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Credit rationing and capital accumulation with investment and consumption loans revisited

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Abstract

A simple model is developed to evaluate the roles of credit rationing and government policies of financial repression in the process of capital accumulation. In the model, credit rationing on both investment and consumption loans decreases as capital accumulates but increases as the government imposes policies of financial repression to a greater extent. While a reduction in credit rationing on consumption loans impedes capital accumulation, such a reduction on investment loans facilitates it. We find that developing countries may be trapped at a low-capital-stock steady state while developed countries converge to a high-capital-stock steady state. Instead of adopting policies of financial liberalization, interestingly, this paper finds that policies of financial repression may enable developing countries to escape the development trap.

JEL classification: O16 Financial markets; Savings and capital investment
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1. Introduction

Economists have long recognized that financial markets are characterized by a wide variety of informational imperfections and have realized that such imperfections cause frictions (i.e., credit rationing) in channeling resources from savers to borrowers. Spurred

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by the development of endogenous growth models, recent literature has set up models to illustrate how asymmetric information and its consequence of credit rationing affect capital investment and economic growth. Nevertheless, two distinct conclusions emerge as this recent literature takes two different directions in examining the effects of credit rationing on capital accumulation.

The first direction of research focuses on the effects of credit rationing on loans for capital investment, showing how credit rationing impedes capital investment and thereby economic growth. Examples include Bencivenga and Smith (1993) and Bose and Cothren (1996). In a neoclassical growth model, Bose and Cothren (1997) further demonstrate that there is a mutual dependency between capital stock and the incidence of credit rationing, such that capital accumulation reduces the incidence of credit rationing and a reduction in credit rationing on investment loans in turn fosters capital accumulation.[1] Parallel to the role of credit rationing on investment loans, another strand of literature focuses over credit constraint on (non-productive) consumption loans. As pointed out by Modigliani (1986), informational imperfections in financial markets may force the economy to save more, because consumers are prohibited from borrowing as much as they want to obtain their optimal consumption profile. Jappelli and Pagano (1994) formally model this argument and show that an exogenously given borrowing constraint on consumption loans will increase the net resources channeled to capital investment and hence facilitate capital accumulation.[2]

While both strands of literature are quite insightful on the role of credit rationing in the process of capital formation, they omit the fact that investment and consumption loans are both present in reality. Such an omission may be misleading in regard to the mutual dependency between credit rationing and capital accumulation. Indeed, with the presence of both consumption and investment loans, an increase in capital stock reduces the incidence of credit rationing on both types of loans. A reduction of credit rationing on investment loans facilitates capital accumulation (as in Bose and Cothren, 1997); however, such a reduction on consumption loans impedes capital formation (as in Jappelli and Pagano, 1994). In particular, the effect from consumption loans may dominate that from investment loans for some levels of capital stock and vice versa for some other levels of capital stock.[3] This implies that the mutual dependency between credit rationing and capital accumulation may be more complicated than that obtained by Bose and Cothren (1997). Moreover, a joint consideration of both consumption and investment loans may be able to shed light on important issues regarding a government's repression policy on financial intermediation.

[1] The co-evolution of the real and financial sectors has long been asserted by Gurley and Shaw (1955). For recent studies, see Greenwood and Smith (1997) and Bencivenga and Smith (1998).

[2] Bayoumi (1993) has a similar argument. Jappelli and Pagano (1994) find evidence supporting this argument. Moreover, a recent empirical study by Bandiera et al. (2000) also finds that financial reform may relax households' constraints and thereby result in a reduction in savings.

[3] Hung and Cothren (2002) first integrate investment and consumption loans into an endogenous growth and show that any correlation between the credit market and economic growth is possible. Due to their simple structure, the issues related to capital dynamics are not examined.

Apart from the mutual dependency between capital stock and credit rationing, government regulation and repression policies on financial intermediation, such as financial restrictions, directed credit programs, and taxation on financial institutions, are also responsible for widespread credit rationing (see Gonzalez-Vega, 1984; Carter, 1988; Bhatt, 1988; World Bank, 1989). Given this, if one considers only investment loans, then one would suggest that developing countries, whose capital stock is relatively low and thereby credit rationing is more severe, should not repress their financial sectors in order to speed up capital formation.[4] In reality, however, one usually observes that governments of developing countries impose more restrictions on financial intermediation than do developed countries.[5]

By considering both investment and consumption loans, it is possible that, without government repression, financial intermediation in developing countries allocates resources inadequately to consumption loans, and thereby the relaxation of credit rationing on consumption loans may dominate that on investment loans along with capital accumulation. This leads to a situation whereby capital accumulation reduces the incidence of credit rationing, but such a reduction is detrimental to capital accumulation. In this case, government repression on financial intermediation, which mainly depresses consumption loans, may be helpful to capital accumulation. On the other hand, financial intermediation in developed countries, which is more efficient, allocates resources adequately so that the effect from investment loans dominates that from consumption loans. In this regard, government repression on financial intermediation is not desirable.[6]

The purpose of this paper is to develop a simple model for exploring these untouched issues. To accomplish this purpose, the model has two important features that are different from the pre-existing models. First, to fully understand the net effect of credit rationing on capital accumulation, one must consider both consumption and investment loans. Second, as is stated, the incidence of credit rationing is affected by capital stock as well as a government's repression policy, implying that credit rationing on investment and consumption loans must arise endogenously.[7] To this end, we consider a standard model of asymmetric information with the problem of adverse selection. More specifically, there are two groups of borrowers: consumers and entrepreneurs. Consumers must borrow for their young-age consumption while entrepreneurs must borrow for capital investment. Each group of borrowers consists of two types: low-risk borrowers and high-risk ones. A consumer's type refers to the probability of getting a unit of old-age labor while an

[4] This has long been asserted by McKinnon (1973) and Shaw (1973).

[5] See Chapter 4 in World Bank (1989). Indeed, according to Fry (1995) and Barro (1997), government repression (or regulation) on financial intermediation raises the costs of financial intermediation and, as is pointed out by Fry (1995, page 325), the costs of financial intermediation in developing countries are higher than that in developed countries.

[6] Economists have provided some reasoning for why a government should regulate its financial sectors. For a comprehensive survey, see Fry (1995, Chapter 6). Nevertheless, the fact that developing countries regulate their financial sector to a greater extent than do developed countries is rarely explained.

[7] It is worth noting that the pre-existing studies on consumption loans, such as Bayoumi (1993) and Jappelli and Pagano (1994), typically assume that a credit constraint is exogenously given. This exogenously given credit constraint is not adequate for examining the dynamical process of capital investment.

entrepreneur's type corresponds to the probability of success on capital investment. Similar to Bencivenga and Smith (1993), a borrower's type is private information, which induces a high-risk borrower to pretend to be a low-risk one and vice versa. As is in Bencivenga and Smith (1993), the equilibrium contracts feature that some fractions of low-risk borrowers are credit rationed.

It is further assumed that there is financial intermediation between lenders and borrowers. While the establishment of financial intermediation is costless, there is an intermediation cost, which according to Bernanke (1983) is needed to channel funds from lenders to borrowers.[8] As indicated by Fry (1995), a government policy of financial repression increases the cost of intermediation. Hence, we interpret an increase in the intermediation cost as an indicator that the government imposes more financial repression on financial intermediation. Under this setting, the amount of credit rationing decreases as capital accumulates but increases as the intermediation cost goes up. As a result, this model is more capable for examining the net effects of credit rationing as well as the policy of financial repression in the process of capital accumulation.

We show that if the economy's initial capital stock is sufficiently low, then it is not optimal for all borrowers to borrow. In other words, all borrowers are severely credit rationed. In this case, the economy's capital is converted by financial intermediaries' safe investment, whose rate of capital production is relatively low.[9] Along with the accumulation of capital, the key point is which group of borrowers first begins to borrow. Under some parameter conditions, financial intermediation in developing countries (characterized by a relatively low level of initial capital stock) may allocate resources inadequately to high-risk entrepreneurs (less-efficient capital borrowers) and both high-risk and low-risk consumers. For this situation, along with capital accumulation, the probability of getting loans for low-risk consumers increases (that is, the incidence of credit rationing decreases). In other words, the volume of the consumption loans rises as capital accumulates. As the more efficient capital borrowers (i.e., low-risk entrepreneurs) are severely credit rationed in these countries, the increases in the total volume of consumption loans alone are detrimental to capital accumulation and therefore developing countries converge to a steady state with a low level of capital stock.[10]

If the economy's initial capital stock is relatively high (such as developed countries), then all borrowers (including low-risk entrepreneurs) apply for loans, and as capital accumulates, the probability of getting loans for low-risk consumers as well as low-risk entrepreneurs increases. While a decrease in the incidence of credit rationing on consumption loans impedes capital formation, such a decrease in investment loans facilitates it. Since the projects of low-risk entrepreneurs are more efficient in producing capital than the safe investment of financial intermediation, it is possible that the effect

[8] According to Barro (1997), the intermediation costs create a spread between the deposit rate and the loan rate. In general, the intermediation costs include the expense of serving deposits and loans, the implicit and explicit taxation imposed on financial intermediation, and the legal rights of creditors. All of these are affected by a government's repression (or regulation) policy on financial intermediation.

