Can Growth-enhanced Monetary Policy Improve Welfare When People Seek Social Status?

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Abstract

This paper examines the growth and welfare effects from an increase in the rate of money supply in an Ak type growth model with a relative wealth-enhanced social status motive, production externalities, and liquidity constraints. When only consumption is constrained by liquidity, fast money supply can hasten output growth unless seigniorage revenue is wasted and production externalities do not exist. We find that even though money growth normally promotes economic growth, it does not improve welfare when capital stock is over-accumulated. In general, an optimal monetary policy minimizes seigniorage. Our results also conclude that the optimal monetary policy rarely follows the *Friedman rule*.

Keywords: Wealth-enhanced social status, Production externalities, Cash-in-advance constraint, Monetary policy

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1. Introduction

In the literature there appears to be no agreement as to the effects of an increase in the money growth rate upon output growth and subsequently upon welfare. One channel that money growth promotes output growth is through an increase in the rate of return on an asset that is the driving force of growth - for example, capital stock. Introducing social status into agents' preferences has long been recognized as a powerful motivating force that can increase investment in physical capital and hence promote output growth when there is an increase in money growth rate. Previous studies elaborate on this positive output growth effect of money by combining a one-sector-Barro (1990)-Rebelo (1991) Ak model with either a money-in-utility approach (Zou, 1998) or a cash-in-advance (CIA) constraint on consumption (Chang et al., 2000; Chen and Guo, 2009; 2011), where seigniorage revenue is rebated as a lump-sum transfer. Inspired by these works, this paper first examines the output growth effect of money by adding two distinct features that are absent in the above literature: production externalities, as introduced in Romer (1986), and seigniorage revenue that is wasted on useless government spending. Second, when monetary policy is growth enhancing, we follow to address an important question: does it improve welfare? Furthermore, is there an optimal rate of money growth in accordance with the Friedman rule?

Friedman (1969) proposes that a requirement of the welfare maximizing monetary policy is to set the nominal interest rate at zero. Under the assumptions of homothetic preferences and costless production of money, a money-in-utility model supports Friedman rule to be the welfare maximizing monetary policy.[1] Moreover, when a higher rate of money growth hinders economic growth, the optimality of

[1] See Walsh (2010, pp.170-188) for a description of optimal seigniorage.

Friedman rule is again widely advocated.[2] A question regarding the optimal conduct of monetary policy inevitably arises: if money growth raises the rate of output growth, can the Friedman rule ever be optimal?

We answer the aforementioned questions by employing 'AK' type models with and without production externalities, considering a relative wealth-enhanced social status motive and placing a CIA constraint on consumption. In order to examine whether different usages of seigniorage revenue affect growth and welfare, we assume that seigniorage revenue is either lump-sum transferred to the public or it is spent on useless government expenditures (e.g. Pelloni and Waldmann, 2000).[3]

Given that the CIA constraint is placed only on consumption and seigniorage revenue is lump-sum transferred to the public, our results support the Mundell-Tobin effect in terms of growth - that is, money growth stimulates economic growth. The key point is that when an increase in money growth raises the CIA cost, the presence of the desire for social status depresses consumption, enhances capital formation, and in turn lifts output growth. This finding is the same as the result seen in Chang, et al. (2000) and Chen and Guo (2009, 2011), in which only capital stock constitutes a wealth-enhanced social status in their Ak models. Therefore, even though there is theoretical soundness in our assumption that it is "wealth" (all kinds of assets, including real balances) to bring status and only "relative" wealth matters for an

[2] For example, Palivos and Yip (1995) and Dotsey and Sarte (2000) agree on applying the Friedman rule to generate the optimal growth rate. Furthermore, Palivos and Yip (1995) claim that combining income taxation and the Friedman rule can maximize social welfare.

[3] Pelloni and Waldmann (2000) point out that "waste (by useless government spending) may improve welfare," in a modified Romer's (1986) model with elastic labor supply. Under Romer's technology in our paper, the useless government spending financed by seigniorage has a positive growth effect that is channeled through an increase in the agent's social status, but it is unable to improve welfare.

individual to perceive a higher-than-average status, this assumption may not be crucial when investigating the growth effect of money. However, if seigniorage revenue is spent on useless government expenditures, which is an issue neglected in Chang, et al. (2000) and Chen and Guo (2009, 2011), we find that monetary policy is neutral in promoting output growth unless the status-seeking motive and production externalities co-exist.

Although Ahmed and Rogers (2000) and Benhabib and Spiegel (2009) empirically support the positive relationship between inflation and growth for moderate-inflation economies, we believe it would be interesting to extend our model to generate a possible negative correlation between inflation (money growth) and output growth. In an Ak model that does not consider social status, Chen and Guo (2008) derive a negative output growth effect of money when the generalized CIA-constrained ratio of consumption to investment is within a certain range. By adding a capital-induced social status motive, Chen and Guo (2009, 2011) stress that higher inflation is detrimental to economic growth when money holdings are required for all purchases of consumption and investment. With the same CIA constraint on consumption and investment, our investigation herein confirms that the negative correlation between money and output growth is robust to, at least, several specifications: whether or not we take into account social status; whether we consider absolute capital stock or relative wealth as social status; whether seigniorage revenue is lump-sum transferred or wasted on useless expenditures; and whether the Ak technology has or does not have production externalities.

