Capital Market Imperfection and Economic Growth

by

MASAKO OYAMA*

Faculty of Economics,Hitotsubashi University

2-1, Naka, Kunitachi, 186-8601

Abstract

This paper explains adverse international capital flows and economic growth using a model with asymmetric information in the capital market. The capital markets in developing countries are found to suffer more severely from asymmetric information than those in developed ones, which results in a lower rate of return on investment and severer credit rationing. Thus, capital flows from developing to developed countries, lowering the growth rate of the developing countries.

JEL Classification Numbers: E44, F21, F43, 016, 040

Keywords: economic growth; capital flows; asymmetric information; credit rationing; development.

---

*I wish to express my thanks to Robert M. Townsend, Maitreesh Ghatak, Masahiro Kawai, Masayuki Otaki, Kazuo Ueda, Kazumasa Iwata, Masaya Sakuragawa, Shigeru Wakita, Hidehiko Ishihara, and the seminar participants at the University of Tokyo and the annual meeting of the Japan Association of Economics and Econometrics for their useful comments and suggestions. Please direct comments to oyama@econ.hit-u.ac.jp

Two important questions for developing countries are: do poor countries tend to grow faster than rich ones and does sufficient international capital flow from the developed countries to the developing countries?

Cross-section empirical research has shown that poor countries do not grow faster and, therefore, per capita income across countries do not exhibit convergence (Barro, 1991).[1]In addition, the magnitude of international capital flowing from developed to developing countries is less than that theoretically predicted by standard neoclassical theory (Lucas, 1990). In fact, even adverse flows have been observed, for example, the capital flight from Latin America to the United States in the 1970s and the outflow of oil-dollars from the Middle East to the Eurodollar market.

These two factors cannot be explained with standard neoclassical theory, and used to be called “puzzles”. Recently, much research has been directed at explaining these findings concerning economic growth (Lucas, 1988; Barro, 1990; Sala-i-Martin, 1990a, b) and international capital flows (Gertler and Rogoff, 1990; Lucas, 1990). These models, however, examine and attempt to provide a theoretical rationalization for only one of these empirical findings.

In contrast, this paper develops a theoretical model which explain these two phenomena simultaneously by blending endogenous growth theory and the theory of imperfect capital markets (Williamson, 1986; Stiglitz and Weiss, 1981; Levine, 1997; Von Thadden, 1995). By developing a dynamic, two-country model based on Williamson (1986), the present research elucidates the relationship among credit rationing, international capital flows, and growth rates. This paper differs from Hamada and Sakuragawa (1993) by developing a model that can also explain the fact that credit rationing is widely observed in developing countries (World Bank, 1989; McKinnon, 1991).

The plan of the paper is as follows. The framework of the employed model is explained in section I, while section II derives (i) the properties of the optimal contract; and (ii) the resultant equilibrium of the capital market associated with credit rationing. In section III, the equilibria among all markets and the dynamics of the economy are examined and this is followed in section IV by the construction of a corresponding two-country model. Finally, some conclusions are presented.

I. The Model

An overlapping-generations model based on Williamson's (1986) static model is constructed. The economy is comprised of individuals and firms. In the first period, t=1, a set of initial old agents is present, and in each period t=1,2, ..., ∞ , a continuum of agents who live for two periods are born. It is assumed that the population is constant, and that half are lenders and half are entrepreneurs.

A. Lenders

Each lender is endowed with one unit of labor only in the first period of life. During this period, each supplies his labor inelastically to firms and receives a wage w_t . Although lenders can consume w_t in both periods of their life, goods are perishable and require special investment technology to be carried over to the next period. Since only entrepreneurs are endowed with investment technology, in order for lenders to consume goods in the second period, they must lend their goods to entrepreneurs in the first period and receive payment in the second period.

It is assumed that lenders are risk-neutral and maximize the expected value of their utility, $V(c_1, c_2, eq_t)$, where c_1 and c_2 are, respectively, the consumption in the first and second period, and e is the monitoring cost per unit of lending. This assumption considerably simplifies the contracting problem because it enables the analysis of the effect of asymmetric information without a consideration of risk-sharing issues. A lender's utility function is given by

$$V(c_1, c_2, eq_t) = c_1 + \frac{c_2 - eq_t}{1+\rho},$$

where ρ is the rate of time preference, eq_t is the monitoring effort the lenders must expend upon entrepreneur default, and q_t is the amount of lending. To generate an upward-sloping supply curve for loanable funds, it is assumed that each lender has a different ρ and that the ρ follows a uniform distribution over [0, $\bar{\rho}$] ($\bar{\rho}$ > 0). Consequently, only the "patient" lenders actually lend their goods to entrepreneurs and consume some goods in the second period. These lenders are defined as those whose rate of time preference are lower than the expected rate of return from lending, r. The other "impatient" lenders do not lend any goods to entrepreneurs, thus entirely consuming their wage in the first period. If we were to select a lender at random, the probability that the lender actually lends goods, $\Pr[\rho < r_{t+1}]$, can be expressed as

$$\Pr[\rho < r_{t+1}] = r_{t+1}/\bar{\rho}.$$

Therefore, a proportion $r_{t+1}/\bar{\rho}$ of the lenders lend their earnings to entrepreneurs. As a result, if the expected rate of return from lending increases, more lenders lend their goods to entrepreneurs, increasing the supply of goods.

B. Entrepreneurs

Entrepreneurs have zero endowments of goods and labor in both periods of their life. In the first period, however, each has access to one investment project yielding a random return in the second period, for example, if q_t units of goods are invested, the project yields $q_t\tilde{v}_{t+1}$ units in the following period, where $\tilde{v}_{t+1}$ is the random return per unit of investment. It is assumed that: (i) the risk is idiosyncratic; (ii) $\tilde{v}_{t+1}$ follows a uniform distribution over $[0,\ 2\mu]$ (μ>1); and (iii) the $\tilde{v}_{t+1}$ are independently and identically distributed across entrepreneurs. Since entrepreneurs have no goods or labor in the first period, they must invest by borrowing goods from a lender. A constraint is imposed so that an entrepreneur can only borrow from one lender.