[9] The safe investment must be implemented in a large scale; hence, an individual lender with limited resources has no such access. See below.

[10] In other words, the effect from consumption loans dominates that from investment loans.

from investment loans dominates that from consumption loans. As a result, developed countries whose initial capital stocks are relatively high will converge to a steady state with a high level of capital stock.

As is quite clear, developing countries may be trapped at a steady state with a low level of capital stock. This so-called development trap arises, because financial intermediation in developing countries inadequately allocates resources to consumers as well as less-efficient entrepreneurs without financing the more efficient entrepreneurs (low-risk entrepreneurs). Having these results in mind, we turn our attention to a government's repression policy of financial intermediation, which is measured by an increase in the costs of intermediation. It is found that the financial repression increases (decreases) the steady-state capital stock for developing (developed) countries. In particular, it is further found that a development trap that occurs in developing countries could be evaded if the governments repress their financial intermediation to a greater extent (so that the cost of financial intermediation increases) under low levels of capital stock and relax such a repression when the capital stock is relatively high. Consequently, this paper not only provides a complete picture for the mutual dependency between credit rationing and capital accumulation, but also gives rise to a theoretical underpinning as to why developing countries, whose credit rationing is more severe, should repress their financial intermediation to a greater extent.

This paper is organized as follows. Section 2 presents the basic model and Section 3 describes equilibrium contracts to investment and consumption loans. In Section 4, we discuss the possible equilibrium contracts offered by financial intermediation for a given capital stock and then examine the dynamics of capital accumulation. We consider the effects of a government's repression policy on financial intermediation in Section 5. Section 6 concludes.

2. Model

The model herein is a modified version of Bencivenga and Smith (1993) and Bose and Cothren (1996, 1997). The economy contains a sequence of two-period-lived overlapping generations. Agents of each generation are identical in size and composition and are classified as borrowers and lenders. Borrowers are further divided into two groups with equal size: consumers and entrepreneurs. For simplicity, the population of the lender and borrower is normalized to n and 2, respectively.[11] Moreover, to introduce asymmetric information, we assume that there are two types of borrowers in each group and a borrower's type is private information. The distinction of borrowers' types will be made explicitly later. There are two goods in the economy: a perishable output (consumption) good and a capital good. Each young lender (saver) of generation t is endowed with one unit of labor and has the utility function given as

$$U^l(c_t, c_{t+1}) = c_{t+1}, \tag{1}$$

[11] We assume that n is sufficiently large to ensure that loans are potentially satisfied. See below.

where c_m is consumption of the lender in period m, $m=t$, $t+1$. Given (1), each young lender will provide his labor to earn the competitively-determined wage rate and save the entire wage income for old-period consumption.

There is financial intermediation (the bank) between lenders and borrowers. The role of financial intermediation in this model will be discussed below. A young lender can deposit his wage into a financial intermediary in return for a competitively-determined deposit rate. Similarly, after receiving deposits from lenders, each bank can loan to borrowers in return for a competitively-determined loan rate.

2.1. Consumer borrowers

The utility of a representative type-i consumer of generation t is given as

$$U_t^i = c_t^i + \beta_c^i c_{t+1}^i, \quad i = H, L, \tag{2}$$

where c_m^i is the consumption of a type-i consumer in period m, $m=t$, $t+1$, and β_c^i is the discount factor. The types of consumers refer to the probability of getting a unit of old-period labor. With probability p^i, $i=H$, L, a young type-i consumer will be endowed with one unit of labor when old. With probability $1-p^i$, the consumer receives nothing; thus, he will claim bankruptcy in this case. Assuming that $1 \geq p^L > p^H > 0$ is satisfied, type-L consumers are low-risk. For simplicity, each young consumer has no endowment. A λ fraction of consumers is type-H.

Since borrowers' type is private information, a type-H consumer may have an incentive to pretend to be a type-L consumer, and vice versa. As in Bencivenga and Smith (1993), this raises a problem of adverse selection. To deal with this problem, each bank will design contracts to induce a self-selection mechanism and separate borrowers according to their types. Following Bencivenga and Smith (1993), this can be achieved by setting an environment such that different types of borrowers have different opportunity costs being denied credit. For this purpose, we assume that $\beta_c^L > \beta_c^H = 0$.[12] As will be seen, while a type-H consumer may have an incentive to pretend to be a type-L, this assumption will prevent the type-L consumers from mimicking type-H consumers, which can be further exploited by the bank to design incentive-compatibility contracts that separate borrowers according to their types.

2.2. Entrepreneur borrowers

Entrepreneurs have a structure similar to consumers. Entrepreneurs only value consumption in their old period. Each entrepreneur is endowed with an investment project when he is young. The project can be utilized to produce capital with a consumption good as input. With probability p^i, $i=H$, L, a type-i entrepreneur's project will yield Q units of capital per unit of input between periods. With probability $1-p^i$, the project fails and produces nothing. Assuming that $1 \geq p^L > p^H > 0$ is satisfied, type-L

[12] Therefore, if a young consumer obtains no credit, then his expected lifetime utility level is $\beta_c^L p_L w_{t+1}$ for a type-L consumer and 0 for a type-H. Assuming that β_c^H is equal to 0 simplifies our mathematical notation.

borrowers are of low-risk. A λ fraction of entrepreneurs is type-H. Entrepreneurs' projects are not tradable. Notice that ε is assumed to be less than p^H; thus, the rate of return from intermediaries' safe investment is inferior to that from entrepreneurs' investment.

To make distinctions between types of entrepreneurs in the case of being denied credit, it is assumed that the project of young type-L entrepreneurs can be utilized for home production without input in the old period. Nonetheless, the project of type-H entrepreneurs has no such access. A project, if being implemented for capital production at t, cannot be utilized for home production at $t+1$. We follow Bose and Cothren (1997) by assuming that the amount of home production (consumption good) produced by a type-L capital borrower is equal to β_e.

The capital stock produced between time t and $t+1$ is available for producing output at time $t+1$. We assume that each old entrepreneur becomes a firm operator no matter what the outcome is of his project. An old entrepreneur is able to produce the output by renting capital (in positive or negative amounts) and hiring labor at competitively-determined rental rates. The production function of the output at time $t+1$ is given as

$$y_{t+1} = A\Phi_{t+1}^{\eta} k_{t+1}^{\theta} N_{t+1}^{1-\theta}, \tag{3}$$

where k_{t+1} and N_{t+1} are the amount of capital and labor employed by each firm, respectively, and Φ_{t+1} is the average per firm capital stock. Capital depreciates fully after production. Since each firm employs the same amount of capital in equilibrium, $\Phi_{t+1}=k_{t+1}$. To further simplify the analysis, we assume that $\eta=1-\theta$. This assumption implies that the production technology displays a linear relationship as in the "AK" model. Since labor and capital markets are competitive, the rental rates of labor and capital are given as

$$w_{t+1} = A(1-\theta)k_{t+1}^{\eta+\theta} N_{t+1}^{-\theta} = A(1-\theta)k_{t+1}N^{-\theta}, \tag{4}$$

and

$$\rho_{t+1} = \rho = A\theta k_{t+1}^{\eta+\theta-1} N_{t+1}^{1-\theta} = A\theta N^{1-\theta}. \tag{5}$$

Notice that in financial market equilibrium, per firm labor employment N_t is constant over time.[13]

2.3. Financial intermediary and the intermediation costs

Financial intermediaries (the banks) arise in this framework by performing the roles of risk- and fund-pooling. Indeed, a lender's direct lending to borrowers is risky. However, by pooling lenders' resources and lending them to a large number of borrowers, each bank will derive a constant rate of return without uncertainty from lending activities. Moreover, the bank has access to a safe technology (a safe investment), which must be implemented on a large scale (so that the individual lender has no such an access). The

[13] The number of firms is equal to one (all old entrepreneurs) while the total amount of labor includes all young lenders and old consumers (who obtain labor endowment). In a separating equilibrium, both are constant over time (see below).

safe investment can convert one unit of time t output into $Q\varepsilon$ units of time $t+1$ capital. As the rental rate of capital in time $t+1$ is ρ_{t+1}, this implies that each bank faces a riskless interest rate equal to $Q\varepsilon\rho_{t+1}$.