To the best of our knowledge, many studies have offered new views for the impact of social status on economic growth, but none have ever examined the welfare implications of higher inflation.[4] Can the prevailing Mundell-Tobin effect ever dominate the negative liquidity cost on consumption such that an expansion in money supply improves social welfare? Given that the quest for social status leads individuals to compare themselves with other people, an average individual should not acquire or lose extra utility from his relative situation in any equilibrium growth path. Therefore, in contrast to the assumption that absolute capital or wealth brings social status, for welfare analysis, it is more meaningful to adopt our specification that only the "relative" wealth can determine social status. Through the channel of relative wealth-enhanced social status, our model implies that money growth, which stimulates investment, will result in an over-accumulation of capital from a welfare perspective. In general, we confirm the negative relationship between inflation and welfare, which agrees with the findings in most previous studies.[5] An optimal monetary policy usually minimizes seigniorage, with the one exception where seigniorage is rebated as a lump-sum transfer and the Ak technology has production externalities. Under these circumstances, there exists a unique optimal rate of money growth aimed at equating a negative investment effect from production externalities with a positive effect of capital accumulation from the social status-seeking motive. Neither case shows that the optimal monetary policy follows the Friedman rule.

This paper is organized as follows. Section 2 outlines the basic framework. Section 3 includes three subsections. Sections 3.1 and 3.2 investigate the growth

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[4] Chang (2006) studies the impact of an increase in the consumption tax rate on social welfare in order to determine the optimal consumption tax policy. It appears that this is the only paper that investigates the welfare effects of government policy through a model that includes a social status-seeking motive.

[5] See Lucas (2000) for a survey.

effects of money expansion wherein the seigniorage revenue is rebated in a lump-sum transfer and spent on useless government expenditures, respectively. Section 3.3 extends the CIA constraint to both consumption and investment. Section 4 turns to the welfare analysis and determines the optimal seigniorage. Section 5 concludes the main findings.

2. The model

Consider an economy that consists of a representative, infinitely-lived agent and a government, and this economy is modeled under an endogenous growth framework with production externalities and a liquidity constraint on consumption. Labor is inelastically supplied and normalized to unity. The government executes a constant growth rate of money supply and uses the resulting seigniorage either to finance its purchases or as a lump-sum transfer to the representative agent.

The representative agent's optimization problem is:

$$\text{Max.} \int_0^\infty \left[\ln c + \beta \upsilon\left(\frac{m+k}{\bar{m}+\bar{k}} \right) \right] e^{-\rho t} dt, \tag{1}$$

subject to

$$\dot{m} + \dot{k} = y + \theta\tau - c - \pi m, \tag{2}$$

$$c \le m,^{6} \tag{3}$$

where $y =$ real output, $c =$ real consumption, $m =$ real balances, $k =$ capital stock, $\tau =$ real lump-sum transfers from the government, $\pi =$ rate of inflation, $\rho =$ a constant rate of time preference, $\beta =$ a non-negative measure of the agent's desire for social status, and $\theta =$ an indicator with the value of either one or zero. An upper bar

[6] Even if holding money results in utilities, inflation is detrimental to real balances. Money cannot compete with capital as a way to accumulate real wealth. This feature means that the CIA constraint is always bound at equality.

over a variable indicates the average amount of the variable, and an overdot denotes its time derivative. The function υ satisfies $\upsilon' > 0$ and $\upsilon'' < 0$.

The utility function in Eq. (1) features the possible benefits stemming from relative real wealth, which represents a relative wealth-enhanced social status. The relative real wealth is defined as the agent's real balances and capital stock relative to the average of aggregate real balances and capital stock in the economy. Equation (2) is the budget constraint that describes how real wealth is accumulated, taking the initial values of k and m as given. Equation (3) is the CIA constraint, requiring that consumption goods be purchased by means of real balances.

We assume the production function is:

$$y = f(k; \bar{k}) = Ak^{\alpha}\bar{k}^{1-\alpha}, \quad 0 < \alpha \le 1. \tag{4}$$

In the case that $\alpha = 1$, the production function takes the 'Ak' technology form, $y = Ak$, which has been used in Barro (1990) and Rebelo (1991). For more general cases where α lies between zero and one, the technology embodies capital externalities, which is an assumption in Romer (1986). Note that at equilibrium, $\partial f(k; \bar{k}) / \partial k = \alpha A = A$ in the case of Barro-Rebelo's 'Ak' technology and $\partial f(k; \bar{k}) / \partial k = \alpha A < A$ in the case of Romer's technology.

