beta v''(w^*)[1+\gamma\varphi_I f'(k^*)]\}}{x^*u''(c^*)\varphi_I}-\frac{\lambda_m^*\varphi_I f'(k^*)[f'(k^*)-\delta]}{x^*},$$

$$J_{33}=(\rho+\mu+\frac{1}{\varphi_c})[1+\frac{\lambda_m^*(\varphi_c-\varphi_I)^2}{x^*u''(c^*)\varphi_I}]-\frac{\lambda_m^*(\varphi_c-\varphi_I)\varphi_c}{x^*u''(c^*)\varphi_I}[(\rho+\delta)(1-\frac{\varphi_I}{\varphi_c})-f'(k^*)],$$

$$x^*=(\varphi_c-\varphi_I)c^*+\varphi_I f(k^*)+\frac{(\varphi_c-\varphi_I)\lambda_m^*}{u''(c^*)}(1-\frac{\varphi_c}{\varphi_I}),$$

$$z^*=\mu[(\varphi_c-\varphi_I)c^*+\varphi_I f(k^*)]-\frac{(\varphi_c-\varphi_I)}{u''(c^*)}(1-\frac{\varphi_c}{\varphi_I})[(\rho+\frac{1}{\varphi_I})\lambda_m^*-\frac{\lambda_k^*}{\varphi_I}-\beta\gamma v'(w^*)].$$

The determinant of the Jacobean matrix in (A1), denoted as *Det J*, is

$$DetJ=[f'(k^*)-\delta](J_{11}J_{33}-J_{13}J_{31})+J_{12}J_{33}-J_{13}J_{32}=\frac{1}{u''(c^*)}\frac{\varphi_c}{\varphi_I}[1+\frac{\lambda_m^*(\varphi_c-\varphi_I)^2}{x^*u''(c^*)\varphi_I}]\{\Phi\}\underset{>}{\overset{<}{}}0 \text{ if } \Phi\underset{<}{\overset{>}{}}0,$$

where
$$\Phi\equiv\frac{u''(c^*)[f'(k^*)-\delta]}{\varphi_c}[(\rho+\delta)(\varphi_I(\rho+\mu)+1)-f'(k^*)]-f''(k^*)\lambda_m^*(\rho+\mu+\frac{1}{\varphi_c})$$
$$-\beta v''(w^*)\{\rho+\mu+\frac{1}{\varphi_c}-\gamma[(\rho+\delta)(1-\frac{\varphi_I}{\varphi_c})-f'(k^*)]\}\{[f'(k^*)-\delta]\gamma(\varphi_c-\varphi_I)+1+\gamma\varphi_I f'(k^*)\}.$$

Differentiating (8b) or (10c) with respect to *c* and *k* obtains a positive slope as follows,

$$\left.\frac{dc}{dk}\right|_{\dot{c}=0}=\frac{\Xi}{\Gamma}>0, \tag{A2}$$

where $\Gamma\equiv\beta[u''(c^*)\frac{v'(w^*)}{u'(c^*)^2}-\gamma v''(w^*)\frac{(\varphi_c-\varphi_I)}{u'(c^*)}]\{1+\varphi_c(\rho+\mu)+\gamma[f'(k^*)+(\varphi_I-\varphi_c)(\rho+\delta)]\}<0,$

$$\Xi\equiv f''(k^*)[1+\beta\gamma\varphi_c\frac{v'(w^*)}{u'(c^*)}]+\beta v''(w^*)\frac{[1+\gamma\varphi_I f'(k^*)]}{u'(c^*)}\{1+\varphi_c(\rho+\mu)+\gamma[\varphi_c f'(k^*)+(\varphi_I-\varphi_c)(\rho+\delta)]\}<0.$$

Differentiating (8a) with respect to *c* and *k* obtains

$$\left.\frac{dc}{dk}\right|_{\dot{k}=0}=f'(k)-\delta>0, \tag{A3}$$

which is also positively slopping.

First, for the steady states E_1 and E_3 in Figure 1, the slope of the $\dot{c}=0$ locus is lager than the slope of the $\dot{k}=0$ locus. This indicates the following condition: $\Xi<[f'(k^*)-\delta]\Gamma$. Using the relationship in (8a), this condition is exactly the same as $\Phi>0$. Therefore, *Det J*<0 for the steady states E_1 and E_3 in Figure 1 and thus the steady states E_1 and E_3 are saddle.

