

## **Chapter 2. The Dynamical Interaction of Credit Market Development and Economic Growth\***

### **2.1. Introduction**

Economists have long asserted that the relationship between financial and economic development runs both ways, namely, that financial markets can facilitate economic development, and economic development in turn fosters the development of financial markets<sup>1</sup>. While this issue has undergone a resurgence of interest in recent years, on the theoretical side, most economists focus on channels through which financial markets can influence economic development, and only little attention has been paid to demonstrate the endogenous and dynamical interaction of financial and economic development. On the empirical side, although evidence that confirms the existence of a close relationship between financial and economic development is considerable in recent literature, some economists have further produced evidence indicating that the effects of financial development on economic growth differ between developing and developed countries. For example, by using the total credit to private sector (containing credit to households and firms) as a indicator of financial development, De Gregorio and Guidotti (1995) find that the coefficient of this indicator is bigger and much more significant in predicting growth rates of low- and middle-income countries than of high-income countries (developed countries).

The objective of this paper is to complement recent literature by emphasizing the dynamical interaction between financial markets and economic development. In particular, as recent theoretical models are rarely able to explain the result of De Gregorio and Guidotti (1995), we try to form a model which is able to provide some additional insights into understanding this result. We arrive at this purpose by considering a neoclassical growth model where both investment and consumption are financed via credit markets which are characterized with informational imperfections.

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\* I want to thank my advisor, Professor Richard Cothren, for his valuable comments. I also benefited from the discussion with Robert Bowles. Any remaining errors are my own.

<sup>1</sup> Gurley and Shaw (1955,1960), Goldsmith (1969), Mckinnon (1973), and others have provided considerable evidence in supporting this argument.

An important consequence of informational imperfections in credit markets is that borrowers are usually credit rationed. As a more developed credit market is able to overcome this imperfection, the level of credit rationing is reduced as credit markets develop. We show that the development of credit markets and the level of capital stock are related. This relationship is clear when credit to entrepreneurs is rationed, since in this case entrepreneurs will borrow and invest less, resulting in a lower level of capital. Causality may, however, run in the opposite direction. This result has been demonstrated by Ma and Smith (1996) and Bose and Cothren (1997); however, these are not able to explain the result derived by De Gregorio and Guidotti (1995). In contrast to Ma and Smith (1996) and Bose and Cothren (1997), we include both consumer and entrepreneurial credit to reconsider the credit market development. As is known (see Modigliani (1986) and Jappelli and Pagano (1994)), credit market imperfections may impede consumers from carrying out their unconstrained optimal consumption profiles and thus may result in a higher saving rate. Therefore, the development of credit markets may increase consumption loans, lower savings, and thus hurt economic growth.

In our framework, the relationship between credit market development and the capital accumulation path is ambiguous. The development of credit markets, on one hand, reduces the level of credit rationing to entrepreneurs, and on the other hand, it also benefits consumers and enables them to consume more. The decrease of credit rationing to entrepreneurs favors capital accumulation, but the decrease of credit rationing to consumers is harmful to capital accumulation. Of course, the effect of development of credit markets on consumer and entrepreneurial credit depends on different parameters and relates to the different level of capital stock. Specifically, we show that, at an early stage of credit market development, entrepreneurs may benefit first, and the capital accumulation path will be pushed up. This will continue until a critical level of capital stock is crossed, at which consumers' credit rationing is reduced. The latter effect of credit market development on consumers will adversely affect capital accumulation. This result can explain the work of De Gregorio and Guidotti (1995) as the total credit allocated to firms and households differs between developing and developed countries. Moreover, credit conditions of consumers and entrepreneurs are related and may depend on each other in this framework.

The structure of this paper is as follows. Section 2 presents the basic model and indicates that the development of credit markets on consumer and entrepreneurial credit depends on the different

level of capital stock. Section 3 shows that the capital accumulation path of the economy depends on credit market development. We determine equilibrium contracts to consumers and entrepreneurs for a given level of capital stock in section 4. In section 5, we illustrate the joint dependency of credit market development and capital accumulation by considering credit to consumers and entrepreneurs together. The conclusion and an extension are provided in section 6.

## 2.2 Model

This is a modified version of the model in Bose and Cothren (1997). The model is a simple two-period overlapping generation (OG) model and the economy is an infinite horizon with discrete time indexed by  $t = 0, 1, 2, 3, \dots$ . Each generation is identical in composition and size and contains two kinds of agents: lenders and borrowers. Moreover, borrowers are classified as two different types and are further divided into two groups, referred to as consumers and entrepreneurs. Each population of consumers and entrepreneurs is normalized to 1, respectively, and the total population is  $2 + n$ , where  $n$  is the population of lenders. In addition, there exists a competitive financial system in the economy whose activities are described below.

### 2.2.1. Lenders and Financial Intermediaries

Each lender is endowed with one unit of labor force in his first period of life and care only about his second period consumption. Thus, the typical activity for a lender in this framework is inelastically to supply his first period labor to the competitive market, earning the ruling wage rate and saving this wage rate for his second period consumption. As we will describe below, each lender can save through deposits in financial intermediaries in return for a sure interest rate.

The economy contains a competitive financial system<sup>2</sup>, in which every financial intermediary acts as a middleman between lenders and borrowers. An additional role for financial intermediaries to play is to provide access to safe investment. Assume that financial intermediaries can convert  $q$  units of time  $t$  consumption goods into  $q\Omega\varepsilon$  units of  $t+1$  capital, which can be rented to firms in

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<sup>2</sup> The existence of financial intermediaries has been justified in many papers. For the example, see Williamson (1986).

time  $t+1$  in return for a competitively determined rental rate,  $\rho_{t+1}$ . This is to say every financial intermediary can obtain a riskless gross rate of return equal to  $\Omega\varepsilon\rho_{t+1}$ . We assume that the size of each financial intermediary in this framework is large enough to eliminate risk and the competition between financial intermediaries ensures that each financial intermediary earns zero profits. To simplify our analysis, we further assume that the total supply of credit is always bigger than the demand<sup>3</sup>. Given that financial intermediaries earn zero profit, we see that the sure interest rate (deposit rate) should be equal to  $\Omega\varepsilon\rho_{t+1}$ , the riskless rate of return to financial intermediaries. We denote this riskless rate of return as  $r_{t+1}$  hereafter.

### 2.2.2 Consumer Borrowers

We have two kinds of consumers: Type  $H$  and Type  $L$  consumers. Consumers' types refer to the probability of getting a single unit of labor endowment in their second period of life. With probability  $p_i$ ,  $i = H, L$ , a Type  $i$  consumer will get one unit of labor in his second period of life, and with probability  $1 - p_i$ , he will get nothing. Assuming that  $1 \geq p_L > p_H \geq 0$  is satisfied, one can refer to Type  $H$  as high-risk consumers and Type  $L$  as low-risk ones. Neither consumer type is endowed with first period labor; thus, each must borrow from financial intermediaries for the first period consumption. To introduce asymmetric information, we further assume that only a consumer knows his own types. A  $\lambda \in (0, 1)$  fraction of consumers is Type  $H$ .

In order for financial intermediaries to separate these two types of consumer borrowers, we assume that consumers have different preferences. Specifically, the utility function for low-risk consumers is  $c_{t,t} + \beta c_{t,t+1}$  and  $c_{t,t}$  for the high-risk, where  $c_{t,t}$  and  $c_{t,t+1}$  are the first and second period consumption of generation  $t$  consumers. Therefore, the utility level is 0 if high-risk consumers are not granted credit in the first period. For low-risk consumers, this will be  $\beta p_L w_{t+1}$ , where  $p_L w_{t+1}$  is the expected income of low-risk consumers in time  $t+1$ .

Under this setting, it is obvious that, to induce low-risk consumers to enter the credit market,

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<sup>3</sup> That is, assume that  $n$  is sufficiently large. This assumption is not essential in this framework and only serves to simplify our analysis to the extent that the interest rate is not influenced by the contracting regime.

the discount factor,  $\beta$ , has to be small. Specifically, the loan rate charged to low-risk consumers has to be less than or equal to  $1/\beta$ . Otherwise, low-risk consumers have no incentives to borrow. Assuming that  $\beta$  is small enough, we see that low-risk consumers are all inclined to borrow all their expected second period income,  $p_L w_{t+1}$ . As financial intermediaries face an opportunity cost of lending equal to  $\Omega \varepsilon \rho_{t+1}$  and they earn zero profit, the following condition should be satisfied in any contract:

$$p_L w_{t+1} = q \Omega \varepsilon \rho_{t+1}, \quad (1)$$

where  $q$  is the loan size to low-risk borrowers.

In this framework, low-risk consumers have no incentives to be considered as the high-risk. Therefore, as in the work of Bose and Cothren (1997), the separation of these two types of consumers can be achieved by distorting the first best contract of low-risk consumers to induce a self-selection. The best contract to high risk consumers specifies that the loan rate ( $R_{cH,t+1}$ ) is  $\Omega \varepsilon \rho_{t+1} / p_H$ ; and the maximum attainable quantity is  $w_{t+1} / R_{cH,t+1}$ , where the subscript  $cH$  represents high-risk consumers. We denote this contract as  $C_{cH,t}$ . To prevent high-risk consumers from choosing a low-risk contract, financial intermediaries must distort the low-risk contract, so that high-risk consumers are at least indifferent between accepting  $C_{cH,t}$  and  $C_{cL,t}$ .

