DOI: 10.6277/TER.2015.432.2

Asymmetric Information and Alternative Government Financing: A Comparison

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This paper compares the relative merits of alternative government financing in the presence of asymmetric information. We first establish that the share of government expenditure determines whether or not credit is rationed, which in turn plays an important role in determining the relative merits of monetary and income-tax financing. It is found that monetary financing leads to both higher inflation and economic growth than income-tax financing if credit is not rationed. If credit is rationed, however, monetary financing leads to a higher inflation rate but a lower growth rate than tax financing. In comparing social welfare, we find that monetary (income-tax) financing is better than income-tax (monetary) if credit is not rationed (rationed). Our results reconcile the pre-existing literature and are consistent with some empirical evidence.

Keywords: asymmetric information, credit rationing, money and income-tax financing, endogenous growth
JEL classification: E44, G14, O11

1 Introduction

Recent studies on endogenous growth have established that government policies exert great impacts not only on an economy's level of output but also on its growth rate. Such recognition, recently, has also aroused much

*Distinguished Professor, Department of Economics, National Chengchi University. The author gratefully acknowledges the constructive comments from two anonymous referees.

經濟論文叢刊 (*Taiwan Economic Review*), 43:2 (2015), 183–218。
國立台灣大學經濟學系出版

discussion on the relative merits of alternative modes of government expenditure financing.[1] van der Ploeg and Alogoskoufis (1994), for example, construct a simple model of endogenous growth with money-in-utility function and non-interconnected overlapping generations to compare the effects of lump-sum-tax-financed, debt-financed, money-financed increases in government spending on growth and inflation. Palivos and Yip (1995), on the other hand, compare the relative merits of money financing and income-tax financing in a linear technology of endogenous growth with a generalized cash-in-advance (CIA) constraint. In an endogenous growth model with spatial separation, limited communication, and liquidity preference shocks, Espinosa-Vega and Yip (1999) and Espinosa-Vega and Yip (2002) investigate the impacts of increases in money-financed and income-tax-financed government expenditure on inflation, economic growth, and social welfare. Using a similar framework, Bose, Holman, and Neanidis (2007) examine whether the optimal government expenditure financing depends on the level of economic development. Gokan (2002) focuses on the similar issue in a stochastic endogenous growth model.

Parallel to the policy issues under endogenous growth models, another focus of recent literature has been on the functions performed by financial markets. Indeed, it has long been recognized by McKinnon (1973) and Shaw (1973) that financial markets, whose operations play an important role in determining the performance of the economy, are characterized by a wide variety of imperfections. One imperfection that has been received much attention is asymmetric information. Examples include Bencivenga and Smith (1993), Bose and Cothren (1996), and Hung (2005). More importantly, some recent studies have further recognized that inflation as well as taxation may influence the problem of asymmetric information. Azariadis and Smith (1996), Huybens and Smith (1999), Bose (2002), and Hung (2001) and Hung (2008), for example, have documented that higher rates of inflation may exacerbate the problems of asymmetric information and thus adversely affect the operations of financial markets. This in turn may lower the steady state capital stocks and economic growth.[2] On the other

[1] It is a consensus in the literature that both money and income tax financings result in distortions to the economy. Due to this, the research agenda in the recent literature is to compare the relative merits of these two primary modes of government expenditure financing.

[2] Azariadis and Smith (1996) add informational asymmetry into a standard monetary

hand, Ho and Wang (2005) and Hung and Liao (2007) have argued that government taxation exacerbates the problem of asymmetric information and hence has significant implications on capital investment and economic growth.

From the aforementioned studies, it is obvious that there is an interaction between the policies of government expenditure financing and asymmetric information. However, no attention has been given to this interaction in the literature, despite that this interaction may contain important implications to the relative merits of government expenditure financing. The objective of this paper is to fill this important gap in the literature by constructing a model that is able to highlight the roles of asymmetric information on the relative merits of government expenditure financing.

To do so, this paper sets up a simple endogenous growth model with two-period-lived overlapping generations of two types: illegitimate or low-quality borrowers (type-1 agents) and legitimate or high-quality borrowers (type-2 agents). Following Azariadis and Smith (1996), asymmetric information is introduced by assuming that agents' types are private information and type-1 agents, if provided the opportunity, will mimic the behavior of type-2 agents to borrow from financial intermediary (banks). In this latter case, the type-1 agents will abscond with the loans and hence leave the bank with nothing. Facing this so-called adverse selection problem, the bank will offer contracts to the borrowers subject to an incentive-compatibility constraint that prevents type-1 agents from mimicking the behavior of type-2. This incentive-compatibility constraint, if binding, will prevent the high-quality (type-2) borrowers from borrowing as much as they like and thereby result in credit rationing. The purpose of this paper is to investigate how

growth model and find that the resulting incentive-compatibility constraint is not binding (*resp.* binding) when inflation is low (*resp.* high). This enables them to uncover a non-linear relationship between the money growth rate and long-run output levels, which accords well with some empirical studies. Huybens and Smith (1999) develop a neoclassical growth model with costly-state-verification problems to explain a large set of empirical facts on inflation, the volume of banking lending activity and the volume of trading in equity markets, and real economic performance. In their analysis, multiple equilibria may arise and an increase in the money growth rate, under the high-capital-stock steady state, will be harmful to bank lending activity and to the volume of trading in equity market. Hung (2001) and Bose (2002) examine the roles of asymmetric information in the inflation-growth relationships in models of endogenous growth. In all of these papers, the analysis on the relative merits of government expenditure financing is ignored.

this incentive-compatibility constraint is affected by the size of government expenditure as well as its financing policies.

Our model closely follows Azariadis and Smith (1996) who present a model in which money and capital are perfect substitutes and hence the rates of returns on both assets (loans and money) as well as on bank deposits must be equal. An increase in the inflation rate, obviously, lowers the returns on money as well as bank deposits. This lowers the utility of type-1 agents when they reveal their true type to work and deposit their wage income into the bank. Consequently, if the inflation rate is relatively high, a further increase in the inflation rate will induce type-1 agents to misrepresent their type. To deter this behavior, the bank must lower the amount of each loan to satisfy the incentive-compatibility constraint. In other words, when inflation rates are relatively high, the incentive-compatibility constraint becomes binding. In this case, type-2 agents cannot borrow as much as they want so that they are credit rationed. It is also clear that a further increase in the inflation rate under the rationing equilibrium will exacerbate the incentive problem and hence credit rationing becomes more severe. On the other hand, if the inflation rates are relatively low, then type-1 agents will have no incentives to pretend as type-2 and hence the incentive-compatibility constraint is not binding. In such a case, type-2 agents can borrow as much as they want so that credit is not rationing.

In contrast to Azariadis and Smith (1996) who focus on how the money growth rate influences the dynamics of the economy, we extend the above scenario into an AK model with a government financing its spending by taxing output or printing money. We examine particularly how this incentive constraint is affected by the government modes of expenditure financing and compare the growth and inflation rates as well as social welfare under money and income-tax financing. To facilitate the comparison, we also follow Palivos and Yip (1995) to obtain the corresponding tax rate for each of the two financing policies by setting the other tax rate to zero.

Most studies on policy discussions reach a conclusion that money financing always leads to higher inflation and lower economic growth. Therefore, income taxation is often suggested to finance government expenditure (e.g., McKinnon (1991)). This conventional wisdom, however, is challenged by recent studies. van der Ploeg and Alogoskoufis (1994), for example, conclude that a money-financed increase in government consumption results in a higher growth rate and a bigger increase in inflation than a tax-financed increase. Similar conclusion is obtained by Palivos and Yip

(1995) under the CIA economy and Gokan (2002) under a stochastic world. On the other hand, Espinosa-Vega and Yip (1999) and Espinosa-Vega and Yip (2002) find that the conclusion depends on agents' attitude toward liquidity shocks. If savers exhibit a high degree of risk aversion, an increase in seigniorage-financed government expenditure raises the inflation rate but lowers economic growth. If savers' degree of risk aversion is relatively low, such an increase leads to both higher rates for inflation and economic growth. Bose, Holman, and Neanidis (2007), on the other hand, reach a result that tax financing is better (*resp.* worse) than money financing for developing (*resp.* developed) countries.

By introducing the possibility of a binding borrowing constraint (and credit rationing), interestingly, this paper finds that whether or not the incentive constraint is binding plays an important role in determining the effects of money and income-tax financing. Specifically, it is shown that for any given share of government expenditure money financing yields a higher inflation rate as well as a lower growth rate than tax financing if credit is rationing. This is consistent with the conventional wisdom. However, if credit is non-rationing, money financing leads to both higher inflation and economic growth, a result consistent with recent studies. Note that credit is rationing (*resp.* non-rationing) if the share of government expenditure is relatively large (*resp.* small). Hence, our model indicates that the size of government is relevant in determining the effects of alternative government financing, a result that is not observed by recent studies.

The intuition underlying our results is straightforward. For familiar reasons, money financing always leads to higher inflation than tax financing. When the incentive-compatibility constraint is binding (i.e., credit is rationing), higher inflation further exacerbates the problem of asymmetric information and thereby type-2 agents are more credit rationed. This seriously impedes capital investment and hence economic growth. Thus, when credit is rationing, tax financing yields a higher rate of economic growth than money financing. On the other hand, if the constraint is not binding, there is no credit rationing and, in fact, higher inflation facilitates capital accumulation since the loan rate is negatively correlated with the inflation rate.[3] This implies that money financing yields a higher rate of economic growth than tax financing.

[3]The positive correlation between inflation and capital accumulation originates from Mundell (1965) and Tobin (1965).

It is interesting to note that our model may yield an inflation-growth relationship that is consistent with recent empirical studies (Fischer, 1993; Bruno and Easterly, 1998; Ghosh and Phillips, 1998; Khan and Senhadji, 2001; Burdekin et al., 2004), which have found a negative correlation between inflation and economic growth for high levels of inflation rates. As stated, credit rationing (*resp.* non-rationing) arises when the share of government spending is relatively large (*resp.* small). Moreover, we find that an increase in the share of government spending always raises the equilibrium inflation rate, regardless tax financing or money financing. These two results imply that credit rationing (*resp.* non-rationing) arises for high (*resp.* low) levels of the inflation rate. Thus, when the inflation rates are relatively high, credit is rationing and, as stated above, a further increase in the inflation rate (caused by a further increase in the share of government spending) exacerbates the problem of asymmetric information and hence leads to a decrease in economic growth, no matter how the government finances its expenditure. For low levels of the inflation rates, recent empirical studies find that an increase in the inflation rate may lead to an increase, a decrease, or have no significant effects on economic growth. In our model, credit is non-rationing with low levels of the inflation rates and, when credit is non-rationing, there is a positive (*resp.* negative) correlation between inflation and economic growth under money (*resp.* tax) financing. This implies that an increase in the inflation rate may lead to an increase, a decrease, or have no effect on economic growth when all the countries with money and tax financings are pooled together.