It is further assumed that each young lender can launch a bank without any cost. Under this framework, the large number of lenders ensures competitive behaviors among banks. While it is costless to establish a bank, there are intermediation costs, which according to Bernanke (1983) are defined as costs associated with channeling resources from lenders to borrowers.[14] Specifically, we assume that it costs a bank F units of resources to proceed with a loan between the lender and borrower. As is well recognized, such costs create a spread between the rates of deposit and loan, and are usually regarded as an indicator to the efficiency of banking sector.[15]

It is worth noting that the costs of financial intermediation are related to government policy of financial regulations (financial repression). Indeed, as pointed out by Fry (1995, page 235), a government policy of financial repression increases the costs of intermediation.[16] Give this, we will interpret an increase in the costs of financial intermediation as an indicator that the government imposes more repression (restrictions) on its financial intermediation.[17]

3. Operations of financial markets and equilibrium contracts

Financial markets operate in a way described by Bencivenga and Smith (1993). At the beginning of time t, each bank announces a set of contracts intended for entrepreneurs and a set of contracts for consumers. If a bank's offers are not dominated by others, then it is approached by the potential borrowers. The equilibrium contracts are defined such that there is no incentive for any bank to offer alternative contracts, taking w_t, ρ_{t+1}, w_{t+1}, and other banks' offers as given.

To derive the terms of contracts in equilibrium, one observes the following. First, competition will force the bank to offer contracts under which the expected payoff of the potential borrower is maximized. Second, competition also ensures that each bank earns

[14] See also Fry (1995) and Barro (1997).

[15] Pagano (1993) asserts that financial intermediation absorbs resources in the process of transferring funds from lenders to borrowers and the development of financial markets is able to enhance the efficiency of resource allocation and thereby reduce the leakage of resources. Note that a higher level of intermediation costs corresponds to the case where financial intermediation absorbs more resources and thereby the efficiency of financial intermediation is low.

[16] Fry (1995) points out that government repression policies, such as raising the reserve requirement, credit programs, or taxation on financial intermediation, raise the intermediation costs. Morris (1985) also indicates that government selective credit policies, which are often observed in developing countries, also involve substantial administration costs for financial intermediation.

[17] The costs of intermediation may be related to the country's legal environment. Indeed, legislation such as the legal rights of creditors can improve debt collection and therefore enhance the efficiency of contract enforcement, which further reduces the costs of financial intermediation. It is worth noting that recent empirical evidence by Levine (1998) and Levine et al. (2000) point out that the legal rights of creditors and the efficiency of contract enforcement account for cross-country differences in financial development. From this, the government may affect the costs of intermediation by manipulating legislation.

zero profit from loan transactions. This implies that the net return from lending to a borrower is equal to that from the safe investment. Third, since entrepreneurs' investment technology is linear (in the case of being successful), all entrepreneurs will want to borrow as much as possible to implement their projects. As is in Bencivenga and Smith (1993), a maximal scale is needed to limit the size of each project (each capital loan). Following Bencivenga and Smith (1993), we assume that this maximal scale of entrepreneurs' projects is equal to the wage rate in the same period, w_t.[18] Fourth, to solve the adverse selection problem, the incentive constraints have to be set such that borrowers will truthfully reveal their types.

Before characterizing equilibrium contracts, it should be noted that each bank is assumed to be able to distinguish consumers from entrepreneurs. If not, consumers (entrepreneurs) may have incentives to pretend to be entrepreneurs (consumers) and this will complicate informational problems. In theory, this may be an interesting issue. Nevertheless, in practice, it is usually observed that each bank has different procedures to evaluate and proceed with loans for the purpose of consumption and investment. Therefore, we rule out this possibility to keep the ensuing analysis as simple as possible.

3.1. Equilibrium loan rates

We are now in a position to characterize equilibrium contracts. To begin with, we first derive the loan rate to each type of borrowers. Let $R^i_{j,t+1}$ be the specified interest rate charged to a type-i borrower between time t and $t+1$ when entrepreneurs' capital projects are successful or consumers receive labor endowment (the superscript i, $i=H, L$, refers to the types of borrowers and the subscript j, $j=e, c$, refers to *entrepreneurs* and *consumers*). Denote q^i_j, $i=H, L$ and $j=e, c$, as the loan quantity. As stated, competition forces the bank to earn zero profit in lending to borrowers. This can be expressed as

$$p^i q^i_j R^i_{j,t+1} - F = q^i_j Q\varepsilon\rho_{t+1}, \quad i = H, L, j = e, c.$$

From this, the loan rate $R_{j,t+1}{}^i$ is given as

$$R^i_{j,t+1} = \frac{q^i_j Q\varepsilon\rho_{t+1} + F}{p^i q^i_j}, \quad i = H, L, j = e, c. \tag{6}$$

Notice that the loan rate consists of two components: one is to cover the rate of return from the safe investment and the other is to compensate the intermediation costs.

3.2. Equilibrium contract for consumers

In a separating equilibrium, each bank offers incentive-compatibility contracts to separate borrowers according to types. To this end, a bank offers a C^H_c (intended for type-H consumers) contract and a C^L_c contract (intended for type-L consumers). Following Bencivenga and Smith (1993), the separation can be achieved by distorting

[18] Essentially, this assumption is meant to tie the loan size to the current capital stock, which, as is claimed by Bencivenga and Smith (1993), is necessary.

the first-best contract for type-L consumers and offering type-H consumers their corresponding first-best contract such that type-H consumers are indifferent between accepting C_c^H and C_c^L.[19] Since a consumer derives nothing with probability $1-p^i$, he always claims bankruptcy in this case. Given the characteristics of type-H consumers, the first-best contract for a type-H consumer specifies the loan rate as given in Eq. (6) and loan quantity (q_c^H) is equal to $w_{t+1}/R_{c,t+1}^H$.[20]

As in Bencivenga and Smith (1993), the distortion can be achieved by rationing a fraction of borrowers who apply for C^L; in other words, consumers who apply for C^L may be rejected. Given the characteristics of type-L consumers, the C^L contract (intended for type-L consumers) will specify the loan rate as $R_{c,t+1}^L$ and the loan size is $w_{t+1}/R_{c,t+1}^L$. Denoting $\pi_{c,t}$ as the probability of getting a loan for a consumer who applies for C^L at time t, the expected payoff of a type-L consumer who applies for C^L in time t is given as

$$\pi_{c,t}\frac{w_{t+1}}{R_{c,t+1}^L}+\left(1-\pi_{c,t}\right)\beta_c^L p^L w_{t+1}. \tag{7}$$

Competition forces banks to maximize Eq. (7) subject to Eq. (6) and the constraints for the self-selection mechanism given as

$$w_{t+1}/R_{c,t+1}^H \geq \pi_{c,t} w_{t+1}/R_{c,t+1}^L \tag{8}$$

and

$$\frac{\pi_{c,t}w_{t+1}}{R_{c,t+1}^L}+\left(1-\pi_{c,t}\right)\beta_c^L p^L w_{t+1} \geq w_{t+1}/R_{c,t+1}^H. \tag{9}$$

The left-hand side of Eq. (8) is the expected payoff of a type-H consumer in accepting C_c^H (in revealing his true type), while the right-hand side is the expected payoff of a type-H consumer when he pretends to be type-L.[21] Similarly, Eq. (9) is the incentive constraint, which ensures that a type-L consumer prefers C_c^L over C_c^H. In a separating equilibrium, at least one of Eqs. (8) and (9) must hold with strict inequality.

From Eq. (6), the loan quantity for a type-i consumer, q_c^i, should be given as

$$q_c^i=\frac{w_{t+1}}{R_{c,t+1}^i}=\frac{p^i w_{t+1}-F}{Q\varepsilon\rho_{t+1}},\quad i=H,L. \tag{10}$$

Note that if a type-L consumer does not apply for a loan, then his lifetime utility is equal to $\beta_c^L p^L w_{t+1}$. To induce a type-L consumer to apply for C_c^L, it must be the case that[22]

$$\frac{\pi_{c,t}w_{t+1}}{R_{c,t+1}^L}+\left(1-\pi_{c,t}\right)\beta_c^L p^L w_{t+1} > \beta_c^L p^L w_{t+1},$$

[19] In such a case, type-H consumers choose C_c^H. One can also easily verify that type-L consumers will prefer C_c^L over C_c^H (see below).

[20] Recall that $\beta_c^H=0$; i.e., type-H consumers value only their young-age consumption. Thus, a type-H consumer will want to borrow the present value of his entire old-age wage for young-age consumption.

[21] Recall that a type-H consumer values only young-age consumption ($\beta_c^H=0$).

[22] For simplicity, it is assumed that the type-L consumer will not apply for C_c^L if both are equal.

or

$$\pi_{c,t} w_{t+1} \left[\frac{1}{R^L_{c,t+1}} - \beta^L_c p^L \right] > 0.$$

For this inequality to hold, both $\pi_{c,t}$ and $1/R^L_{c,t+1} - \beta^L_c p^L$ must be positive. Suppose now that $1/R^L_{c,t+1} - \beta^L_c p^L$ is greater than 0. In this case, the expected payoff of a type-L consumer (i.e., Eq. (7)) is increasing in $\pi_{c,t}$, implying that the incentive-compatibility constraint in Eq. (8) is binding. As a result, Eq. (8) should hold as equality, and so we have

$$\pi_{c,t} = \frac{R^L_{c,t+1}}{R^H_{c,t+1}} = \frac{p^H w_{t+1} - F}{p^L w_{t+1} - F}. \tag{11}$$

Using Eq. (11), one can verify that the incentive constraint in Eq. (9) holds with a strict inequality; hence, the separating equilibrium can be derived. The higher the value is of $\pi_{c,t}$, the lower the amount will be of credit rationing for a type-L consumer.

