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Inflation, financial development, and economic growth

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Abstract

A simple endogenous growth model is developed to illustrate the important role played by inflation in determining the effects of financial development on economic growth. In the model, money is needed for loan transactions and the operations of financial markets are subject to informational imperfections. Results demonstrate that if a government's spending share is relatively large, then multiple equilibria arise under which financial development, measured by a decrease in the monitoring cost, is shown to *raise* inflation and *reduce* economic growth for countries with relatively high initial inflation rates. Only when initial inflation rates are relatively low will financial development *reduce* inflation and *promote* growth. Effects of an expansion policy in which the government raises its spending share on equilibrium inflation and economic growth are also examined.

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1. Introduction

Stimulated by the development of the endogenous growth model, the last decade has witnessed a resurgence of interest in the relationship between financial development and economic growth. For example, recent studies (as in Bose & Cothren, 1996, 1997; Saint-Paul,

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1992) have developed theoretical models of endogenous growth to demonstrate how the development of financial markets eases informational frictions in financial markets, enhances the economy's efficiency of resource allocations, and thereby fosters economic growth.[1] On the empirical side, a significantly positive correlation between indicators of financial development and economic growth has been reported by King and Levine (1993a, 1993b) and Levine and Zervos (1998).

While recent theoretical and empirical literature has concluded that financial development promotes economic growth, some empirical studies, such as De Gregorior and Guidotti (1995), have found that financial development significantly *reduces* economic growth for countries in Latin America during the 1970s and the 1980s, the time period when countries there experienced relatively high inflation rates. This has led to the World Banks' Operating Directive on the financial sector to recommend developing countries not to pursue financial reforms unless their inflation rates are sufficiently low.[2] Apparently, a possibility that high inflation could adversely affect the operations of financial markets and thus change the relationship between financial development and economic growth arises. Indeed, the empirical study by Boyd, Levine, and Smith (2001) has documented that inflation is negatively correlated with the performance of financial markets. This possibility has been ignored by most theoretical literature. The purpose of this paper is to construct a model that may be able to highlight the important roles played by inflation in determining the effects of financial development on economic growth.

To this end, a simple endogenous growth of a three-period-lived overlapping generations (OG) model with informational imperfections existing in financial markets is developed. More specifically, a framework in which both adverse selection and costly state verification problems arise due to informational problems is considered. The presence of the adverse selection problem gives rise to credit rationing and the costly state verification problem requires the lender, with a loss in real resources, to verify the borrower when a failure of project is claimed. I then follow Di Giorgio (1999) by interpreting a decrease in the verification cost as financial development. Indeed, as pointed out by Pagano (1993), financial institutions absorb resources in the process of transferring funds from savers to borrowers and the development of financial markets is able to enhance the efficiency of financial institutions and reduce this linkage of resources. Furthermore, the government in this model relies on printing money to finance its deficits. To allow money valued in this model, this paper constructs a framework which results in a cash-in-advance (CIA) constraint in any trade between lenders and borrowers. Due to this constraint, loan transactions have to be finalized one period in advance.

In this framework, both inflation and financial development influence the amount of credit rationing in financial markets.[3] As an economy's capital investment is financed through

[1] For a survey, see Beci and Wang (1997).

[2] See Boyd, Levine, and Smith (1996) for this point.

[3] Recent theoretical studies have modeled that inflation is the only force affecting the operations of financial markets as well as the amount of credit rationing. See the discussion below.

financial markets, the amount of credit rationing in turn determines economic growth. Results in this framework further demonstrate that an increase in the inflation rate is detrimental to the operations of financial markets and thus results in a lower economic growth, a result consistent with the empirical work of Boyd et al. (2001). Moreover, if the share of the government deficits is relatively large, then multiple equilibria arise, of which one is characterized with high inflation and the other with low inflation. In this case, the effects of financial development on economic growth depend crucially on the initial status of equilibrium. Specifically, it is shown that financial development *reduces* the equilibrium inflation rate and *promotes* economic growth for countries with relatively low initial inflation rates. For countries with relatively high initial inflation rates, financial development will *increase* the equilibrium inflation rate and *reduce* economic growth.

The result derived above, on the one hand, accounts for the empirical findings of De Gregorior and Guidotti (1995) and bolsters the suggestion made by the World Banks' Operating Directive on the financial sector. On the other hand, it also provides a possible explanation to the empirical work of Bruno and Easterly (1998) and Bullard and Keating (1995), who show that initial inflation rates play an important role in determining the long-run relationship between inflation and economic growth. In particular, both papers have found a significantly negative correlation between inflation and economic growth for countries with high initial inflation rates. The theoretical model developed in this paper indeed displays a negative correlation between inflation and economic growth for countries with high initial inflation rates and points out that the possible underlying force is financial development.

In addition, the effects of the government expansion policy also depend crucially on the initial equilibrium inflation. Specifically, an expansion policy in which the government increases its share of spending will raise the inflation rate and reduce economic growth for those countries whose initial inflation rates are low. For countries with relatively high initial inflation rates, such a policy reduces inflation and promotes economic growth. Some policy implications based on results of this framework are also discussed.

A number of related papers are as follows. Azariadis and Smith (1996) developed a model with a different structure of financial market frictions under which inflation is the only force to influence the operations of financial markets. They then showed that inflation exacerbates financial market frictions and this in turn significantly reduces economic growth for countries with relatively high initial inflation rates. Similarly, Huybens and Smith (1999) provided a model that mainly focuses on the role played by the inflation rate in affecting the operations and evolution of financial markets. The possibility that the initial inflation rates may play a key role in determining the effects of financial development on the equilibrium inflation and economic growth rates is ignored in both papers.

This paper is organized as follows. Section 2 describes the environment of the model and Section 3 derives the optimal loan contracts in the presence of adverse selection and costly state verification problems. Section 4 characterizes equilibrium consequences. In Section 5, I perform comparative-static analysis and examine the effects of financial development and the government policy on equilibrium inflation and economic growth. A few concluding remarks follow.

2. Model

Consider a model economy populated with an infinite sequence of three-period-lived OG.[4] Each generation has an identical size and composition, and contains two kinds of agents: lenders and borrowers. For simplicity, each population of lenders and borrowers is normalized to one. Agents of each generation have perfect foresight. Time is discrete and indexed by $t=0, 1, 2\ldots$. In addition, there is a government that relies on printing money to finance its deficits.

2.1. Behaviors of agents

Each young lender is endowed with n units of labor, which is supplied inelastically to earn the real wage rate. A lender cares only about old-age consumption. Moreover, each lender is also endowed with a constant returns-to-scale technology that can convert one unit of time t output into s, $s>0$, units of time $t+2$ output (a storage). Thus, to consume in the old age, a young lender can simply utilize this technology to store his young wage income and consume when old. Alternatively, each young lender can loan to borrowers.

Borrowers also care only about old-age consumption. Each borrower, in his second period of life, is endowed with a risky project, which is able to convert output into capital between periods. Borrowers are not endowed with any other resource at any date; thus, to produce capital, a borrower has to seek external funding from financial markets. As is well recognized, financial markets are characterized with a wide variety of informational imperfections and such imperfections may give rise to adverse selection and costly state verification problems.

To introduce informational imperfections, we have the following assumptions. First, there are two types of borrowers and only the borrower knows his type. With probability p_i, $i=\mathrm{h}, \mathrm{l}$, the capital-producing project operated by a type i middle-age borrower at time $t+1$ can convert x units of time $t+1$ output into Qx units of time $t+2$ capital. With probability $1-p_i$, the capital production fails and nothing is produced. In this case, the borrower will claim bankruptcy. By assumption, $1>p_\mathrm{l}>p_\mathrm{h}>0$. As in Bencivenga and Smith (1993), this assumption raises an issue of distinguishing type l borrowers from type h (known as adverse selection problem).