In terms of social welfare, recent studies imply that a mixed financing may be optimal for the government to finance its expenditure, since the social welfare function is increasing in the growth rate but decreasing in the inflation rate. Nevertheless, Palivos and Yip (1995) find that money financing yields a higher level of social welfare than tax financing if a larger fraction of investment purchases is subject to the CIA constraint. Espinosa-Vega and Yip (1999) obtain a similar result under the case where agents are fairly risk averse. Gokan (2002), on the other hand, finds that taxes on wealth are more desirable than seigniorage for the government to finance its consumption in terms of social welfare, a result consistent with the conventional wisdom.

With the possibility of credit rationing, our conclusion regarding social welfare depends again on whether or not credit is rationing. We find that if the Pareto weight placed on each generation in the social welfare function is not too small, income tax financing yields a higher level of social welfare than money financing under the rationing equilibrium. By contrast, money financing yields a higher level of social welfare than tax financing under the non-rationing equilibrium. Recall that credit is rationing (*resp.* non-rationing) if the share of government spending and hence the equilibrium inflation rate are relatively high (*resp.* low). Thus, our model suggests that the government should utilize taxation (*resp.* seigniorage) instead of seigniorage (*resp.* taxation) to finance its consumption if the economy's inflation rate is relatively high (*resp.* low). This may provide a theoretical explanation for the empirical evidence of Mankiw (1987), who finds a positive correlation between tax rates and inflation rates in the postwar United States.

The rest of this paper is organized as follows. Section 2 describes the basic model and Section 3 analyzes market equilibrium. The existence of equilibrium under alternative financing is presented in Section 4. In Section 5, we compare economic growth, inflation, and social welfare under alternative modes of government financing. Section 6 concludes.

2 The Environment

Consider a model economy populated with infinite sequence of two-period-lived overlapping generations (OLG).[4] Time is discrete and indexed by $t = 0, 1, \cdots$ The size and composition of each generation are identical. Each generation contains a continuum of agents with unit mass. Agents of each

[4]Azariadis and Smith (1996) introduce an informational asymmetry into a standard monetary model and examine how a change in the money growth rate influences agents' incentives and, through this channel, the dynamics as well as the steady state output of the economy. As our focus in this model is to compare the relative merits of government financing in an endogenous growth model, we modify their model in two ways. First, the production technology for output in our model is an AK type so that the balanced growth path can be obtained. This modification enables us to examine the relationship between inflation and economic growth, instead of the relationship between the money growth rate and steady state output in Azariadis and Smith (1996). It is worth noting that most recent studies have provided evidence on the correlation between inflation and economic growth, not on inflation and the output level. Second, we introduce a government that must finance its spending by taxing output or printing money, with the corresponding tax rates of output taxation or seigniorage being endogenously determined. In Azariadis and Smith (1996), they solely focus on the monetary policy (to be more specific, the money growth rate), in which government revenues derived from an increase in the money growth rate are transferred back to output producers in a lump-sum fashion.

generation are divided into two types, with a λ (*resp.* $1-\lambda$) fraction being of type-1 (*resp.* type-2). All agents are risk neutral and care only old-age consumption. The government of this economy in each period faces an exogenously given amount of expenditure that can be financed by taxing output or printing money.

2.1 Type-1 Agents

Type-1 agent is designated as the household-firm. Specifically, each type-1 agent is endowed with one unit of labor when young and nothing when old. The young labor endowment is inelastically supplied to earn the comparatively-determined, after-tax wage rate $(1-\tau)w_t$, where τ is the tax rate on output. Each type-1 agent is also endowed with a storage technology; hence, she can simply store her young-age wage by which a unit of output stored at t yields x, $1 > x > 0$, units of consumption goods at $t+1$. Alternatively, each type-1 agent can lend to type-2 agents (designated as borrowers) to exchange for consumption in the next period. Finally, a type-1 agent may exchange his young wage for money and use the money to exchange output in the old age for consumption.

As in the literature, direct lending/borrowing between type-1 and type-2 agents is too costly to proceed. Thus, any type-1 agent who intends to lend to type-2 agents can establish a financial intermediation (or in short, a bank) that accepts deposits from other young type-1 agents and make loans to young type-2. We also assume that there is no any cost associated with banking activities. This together with the assumption that any young type-1 agents can establish a bank ensures the competitive behavior of each bank. Since banking deposits and money are perfect substitutes, the rate of return from banking deposits is equal to that from holding money. As agents are risk neutral, this implies that young type-1 agents are indifferent between making deposits and holding money. Due to this, we assume that young type-1 agents who work for the after-tax wage rate will deposit all of their wage incomes in a bank. After accepting deposits, the bank, in turn, makes loans to type-2 agents and exchanges the remaining for money. Denote r_{t+1} as the rate of return form banking deposits between t and $t+1$. The old-age consumption for a type-1 agent who works is equal to $(1-\tau)w_t r_{t+1}$.

Following Azariadis and Smith (1996), agents' type and input into storage (by type-1 agents) are private information while market activities such as working, borrowing, and capital producing are observable. This implies that each type-1 agent, instead of working and making deposits, may pretend as a young type-2 to obtain a loan from the bank. Under such a case, the type-1 agent cannot provide her labor to earn the wage rate, because doing so will be detected and punished immediately. Moreover, since capital producing is observable and type-1 agents have no access to a capital project, any type-1 agent, who pretended as a type-2 and obtained a loan from the bank, must go underground (thus, financing old-age consumption by using the storage technology) and abscond with the loan. Denote b_t as the amount of a loan obtained from the bank at t. Then, the amount of old-age consumption for a type-1 agent who pretends as a type-2 to borrow is equal to $b_t x$. By weighting the amount of old-age consumption in the cases of working and mimicking, a type-1 agent will have no incentive to pretend as type-2 agent if

$$(1-\tau)w_t r_{t+1} \geq b_t x. \tag{1}$$

In the ensuing analysis, we focus on the separating equilibrium in which eq.(1) always satisfies.

2.2 Type-2 Agents

Each type-2 agent is endowed with a capital project when young and a unit of labor when old. The capital project, with external funding from the bank, can convert time t output into time $t+1$ capital. By borrowing b_t at t, the capital project of type-2 agent can produce z_{t+1},

$$z_{t+1} = a\,[b_t]^{\beta}\,\bar{k}_t^{1-\beta}, \quad a > 0, \beta(0,1), \tag{2}$$

units of time $t+1$ capital at the beginning of period $t+1$. Note that the amount of capital produced by the project depends on the amount borrowed b_t as well as per firm capital stock at the same period. This latter assumption captures the idea that there is a spillover effect on capital production across generations.[5] Recall that working is observable. Thus, a type-2 agent, who is not endowed with labor when young, cannot pretend as a type-1.

[5]This assumption is needed for the balanced growth path. Alternatively, Bencivenga and Smith (1993) interpret this assumption as the borrower learns to operate the project more efficiently along with the increase in the capital stock of the economy. It should be noted, however, that the capital stock per firm at t is exogenous to the type-2 agent (borrower). Note also that $\bar{k}_t = k_t$ in any equilibrium as type-2 agents are homogenous.

After obtaining b_t and produce z_{t+1} units of capital (given in eq. (2)) at the beginning of time $t+1$, the type-2 old agent can rent out the capital to firms for output production, earning the competitively-determined, after-tax rental rate of capital $(1-\tau)\rho$. Denote R_{t+1} as the loan rate (in terms of output at $t+1$).Then, the amount of old-age consumption to a type-2 agent at $t+1$ (denoted as c^2_{t+1}) is given as

$$c^2_{t+1} = a\,[b_t]^{\beta}\,k_t^{1-\beta}(1-\tau)\rho - R_{t+1}b_t + (1-\tau)w_{t+1}, \tag{3}$$

where the last term is derived from labor endowment in the old age.

2.3 Output Production

A single final commodity (output) is produced by firms in each period. Each type-1 agent becomes a firm operator in the second period of life. A firm operator can rent capital from the old type-2 agents and hire labor from young type-1 agents and old type-2 agents to produce output. Specifically, the production function of output y_t for each firm is given as

$$y_t = A\bar{k}_t^{\mu} k_t^{\sigma} N_t^{1-\sigma}, \quad A > 0, \;\; \sigma \in (0, 1), \tag{4}$$

where k_t and N_t are the amount of capital and labor employed by each firm, $\bar{k}_t$ is the average per firm capital stock, and A is a non-negative parameter. Capital depreciates fully after production. Each firm will employ the same amount of capital in equilibrium; therefore, $\bar{k}_t = k_t$. For simplicity, it is assumed that $\mu = 1-\sigma$; hence, the production technology in eq.(4) is a linear one as in AK model.[6]

Labor and capital markets are competitive; thus the rental rates of labor and capital at t are given as

$$w_t = (1-\sigma)Ak_t^{\mu+\sigma}N_t^{-\sigma} = (1-\sigma)Ak_tN_t^{-\sigma} \tag{5}$$

and

$$\rho_t = \sigma A k_t^{\mu+\sigma-1}N_t^{1-\sigma} = \sigma A N_t^{1-\sigma} = \rho. \tag{6}$$

[6]Note that the assumptions of $\mu = 1-\sigma$ and the externality from $\bar{k}_t$ in eq. (4) enable us to derive a balanced growth path. Without these two assumptions, we can only compare the relative merits of alternative modes of government financing in terms of the output level and inflation rate at the steady state. As we wish to follow recent literature by comparing the relative merits of government financing in terms of economic growth and inflation, we maintain these two assumptions in this paper.

Under the separating equilibrium where each lender/bank offers contracts that prevents type-1 agents from mimicking type-2, the number of firms (old type-1 agents) is equal to λ and the total labor (including young type-1 agents and old type-2 agents) is equal to 1. Therefore, $N_t = N = 1/\lambda$.