In the second period, entrepreneurs become firm owners using their acquired $q_t\tilde{v}_{t+1}$ units of goods as capital. After goods are produced by firms expending capital and labor, entrepreneurs receive $q_t\tilde{v}_{t+1}\, i_i$ units of goods in this period as capital returns. By assuming that capital does not depreciate during production, each entrepreneur acquires a total of $q_t\tilde{v}_{t+1}(1+i_t)$ units of goods, which are subsequently either consumed or used to pay interest to their lender.

Since entrepreneurs only consume in the second period of life, they need only maximize their expected second period utility. They are assumed to be risk-neutral with respect to consumption realizations, and their corresponding utility is expressed as

$$U(c) = c\,,$$

where c is consumption in the second period.

C. Information Structure

An asymmetric information structure is assumed regarding the outcome of risky investment projects. The realization of $\tilde{v}_{t+1}$, denoted as v_{t+1}, is observable at no cost only to the entrepreneur, though all agents are assumed to know the distribution of $\tilde{v}_{t+1}$. After the investment returns are realized, a lender can verify the realized return on any project by expending e units of non-pecuniary costs (effort) per unit of investment, where $e > 0$. Lenders are endowed with an unbounded quantity of e. However, for each monitored project in which q_t units of goods were invested, they lose eq_t units of utility as shown in their utility function.

D. Firms

The firms acquired by the old entrepreneurs are perfectly competitive and produce goods using neoclassical production technology with constant returns to scale employing two factors, capital and labor. Because production technology at the firm level is homogeneous of degree one in the input factors, the output of goods can be described in terms of the action of a single, aggregate, price-taking firm. Accordingly, the aggregate production function can be represented as

$$Y_t = L_t^{1-\delta} K_t^{\delta} \bar{k}_t^{1-\delta}, \tag{1}$$

where aggregate capital input in period t is denoted as K_t, aggregate labor input as L_t, aggregate output as Y_t, and average per capita capital that enhances the general productivity level as $\bar{k}_t$. Since this production function is linearly homogeneous, the technology can be expressed in per capita terms, as

$$y_t = k_t^{\delta} \bar{k}_t^{1-\delta} \qquad (0<\delta<1), \tag{2}$$

where $k_t = K_t / L_t$ represents capital per unit of labor and $y_t = Y_t / L_t$ is output per unit of labor. Since this production function exhibits a Marshallian externality, the social marginal product of capital is constant that the steady-state growth is positive and endogenously determined.

Since firms maximize profits, their demands for factors are given by the following first-order conditions for profit maximization. Equating the social per capita capital and the private per capita capital so that $k_t = \bar{k}_t$, we obtain

$$w_t = f(k_t) - k_t f'(k_t) = (1-\delta)k_t, \tag{3}$$

and

$$i_t = f'(k_t) = \delta, \tag{4}$$

where i_t represents the rental rate of capital. Note that factor payments exhaust output when each factor is paid its private marginal product, because of the assumption of constant returns to scale with respect to private inputs. In addition, capital is supplied by old entrepreneurs and labor by young lenders.

II. Optimal Contract

The form of the optimal contract in the proposed setting is now considered. Asymmetric information requires that the contract be incentive compatible so that the borrowers are honest. This necessity results in an upper bound on the expected rate of return to lenders, lowers the supply of loans, and leads to credit rationing.

The assumption that each entrepreneur can borrow from only one lender, and vice versa, is not essential. If it is relaxed and entrepreneurs can borrow from several lenders, financial intermediation arises endogenously as in Williamson's model (1986). Financial intermediation, however, does not in any way alter the main result of this model. Thus, this assumption is imposed, and for simplicity, only the case of direct lending is examined.

Entrepreneurs must offer a contract to lenders in the first period so as to operate their investment project. Contracts specify units of goods borrowed in the first period, payment in the second period, and the state when monitoring occurs. The contract made between an entrepreneur and a lender is denoted by the set $\{q_t, R(v_{t+1}), S_{t+1}\}$, where q_t is the amount of lending, $R(v_{t+1})$ is an integrable, positive payment function per unit of lending, and S_{t+1} is a subset of $v_{t+1} \in [0, 2\mu]$ in which verification occurs. As an entrepreneur's investment project has idiosyncratic risk and yields a random return, the payment must be a function of realized output.

As demonstrated by Williamson (1986), a standard debt contract is optimal among the set of all contracts (see the proof in the Appendix). That is, the contract has the following properties:

for $\exists \overline{R}_{t+1}$,

$$
\begin{aligned}
R(v_{t+1}) &= v_{t+1}(1+\delta) && \text{if } v_{t+1}(1+\delta) < \overline{R}_{t+1}, \\
&= \overline{R}_{t+1} && \text{if } v_{t+1}(1+\delta) \geq \overline{R}_{t+1},
\end{aligned}
$$

$$S_{t+1} = \{v_{t+1}: v_{t+1}(1+\delta) < \overline{R}_{t+1}\},$$

$$S^c_{t+1} = \{v_{t+1}: v_{t+1}(1+\delta) \geq \overline{R}_{t+1}\},$$

$$q_t = (1-\delta)k_t.$$

These properties indicate the following situations. After entrepreneurs gain an output realization, v_{t+1}, they use these goods as inputs in their firms and receive $v_{t+1}(1+\delta)$ units of goods. If $v_{t+1}(1+\delta)$ is equal to or larger than $\overline{R}_{t+1}$, the entrepreneur pays back $\overline{R}_{t+1}$ units of goods to lenders, and no monitoring occurs. On the other hand, if $v_{t+1}(1+\delta)$ is less than $\overline{R}_{t+1}$, the entrepreneur cannot pay $\overline{R}_{t+1}$ and become bankrupt. In this case, monitoring occurs to ensure that default actually occurs, with the entrepreneur paying back all he/she can afford, namely, all the goods, $v_{t+1}(1+\delta)$. If bankruptcy occurs, the entrepreneur receives a zero return.