Using Eqs. (6) and (10), it is easy to verify that $1/R^L_{c,t+1} - \beta^L_c p^L$ if

$$p^L w_{t+1} > \frac{F}{\left(1 - \beta^L_c Q \varepsilon \rho\right)}.$$

By assuming that $1 > \beta^L_c Q \varepsilon \rho$, we can utilize Eq. (4) to rewrite the above inequality as[23]

$$k_{t+1} > \frac{F}{p^L \left(1 - \beta^L_c Q \varepsilon \rho\right) A (1-\theta) N^{-\theta}} \equiv k_c. \tag{12}$$

Note that the condition for $\pi_{c,t} > 0$ is $p^H w_{t+1} - F > 0$.[24] Utilizing Eq. (4), it is clear that $\pi_{c,t} > 0$ if

$$k_{t+1} > \frac{F}{p^H A (1-\theta) N^{-\theta}} \equiv k_{\pi c}. \tag{13}$$

A type-L consumer is obviously willing to borrow if $k_{t+1} > \max\{k_c, k_{\pi c}\}$. Note that a type-$H$ consumer always obtains a loan when he is willing to borrow. Hence, the expected payoff of a type-H consumer when he applies for C^H_c is $w_{t+1}/R^H_{c,t+1}$, which should be greater than 0, the expected payoff when he does not borrow.[25] By Eq. (10), this requires that $p^H w_{t+1} - F > 0$, which is the condition in Eq. (13). As a result, type-H consumers will apply for loans if $k_{t+1} > k_{\pi c}$. Note that borrowing takes place at time t. In other words, for a given time t capital stock, if the next period's capital stock, which may be affected by the equilibrium contracts to entrepreneurs, is less than (or equal to) $k_{\pi c}$, then the amount borrowed by consumers is equal to zero.

[23] If $1 < \beta^L_c Q \varepsilon \rho$, then k_{t+1} is always greater than k_c. In this case, a type-L consumer is willing to borrow if $\pi_{c,t} > 0$.

[24] If $p^H w_{t+1} - F > 0$, then $p^L w_{t+1} - F > 0$ and hence $\pi_{c,t} > 0$.

[25] Similarly, if $w_{t+1}/R^H_{c,t+1} = 0$, then type-H consumers will not borrow.

For future reference, it is easy to verify that

$$\frac{\partial \pi_{c,t}}{\partial F} = \frac{w_{t+1}(p^H - p^L)}{[p^L w_{t+1} - F]^2} < 0 \tag{14}$$

and

$$\frac{\partial \pi_{c,t}}{\partial k_{t+1}} = \frac{A(1-\theta)N^{-\theta}F(p^L - p^H)}{[p^L w_{t+1} - F]^2} > 0. \tag{15}$$

Hence, either a decrease in the intermediation costs or an increase in capital stock will reduce the amount of credit rationing on consumption loans. We summarize the equilibrium contracts to consumers as follows.

Proposition 1. *For a given time t per firm capital stock k_t, each bank offers a contract C_c^L (intended for type-L consumers) if the next period per firm capital stock k_{t+1} satisfies that $k_{t+1} > \max\{k_c, k_{\pi c}\}$ and a contract C_c^H (intended for type-H consumers) if the next period per firm capital stock k_{t+1} satisfies that $k_{t+1} > k_{\pi c}$. The C_c^L contract specifies that with probability $\pi_{c,t}$ (given in Eq. (11)) the loan application will be accepted, of which the loan rate is $R_{c,t+1}^L$ (given by Eq. (6)) and the loan size is equal to $q_{c,t}^L$ (given in Eq. (10)). The C_c^H contract specifies that any consumer who applies for this contract will be accepted. The loan rate under C_c^H is $R_{c,t+1}^H$ (given by Eq. (6)) and the size is $q_{c,t}^H$ (given in Eq. (10)).*

3.3. Equilibrium contract for entrepreneurs

The equilibrium contracts for type-H and type-L entrepreneurs are similar to that for consumers. The loan rate charged to type-i entrepreneurs, $i=H, L$, is given in Eq. (6). Since entrepreneurs of any type will implement their project at the maximal scale, the loan quantity to either type of entrepreneur, $q_{e,t}^i$, is w_t. Moreover, an entrepreneur obtains nothing if his project fails; thus, he always claims bankruptcy when his project fails. As a consequence, the most preferred contract for type-H entrepreneurs (denoted as C_e^H) specifies the quantity of the loan to equal w_t and the loan rate, $R_{e,t+1}^H$, be as given in Eq. (6).

To derive the contract intended to type-L entrepreneurs (denoted as C_e^L), first note that the expected payoff of a type-L entrepreneur is given as

$$\pi_{e,t} p^L w_t \left(Q\rho_{t+1} - R_{e,t+1}^L\right) + (1 - \pi_{e,t})\beta_e, \tag{16}$$

where $\pi_{e,t}$ is the probability of obtaining credit in C_e^L. Each bank maximizes (16) subject to (6) as well as the constraints for the self-selection mechanism given as

$$p^H w_t \left(Q\rho_{t+1} - R_{e,t+1}^H\right) \geq p^H w_t \pi_{e,t} \left(Q\rho_{t+1} - R_{e,t+1}^L\right) \tag{17}$$

and

$$\pi_{e,t} p^L w_t \left(Q\rho_{t+1} - R_{e,t+1}^L\right) + (1 - \pi_{e,t})\beta_e p^L w_t \geq p^L w_t \left(Q\rho_{t+1} - R_{e,t+1}^H\right). \tag{18}$$

To induce borrowing, the expected payoff of a type-L entrepreneur under C_e^L (i.e., Eq. (16)) should be greater than β_e.[26] This implies that $\pi_{e,t}\left[p^L w_t(Q\rho_{t+1} - R_{e,t+1}^L) - \beta_e\right] > 0$.

Suppose first that $p^L w_t(Q\rho_{t+1} - R_{e,t+1}^L) - \beta_e > 0$. Under this, one sees that the expected payoff of a type-L entrepreneur (Eq. (16)) is increasing in $\pi_{e,t}$, making Eq. (17) binding. As a result, we have

$$\pi_{e,t} = \frac{Q\rho_{t+1} - R_{e,t+1}^H}{Q\rho_{t+1} - R_{e,t+1}^L} = \frac{p^L\left[w_t Q\rho_{t+1}(p^H - \varepsilon) - F\right]}{p^H\left[w_t Q\rho_{t+1}(p^L - \varepsilon) - F\right]}. \tag{19}$$

Note that $p^L w_t(Q\rho_{t+1} - R_{e,t+1}^L) - \beta_e > 0$ if

$$k_t > \frac{\beta_e + F}{A(1-\theta)N^{-\theta}(p^L - \varepsilon)Q\rho_{t+1}} \equiv k_e. \tag{20}$$

Moreover, $\pi_{e,t} > 0$ if $w_t Q\rho_{t+1}(p^H - \varepsilon) - F > 0$, or equivalently,

$$k_t > \frac{F}{A(1-\theta)N^{-\theta}(p^H - \varepsilon)Q\rho_{t+1}} \equiv k_{\pi e}. \tag{21}$$

As a result, type-L entrepreneur will borrow if $k_t > \max\{k_e, k_{\pi e}\}$.

On the other hand, type-H entrepreneurs always obtain loans if they apply for C_e^H, and their old-age consumption is zero if they do not apply. This implies that type-H entrepreneurs will apply for loans if $Q\rho_{t+1} - R_{e,t+1}^H > 0$, which is the same condition stated in Eq. (21).

For future reference, it is easy to verify that

$$\frac{\partial \pi_{e,t}}{\partial F} = \frac{p^L w_t Q\rho_{t+1}(p^H - p^L)}{p^H\left[w_t Q\rho_{t+1}(p^L - \varepsilon) - F\right]^2} < 0 \tag{22}$$

and

$$\frac{\partial \pi_{e,t}}{\partial k_t} = \frac{p^L Q\rho F(p^L - p^H)A(1-\theta)N^{-\theta}}{p^H\left[w_t Q\rho(p^L - \varepsilon) - F\right]^2} > 0. \tag{23}$$

Either a reduction in the intermediation cost or an increase in the capital stock reduces the incidence of credit rationing on investment loans. Moreover, one can verify that

$$\frac{\partial^2 \pi_{e,t}}{\partial k_t^2} = \frac{-2Q\rho(p^L - \varepsilon)A(1-\theta)N^{-\theta}}{\left[w_t Q\rho(p^L - \varepsilon) - F\right]} \frac{\partial \pi_{e,t}}{\partial k_t} < 0. \tag{24}$$

The following proposition summarizes the equilibrium contracts for entrepreneurs.