Let λ be the costate variable and γ be the multiplier associated with the CIA constraint (Eq. (3)). The current value Hamiltonian H is:

$$H = \ln c + \beta\upsilon\left(\frac{m+k}{\bar{m}+\bar{k}}\right) + \lambda\left(Ak^{\alpha}\bar{k}^{1-\alpha} + \theta\tau - c - \pi m\right) + \gamma(m - c).$$

The optimal solution is implied by the first-order conditions for the representative agent:

$$\frac{1}{c} = \lambda + \gamma, \tag{5}$$

$$\beta \upsilon'\left(\frac{m+k}{\overline{m}+\overline{k}}\right)\frac{1}{\overline{m}+\overline{k}} - \lambda\pi + \gamma = -\dot{\lambda} + \lambda\rho \,, \tag{6}$$

$$\beta \upsilon'\left(\frac{m+k}{\overline{m}+\overline{k}}\right)\frac{1}{\overline{m}+\overline{k}} + \lambda\alpha A k^{\alpha-1}\overline{k}^{1-\alpha} = -\dot{\lambda} + \lambda\rho \,, \tag{7}$$

together with Eqs. (2) and (3), and the transversality conditions of *m* and *k*:

$$\lim_{t\to\infty} \exp(-\rho t)\lambda m = 0 \quad \text{and} \quad \lim_{t\to\infty} \exp(-\rho t)\lambda k = 0.$$

Equation (5) asserts that the marginal utility of current consumption equals its marginal cost, which consists of the marginal utility of owning an additional unit of wealth as well as the cost accompanied by the CIA constraint. Equation (6) is the Euler condition that determines the optimal accumulation of real balances based on their effective rate of returns. The effective rate of returns on holding money equals the rewards from the relative wealth-induced social status and the transaction value of money, minus the inflation cost. Similarly, Eq. (7) determines the optimal accumulation of capital stock based on the marginal product of capital as well as the marginal utility benefit from the agent's status-seeking capital accumulation. The government simply institutes a constant rate of monetary growth (μ) and keeps its budget balanced all the time by spending its seigniorage revenue either on purchases (*G*) or on a lump-sum transfer to the representative agent (τ):

$$\theta\tau + (1-\theta)G = \mu m \,, \tag{8}$$

where $\theta = 0$ when the increase in money is used to finance government purchases, and $\theta = 1$ when the money is transferred to the agent.

By definition, the law of motion for governing real balances is:

$$\dot{m} = (\mu - \pi)m \,. \tag{9}$$

Within the framework of a representative agent, at equilibrium $m = \overline{m}$ and $k = \overline{k}$. Combining Eqs. (3), (5)-(7), and (9) gives the growth rate of real balances:

$$\frac{\dot{m}}{m}=\mu-\frac{1}{\lambda m}+1+\alpha A. \qquad (10)$$

From Eqs. (2), (3), and (9), the goods market equilibrium condition implies:

$$\frac{\dot{k}}{k}=A+\theta\frac{\tau}{k}-(1+\mu)\frac{m}{k}. \qquad (11)$$

From Eq. (7), the evolution of the shadow price of real wealth is:

$$-\frac{\dot{\lambda}}{\lambda}=\alpha A-\rho+\beta\upsilon'(1)\frac{1}{\lambda k\left[(m/k)+1\right]}. \qquad (12)$$

Equations (10)-(12) are a set of dynamic equations that represent the dynamic behaviors of *m*, *k*, and λ in the economy. Along the balanced growth path, the following relation holds for the growth rates of capital, real balances, and shadow price:

$$\frac{\dot{k}}{k}=\frac{\dot{m}}{m}=-\frac{\dot{\lambda}}{\lambda}=\hat{\phi}, \qquad (13)$$

where $\hat{\phi}$ denotes the steady-state growth rate of the economy.

It is worth noting that, from Eqs. (12) and (13), we have the following equation in the steady state:

$$\hat{\phi}=\alpha A-\rho+\beta\upsilon'(1)\frac{1}{\lambda k\left[(m/k)+1\right]}. \qquad (14)$$

Here, $\beta>0$ ($\beta=0$) corresponds to the situation where the effect of relative wealth-induced social status is present (absent). Without the effect of wealth-induced social status ($\beta=0$), Eq. (14) reduces to:

$$\hat{\phi}=\alpha A-\rho. \qquad (15)$$

In the case that $\alpha=1$, Eq. (15) turns out to be the standard result in the Barro-Rebelo ‘AK’ model. But with the social status-seeking motive and production externalities, Eq. (14) points out that the assumption of $A>\rho$ is neither sufficient nor necessary for an economy exhibiting sustained growth.

We next define $x \equiv 1/(\lambda k)$ and $z \equiv m/k$. Along the balanced growth path, the transformed variables x and z will stay constant in the steady state. It is easy to show that there are two positive eigenvalues corresponding to the two jump variables (x and z). This guarantees the unique equilibrium of the model.