The second assumption is that the outcome of the capital project is costlessly observable only to the borrower who operates it. Nonetheless, any other agent can observe the true outcome by expending some real resource in verifying. As is well known, without verification, this assumption creates incentives for a borrower to always claim bankruptcy independent of the true outcome. Thus, to be incentive compatible, a loan contract requires the lender to verify whenever a failure of project is claimed. Verification is costly as it incurs δ units of *consumption goods* per unit of loans made.

The capital produced by a borrower's risky investment between time $t+1$ and $t+2$ is available for producing output in time $t+2$. I assume that each old borrower operates a firm. An old borrower is able to produce output by renting capital (in positive or negative amount)

[4] With some variations, this model is similar to that of Bencivenga and Smith (1993) and Bose and Cothren (1997).

and hiring labor (including all young lenders) at competitively determined rental rates. The production function of output at time $t+2$ is given as (Eq. (1)):

$$y_{t+2} = \Phi^{\eta}_{t+2} k^{\sigma}_{t+2} N^{1-\sigma}_{t+2} \tag{1}$$

where k_{t+2} and N_{t+2} are the amount of capital and labor employed by each firm, and Φ_{t+2} is the average per firm capital stock. Capital depreciates fully after production. In equilibrium, each firm will employ the same amount of capital; thus, $\Phi_{t+2} = k_{t+2}$. Furthermore, for simplicity, $\eta = 1 - \sigma$.[5] Labor and capital markets are competitive so that the rental rates of labor (w_{t+2}) and capital (ρ_{t+2}) at time $t+2$ are given as (Eqs. (2) and (3)):

$$w_{t+2} = (1-\sigma) k^{\eta+\sigma}_{t+2} N^{-\sigma}_{t+2} \tag{2}$$

and

$$\rho_{t+2} = \sigma k^{\eta+\sigma-1}_{t+2} N^{1-\sigma}_{t+2} = \sigma N^{1-\sigma}_{t+2}, \tag{3}$$

where $N_{t+2} = n$.[6]

2.2. Money

As stated beforehand, the lender has to make the portfolio decision when young, whereas the entrepreneur can only implement his capital project during the middle-age period. We also assume that intergenerational loan transactions are too costly to proceed.[7] Recall that it takes two periods for a lender's storing technology to function. Therefore, if a young lender intends to finance the borrower, then he has to hold money and utilize this money to proceed loan transactions in the next period.

The structure of this model results in a CIA constraint in loan transactions. As the borrower is the only agent who owns an investment project for converting output into capital, this resulting CIA constraint captures the spirit of Stockman (1981), who developed a model under which individuals are subject to a CIA constraint for the purchase of capital. Under this constraint, Stockman shows that inflation reduces equilibrium holdings of real balance and thus capital stock. In this model, inflation plays a similar role as in Stockman's model. Typically, an increase in the inflation rate will raise the opportunity cost in lending to the borrower[8] and, as will be seen, exacerbate informational problems in financial markets. It is worth noting that Azariadis and Smith (1996) developed a different structure of informational problems, but with a similar result.[9]

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[5] This assumption implies that the output production technology is a linear one as in the "AK" model.

[6] Each old borrower operates a firm; thus, the total number of firms is one. Moreover, the total labor to firm is equal to n as each young lender will provide his n units of labor endowment to work.

[7] Indeed, in traditional OG models, money serves for *intergenerational* transactions while loans are for *intragenerational* transactions.

[8] This is true given a constant rate of return from a lender's storage.

[9] See below for a further discussion on this point.

2.3. Government

Similar to Bhattacharya, Guzman, Huybens, and Smith (1997), the government at time t has a per lender expenditure proportional to the current wage rate.[10] Specifically, the government at t faces θw_t units of deficits per lender, where θ is a constant and w_t is the real wage rate at time t. The government finances its expenditure by printing money. Denoting the time t supply of money (per lender) by M_t, the government budget constraint at t is given as:

$$\theta w_t = \frac{M_t - M_{t-1}}{P_t}, \tag{4}$$

where P_t is the price level at time t. Letting m_t be the real balance of money held by a young lender at time t, Eq. (4) can be rewritten as:

$$\theta w_t = m_t - m_{t-1} R^m_{t-1}, \tag{5}$$

where R^m_{t-1} is the gross rate of real return from holding money (the inverse of the gross inflation rate) between time $t-1$ and t (that is, $P_{t-1}/P_t = R^m_{t-1}$).

To complete the description of the model, the government issues M_0 units of money during the initial period. Moreover, each initial old borrower who operates a firm is endowed with k_0 units of capital.

3. Equilibrium contracts in financial markets

The operations of financial markets in this framework are similar to that described by Bencivenga and Smith (1993). Note that due to the resulting CIA constraint, loans between lenders and borrowers have to be finalized one period in advance. Specifically, after a young lender of generation t is paid with nw_t units of output (wage income), he then decides how much to store and how much to finance the borrower (by way of holding money). To finance the borrower, the young lender announces loan contracts intended to each type of borrower and if a lender's offer is not dominated by others, he is approached with a potential borrower. Following Bencivenga and Smith, that competition among lenders ensures that all gains from trade accrue to borrowers. The equilibrium contract at time t in financial markets is then defined such that there is no incentive for any lender to offer an alternative contract, taking w_{t+1} (the wage rate in time $t+1$), ρ_{t+2}, and other lenders' offers as given.

If both the young lender and borrower reach a mutual agreement in the terms of the contract, then the young lender will sell his wage income for money and hand over this money to the middle-age borrower. The middle-age borrower can utilize this money to purchase current-period output to initiate his project. We assume that the rate of return from

[10] Due to the resulting CIA constraint, only the lender needs to hold money. Therefore, for simplicity, I assume that a government's budget constraint is proportional to each lender. It should be noted that, however, the following results do not hinge on this assumption.

money is less than that from the lender's storage; that is, $R^{m2} \leq s$.[11] Given this assumption, the young lender will only acquire the amount of money exactly needed by the borrower.

Note that lending to borrowers is subject to adverse selection and costly state verification problems. To solve the first problem, each lender designs contracts to induce a self-selection and separates borrowers as to types. For the costly state verification problem, the optimal contracts mandate that the lender will verify if the borrower claims bankruptcy. As a consequence, the equilibrium contract to borrowers has a feature such that a self-selection mechanism is created to separate borrowers as to types ex ante and nonstochastic monitoring is specified in the case of bankruptcy ex post. We now turn to determine the terms of the equilibrium contract in financial markets.

3.1. Equilibrium loan contracts

Before proceeding, note first that the borrowers' capital technology is a linear one. Therefore, a maximal scale is needed to bound the size of the loan. As argued by Bencivenga and Smith (1993), this maximal scale has to tie the current capital stock. Following this argument, we assume that this maximal scale is equal to the wage rate at the same period; that is, this maximal scale at time $t+1$ is equal to w_{t+1}.[12] Furthermore, as in Bencivenga and Smith, to induce a self-selection we need a situation wherein different types of borrowers have different opportunity costs being rejected with loans. To this end, I follow Bose and Cothren (1997) by assuming that the project of a type i borrower can be utilized for home production without input. Nonetheless, the project of type h entrepreneurs has no such access. A project, if implemented for capital production in $t+1$, cannot be utilized for home production in $t+2$. Given this, a type l borrower will have no incentives to be considered as type h. To allow for a balanced growth, I further assume that the amount of home production produced at time $t+2$ is proportional to the wage income at $t+1$; that is, there is vw_{t+1} with v being sufficiently small to ensure that borrowing is desirable.