Following the work of Bose and Cothren (1997), financial intermediaries separate borrowers by either rationing or screening some fraction of consumers who apply for the low-risk contract. We express the contract intended for low-risk consumers as  $C_{cL,t} = \{ \{ \phi_t^c, \pi_t^c, q_{cL,t}^r, R_{cL,t}^r \}, \{ (1 - \phi_t^c), q_{cL,t}^s, R_{cL,t}^s \} \}$ . With probability  $\phi_t^c$ , consumers who apply for this contract are not screened. If consumers are not screened, the probability of getting a loan is  $\pi_t^c$ , and the loan size and loan rate are  $q_{cL,t}^r$  and  $R_{cL,t}^r$ . With probability  $1 - \phi_t^c$ , consumers are screened. If consumers are screened and found to be the high-risk, it is optimal for financial intermediaries not to grant credit to the consumer, because by doing this financial intermediaries can make  $C_{cL,t}$  as unattractive as possible to the high-risk. On the other hand, if a consumer is found to be the low-risk, he gets loans, whose terms are  $q_{cL,t}^s$  and  $R_{cL,t}^s$ . If  $\phi_t^c = 1$ , we say that consumer credit is under a rationing regime, as only a rationing contract is offered to consumers. However, there will be a screening contract if

$\phi_t^c < 1$ . Moreover, the screening technology will absorb  $\delta$  unit of resources when it is applied.

Before we determine the equilibrium contract  $C_{cL}$ , note that equation (1) can be used to characterize the loan rates and loan sizes offered by financial intermediaries in any contracting regime as

$$R_{cL,t}^i = \frac{\Omega \varepsilon \rho_{t+1}}{P_L} \quad (2)$$

and

$$q_{cL,t}^i = \frac{P_L W_{t+1}}{\Omega \varepsilon \rho_{t+1}}, \quad (3)$$

where  $i = r, s$ . Note that the superscript  $r$  (rationing) and  $s$  (screening) refer to contract terms in  $C_{cL,t}$ . In equilibrium, financial intermediaries must offer the preferred contract in which borrowers have no incentive to deviate. Therefore, the alternative contract most preferring to low-risk consumers can be derived as follows:

*Proposition 1.*

(1) If  $\beta > \frac{(1-\delta)}{\Omega \varepsilon \rho_{t+1}} \equiv \beta^*$ , in equilibrium financial intermediaries offer a rationing contract to

consumers. That is,  $\phi_t^c = 1$ , and the probability of getting credit,  $\pi_t^c$ , is equal to  $\frac{P_H}{P_L}$ .

(2) If  $\beta < \frac{(1-\delta)}{\Omega \varepsilon \rho_{t+1}} \equiv \beta^*$ , in equilibrium financial intermediaries offer a screening contract to

consumers, where  $\pi_t^c = 1$  and  $\phi_t^c = \frac{P_H}{P_L}$ .

(3) If  $\beta = \frac{(1-\delta)}{\Omega \varepsilon \rho_{t+1}} \equiv \beta^*$ , financial intermediaries are indifferent between offering the rationing

and screening contracts in equilibrium.

Proof: See Appendix C.

The explanation underlying Proposition 1 follows one's intuition. The net payoff of consumers in states of rationing is  $\beta p_L W_{t+1}$ . In states of screening, the net payoff is

$(1-\delta)p_L w_{t+1} / \Omega \varepsilon \rho_{t+1}$ . Clearly, the rationing states dominate the screening if  $\beta p_L w_{t+1} > (1-\delta)p_L w_{t+1} / \Omega \varepsilon \rho_{t+1}$ , or  $\beta > (1-\delta) / \Omega \varepsilon \rho_{t+1} \equiv \beta^*$ . Note that a decrease in the screening cost will make the screening contract more attractive to consumers. Also, we have assumed that  $R \leq 1/\beta$  to ensure that low-risk consumers will have incentives to borrow. Therefore, given (2) and Proposition 1, it must be the case that

$$p_L \geq 1 - \delta. \quad (4)$$

### 2.2.3. Entrepreneur Borrowers

An entrepreneur in time  $t$  cares only about in time  $t+1$  consumption and is endowed with one investment project in time  $t$ . This project can be used to produce time  $t+1$  capital using a linear technology with time  $t$  inputs. The types of entrepreneurs refer to the probability of success of their projects. With probability  $p_i$ ,  $i = H, L$ , a type  $i$  entrepreneur's investment project can convert  $q$  units of time  $t$  output into  $q\Omega$  units of time  $t+1$  capital. Assuming that  $1 \geq p_L > p_H \geq 0$  is satisfied, we call Type  $L$  entrepreneurs low-risk entrepreneurs. Moreover, since entrepreneurs' capital technology is linear, we need to impose a maximal scale for each investment project. We assume that this maximal scale at time  $t$  is equal to the wage rate at the same period. In essence, this assumption ties the maximal scale to the economy's current capital stock

Since time  $t$  entrepreneurs are not endowed with outputs, they must borrow from financial intermediaries to implement their projects. To induce separating contracts, we assume that the investment project of a low-risk entrepreneur can be used to produce home product without any input. However, if no funding is derived by high-risk entrepreneurs, they consume nothing in their life. The amount of home product a low-risk entrepreneur's project can produce is fixed and equal to  $Z$ .

All time  $t$  entrepreneurs become firm operators at time  $t+1$ . A firm operator can hire labor and capital to produce time  $t+1$  output according to the following production technology:

$$y_{t+1} = k_{t+1}^\theta L_{t+1}^{1-\theta}, \quad (5)$$

where  $k_{t+1}$  and  $L_{t+1}$  are the amounts of capital and labor employed by each firm and  $\theta < 1$ . Since the labor and capital markets are competitive, the rental rates of labor and capital in time  $t+1$  are

$$w_{t+1} = (1 - \theta) k_{t+1}^\theta L_{t+1}^{-\theta} \quad (6)$$

and

$$\rho_{t+1} = \theta k_{t+1}^{\theta-1} L_{t+1}^{1-\theta}, \quad (7)$$

respectively.

Similar to consumer borrowers, financial intermediaries are able to separate these two types of entrepreneurs by distorting the first best contract to low-risk entrepreneurs. The first best contract for high-risk entrepreneurs,  $C_{eH,t}$ , is  $C_{eH,t} = (q_{eH,t}, R_{eH,t}) = (w_t, \Omega \varepsilon \rho_{t+1} / p_H)$ . The contract intended for low-risk entrepreneurs  $C_{eL}$  can be expressed as  $C_{eL} = [\{\phi_t^e, \pi_t^e, q_{eL,t}^r, R_{eL,t}^r\}, \{(1 - \phi_t^e), q_{eL,t}^s, R_{eL,t}^s\}]$ , where  $\phi, \pi, q, R$  are as defined for consumer borrowers except that the subscript  $e$  refers to entrepreneurs. Note that the screening technology will absorb  $\delta$  units when it is applied. As a result, each Type  $L$  entrepreneur has to borrow  $(1 + \delta) q_{eL,t}^s$  to implement his project at maximal scale<sup>4</sup>. The optimal contract for low-risk entrepreneurs,  $C_{eL}$  is determined as follows:

*Proposition 2:*

- (1) If  $Z > \frac{(p_L - \varepsilon)}{p_L + \varepsilon \delta} \Omega \rho_{t+1} w_t p_L \equiv Z^*$ , low-risk entrepreneurs prefer a rationing contract,

whose terms are

$$\pi_t^e = (1 - \varepsilon / p_H) / (1 - \varepsilon / p_L) \text{ and } \phi_t^e = 1$$

$$R_{eL,t}^r = \Omega \varepsilon \rho_{t+1} / p_L \text{ and } q_{eL,t}^r = w_t$$

- (2) If  $Z < \frac{(p_L - \varepsilon)}{p_L + \varepsilon \delta} \Omega \rho_{t+1} w_t p_L \equiv Z^*$ , low-risk entrepreneurs prefer a screening contract,

whose terms are

$$\pi_t^e = 1, \text{ and } \phi_t^e = [p_L (1 - \frac{\varepsilon}{p_H}) + \varepsilon (1 + \delta)] / (p_L + \varepsilon \delta)$$

$$R_{eL,t}^r = \Omega \varepsilon \rho_{t+1} [1 + \delta (1 - \phi_t^e)] / p_L \phi_t^e \text{ and } R_{eL,t}^s = 0$$

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<sup>4</sup> That is, each entrepreneur uses  $q_{eL,t}^s$  to implement his project, and  $\delta q_{eL,t}^s$  for the screening technology.



$$q_{eL,t}^r = w_t \text{ and } q_{eL,t}^s = w_t$$

(3) If  $Z = \frac{(p_L - \varepsilon)}{p_L + \varepsilon \delta} \Omega \rho_{t+1} w_t p_L \equiv Z^*$ , low-risk entrepreneurs are indifferent between a rationing and a screening contract.

Proof: See Appendix D.

The intuition underlying this result is similar to Proposition 1. Note that  $(p_L - \varepsilon)/(p_L + \varepsilon \delta)$  is a decreasing function of  $\delta$ . Thus, a decrease in the screening cost will make the screening contract more attractive.

### 2.3. The Capital Accumulation Path

Proposition 1 and 2 display that the equilibrium loan contracts for low-risk consumers and entrepreneurs depend upon the rate of return to capital,  $\rho_{t+1}$ , the wage rates,  $w_t$  and  $w_{t+1}$ , and other parameters. Since total employment (including all young lenders and old consumers who have labor endowment) equals  $\lambda p_H + (1 - \lambda)p_L + n$  and is independent of time, and the total number of firms is 1 (all entrepreneurs), these results imply that the equilibrium contracts in time  $t$  depend upon per firm capital stock in time  $t$  and  $t+1$ . As the equilibrium contracts will influence the level of capital stock, in turn, we will show in this section that the capital accumulation path of the economy also depends upon the terms of equilibrium contracts to consumers and entrepreneurs. Since there are two groups of borrowers and two kinds of contracts, therefore, we have four cases to consider.