The set of Pareto optimal contracts can be examined by considering the following optimization problem.

$$\max_{\overline{R}_{t+1}} \ \pi^{e}(\overline{R}_{t+1}) = [\int_{\overline{R}_{t+1}/1+\delta}^{2\mu} \{v_{t+1}(1+\delta) - \overline{R}_{t+1}\} \frac{1}{2\mu} dv_{t+1}]\, q_t \tag{3}$$

$$\text{s.t.} \quad \pi^{l}(\overline{R}_{t+1}) = \int_{\overline{R}_{t+1}/1+\delta}^{2\mu} \overline{R}_{t+1} \frac{1}{2\mu} dv_{t+1} + \int_{0}^{\overline{R}_{t+1}/1+\delta} \{v_{t+1}(1+\delta) - e\} \frac{1}{2\mu} dv_{t+1} \tag{4}$$

$$\pi^{l}(\overline{R}_{t+1}) \quad \text{given}$$

where π^{e} denotes the entrepreneur's expected utility and π^{l} the lender's expected second-period profit per unit of lending. After integration, the problem becomes

$$\max_{\overline{R}_{t+1}} \ \pi^{e}(\overline{R}_{t+1}) = \frac{\theta}{2} - \frac{\overline{R}_{t+1}^{2}}{2\theta}, \tag{3'}$$

$$\text{s.t.} \quad \pi^{l}(\overline{R}_{t+1}) = \overline{R}_{t+1} - \frac{\overline{R}_{t+1}^{2}}{2\theta} - \frac{e\overline{R}_{t+1}}{\theta}, \tag{4'}$$

$$\pi^{l}(\overline{R}_{t+1}) \quad \text{given}$$

where $\theta \underset{d}{=} 2\mu(1+\delta)$ denotes the maximun return per unit of investment to an entrepreneur. To characterize the solution to (3') and (4'), it is useful to examine the shape of the lender's profit function $\pi^{l}(\overline{R}_{t+1})$. Differentiating (4') with respect to $\overline{R}_{t+1}$ gives

$$\pi^{l}{}'(\overline{R}_{t+1}) = 1 - \frac{\overline{R}_{t+1}}{\theta} - \frac{e}{\theta}, \tag{5}$$

$$\pi^{l}{}''(\overline{R}_{t+1}) = -\frac{1}{\theta} < 0, \tag{6}$$

$$\lim_{\overline{R}_{t+1} \to 2\mu(1+\delta)} \pi^{l}{}'(\overline{R}_{t+1}) = -\frac{e}{\theta} < 0, \tag{7}$$

$$\lim_{\overline{R}_{t+1} \to 0} \pi^{l}{}'(\overline{R}_{t+1}) = 1 - \frac{e}{\theta}. \tag{8}$$

The following assumption is imposed on $\pi^l(\overline{R}_{t+1})$.

Assumption 1

$$1-\frac{e}{\theta} > 0.$$

Assumption 1 imposes a restriction on the relative size of the monitoring cost, e and the maximum return of investment, θ. If assumption 1 is violated and e is larger than θ, then $\lim_{\overline{R}_{t+1}\to 0} \pi^{l}{}'(\overline{R}_{t+1}) < 0$ and $\pi^l(0) = 0$. In this case, it is not profitable for lenders to supply goods to entrepreneurs at any $\overline{R}_{t+1}$, because e is so large, and hence, no lending occurs in equilibrium. Note that assumption 1 excludes this extreme case and assures an equilibrium in which lending takes place. From (8), under assumption 1, $\pi^l(\overline{R}_{t+1})$ is strictly concave and reaches a maximum at some interior value, that is, $\overline{R}_{t+1}{}^* \in (0, \theta)$. Namely, the expected return of lenders have an upper bound due to asymmetric information. A concave $\pi^l(\overline{R}_{t+1})$ results from two different effects when $\overline{R}_{t+1}$ is increased. One effect is that the expected return rises even if the ratio of bankrupt entrepreneurs remains constant. The other is that the ratio of entrepreneurs who default rises. Under assumption 1, the first effect is large when $\overline{R}_{t+1}$ is small, while the second one dominates the first when $\overline{R}_{t+1}$ is large, thereby making $\pi^l(\overline{R}_{t+1})$ concave.[2]

Define $\pi^l(\overline{R}_{t+1}) \underset{d}{=} 1+r$, and the loan supply is expressed as

$$Q_s^* = \frac{r_{t+1}^*}{\overline{\rho}}(1-\delta)k_t, \tag{9}$$

because only the proportion $r_{t+1}^*/\overline{\rho}$ of lenders actually lend their goods as explained in section I and each lender supplies $w_t = (1-\delta)k_t$ units of goods.

With this preparation, calculate the frontier of Pareto optimal $\pi^l(\overline{R}_{t+1})$ and $\pi^e(\overline{R}_{t+1})$ by solving (3') and (4') (See figure 2). It is given by

$$\pi^l = [-2\theta(\pi^e - \frac{\theta}{2})]^{1/2}[1-\frac{e}{\theta} + (-2\theta)^{-1/2}(\pi^e - \frac{\theta}{2})^{1/2}],$$

where

$$\frac{d\ \pi^l}{d\pi^e} = \frac{d\pi^l}{d\pi^e}\theta[-2\theta(\pi^e - \frac{\theta}{2})]^{-1/2},$$

$$\frac{d^2\pi^l}{d\pi^{e2}} = -\frac{1}{2}[-2\theta(\pi^e - \frac{\theta}{2})]^{-3/2} \ < \ 0.$$

$$\pi^l > 0 \quad when \quad \pi^e = 0,$$

$$\frac{d\ \pi^l}{d\pi^e} = 0 \quad when \quad \frac{d\pi^l}{d\overline{R}^e} = 0.$$

The assumption of perfect competition in capital market ensures that agents will enter into an optimal contract and thus end up on the contract curve, though the precise allocation depends on the bargaining power of the agents. It is assumed that entrepreneurs offer a take-it-or-leave-it contract, and therefore have more barganing power and can lower the return of lenders to the reservation utility 1+ r (point F in figure 2). This contract, however, may not be realized, as there is a possibility of credit rationing due to asymmetric informaion. As shown above, there is an upper bound of the expected return of lenders and therefore supply of capital. If there is large enough demand for capital, there is always excess demand for capital, and lenders end up to have all the bargaing power, and point F cannot be the equilibrium. Entrepreneurs must compete with one another to receive loans from lenders, and offer the contract corresponding to the point G in figure 2, where lender's expected utitlity is maximized. As credit rationing is widely observed in the deloping countries, point G is considerd to be realized in the real world and will be examined in this paper.