2.4 Government

The final agent in the model is the government, which needs to finance its spending in each period. In order to simplify analysis, we follow Palivos and Yip (1995) by assuming that government spending (expenditure) does not enter into agents' utility or production function.[7]

Government expenditures at t are proportional to per firm (or per type-1 agent) output at the same period, i.e., θy_t, where $\theta \in (0, 1)$ is the ratio of government spending to the output leve1. In other words, the government must collect θy_t and spend it by the end of time t. Government can finance its spending by taxing output or seigniorage. Denoting the time t supply of money per agent of type-1 by M_t,[8] the government budget constraint (again, on the basis of per type-1 agent) at t is given as

$$\theta y_t = \tau y_t + \frac{M_t - M_{t-1}}{P_t}, \tag{7}$$

where τ is the output tax rate and P_t is the price level at time t. Letting m_t be the real balances held by type-1 agent at time t, eq. (7) can be rewritten as

$$(\theta - \tau) y_t = m_t - m_{t-1} R^m_{t-1}, \tag{8}$$

where $R^m_{t-1} = P_{t-1}/P_t$ is the gross real rate of returns from holding money between time $t - 1$ and t (the inverse of the inflation rate). It should be clear that if the government finances its spending by output taxation only, then $\theta = \tau$ and thereby $M_t = M_{t-1} (m_t = m_{t-1} R^m_{t-1})$; on the other hand, if only seigniorage is used, then $\tau = 0$.

Finally, the government issues M_0 units of money at the initial period and there is also an initial old generation of type-1 agents (with population equal to λ) who is endowed with k_0 units of capital.

[7] Indeed, as is claimed by Palivos and Yip (1995), such a consideration will not affect the relative ranking of alternative financial methods.

[8] Note that each type-1 agent operates a firm under the separating equilibrium, which is the equilibrium we consider. As a result, per type-1 agent is equivalent to per firm in this model.

3 Market Equilibrium

Since labor supply is inelastically and the market for final output is competitive, eq. (5) is the condition for labor market equilibrium. Aside from labor market, we next consider the equilibrium conditions for loan, money, and capital markets. Recall that type-1 agents will deposit all of their after-tax wage incomes into a bank and the bank will first fulfill the loan demand of type-2 agents and then exchange the remaining deposits for money. This has two implications. First, the equilibrium of loan market is solely determined by the demand side (i.e., the loan demand of type-2 agents). Second, once the equilibrium loan market is determined, the equilibrium of money and capital markets can be decided accordingly.

3.1 Equilibrium of Loan Market

We follow Azariadis and Smith (1996) by focusing on the separating equilibrium of loan market in which the bank offers a contract that prevents type-1 agents from mimicking the behaviors of type-2 agents.[9] In other words, no any type-1 agent pretends as type-2 in the equilibrium. To achieve this, the loan contract must be subject to the incentive constraint given in eq. (1). Note that competition among banks and no any cost associated with banking activity also imply that the loan rate is equal to the deposit rate (which is also equal to R_t^m); hence, $R_{t+1} = r_{t+1} = R_t^m$. Taking R_{t+1} (and R_t^m) as given, the type-2 agent then selects b_t to maximize his old-age consumption given in eq. (3) subject to the incentive constraint in eq. (1). Assuming first that the incentive constraint is not binding, then optimal b_t is given as

$$b_t = b_t^n = \left[\frac{R_t^m}{a\beta(1-\tau)\rho}\right]^{\frac{1}{\beta-1}} k_t, \tag{9}$$

where the superscript n indicates the non-rationing case (as the incentive constraint is not binding). Note that this case is the Walrasian equilibrium in Azariadis and Smith (1996) and Azariadis and Smith (1998). As stated, eq. (9) can be viewed as the condition for loan market equilibrium under non-rationing case.

Note that if b_t^n is greater than the one implied by eq. (1), then the incentive constraint in eq. (1) becomes binding. In this case, the separating

[9] As in Azariadis and Smith (1996), if λ is sufficiently large, then the non-trivial equilibrium contract in the loan market is the separating contract.

equilibrium implies that the amount the type-2 agent can borrow is determined by eq. (1); hence,

$$b_t = b_t^r = \frac{(1-\tau)w_t R_t^m}{x}. \quad (10)$$

In this case, we call that type-2 agents are credit rationed (the superscript r refers to credit rationing) because the amount the type-2 agent received is less than the one that maximizes his old-age consumption (i.e., b_t^n). Alternatively, this case corresponds to the private information equilibrium in Azariadis and Smith (1996) and Azariadis and Smith (1998). Similarly, eq. (10) is the equilibrium condition for the rationing case.

Before proceeding further, some additional assumptions are needed to raise asymmetric information and the possibility of credit rationing. First, the rate of return from the storage technology (i.e., x) must be less than the rate of return from banking deposits r_{t+1}; otherwise, type-1 agents will not make deposits into the bank. As $r_{t+1} = R_{t+1} = R_t^m$, we have the following result:

$$r_{t+1} = R_{t+1} = R_t^m \geq x. \quad (11)$$

Second, since labor generates no disutility, the amount borrowed by the type-2 agents should be greater than the one generated by a type-l agent's labor. Otherwise, no type-l agents have incentive to pretend as type-2 and hence informational problems will essentially disappear.[10] Thus, $b_t^i \geq (1-\tau)w_t$, $i = r, n$, should satisfy. Eqs. (10) and (11) implies that b_t^r is always greater than or equal to $(1-\tau)w_t$. The requirement of $b_t^n \geq (1-\tau)w_t$ implies that there is an upper bound of R_t^m that is given as $(1-\tau)^\beta[(1-\sigma)AN^{-\sigma}]^{\beta-1}a\beta\rho$. We denote this upper bound as $\bar{R}^m$.[11] Finally, one can see that b_t^n is decreasing in R_t^m while b_t^r is increasing in R_t^m, as depicted in Figure 1.

Note that eq. (11) indicates that lower bound of R_t^m is equal to x. As can be seen in Figure 1, if $b_t^r > b_t^n$ when $R_t^m = x$, then there will be no credit rationing for $R_t^m \geq x$.[12] To rule out this uninteresting case, we focus on the situation where $b_t^r < b_t^n$ when $R_t^m = x$. The parameter condition

[10] Indeed, working does not generate disutility to type-1 agents and pretending as a type-2 agent prevents the type-1 agent from working.

[11] If the government relies only on seigniorage to finance its spending, $\tau = 0$ and hence the upper bound of $\bar{R}^m$ under money financing is $[(1-\sigma)AN^{-\sigma}]^{\beta-1}a\beta\rho$.

[12] If $b_t^r > b_t^n$ when $R_t^m = x$, then b_t^r is always greater than b_t^n for $R_t^m \geq x$.

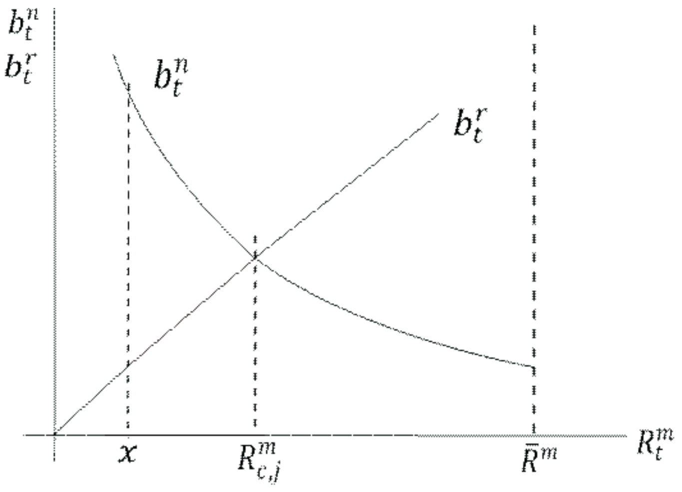

Figure 1: Credit Rationing and Non-rationing

for this situation is $x < (1-\tau)^{\beta}[(1-\sigma)AN^{-\sigma}]^{\beta-1}a\beta\rho$, which is always satisfied because $x \leq R_t^m < \bar{R}^m = (1-\tau)^{\beta}[(1-\sigma)AN^{-\sigma}]^{\beta-1}a\beta\rho$. On the other hand, if $\bar{R}^m > x$, then one can verify that $b_t^r > b_t^n$ when $R_t^m = \bar{R}^m$. As a consequence, we establish that there is a critical value of R_t^m, $R_t^m \in [x, \bar{R}^m]$, under which $b_t^r = b_t^n$. Denote this critical value of R_t^m as $R_{c,j}^m$, where the subscript j, $j = M, T$, refers to money financing (M) or tax financing (T).[13] We then have the following proposition.

Proposition 1. If $R_t^m < R_{c,j}^m$, then $b_t = b_t^r$ and credit rationing arises. On the other hand, if $R_t^m > R_{c,j}^m$, then $b_t = b_t^n$ and credit is non-rationing. An increase in the inflation rate (i.e., a decrease in R_t^m) lowers (*resp.* raises) the size of loans b_t if credit is rationing (*resp.* non-rationing).

Corollary 1. An increase in the inflation rate is associated with an increase (*resp.* *a* decrease) in the amount borrowed by type-2 agents when $R_t^m >$ (*resp.* $<$) $R_{c,j}^m$.

The intuition underlying Proposition 1 and Corollary 1 is similar to Azariadis and Smith (1996); hence, we ignore it.

[13]Note that $\tau = 0$ under money financing and $\tau = \theta$ under tax financing. Hence, $R_{c,M}^m = \{a\beta\rho[(1-\sigma)AN^{-\sigma}]^{\beta-1}x^{1-\beta}\}^{1/(2-\beta)}$ while $R_{c,T}^m = \{a\beta\rho[(1-\sigma)AN^{-\sigma}]^{\beta-1}x^{1-\beta}\}^{1/(2-\beta)}(1-\tau)^{\beta/(2-\beta)}$. For given parameters, $R_{c,M}^m > R_{c,T}^m$.