***Case 1: The rationing contract is offered both to consumers and entrepreneurs; that is, both  $\beta > \beta^*$  and  $Z > Z^*$  are satisfied.***

In this case, some fraction of low-risk borrowers in each groups is not granted credit. High-risk consumers borrow the amount equal to  $\frac{p_H w_{t+1}}{\Omega \varepsilon \rho_{t+1}}$  and low-risk consumers borrow  $\frac{p_L w_{t+1}}{\Omega \varepsilon \rho_{t+1}}$ , so the total resources consumed by consumers are given as

$$\lambda \frac{p_H w_{t+1}}{\Omega \varepsilon \rho_{t+1}} + (1 - \lambda) \pi_t^c \frac{p_L w_{t+1}}{\Omega \varepsilon \rho_{t+1}} = [\lambda p_H + (1 - \lambda) \pi_t^c p_L] \frac{w_{t+1}}{\Omega \varepsilon \rho_{t+1}}. \quad (8)$$

Both high- and low-risk entrepreneurs borrow  $w_t$  and thus the total resources used by entrepreneurs are

$$\lambda w_t + (1 - \lambda) \pi_t^e w_t = [\lambda + (1 - \lambda) \pi_t^e] w_t. \quad (9)$$

This yields an amount of capital equal to

$$\lambda w_t p_H \Omega + (1 - \lambda) w_t \pi_t^e p_L \Omega. \quad (10)$$

As the number of firms is  $I$ , the per firm capital stock in time  $t+1$  can be expressed as

$$k_{t+1} = [\lambda p_H + (1 - \lambda) \pi_t^e p_L] \Omega w_t + [n w_t - \lambda w_t - (1 - \lambda) \pi_t^e w_t - [\lambda p_H + (1 - \lambda) \pi_t^c p_L] \frac{w_{t+1}}{\Omega \varepsilon \rho_{t+1}}] \Omega \varepsilon$$

$$\text{or, } k_{t+1} = [\lambda p_H + (1 - \lambda) \pi_t^e (p_L - \varepsilon) + (n - \lambda) \varepsilon] \Omega w_t - \frac{w_{t+1}}{\rho_{t+1}} (\lambda p_H + (1 - \lambda) \pi_t^c p_L).$$

Substituting the rental rates of labor and capital in time  $t+1$  and knowing that labor employed by each firm is independent of time, we finally derive per firm capital stock as

$$k_{t+1} = \frac{[\lambda p_H + (1 - \lambda) \pi_t^e (p_L - \varepsilon) + (n - \lambda) \varepsilon] \theta L}{(\lambda p_H + (1 - \lambda) p_L \pi_t^c) (1 - \theta) + \theta L} \Omega w_t.$$

Since the time  $t$  wage rate,  $w_t$ , is equal to  $(1 - \theta) k_t^\theta L^{-\theta}$ , we can rewrite this equation as

$$k_{t+1} = \frac{[\lambda p_H + (1 - \lambda) \pi_t^e (p_L - \varepsilon) + (n - \lambda) \varepsilon] \theta (1 - \theta) \Omega L^{1-\theta}}{(\lambda p_H + (1 - \lambda) \pi_t^c p_L) (1 - \theta) + \theta L} k_t^\theta = A_{r,r} k_t^\theta, \quad (11)$$

where  $A_{r,r}$  is defined implicitly and the first and second subscripts of  $A$  denote the contract forms offered to entrepreneurs and consumers, respectively (both are rationing in this case). Equation (11) is the dynamic path of capital accumulation in this case. We refer to this capital accumulation path as ‘Path RR’. Given (11), the only non-trivial steady state in this case,  $k_{r,r}^{ss}$ , is given by

$$k_{r,r}^{ss} = A_{r,r}^{\frac{1}{1-\theta}}. \quad (12)$$

Note that since  $\frac{\partial A_{r,r}}{\partial \pi_t^e} > 0$  and  $\frac{\partial A_{r,r}}{\partial \pi_t^c} < 0$ , the decrease in credit rationing of entrepreneurs will shift

the capital accumulation curve up, while the decrease of credit rationing of consumers shifts the

curve down.

**Case 2: The screening contract is offered to both consumers and entrepreneurs; that is, both  $\beta < \beta^*$  and  $Z < Z^*$  are satisfied.**

Financial intermediaries will screen some fraction of low-risk consumers and entrepreneurs. In this situation all low-risk borrowers are granted credit. The total resources consumed by consumers and used by entrepreneurs are

$$[\lambda p_H + (1-\lambda)p_L] \frac{w_{t+1}}{\Omega \varepsilon \rho_{t+1}} \quad (13)$$

and

$$\lambda w_t + (1-\lambda)[\phi_t^e w_t + (1-\phi_t^e)w_t(1+\delta)] = w_t[\lambda + (1-\lambda)(1+\delta(1-\phi_t^e))], \quad (14)$$

respectively. The capital stocks produced by entrepreneurs are equal to

$$[\lambda p_H + (1-\lambda)p_L] w_t \Omega. \quad (15)$$

Therefore, per firm capital stocks in time  $t+1$  can be derived as

$$k_{t+1} = [\lambda p_H + (1-\lambda)p_L] w_t \Omega + [nw_t - [\lambda + (1-\lambda)(1+\delta(1-\phi_t^e))]w_t - [\lambda p_H + (1-\lambda)p_L] \frac{w_{t+1}}{\Omega \varepsilon \rho_{t+1}}] \Omega \varepsilon.$$

After some manipulations, we finally derive per firm capital stocks at time  $t+1$  as

$$k_{t+1} = \frac{[\lambda p_H + (1-\lambda)(p_L - (1+\delta(1-\phi_t^e))\varepsilon) + (n-\lambda)\varepsilon] \theta (1-\theta) \Omega L^{1-\theta}}{[\lambda p_H + (1-\lambda)p_L](1-\theta) + \theta L} k_t^\theta = A_{s,s} k_t^\theta. \quad (16)$$

The capital accumulation path in this case is referred to as ‘Path SS’, and the non-trivial steady state is given by

$$k_{s,s}^{ss} = A_{s,s}^{\frac{1}{1-\theta}}. \quad (17)$$

Note that  $\frac{\partial A_{s,s}}{\partial \delta} < 0$  so that the decrease in the screening cost will shift the capital accumulation curve up.

**Case 3: Financial intermediaries offer entrepreneurs the rationing contract and consumers the screening; that is,  $Z > Z^*$  and  $\beta < \beta^*$ .**

The total resources consumed by consumers are given in (13). Entrepreneurs will borrow the amount given in (9) and thus per firm capital is

$$k_{t+1} = [\lambda p_H + (1-\lambda)p_L \pi_t^e] + [nw_t - \lambda w_t - (1-\lambda)\pi_t^e - [\lambda p_H + (1-\lambda)p_L] \frac{w_{t+1}}{\Omega \epsilon \rho_{t+1}}] \Omega \epsilon .$$

The capital accumulation path in this case (referred to as ‘Path RS’) is

$$k_{t+1} = \frac{[\lambda p_H + (1-\lambda)\pi_t^e (p_L - \epsilon) + (n-\lambda)\epsilon] \theta (1-\theta) \Omega L^{1-\theta}}{[\lambda p_H + (1-\lambda)p_L] (1-\theta) + \theta L} k_t^\theta = A_{r,s} k_t^\theta . \quad (17)$$

The only non-trivial steady state is

$$k_{r,s}^{ss} = A_{r,s}^{\frac{1}{1-\theta}} . \quad (18)$$

Note that since  $\frac{\partial A_{r,s}}{\partial \pi_t^e} > 0$ , the decrease of credit rationing of entrepreneurs will shift the capital accumulation curve up.

**Case 4. Financial intermediaries offer entrepreneurs the screening contract and consumers the rationing contract; that is,  $Z < Z^*$  and  $\beta > \beta^*$ .**

In this case, consumers consume the amount given in (8) and entrepreneurs borrow the amount in (14). The per firm capital stock is given by

$$k_{t+1} = [\lambda p_H + (1-\lambda)(p_L - (1+\delta(1-\phi_t^e))\epsilon) + (n-\lambda)\epsilon] w_t \Omega - [\lambda p_H + (1-\lambda)p_L \pi_t^c] \frac{w_{t+1}}{\rho_{t+1}} .$$

The capital accumulation path (referred to as ‘Path SR’) in this case is

$$k_{t+1} = \frac{[\lambda p_H + (1-\lambda)(p_L - (1+\delta(1-\phi_t^e))\varepsilon + (n-\lambda)\varepsilon)\theta(1-\theta)\Omega L^{1-\theta}]}{[\lambda p_H + (1-\lambda)p_L \pi_t^c](1-\theta) + \theta L} k_t^\theta = A_{s,r} k_t^\theta. \quad (19)$$

The only non-trivial steady state in this case is

$$k_{s,r}^{ss} = A_{s,r}^{\frac{1}{1-\theta}}. \quad (20)$$

As  $\frac{\partial A_{s,r}}{\partial \pi_t^c} < 0$ , the decrease of credit rationing of consumers will shift the capital accumulation curve down.

These four cases indicate that the capital accumulation path depends on the equilibrium contracts of consumers and entrepreneurs. To proceed further we need to establish the relationships of the capital accumulation paths among these cases. To begin, note that the resources consumed by consumers in screening are bigger than in rationing. This can be seen by comparing (8) and (13). In other words, the resources left for financial intermediaries to produce capital are smaller in the case where consumer credit is in a screening regime than in the case where it is in a rationing. As a result we have the relation  $A_{r,r} > A_{r,s}$  and  $A_{s,r} > A_{s,s}$ . Second, the resources used by entrepreneurs in screening include a fully funded investment project plus screening costs. As a result financial intermediaries have fewer resources to produce capital when entrepreneurs are screened rather than rationed. However, entrepreneurs can produce more capital in screening. Therefore, the overall effect of the change of contracting regimes of entrepreneurs on capital production is ambiguous. Proposition 3 below establishes this relationship.