[26] For simplicity, we assume that an entrepreneur will not apply for loans if he is indifferent to borrowing or not.

Proposition 2. *For a given per firm capital stock k_t, each bank offers a C_e^H contract if $k_t > \max\{k_e, k_{\pi e}\}$ and a C_e^L contract (intended for type-L entrepreneurs) if $k_t > k_{\pi e}$. The C_e^L contract specifies that with probability $\pi_{e,t}$ (given in Eq. (19)) the loan application will be accepted, of which the loan rate is $R_{e,t+1}^L$ (given by Eq. (6)) and the loan size is equal to w_t. The C_e^H contract features that the loan rate is $R_{e,t+1}^H$ (given by Eq. (6)) and the loan size is equal to w_t.*

3.4. Discussion

It has been recognized that informational imperfections give rise to credit rationing and that the development of financial markets is able to ease informational imperfections and reduce the incidence of credit rationing.[27] In general, there are two components of financial development—an endogenous component and an exogenous one. The literature has long asserted that the relationship between financial markets and economic growth runs both ways; namely, financial development facilitates capital formation and capital accumulation in turn fosters the development of financial markets.[28] This implies that the development of financial markets and the economy's capital stock (and income level) are jointly determined. In contrast with this endogenous component of financial development, recent empirical evidence (as in Levine, 1998; Levine et al., 2000) points out that the cross-country difference in the legal rights of creditors, the efficiency of contract enforcement, and the origin of the legal system crucially account for cross-country differences in financial development. Moreover, a government's repression policy may impede financial development (as in Bencivenga and Smith, 1992). Obviously, these factors may not correlate with income levels, and hence, they are exogenous components of financial development.[29]

The model we have developed here captures both the endogenous and exogenous components of financial development.[30] It is worth noting that the distinction between exogenous and endogenous components of financial development with the presence of investment and consumption loans enables us to examine an important issue that is ignored by recent studies. With the focus on investment loans alone, recent studies assert that financial development facilitates capital formation and economic growth. Given this, developing countries, whose capital stock (and hence the endogenous component of financial development) is relatively low, should de-regulate (or liberalize) their financial sectors in order to speed up financial development. In reality, however, one observes that

[27] See Bose and Cothren (1997), for the example.

[28] See Greenwood and Jovanovic (1990), Bose and Cothren (1997), and Greenwood and Smith (1997).

[29] As an alternative interpretation, Pagano (1993) asserts that 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 stresses that financial development is able to reduce this leakage of resources so as to reduce this spread. As shown in Eq. (6), it is obvious that either a decrease in F or an increase in q_j^i (related to per firm capital stock) reduces this spread and thus captures the effects of financial development.

[30] From Eqs. (14), (15), (22), and (23), either an increase in the capital stock (an endogenous component) or a decrease in the monitoring cost (an exogenous component) can reduce the incidence of credit rationing.

the governments of developing countries usually regulate (or repress) their financial sectors to a greater extent (see Fry, 1995).[31]

In the model herein, the liberalization of financial intermediation has two opposite effects on capital formation. This may give rise to theoretical reasoning under which the governments of developing countries should repress their financial sectors to a greater extent. Such a case arises in developing countries when the negative effect of the exogenous component of financial development from consumption loans dominates the positive one from investment loans. On the other hand, for developed countries whose endogenous component of financial development is more advanced, one may observe the opposite case; that is, the positive effect of the exogenous component of financial development dominates the negative one. We will present this case below.

4. Equilibrium contracts and capital dynamics

After obtaining the equilibrium contracts, we now examine the dynamics of capital accumulation. Recall that each population of consumers and entrepreneurs is equal to 1. From consumers' equilibrium contracts, we see that for given parameters, the total amount borrowed by consumers is $\lambda w_{t+1}/R^H_{c,t+1}+(1-\lambda)\pi_{c,t}w_{t+1}/R^L_{c,t+1}$ if $k_{t+1}>k_c$, $\lambda w_{t+1}/R^H_{c,t+1}$ if $k_c \geq k_{t+1}>k_{\pi c}$, and 0 if $k_{t+1}\leq k_{\pi c}$. For entrepreneurs, they borrow an amount equal to $[\lambda+(1-\lambda)\pi_{e,t}]w_t$ if $k_t>k_e$, λw_t if $k_e \geq k_t>k_{\pi e}$, and 0 if $k_t\leq k_{\pi e}$. The total amount of capital produced by entrepreneur borrowers is $[\lambda p^H+(1-\lambda)p^L\pi_{e,t}]Qw_t$ if $k_t>k_e$, $\lambda p^H Qw_t$ if $k_e \geq k_t>k_{\pi e}$, and 0 if $k_t\leq k_{\pi e}$.

4.1. The possibilities of contracts offered

Depending on the values of k_t, k_{t+1}, k_e, $k_{\pi e}$, k_c, and $k_{\pi c}$, there are many possibilities regarding the equilibrium loan contracts offered by financial intermediation at time t. For an illustrative purpose, we consider the following cases.

Case A. Each bank does not offer loans to consumers and entrepreneurs.

All the borrowers are credit rationed in this case. All young lenders deposit their wages into banks; hence, total intermediated resources are nw_t. As each bank does not offer loans, time $t+1$ per firm capital stock is given by

$$k_{t+1} = nw_t Q\varepsilon.$$

In other words, all capital is produced by intermediaries' safe investment. By Eq. (4), this can be rewritten as

$$k_{t+1} = nQ\varepsilon A(1-\theta)N^{-\theta}k_t. \tag{25}$$

It is easy to verify that $\partial k_{t+1}/\partial k_t = nQ\varepsilon A(1-\theta)N^{-\theta}>0$ and $\partial^2 k_{t+1}/\partial k_t^2 = 0$.

[31] As is indicated, Fry (1995, page 325) concludes that banking in developing countries is more heavily taxed and suffers higher losses than that in OECD countries; hence, the costs of financial intermediation are higher in developing countries than in developed ones.

Case B. Each bank offers only a C_e^H contract.

In this case, time $t+1$ per firm capital stock is produced by intermediaries' safe investment as well as type-H entrepreneurs. Therefore,

$$k_{t+1} = (n-\lambda)w_t Q\varepsilon + \lambda p^H Q w_t.$$

Substituting Eq. (4) into the above equation, we have

$$k_{t+1} = \left[nQ\varepsilon + \lambda\left(p^H - \varepsilon\right)Q\right]A(1-\theta)N^{-\theta}k_t. \tag{26}$$

Obviously, $\partial k_{t+1}/\partial k_t = [nQ\varepsilon + \lambda\ (p^H - \varepsilon)Q]A(1-\theta)N^{-\theta} > 0$ and $\partial^2 k_{t+1}/\partial k_t^2 = 0$. Note that $\partial k_{t+1}/\partial k_t$ in this case is greater than that in Case A.

Case C. Each bank offers C_e^H and C_c^H contracts.

In this case, time $t+1$ per firm capital stock is given by

$$k_{t+1} = \left[nw_t - \lambda w_t - \lambda\frac{w_{t+1}}{R^H_{c,t+1}}\right]Q\varepsilon + p^H\lambda Q w_t,$$

which by Eqs. (4) and (10) can be rewritten as

$$k_{t+1} = \frac{\theta N[n\varepsilon + \lambda(p^H - \varepsilon)]QA(1-\theta)N^{-\theta}k_t + \dfrac{\lambda F}{A\theta N^{1-\theta}}}{\theta N + \lambda p^H(1-\theta)}. \tag{27}$$

Obviously, one can verify that $\partial k_{t+1}/\partial k_t > 0$ and $\partial^2 k_{t+1}/\partial k_t^2 = 0$.

Case D. Each bank offers C_e^H, C_c^H, and C_c^L contracts.

In this case, only type-L entrepreneurs are credit rationed and hence the time $t+1$ per firm capital stock is given by

$$k_{t+1} = \left[nw_t - \lambda w_t - \lambda\frac{w_{t+1}}{R^H_{c,t+1}} - (1-\lambda)\frac{w_{t+1}}{R^L_{c,t+1}}\right]Q\varepsilon + p^H\lambda Q w_t,$$

which by Eqs. (4) and (10) can be rewritten as

$$k_{t+1} = \frac{\theta N[n\varepsilon + \lambda(p^H - \varepsilon)]QA(1-\theta)N^{-\theta}k_t + \dfrac{F}{A\theta N^{1-\theta}}}{\theta N + p^H(1-\theta)}. \tag{28}$$

Obviously, one can verify that $\partial k_{t+1}/\partial k_t > 0$ and $\partial^2 k_{t+1}/\partial k_t^2 = 0$.

Case E. Each bank offers C_e^H, and C_e^L contracts.