3.2 Money Market Equilibrium

Once we obtain b_t^i, $i = r, n$, from the loan market equilibrium, we can determine the money market equilibrium. Recall that the total demand of loan is equal to $(1-\lambda)b_t^i$. Since the population of type-1 agent is equal to λ, each type-1 agent, on average, lends $(1-\lambda)b_t^i/\lambda$ to the type-2 agents. After fulfilling the needs of type-2 agents, the bank will exchange the remaining wage rate for real money balances. Denote m_t^i, $i = r, n$, as the real money balance per type-1 agent under the cases of rationing and non-rationing. Then, the condition for money market equilibrium (in terms of per type-1 agent) can be expressed as[14]

$$m_t^i = (1-\tau)w_t - \frac{1-\lambda}{\lambda}b_t^i. \tag{12}$$

Substituting b_t^r and b_t^n into the above equation, we obtain the money market equilibrium under the cases of credit rationing (denoted as m_t^r) and non-rationing (m_t^n) as

$$m_t^r = \left[1 - \frac{(1-\lambda)R_t^m}{\lambda x}\right](1-\sigma)AN^{-\sigma}(1-\tau)k_t \tag{12a}$$

and

$$m_t^n = \left[(1-\sigma)AN^{-\sigma} - \frac{1-\lambda}{\lambda(1-\tau)}\left(\frac{a\beta(1-\tau)\rho}{R_t^m}\right)^{\frac{1}{1-\beta}}\right](1-\tau)k_t, \tag{12b}$$

respectively. Since $b_t^r \geq$ (*resp.* $<$) b_t^n for $R_t^m \geq$ (*resp.* $<$) $R_{c,j}^m$, we see that $m_t^n \geq$ (*resp.* $<$) m_t^r for $R_t^m \geq$ (*resp.* $<$) $R_{c,j}^m$. Moreover, as λ is sufficiently large, a non-negative m_t^i exists for $R_t^m \in [x, \bar{R}^m]$. Eqs.(12a) and (12b) imply that the growth rate of m_t^i, is equal to that of k_t along the balanced growth path (BGP) where R_t^m remains constant over time. In other words, $m_t^i = gm_{t-1}^i$ where g is the balanced growth rate.

[14] Again, the LHS can be viewed as the supply of real money while the RHS is the demand. Recall also that we have assumed that $b_t^i \geq (1-\tau)w_t$, $i = r, n$. Hence, non-negative real money balance requires that $\lambda \geq 0.5$, which is assumed to hold in our analysis.

3.3 Capital Market Equilibrium

Recall that each type-1 agent becomes a firm in her old age; hence, the number of firms under the separating equilibrium is equal to λ. Moreover, there are $1-\lambda$ borrowers (type-2 agents), and each of them borrows b_t at time t and produces z_{t+1} units of capital at the beginning of time $t+1$. Denote the capital stock per firm at time $t+1$ as k_{t+1}. Then, capital market equilibrium at $t+1$ implies that[15]

$$k_{t+1} = \frac{(1-\lambda)z_{t+1}}{\lambda} = \frac{(1-\lambda)}{\lambda} a\,[b_t]^{\beta}\, k_t^{1-\beta}. \tag{13}$$

If credit is rationing (so that $b_t = b_t^r$), then capital market equilibrium implies the capital stock (denoted as k_{t+1}^r) is given as

$$\begin{aligned} k_{t+1}^r &= \frac{(1-\lambda)}{\lambda} a \left[\frac{(1-\tau)w_t R_t^m}{x}\right]^{\beta} k_t^{1-\beta} \\ &= \frac{(1-\lambda)}{\lambda} a \left(R_t^m\right)^{\beta} x^{-\beta}(1-\tau)^{\beta}\left[(1-\sigma)AN^{-\sigma}\right]^{\beta} k_t. \end{aligned} \tag{13a}$$

If credit is non-rationing, then $b_t = b_t^n$; hence, the capital market equilibrium implies that the capital stock in this case (denoted as k_{t+1}^n) is given as

$$k_{t+1}^n = \frac{(1-\lambda)}{\lambda} a \left[\frac{R_t^m}{a\beta(1-\tau)\rho}\right]^{\frac{\beta}{\beta-1}} k_t. \tag{13b}$$

Recall that $b_t^r \geq$ (*resp.* $<$) b_t^n if $R_t^m \geq$ (*resp.* $<$) $R_{c,j}^m$. Thus, $k_{t+1}^r \geq$ (*resp.* $<$) k_{t+1}^n if $R_t^m \geq$ (*resp.* $<$) $R_{c,j}^m$.

4 General Equilibrium under Alternative Financing

We have specified the equilibrium conditions for loans, money, and capital markets, respectively. In this section, we utilize these conditions to establish the general equilibrium of the economy along the BGP for money financing and tax financing, respectively. Note that any feasible BGP displays that $R_t^m = R^m$ and $m_t^i = m^i$ (as well as $g_t = g$); hence, we will suppress time subscripts in these variables when they are not necessary.

[15] The LHS of this equation is the demand of capital while the RHS is the supply.

To begin with, note that $m_t^i = gm_{t-1}^i$ under the BGP. Substituting this into the government budget constraint in eq. (8), we have[16]

$$(\theta - \tau)y_t = m_{t-1}^i \left(g - R_{t-1}^m\right). \tag{14}$$

Combining eq. (14) with the condition of money market equilibrium in eq. (12a) or eq. (12b), we can obtain an equation incorporating the money market equilibrium with a balanced government budget. The general equilibrium of the economy under alternative modes of government financing is then jointly determined by this equation as well as the condition of capital market equilibrium in eq. (13a) or (13b).

4.1 Money Financing

Substituting eq. (12a) into eq. (14) with $\tau = 0$, we have

$$g_M^{r,b} = R^m \frac{\lambda x - (1-\lambda)R^m}{\left[1 - \frac{\theta N}{(1-\sigma)}\right]\lambda x - (1-\lambda)R^m}. \tag{15}$$

where $g_M^{r,b}$ as the growth rate along the BGP in which the government budget is balanced and money market is under equilibrium.[17] Similarly, denote $g_M^{n,b}$ as corresponding the BGP growth rate in the non-rationing case. From eq.(12b) (with $\tau = 0$), we have

$$g_M^{n,b} = R^m \frac{N^{-\sigma}A\lambda - \frac{(1-\lambda)}{(1-\sigma)}\left(\frac{a\beta\rho}{R^m}\right)^{\frac{1}{1-\beta}}}{\left[1 - \frac{\theta N}{1-\sigma}\right]N^{-\sigma}A\lambda - \frac{(1-\lambda)}{(1-\sigma)}\left(\frac{a\beta\rho}{R^m}\right)^{\frac{1}{1-\beta}}}. \tag{16}$$

For future reference, note that, first, both $g_M^{r,b}$ and $g_M^{n,b}$ are increasing functions of θ for a given R^m and, second, $g_M^{r,b} > R^m$ and $g_M^{n,b} > R^m$ for any $\theta > 0$.

We next obtain the growth rate along with a BGP from capital market equilibrium. Denote $g_M^{r,k}$ as the BGP growth rate for capital market equilibrium in the rationing case. From eq. (13a) with $\tau = 0$, we have

$$g_M^{r,k} = \frac{k_{t+1}}{k_t} = \left(\frac{R_t^m}{x}\right)^{\beta} v, \tag{17}$$

[16]Note that m_{t-1}^i is the inflation tax base while $(g_M - R_{t-1}^m)$ is the inflation tax rate.

[17]The first superscript r refers to credit rationing and the second superscript b corresponds to the balanced government budget as well as money market equilibrium.

where $v \equiv (1-\lambda)a[(1-\sigma)AN^{-\sigma}]^{\beta}/\lambda$. On the other hand, if credit is non-rationing, the BGP growth rate under capital market equilibrium (denoted as $g_M^{n,k}$) can be derived from eq.(13b) with $\tau = 0$ as

$$g_M^{n,k} = \left(R^m\right)^{\beta/(\beta-1)} u, \tag{18}$$

where $u \equiv (1-\lambda)a(a\beta\rho)^{\beta/(1-\beta)}/\lambda$. Note that both $g_M^{r,k}$ and $g_M^{n,k}$ are independent of θ.

Obviously, the general equilibrium of the economy under money financing is jointly determined by $g_M^{r,b}$ and $g_M^{r,k}$ for the rationing case and by $g_M^{n,b}$ and $g_M^{n,k}$ for the non-rationing case. The following lemma characterizes $g_M^{r,k}$, $g_M^{n,k}$, $g_M^{r,b}$, and $g_M^{n,b}$ as functions of R^m.[18]

Lemma 1. (1) $(\partial g_M^{r,b}/\partial R^m) > 0$; $(\partial^2 g_M^{r,b}/\partial R^{m2}) > 0$; (2) $(\partial g_M^{n,b}/R^m) > 0$; $(\partial^2 g_M^{n,b}/\partial R^{m2}) < 0$; (3) $(\partial g_M^{r,k}/\partial R^m) > 0$; $(\partial^2 g_M^{r,k}/\partial R^{m2}) < 0$; (4) $(\partial g_M^{n,k}/\partial R^m) < 0$; $(\partial^2 g_M^{n,k}/\partial R^{m2}) > 0$.

Lemma 1 indicates that $g_M^{r,k}$ and $g_M^{n,b}$ are strictly concave in R^m but $g_M^{r,b}$ and $g_M^{n,k}$ are strictly convex in R^m. Moreover, when $R^m = 0$, $g_M^{r,k}$, $g_M^{r,b}$ and $g_M^{n,b}$ are all equal to 0 while $g_M^{n,k}$ is equal to infinity.[19] Recall that $g_M^{r,b}$ and $g_M^{n,b}$ are increasing functions of θ while $g_M^{r,k}$ and $g_M^{n,k}$ are independent of θ. This implies that the ratio of government spending θ plays an important role in determining whether credit is rationing or non-rationing under the general equilibrium. Specifically, a higher value of θ requires the government to print more money for financing its spending. More money leads to higher inflation and hence lowers R^m, which leads to credit rationing. Given this, Proposition 1 then implies that there is a critical level of θ (denoted as θ_M^*) such that if $\theta \geq$ (*resp.* $<$) θ_M^*, then the equilibrium R^m is less (*resp.* greater) than the critical R^m under money financing (i.e., $R_{c,M}^m$) and hence credit rationing (*resp.* non-rationing) arises under the equilibrium.[20] Similarly, we can also find a $\bar{\theta}_M$ such that if $\theta > \bar{\theta}_M$, then the equilibrium R^m is less than x, implying that money will disappear when $\theta > \bar{\theta}_M$. Hence, we have the following results:

Proposition 2. (Equilibrium under Money Financing) If the ratio of government spending θ satisfies that $\bar{\theta}_M \geq \theta > \theta_M^*$, then there is a unique

[18] The proof is available from the author upon request.

[19] Figure 4 in Appendix depicts the loci of $g_M^{r,k}$, $g_M^{r,b}$, $g_M^{n,b}$ and $g_M^{n,k}$ as functions of R^m.

[20] See Appendix for a more detailed derivation.

equilibrium displaying credit rationing. If $\theta_M^* \geq \theta > 0$, then there is a unique equilibrium exhibiting credit non-rationing.