*Proposition 3.*

Assume that, compared to a rationing regime, the decrease of capital produced by financial intermediaries in a screening regime of entrepreneurial credit is  $\Delta Fis$  and the increase of capital produced by entrepreneurs in a screening regime is  $\Delta Ents$ . Then, there exists a  $\delta^*$ , where if  $\delta < \delta^*$ ,  $\Delta Ents > \Delta Fis$ . If  $\delta > \delta^*$ ,  $\Delta Ents < \Delta Fis$ .

Proof: See Appendix E.

The intuition underlying Proposition 3 is clear. If the screening cost is high ( $\delta > \delta^*$ ), the

resources lost in the process of screening entrepreneurs is large and financial intermediaries will produce little capital. Consequently, the relation  $\Delta Ents < \Delta Fis$  could hold. We assume that  $\delta < \delta^*$  in the remainder of this paper. Therefore, the relation  $A_{s,r} > A_{r,r}$  and  $A_{s,s} > A_{r,s}$  are satisfied.

Finally, a comparison of (11) and (16) reveals that any relationship between  $A_{r,r}$  and  $A_{s,s}$  is possible, depending upon the values of  $\delta$  and  $\varepsilon$ . If  $\delta$  and  $\varepsilon$  are sufficiently large,  $A_{r,r} > A_{s,s}$ ; otherwise,  $A_{r,r} < A_{s,s}$ <sup>5</sup>. Overall, we have two cases:  $A_{s,r} > A_{s,s} > A_{r,r} > A_{r,s}$  or  $A_{s,r} > A_{r,r} > A_{s,s} > A_{r,s}$ .

## 2.4. Equilibrium Contract

As  $w_t$ ,  $w_{t+1}$ , and  $\rho_{t+1}$  determine equilibrium contracts for consumers and entrepreneurs and equilibrium contracts, in turn, determining the capital accumulation path, we see that capital stock in time  $t$  and contracting regimes of consumers and entrepreneurs are jointly determined. In particular, this mutual dependency is more complicated as contracting regimes of entrepreneurs and consumers are related and may depend on each other. Thus, to be able to determine the equilibrium capital dynamic path in the next section, we have to illustrate this relationship more clearly in this section. To make this illustration as simple as possible, we determine equilibrium contract to consumers and entrepreneurs separately in this section. Note that we consider the case that  $A_{s,r} > A_{r,r} > A_{s,s} > A_{r,s}$ .

### 2.4.1 Equilibrium Contract to Consumers

According to Proposition 1, the equilibrium contract to consumers depends on the relationship between  $\beta$  and  $\beta^*$ , which is defined as  $\frac{(1-\delta)}{\Omega\varepsilon\rho_{t+1}}$ . Substituting for  $\rho_{t+1}$  and given that

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<sup>5</sup> As shown in (11) and (16), the relationship between  $A_{r,r}$  and  $A_{s,s}$  is quite complicated. We are not able to find the critical values of  $\delta$  and  $\varepsilon$  for which a clear-cut relation of  $A_{r,r}$  and  $A_{s,s}$  can be derived. Nonetheless, it is easy to see that any relationship between  $A_{r,r}$  and  $A_{s,s}$  is possible, and this relationship is influenced by  $\delta$  and  $\varepsilon$ .

$k_{t+1} = Ak_t^\theta$  (as shown in the last section), we derive

$$\beta^*(k_t) = \frac{(1-\delta)}{\Omega \varepsilon \rho_{t+1}} = \frac{(1-\delta)}{\Omega \varepsilon \theta L^{1-\theta}} k_{t+1}^{1-\theta} = hA^{1-\theta} k_t^{\theta(1-\theta)}, \quad (22)$$

where  $h$  is defined implicitly. As shown in Proposition 1, for a given  $k_t$  the equilibrium contract to consumers will be the rationing contract if  $\beta > \beta^*(k_t)$  holds and the screening contract if  $\beta < \beta^*(k_t)$ . Given the fact that the equilibrium contract to entrepreneurs will influence capital stock as well, one sees that the relationship between  $\beta$  and  $\beta^*(k_t)$  is also determined by entrepreneurial credit. To remote the effect of entrepreneurial credit in this section, we provide two cases to discuss the equilibrium contract to consumers as entrepreneurial credit is fixed under a rationing regime and screening regime, respectively.

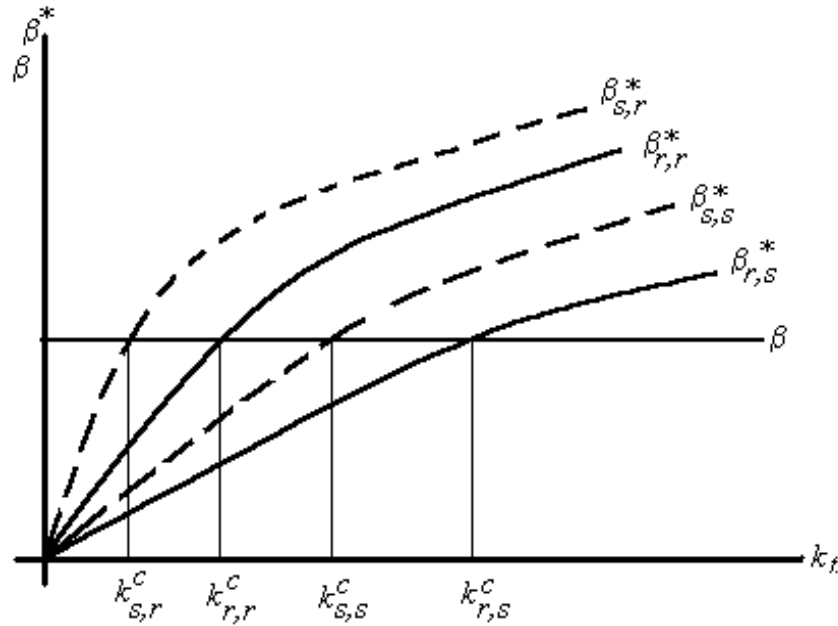


Figure 2.1.  $\beta$  and  $\beta^*(k_t)$  in four capital accumulation paths.

Case 1: Entrepreneurial credit is in a rationing regime.

If entrepreneurial credit is in a rationing regime, the capital accumulation path is either Path RR or Path RS, depending on the relationship between  $\beta$  and  $\beta^*(k_t)$ . Substituting  $A_{r,r}$  and  $A_{r,s}$

into (22), we derive the corresponding  $\beta^*(k_t)$  as  $\beta_{r,r}^*(k_t)$  and  $\beta_{r,s}^*(k_t)$ , respectively. Given that  $A_{r,r} > A_{r,s}$ , we see that, for a given  $k_t$ ,  $\beta_{r,r}^*(k_t) > \beta_{r,s}^*(k_t)$ . We plot the relationship of  $\beta$ ,  $\beta_{r,r}^*(k_t)$  and  $\beta_{r,s}^*(k_t)$  in Figure 2.1 (solid lines). Note that, as shown in the figure, we denote  $k_{r,r}^c$  and  $k_{r,s}^c$  as the capital level that equates  $\beta_{r,r}^*(k_t)$  and  $\beta_{r,s}^*(k_t)$  to  $\beta$ , respectively. Then, we have the following areas.

*Area I:*  $k_t < k_{r,r}^c$ .

Since  $\beta_{r,r}^*(k_t) > \beta$  in this area, a rationing contract is offered to consumers in equilibrium and capital accumulates along Path RR.

*Area II:*  $k_{r,r}^c < k_t < k_{r,s}^c$

The equilibrium contract to consumers will be a rationing contract if  $\beta > \beta_{r,r}^*(k_t)$  or a screening contract if  $\beta_{r,s}^*(k_t) > \beta$ . Obviously, neither condition is satisfied in this area. If neither a rationing nor a screening is the equilibrium contract to consumers, according to Proposition 1, the third possibility is that financial intermediaries are indifferent between offering a rationing and screening contract to consumers. Obviously, under such a situation, the relation  $\beta^*(k_t) = \beta$  should hold. Since  $\beta_{r,r}^*(k_t) > \beta > \beta_{r,s}^*(k_t)$ , it is possible that financial intermediaries offer a linear combination of rationing and screening to consumers and the relation  $\beta^*(k_t) = \beta$  is satisfied. We call this a mixed contract. Proposition 4 states properties of this mixed contract.

*Proposition 4.* For any  $k_t$ , if entrepreneurial credit is in a rationing regime and the relation  $\beta_{r,r}^*(k_t) > \beta > \beta_{r,s}^*(k_t)$  holds, then there exists a  $\mu_t \in [0,1]$  and an equilibrium at time t, where financial intermediaries offer the rationing contract with probability  $\mu_t$  and the screening contract with probability  $1 - \mu_t$  to consumers. As a result, the capital accumulation path will lie between Path RR and RS. In addition, the value of  $\mu_t$  decreases as  $k_t$  increases if entrepreneurial credit remains in a rationing regime.

*Proof:* Let  $k_{t+1}^{r,m}$  denote the time t+1 per firm capital stock when financial intermediaries at time t



offer the rationing contract to all entrepreneurs, and the rationing contract with probability  $\mu_l$  and the screening contract with probability  $1-\mu_l$  to consumers. Then it is clear that

$$k_{t+1}^{r,m} = [\mu_l A_{r,r} + (1-\mu_l) A_{r,s}] k_t^\theta, \quad (23)$$

implying that the capital accumulation path lies between Path RR and RS.