The time $t+1$ per firm capital stock is given by

$$k_{t+1} = \left[nw_t - \lambda w_t - (1-\lambda)\pi_{e,t}w_t\right]Q\varepsilon + \lambda p^H Q w_t + (1-\lambda)p^L\pi_{e,t}Q w_t,$$

which can be rewritten as

$$k_{t+1} = \left[n\varepsilon + \lambda\left(p^H - \varepsilon\right) + (1-\lambda)\left(p^L - \varepsilon\right)\pi_{e,t}\right] QA(1-\theta)N^{-\theta}k_t. \tag{29}$$

From Eq. (29), one can verify that

$$\frac{\partial k_{t+1}}{\partial k_t} = \left[n\varepsilon + \lambda\left(p^H - \varepsilon\right) + (1-\lambda)\left(p^L - \varepsilon\right)\pi_{e,t} + (1-\lambda)\left(p^L - \varepsilon\right)\frac{\partial \pi_{e,t}}{\partial k_t}k_t\right] \times QA(1-\theta)N^{-\theta} \tag{30}$$

and

$$\frac{\partial^2 k_{t+1}}{\partial k_t^2} = \left[2(1-\lambda)\left(p^L - \varepsilon\right)\frac{\partial \pi_{e,t}}{\partial k_t} + (1-\lambda)\left(p^L - \varepsilon\right)k_t\frac{\partial^2 \pi_{e,t}}{\partial k_t^2}\right] QA(1-\theta)N^{-\theta}$$
$$= 2QA(1-\theta)N^{-\theta}(1-\lambda)\left(p^L - \varepsilon\right)\frac{\partial \pi_{e,t}}{\partial k_t}\left(1 - \frac{w_t Q\rho(p^L - \varepsilon)}{w_t Q\rho(p^L - \varepsilon) - F}\right). \tag{31}$$

Since $\partial \pi_{e,t}/\partial k_t > 0$, it is clear that $\partial k_{t+1}/\partial k_t > 0$ and $\partial^2 k_{t+1}/\partial k_t^2 < 0$.

Case F. Each bank offers C_e^H, C_c^H, and C_e^L contracts.

In this case,

$$k_{t+1} = \left[nw_t - \lambda w_t - (1-\lambda)\pi_{e,t}w_t - \lambda\frac{w_{t+1}}{R_{c,t+1}^H}\right] Q\varepsilon + \lambda p^H Q w_t + (1-\lambda)p^L \pi_{e,t} Q w_t,$$

which further implies that

$$k_{t+1} = \frac{\theta N\left\{\left[n\varepsilon + \lambda(p^H - \varepsilon) + (1-\lambda)(p^L - \varepsilon)\pi_{e,t}\right] QA(1-\theta)N^{-\theta}k_t + \dfrac{\lambda F}{A\theta N^{1-\theta}}\right\}}{\theta N + \lambda p^H(1-\theta)}. \tag{32}$$

Similar to the previous case, $\partial k_{t+1}/\partial k_t > 0$ and $\partial^2 k_{t+1}/\partial k_t^2 < 0$.

Case G. Each bank offers C_c^H, C_c^L, C_e^H, and C_e^L contracts.

In this case, time $t+1$ per firm capital stock is given as[32]

$$k_{t+1} = \left[nw_t - \lambda\frac{w_{t+1}}{R_{c,t+1}^H} - (1-\lambda)\pi_{c,t}\frac{w_{t+1}}{R_{c,t+1}^L} - \lambda w_t - (1-\lambda)\pi_{e,t}w_t\right] Q\varepsilon + \lambda p^H Q w_t + (1-\lambda)p^L \pi_{e,t} Q w_t,$$

[32] It is assumed that n is large enough to ensure that the value in the square brackets in the right-hand side of the equation is positive.

which can be rewritten since

$$k_{t+1} = \frac{\theta N\left\{\left[n\varepsilon + \lambda(p^H - \varepsilon) + (1-\lambda)(p^L - \varepsilon)\pi_{e,t}\right]QA(1-\theta)N^{-\theta}k_t + \dfrac{F}{A\theta N^{1-\theta}}\right\}}{\theta N + p^H(1-\theta)}. \tag{33}$$

Similar to Case E, one can show that $\partial k_{t+1}/\partial k_t > 0$ and $\partial^2 k_{t+1}/\partial k_t^2 < 0$.

4.2. Capital dynamics

We are now in a position to analyze the dynamics of capital accumulation. To simplify our analyses, we assume that $k_e > k_{\pi e}$. Moreover, a comparison between Case C and Case D reveals that there is no difference in capital accumulation between these two cases. Thus, we assume that $k_c = k_{\pi c}$. Given these two assumptions, we consider the following two cases: $k_{\pi e} < k_e < k_c$ and $k_{\pi e} < k_c < k_e$.[33] Furthermore, for an illustrative purpose, we also impose the following two conditions for parameters:

Condition 1. $1 < nQ\varepsilon A(1-\theta)N^{-\theta}$;

Condition 2. $\frac{\theta N + p^H(1-\theta)}{\theta N} > [n\varepsilon + \lambda(p^H - \varepsilon) + (p^L - \varepsilon)]QA(1-\theta)N^{-\theta}$.

We now consider each in turn.

Case 1. $k_{\pi e} < k_e < k_c$.

The dynamics of capital accumulation under this case are depicted in Fig. 1. Starting from an initial capital stock (denoted as k_0), all borrowers are credit rationed so that capital accumulates along with Line **A** (i.e., Eq. (25) in Case A). Condition 1 implies that Line **A** lies above the 45° line. Once $k_t > k_{\pi e}$, type-H entrepreneurs will borrow, but type-L entrepreneurs and both types of consumers are credit rationed; thus, capital accumulates along with Line **B** (i.e., Eq. (26) in Case B).

Capital will accumulate along with Line **B** until $k_t > k_e$, where, in addition to type-H entrepreneurs, a fraction of type-L entrepreneurs will borrow. As a result, capital accumulates along with Curve **E** (i.e., Eq. (29) in Case E). Note that Eq. (29) implies that k_{t+1} is equal to zero for a positive value of k_t; in other words, Curve **E** starts at somewhere below the 45 degree line. As is assumed, Curve **E** intersects Line **B** when $k_t = k_e$. Note that the amount of credit rationing on type-L entrepreneurs decreases as capital accumulates in this case. Moreover, type-L entrepreneurs will not borrow at $k_t = k_e$ so that Line **B** coincides with Curve **E** when $k_t = k_e$. Once capital reaches k_c', type-H consumers and a fraction of type-L consumers are indifferent in applying loans. This is so, because k_{t+1} is equal to k_c along with Curve **E** when k_t is equal to k_c'. In other words, capital accumulates along with Curve **G** (i.e., Eq. (33) in Case G) when $k_t > k_c'$. Note that the amount of credit

[33] The other case is $k_c < k_{\pi e} < k_e$, whose dynamics of capital accumulation are similar to Case 2 below.

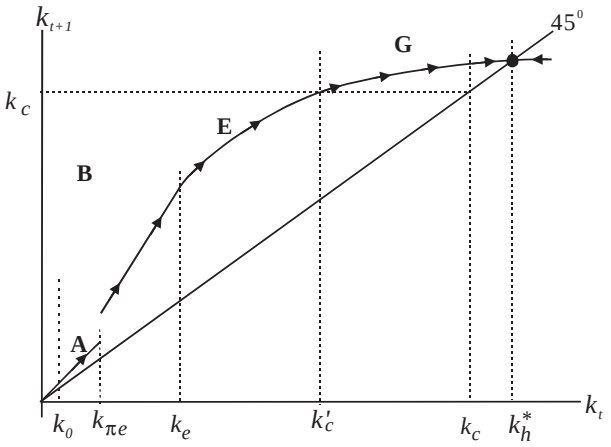

Fig. 1. Capital dynamics under Case 1.

rationing on type-L consumers decreases as capital accumulates in this case. As $\partial k_{t+1}/\partial k_t > 0$ and $\partial^2 k_{t+1}/\partial k_t^2 < 0$ under Case G, Curve **G** should cross the 45° line once; thus, there is a unique steady state with a relatively high level of capital stock k_h^*. Note that for similar reasons, Curve **E** coincides with Curve **G** at $k_t = k_c'$.

Case 2. $k_{\pi e} < k_c < k_e$.

Fig. 2 corresponds to this case. Similar to the previous case, starting from $k_t = 0$ capital accumulates along with Line **A**. For $k_t > k_{\pi e}$, capital accumulates along with Line **B** until it reaches k_c', at which all type-H consumers and a fraction of type-L consumers are about to borrow.[34] In other words, if $k_t > k_c'$, then capital accumulates along with Line **D** (i.e., Eq. (28) in Case D). Note the Eq. (28) implies that k_{t+1} is positive if $k_t = 0$.