Moreover, the fact that an increase in θ reduces the equilibrium R^m also leads to the following result according to Corollary 1.

Corollary 2. Under money financing, a further increase in the share of government spending θ for $\bar{\theta}_M \geq \theta > \theta_M^*$ is associated with an increase in the inflation rate and a decrease in economic growth. On the other hand, such an increase for $\theta_M^* \geq \theta > 0$ raises the inflation rate and economic growth.

The intuition underlying Corollary 2 is straightforward. A larger θ leads to a higher inflation rate and hence a lower R^m. As in Azariadis and Smith (1996), a lower R^m (which corresponds to a higher θ in the current paper) implies that the type-1 agent is more inclined to mimic the behaviors of type-2 agents and hence the incentive constraint becomes binding, leading to credit rationing. By contrast, if θ is relatively small, the inflation rate is low and hence type-1 agents have no incentive to pretend as type-2 ones, leading to credit non-rationing. Recall from Corollary 1 that an increase in the inflation rate is associated with an increase (*resp.* a decrease) in the amount borrowed by type-2 agents when $R_t^m >$ (*resp.* $<$) $R_{c,M}^m$ (and hence $\theta <$ (*resp.* $>$) θ_M^*). Because a larger amount borrowed by type-2 agents produces a higher amount of capital and hence a higher rate of economic growth, we derive Corollary 2. Note that Corollary 2 implies that there is a nonlinear correlation between inflation and economic growth under money financing, as an increase in the inflation rate is associated with a decrease (*resp.* an increase) in economic growth for higher (*resp.* lower) levels of inflation.

4.2 Tax Financing

In this case, θ is equal to τ so that $M_t = M_{t-1}$ and hence $m_t^i = m_{t-1}^i R_{t-1}^m$ in eq. (14) of the government budget constraint. Let g_T be the growth rate under tax financing. The condition for the balanced government budget as well as money market equilibrium reduces to $g_T = R_T^m$.[21] On the

[21] The government budget constraint can be expressed as $(\theta - \tau)y_t = m_{t-1}^i(g_T - R^m)$. Under tax financing, $\theta = \tau$ and thereby $g_T = R^m$. In other words, m_{t-1}^i (in eqs. (12a) and (12b)) is irrelevant for the equilibrium under tax financing.

other hand, the equilibrium conditions for capital market are still given by eqs.(13a) and (13b) with $\theta = \tau$ for the cases of credit rationing and non-rationing. Utilizing eq.(3) with $\theta = \tau$, the growth rates that clear capital market for the cases of credit rationing and non-rationing are given by

$$g_T = g_T^{r,k} = \left(\frac{R^m}{x}\right)^{\beta} (1-\theta)^{\beta} v \tag{19}$$

and

$$g_T = g_T^{n,k} = \left[\frac{R^m}{(1-\theta)}\right]^{\frac{\beta}{1-\beta}} u, \tag{20}$$

respectively. Note that an increase in τ (and hence θ under tax financing) reduces the size of capital loans (i.e., b_t^r and b_t^n), which is detrimental to capital investment and economic growth.

Eqs. (19) and (20) indicates that an increase in θ increases $g_T^{r,k}$ and $g_T^{n,k}$ without affecting $g_T = R_T^m$, indicating that the equilibrium R^m is a decreasing function of θ. This enables us to derive a θ_T^* such that credit rationing (*resp.* non-rationing) arises when $\theta \geq$ (*resp.* $<$) θ_T^*. Moreover, we can find a $\bar{\theta}_T$ such that if $\theta > \bar{\theta}_T$, the equilibrium of R^m is less than x. Hence, we have the following results:

Proposition 3. (Equilibrium under Tax Financing) If the ratio of government spending θ satisfies that $\bar{\theta}_T \geq \theta > \theta_T^*$, then there is a unique equilibrium displaying credit rationing. If $\theta_T^* > \theta > 0$, then the unique equilibrium exhibits credit non-rationing.

Corollary 3. Under tax financing, an increase in the ratio of government spending θ is associated with an increase in the inflation rate, which always leads to a decrease in economic growth.

The intuition of Proposition 3 is also clear. Under tax financing, the ratio of government spending is equal to the tax rate. A higher θ (and hence a higher τ) leads to a lower after-tax wage rate. This will exacerbate the problem of informational imperfection by inducing type-1 agents to mimic type-2 ones, instead of working for the after-tax wage. Thus, if θ is relatively high, the incentive constraint becomes binding and credit is rationing. On the other hand, if θ is relatively low, the incentive constraint is not binding and hence type-2 borrower can borrow as much as they want. Moreover, since money market equilibrium under tax financing requires that the growth rate is equal to the rate of return from money, an increase in θ, that reduces the size of capital loans and hence economic growth, is associated with a lower rate of return from money and thus a higher inflation rate.

Before comparing the equilibrium economic growth, inflation, and social welfare, it is worth noting that our model may provide theoretical explanations to recent empirical studies on the inflation-growth correlations. Since the work of Fischer (1993), a large body of literature (Bruno and Easterly, 1998; Ghosh and Phillips, 1998; Khan and Senhadji, 2001; Burdekin et al., 2004) has discovered a nonlinear correlation between inflation and economic growth. In particular, these studies reach a consensus that an increase in the inflation unambiguously leads to a decrease in economic growth for high levels of initial inflation rates. For low levels of initial inflation rates, an increase in the inflation rate may lead to a decrease, an increase, or have no significant effect on economic growth.

Recall that credit rationing (*resp.* non-rationing) arises for high (*resp.* low) levels of inflation rates. According to Propositions 2 and 3 as well as Corollaries 2 and 3, an increase in the inflation rate always leads to a decrease in economic growth for high levels of initial inflation rates (i.e., under the rationing equilibrium), regardless how the government finances its spending. However, for low levels of initial inflation rates (i.e., under the non-rationing equilibrium), an increase in the inflation rate leads to an increase (*resp.* a decrease) under money (*resp.* tax) financing. Accordingly, if we pool all countries (who may finance their expenditure by printing money or levying tax) together, then we may reach a conclusion that an increase in the inflation rate may lead to an increase, a decrease, or have no significant effect on economic growth, depending on the number of countries that utilize tax or money financing in the sample.

5 Comparison of Output Growth, Inflation, and Welfare

Recall that, for a given θ, credit is rationing (*resp.* non-rationing) if $\bar{\theta}_T > \theta > \theta_T^*$ (*resp.* $0 < \theta < \theta_T^*$) under tax financing. Similarly, credit rationing (*resp.* non-rationing) if $\bar{\theta}_M > \theta > \theta_M^*$ (*resp.* $\theta_M^* > \theta > 0$) under money financing. To simplify our analysis, we report the two cases: $\min\{\bar{\theta}_M, \bar{\theta}_T\} > \theta > \max\{\theta_T^*, \theta_M^*\}$ and $\min\{\theta_T^*, \theta_M^*\} > \theta$.[22] The case of $\min\{\bar{\theta}_M, \bar{\theta}_T\} >$

[22] It is easy to verify $\bar{\theta}_T > \theta_T^*$ and $\bar{\theta}_M > \theta_M^*$. On the other hand, θ_M^* may be greater or less than θ_T^*. Regardless whether $\theta_M^* > \theta_T^*$ or $\theta_M^* < \theta_T^*$, we assume that $\bar{\theta}_M > \theta_T^*$

$\theta > \max\{\theta^*_T, \theta^*_M\}$ indicates that the equilibrium displays credit rationing no matter how the government finances its spending. Similarly, the case of $\min\{\theta^*_T, \theta^*_M\} > \theta$ implies that the equilibrium exhibits non-rationing regardless whether the government finances its spending by seigniorage or tax financing.

5.1 Comparing Output Growth

We now compare output in the cases of credit rationing and non-rationing.

Case 1. Credit Rationing: $\min\{\bar{\theta}_M, \bar{\theta}_T\} > \theta > \max\{\theta^*_T, \theta^*_M\}$

We depict the loci defined by $g_M^{r,k}$, $g_M^{r,b}$ and $g_T^{r,k}$ with the 45-degree line according Lemma 1 in Figure 2. A comparison between eqs. (17) and (19) reveals that for a given R^m the locus of $g_M^{r,k}$ is higher than that of $g_T^{r,k}$, as is depicted in Figure 2. Moreover, the locus of $g_M^{r,b}$ is higher than that of the 45-degree line. Recall also that equilibrium rate of growth under tax financing g_{T*} is determined by the intersection of $g_T^{r,k}$ and the 45-degree line (Point J in Figure 2); hence,[23]

$$g^r_{T*} = \left(\frac{1-\theta}{x}\right)^{\beta/(1-\beta)} v^{1/(1-\beta)} = R^{mr}_{T*}, \tag{21}$$

where g^r_{T*} and R^{mr}_{T*} are the growth rate and the inverse of the equilibrium inflation rate under tax financing.

On the other hand, g^r_{M*} is determined by the intersection of $g_M^{r,b}$ and $g_M^{r,k}$. To compare g^r_{T*} with g^r_{M*} we first substitute g^r_{T*} into $g_M^{r,k}$ to obtain the corresponding R^m (which is denoted as R^m_1 in Figure 2). Substituting this

and $\bar{\theta}_T > \theta^*_M$. Conditions about these two assumptions are provided in an appendix that is available upon request. Given these two assumptions, we can always find θs satisfying $\min\{\bar{\theta}_M, \bar{\theta}_T\} > \theta > \max\{\theta^*_T, \theta^*_M\}$. As an example, consider an economy in which $A = 1, a = 3, \beta = 0.9, \sigma = 0.3, \lambda = 0.79$, and $x = 0.5$. In this economy, $\bar{\theta}_T = 8.7\%$, $\theta^*_T = 2.3\%$, $\bar{\theta}_M = 3.2\%$, and $\theta^*_M = 2\%$. Thus, credit rationing arises under two modes of government financing if $\min\{\bar{\theta}_M, \bar{\theta}_T\} = 3.2\% > \theta > \max\{\theta^*_T, \theta^*_M\} = 2.3\%$. Note that an economy with a given θ may be in the rationing or non-rationing regimes under different modes of government financing. We compare the growth rate and the inflation rate for this situation in an appendix that is available from the author upon request.

[23]Note that the growth rate is equal to R^m under the 45-degree line. Substituting $R^m = g_{T*}$ into eq.(21), one can obtain g^r_{T*}.