As in Bencivenga and Smith (1993), the contract offered by a lender to a type i borrower at time t comprises a 3-tuple $\{\pi_t^i, q_t^i, R_t^i\}$, where $\pi_t^i \in [0,1]$ is the probability with which a lender offers the loan, q_t^i is the quantity of the loan offered, and R_t^i is the loan rate the borrower has to pay when his project is successful. Given this, a type l borrower's expected payoff is:

$$p_{\mathrm{l}}\pi_t^{\mathrm{l}} q_t^i (Q\rho_{t+2} - R_t^{\mathrm{l}}) + (1 - \pi_t^{\mathrm{l}}) v w_{t+1} \tag{6}$$

likewise,

$$p_{\mathrm{h}}\pi_t^{\mathrm{h}} q_t^i (Q\rho_{t+2} - R_t^{\mathrm{h}}) \tag{7}$$

for a type h borrower.

[11] If the lender simply holds money for two periods, then the rate of return is R^{m2}. However, the rate of return from the lender's storage (two periods) is s. It should be clear that the upper bound of R^m is thus equal to $s^{1/2}$.

[12] Alternatively, we could assume a capital production technology with decreasing returns to scale and allow the borrower to choose the size of loans. Nonetheless, as in Bencivenga and Smith, this paper focuses on the adverse selection problem in which the amount of credit rationing is defined by the number of loans made to the borrowers, not the size. Therefore, this assumption is maintained.

To prevent a type h borrower from pretending to be type l or vice versa, the contract terms have to satisfy self-selection constraints given as

$$p_{\mathrm{h}}\pi_t^{\mathrm{h}}q_t^{\mathrm{h}}(Q\rho_{t+2} - R_t^{\mathrm{h}}) \geq p_{\mathrm{h}}\pi_t^{\mathrm{l}}q_t^{\mathrm{l}}(Q\rho_{t+2} - R_t^{\mathrm{l}}) \tag{8}$$

and

$$p_{\mathrm{l}}\pi_t^{\mathrm{l}}q_t^{\mathrm{l}}(Q\rho_{t+2} - R_t^{\mathrm{l}}) + (1 - \pi_t^{\mathrm{l}})vw_{t+1} \geq p_{\mathrm{l}}\pi_t^{\mathrm{h}}q_t^{\mathrm{h}}(Q\rho_{t-2} - R_t^{\mathrm{h}}) + (1 - \pi_t^{\mathrm{h}})vw_{t+1} \tag{9}$$

for all t.

The terms of the optimal contract are determined by the following. First, given the project's linear technology, a borrower will want to implement his project at the maximal scale, w_{t+1}. I also follow Bencivenga and Smith (1993) by assuming that a borrower can only contract with a lender. Given these assumptions, if a young lender at time t intends to finance a middle-age borrower at the scale of w_{t+1} in the next period, then the actual amount of resources (in real term) needed at time t is $P_{t+1}w_{t+1}/P_t$, where P_t is the price level in time t. In other words, the lender needs to sell the real amount of $P_{t+1}w_{t+1}/P_t$ for money. Given the price level P_t, the lender can obtain the amount of money equal to $P_{t+1}w_{t+1}$. In the next period, the lender hands this over to the borrower for purchasing the amount of time $t+1$ output equal to w_{t+1} and the borrower can utilize this amount of time $t+1$ output to initiate his project.

It is assumed that n is sufficiently large. This assumption ensures that loans are potentially satisfied and lenders are willing to loan to borrowers.[13,14] Note that labor markets are competitive; therefore, the young lender and borrower at time t will take the wage rate of w_t and w_{t+1} as given.

Second, competition will force lenders to earn zero profit. This implies that the rate of return from lending to borrowers has to equate the rate of return from the lender's storage. Recall that R_t^i is the interest rate charged to a type i borrower by the lender. If self-selection constraints are satisfied, zero-profit constraint is expressed as:[15]

$$w_{t+1}[p_iR_t^i - (1 - p_i)\delta] = \frac{P_{t+1}}{P_t}w_{t+1}s, \qquad t \geq 0. \tag{10}$$

[13] If a lender loans to a borrower whose project finally fails, then the lender has to monitor the borrower, which costs the lender δ units of consumption goods per unit lent. To be able for the lender to pay this monitoring cost, it must be the case that $w_{t+1}\delta \leq (n_{wt} - (p_{t+1}/p_t)w_{t+1})s$. [The left-hand side of this inequality is the monitoring cost while the right-hand side is the amount of consumption goods converted by the lender's storage.] This can be further rewritten as $n \geq g(\delta + (s/R^m))/s$. If this inequality is not satisfied, the lender is not able to monitor the borrower, which raises the issue of credibility of ex post monitoring. For simplicity, it is assumed that n is sufficiently large so that this inequality is always satisfied for $R^m \in [\underline{R}^m, \overline{R}^m]$, where $\underline{R}^m$ and $\overline{R}^m$ are the lower and upper bounds of R^m (see below). It should be noted, however, that the possibility of multiple equilibria obtained below does not hinge on this inequality.

[14] I am indebted to an anonymous referee for pointing this out.

[15] Recall that it needs $P_{t+1}w_{t+1}/P_t$ units of real resources at time t to finance the borrower with w_{t+1} units of time $t+1$ output.

Note that the left-hand side of Eq. (10) is the return from lending to a borrower and the right-hand side is the return from storage. From Eq. (10), the loan rate charged to a type i borrower is given as:

$$R_t^i = \frac{\phi_t + (1-p_i)\delta}{p_i}, \qquad i = \mathrm{h}, \mathrm{l}, \tag{11}$$

where $\phi_t = s/R_t^m$ and $R_t^m = P_t/P_{t+1}$.

Third, to ensure that borrowing is desirable, we assume that $Q\rho_{t+2} > R_t^{\mathrm{h}}$.[16] Furthermore, v is assumed to be sufficiently small (smaller than $Q\rho_{t+2} - R_t^{\mathrm{l}}$) so that the expected returns for type h and type l borrowers are increasing respectively with π_t^{h} and π_t^{l} (see Eqs. (6) and (7)). Note that competition also implies that a lender offers the contract under which the expected return of the borrower is maximized. To this end, the lender will maximize the type h borrower's expected payoff (given in Eq. (7)) by setting $\pi_t^{\mathrm{h}} = 1$. Nevertheless, since type h borrowers have incentives to pretend to be type l borrowers, the value of π_t^{l} has to be set in a manner such that type h borrowers are indifferent between type h and type l contracts, which implies that Eq. (8) should hold with equality; thus

$$\pi_t^{\mathrm{l}} = \frac{(Q\rho_{t+2} - R_t^{\mathrm{h}})}{(Q\rho_{t+2} - R_t^{\mathrm{l}})} = \frac{p_{\mathrm{l}}(p_h Q\rho_{t+2} - \phi_t - (1-p_{\mathrm{h}})\delta)}{p_{\mathrm{h}}(p_{\mathrm{l}} Q\rho_{t+2} - \phi_t - (1-p_{\mathrm{l}})\delta)}. \tag{12}$$

Notice that since $R_t^{\mathrm{l}} > R_t^{\mathrm{h}}$, $\pi_t^{\mathrm{l}} < 1$. Note also that π_t^{l} should be nonnegative; thus, $p_{\mathrm{h}} Q\rho_{t+2} - (1-p_{\mathrm{h}})\delta \geq \phi_t$. This implies that there is a lower bound of R_t^m (denoted as $\underline{R}^m$) given as $s/[p_{\mathrm{h}} Q\rho_{t+2} - (1-p_{\mathrm{h}})\delta]$. Using Eq. (12), one can easily verify that the self-selection constraint of Eq. (9) is also satisfied.