Proposition: An equilibrium occurs when the loan interest rate, $\overline{R}_{t+1}{}^{*}$, the expected rate of return from lending, r^{*}_{t+1}, and the aggregate loan quantity, Q^{*}, satisfy the following three conditions:

1) $\overline{R}_{t+1}{}^{*}$ solves (3`) s.t. (4`).

2) $Q_s^* = \dfrac{r_{t+1}^*}{\bar{\rho}}(1-\delta)k_t$.

3) Either (a) $Q_s^* = Q_d$,

or (b) $Q_s^* < Q_d$ and $\pi^{l}{}'(\bar{R}_{t+1}) = 1 - \dfrac{\bar{R}_{t+1}}{2\mu(1+\delta)} - \dfrac{e}{2\mu(1+\delta)} = 0$,

where Q_d^* denotes the aggregate demand for capital.

An equilibrium with credit rationing (point G) corrresponds to 3(b), while an equilibrium without rationing (point F) correspond to 3(a). As shown in Figure 1(a), $\pi^l(\bar{R}_{t+1})$ in the fourth quadrant represents the relationship between $\bar{R}_{t+1}$ and r_{t+1}, where for any given $\bar{R}_{t+1}$, the lender's expected rate of return, $1+r_{t+1}$, can be determined. In the third quadrant, $1+r_{t+1}$ is transformed to r_{t+1} by subtracting 1, and in the second quadrant, the supply curve of loanable goods is shown as a function of r_{t+1}. In the first quadrant, the supply curve of the goods is drawn as a function of $\bar{R}_{t+1}$, being derived by relating $\bar{R}_{t+1}$ in IV to Q_s in the second quadrant. Since the loan demand is constant and independent of $\bar{R}_{t+1}$, the loan demand Q_d is drawn as a horizontal line.[3]

An equilibrium without credit rationing (Figure 1a) occurs when Q_d is small enough, and $Q_d = Q_s$. On the other hand, an equilibrium with credit rationing (Figure 1b) occurs when Q_d is so large that $Q_s < Q_d$ for any $\bar{R}_{t+1}$. With such excess demand present, lenders have greater bargaining power than entrepreneurs who must offer lenders the highest possible profit in order to win a loan. Therefore, as indicated in Figure 1b, E is the equilibrium point which corresponds to maximum $\pi^l(\bar{R}_{t+1})$, AE is the loan supply, and AB is the loan demand. The entrepreneurs corresponding to BE cannot, therefore, borrow any goods. Credit is rationed in the sense that entrepreneurs are identical ex ante, though some can borrow and others cannot at the rate $\bar{R}_{t+1}^*$. As the number of lenders and entrepreneurs in each generation is equal, only the proportion $r^* / \overline{\rho}$ of borrowers can receive loans.

In this equilibrium with credit rationing, $\overline{R}^*_{t+1}$ is chosen to satisfy the following first-order condition:

$$\pi^{l}{}'(\overline{R}_{t+1}) = 1 - \frac{\overline{R}_{t+1}}{\theta} - \frac{e}{\theta} = 0, \tag{10}$$

or equivalently

$$\overline{R}^*_{t+1} = \theta - e. \tag{11}$$

The equilibrium expected rate of return r^*_{t+1} is determined by

$$\pi^{l}(\overline{R}^*_{t+1}) = 1 + r^*_{t+1}, \tag{12}$$

that is,

$$r^*_{t+1} = \frac{\theta}{2} - e + \frac{e^2}{2\theta} - 1. \tag{13}$$

III. Equilibrium with Credit Rationing

The equilibrium of the loan market has now been characterized using the standard debt contract and credit rationing. Let us now examine the equilibrium conditions in other markets and also the dynamics of the economy.

In the factor markets, labor and capital are supplied inelastically. An equilibrium arises when the wage and rental rate of capital are such that the respective demand and the supplies of labor and capital are equal. Firms are price-takers and act competitively, hiring labor up to the point where the marginal product of labor is equal to the wage, and renting capital up to the point where the marginal product of capital is equal to the rental rate. Thus, the factor market equilibrium conditions can be represented using (1) and (2).

For any period t, entrepreneurs invest goods so that their output of the investment in period t+1 becomes k_{t+1}. Since the expected output per investment is μ and the total amount of invested goods is equal to the supply of the loans from lenders, capital accumulation can be expressed as

$$k_{t+1} = \frac{r^*_{t+1}}{\bar{\rho}}(1-\delta)k_t\mu = \frac{1}{\bar{\rho}}\{\frac{\theta}{2} - e + \frac{e^2}{2\theta} - 1\}(1-\delta)k_t\mu . \tag{14}$$

The dynamic behavior of the capital stock can be inferred from the capital accumulation equation (14). Dividing both sides by k_t gives the following growth rate of the capital stock:

$$\frac{k_{t+1}}{k_t} = \frac{r^*_{t+1}}{\bar{\rho}}(1-\delta)\mu = \frac{1}{\bar{\rho}}\{\frac{\theta}{2} - e + \frac{e^2}{2\theta} - 1\}(1-\delta)\mu . \tag{14'}$$

Since the production function is $y_t = k_t{}^{\delta}\bar{k}_t^{1-\delta}$, y_{t+1}/y_t equals k_{t+1}/k_t for $\forall t > 1$ in equilibrium, and (14') gives the equilibrium rate of growth of per capita output. It should be noted that this growth rate is not dependent on time and that the economy is in steady state after the first period. These are the natural results of the production function which exhibits constant returns to the accumulatable input, k_t (AK model: Rebelo. 1990). In addition, the growth rate can be positive or negative depending on the size of e.