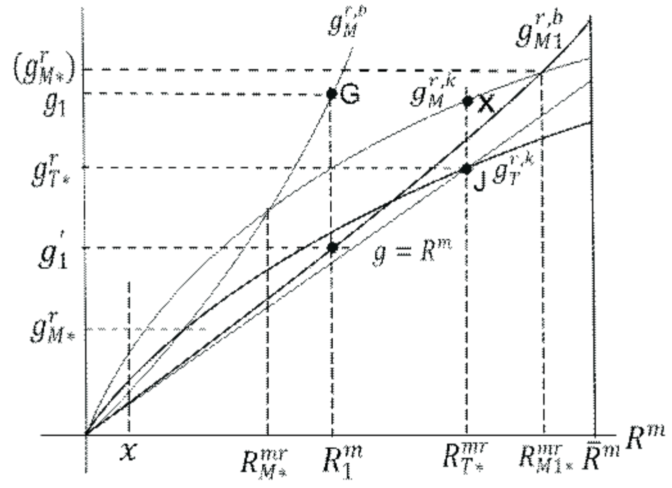

Figure 2: Comparison of Money and Tax Financing: Rationing

R_1^m into $g_M^{r,b}$ (i.e., eq.(15)), we derive the corresponding growth rate under eq. (15) (denoted as g_1 in Figure 2). Clearly, if g_1 (such as Point G in Figure 2) is greater than g^r_{T*}, then the loci of $g_M^{r,b}$ and $g_M^{r,k}$ must intersect each other at the growth rate g^r_{M*} that is less than g^r_{T*}. On the other hand, if the locus of $g_M^{r,b}$ is like the one labeled as $g_{M1}^{r,b}$ in Figure 2, then g_1 (which is equal to g_1' in Figure 2 in this case) is less than g^r_{T*}. In this case, it is clear that g^r_{M*} (denoted as (g^r_{M*}) in Figure 2) must be greater than g^r_{T*}.

Note that $R_1^m = [(1-\theta)v]^{1/(1-\beta)}x^{-\beta/(1-\beta)}$. Hence, $g^r_{T*} > g^r_{M*}$ if

$$\frac{g^r_{T*}}{g_1} = \frac{\left(\frac{1-\theta}{x}\right)^{\beta/(1-\beta)} v^{1/(1-\beta)}}{\frac{\lambda x-(1-\lambda)[(1-\theta)v]^{1/(1-\beta)}x^{-\beta/(1-\beta)}}{\left[\left(1-\frac{\theta N}{1-\sigma}\right)\lambda x/[(1-\theta)v]^{1/(1-\beta)}x^{-\beta/(1-\beta)}\right]-(1-\lambda)}} < 1. \qquad (22)$$

After some manipulations, it can be found that $g^r_{T*}/g_1 < 1$ is always satisfied for any $\theta > 0$. Hence, we conclude that $g^r_{T*} > g^r_{M*}$ for any θ, $\min\{\bar{\theta}_M, \bar{\theta}_T\} > \theta > \max\{\theta^*_T, \theta^*_M\}$. We summarize this result in the following proposition.

Proposition 4. For a given θ where $\min\{\bar{\theta}_M, \bar{\theta}_T\} > \theta > \max\{\theta^*_T, \theta^*_M\}$, the equilibrium growth rate of tax financing is greater than that of money financing.

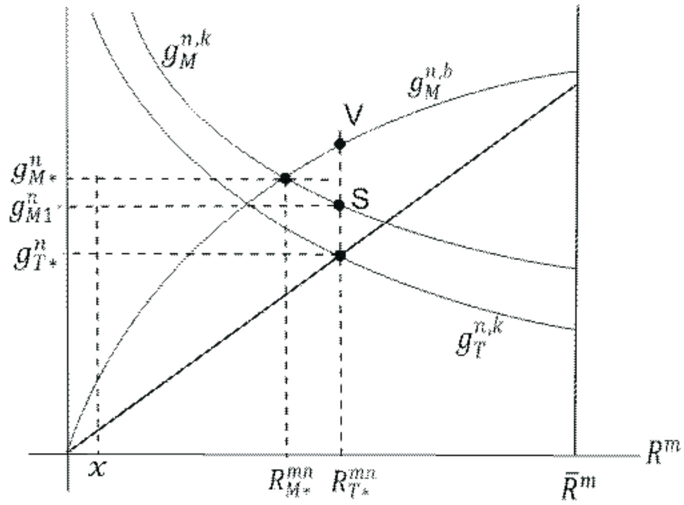

Figure 3: Comparison of Money and Tax Financing: Non-rationing

Case 2. Credit Non-rationing: $\min\{\theta_T^*, \theta_M^*\} > \theta$

Regardless of financing method, credit is non-rationing in this case. Recall that the equilibrium growth rate in the non-rationing case is determined by the intersection of $g_T^{n,k}$ and the 45-degree line under tax financing. This implies that the equilibrium growth rate is located at the 45-degree line, as depicted as R_{T*}^{mn} in Figure 3. On the other hand, the equilibrium growth rate under money financing is determined by the intersection between $g_M^{n,b}$ and $g_M^{n,k}$. A comparison between eqs. (18) and (20) reveals that the locus of $g_M^{n,k}$ is higher than that of $g_T^{n,k}$ for any given θ and R^m. Moreover, for any given R^m the growth rate obtained from $g_M^{n,b}$ is always greater than R^m, implying that the locus defined by $g_M^{n,b}$ is always higher than the 45-degree line. This further implies that the growth rate under money financing (the intersection of $g_M^{n,b}$ and $g_M^{n,k}$) is always greater than that under tax financing (the intersection between $g_M^{n,k}$ and the 45-degree line).[24] The following proposition summarizes our result.

Proposition 5. For any given θ, $\min\{\theta_T^*, \theta_M^*\} > \theta$, the equilibrium growth

[24] In Figure 3, g_{T*}^n and g_{M*}^n are the equilibrium growth rates while R_{T*}^{mn} and R_{M*}^{mn} are the rates of returns from money holdings for the case of non-rationing under income-tax and money financing.

rate of money financing is greater than that of tax financing.

5.2 Comparing the Inflation Rate

Again, we compare the equilibrium inflation rate for the rationing equilibrium and non-rationing equilibrium.

Case 1. Credit Rationing

The equilibrium R^m for tax financing is denoted as R^{mr}_{T*} (Point J in Figure 2). Alternatively, for given parameters, we depict two possibilities for the equilibrium R^m under money financing: one is less than R^{mr}_{T*} (denoted as R^{mr}_{M*}) and the other one is greater than R^{mr}_{T*} (denoted as R^{mr}_{M1*} in Figure 2). Recall that the equilibrium R^m under tax financing is equal to R^{mr}_{T*} (Point J in Figure 2). Results of Lemma 1 imply that the equilibrium R^m under money financing is lower than that of tax financing if the growth rate obtained from $g^{r,b}_M$ is greater than that obtained from $g^{r,k}_M$ when $R^m = R^{mr}_{T*}$ (see Figure 2).[25] Substituting R^{mr}_{T*} from eq. (21) into $g^{r,b}_M$ and $g^{r,k}_M$, the condition that money financing leads to a lower rate of return from money holdings can be expressed as

$$\left(\frac{\theta}{x}\right)^{\frac{\beta}{1-\beta}} v^{\frac{1}{1-\beta}} \frac{\lambda x - (1-\lambda)\left[\frac{(1-\theta)}{x}\right]^{\frac{\beta}{1-\beta}} v^{\frac{1}{1-\beta}}}{\left(1-\frac{\theta N}{1-\sigma}\right)\lambda x - (1-\lambda)\left[\frac{(1-\theta)}{x}\right]^{\frac{\beta}{1-\beta}} v^{\frac{1}{1-\beta}}} > \left[\left(\frac{1-\theta}{x}\right)^{\frac{\beta}{1-\beta}} v^{\frac{1}{1-\beta}}\right]^{\beta} x^{-\beta} v. \tag{23}$$

The sufficient condition for the above inequality is $(1-\theta)^{\beta} > (1 - (\theta N)/(1-\sigma))$, which always holds since $(1-\theta)^{\beta} > (1-\theta) > (1 - (\theta)/(1-\sigma)) > (1-(\theta N)/(1-\sigma))$.[26] Thus, we have the following result:

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[25] If the growth rate obtained from $g^{r,b}_M$ (such as the locus of $g^{r,b}_M$ in Figure 2) is greater than that obtained from $g^{r,k}_M$ (such as point X in Figure 2) when $R^m = R^{mr}_{T*}$, the equilibrium R^m under money financing is equal to R^{mr}_{M*} in Figure 2. Obviously, $R^{mr}_{M*} < R^{mr}_{T*}$. On the other hand, if $g^{r,b}_M$ is the locus of $g^{r,b}_{M1}$ in Figure 2, the equilibrium R^m under money financing is equal to R^{mr}_{M1*}, which is greater than R^{mr}_{T*}.

[26] Recall that $N = 1/\lambda$, which is greater than one.

Proposition 6. For any θ, $\min\{\bar{\theta}_M, \bar{\theta}_T\} > \theta > \max\{\theta_T^*, \theta_M^*\}$, money financing results in a higher inflation rate than tax financing.

Case 2. Non-rationing

Following the similar logic of Proposition 4, the equilibrium R^m under money financing is less than that under tax financing if the growth rate of the locus $g_M^{n,b}$ (Point V in Figure 3) is greater than that of the locus $g_M^{n,k}$ (Point S) when $R^m = R_{T*}^{mn}$. Substituting R_{T*}^{mn} into $g_M^{n,b}$ and $g_M^{n,k}$, we see that the resulting growth rate of the locus $g_M^{n,b}$ is greater than that of the locus $g_M^{n,k}$ if

$$N^{-\sigma} A\lambda \left[1 - (1-\theta)^{\frac{-\beta}{1-\beta}} \left(1 - \frac{\theta N}{1-\sigma}\right)\right] > (1-\lambda)(a\beta\rho)^{\frac{1}{1-\beta}} \left[(1-\theta)^{\beta} u^{1-\beta}\right]^{\frac{-1}{1-\beta}} \left[1 - (1-\theta)^{\frac{-\beta}{1-\beta}}\right]. \quad (24)$$

Since we assume that the denominator of $g_M^{n,b}$ is positive so that $[1 - (\theta N)/(1-\sigma)]N^{-\sigma} A\lambda > (1-\lambda)(a\beta\rho)^{1/(1-\beta)}[(1-\theta)^{\beta} u^{1-\beta}]^{-1/(1-\beta)}$, a sufficient condition for the above inequality is $(1 - (\theta N)/(1-\sigma)) < 1$, which always holds for $1 > \theta > 0$. Hence, we have the following proposition.