Substituting (23) into (22), we derive the function of  $\beta^*$  in this case as

$$\beta_{r,m}^*(k_t) = h[\mu_l A_{r,r} + (1-\mu_l) A_{r,s}]^{1-\theta} k_t^{\theta(1-\theta)}.$$

According to Proposition 1, if  $\beta$  is strictly greater or less than  $\beta_{r,m}^*(k_t)$ , then obviously this mixed contract fail to be an equilibrium contract to consumers. The mixed contract could be an equilibrium contract only if  $\beta_{r,m}^*(k_t) = \beta$ ; that is, if and only if entrepreneurs are indifferent between the rationing and screening contract. Therefore, the following relation should hold in equilibrium:

$$\beta_{r,m}^*(k_t) = h[\mu_l A_{r,r} + (1-\mu_l) A_{r,s}]^{1-\theta} k_t^{\theta(1-\theta)} = \beta. \quad (24)$$

Note that  $\beta_{r,m}^*(k_t)$  lies between  $\beta_{r,r}^*(k_t)$  and  $\beta_{r,s}^*(k_t)$ . Since for a given  $k_t$ ,  $\beta_{r,r}^*(k_t) > \beta > \beta_{r,s}^*(k_t)$  there always exists a unique  $\mu_l$  yielding  $\beta_{r,m}^*(k_t) = \beta$ .

Moreover,  $\mu_l$  should decrease as  $k_t$  increases. This is so because both  $\beta_{r,r}^*(k_t)$  and  $\beta_{r,s}^*(k_t)$  are increasing function of  $k_t$  and  $\beta_{r,r}^*(k_t) > \beta_{r,s}^*(k_t)$  for any  $k_t$ . In other words, as  $k_t$  increases, financial intermediaries offer the screening contract to a larger fraction of consumers.

*Area III.*  $k_t > k_{r,s}^c$

The equilibrium contract to consumers is a screening contract because  $\beta < \beta_{r,s}^*(k_t)$ . Thus the capital accumulation path is Path RS as entrepreneurial credit is in a rationing regime.

Case 2: Entrepreneurial credit is in a screening regime.

The capital accumulation path is either Path SR or SS, depending on the relationship between  $\beta$  and  $\beta^*(k_t)$ . Substituting (17) and (20) into (22), we can derive the function of  $\beta^*(k_t)$  in Path SS and SR as  $\beta_{s,s}^*(k_t)$  and  $\beta_{s,r}^*(k_t)$ , respectively. We plot  $\beta$ ,  $\beta_{s,s}^*(k_t)$  and  $\beta_{s,r}^*(k_t)$  in Figure 1 (dotted lines). As shown in Figure 1, we define the capital level which equates  $\beta_{s,s}^*(k_t)$  and

$\beta_{s,r}^*(k_t)$  to  $\beta$  as  $k_{s,r}^c$  and  $k_{s,s}^c$ , respectively.

The analysis is similar to that of the previous case. In *area I* ( $k_t < k_{s,r}^c$ ), the equilibrium contract to consumers is the rationing contract because  $\beta > \beta_{s,r}^*(k_t)$ . As entrepreneurial credit is in a screening regime, the capital accumulation path is SR. In *area II* ( $k_{s,r}^c < k_t < k_{s,s}^c$ ), neither a rationing nor a screening contract is the equilibrium contract. In this case the only possible equilibrium contract to consumers is a mixed one. Proposition 5 below specifies properties of this mixed contract. In *area III* ( $k_t > k_{s,s}^c$ ), a screening contract will be offered to consumers because  $\beta < \beta_{s,s}^*(k_t)$ . The capital accumulation path in this area is path SS.

*Proposition 5.* For any  $k_t$ , if entrepreneurial credit is in a screening regime and the relation  $\beta_{s,r}^*(k_t) > \beta > \beta_{s,s}^*(k_t)$  holds, then there exists a  $\mu_2 \in [0,1]$  and an equilibrium at time t, where financial intermediaries offer the rationing contract with probability  $\mu_2$  and the screening contract with probability  $1 - \mu_2$  to consumers. As a result, the capital accumulation path will lie between Path SR and SS. In addition, the value of  $\mu_2$  decrease as  $k_t$  increases if entrepreneurial credit is still in a screening regime.

The proof of Proposition 5 is similar to Proposition 4 and ignored here. Some interesting results are delivered by these two cases. First, the use of a screening contract by consumers is harmful to an economy's capital accumulation. Namely, in either case, the capital accumulation path is shifted down in *area III* compared to *area I*. For example, in Case 1 the capital accumulation path in *area I* is Path RR. For *area III*, it is Path RS. Given that  $A_{r,r} > A_{r,s}$ , we see that the use of the screening contract of consumers is detrimental to capital accumulation, supporting the work of Jappelli and Pagano (1994), which shows that consumer credit rationing may induce a higher saving rate and promote growth. The results here show that consumers are more likely to be credit rationed at a low level of capital stock (in *area I*). Under such a situation, the capital accumulation path is higher and so is the economic growth rate. However, as capital is accumulated to some critical levels (in *area III*), consumers' credit rationing is reduced and consumers are able to consume more. In this situation, the capital accumulation path is shifted down, resulting in a lower

growth rate.

Second, by comparing these two cases, one sees that the development of credit markets for entrepreneurial credit (i.e., from a rationing regime to a screening regime) favors capital accumulation. For example, the capital accumulation path is RR in *area I* for case 1. For case 2, it is Path SR in *area I*. Given that  $A_{s,r} > A_{r,r}$ , we see that the capital accumulation is higher in case 2 than in case 1. [Recall that the entrepreneur market is in a rationing regime in case 1 and a screening regime in case 2.] Therefore, the development of credit markets in the entrepreneurial market is growth-enhancing, consistent with the conclusion of recent literature.

Finally, according to Propositions 4 and 5, financial intermediaries will screen consumers more as  $k_t$  increases in the mixed strategy equilibrium, indicating that the transition of consumer credit from rationing to screening takes place in this mixed regime. Under this transition, for example, if entrepreneurial credit is always in a rationing regime (Case 1), the capital accumulation path will shift gradually from Path RR to Path RS.

## 2.4.2 Equilibrium Contract to Entrepreneurs

The analysis of the equilibrium contract to entrepreneurs will be similar to that of consumers. According to Proposition 2, the equilibrium contract of entrepreneurs' loans depends on the relationship between  $Z$  and  $Z^*$ , which is given as

$$Z^* = \frac{(p_L - \varepsilon)p_L \Omega}{p_L + \delta \varepsilon} \rho_{t+1} w_t.$$

Since  $\rho_{t+1} = \theta k_{t+1}^{\theta-1} L^{1-\theta}$  and  $k_{t+1} = A k_t^\theta$  ( $A$  defined in Section 3), we can rewrite this expression as

$$Z^*(k_t) = \frac{(p_L - \varepsilon)p_L \Omega}{p_L + \delta \varepsilon} L^{1-2\theta} \theta (1-\theta) k_{t+1}^{\theta-1} k_t^\theta = f A^{\theta-1} k_t^{\theta^2}, \quad (25)$$

where  $f$  is defined explicitly. Similar to the previous section, to remove the influence of consumer credit in determining the relationship between  $Z$  and  $Z^*(k_t)$ , we analyze the equilibrium contract of entrepreneurs by considering two cases: when consumer credit is in a rationing and a screening regime, respectively.

Case 1. Consumer credit is in a rationing regime.

The capital accumulation path will be either Path RR or SR, depending on the relationship between  $Z$  and  $Z^*(k_t)$ . Substituting (12) and (20) into (25), we can derive the function of  $Z^*(k_t)$  in Path RR and SR as  $Z_{r,r}^*(k_t)$  and  $Z_{s,r}^*(k_t)$ , respectively. Note that, for any  $k_t$ ,  $Z_{r,r}^*(k_t) > Z_{s,r}^*(k_t)$  because  $\theta < 1$  and  $A_{s,r} > A_{r,r}$ . The relationship between  $Z$ ,  $Z_{r,r}^*(k_t)$  and  $Z_{s,r}^*(k_t)$  is plotted in Figure 2.2 (solid lines). As in the figure, we define  $k_{r,r}^e$  and  $k_{s,r}^e$  as the capital level equating  $Z$  to  $Z_{r,r}^*(k_t)$  and  $Z_{s,r}^*(k_t)$ , respectively.

*Area I.*  $k_t < k_{r,r}^e$ .

As  $Z > Z_{r,r}^*$  in this area, financial intermediaries will offer a rationing contract to entrepreneurs, so the capital accumulation path is RR.

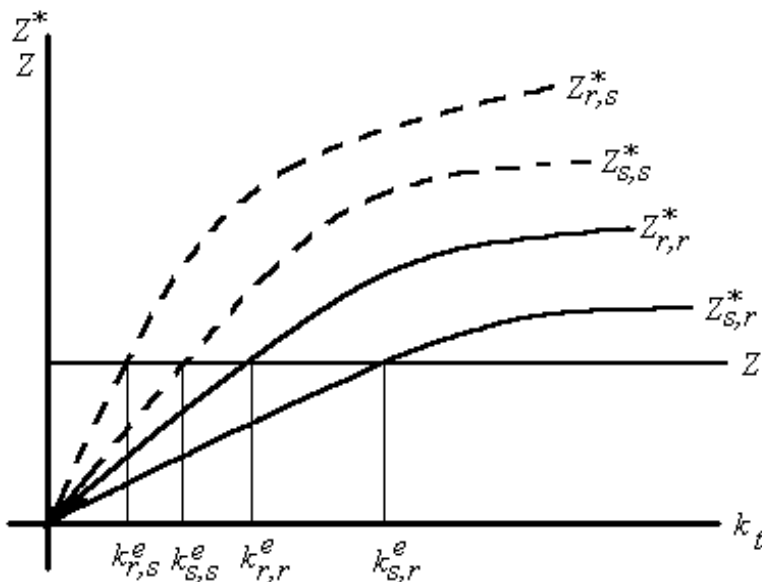


Figure 2.2.  $Z$  and  $Z^*(k_t)$  in four capital accumulation paths.