IV. The Two-Country Model

The previous section showed the equilibrium growth rate of a closed economy when credit rationing exists in the capital market. Two countries with different levels of informational asymmetry are now introduced, and the effects of this difference are examined.

In developing countries, the financial market is not well developed and the effects of asymmetric information are more severe. Their legal and accounting systems are also relatively primitive. Consequently, the two-country model employed here describes a severely imperfect capital market since the monitoring cost e is larger in developing countries than in developed ones. Although an imperfect capital market naturally causes many effects, for simplicity, all these effects are expressed using only the monitoring cost.

As the cost of verifying bankruptcy increases, this intuitively leads to lower returns to lenders resulting in the following two main effects: (1) The supply of loanable goods decreases, causing a reduction in available credit. Therefore, the amount of lending is expected to decrease which subsequently reduces the growth rate of both per capita capital and income; and (2) If the two countries open their capital markets to each other, capital will flow into the country having a higher rate of return on investment, that is, capital flows into the more developed countries. Effect (2) can be written as the following proposition.

Proposition 1. The expected rate of return on investment is lower in developing countries than in the developed countries. Therefore, if the two countries open their capital markets, capital flows from the former to the latter country.[4]

Proof. It is sufficient to prove $\partial r_{t+1}^{*} / \partial e < 0$. From (13) and assumption 1,

$$\frac{\partial}{\partial e} r_{t+1}^{*} = -1 + \frac{e}{\theta} < 0.$$

Q.E.D.

In building a two-country model, it is assumed that some cost must be incurred in moving capital across borders. The cost of capital movement is expressed as $\varphi(b)$, where b denotes the amount of international capital flows. It is assumed that $\varphi(b)$ satisfies

$$\varphi(0) = 0, \quad \varphi'(b) > 0,$$

that is, the cost of capital movement is an increasing function of the flow of capital. This cost is introduced in this model in order to prevent the unrealistic equilibrium where all the capital in the developing country flow into the developed country.

The variables in developed countries (North) are denoted by the superscript N, while those in developing countries (South) by S. Thus, r^N is greater than r^S as shown in Proposition 1. When the two countries open their capital markets, capital accordingly flows from the developing to developed country until the following condition is satisfied:

$$r^N - \varphi(b^*) = r^S,$$

where b^* denotes the equilibrium amount of capital flows. This condition indicates that the expected returns, including the cost of capital movement, must be equalized in equilibrium.

This equilibrium condition gives the amount of capital flowing from the developing countries to the developed countries. Next, let us consider the growth rates of output in each economy. As stated earlier, even when no capital flows exist, the growth rate of output is higher in the developed country because its domestic loan supply is larger due to the less severe effects of informational asymmetry. Another effect which occurs when the two countries open their capital markets is that the growth rates diverge even more as a result of international capital movement as shown by the following proposition.

Proposition 2. Due to international capital flows and the more severe effects of asymmetric information in developing countries, the growth rate of per capita output in these countries is comparatively lower which causes per capita income to diverge. Such a divergence is contrary to the prediction from neoclassical theory.

Proof : When international capital flows are present, the supply of loanable goods in each country is given by

$$Q_s^N = \frac{r_{t+1}^{N*}}{\bar{\rho}}(1-\delta)k_t + b^*, \tag{15}$$

$$Q_s^S = \frac{r_{t+1}^{S*}}{\bar{\rho}}(1-\delta)k_t, \tag{16}$$

where the first and second terms on the right hand side of (15) are, respectively, the domestic loan supply and the capital supplied from abroad. In the South, the lenders with $\rho \le r^S$ supply their goods to domestic entrepreneurs as before, while those with $r^S < \rho < r^N$ supply their goods to entrepreneurs in the North. In autarky, the latter lenders consume their goods in the first period. Consequently, the opening of the capital market increases the supply of loanable funds to the North without decreasing that in the South. The dynamic behavior of k_t in each country is expressed by

$$\{\frac{r_{t+1}^{N*}}{\bar{\rho}}(1-\delta)k_t^N + b^*\}\mu = k_{t+1}^N,$$

$$\{\frac{r_{t+1}^{S*}}{\bar{\rho}}(1-\delta)k_t^s\}\mu = k_{t+1}^S.$$

From these equations, their corresponding growth rates $y_{t+1}/y_t = k_{t+1}/k_t$ are

$$\frac{y_{t+1}^N}{y_t^N} = \frac{k_{t+1}^N}{k_t^N} = \{\frac{r_{t+1}^{N*}(1-\delta)}{\bar{\rho}} + \frac{b^*}{k_t^N}\}\mu, \tag{17}$$

$$\frac{y_{t+1}^S}{y_t^S} = \frac{k_{t+1}^S}{k_t^S} = \{\frac{r_{t+1}^{S*}(1-\delta)}{\bar{\rho}}\}\mu, \tag{18}$$

where the first term on the right hand side of (17) is larger than that in (18) because $r_{t+1}^{N*} > r_{t+1}^{S*}$, which represents the effect of credit rationing. Moreover, the second term in

(15) is positive and represents the effect of international capital flows. Therefore, the growth rate of the developed country is relatively larger. Q.E.D.

If we consider the welfare property of the dynamic equilibrium, it is also possible to show that the welfare of the developed country grows relatively faster.