3. Growth effects of monetary policy

3.1 Lump-sum transfer of seigniorage

This section examines whether money growth affects the growth rate of the economy when the government transfers seigniorage revenue in a lump-sum manner to the agent, i.e. $\theta = 1$. The government budget constraint becomes $\tau = \mu m$. Substituting $\theta = 1$ and $\tau = \mu m$ into Eq. (11), the goods market equilibrium condition reduces to:

$$\frac{\dot{k}}{k} = A - \frac{m}{k} = A - z\,. \tag{16}$$

With the definitions of x and z, and from Eqs. (10), (12), and (16), the following two equations hold in the steady state:

$$\frac{\dot{x}}{x} = -\frac{\dot{\lambda}}{\lambda} - \frac{\dot{k}}{k} = \alpha A - \rho + \beta \upsilon'(1)\frac{\hat{x}}{1+\hat{z}} - A + \hat{z} = 0\,, \tag{17}$$

$$\frac{\dot{z}}{z} = \frac{\dot{m}}{m} - \frac{\dot{k}}{k} = \mu - \frac{\hat{x}}{\hat{z}} + 1 + \alpha A - A + \hat{z} = 0\,, \tag{18}$$

where a hat over a variable denotes the steady-state value of the variable.

From Eq. (16), the steady-state growth rate $\hat{\phi}$ is:

$$\hat{\phi} = A - \hat{z}\,. \tag{19}$$

The economy exhibits sustained growth as long as $A > \hat{z}$ - that is, the output-capital ratio is higher than the consumption-capital ratio.

Differentiating Eqs. (17) and (18) with respect to μ and together with Eq. (19), we have:

$$\frac{\partial\hat{\phi}}{\partial\mu} = -\frac{\partial\hat{z}}{\partial\mu} = \frac{\beta\upsilon'(1)}{\Delta} > (=)0 \text{, as } \beta > (=)0 \text{,} \tag{20}$$

where $\Delta = \beta\upsilon'(1)\left(1 + \frac{\hat{x}}{\hat{z}^2(1+\hat{z})}\right) + \frac{1}{\hat{z}}\left(1+\hat{z}\right) > 0$.

In the case that social status does not provide direct benefits ($\beta = 0$), a higher rate of money growth leaves output growth unchanged. The monetary policy is neutral in affecting economic growth. On the other hand, when social status provides direct benefits ($\beta > 0$), an increase in the money growth rate positively affects the long-run growth rate of the economy. These conclusions are consistent with the results found by Zou (1998), Chang, et al. (2000), and Chen and Guo (2009, 2011).

We first intuitively explain the result in the absence of social status-seeking motive. A rise in the rate of money growth causes a higher inflation rate, but the rate of return on capital remains unchanged. Thus, there is no intertemporal substitution effect for the choice of consumption path. Moreover, since the government returns all its seigniorage revenue to the public in a lump-sum manner, there is also no wealth effect for the choice of consumption path. The consumption-capital ratio is completely determined by $\hat{z} = (1-\alpha)A + \rho$, as from Eqs. (13), (15), and (16). From Eq. (20), the only way money growth can change economic growth is by changing the ratio of consumption over capital. This is in fact impossible without the presence of social status-seeking incentives. The monetary policy therefore has no effect on economic growth, and its neutrality holds.

We next consider the case that wealth accumulation promotes higher social status.

There is a chance that individuals' choices can switch between consumption and investment, because the return of capital stock depends on the rate of money growth. The consumption-capital ratio is implicitly determined by:

$$\hat{z} = (1-\alpha)A + \rho - \beta\upsilon'(1)\frac{\hat{x}}{\hat{z}+1}. \qquad (21)$$

Obviously, this ratio is lower in the case of $\beta > 0$ than in the case of $\beta = 0$. Equation (21) provides a channel through which faster money growth can raise an economy's output growth by affecting the steady-state values of x and z, or specifically, by stimulating capital accumulation. Because the economy exhibits constant returns to scale with respect to aggregate capital, this stimulated capital accumulation raises its economic growth. More formally, we prove the following proposition.

Proposition 1: For 'Ak' type models with the CIA constraint on consumption, a higher rate of money growth, which is associated with a lump-sum transfer of seigniorage revenue to the public, raises the economic growth rate only when the social status-seeking motive exists; otherwise, it is neutral.

The reason behind this proposition is rather intuitive. When people seek social status, the return of capital stock is endogenously determined. Since a rise in the rate of money growth depresses the relative return of real balances to capital stock, it enhances capital accumulation and economic growth.

3.2 Government spending financed by seigniorage

We now examine the growth effect of monetary policy when the government spends seigniorage revenue on public expenditures, i.e. $\theta = 0$. The government budget constraint reduces to $G = \mu m$. Even though government spending is resource consuming, we assume that it does not help production nor does it enhance utilities. In other words, in essence government spending is useless.

The evolution of real balances and the shadow price remains the same as in Eqs. (10) and (12), but the goods market equilibrium condition of Eq. (11) becomes:

$$\frac{\dot{k}}{k} = A - (1+\mu)\frac{m}{k} = A - (1+\mu)z\,. \tag{22}$$

Substituting the definitions of x and z into Eqs. (10), (12), and (22) gives the steady-state relationships:

$$\frac{\dot{x}}{x} = -\frac{\dot{\lambda}}{\lambda} - \frac{\dot{k}}{k} = \alpha A - \rho + \beta \upsilon'(1)\frac{\hat{x}}{1+\hat{z}} - A + (1+\mu)\hat{z} = 0\,, \tag{23}$$

$$\frac{\dot{z}}{z} = \frac{\dot{m}}{m} - \frac{\dot{k}}{k} = \mu - \frac{\hat{x}}{\hat{z}} + 1 + \alpha A - A + (1+\mu)\hat{z} = 0\,. \tag{24}$$

Differentiating Eqs. (23) and (24) with respect to μ, we have:

$$\frac{\partial \hat{z}}{\partial \mu} = -\frac{\beta \upsilon'(1) + 1}{\tilde{\Delta}} < 0\,, \tag{25}$$

where $\tilde{\Delta} = \frac{\beta \upsilon'(1)}{1+\hat{z}}\left(1 + \mu + \frac{\hat{x}}{\hat{z}^2(1+\hat{z})}\right) + \frac{1}{\hat{z}}(1+\mu) > 0$.