Note that Line **B** coincides with Line **D** at $k_t = k_c'$, because consumers will not borrow when $k_t = k_c'$. Moreover, Condition 2 implies that the slope of Line **D** is less than one. As is shown, Line **D** crosses the 45° line at k_l^*. Note that $k_{t+1}/k_t = 1$ when $k_t = k_l^*$; hence, the value of k_l^* can be obtained from Eq. (28) as

$$\frac{k_{t+1}}{k_t} = 1 = \frac{\theta N\left\{[n\varepsilon + \lambda(p^H - \varepsilon)]QA(1-\theta)N^{-\theta} + \dfrac{F}{A\theta N^{1-\theta}k_l*}\right\}}{\theta N + p^H(1-\theta)}. \tag{34}$$

Capital accumulates along with Line **D** for $k_t > k_c'$ until k_t gets to k_e, at which point a fraction of type-L entrepreneurs are indifferent in applying (or not applying) for loans. Once k_t is greater than k_e, a fraction of type-L entrepreneurs will borrow and capital accumulates along with Curve **G**, which is Eq. (33) in Case G. Eq. (33) implies that, similar to Curve **E**, k_{t+1} is equal to zero for a positive value of k_t; thus, Curve **G** starts at

[34] It is assumed that if $k_t = k_c'$ along with Line **B**, then $k_{t+1} = k_c$. Equating k_{t+1} in Eq. (26) to k_c in Eq. (12), one can find that $k_c' = F/p^H[A(1-\theta)N^{-\theta}]^2[n\varepsilon + \lambda(1-p^H)]Q$.

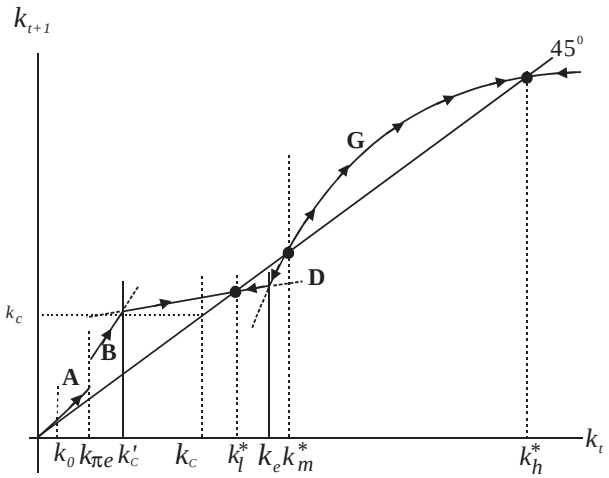

Fig. 2. Capital dynamics under Case 2.

somewhere below the 45 degree line. Note that, as shown in Fig. 2, k_e is assumed to be greater than k_l^*. Obtaining k_l^* from Eq. (34) and comparing it with k_e in Eq. (20), we see that the sufficient condition for $k_e > k_l^*$ is

$$\frac{\theta N + p^H(1-\theta)}{\theta N} > \left[n\varepsilon + \lambda\left(p^H - \varepsilon\right) + \left(p^L - \varepsilon\right)\right] QA(1-\theta)N^{-\theta}. \qquad \text{(Condition 2)}$$

According to Case G, Curve **G** should cross the 45° line twice.[35] Consequently, there are three steady states for an economy with an initial capital stock k_0 in this case: k_l^*, k_m^*, and k_h^*. It is also obvious that the steady-state k_m^* is not stable; therefore, we ignore it in the ensuing analysis. Note that type-H entrepreneurs and both types of consumers borrow in the steady-state k_l^* while all types of borrowers apply loans at the steady-state k_h^*.

It is obvious that the economy's steady-state equilibrium under Case 2 depends on the initial capital stock k_0. For developing countries whose initial capital stock is relatively low (i.e., $k_0 \in (0, k_m^*)$), their long-run steady-state equilibrium is k_l^*. On the other hand, for developed countries whose initial capital stock is relatively high (i.e., $k_0 > k_m^*$), their long-run steady-state equilibrium is k_h^*. Given that $k_h^* > k_l^*$, it is clear that the developing countries are likely to be trapped at a steady state with a low level of capital stock.[36]

If we compare Case 2 with Case 1, then we can infer that the cause of the development trap in Case 2 is that consumption loans appear too early in the process of capital accumulation.[37] Specifically, consumers start to borrow before type-L entrepreneurs in Case 2 while the reverse is true in Case 1. As will be shown in the next section, this may

[35] It is also possible that Curve **G** always lies below the 45° line, implying that type-L entrepreneurs will not borrow in any steady-state equilibrium. Obviously, this is not an interesting case and therefore we ignore it here.

[36] It should be easy to verify that the steady-state welfare of lenders, consumers, and entrepreneurs in k_h^* is greater than that in k_l^*.

[37] That is, type-H consumers and a fraction of type-L consumers start to borrow earlier than do type-L entrepreneurs.

be the reason as to why the governments of developing countries should repress their financial intermediations.

The following proposition formally summarizes these two cases.

Proposition 3. *Consider an economy with an initial capital stock k_0, $k_0>0$. Suppose that $k_{\pi e}<k_e$ and $k_{\pi c}=k_c$ as well as Conditions 1 and 2 hold for this economy. If $k_{\pi e}<k_e<k_c$, then there exists a unique, stable steady-state equilibrium, under which the steady-state capital stock is relatively high. If $k_{\pi e}<k_c<k_e$, then there may have three steady-state equilibria, under which two of them are stable and one is unstable. Of these two stable equilibria, one is characterized with a low level of steady-state capital stock (a development trap), while the other is characterized as a high level of steady-state capital stock.*

5. Financial repression, the intermediation cost, and capital accumulation

After deriving the dynamics of capital stock, we turn our attention to a government's repression policy on financial intermediation, which is represented by the magnitude of the intermediation cost. As asserted, the intermediation cost increases if the government represses its financial intermediation to a greater extent. Note that the high-capital-stock steady state in Case 1 possesses properties analogous to k_h^* in Case 2; hence, for simplicity, we only focus on Case 2 in examining the effects of a government policy of financial repression.

To begin with, we first observe the following results.

Lemma 1. *For a given k_t, a change in F leads to*

$$\text{(i)}\ \frac{\partial k_{t+1}}{\partial F}\Big|_{\text{Case A}}=0;\quad \text{(ii)}\ \frac{\partial k_{t+1}}{\partial F}\Big|_{\text{Case B}}=0;\quad \text{(iii)}\ \frac{\partial k_{t+1}}{\partial F}\Big|_{\text{Case D}}>0;$$
$$\text{(iv)}\ \frac{\partial k_{t+1}}{\partial F}\Big|_{\text{Case G}}<0 \text{ if } (1-\lambda)p^L\left(p^L-p^H\right)>p^H\left(p^L-\varepsilon\right). \tag{35}$$

The results of Lemma 1 are straightforward. In Case A where time $t+1$ capital stock is produced by intermediaries' safe investment, a change in the intermediation cost has no effect on capital accumulation. In Case B where type-H entrepreneurs borrow, a change in the intermediation cost still has no effect on the amount borrowed by type-H entrepreneurs and thereby it does not affect capital accumulation. In Case D where all type-H entrepreneurs, all type-H consumers, and a fraction of type-L consumers apply for loans, an increase in the intermediation cost raises the loan rate, which exacerbates the problem of asymmetric information on consumption loans and thereby reduces $\pi_{c,t}$. As a consequence, the amount borrowed by consumers decreases, which facilitates capital accumulation and hence shifts Line **D** up. In Case G, the effect of a change in F can be obtained by

$$\frac{\partial k_{t+1}}{\partial F}=\frac{\theta N}{\theta N+p^H(1-\theta)}\left[(1-\lambda)\left(p^L-\varepsilon\right)\frac{\partial \pi_{e,t}}{\partial F}\right]QA(1-\theta)N^{-\theta}k_t+\frac{1}{\rho}. \tag{36}$$

Recall that $\partial\pi_{e,t}/\partial F<0$ for a given k_t. Hence, the sign of $\partial k_{t+1}/\partial F$ is ambiguous. An increase in F exacerbates the problem of asymmetric information and thereby increases the amount of credit rationing for both consumption and investment loans (i.e., reducing $\pi_{c,t}$ and $\pi_{e,t}$). A reduction in $\pi_{c,t}$ facilitates capital accumulation while such a reduction in $\pi_{e,t}$ impedes capital accumulation. By using Eq. (22), Eq. (36) can be further rewritten as

$$\frac{\partial k_{t+1}}{\partial F}\Big|_{\text{Case E}} = \frac{\theta N}{\theta N + p^H(1-\theta)}\left\{\frac{1}{\rho} - \frac{(1-\lambda)(p^L-\varepsilon)p^L(p^L-p^H)}{p^H\rho(p^L-\varepsilon)^2} \times \left[\frac{w_tQ\rho}{w_tQ\rho - F/(p^L-\varepsilon)}\right]^2\right\}.$$

Since $w_tQ\rho/[w_tQ\rho - F/(p^L-\varepsilon)]>1$, one sees that $\partial k_{t+1}/\partial F<0$ for any k_t if Eq. (35) holds.[38]

We now examine the effects of a government's repression policy, measured by an increase in the intermediation costs, on capital accumulation. For an illustrative purpose, consider Case 2 where the intermediation costs are equal to F originally and the corresponding loci are Line **A**, Line **B**, Line **D**, and Curve **G** in Fig. 3 (the same as in Case 2). As is indicated in Case 2, the economy with an initial capital stock k_0 may be trapped at a steady state where the level of capital stock is low (i.e., k_l^* in Fig. 3). Assume now that the government represses its financial intermediation to a greater extent so that the intermediation costs are equal to F_1, with $F_1>F$. The corresponding loci for the case where the intermediation costs are equal to F_1 are Line **A**, Line **B**, Line **D′**, and Curve **G′**. From Lemma 1, it is clear that the loci of Line **A** and Line **B** are not affected while the locus of Line **D** shifts up to Line **D′** and the locus of Curve **G** shifts down to Curve **G′**.