Conclusions

This paper has explained the empirical findings that sufficient capital does not flow from developed to developing countries, and their income levels do not converge. If the capital markets in developing countries suffer more severely from asymmetric information, their rate of returns on investment become lower and severer credit rationing occurs in these countries. As a result, capital flows from developing to developed countries, lowering the investment and growth rates in the developing countries. This paper's contribution lies in clarifying the relationship between the credit rationing caused by imperfect capital markets, international capital flows, and growth rates.

The theory proposed suggests that policies which promote the development of the capital markets in developing countries are needed in order to increase capital inflows and improve economic growth. The establishment of a better and more advanced legal and accounting systems are two examples of these policies.

In earlier papers, many other factors have been suggested as explanatory factors for varying growth performances across countries and for why capital flows in particular directions. This paper has provided a plausible theoretical explanation for the simultaneous findings that per capita income across countries do not exhibit convergence and capital does not flow to developing countries in large enough quantities. Whether the credit rationing explanation suggested in this paper provides an explanation that will pass a proper econometric investigation is a question for future research..

Footnotes

1 After controlling for the level of human capital, the initial level of GDP, and other economic factors, conditional convergence is supported by some empirical research (Barro, 1991; Barro and Sala-i-Martin, 1992). This indicates that we must consider several other factors influencing growth rates. Consequently, this paper examines the effects of capital market imperfections on growth (Bencivenga and Smith, 1991, 1993; Levine, 1992; Cohen, 1992; King and Levine, 1993; Pagano, 1993).

2 On the other hand, $\pi^e\left(\overline{R}_{t+1}\right)$ is strictly decreasing in $\overline{R}_{t+1}$ over the range $\overline{R}_{t+1} \in [0, \theta]$.

3 Q_d is assumed to be constant for simplicity. This is not, however, an essential assumption because the loan demand which depends on $\overline{R}_{t+1}$ does not alter the equilibrium as long as Q_d is large enough to cause credit rationing.

4 This effect of an imperfect capital market is contrary to the standard effect of a diminishing marginal product of capital which causes capital flows from developed to developing countries. In the presented model, the marginal product of capital is constant and only the effects of asymmetric information are considered in this proposition. In the real world, however, both these factors and others, for example, political risk have influences. As a result, the direction of the flow of capital is jointly determined by all these factors.

Appendix

The form of the optimal contract is considered here using a proof following along the lines of Williamson (1986) and Hamada and Sakuragawa (1992). It is subsequently shown that the optimal contract is a standard debt contract.

First, consider the optimal level of lending q_t. In section I, the lender痴 utility function and their behavior are explained. It is optimal for any lender to lend all their goods to entrepreneurs in order to maximize utility if the market interest rate is higher than his/her rate of time preference. Thus, the amount of goods each lender supplies is equal to all the goods received as wage w_t. Since a lender is endowed with one unit of labor and the wage rate is $(1-\delta)k_t$ as given by Equation (1), each lender's wage is equal to $(1-\delta)k_t$, that is, $q_t = (1-\delta)k_t$.

After the realization of the investment project, v_{t+1}, the entrepreneurs start firms and obtain $v_{t+1}(1+\delta)$ units of goods, and then send a signal v_{t+1}^d to the lender. Because the contract specifies the range when monitoring occurs, $S_{t+1} \subset [0,\ 2\mu]$, the payment schedule can be written as

$$
\begin{aligned}
R = {} & H(v_{t+1}), \quad if\ v_{t+1}^d \in S_{t+1}, \\
& K(v_{t+1}^d), \quad if\ v_{t+1}^d \notin S_{t+1},
\end{aligned}
$$

where $H(v_{t+1})$ is the payment schedule when monitoring occurs and $K(v_{t+1}^d)$ is the payment schedule when monitoring does not occur. These functions satisfy the following feasibility conditions:

$$0 \le H(v_{t+1}) \le v_{t+1}(1+\delta), \tag{A1}$$

$$0 \le K(v_{t+1}^d) \le v_{t+1}(1+\delta). \tag{A2}$$

When entrepreneurs choose $v_{t+1}^d \notin S_{t+1}$, naturally they will choose v_{t+1}^d which minimizes the payment because no monitoring occurs, that is,

$$v_{t+1}^{d*} = \arg\min_{v_{t+1}^{d}} \; K(v_{t+1}^{d}). \tag{A3}$$

Thus, the payment is constant with no monitoring, that is,

$$\overline{R}_{t+1} = \min_{d \;\; v_{t+1}^{d}} \; K(v_{t+1}^{d}). \tag{A4}$$

Next $H(v_{t+1})$ is characterized. The function $H(v_{t+1})$ must be incentive compatible, namely, it satisfies the following conditions:

$$\begin{aligned} &v_{t+1}^{d} \in S_{t+1} \qquad if \;\; H(v_{t+1}) < \overline{R}_{t+1}, \\ &v_{t+1}^{d} = v_{t+1}^{d*} \qquad if \;\; H(v_{t+1}) \geq \overline{R}_{t+1}, \end{aligned} \tag{A5}$$

and

$$v_{t+1}^{d} \in S_{t+1} \;\; or \;\; v_{t+1}^{d} = v_{t+1}^{d*} \qquad if \;\; H(v_{t+1}) = \overline{R}_{t+1}.$$

These conditions determine S_{t+1} as a function of $H(v_{t+1})$ and $\overline{R}_{t+1}$: $S_{t+1} = \{v_{t+1}\colon H(v_{t+1}) < \overline{R}_{t+1}\}$ and $S_{t+1}^{c} = \{v_{t+1}\colon H(v_{t+1}) \geq \overline{R}_{t+1}\}$. Hence, the optimal contract is specified as $\{q_t, H(v_{t+1}), \overline{R}_{t+1}\}$.