Proposition 7. For any θ, $\min\{\theta_T^*, \theta_M^*\} > \theta$, the inflation rate under money financing is greater than that under tax financing.

For a given θ, money financing requires the government to print more money (than tax financing), regardless whether the equilibrium displays credit rationing or non-rationing. Printing more money leads to a higher inflation so that money financing yields a higher inflation rate than tax financing. With respect to economic growth, recall that b_t^n is decreasing in R^m and τ. Proposition 5 implies that the amount borrowed by a type-2 agent (i.e., b_t^n) under money financing is higher than that under tax financing for a given θ, with $\theta < \min\{\theta_T^*, \theta_M^*\}$. This leads to a higher rate of economic growth under money financing compared with tax financing.

5.3 Comparing the Welfare

To compare the welfare, we first characterize the welfare functions for type-1 and type-2 agents of all generations as follows:[27]

[27]The complete derivation of the welfare functions is available from the author upon request.

Proposition 8. Regardless whether credit is rationing or non-rationing, the welfare functions of type-1 and type-2 agents of all generations for a given share of government spending are increasing in the growth rate and the rate of return from money, no matter how the government finances its spending.

Recall that $g^r_{T*} = R^{mr}_{T*} > g^r_{M*} > R^{mr}_{M*}$ in the rationing equilibrium. Combining this with Proposition 1, however, may not imply that tax financing yields a higher level of welfare to type-1 agents than money financing. This is so because the tax rate is positive (and equal to the share of government spending) under tax financing but is equal to zero under money financing. The presence of the tax rate under tax financing obviously reduces the welfare of type-1 agents, compared with money financing. Nevertheless, we find that $(1-\theta)R^{mr}_{T*} > R^{mr}_{M*}$ under the rationing equilibrium, implying that tax financing tax leads to a higher level of welfare to type-1 agents than money financing under the rationing equilibrium (i.e., for a given θ such that $\min\{\bar{\theta}_M, \bar{\theta}_T\} > \theta > \max\{\theta^*_T, \theta^*_M\}$).[28]

In the case of the non-rationing equilibrium, recall that $g^n_{M*} > g^n_{T*} = R^{mn}_{T*} > R^{mn}_{M*}$. From this, we cannot directly infer the relative merits of government financing from the perspective of type-1 agents' welfare. Note that the importance of economic growth on welfare of type-1 agents in all generations depends on the weight placed on the utility of generation t in the welfare function. Specifically, if the social planner does not discount the welfare of future generations to much,[29] then economic growth is more important to the welfare of type-1 agents of all generations than the equilibrium R^m. Let η^t be the Pareto weight placed on the utility of generation t in the welfare function. Then, we can find a critical level of η (denoted as η^n_{*1}), such that if $\eta > \eta^n_{*1}$, economic growth dominates the rate of return from money in determining the welfare of type-1 agents of all generations. As money financing yields a higher rate of economic growth than tax financing under the non-rationing equilibrium, we conclude that money financing leads to a higher level of welfare for type-1 agents if $\eta > \eta^n_{*1}$.

With respect to the welfare of all type-2 agents, we find that if η is greater than a critical level (denoted as η^r_{*2}), then tax financing yields a higher level of welfare to all type-2 agents under the rationing equilibrium. If credit is non-rationing, we find that money financing always leads to a higher welfare

[28]The derivation is available from the author upon request.

[29]That is, the welfare of future generations is not discounted too heavily.

level to all type-2 agents.[30]

The social welfare function for the economy as a whole is the summation of the welfare functions of all type-1 and type-2 agents. Then, we have the following result:

Proposition 9. Suppose that $\eta > \min\{\eta^n_{*1}, \eta^r_{*2}\}$. Under the rationing equilibrium, tax financing yields a higher level of social welfare than money financing. On the contrary, under the non-rationing equilibrium money financing yield a higher level of social welfare than tax financing.

It is interesting to note that economists are not always agreed with the effect of money and tax financing. McKinnon (1991) asserts that money financing usually leads to higher inflation and lower economic growth. In an AK model incorporated with a cash-in-advance constraint, Palivos and Yip (1995), however, find that money financing yields a higher inflation rate and a higher growth rate than tax financing. In a stochastic AK model with a money-in-the-utility (MIU) setting, Gokan (2002) shows that an increase in the mean of government expenditure under financing of taxes on wealth leads to less than 100% crowding-out on the ratio of consumption over output, which reduces the expected rate of real growth. Under mixed financing of money and bonds, such an increase leads to 100% crowding-out on the ratio of consumption over output and hence has no effect on the rate of real growth. In terms of the inflation rate, a mixed financing of money and bonds leads to a higher inflation rate than a financing of taxes on wealth. Interestingly, our model demonstrates that asymmetric information may play a role to this debate.

In terms of social welfare, various factors that play a role in determining the relative merits of government financing have been discovered in the literature. In a model with an infinitely-lived representative agent, Palivos and Yip (1995) show that the fraction of capital investment that is subject to the cash-in-advance (CIA) constraint (denoted as ϕ in their paper) plays a critical role. They first find that welfare of the representative agent is positively related to economic growth and the consumption at the initial point of time, $c(0)$. While money financing leads to a higher rate of economic growth, it also reduces $c(0)$. They then demonstrate that the government is able to apply the Friedman rule under tax financing that neutralizes the negative effect on growth due to the present of the CIA constraint. As a result,

[30] The derivation is available from the author upon request.

the only negative effect left is the one causing by the income tax, which is independent of ϕ. On the other hand, if the CIA constraint becomes more restrictive (i.e., ϕ is larger) under money financing, then it will cause a larger extent of distortions to capital investment and hence lead to a lower rate of economic growth (with a higher amount of $c(0)$). Given this, Palivos and Yip (1995) find that tax (*resp.* money) financing is able to generate a higher level of welfare than money (*resp.* tax) financing if ϕ is relatively small (*resp.* large).

In Gokan (2002), the key factor in determining the relative merits of government financing is the nominal interest rate. Specifically, a higher level of the nominal interest rate leads to three effects on welfare. First, it lowers the demand for money, which is welfare-deteriorating in the MIU setting. Second, it reduces the equilibrium consumption-output ratio, which is welfare-improving as it facilitates capital investment. Third, it causes an initial jump in the initial price level that leads to a reduction in the initial wealth and hence a lower level of welfare under MIU. Under these three effects, Gokan (2002) shows that, while a rise in the mean of government spending share reduces welfare, mixed financing of money and bonds leads to a larger (*resp.* a smaller) fall in welfare than financing of taxes on wealth if the nominal interest rate is greater (*resp.* less) than a critical level.[31] Interestingly, our model contributes to this literature by showing that asymmetric information may also play a role in determining the relative merits of government financing.

It is also worth noting that our results on social welfare may provide an explanation to Mankiw (1987) hypothesis of optimal seigniorage which asserts that tax and inflation rates should co-vary positively. As is shown, the presence of asymmetric information in this model gives rise to credit rationing (*resp.* non-rationing) when the inflation rate is relatively high (*resp.* low), and tax financing is better (*resp.* worse) than money financing if credit is rationing (*resp.* non-rationing). This implies that the government should utilize taxation (i.e., raise the tax rate) when the inflation rate is relatively

[31] Note that an increase in the mean of the government spending share in Gokan (2002) raises the nominal interest rate, implying that mixed financing of money and bonds leads to a larger fall in welfare when the mean of the government spending share is relatively large. This is consistent with our model. Indeed, we have shown that tax financing yields a higher level of welfare than money financing when credit is rationing, which arises when the share of government spending is relatively large.

high. Therefore, we can observe a positive correlation between inflation and tax rates.

6 Conclusion

This paper incorporates asymmetric information into a simple model of endogenous growth to assess the relative merits of money and tax financing. As is well known, the presence of asymmetric information gives rise to the possibility of credit rationing. It is then found that whether or not credit is rationing plays a significant role in determining the relative merits of money and tax financing.

Results demonstrate that money financing leads to higher inflation for the cases of credit rationing and non-rationing; nevertheless, the growth rate is higher under money (*resp.* tax) financing if credit is non-rationing (*resp.* rationing). In terms of social welfare, money (*resp.* tax) financing is superior to tax (*resp.* money) financing when credit is non-rationing (*resp.* rationing). These results reconcile the pre-existing literature as some studies suggest the government financing its expenditure via seigniorage while others via taxation. Moreover, our model may provide theoretical explanations to the nonlinear correlation between inflation and economic growth as well as a positive correlation between inflation and tax rates.

Finally, some policy implications can be obtained from our analysis. First, the optimal mode of government financing depends on the share of government spending, which it not observed by recent theoretical studies. Indeed, our model indicates that money financing is better than tax financing only for a small fraction of government spending. Once the share of government spending is relatively large, tax financing yields a higher rate of economic growth and a lower rate of inflation, compared with money financing. Second, when credit rationing becomes more severe, an increase in the share of tax-financed spending yields a better outcome than the same increase of money-financed spending. This result may provide a theoretical underpinning to an argument claiming that the government should not use the monetary policy to stimulate the economic downturn caused by financial crisis,[32] though our study focuses on the long-run economic growth

[32]Note that credit rationing is usually more severe after a financial crisis occurred. Krugman (2008), for example, asserts that monetary policy is ineffective during and after a financial crisis.

instead of short-run fluctuations.

Appendix

(1) Derivations of θ_M^* and $\bar{\theta}_M$ under money financing

Denote $R_{c,M}^m$ as the critical value of R^m under money financing such that if $R^m = R_{c,M}^m$, then $b_t^r = b_t^n$ and hence $g_M^{r,k} = g_M^{n,k}$ as well as $g_M^{r,b} = g_M^{n,b}$. Note that since $\tau = 0$ under money financing, $R_{c,M}^m = \{a\beta\rho[(1-\sigma)AN^{-\sigma}]^{\beta-1}x^{1-\beta}\}^{1/(2-\beta)} = (uv^{-1}x^{\beta})^{(1-\beta)/\beta(2-\beta)}$. Lemma 1 implies that $R_{c,M}^m$ is unique. Note that if $R^m > (<) R_{c,M}^m$, then $b_t^r > (<) b_t^n$ and hence $g_M^{r,k} > (<) g_M^{n,k}$ as well as $g_M^{r,b} < (>) g_M^{n,b}$. It is clear that credit rationing (*resp.* non-rationing) arises under the general equilibrium if the equilibrium level of R^m is less (*resp.* greater) than $R_{c,M}^m$.