A higher rate of money growth unambiguously lowers the ratio of real balances (consumption) to capital, $\hat{z}$, if money creation is used to finance useless government spending. This result is different from its counterpart in the lump-sum transfer scenario, wherein the impact of money growth on $\hat{z}$ is negative if the status-seeking motive exists ($\beta > 0$) and it is null otherwise ($\beta = 0$). A lower consumption-capital ratio is due to the negative wealth effect generated by the increase in government spending, regardless of whether or not the status-seeking motive exists.

From Eq. (22), the steady-state growth rate $\hat{\phi}$ is:

$$\hat{\phi} = A - (1+\mu)\hat{z}\,. \tag{26}$$

The economy exhibits sustained growth as long as $A > (1+\mu)\hat{z}$. This simply means the economy will grow if the output-capital ratio is larger than the absorption-capital ratio, which equals the ratio of consumption plus government spending to capital stock.

Differentiating Eq. (26) with respect to μ and together with Eq. (25), we have:

$$\frac{\partial \hat{\phi}}{\partial \mu} = -\hat{z} - (1+\mu)\frac{\partial \hat{z}}{\partial \mu}$$

$$= \frac{\beta \upsilon'(1)(1-\alpha)A}{(1+\hat{z})^2 \tilde{\Delta}} > (=) 0 \text{, as } \beta(1-\alpha) > (=) 0 . \qquad (27)$$

Proposition 2: For 'Ak' type models with the CIA constraint on consumption, a higher rate of money growth, which is associated with seigniorage revenue being used to finance useless government spending, raises the economic growth rate only when the social status-seeking motive and productivity externalities co-exist; otherwise, it is neutral.

If social status does not provide direct benefits ($\beta = 0$), then the monetary policy is neutral in promoting economic growth. This result is consistent to the findings of Palivos and Yip (1995) in the case that government purchases are financed by seigniorage revenue and the CIA restriction applies only on consumption. In Section 3.1 we explain that without a status-seeking motive, a rise in money growth has neither an intertemporal substitution effect nor a wealth effect upon the choice of consumption. In the case that seigniorage revenue is wasted on useless government purchases, a rise in money growth does create a negative wealth effect for the agent by crowding out consumption. Equation (25) shows the undoubted decrease in consumption over capital stock. Nonetheless, under an expenditure shift from the private sector to the government, the aggregate demand remains unchanged. The monetary policy thus has no effect on economic growth, which echoes the result in Section 3.1.

If social status provides direct benefits ($\beta > 0$), then whether or not an increase in the rate of money growth promotes economic growth depends on whether or not capital accumulation has a spillover effect. When there are capital spillovers ($\alpha < 1$), the accumulation of capital is relatively low; a social status incentive helps narrow the capital stock gap between the social optimum and the private optimum. In this case a rise in the rate of money supply, which raises inflation, causes households to shift their demand from real balances (and, equivalently, consumption) to capital stock. This stimulated capital accumulation therefore raises the growth rate of the economy. The monetary policy thus, similar to the result in Section 3.1, has a positive effect on economic growth.

However, when there is no externality in putting capital into production ($\alpha = 1$), Eqs. (23) and (24) imply that the return of capital stock depends only on the constant marginal product of capital and the parameters in the utility function:

$$A + \beta\upsilon'(1)\frac{\hat{x}}{1+\hat{z}} = A + \frac{\rho\beta\upsilon'(1)}{1+\beta\upsilon'(1)}. \tag{28}$$

Together with Eqs. (23) and (26), it is easy to show:

$$\hat{\phi} = A - \frac{\rho}{1+\beta\upsilon'(1)} > A - \rho . \tag{29}$$

Note that the status-seeking motive indeed hastens capital accumulation and promotes economic growth, but this higher growth rate is independent of the rate of money growth.

3.3 CIA on consumption and investment

Before closing this section, it is worthwhile to make a detour to include the expenditures of investment along with consumption goods as being subject to the CIA constraint. By including investment in the liquidity constraint, which is done in Chen and Guo (2009, 2011), we find that money growth has a negative effect on output growth in our model. Therefore, in order to address the question of whether growth-enhanced monetary policy improves welfare, we can simply impose the CIA constraint on consumption.