The set of Pareto optimal contracts can be derived from the following maximizing problem,

$$\max_{(H(v_{t+1}),\overline{R}_{t+1})} \; \pi^{e}(\overline{R}_{t+1}) = \int_{S_{t+1}} \{v_{t+1}(1+\delta) - H(v_{t+1})\} \frac{1}{2\mu} dv_{t+1} + \int_{S_{t+1}^{c}} \{v_{t+1}(1+\delta) - \overline{R}_{t+1}\} \frac{1}{2\mu} dv_{t+1} \tag{A6}$$

$$\text{s.t. } \pi^{l}(\overline{R}_{t+1}) = \int_{S_{t+1}} [H(v_{t+1}) - e] \frac{1}{2\mu} dv_{t+1} + \int_{S_{t+1}^{c}} \overline{R}_{t+1} \frac{1}{2\mu} dv_{t+1}. \tag{A7}$$

$\pi^{l}(\overline{R}_{t+1})$ given.

Proposition. The optimal payment schedule is $H(v_{t+1}) = v_{t+1}(1+\delta)$.

Proof. Suppose not, and that $(H'(v_{t+1}), \overline{R}'_{t+1})$ is the optimal contract. Let

$$B'_{t+1} = \{v_{t+1}: H'(v_{t+1}) < \overline{R}'_{t+1}\} \text{ and } B'^{c}_{t+1} = \{v_{t+1}: H'(v_{t+1}) \geq \overline{R}'_{t+1}\}.$$

Then from (A7),

$$\overline{\pi}^{l}(\overline{R}_{t+1}) \underset{d}{=} \int_{S'_{t+1}} [H'(v_{t+1}) - e]\frac{1}{2\mu} dv_{t+1} + \int_{S'^{c}_{t+1}} \overline{R}'_{t+1} \frac{1}{2\mu} dv_{t+1} .$$

Now consider another payment schedule $H''(v_{t+1})$ with $H''(v_{t+1}) \geq H'(v_{t+1})$ for all $v_{t+1} \in [0,\ 2\mu(1+\delta)]$, $H''(v_{t+1}) > H'(v_{t+1})$ for some $v_{t+1} \in B'$, and $H''(v_{t+1})$ continuous and monotone increasing on $[0,\ 2\mu(1+\delta)]$. Then, there is some $\overline{R}''$ with $0 < \overline{R}'' < \overline{R}'$ such that

$$\overline{\pi}^{l}(\overline{R}_{t+1}) \underset{d}{=} \int_{S''_{t+1}} [H''(v_{t+1}) - e]\frac{1}{2\mu} dv_{t+1} + \int_{S''^{c}_{t+1}} \overline{R}''_{t+1} \frac{1}{2\mu} dv_{t+1}$$

$$B''_{t+1} = \{v_{t+1}: H''(v_{t+1}) < \overline{R}''_{t+1}\} \text{ and } B''^{c}_{t+1} = \{v_{t+1}: H''(v_{t+1}) \geq \overline{R}''_{t+1}\}.$$

The change in the objective function in (A6) as the result of changing the contract from $(H'(v_{t+1}), \overline{R}'_{t+1})$ to $(H''(v_{t+1}), \overline{R}''_{t+1})$ is

$$e[\int_{B'_{t+1}} \frac{1}{2\mu} dv_{t+1} + \int_{B''_{t+1}} \frac{1}{2\mu} dv_{t+1}] > 0 ,$$

as $B'' \subset B'$ and $B' - B'' \neq \phi$. We therefore have a contradiction. Q.E.D.

The proof of the proposition follows Williamson (1986). This proposition indicates that the optimal contract is a debt contract. In other words, either the entrepreneur pays back the fixed payment $\overline{R}_{t+1}$, or defaults and pays all output $v_{t+1}(1+\delta)$ and receives a zero return.

References

Barro, R.J. (1990). Government Spending in a Simple Model of Endogenous Growth, *Econometrica*.

Barro, R. J. (1991). Economic Growth in a Cross Section of Countries, *Quarterly Journal of Economics* 106, 407-443.

Barro, R. J. and Sala-i-Martin, X. (1992). Convergence, *Journal of Political Econonorny*100, 223-25 1.

Bencivenga, V. R. and Smith, B. D. (1991). Financial Intermediation and Endogenous Growth, *Review of Economic Studies* 58, 195-209.

Bencivenga, V. R. and Smith, B. D. (1993). Some Consequences of Credit Rationing in an Endogenous Growth Model, *Journal of Economic Dynamics and Control* 17, 97-122.

Cohen, D. (1992). Growth, Productivity, and Access to the World Financial Market, *Journal of Japan and International Economics* 6, 365-3 82.

Gertler, M. and Rogoff, K. (1990). North-South Lending and Endogenous Domestic Capital Market Inefficiency, *Journal of Monetary Economics*

Hamada, K. and Sakuragawa, M. (1992). Fukanzenjyouhou, Kinyuclmukai, Keizaihatten (Imperfect Information, Financial Intermediation and Economic Development), *Economic Studies Quarterly* 43, 386-400.

Hamada, K. and Sakuragawa, M. (1993). Capital Flight, North-South Lending, and the Stages of Development, *Discussion Paper* No. 682. Economic Growth Center, Yale University

King, R. G. and Levine, R. (1993). Finance, Entrepreneurship, and Growth, *Journal of Monetary Economics* 32, 513-542.

Levine, R. (1992). Financial Intermediary Services and Growth, *Journal of Japan and International Economics* 6, 3 83-405.

Levine, R. (1997). Financial Development and Economic Growth: Views and Agenda, *Journal of Economic Literature*.

Lucas, L. B. (1988). On the Mechanics of Economic Development, *Journal of Monetary Economics*. 3-42.

Lucas. L. E. (1990). Why Doesn't Capital Flow from Rich to Poor Countries? *American Economic Review, ~Papers and Proceedings*~ 92-96.

McKinnon,R.I.(1991). <u>The Order of Economic Liberalization: Financial Control in the Transition to a Market Economy</u>, Johns Hopkins University Press.

Pagano, M. (1993). Financial Markets and Growth, *European Economic Review* 37, 613-622.

Rebelo, S. (1990). Long Run Policy Analysis and Long Run Growth, *NBER Working Paper.*

Sala-i-Martin, X. (1990a). Lecture Notes on Economic Growth (I), *NBER Working Paper* No. 3563.