*Area II.*  $k_{r,r}^e < k_t < k_{s,r}^e$ .

It is clear that neither a rationing nor a screening contract is the equilibrium contract to entrepreneurs because  $k_{r,r}^e < k_t$  and  $k_t < k_{s,r}^e$  in this area. The only possible equilibrium contract to

entrepreneurs is a mixed one; i.e., financial intermediaries offer entrepreneurs the rationing and screening contract at the same time. Proposition 6 summarizes properties of this mixed contract.

*Proposition 6.* For any  $k_t$ , if consumer credit is in a rationing regime and the relation  $Z_{r,r}^*(k_t) > Z > Z_{s,r}^*(k_t)$  holds, then there exists a  $\chi_l \in [0,1]$  and an equilibrium at time  $t$ , where financial intermediaries offer the rationing contract with probability  $\chi_l$  and the screening contract with probability  $1 - \chi_l$  to entrepreneurs. As a result, the capital accumulation path will lie between Path RR and SR. In addition, the value of  $\chi_l$  decreases as  $k_t$  increases if consumer credit is still in a rationing regime.

Proof: Let  $k_{t+1}^{m,r}$  represent the time  $t+1$  per firm capital stock when financial intermediaries at time  $t$  offer the rationing contract to all consumers, and the rationing contract with probability  $\chi_l$  and the screening contract with  $1 - \chi_l$  to entrepreneurs. It is easy to see that

$$k_{t+1}^{m,r} = [\chi_l A_{r,r} + (1 - \chi_l) A_{s,r}] k_t^\theta, \quad (26)$$

implying that the capital accumulation path lies between Path RR and SR. Substituting (26) into (25), we derive  $Z_{m,r}^*(k_t)$  as

$$Z_{m,r}^*(k_t) = f [\chi_l A_{r,r} + (1 - \chi_l) A_{s,r}]^{\theta-1} k_t^{\theta^2}. \quad (27)$$

According to Proposition 2, this mixed strategy will not be the equilibrium strategy if  $Z_{m,r}^*(k_t)$  is strictly greater or less than  $Z$ . Therefore, for this mixed strategy to be an equilibrium we need that  $Z_{m,r}^*(k_t) = Z$ . Clearly,  $Z_{m,r}^*(k_t)$  lies between  $Z_{r,r}^*(k_t)$  and  $Z_{s,r}^*(k_t)$ . Since  $Z_{r,r}^*(k_t) > Z > Z_{s,r}^*(k_t)$  for a given  $k_t$ , there always exists a unique  $\chi_l$  satisfying  $Z_{m,r}^*(k_t) = Z$ . Moreover, as  $k_t$  increases while consumer credit is still in a rationing regime,  $\chi_l$  must decrease to keep  $Z_{m,r}^*(k_t)$  equal to  $Z$  because  $A_{s,r} > A_{r,r}$  and  $\theta < 1$  (see (26)).

*Area III.*  $k_t > k_{s,r}^e$ .

The equilibrium contract to entrepreneurs is a screening contract as  $Z_{s,r}^*(k_t) > Z$ . Therefore, the capital accumulation path is SR.

Case 2. Consumer credit is in a screening regime

If consumer credit is in a screening regime, the capital accumulation path will be either Path RS or SS, depending on the relationship between  $Z$  and  $Z^*(k_t)$ . Substituting (17) and (16) into (25), we derive the function of  $Z^*(k_t)$  in Path RS and SS as  $Z_{r,s}^*(k_t)$  and  $Z_{s,s}^*(k_t)$ , respectively. The relationship between  $Z$ ,  $Z_{r,s}^*(k_t)$  and  $Z_{s,s}^*(k_t)$  is plotted in Figure 2 (dotted lines).

We define  $k_{r,s}^e$  and  $k_{s,s}^e$  as the capital level equating  $Z$  to  $Z_{r,s}^*(k_t)$  and  $Z_{s,s}^*(k_t)$  respectively, as is shown in Figure 2. Similar to the previous case, we have three areas. In *area I* ( $k_t < k_{r,s}^e$ ),  $Z$  is greater than  $Z_{r,s}^*(k_t)$  so the equilibrium contract to entrepreneurs is the rationing contract and capital accumulates according to Path RS. In *area II* ( $k_{r,s}^e < k_t < k_{s,s}^e$ ), the equilibrium contract is a mixed one. Proposition 7 below states properties of this mixed contract. In *area III* ( $k_t > k_{s,s}^e$ ), the equilibrium contract to entrepreneurs is the screening contract and capital accumulates along Path SS.

*Proposition 7.* For any  $k_t$ , if consumer credit is in a screening regime and the relation  $Z_{r,s}^*(k_t) > Z > Z_{s,s}^*(k_t)$  holds, then there exists a  $\chi_2 \in [0,1]$  and an equilibrium at time  $t$ , where financial intermediaries offer the rationing contract with probability  $\chi_2$  and the screening contract with probability  $1 - \chi_2$  to entrepreneurs. As a result, the capital accumulation path will lie between Path RR and SR. In addition, the value of  $\chi_2$  decrease as  $k_t$  increases if consumer credit is still in a rationing regime.

We ignore the proof of Proposition 7 here as it is easy to derive by following the line of argument in the proof of Proposition 6. From these two cases, we observe that, first, the use of a screening contract of entrepreneurs favors capital accumulation. This can be seen by comparing *area I* and *area III* in either case. Second, the effect of credit market development of entrepreneurial credit (from a rationing regime to a screening) on growth also depends on consumer credit. For

example, in *area III* of case 1, where consumer credit is in a rationing regime, the capital accumulates along Path SR. In case 2, where consumer credit is in a screening regime, the capital accumulation path is Path SS in *area III*. Given that  $A_{s,r} > A_{s,s}$ , we see that the effect of credit market development is more efficient in promoting growth in case 1 than in case 2.

Moreover, as shown in Propositions 6 and 7, financial intermediaries will screen more entrepreneurs as  $k_t$  accumulates in this mixed strategy equilibrium. This result implies that the transition of entrepreneurial credit from rationing to screening occurs in this mixed regime. During this transition, for example, if consumer credit is always in a rationing regime (case1), capital will accumulate gradually from Path RR to Path SR.

## 2.5. The Dynamics of Capital Accumulation

A major advantage of this framework is that we are able to show the evolution of credit market development and capital accumulation by considering both entrepreneurial and consumer credit. We have shown the equilibrium contract and capital accumulation path by separating consumer and entrepreneurial credit in the last section. In turn, the objective of this section is to discuss the dynamics of capital accumulation and equilibrium contracts of consumers and entrepreneurs together.

Given the results in Section 4, it is clear that the equilibrium dynamic path for capital is determined by their initial capital stock ( $k_0$ ) and the relationships among  $k_{r,s}^c$ ,  $k_{s,s}^c$ ,  $k_{r,r}^c$ ,  $k_{s,r}^c$ ,  $k_{s,r}^e$ ,  $k_{r,r}^e$ ,  $k_{s,s}^e$ , and the capital level of steady states in each path (i.e.;  $k_{s,r}^{ss}$ ,  $k_{r,r}^{ss}$ ,  $k_{s,s}^{ss}$ ,  $k_{r,s}^{ss}$ ). For illustration purposes, we only consider the case where  $A_{r,r} > A_{s,s}$ , and that overall, the relation  $A_{s,r} > A_{r,r} > A_{s,s} > A_{r,s}$  holds. Note that the relation  $k_{r,s}^c > k_{s,s}^c > k_{r,r}^c > k_{s,r}^c$  holds in this situation for consumers (see Figure 1) and, for entrepreneurs, the relation  $k_{s,r}^e > k_{r,r}^e > k_{s,s}^e > k_{r,s}^e$  is satisfied (see Figure 2). Furthermore, throughout the remaining analysis we assume that the following assumptions are held:

1.  $k_{s,r}^e < k_{s,r}^{ss}$ ,
2.  $k_{r,r}^e < k_{r,r}^{ss}$ ,

3.  $k_{s,s}^e < k_{s,s}^{ss}$ ,
4.  $k_{r,s}^e < k_{r,s}^{ss}$ ,
5.  $k_0 < k_{r,s}^e$ .

Assumptions 1 to 4 ensure that for any capital accumulation path the change of the contracting regime of entrepreneurial credit will take place before capital accumulation gets to its steady state. Moreover, given that  $k_{s,r}^e > k_{r,r}^e > k_{s,s}^e > k_{r,s}^e$ , assumption 5 says that  $k_{s,r}^e$ ,  $k_{r,r}^e$ , and  $k_{s,s}^e$  are all greater than the initial capital level.

We provide three cases in this section. Case 1 refers to the case where entrepreneurial credit will switch from rationing to screening before consumer credit and case 2 discuss the reverse; i.e., consumer credit switches first. In case 3, we present the interactions of entrepreneurial and consumer credit along capital accumulation, which delivers some interesting results.