When money holdings are required for all consumption and investment purchases, our analysis shows that an increase in the money growth rate lowers the economy's output growth rate, regardless of how the money creation is spent and whether or not productivity externalities exist. Furthermore, the negative growth effect is not impacted by the presence of status-seeking incentives.[7] This finding is comparable to the results in Chen and Guo (2008) and Chen and Guo (2009, 2011) and shares the same economic intuition as theirs. A rise in the monetary growth rate μ leads to higher inflation and raises the cost of money holdings. Given that the CIA constraint is imposed on both consumption and investment, there is an increase in the relative shadow price of capital to real balances, thereby reducing the net rate of return of capital and consequently the output growth rate. Especially when investment spending is fully constrained by liquidity, this negative effect on the rate of return of capital cannot be compensated by either a status-seeking motive promoting capital accumulation, as in the case that seigniorage is rebated, or by any further effect from production externalities, as in the case that seigniorage is spent on government expenditures.[8]

Since the CIA constraint imposed on both consumption and investment reduces

[7] The mathematical derivations of the CIA constraint on consumption and investment are available from the authors upon request.

[8] In the case that only a fraction of investment is liquidity constrained, Chang and Tsai (2003) first point out that the growth effect of money supply is uncertain. Intuitively, there is a critical fraction of CIA on investment that balances the positive effect and the negative effect of money supply on economic growth. Readers can refer to Chen and Guo (2008) for a more generalized CIA constraint.

the net rate of return of capital and thus the output growth rate, it does not conform to our following discussion, which aims to analyze whether a growth-enhanced monetary policy improves welfare. We thus go back to an economy where only the purchase of consumption is constrained by the CIA.

4. Optimal seigniorage

Section 3 concludes that when preferences comprise a status-seeking motive and consumption is liquidity constrained, money growth enhances output growth provided that technologies exhibit capital externalities or the seigniorage revenue is transferred back to the public. An immediate question follows: Can the growth-enhanced monetary policy also improve welfare? Furthermore, is there an optimal seigniorage following the Friedman rule?

In this section we allow a benevolent government to set the growth rate of money supply to maximize the utility of the representative agent. Given that there are no transition dynamics for the 'Ak' type models, the lifetime utility of the representative agent, which equals social welfare (W), is:

$$W = \int_0^{\infty}\left[\ln c + \beta\upsilon\left(\frac{m+k}{\bar{m}+\bar{k}}\right)\right]e^{-\rho t}dt = \frac{1}{\rho}\left(\ln k_0 + \ln\hat{z} + \frac{\hat{\phi}}{\rho} + \beta\upsilon(1)\right). \qquad (30)$$

Changes in the growth rate of money supply influence W through two channels: one is on the initial consumption and the other is on the growth rate of the economy, $\hat{\phi}$:

$$\frac{\partial W}{\partial\mu} = \frac{1}{\rho}\left(\frac{1}{\hat{z}}\frac{\partial\hat{z}}{\partial\mu} + \frac{1}{\rho}\frac{\partial\hat{\phi}}{\partial\mu}\right). \qquad (31)$$

Expediting money supply lowers the initial consumption, because it compresses real balances and tightens the CIA constraint on consumption. However, it raises the consumption growth rate in most cases of our discussion in Sections 3.1 and 3.2;

among them, whether or not production exhibits capital externalities plays a key role.[9] We thus classify the following subsections by either a Barro-Rebelo type or Romer type of production.

4.1 Welfare effects in a Barro-Rebelo 'Ak' model

We first discuss the welfare effect of money growth when production takes the Barro-Rebelo 'Ak' form, $y = Ak$. If seigniorage is returned to the public, then from Eq. (20), Eq. (31) becomes:

$$\frac{\partial W}{\partial \mu} = \frac{1}{\rho}\underset{(+)}{\left(\frac{1}{\hat{z}} - \frac{1}{\rho}\right)}\underset{(-)}{\frac{\partial \hat{z}}{\partial \mu}} < 0. \tag{32}$$

The first sign, (+), comes from that the value in the parentheses is positive. We prove this by substituting $\alpha = 1$ into Eq. (21) to yield $\hat{z} = \rho - \beta \upsilon'(1)\hat{x}/(1+\hat{z})$. Therefore, $\hat{z}$ must lie between zero and ρ, $0 < \hat{z} < \rho$. The second sign, $(-)$, signifies that an increase in the rate of money growth decreases the consumption-capital ratio, which is the result from Eq. (20).

On the other hand, when seigniorage goes toward government expenditure, the rate of economic growth shown in Eq. (29) is immune to the rate of money growth. Because government spending crowds out consumption, we straightforwardly obtain:

$$\frac{\partial W}{\partial \mu} = \frac{1}{\rho}\left(\frac{1}{\hat{z}}\right)\frac{\partial \hat{z}}{\partial \mu} < 0. \tag{33}$$

The negative effect of money growth on the consumption-capital ratio, shown in Eq. (25), transmits to social welfare as well. Proposition 3 summarizes the welfare effects of a Barro-Rebelo 'Ak' model:

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[9] In the case that production exhibits capital externalities, monetary policy is always growth-enhancing. In the case that production does not exhibit externalities, monetary policy is growth-enhancing when seigniorage revenue is not wasted on useless government spending.