The capital stock accumulates along with Line **A** for $k_t\le k_{\pi e}$ and along with Line **B** for $k_t>k_{\pi e}$. At the original level of F, consumption loans appear after k_c'. Due to the fact that $F_1>F$, it is clear that consumption loans will appear after k_c'', $k_c''>k_c'$.[39] Thus, capital accumulates along with Line **D′** after k_c''. Under Condition 2, Line **D′** crosses Curve **G′** after it intersects the 45° line; therefore, developing countries (with low levels of capital stock) still converge to a relatively low-capital-stock steady-state $k_l^{*\prime}$. Nevertheless, it is clear that $k_l^{*\prime}>k_l^*$, and hence financial repression raises the steady-state capital stock for developing countries.

The capital stock approaches $k_l^{*\prime}$ along with Line **D′** for a capital stock k_t, $k_c''<k_t<k_l^{*\prime}$. Similarly, the capital stock approaches $k_l^{*\prime}$ along with Curve **G′** and Line **D′** for a capital stock k_t, $k_l^{*\prime}<k_t<k_m^{*\prime}$. For $k_t>k_m^{*\prime}$, the capital stock accumulates along with Curve **G′** to arrive at $k_h^{*\prime}$. As a result, the capital stock of developed countries (with the initial capital stock being greater than $k_m^{*\prime}$) will converge to a high-capital-stock steady-state $k_h^{*\prime}$, which, according to Lemma 1, is less than k_h^*. In other words, financial repression in developed

[38] Obviously, Eq. (35) is a sufficient condition. The necessary condition involves the steady-state capital k_h^*, which, due to the fact that $\pi_{e,t}$ is highly non-linear, is not easy to obtain. We hence only present the sufficiency condition.

[39] Because $F_1>F$, k_c, the critical level of capital stock where consumption loans are about to appear under F_1 (denoted as k_c''), is greater than that under F (denoted as k_c').

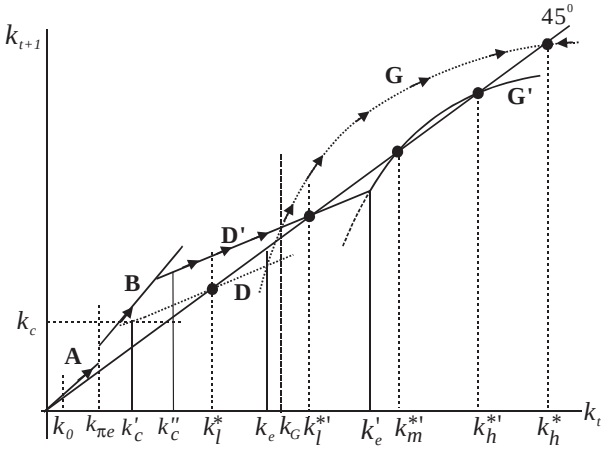

Fig. 3. Financial repression and capital dynamics under Case 2.

countries reduces the steady-state capital stock. This result provides a theoretical underpinning for why developing countries repress financial intermediation to a greater extent than do developed countries. The following proposition summarizes our analysis.

Proposition 4. *Suppose that the parameter conditions in Eq.* (35) *hold. Financial repression, which increases the intermediation cost, raises (reduces) the steady-state capital stock for developing (developed) countries.*

Note that the development trap that occurs in developing countries can be evaded if the government represses its financial intermediation to a greater extent under low levels of capital stock, but relaxes such a repression when the capital stock is relatively high. To see this, suppose that Line **D′** (under F_1) crosses Curve **G** (under F) at k_G (see Fig. 3). A government with an initial capital stock $k_0 \in (0,\ k_G)$ should repress its financial intermediation to a greater extent (so that the intermediation costs are equal to F_1). In this case, the economy's capital accumulates along with Line **A**, Line **B**, and Line **D′**. Once the capital stock arrives at k_G, the government can relax such a repression (so that the intermediation costs return to their original level F) and therefore the economy's capital stock accumulates along with Curve **G** to get k_h^*.[40] Obviously, in this case, the steady-state $k_l^{*\prime}$ can be avoided and we have the following proposition.

Proposition 5. *The development trap can be avoided if the developing economy with an initial capital stock $k_0 \in (0,\ k_G)$ represses its financial intermediation to a greater extent and relaxes such a repression when its capital stock is greater than k_G.*

It is clear that the development trap arises in developing countries (whose initial capital stock is relatively low), because financial intermediation in these countries does not allocate resources adequately. Specifically, at the low-capital-stock steady-state financial

[40] In other words, capital accumulates along with the arrows in Fig. 3.

intermediation allocates resources to type-H entrepreneurs and both types of consumers without financing type-L entrepreneurs' capital project.[41] Note that type-L entrepreneurs are more efficient capital borrowers, because on average they can convert one unit of time t output into p_Q^L units of time $t+1$ capital.[42] Without financing type-L entrepreneurs, the appearance of consumption loans impedes capital accumulation and hence leads developing countries to the steady state with a low level of capital stock. Interestingly, instead of adopting policies of financial liberalization, this paper suggests that it is optimal for governments of developing countries to adopt policies of financial repression.[43] Indeed, financial repression in these countries mainly represses consumption loans, which according to Modigliani (1986) facilitates capital investment.[44]

On the other hand, for developed countries whose initial capital stock is relatively high, financial intermediation allocates resources adequately as type-L entrepreneurs are also financed. In this case, though financial repression reduces consumption loans and thus facilitates capital investment, it also induces type-H entrepreneurs to pretend to be type-L ones and thereby exacerbates asymmetric information on investment loans, which impedes capital investment. As the latter effect dominates the former, it is clear that financial repression impedes capital investment for developed countries. Consequently, our model is able to explain why in reality developing countries repress their financial system to a greater extent than do developed ones.

6. Conclusion

It has long been suggested that governments of developing countries should adopt policies of financial liberalization. In reality, however, it is usually observed that governments of developing countries repress their financial systems to a greater extent than do developed ones. This paper develops a simple model that is able to explain why developing countries should repress their financial system to a greater extent.

We show that developing countries could be trapped at a low-capital-stock steady state while developed countries converge to a high-capital-stock steady state. This so-

[41] I.e., type-L entrepreneurs are credit rationed.

[42] Type-H entrepreneurs can convert one unit of time t output into $p^H Q$ units of time $t+1$ capital.

[43] We have assumed that the intermediation costs for investment and consumption loans are identical. One may assert that the components of intermediation costs may be different for investment and consumption loans and a government of developing countries may be able to impose policies of financial repression, which affect intermediation costs of investment and consumption loans at different magnitude. Specifically, in this case, the government can increase the intermediation costs of consumption loans while keep the intermediation costs of investment loans as low as possible. Nevertheless, in this case, one cannot rule out the possibility that the value of k_c is still less than k_e, and thereby Case 2 as well as the development trap occur. Of course, if the government can manipulate the intermediation costs such that k_c is always greater than k_e, then only Case 1 will arise and thereby the development trap will not occur.

[44] Indeed, evidence has pointed out that household credit is more repressed in developing countries than in developed ones. For example, the observation of the World Bank (see Box 7.4 in World Bank (1989, page 102)) indicates that only a small share of housing investment is financed by the formal financial sector in developing countries. Buckley (1994) reports that the average ratio of mortgage credit supplied by the formal sector to housing investment is less than 22% for developing countries while such a ratio is 85% for developed countries.

called development trap arises, because without government repression, financial intermediation of developing countries may allocate resources inadequately to consumption loans, which implies that the net resources of the economy channeled to capital investment decrease. On the other hand, financial intermediation of developed countries, which is more efficient than that of developing countries, allocates resources adequately to consumption and investment loans. Interestingly, it is shown that the development trap can be avoided if a government represses their financial intermediation to a greater extent (by increasing the costs of financial intermediation) for low levels of capital stocks and relaxes such a repression for high levels of capital stocks.

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