Second, for the steady states E_2 in Figure 1, the slope of the $\dot{c}=0$ locus is smaller than the slope of the $\dot{k}=0$ locus. This indicates the condition of $\Xi>[f'(k^*)-\delta]\Gamma$ which implies $\Phi<0$. As a result, *Det J*>0 and there is no negative eigenvalue. Therefore, E_2 is a source.

Table 1. Quantify comparative-static effects

	k_1	k_3	local effects on k
benchmark	0.1027196	3.7098848	
μ=6	0.07195717	3.508599	decrease
μ=4	0.1666077	3.9417109	increase
μ=1	disappear	5.234797	big push
μ=10	0.02856185	disappear	big crash
φ_I=0.9	0.1431811	4.702492	increase
ρ=0.039	0.1060875	3.846048	increase
β=0.69	0.1014955	3.50148	decrease
γ=0.09	0.10265223	3.70865997	decrease

Benchmark parameters: ρ=0.04, σ=1.5, θ=1, β=0.7, A=0.3, η=0.4, δ=0.065, φ_c=φ_I=1, γ=0.1, and μ=5.

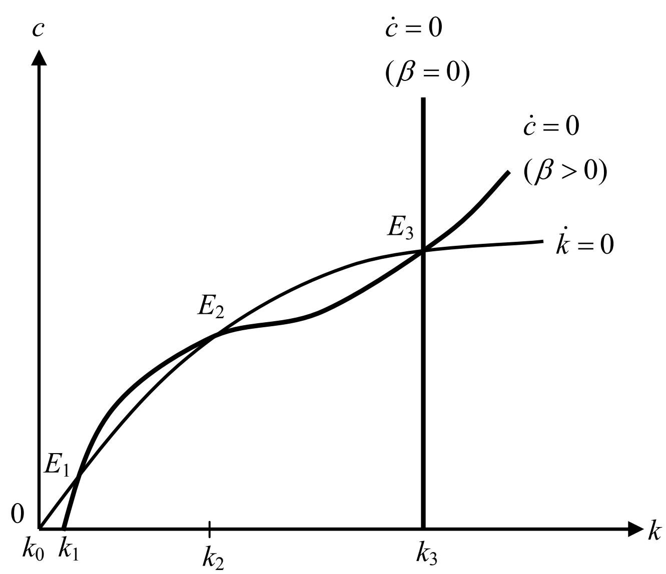

Figure 1. Multiple steady states

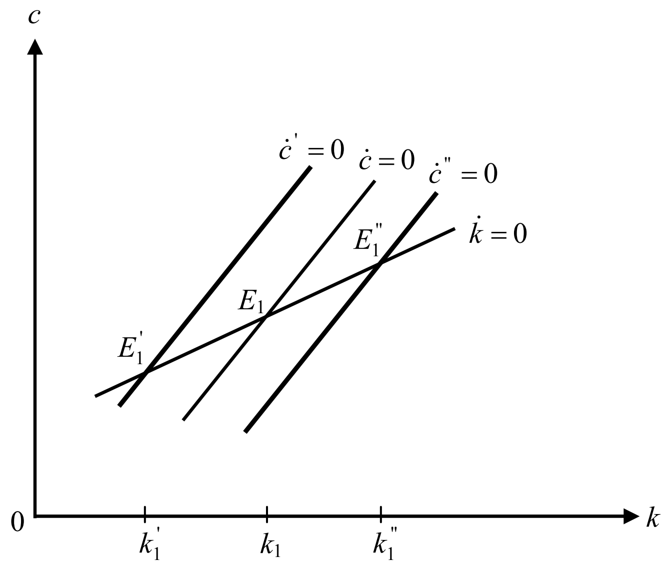

Figure 2. Effects of inflation

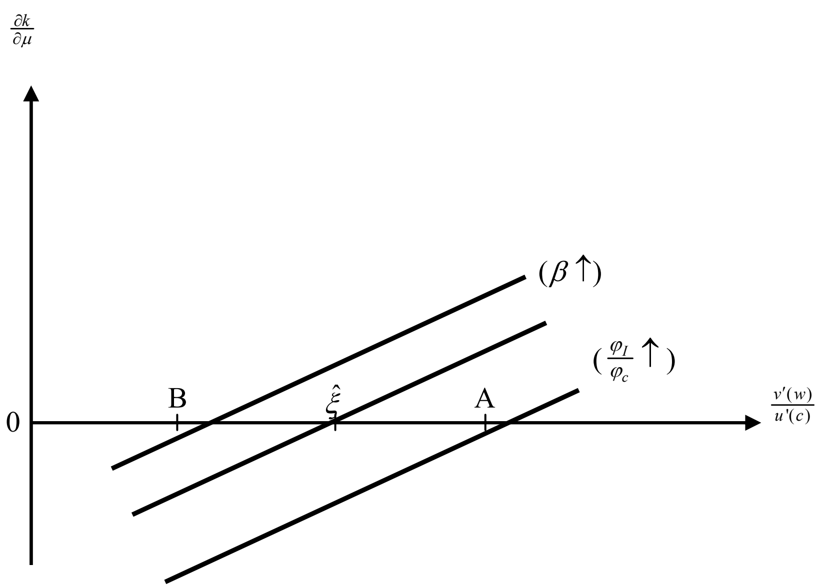

Figure 3. Status effect on the effects of inflation

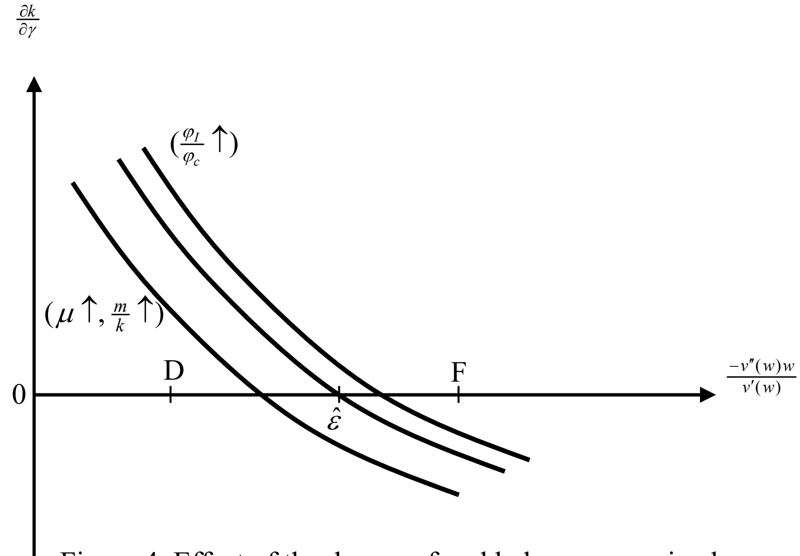

Figure 4. Effect of the degree of real balances perceived as wealth

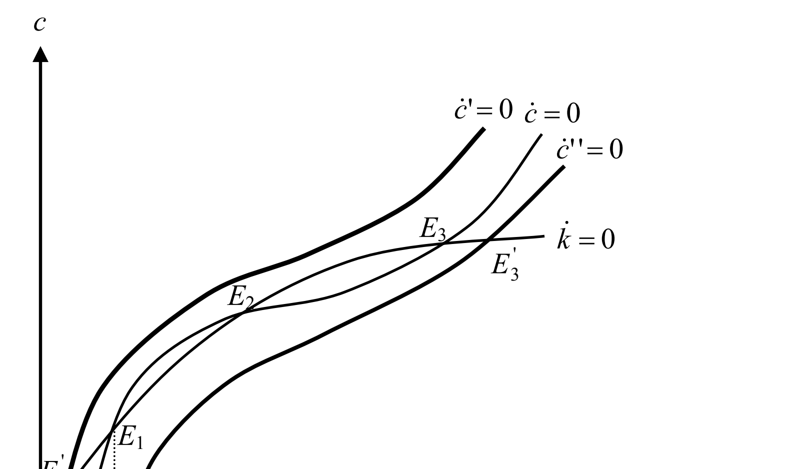

Figure 5. A trap or a big push

Number	Author(s)	Title	Date
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