Note that, as in Di Giorgio (1999), the verification cost per unit of input δ can be viewed as the level of financial development. As stated by Pagano (1993), financial institutions absorb resources in the process of transferring funds from savers to borrowers so that there is a spread between lending and borrowing rates. Pagano then asserted that financial development may be able to reduce this linkage of resources so as to reduce this spread. From Eq. (11), a decrease in δ captures this result.[17] Moreover, recent literature has claimed that financial development will reduce the amount of credit rationing.[18] Eq. (12) conveys this fact since a decrease in δ will increase π_t^{l} so that borrowers have a greater chance in obtaining loans. As a consequence, a decrease in δ will be interpreted as financial development in the ensuing analysis.

Note that, from Eq. (11), $\partial R_t^i/\partial\phi_t$ is larger for type h. This implies that an increase in R_t^m will raise the loan rate on the type h contract relative to the type l, which enables the lender to

[16] Borrowing is desirable if the expected payoff is nonnegative. This requires that $Q\rho_{t+2} > \mathrm{R}_t^{\mathrm{h}}$. Note that, from Eq. (11), $R_t^{\mathrm{l}} > R_t^{\mathrm{h}}$. Thus, if $Q\rho_{t+2} > R_t^{\mathrm{h}}$, $Q\rho_{t+2}$ is automatically greater than R_t^{l}.

[17] In a sense, the lending rate is s/R_t^m, while the borrowing rate is R_t^i for a type i borrower.

[18] For example, Bencivenga and Smith (1993) state that the amount of credit rationing is more severe in developing countries, whose financial sectors are usually less developed.

offer type 1 borrowers with a larger probability. Therefore, $\partial\pi_t^l/\partial R_t^m>0$, implying that an increase in the inflation rate (a decrease in R_t^m) will exacerbate the adverse selection problem and reduce the probability of getting loans for type 1 borrowers. Moreover, it is easy to verify that $\partial^2\pi_t^1/\partial R_t^{m2}<0$,[19] implying that the effects of inflation on the incidence of credit rationing are nonlinear.

The two theoretical conjectures above are consistent with the empirical work of Boyd et al. (2001). In a cross-country investigation, Boyd et al. found that there exists a negative relationship between inflation and the performance of financial markets and this relationship is nonlinear.[20] Since the performance of financial markets in this paper can be viewed as the magnitude of credit rationing on type 1 borrowers,[21] the theoretical results derived in this paper well capture the empirical findings.

It is worth noting that Azariadis and Smith (1996) developed a different structure of the adverse selection problem under which inflation is the only source to exacerbate the adverse selection problem. In the present model, in addition to inflation, the costly state verification problem could also exacerbate adverse selection problems since one can verify that $\partial\pi^1/\partial\delta<0$. Therefore, this model adds another dimension which enables us to investigate an important issue ignored by most theoretical literature.

3.2. Discussion

The existence of money in this model facilitates the loan transactions between lenders and borrowers. While the transaction role of money was well illustrated by Lucas (1980) and Lucas and Stokey (1987), the alternative role of money is its asset value. For example, in a pioneering model studying the relationship between inflation and economic growth, Tobin (1965) modeled money as one of the portfolio choices. Tobin's model then shows that an increase in the inflation rate will induce agents to hold more capital, as the rate of returns from money decreases.

If we model money as a portfolio choice in this framework, then we obtain results inconsistent with empirical findings of Boyd et al. (2001). To see this, assume now that money and capital loans are alternative assets to lenders (as in the Tobin model) while competition among lenders ensures that the rate of returns from capital loans is equal to the rate of return from money.[22] It is then clear that an increase in the inflation rate will lower the opportunity cost of lending to capital borrowers. This will alleviate adverse

[19] See Appendix A for the proof.

[20] That is, as inflation increases, the marginal impact of inflation on the performance of financial markets decreases.

[21] In their study, Boyd et al. find that inflation has a negative impact on bank lending activities. In this paper, an increase in the inflation rate raises the incidence of credit rationing and hence reduces the lending volume, which is consistent with the findings of Boyd et al.

[22] In this case, the model can be reduced to a two-period OG model. See Hung (2001) for a two-period-lived OG model. Note that if the rate of returns from a lender's storage is less than the rate of returns from money, the lender will not utilize his storage technology.

selection problems and reduce the incidence of credit rationing.[23] Obviously, this result is inconsistent to the recent empirical findings.

To be consistent with the empirical findings of Boyd et al. (2001), we highlight the transaction roles of money in this framework, instead of its asset value. It should be noted, however, that the transaction role of money is not the only way to yield results consistent with empirical findings in the presence of asymmetric information. For example, in a different setting to this paper, Azariadis and Smith (1996) model money as a portfolio selection and examine the relationship between inflation and capital accumulation. In their model, the operations of financial markets are subject to adverse selection problems and an increase in the inflation rate decreases the opportunity cost of lending to capital borrowers. Nevertheless, in such a framework, an increase in the inflation rate induces more lenders to pretend to be borrowers and hence exacerbates adverse selection problems. It turns out that this will raise the incidence of credit rationing and impede the accumulation of capital. Since it is more straightforward to consider both adverse selection and costly state verification problems in the present framework than in the model of Azariadis and Smith, we intend to highlight the transaction role of money and examine how inflation influences the operations of financial markets in the presence of asymmetric information.

4. Equilibrium analysis

To perform the equilibrium analysis, we first define a balanced-growth equilibrium as follows.

> *Definition:* Given M_0, θ, and k_0, a balanced-growth equilibrium contains a nonnegative sequence $\{M_t, P_t, \rho_t, w_t, R_t^m, R_t^i, \text{ and } \pi_t^i\}$, $t \geq 1$, such that:
>
> (a) Financial markets are in equilibrium so that Eqs. (8), (9), (11), and (12) are satisfied.
> (b) The money market is clear.
> (c) Capital market clears so that each firm utilizes the same amount of capital to produce output.

Moreover, along with a balanced-growth path, y_t, k_t, w_t, M_t, and P_t all grow at constant rates, whereas ρ_t, R_t^m, R_t^i, and π_t^m remain unchanged.

4.1. Equilibrium under the balanced-growth path

We now examine the properties of equilibrium under a balanced-growth path. Recall that every borrower operates a firm in his last period of life so that the number of firms in each

[23] If the lender does not utilize his storage, the loan rate to a type i borrower becomes $[R_t^m+(1-p_i)\delta]/p_i$. This implies that $\pi^1=(p_1(p_h Q\rho_{t+1}-R_t^m-(1-p_h)\delta)/(p_h(p_1 Q\rho_{t+1}-R_t^m-(1-p_1)\delta)$. Obviously, $\partial\pi^1/\partial R_t^m<0$ in this case, implying that an increase in the inflation rate (a decrease in R_t^m) will reduce the incidence of credit rationing (that is, increase the value of π^1).

period is one. As stated, each firm will employ the same amount of capital so that the per firm capital stock at time $t+2$ is given as:[24]

$$k_{t+2} = w_{t+1}[\lambda p_{\mathrm{h}} + (1-\lambda)p_{\mathrm{l}}\pi^{\mathrm{l}}]Q. \tag{13}$$