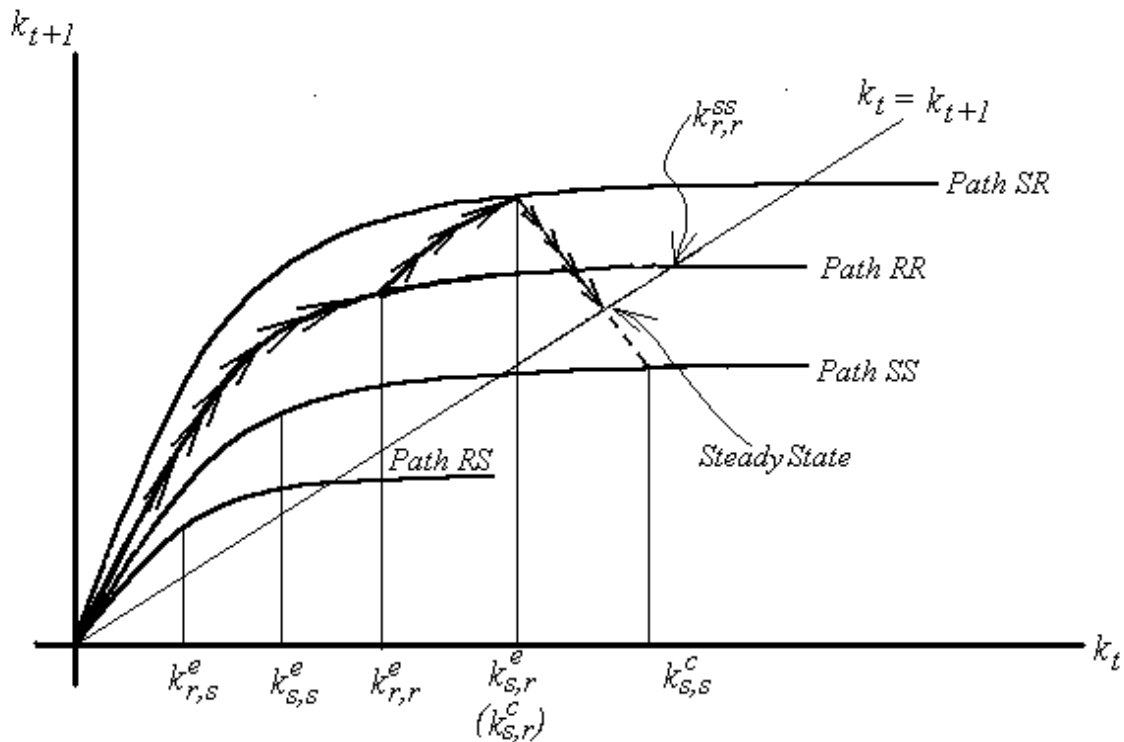
Which credit will switch first depends on the relationship between  $k_{r,r}^c$  and  $k_{r,r}^e$ . For example, suppose that  $k_{r,r}^e < k_{r,r}^c$  and the capital level,  $k_t$ , is just above  $k_{r,r}^e$ . Since  $k_t > k_{r,r}^e$  (i.e.,  $Z < Z_{r,r}^*(k_t)$ ), the rationing contract is not the equilibrium contract to entrepreneurs. In fact, if the relations  $k_t < k_{s,r}^e$  and  $k_t < k_{r,r}^c$  are satisfied in this  $k_t$ , the mixed contract will be the equilibrium contract to entrepreneurs and, for consumers, it is the rationing contract. As we mentioned, the transition of entrepreneurial credit takes place in the mixed regime. Therefore, entrepreneurial credit will switch from a rationing regime to a screening before consumer credit. Note that, given  $A_{r,r} > A_{s,s}$ , Path RR is always higher than Path SS here.

**Case 1 :**  $k_{r,r}^e < k_{r,r}^c$  and  $k_{s,r}^e = k_{s,r}^c$

If  $k_{s,r}^e = k_{s,r}^c$ , the relation  $k_{r,s}^c > k_{s,s}^c > k_{r,r}^c > k_{s,r}^c = k_{s,r}^e > k_{r,r}^e > k_{s,s}^e > k_{r,s}^e$  holds. The capital accumulation path for this economy is plotted in Figure 2.3. As shown in the diagram, the capital is accumulated along the Path RR in the low level of capital stocks. Once capital accumulates to  $k_{r,r}^e$ , some fraction of financial intermediaries will start to use the information gathering technology to separate entrepreneurs, and then capital will accumulate along the path situated between Path RR and Path SR until it gets  $k_{s,r}^e$ , where the transition of contracting regime of entrepreneurial credit has



completed. Since  $k_{s,r}^e = k_{s,r}^c$  in this case, when capital accumulates to  $k_{s,r}^c$ , some fraction of financial intermediaries will start to screen consumers. This will continue until capital accumulates to  $k_{s,s}^c$ , where financial intermediaries offer the screening contract to both consumers and entrepreneurs. Therefore, the capital accumulation path will lie between Path SR and Path SS in the interval of  $k_{s,r}^c < k_t < k_{s,s}^c$ . As we assume that  $k_{s,s}^c > k_{s,s}^{ss}$  in the diagram, we will derive the steady state of capital stock before the transition of contracting regime to consumers from rationing to screening has completed.

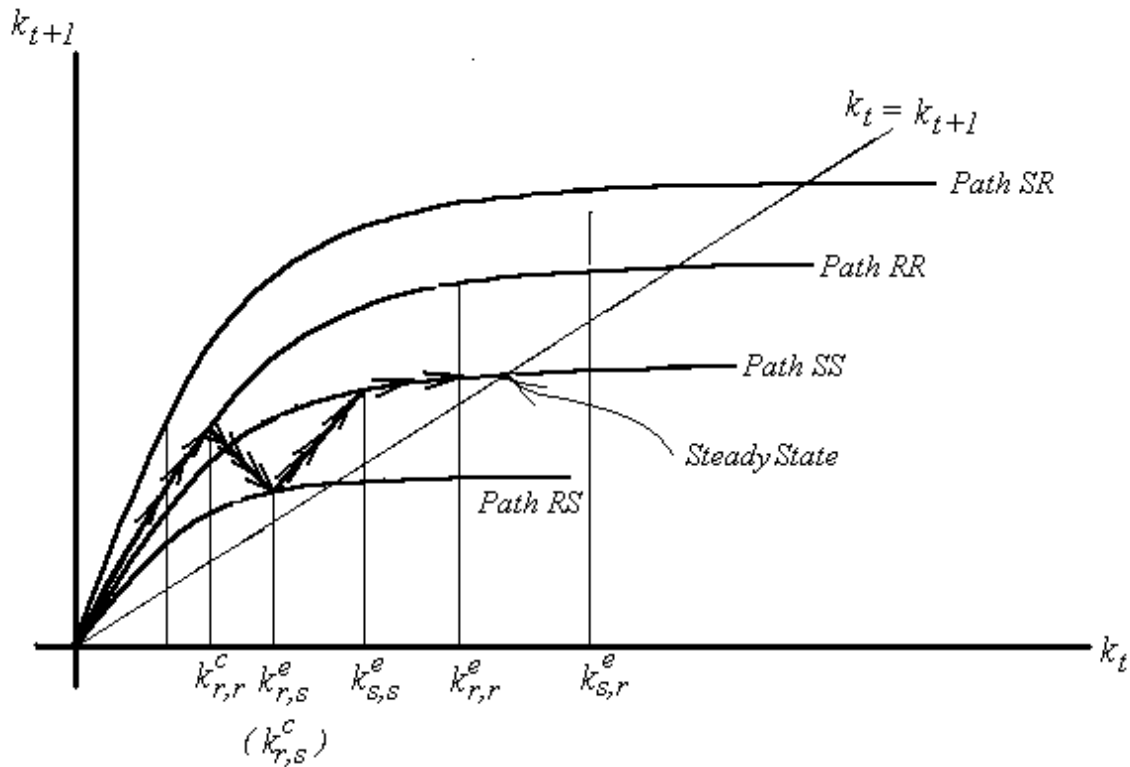


**Figure 2.3.** Capital Accumulation Path in Case 1

**Case 2.**  $k_{r,s}^e = k_{r,s}^c$

If  $k_{r,s}^e = k_{r,s}^c$ , it means that  $k_{r,r}^c < k_{r,r}^e$ , so consumer credit will switch before entrepreneurial credit. We plot the capital dynamics of this case in Figure 2.4. As in the diagram, capital accumulates along Path RR at the low level of capital stock. Once  $k_{r,r}^c$  is reached, some fraction of consumers will be screened by financial intermediaries, and the capital accumulation path will lie in between Path RR and RS until  $k_{r,s}^c$  ( $k_{r,s}^e$ ) is reached.

Similar to the previous case, at  $k_{r,s}^e$ , financial intermediaries will start to use the costly information gathering technology to screen some fraction of entrepreneurs, and thus the capital accumulation path lies between Path RS and SS. Under this situation, the steady state of capital stock is equal to  $k_{s,s}^{ss}$ <sup>6</sup>. An important implication delivered by this case is that, comparing Case 1 and 2, we see that the steady state of capital stock in Case 1 is never less than that in Case 2, implying that the economy's steady state of capital stock will benefit if entrepreneurial credit switches before consumer credit. Moreover, the steady state capital stock of the economy with undeveloped credit markets (i.e., both types of credit are still in the rationing regime) could be higher than that of the economy with fully developed credit markets (i.e., both types of credit are in the screening regime.).