Sala-i-Martin, X. (1990b). Lecture Notes on Economic Growth (II), *NBER Working Paper* No. 3564.

Stiglitz, J. B. and Weiss, A. (1981). Credit Rationing in Markets with Imperfect Information, *American Economic Review* 71, 393-4 10.

Von Thadden, E. (1995). Long-Term Contracts, Short-Term Investment and Monitoring, *Review of Economic Studies.*

Williamson, S. D. (1986). Costly Monitoring, Financial Intermediation, and Equilibrium Credit Rationing, *Journal of Monetary Economics* 18, 159-179.

World Bank, (1989). <u>World Development Report 1989</u>, Oxford University Press.

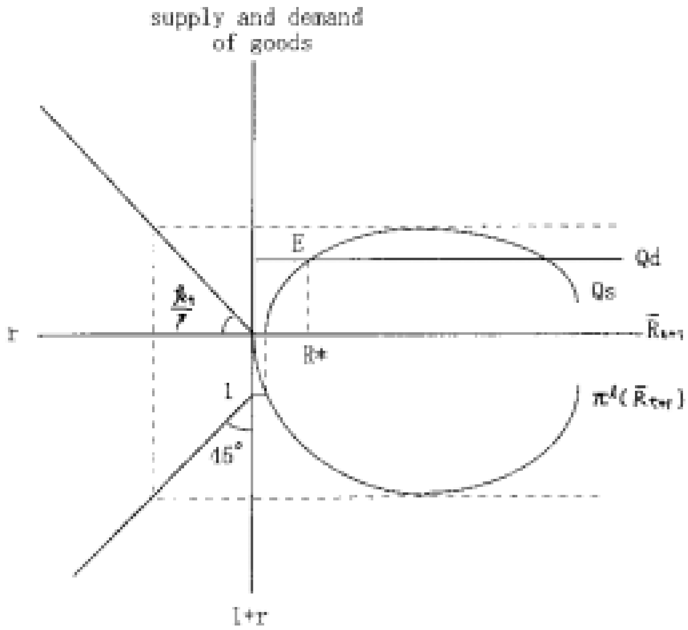

Figure 1a

(Equilibrium without credit rationing)

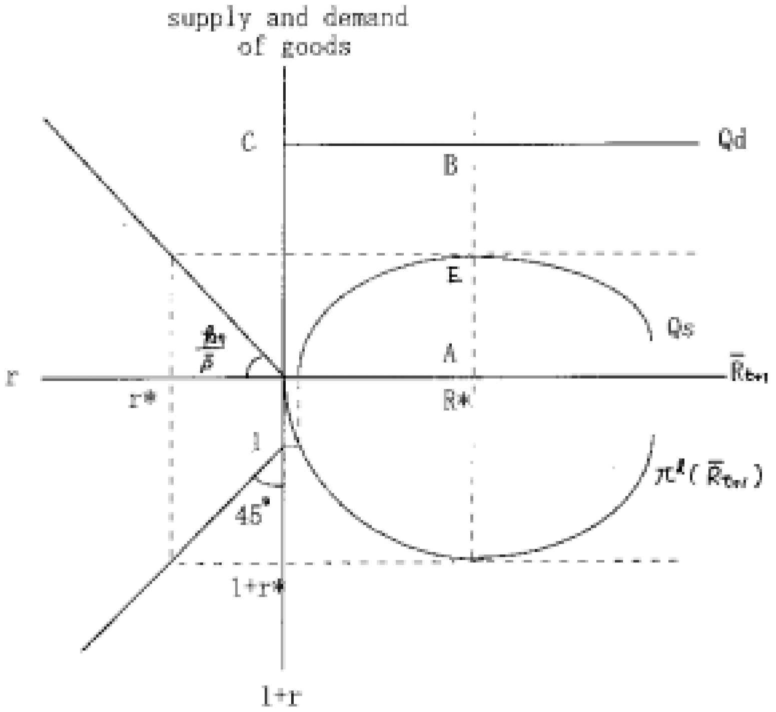

Figure 1b

(Equilibrium with credit rationing)

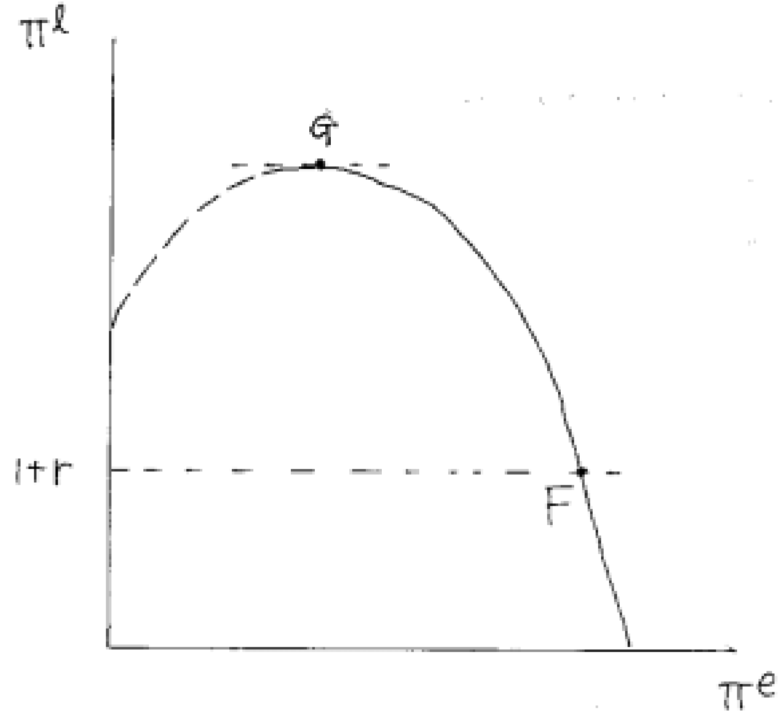

Figure 2