Using Eq. (2), the equilibrium growth rate between time $t+1$ and $t+2$ is given as

$$g = \frac{k_{t+2}}{k_{t+1}} = (1-\sigma)[\lambda p_{\mathrm{h}} + (1-\lambda)p_{\mathrm{l}}\pi^{\mathrm{l}}]Q \tag{14}$$

The condition under which the money market clears at t is given as

$$m_t = \frac{M_t}{P_t} = w_{t+1}[\lambda + (1-\lambda)\pi^{\mathrm{l}}]. \tag{15}$$

From Eq. (15), m_t grows at the same rate as the wage under a balanced-growth path so that $m_t = gm_{t-1}$. Given this, the government budget constraint in Eq. (5) can be rewritten as:

$$\theta w_t = m_{t-1}(g - R^m). \tag{16}$$

Using Eq. (15), $m_{t-1} = w_t[\lambda + (1-\lambda)\pi^{\mathrm{l}}]$. Therefore, Eq. (16) becomes

$$\theta = (g - R^m)[\lambda + (1-\lambda)\pi^{\mathrm{l}}] \tag{17}$$

For future reference, note that, for a given wage rate, $(g - R^m)$ and $[\lambda + (1-\lambda)\pi^{\mathrm{l}}]$ can be viewed as the inflation tax rate and the inflation tax base, respectively. It is obvious that Eqs. (14) and (17) jointly determine the equilibrium levels of R^m and g under a balanced-growth path. For illustrative purpose, we rewrite Eq. (17) as:

$$g = \frac{\theta}{\lambda + (1-\lambda)\pi^{\mathrm{l}}} + R^m \tag{18}$$

It now becomes clear that Eqs. (12), (13), and (18) characterize the aggregate equilibrium of the economy under a balanced-growth path. To solve for the aggregate equilibrium, first substitute Eq. (12) into Eq. (14), which results in an equation indicating the relation between the economic growth rate and R^m under which financial and capital markets clear. This equation, together with Eq. (18) (obtained from the government budget constraint), enables us to derive two unknown variables: g and R^m. For the latter purpose, we first observe the properties of Eqs. (14) and (18) as follows (see Appendix A for the complete derivation).

Lemma 1: *(1)* $(\partial g/\partial R^m)|_{(14)} > 0$; *(2)* $(\partial^2 g/\partial R^{m2})|_{(14)} < 0$; *(3)* $(\partial g/\partial R^m)|_{(18)} > 0$, *if* θ *is not too large; (4)* $(\partial^2 g/\partial R^{m2})|_{(18)} > 0$.

Note that (14) is derived directly from Eq. (13), the condition for capital market equilibrium. By utilizing Eq. (12), the locus defined by (14) is the equilibrium condition

[24] We suppress time subscripts of the parameters that remain unchanged under a balanced-growth path.

for financial and capital markets. Since $\partial\pi_t^1/\partial R_t^m>0$, an increase in R^m (a decrease in the inflation rate) will increase the holdings of the real balance; nonetheless, due to self-selection constraints in Eq. (8), this rate of increase is decreasing so that the locus defined by (14) is a strictly concave function of R^m. On the other hand, the locus defined by (17) refers to the combination of the inflation tax rate and inflation tax base that covers exogenously given government spending. Alternatively, to finance a constant ratio of government spending, the inflation tax rate, $g-R^m$, has to equate the ratio of government spending share to the inflation tax base, as implied by (18).[25]

According to Eq. (18), to finance a given spending share, an increase in R^m has two opposite effects on economic growth. First, an increase in R^m will raise the economic growth rate, which can be referred to as the Stockman effect. Second, an increase in R^m will ease the informational imperfections and raise the inflation tax base, $[\lambda+(1-\lambda)\pi^1]$. An increase in the inflation tax base in turn will lower the ratio of government spending share to the inflation tax base, which will lower the economic growth rate. Moreover, it is clear that the magnitude of the second effect depends positively on the government spending share. Lemma 1 states that if government spending is not too large (that is, θ is less than a certain level, which we define as θ^*),[26] then the first effect always dominates the second and the growth rate in (18) is an increasing function of R^m. We hereafter consider only the case where $\theta<\theta^*$ always hold. Since the loci defined by (14) and (18) jointly determine the equilibrium sequence of g and R^m, we conclude that the self-selection constraints, which are derived from adverse selection and influenced by inflation as well as costly state verification, play a key role in determining the properties of (14) and (18) and thus equilibrium consequences.

According to Lemma 1, the loci defined by (14) and (18) have configurations depicted in Fig. 1. From the figure, one can infer that multiple equilibria could arise if the growth rate derived from (18) in the upper and lower bounds of R^m, respectively is greater than that derived from (14). Recall that the upper bound of R^m is $s^{1/2}$ and the lower bound, $\underline{R}^m$, is given as $s/[p_hQ\rho_{t+1}-(1-p_h)\delta]$. When R^m, $R^m=\overline{R}^m=s^{1/2}$, π^1 is given as (Eq. (19)):

$$\pi^1=\overline{\pi}^1=\frac{p_l(p_hQ\rho_{t+1}-s^{1/2}-(1-p_h)\delta)}{p_h(p_lQ\rho_{t+1})-s^{1/2}-(1-p_l)\delta)}. \tag{19}$$

We assume that $p_hQ\rho_{t+1}-(1-p_h)\delta>s^{1/2}$. When $R^m=\underline{R}^m$, $\pi^1=0$. Note that $\partial g/\partial\theta|_{(18)}>\partial g/\partial\theta|_{(14)}=0$ at either $R^m=\overline{R}^m=s^{1/2}$ or $R^m=\underline{R}^m$. Define θ_1^* such that if $\theta=\theta_1^*$, then $g_{(18)}(\underline{R}^m)=g_{(14)}(\underline{R}^m)$, and θ_2^* such that $g_{(18)}(s^{1/2})=g_{(14)}(s^{1/2})$ if $\theta=\theta_2^*$. Then, $g_{(18)}(\underline{R}^m)>g_{(14)}(\underline{R}^m)$ $>g_{(14)}(\underline{R}^m)$ if $\theta>\theta_1^*$ and $g_{(18)}(s^{1/2})>g_{(14)}(s^{1/2})$ if $\theta>\theta_2^*$. Obviously, θ_1^* could be either greater or less than θ_2^*. If $\theta_1^*>\theta_2^*$, then we have the following cases: (1) $\theta>\theta_1^*>\theta_2^*$, (2) $\theta_1^*>\theta>\theta_2^*$, and (3) $\theta_1^*>\theta_2^*>\theta$.

If $\theta>\theta_1^*>\theta_2^*$,[27] both relations of $g_{(18)}(\underline{R}^m)>g_{(14)}(\underline{R}^m)$ and $g_{(18)}(\overline{R}^m)>g_{(14)}(\overline{R}^m)$ hold. In this case, it is clear that there are either two equilibria or none. The locus defined by (18) in this

[25] Note that the first term of the right-hand side in Eq. (18) is the ratio of government spending share to the inflation tax base.

[26] The derivation of θ^* can be found in Appendix A.

[27] Implicitly, we assume that $\theta^*>\theta>\theta^*{}_1$ to guarantee the existence of multiple equilibria.