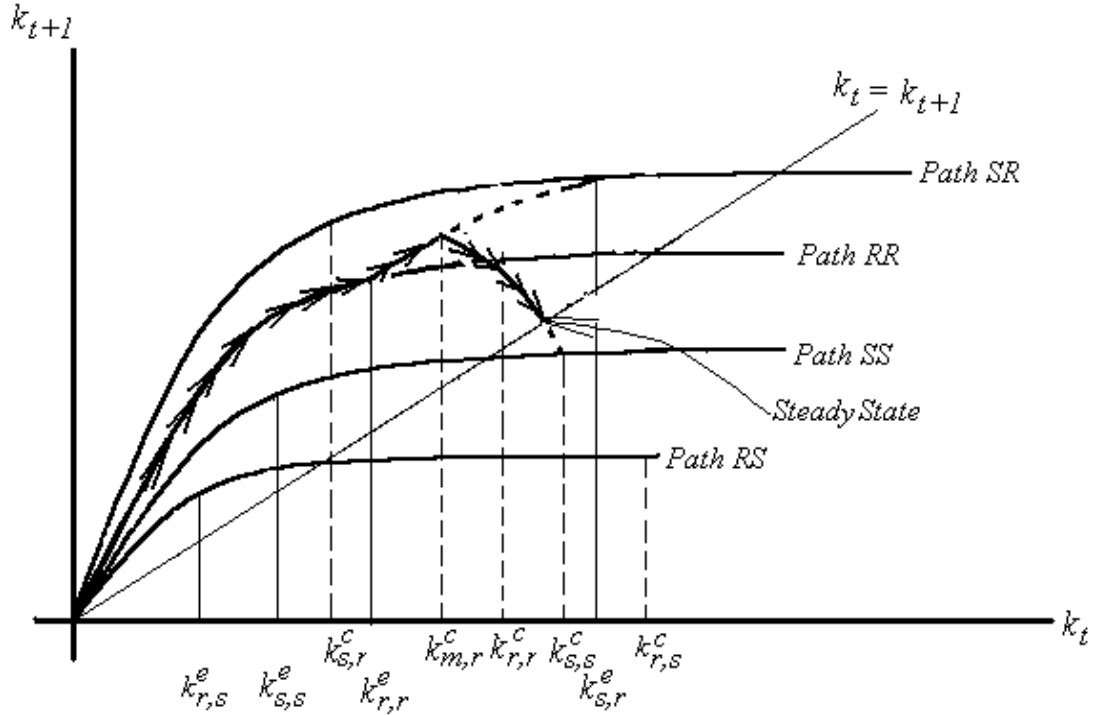
**Figure 2.4.** Capital Accumulation Path in Case 2

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<sup>6</sup> If we consider the case where Path SS is greater than Path RR, the steady state of capital stock (equal to  $k_{s,s}^{ss}$ ) is greater than the one where credit market is not developed ( $k_{r,r}^{ss}$ ). In this situation, we derive the similar conclusion of recent literature.

**Case 3.**  $k_{r,r}^c > k_{r,r}^e$  and overall,  $k_{r,s}^c > k_{s,r}^e > k_{s,s}^e > k_{r,r}^c > k_{r,r}^e > k_{s,r}^c > k_{s,s}^e > k_{r,s}^e$  (see Figure 2.5).

Cases 1 and 2 show that the decrease of credit rationing of entrepreneurs favors capital accumulation and the decrease of credit rationing of consumers has an adverse effect. These results are derived as the development of one market starts after the other has completed. However, it is possible that the transition of one market will start before the other has completed. Under such a situation, credit conditions of consumers and entrepreneurs will influence each other.



**Figure 2.5.** Capital Accumulation Path in case 3

The corresponding diagram for this case is plotted in Figure 5. Similar to the previous cases, capital accumulates along Path RR until it gets to  $k_{r,r}^e$ , where entrepreneurial credit switches to a mixed regime. Then the capital accumulation path will lie between Path RR and SR. If entrepreneurial credit is in a mixed regime while consumer credit is in a rationing regime, we see that capital will accumulate as

$$k_{t+1}^{m,r} = [\chi_1 A_{r,r} + (1 - \chi_1) A_{s,r}] k_t^\theta, \quad (28)$$

implying that capital accumulates between Path RR and SR. Clearly, for consumer credit  $\beta_{m,r}^*$  will

lie between  $\beta_{r,r}^*$  and  $\beta_{s,r}^*$  (see Figure 1) if capital accumulates following (28). Denote  $k_{m,r}^c$  as the capital level where  $\beta_{m,r}^* = \beta$ . Obviously, from Figure 1 we see that  $k_{m,r}^c < k_{r,r}^c$ . Therefore, once capital accumulates beyond  $k_{m,r}^c$ , the rationing contract is not an equilibrium contract to consumers as  $\beta_{m,r}^* > \beta$ . As a result, consumer credit will be in a mixed regime after  $k_{m,r}^c$ .

After capital accumulates to  $k_{m,r}^c$ , the equilibrium will be that financial intermediaries offer a screening contract to entrepreneurs and a mixed contract to consumers. To see this point, suppose that capital stock is just greater than  $k_{m,r}^c$  but still less than  $k_{r,r}^c$ . Then we consider the following cases. First, assume that financial intermediaries screen some fraction of consumers while offering a rationing contract to entrepreneurs. In this situation, capital accumulates between Paths RR and RS and  $Z^*$  (denoted as  $Z_{r,m}^*$ ) lies between  $Z_{r,r}^*$  and  $Z_{r,s}^*$  (see Figure 2). Clearly, if capital is greater than  $k_{r,r}^e$ ,  $Z_{r,m}^* > Z$ , so a rationing contract is not an equilibrium contract to entrepreneurs. Second, financial intermediaries offer a screening contract to consumers and a mixed contract to entrepreneurs. Under such a situation, the capital accumulation path lies between Paths RS and SS, so  $\beta^*$  (denoted as  $\beta_{m,s}^*$ ) will lie between  $\beta_{r,s}^*$  and  $\beta_{s,s}^*$ . From Figure 1, it is clear that  $\beta > \beta_{m,s}^*$  if capital is less than  $k_{r,r}^c$ . Consequently, a screening contract is not an equilibrium contract. Finally, financial intermediaries may offer both borrowers the mixed contract. In this situation, the capital accumulation path will lie between Paths RR and SS.  $Z^*$  (denoted as  $Z_{m,m}^*$ ) lies between  $Z_{s,s}^*$  and  $Z_{r,r}^*$ . From Figure 2 it is obvious that  $Z_{m,m}^* > Z$  if capital is greater than  $k_{r,r}^e$ . Thus a mixed contract is not an equilibrium contract to entrepreneurs.

Apart from these three possibilities, the only possible equilibrium is that financial intermediaries offer a screening contract to entrepreneurs and a mixed contract to consumers. Therefore, capital will accumulate between Paths SR and SS after  $k_{m,r}^c$  and the capital accumulation path is shifting down as capital accumulates. This will continue until  $k_{s,s}^c$  is reached. Given that the relation  $k_{s,s}^c > k_{s,s}^{ss}$  is assumed in Figure 5, the economy will get its steady state before  $k_{s,s}^{ss}$ .

In this case, we see that credit conditions of entrepreneurs and consumers are influenced by each other. In particular, at  $k_{m,r}^c$ , the transition of consumer credit from the rationing to mixed regime will force the entrepreneur market to switch completely from a mixed regime to a screening

regime (a jump from a mixed regime to a screening regime). In contrast to the previous cases where the decrease of credit rationing to entrepreneurs will shift the capital accumulation curve up, in this case, even if the entrepreneur market is switched from a mixed regime to a screening regime, the capital accumulation path is actually shifted down. Obviously, the key force driving this result is that consumers are able to consume more.

From these three cases, we see that the relationship between credit market development and economic growth is ambiguous. Specifically, this relationship depends on the level of credit market and economic development. For example, Case 1 and 3 deliverer the situation that economic development is benefited by the development of credit market at the early stage. Once a critical level of capital stock is reached, the further development of credit market is detrimental to economic development as it enables consumers to consume more. This result contributes to the work of De Gregorio and Guidotti (1995), which uses the total credit to private sectors as indicator of credit market development, and shows that the effect of credit market development on economic growth is much more significant in developing countries than in developed countries. As in Figure 3, for developing countries (i.e., for the countries whose per firm capital stock is small (less than  $k_{s,r}^e$ )) the development of credit market favors economic growth. For developed countries ( $k_t > k_{s,r}^e$ ), the development of credit markets benefits consumers and reduces the available resources for investment. In other words, our model provides reasons for this result as the proportion of private sector credit allocated to consumers and entrepreneurs differs between developing and developed countries.

Given the results of this section, an important issue to determine an economy's growth path is the sequence of credit market development along with capital accumulation. In case 1, the entrepreneur market develops before the consumer market so that the economy grows faster at the early stage of development. However, if the consumer credit develops first as shown in case 2, the economy suffers at the early stage of development. Moreover, if both markets develop at the same time, credit conditions of consumers and entrepreneurs depend on each other. For example, the use of the mixed contract of consumers will push entrepreneurial credit to a screening regime and shift down the capital accumulation path. This result may justify government interventions in the consumer market to relieve resources for industrial investment in developing countries (see Ch 7. World Development Report 1989.).

## 2.6. Conclusion

This paper considers the relationship between credit market development and economic growth by integrating credit to consumers and entrepreneurs. We also focus on the endogenous interaction between credit market development and capital accumulation. The model we develop here is useful as it provides a more realistic framework for analyzing the relationship between credit market development and economic growth than do preexisting models which consider credit to entrepreneurs alone.

In this framework, the lending regimes of consumer credit and entrepreneurial credit are endogenously determined by the level of capital stock. In addition, the capital accumulation path of the economy depends on the lending regime of consumers and entrepreneurs. As a result, there exists a joint dependency between credit market development and capital accumulation. Moreover, this framework has fruitful properties in discussing the interaction between credit market development and economic growth as the lending regimes of consumers and entrepreneurs are related and may depend on each other in some circumstances. We show that which kind of credit (consumer credit or entrepreneurial) will switch first from a rationing to a screening regime along capital accumulation matters very much in determining the growth pattern of the economy. Also, our model can be used to explain the work of De Gregorio and Guidotti (1995), which provides evidence showing that the effects of credit market development on economic growth differ between developing and developed countries.

An interesting extension of this framework is to endogenize the screening cost,  $\delta$ . This could be done by making  $\delta$  dependent on the total volume of lending, or equivalently, on the current level of capital. This is the idea that there is an externality in learning how to evaluate borrowers. Therefore, the cost of distinguishing high-risk from low-risk will fall as more loans are extended. In this framework, the development of one market could benefit the other one, and this fact should be able to provide more interesting dynamical interactions between credit market and economic development. We then may be able to discuss some government interventions in credit markets to facilitate economic growth.