Proposition 3: When relative wealth-enhanced social status exists, a higher rate of money growth (and thus a higher inflation rate) in a Barro-Rebelo 'Ak' model always lowers social welfare no matter whether or not it raises the rate of economic growth, or equivalently, no matter how the seigniorage revenue is spent.

Proposition 3 points out a monotonically negative relationship between the growth rate of money supply and social welfare. A competitive economy under a Barro-Rebelo 'Ak' model with a status-seeking motive grows too fast as compared to its social optimum.[10] Thus, the optimal monetary policy is to choose a growth rate of money supply as low as possible to slow down economic growth. In an economy where seigniorage revenue is distributed to the public, the combination of a monetary contraction with a negative transfer (lump-sum taxation) can improve social welfare. However, if seigniorage revenue has to finance non-negative government expenditure, then the constrained optimal rate of money growth is set to zero.

4.2 Welfare effects in a Romer model

We next examine the Romer growth model whereby capital induces positive spillovers in production. Under the consideration of social status, we find that the economy can make up for capital accumulation. As such, it is possible to remedy a below-social-optimum rate of growth in an economy characterized by Romer's technology, but lacking in social status-seeking incentives. When seigniorage is rebated to the public, we can derive the first-order condition for maximum welfare by substituting Eq. (20) into Eq. (31) and let it be zero:

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[10] When seigniorage revenue is spent on useless government expenditure, Eq. (29) shows the economic growth rate is always higher than the social optimum rate, $A-\rho$. When seigniorage revenue is lump-sum transferred to the public, Eq. (14) determines the economic growth rate as: $\hat{\phi} = A-\rho+\beta\upsilon'(1)\dfrac{\hat{x}}{1+\hat{z}} > A-\rho$, for all possible growth rates of money supply.

$$\frac{\partial W}{\partial \mu} = \frac{1}{\rho}\left(\frac{1}{\hat{z}} - \frac{1}{\rho}\right)\frac{\partial \hat{z}}{\partial \mu} = 0\,. \tag{34}$$

From Eq. (34), there exists a unique growth rate of money supply that balances the negative effect on consumption and the positive effect on the economic growth rate. We set this optimal growth rate of money supply to equate the consumption-capital ratio with the rate of time preference. If the implied optimal growth rate of money is greater than zero, then the public receives a lump-sum transfer; otherwise, the public pays a lump-sum tax. In either case, the optimal monetary policy recovers the optimal growth rate of the 'Ak' model without considering social status (i.e. $A-\rho$). Moreover, in either case, the implied inflation rate and consequently the implied nominal interest rate are functions of structural parameters. Such a result is hardly consistent with the Friedman rule.

Proposition 4: When seigniorage revenue (expenditure) goes back to the public as a lump-sum transfer (tax) and relative wealth-enhanced social status exists, a Romer's economy grows at the optimal rate if and only if the rate of money growth is set to equate the consumption-capital ratio with the representative agent's rate of time preference. Moreover, the optimal rate of economic growth is the same as that in the traditional Ak model.

The intuition is quite straightforward. Capital externalities in production generate negative spillover effects in the investment decision, while the incentive for wealth-enhanced social status results in capital over-accumulation. By balancing the negative spillover of production externalities and the positive spillover of the social status-seeking incentive, the optimal growth rate of money supply leads to the optimal economic growth rate of $A-\rho$ if no additional resources are wasted.

When seigniorage revenue is used to finance useless government spending, the welfare effect of money growth mimics the welfare effect in a Barro-Rebelo ‘Ak’ model. We can derive the first-order condition for welfare maximum by substituting Eqs. (25) and (27) into Eq. (31). Under the premise that positive output growth requires $\hat{z} < A$, and with economically reasonable values of the structural parameters, we obtain the effect of money growth on welfare as:[11]

$$\frac{\partial W}{\partial \mu} = \frac{1+\beta\upsilon'(1)}{\rho(1+\hat{z})^2\tilde{\Delta}}\left(\frac{\beta\upsilon'(1)(1-\alpha)A}{\rho\left[1+\beta\upsilon'(1)\right]} - \frac{(1+\hat{z})^2}{\hat{z}}\right) < 0 . \tag{35}$$

The optimal seigniorage should be as low as possible as it is in the Barro-Rebelo ‘Ak’ model - that is, the practical and optimal μ degenerates to zero. Notice that our results show that monetary growth, which finances useless government expenditure, actually worsens welfare. The result is contrary to that in Pelloni and Waldmann (2000).

Proposition 5: When seigniorage revenue is used to finance useless government spending and relative wealth-enhanced social status exists, a higher rate of money growth (and thus a higher inflation rate) in a Romer's model always lowers social welfare. The optimal non-negative rate of money growth goes down to null in order to minimize wasted resources.

As proven in Appendix A, the optimal rate of economic growth is lower than $A-\rho/[1+\beta\upsilon'(1)]$ with a lower bound of $\alpha A-\rho/[1+\beta\upsilon'(1)]$. Moreover, the optimal nominal interest rate lies between $\rho/[1+\beta\upsilon'(1)]-(1-\alpha)A$ and $\rho/[1+\beta\upsilon'(1)]$. This result is different from what the Friedman rule suggests, unless we encounter the rare occasion whereby $\rho/[1+\beta\upsilon'(1)] = (1-\alpha)A$.