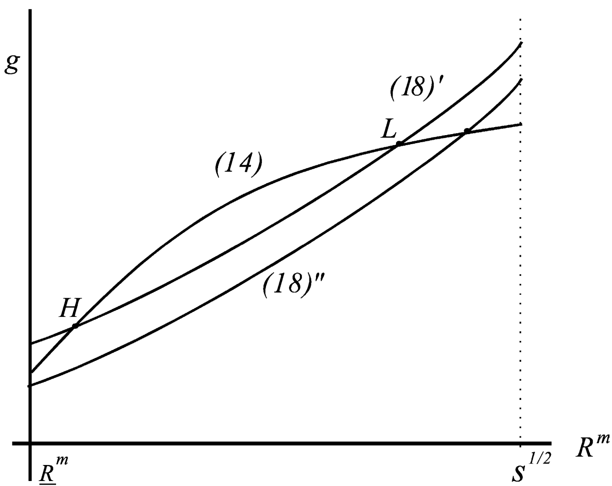

Fig. 1. Uniqueness and multiplicity of equilibrium.

case is labeled (18)′ in Fig. 1. From the figure, the key factor ensuring two equilibria is that the slope of (18) is sufficiently flat for a given locus of (14). Obviously, this requires that θ is not too large.[28] Assuming that this is the case, a relatively large ratio of government deficits will raise multiple equilibria.

From Fig. 1, one of the equilibria is characterized with high inflation (labeled as 'H' in Fig. 1) and the other is low inflation (labeled as 'L'). Obviously, high (low) inflation is accompanied with low (high) economic growth. In the second case where $\theta_1^*>\theta>\theta_2^*$, there is a unique equilibrium since $g_{(18)}(\underline{R}^m)<g_{(14)}(\underline{R}^m)$ and $g_{(18)}(\bar{R}^m)>g_{(14)}(\bar{R}^m)$. The locus of (18) in the second case is labeled as (18)″ in Fig. 1. It is clear that the inflation rate is lower in the case of $\theta_1^*>\theta>\theta_2^*$ than in the case of $\theta>\theta_1^*\theta_2^*$ (either the high or low equilibrium inflation rate). This implies that a reduction of government spending share can reduce the equilibrium inflation rate. Finally, it is obvious that there is no equilibrium if $\theta_1^*>\theta_2^*>\theta$.

It could similarly be the case that $\theta_2^*>\theta_1^*$. In this situation, if $\theta>\theta_2^*>\theta_1^*$,[29] then $g_{(18)}(\underline{R}^m)>g_{(14)}(\underline{R}^m)$ and $g_{(18)}(\bar{R}^m)>g_{(14)}(\bar{R}^m)$. Thus, multiple equilibria could arise. If $\theta_2^*>\theta>\theta_1^*$, then $g_{(18)}(\underline{R}^m)>g_{(14)}(\underline{R}^m)$ and $g_{(18)}(\bar{R}^m)<g_{(14)}(\bar{R}^m)$ so that a unique equilibrium exists. However, contrasting to Fig. 1, in this case, the equilibrium inflation in the case of $\theta_2^*>\theta>\theta_1^*$ will be higher than that of $\theta>\theta_2^*>\theta_1^*$. In other words, if $\theta_2^*>\theta_1^*$, then a reduction of government spending share tends to increase the equilibrium inflation rate. This obviously contradicts the intuitions that a reduction of government spending share that is exclusively financed by seigniorage should decrease the money stocks and the equilibrium inflation rate. As a result, we rule out the possibility of $\theta_2^*>\theta_1^*$ and focus on Fig. 1.

[28] A comparison between Eqs. (A3) and (A5) in Appendix A can see this result. Of course, θ has to be greater than θ_1^*.

[29] Again, we assume that $\theta^*>\theta>\theta_2^*>\theta_1^*$.

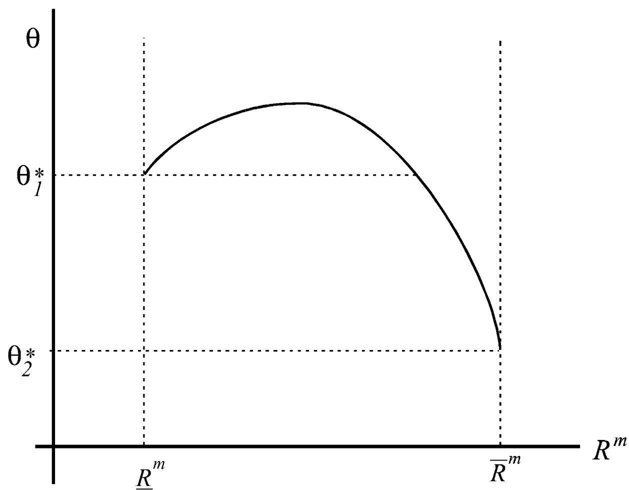

Fig. 2. The seigniorage Laffer curve.

Example: Consider an economy where $p_l = 0.8$, $p_h = 0.4$, $n = 2$, $\lambda = 0.7$, $s = 1$, $\sigma = 0.5$, $\delta = 0.4$, and $Q = 8$. In this economy, $\theta^* = 0.46$, $\theta_1^* = 0.21$, and $\theta_2^* = 0.13$. Moreover, if $\theta > 0.35$, then there is no equilibrium even though θ is less than θ^*. Consequently, for $0.35 > \theta > 0.21$, there are multiple equilibria. If $0.21 > \theta > 0.13$, then there is a unique equilibrium.

The following proposition summarizes our analysis.

Proposition 1: *If $\theta > \theta_1^* > \theta_2^*$ and θ is not too large, then there are two equilibria of which one is characterized with high economic growth and low inflation and the other is low economic growth and high inflation. If $\theta_1^* \theta > \theta_2^*$, there is a unique equilibrium. Finally, there is no equilibrium if $\theta_1^* > \theta_2^* > \theta$.*

To get more concrete idea of Proposition 1, substituting Eq. (14) into Eq. (17) derives the government's spending share as the function of R^m. Differentiating this relation with respect to R^m, one sees that the government's spending share (the government's seigniorage revenue) is first increasing and then decreasing with R^m.[30] Therefore, we have a seigniorage Laffer curve as depicted in Fig. 2. From the figure, it is clear that multiple equilibria are possible if $\theta > \theta_1^*$, and if $\theta_1^* > \theta > \theta_2^*$, then a unique equilibrium arises. Intuitively, a decrease in the inflation rate will alleviate the adverse selection problem and increase the probability of getting loans for type l borrowers. This in turn raises the inflation tax base. Then, as implied in Eq. (17), to finance a constant share of government spending, the inflation tax rate, $g - R^m$, should then be decreasing as R^m is increasing. Moreover, the growth rate is also increasing with the inflation tax base (see Eq. (14)). As a result, to finance a constant θ in equilibrium, there can

[30] Note that the value of $\partial \pi^l / \partial R^m > 0$ is large (small) for small (large) values of R^m (see Eq. (A1) in Appendix A). This guarantees that the government revenue tends to increase (decrease) with R^m for low (large) levels of R^m.

be either high economic growth with low inflation or low economic growth with high inflation, provided that this θ is relatively large. This gives rise to the rationales of multiple equilibria. On the other hand, if θ is relatively small, then only high economic growth with low inflation can be the equilibrium.

Note that the equilibrium of R^m and g is jointly determined by the government budget constraint and the equilibrium of capital markets, which are exogenous to the lender and borrower. In other words, each lender and borrower will take R^m and g as given, and hence, each fails to pick one of the multiple equilibria. If there is any way to eliminate the indeterminacy of equilibrium, then it must be from the objective of the government.[31] So far, we have not considered the objective of government. As can be seen in the next section, if the government intends to maximize social welfare (which appears to be the high-growth and low-inflation equilibrium), then the government should reduce its deficits to eliminate the possibility of low-growth and high-inflation equilibrium.