To see that θ plays an important role in determining whether credit is rationing or non-rationing, we first depict $g_M^{r,k}$ and $g_M^{n,k}$ according to Lemma 1 in Figure 4. Obviously, $g_M^{r,k}$ intersects $g_M^{n,k}$ at $R^m = R_{c,M}^m$. We next depict the loci of $g_M^{r,b}$ and $g_M^{n,b}$. For this purpose, note that $g_M^{r,b} = g_M^{n,b} = 0$ if $R^m = 0$. Moreover, $g_M^{r,b}$ and $g_M^{n,b}$ are functions of θ and, in particular, an increase in θ rotates the loci of $g_M^{r,b}$ and $g_M^{n,b}$ counterclockwise. Given this, there must exist a unique θ_M^* such that if $\theta = \theta_M^*$, then $g_M^{r,b}$ (denoted as $g_M^{r,b}(\theta = \theta_M^*)$ in the figure) goes through the intersection of $g_M^{r,k}$ and $g_M^{n,k}$ at $R^m = R_{c,M}^m$. Substituting this θ_M^* into $g_M^{n,b}$, the locus of $g_M^{n,b}$ (denoted as $g_M^{n,b}(\theta = \theta_M^*)$ in the figure) must also intersect $g_M^{r,b}(\theta = \theta_M^*)$ at $R^m = R_{Mc}^m$. Now, suppose that $\theta > \theta_M^*$. This will rotate the locus of $g_M^{r,b}$ (denoted as $g_M^{r,b}(\theta > \theta_M^*)$ in the figure) counterclockwise, implying that $g_M^{r,b}$ intersects $g_M^{r,k}$ at $R^m < R_{c,M}^m$ (located at point A in Figure 4) and hence credit rationing arises. To see this, note that when $\theta > \theta_M^*$, $g_M^{n,b}$ will intersects $g_M^{n,k}$ at $R^m < R_{c,M}^m$. Since credit rationing arises when $R^m < R_{c,M}^m$, non-rationing is not the equilibrium consequence in this case. Similarly, credit rationing is not the equilibrium consequence when $\theta < \theta_M^*$. Following similar logic, we can find a $\bar{\theta}_M, \bar{\theta}_M > \theta_M^*$, in which if $\theta = \bar{\theta}_M$, $g_M^{r,b}$ intersects $g_M^{r,k}$ at $R^m = x$. As a result, credit rationing arises for a given θ if $\bar{\theta}_M \geq \theta > \theta_M^*$. On the other hand, if $\theta < \theta_M^*$, the locus of $g_M^{n,b}$ becomes the one denoted as $g_M^{n,b}(\theta < \theta_M^*)$ in Figure 4. In this case, $g_M^{n,k}$ intersects $g_M^{n,b}(\theta < \theta_M^*)$ at $R^m > R_{c,M}^m$ (located at point B) and hence credit is non-rationing. Thus, credit non-rationing arises for a given θ if $\theta_M^* > \theta > 0$.

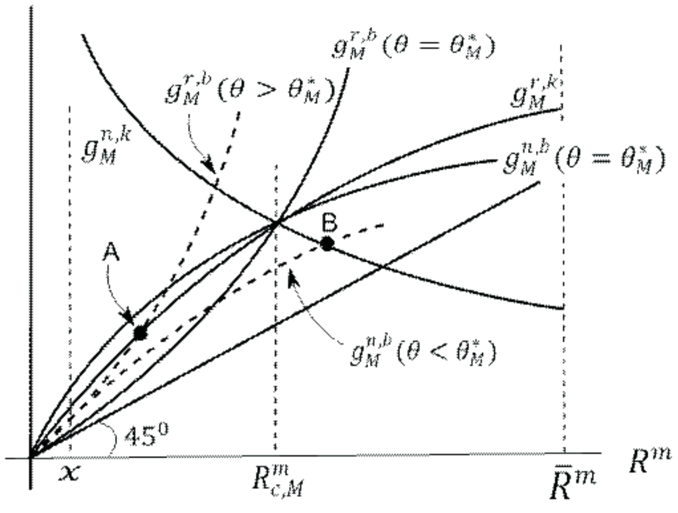

Figure 4: Equilibrium Credit Rationing and Non-rationing Under Money Financing

(2) Derivations of θ_T^* and $\bar{\theta}_T$

Define $R_{c,T}^m$ as the critical level of R^m under tax financing such that, for a given θ, if $R^m = R_{c,T}^m$, then $b_t^r = b_t^n$. Obviously, $R_{c,T}^m$ is affected by a change on θ. Hence, credit rationing (non-rationing) arises if the equilibrium value of R^m is less (greater) than $R_{c,T}^m$. Moreover, we let $g_{T*}^r(g_{T*}^n)$ and $R_{T*}^{mr}(R_{T*}^{mn})$ be the equilibrium rates of growth and return from money holdings under credit rationing (non-rationing). Then, eq.(19) and $g_T = R^m$ determine the equilibrium values of $\{g_{T*}^r, R_{T*}^{mr}\}$ for the case of credit rationing and eq.(20) as well as $g_T = R^m$ determine values of $\{g_{T*}^n, R_{T*}^{mn}\}$ for the case of non-rationing. Recall that credit rationing (non-rationing) arises when $R^m < (>) R_{c,T}^m$. Thus, the equilibrium rate of return from money under credit rationing (non-rationing) must be less (greater) than $R_{c,T}^m$.

It is clear that $g_T^{r,k}$ is a concave function of R^m while $g_T^{n,k}$ is decreasing in R^m. We depict the loci defined by $g_T^{r,k}$, $g_T^{n,k}$ and $g_T = R^m$ (a 45-degree line) in Figure 5. Moreover, an increase in θ rotates the loci of $g_T^{r,k}$ and $g_T^{n,k}$ clockwise without affecting the 45 degree line (i.e., $g_T = R^m$). This latter result also implies that, similar to money financing, the ratio of government spending determines whether credit rationing or non-rationing arises. To see this, we first depict $g_T^{n,k}$ in Figure 5. As can be seen, $g_T^{n,k}$ intersects

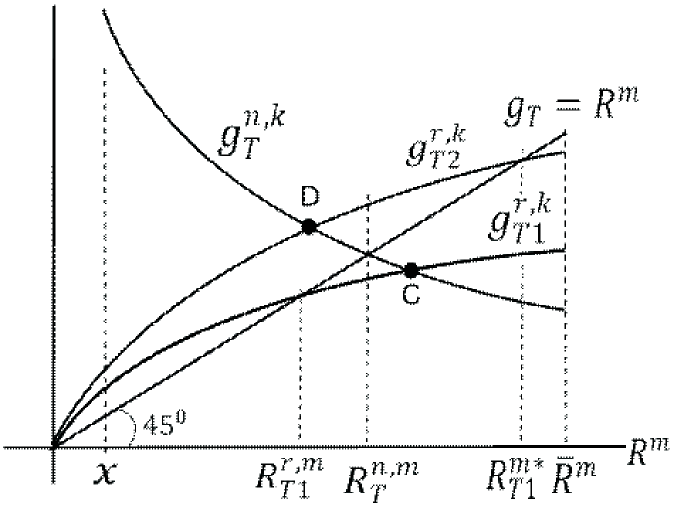

Figure 5: Equilibrium Credit Rationing and Non-rationing Under Tax Financing

the 45 degree line at $R^m = R_T^{n,m}$. Then, there are two possibilities on the relative positions of $g_T^{r,k}$ for a given θ. The first possibility of $g_T^{r,k}$ is depicted as $g_{T1}^{r,k}$ in Figure 5. In this case, $g_{T1}^{r,k}$ intersects the 45 degree line at $R^m = R_{T1}^{r,m}$, which is less than $R_T^{n,m}$. Since $R_{T1}^{r,m}$ is less than the critical value of R^m (located at point C in Figure 5), credit rationing is the equilibrium consequence. On the other hand, $R_T^{n,m}$ is less than the critical value of R^m (point C in Figure 5), implying that $b_t^r < b_t^n$ at this critical value of R^m and hence non-rationing is not the equilibrium. The second possibility $g_T^{r,k}$ is depicted as $g_{T2}^{r,k}$ in Figure 5, which intersects the 45 degree line at $R^m = R_{T2}^{r,m}$. As shown, $R_{T2}^{r,m}$ is greater than the critical value of R^m (located at point D in Figure 5), implying that credit rationing is not the equilibrium. By contrast, credit non-rationing is the equilibrium outcome because $R_T^{n,m}$ is greater than the critical value of R^m.

From the above analysis, we can see that whether credit is rationing or non-rationing for a given θ depends on $R_T^{n,m} > R_T^{r,m}$ (the first possibility) or $R_T^{n,m} < R_T^{r,m}$ (the second possibility). Note that $R_T^{r,m} = [x^{-\beta}(1-\theta)^{\beta}v]^{1/(1-\beta)}$ and $R_T^{n,m} = (1-\theta)^{\beta}u^{1-\beta}$. As a result, credit is rationing (non-rationing) if $\theta > (<)\theta_T^* \equiv 1 - u^{((1-\beta)/(\beta))^2}x^{1/\beta}v^{-1/\beta^2}$. We can also find a $\bar{\theta}_T$ such that if $\theta = \bar{\theta}_T = 1 - (xv^{-1})^{1/\beta}$, $g_{T1}^{r,k}$ intersects the 45 degree line at $R^m = x$.

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投稿日期: 2013年11月29日, 接受日期: 2014年5月21日

訊息不對稱與不同政府融通工具的比較

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本文建立一個資本市場存在訊息不對稱的模型,比較政府課所得稅及課鑄幣稅融通其支出的優缺點。我們首先建立, 在資本市場存在訊息不對稱之下, 政府支出的比例決定了貸款人是否受到借貸限制 (credit rationing), 而借貸限制是否存在則進一步決定所得稅與鑄幣稅融通的相對優點。當借貸限制不存在時, 鑄幣稅融通所得到的經濟成長率及通貨膨脹率皆高於所得稅融通。當借貸限制存在時, 鑄幣稅融通有較高的通貨膨脹率及較低的經濟成長率。從社會福利的角度來看, 當借貸限制不存在時, 鑄幣稅融通優於所得稅融通; 反之, 則所得稅融通優於鑄幣稅融通。本文的結論調和了許多理論文獻, 也與近期的一些實證文獻一致。

關鍵詞: 訊息不對稱, 信用限制, 貨幣與所得稅融通, 內生成長
JEL 分類代號: E44, G14, O11