To summarize this section, there exists a unique optimal rate of money growth

[11] The inequality sign of Eq. (35) holds for reasonable ranges of parameters implied by empirical studies: $0.3 < \alpha < 0.5$, $0.04 < A < 0.1$, and $0.01 < \rho < 0.04$.

only when production exhibits capital externalities, seigniorage is rebated to the public, and there is a status-seeking motive. However, minimizing seigniorage always improves welfare when production does not exhibit capital spillovers or when production does exhibit capital spillovers and seigniorage is spent on useless public expenditure. In either case, the optimal monetary policy rarely follows the Friedman rule.

5. Conclusions

In this paper we utilize monetary 'Ak' type models with relative wealth-enhanced social status to assess the growth and welfare effects of an increase in seigniorage. When the CIA constraint is only placed on consumption, the return of capital is higher than that of real balances in response to inflation. A higher growth rate of money supply shifts resources from consumption to investment, reinforcing capital accumulation and economic growth. This positive correlation between output and money growth is consistent with previous results in the literature in which social status relies on either capital stock only or on absolute wealth composed of some assets. However, our paper points out one exception that is worth paying attention: if production does not exhibit capital externalities and seigniorage revenue is wasted on useless government expenditures, then money growth has a neutral impact on output growth. In addition, when both consumption and investment are constrained by liquidity, the growth effect of money becomes negative.

The specification that only relative wealth matters for social status allows us to analyze the social welfare optimum problem. As for the question of whether growth-enhanced monetary policy can improve welfare, our answer is negative in most of the circumstances. The existence of a status-seeking motive generally accompanies a problem of capital over-accumulation in the economy. When money growth further withdraws resources from consumption to capital, the increase in money supply doubtlessly widens the difference of equilibrium capital stock from its social optimality. The optimal rate of money growth thus moves down to null. However, when production exhibits capital externalities, there is a problem of underinvestment in the economy. Provided that seigniorage revenue is not wasted on useless government spending, the optimal rate of money growth can bring the economy to its social optimum by internally taking care of production externalities and the social status-seeking motive.

Our welfare analysis of the growth-enhanced monetary policy concludes that whether or not money growth can improve welfare hinges on two distinct features that we have added to previous works in the literature: production externalities and seigniorage revenue being wasted on government spending. We also conclude that the Friedman rule would rarely be implemented in these economies.

To the best of our knowledge, the literature on introducing social status into agents' preferences has not yet considered a non-separable utility function between consumption and wealth, which is composed of real balances and capital stock. Further research efforts could consider the general utility function to explore more interesting results.

Appendix A. Find the economic growth rate and nominal interest rate (*R*) when $\mu^* = 0$ in the case that $\alpha < 1$ and $\theta = 0$

In the case that $\alpha < 1$ and $\theta = 0$, the steady-state economic growth rate equals:

$$\hat{\phi} = \alpha A - \rho + \beta \upsilon'(1) \frac{\hat{x}}{1+\hat{z}} = A - (1+\mu)\hat{z} = \mu - \frac{\hat{x}}{\hat{z}} + (1+\alpha A). \qquad \text{(A.1)}$$

When $\mu^* = 0$, (A.1) becomes:

$$\hat{\phi}^0 = \alpha A - \rho + \beta \upsilon'(1) \frac{\hat{x}^0}{1+\hat{z}^0} = A - \hat{z}^0 = 1 + \alpha A - \frac{\hat{x}^0}{\hat{z}^0}, \tag{A.2}$$

where $\hat{\phi}^0$, $\hat{x}^0$, and $\hat{z}^0$ respectively denote the steady-state ϕ, *x*, and *z* under a zero rate of money growth, $\mu^* = 0$.

From Eq. (A.2), we have:

$$(\hat{z}^0)^2 + \left[1 - \frac{\rho}{1+\beta\upsilon'(1)} - (1-\alpha)A\right]\hat{z}^0 - \frac{(1-\alpha)A + \rho}{1+\beta\upsilon'(1)} = 0. \tag{A.3}$$

By the *mean value theorem*, it is easy to prove that the positive root of Eq. (A.3) follows the relationship: $\frac{\rho}{1+\beta\upsilon'(1)} < \frac{\rho + (1-\alpha)A}{1+\beta\upsilon'(1)} < \hat{z}^0 < \frac{\rho}{1+\beta\upsilon'(1)} + (1-\alpha)A$. Because $\hat{\phi}^0 = A - \hat{z}^0$, the inequality, $A - \frac{\rho}{1+\beta\upsilon'(1)} > \hat{\phi}^0 > \alpha A - \frac{\rho}{1+\beta\upsilon'(1)}$, thus holds. The nominal rate of interest, $R^* = \alpha A + (\mu^* - \hat{\phi}^0) = \hat{z}^0 - (1-\alpha)A,$ follows to satisfy the inequality of $\frac{\rho}{1+\beta\upsilon'(1)} > R^* > \frac{\rho}{1+\beta\upsilon'(1)} - (1-\alpha)A$.

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