4.2. Discussion

The analysis proceeding so far indicates that multiple equilibria may arise in this framework. This result is consistent with many theoretical models.[32] It is of interest to point out that the existence of multiple equilibrium in this model hinges on the existence of asymmetric information.[33] If information regarding the type of borrowers and the outcome of the projects is public, then multiple equilibria will disappear in this framework and there generally exists a unique equilibrium even though the government spending share is relatively large. To see this, suppose now that information is public. The loan rate to a type i borrower (R^i) is then equal to ϕ_t/p_i. Moreover, competition among lenders implies that $\pi^h = \pi^l = 1$.[34] Thus, credit rationing disappears under public information. In this case, the growth rate is given as $(1-\sigma)[\lambda p_h + (1-\lambda)p_l]Q$, which is independent of R^m. This implies that the locus defined by (14) is a horizontal line. On the other hand, the locus defined by (18) is an increasing function of R^m. Consequently, a unique equilibrium exists if there is any equilibrium.

5. Inflation, financial development, and government policy

Having established the properties of equilibrium, this section will study the effects of financial development as well as changes in government policy on equilibrium inflation and

[31] Indeed, economists such as Friedman (1960) and Simons (1948) have long asserted that the source of indeterminacy is free and unregulated financial markets. In other words, government could play a role in solving the problems of indeterminacy.

[32] See, for example, Bhattacharya et al. (1997) and Espinosa and Yip (1999). For a comprehensive survey, see Benhabib and Farmer (1999).

[33] Indeed, as pointed out by Benhabib and Farmer (1999), asymmetric information is one of the causes of indeterminacy.

[34] Recall that the expected payoff of a type i borrower is increasing in π^l.

economic growth. In the ensuing analysis, we mainly consider the first case where multiple equilibria arise. The case of a unique equilibrium should be easy to derive. In fact, the unique equilibrium has properties analogous to the low-inflation and high-growth equilibrium of multiple equilibria mentioned in the previous section.

5.1. Analyses of financial development and government policy

We first examine the effects of financial development. To do so, we observe the following lemma (see Appendix B for the complete derivation).

Lemma 2: *(1)* $(\partial g/\partial \delta)|_{(14)} < 0$; *(2)* $(\partial g/\partial \delta)|_{(18)} > 0$.

Financial development, measured by a decrease in δ, will accordingly shift the locus defined by (14) up and the locus defined by (18) down, as shown in Fig. 3. The figure conveys that effects of financial development on equilibrium inflation and economic growth depend on the initial equilibrium inflation rates. Specifically, financial development tends to reduce inflation and raises economic growth if the initial equilibrium is low inflation. On the other hand, such development in financial market will increase inflation and reduce economic growth if the country's initial equilibrium is high inflation. The following proposition summarizes our findings.

Proposition 2: *Financial development raises the equilibrium inflation rate and lowers economic growth in countries with relatively high initial inflation rates. Nonetheless, such development can reduce inflation and raise economic growth for those countries whose initial inflation rates are relatively low.*

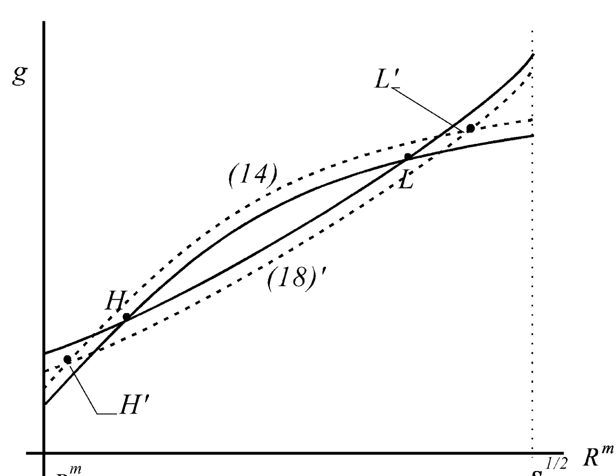

Fig. 3. Effects of financial development.

To understand the intuition of this proposition, first hold for the moment the economic growth rate as fixed. Recall that financial development will alleviate the adverse selection problem and increase π^l. For a fixed growth rate, the inflation rate has to increase and cancel out the effect from financial development,[35] as implied by (14). On the other hand, financial development tends to reduce the ratio of government's spending share to the inflation tax base and thus, for a fixed growth rate, inflation has to decrease to cancel out the effect from financial development, as shown in (18). Proposition 2 states that if the initial inflation rates are low, then the second effect (from (18)) dominates the first (from (14)) so that financial development reduces the equilibrium inflation rates. The reverse is true for countries with high initial inflation rates. To see this mathematically, define A such that

$$A \equiv (1-\sigma)[\lambda p_h + (1-\lambda)p_l\pi^l]Q - \frac{\theta}{[\lambda + (1-\lambda)\pi^l]} - R^m \tag{20}$$

Obviously, $A=0$ in any balanced-growth path. Total differentiation of Eq. (20), one sees that

$$\frac{dR^m}{d\delta} = \frac{-\frac{\partial\pi^l}{\partial\delta}(1-\lambda)\left[(1-\sigma)p_lQ + \theta(\lambda + (1-\lambda)\pi^l)^{-2}\right]}{\left[\frac{\partial\pi^i}{\partial R^m}(1-\sigma)(1-\lambda)p_lQ\right] + \left[\frac{\partial\pi^i}{\partial R^m}\theta(1-\lambda)(\lambda+(1-\lambda)\pi^l)^{-2} - 1\right]} \tag{21}$$

in any balanced-growth path. Clearly, the sign of Eq. (21) will depend crucially on the sign of the denominator of Eq. (21) as the sign of the numerator is always positive. Note that the first square brackets in the denominator are the effect from (14) and always positive, and that the second square brackets are the effect from (18).

Note further that if $\theta < \theta^*, (\partial\pi^i/\partial R^m)\theta(1-\lambda)(\lambda+(1-\lambda)\pi^l)^{-2} - 1$ is always negative.[36] Consequently, the sign of the denominator depends on these two different effects. Specifically, the value of $\partial\pi^l/\partial R^m$ is small (large) if the initial inflation rates are relatively low (high).[37] This implies that the sign of the denominator of Eq. (21) becomes negative (positive) if the initial inflation rates are relatively low (high). Therefore, financial development tends to reduce inflation (raise R^m) if initial inflation rates are relatively low. If initial inflation rates are relatively high, then financial development will raise inflation. Of course, an increase (a reduction) in inflation is accompanied with a reduction (an increase) in economic growth.

We next examine the effects of an expansion policy on equilibrium inflation and economic growth. When the government increases its deficits, θ increases and such an increase will unambiguously shift the locus defined by (18) up as illustrated in Fig. 4. Again, initial inflation rates play an important role in determining the effects of such a policy. Typically, an increase of θ will raise inflation and reduce economic growth if initial

[35] Recall that $(\partial\pi^l/\partial\delta) < 0$ and $(\partial\pi^l/\partial R^m) > 0$.

[36] See Eq. (A8) in Appendix A.

[37] See Eq. (A1) in Appendix A.

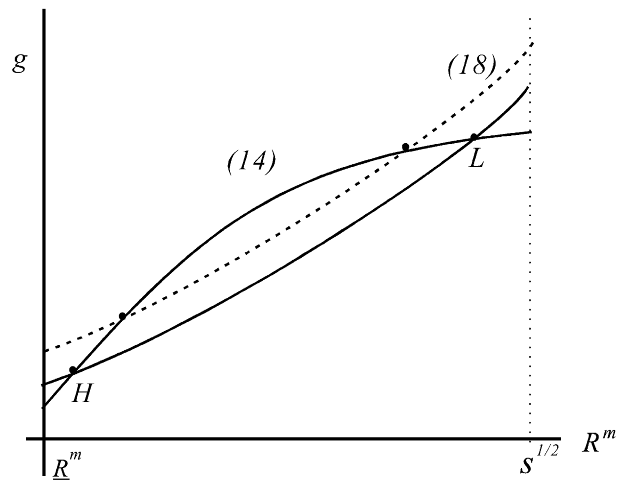

Fig. 4. Effects of an expansion policy.

inflation rates are low, but such an increase can reduce inflation and raise economic growth for countries with relatively high initial inflation rates. We summarize these results in the following proposition.

Proposition 3: *An expansion policy in which the government increases its share of spending will raise inflation and reduce economic growth for countries with relatively low initial inflation rates. For countries with relatively high initial inflation rates, such a policy can reduce inflation and promote economic growth.*

As shown in Fig. 2, for relatively high levels of θ, an increase in inflation is accompanied by a reduction (an increase) in government's seigniorage revenue if initial inflation rates are high (low). Therefore, if the government increases its deficit share that is exclusively financed by seigniorage, the rate of inflation must rise (fall) in low (high)-inflation equilibrium. A rise (reduction) in inflation will be associated with a reduction (rise) in the economic growth rate.

5.2. Policy implications

It is obvious that both low inflation and high economic growth benefit each generation on the ground of welfare in this framework. Given this, the high-inflation equilibrium is obviously not desirable. It is then optimal for a government whose spending share is relatively large to reduce its spending, and as in Proposition 1, if the ratio of government spending is sufficiently low (lower than θ_1^* but greater than θ_2^*), then a unique equilibrium could arise under which the equilibrium inflation rate will be low and the equilibrium growth rate is high. If, on the other hand, reducing spending is not possible, the government may want to repress its financial system (which raises the monitoring cost) if the country's initial inflation rates are relatively high. As in Proposition 3, financial repression is able to raise social welfare for countries with relatively high rates of initial inflation. This may justify why some developing countries repress their financial systems, despite the fact that financial development can raise an economy's efficiency of resource allocation.[38]

6. Conclusion

This paper develops a simple framework which allows inflation to play an important role in determining the relationship between financial development and economic growth. In contrast to existing literature that views inflation as the only force to affect the operations of financial markets, this paper follows Di Giorgio (1999) and Pagano (1993) by considering a reduction in the verification cost as financial development. Given this, both inflation and financial development influence the operations of financial markets and thus economic growth.

Results show that multiple equilibria appear if the share of government spending is relatively large. In this case, the initial inflation rates are shown to play a key role in determining the effects of financial development and government policies on the equilibrium inflation and economic growth rates. Typically, financial development is shown to *raise* inflation and *reduce* economic growth for countries with relatively high initial inflation rates. The reverse is true for countries with relatively low initial inflation rates. This result may account for the empirical findings of De Gregorior and Guidotti (1995). Finally, initial inflation rates are also shown to play an important role in determining the effects of an expansion policy in which government increases its spending share on equilibrium inflation and economic growth in a balanced-growth path. Future empirical studies may validate this theoretical conjecture.

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[38] Roubini and Sala-i-Matin (1995) offer another reason as to why a government intends to repress its financial sector, despite the fact that financial development improves the efficiency of the financial sector.

Appendix A. The derivation of Lemma 1

To prove, note that

$$\frac{\partial \pi^1}{\partial R^m} = \frac{p_l p_h s(p_l - p_h)(Q\rho + \delta)}{R^{m2}[p_h(p_l Q\rho - \phi_t - (1 - p_l)\delta)]^2} > 0, \tag{A1}$$

and (Eq. (A2))

$$\frac{\partial^2 \pi^1}{\partial R^{m2}} = -\frac{\left\{2R^m[p_h(p_l Q\rho - \phi_t - (1 - p_l)\delta)]^2 - 2R^{m2}[p_h(p_l Q\rho - \phi_t - (1 - p_l)\delta)]p_h \frac{\partial \phi_t}{\partial R^m}\right\}B}{[R^{m2}[p_h(p_l Q\rho - \phi_t - (1 - p_l)\delta)]^2]^2} \tag{A2}$$

where $B = p_l p_h s(p_l - p_h)(Q\rho + \delta) > 0$.

Since $\phi = (s/R^m)$,$(\partial\phi/\partial R^m) < 0$ Thus, $(\partial^2\pi^1/\partial R^{m2}) < 0$. From these results, one sees that

$$\left.\frac{\partial g}{\partial R^m}\right|_{(14)} = (1 - \sigma)Q(1 - \lambda)p_l \frac{\partial \pi^1}{\partial R^m} > 0 \tag{A3}$$

and (Eq. (A4))

$$\left.\frac{\partial^2 g}{\partial R^{m2}}\right|_{(14)} = (1 - \sigma)Q(1 - \lambda)p_l \frac{\partial^2 \pi^1}{\partial R^{m2}} < 0. \tag{A4}$$

Moreover,

$$\left.\frac{\partial g}{\partial R^m}\right|_{(18)} = 1 - \frac{\theta(1 - \lambda)\frac{\partial \pi}{\partial R^m}}{[\lambda + (1 - \lambda)\pi^1]^2} \tag{A5}$$

and (Eq. (A6))

$$\left.\frac{\partial^2 g}{\partial R^{m2}}\right|_{(18)} = -\frac{\theta(1 - \lambda)\frac{\partial^2 \pi}{\partial R^{m2}}[\lambda + (1 - \lambda)\pi^1]^2 - 2[\lambda + (1 - \lambda)\pi^1](1 - \lambda)\frac{\partial \pi}{\partial R^m}}{[\lambda + (1 - \lambda)\pi^1]^4}. \tag{A6}$$

Clearly, $(\partial g/\partial R^m)|_{(18)} > 0$ if $1 >$, $(\theta(1\text{-}\lambda)(\partial\pi/\partial R^m)/[\lambda + (1 + \lambda)\pi^1]^2)$or, equivalently, if

$$0 < \frac{[\lambda + (1 - \lambda)\pi^1]^2 R^{m2}[p_h(p_l Q\rho_{t+1} - \phi_t - (1 - p_l)\delta)]^2}{(1 - \lambda)p_l p_h s(p_l - p_h)(Q\rho + \delta)}. \tag{A7}$$

Since the right-hand side of Eq. (A7) is an increasing function of R^m, one sees that the above inequality always holds for $R^m \in [\underline{R}^m, \overline{R}^m]$ if

$$\theta < \frac{\lambda^2 s p_h(p_l - p_h)(Q\rho + \delta)}{(1 - \lambda)p_l(p_h Q\rho - (1 - p_h)\delta)^2} \equiv \theta^*. \tag{A8}$$

Finally, it is easy to verify that $(\partial^2 g/\partial R^{m2})|_{(18)}>0$.

Appendix B. Proof of Lemma 2

Notice that (Eq. (A9))

$$\frac{\partial \pi^l}{\partial \delta}=\frac{p_l p_h(p_l-p_h)(\phi_t-Q\rho)}{[p_h(p_l Q\rho-\phi_t-(1-p_l)\delta)]^2}<0. \tag{A9}$$

One then sees that (Eq. (A10))

$$\left.\frac{\partial g}{\partial \delta}\right|_{(14)}=(1-\sigma)(1-\lambda)p_l Q\frac{\partial \pi^l}{\partial \delta}<0 \tag{A10}$$

and (Eq. (A11))

$$\left.\frac{\partial g}{\partial \delta}\right|_{(18)}=\frac{-\theta(1-\lambda)\frac{\partial \pi^l}{\partial \delta}}{[(\lambda+(1-\lambda)\pi^l)]^2}>0. \tag{A11}$$

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