Financial Intermediation and Endogenous Growth

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This paper originated as a result of several conversations with Jeremy Greenwood. We alone are responsible for any errors.

This paper considers the role of financial intermediaries, and in general of competitive financial markets, in stimulating economic growth. In doing so it builds on two important literatures. The literature on endogenous growth associated with the work of Lucas (1985), Prescott and Boyd (1987), Rebelo (1987), and Romer (1986, 1987) has permitted an understanding of how sustained growth is possible without appealing to forces such as exogenous technological change. The literature on the economic role of financial intermediaries pioneered by Boyd and Prescott (1986), Diamond (1984), and Diamond and Dybvig (1983) has enhanced understanding of the functions of these institutions in efficient resource allocation. The present paper focuses on how the natural functions of financial intermediaries in the process of resource allocation also naturally tend to foster economic growth.

That intermediaries (and more generally, efficient financial markets) play an important role in generating growth has been a central theme of the literature on early industrialization and the modern development literature. (For two examples see Cameron (1967) and McKinnon (1973).) In fact, in the early stages of economic development intermediaries essentially make up the whole of organized financial markets. However, to date little work has been done on developing general equilibrium models that explain how financial intermediation can enhance growth. Townsend (1983) produces a model in which the development of financial markets plays an important role in explaining many observations about money and economic growth. However, in Townsend's model the process that generates economic growth is exogenous.

It is argued in the sequel that even rudimentary financial intermediaries can function to increase economic growth. The argument proceeds from a fairly basic list of the important activities of any bank. (i) Banks accept deposits from a large number of agents, and also lend to a large number of agents. In general, then, a law of large numbers operates to make withdrawal demand fairly predictable. (ii) Banks hold liquid reserves against predictable withdrawal demand. (iii) Banks issue liabilities that are more liquid than their primary assets. (iv) Banks eliminate (or reduce) the need for self-financing of investments.

The fact that banks provide liquidity permits risk averse savers to save in the form of bank deposits, rather than by holding liquid assets that are not directly productive. Banks can, in turn, lend these funds to productive investors. In addition, by exploiting the fact that they have large numbers of depositors, and hence predictable withdrawal demand, banks can economize on the holding of liquid reserves (that do not contribute to capital accumulation). In particular, banks can economize on the holding of liquid reserves relative to an economy in which each individual saver must hold liquid assets as a form of self-insurance against unpredictable liquidity needs. Finally, by eliminating the need for self-finance, banks prevent productive capital from being liquidated by self-financed entrepreneurs who have (unpredictable) liquidity needs. To summarize then, financial intermediaries permit an economy to reduce the fraction of its savings held in the form of unproductive (but liquid) assets, and to reduce the liquidation of productive investments. These roles are stressed in the literature on the contribution of financial intermediaries to growth in developing countries. In addition, in accomplishing these objectives intermediaries will have an affect on agents' savings behavior that may further enhance growth. This, however, is not necessary to the argument, and the first set of models considered below abstracts from this kind of consideration.

The argument above centers on the role of intermediaries in influencing the form that savings takes, and possibly in influencing the level of total savings as well. Until recently, however, there were no analytical tools that suggested any theoretical relation between savings behavior and growth. An important contribution of the "endogenous growth" literature has been to demonstrate that savings behavior does directly influence equilibrium growth rates, as pointed out in particular by Lucas (1985), Prescott and Boyd (1987), and Rebelo (1987). Thus in the presence of factors that lead to "endogenous growth", the activities of intermediaries will naturally influence growth rates.

Since the analysis here draws heavily on the contributions of the "endogenous growth" literature, it is appropriate to say a word about what the introduction of financial markets adds to our understanding of growth. First, there is a large historical literature (e.g., Cameron (1967)) as well as a large development literature (e.g., McKinnon (1973) and Shaw (1973)) that suggests that economies with well-developed financial markets grow faster than economies with poorly developed financial markets. If true, and the evidence is surveyed below, it is important to introduce financial markets into models of endogenous growth in order to understand this phenomenon. Second, the models of endogenous growth that have been completely worked out predict either (a) identical growth rates for economies with identical agents and technologies, or (b) growth rates that increase as per capita capital (or human capital) stocks increase. These predictions are counterfactual in several important cases, as discussed below. As will be seen, considerations of the state of financial markets permit an explanation of why economies grow at different rates in ways that cannot be explained by differences in other economic factors, or by differences in "initial" (per capita) capital stocks.

The model used to explore these issues is as follows. A three period lived overlapping generations model is constructed in which all agents (including banks) have access to a "liquid" investment that is not directly productive, and an "illiquid" investment that produces productive capital. Capital, owned by old entrepreneurs, combined with the labor of young workers, is used to produce a single consumption good. Each young worker making a savings decision also faces some probability that investments will have to be liquidated at an "inopportune" time (after one period). There is a large number of such agents. Thus an incentive for banks to form and provide "liquidity" to depositors is present in exactly the same form as is now familiar from Diamond and Dybvig (1983). The banks in the model closely resemble those of Diamond-Dybvig. Hence the role of banks in overcoming informational frictions present in investment decisions emphasized by Boyd and Prescott (1986) or Diamond (1984) is not considered here. However, as argued below, the provision of liquidity by banks seems at least as important in explaining their role in economic growth as does their information-generating role.

If banks are allowed to form, then, they will. Banks will hold liquid reserves against predictable withdrawal demand. Relative to the situation absent banks (autarky), banks economize on liquid reserve holdings by the economy as a whole. They also reduce the liquidation of productive capital. The presence of intermediaries therefore causes a higher proportion of savings to be in the form of productive capital. In addition, there is an externality in production in the model of the form introduced by Prescott and Boyd (1987) and Romer (1986). Thus higher savings in the form of capital leads to a higher equilibrium growth rate.

The model most closely resembles Prescott and Boyd (1987) both in structure, and in emphasizing the role of institutions in growth. It can also be used, much like the Prescott-Boyd model, to analyze how economic policy impacts on growth. Such analysis is left as a future research topic, however. The remainder of the paper proceeds as follows. Because it has been suggested that "the importance of financial matters is very badly over-stressed" (Lucas (1985), p. 5) in these contexts, section I reviews the evidence on the relationship between the development of financial intermediation and growth. Section I considers evidence both from the history of industrialized economies, and from modern development experience. Section II presents a model in which there is a trivial savings decision, and compares equilibrium growth rates in economies without financial intermediaries and economies with a competitive banking system. The fact that the savings decision is trivial serves to emphasize that intermediaries need not increase savings rates in order to lead to higher growth. However, to demonstrate that the results do not depend on presenting agents with trivial savings decisions, section III extends the analysis to allow for a non-trivial savings decision. Section IV concludes.

I. Intermediation and Growth: Some Evidence

A. Evidence from Early Industrialization[1]

There is much historical literature discussing the role of financial intermediation in enhancing economic growth. This section summarizes some examples of the importance of this role. However, it is useful to begin with an overview of exactly what the general contributions of the banking sector have been in the "early stages of industrialization".

According to Cameron (1967, p. 1), "there are a number of historical instances in which financial institutions constituted leading sectors in development; these institutions were 'growth-inducing' through direct industrial promotion and finance". The means by which intermediaries introduced "an important possibility for growth" was by creating

> a more efficient allocation of the initial stock of tangible wealth...with which countries begin the process of industrialization. Typically, in preindustrial countries, a considerable proportion of tangible wealth is held in unproductive forms, such as excessive inventories and hoards of precious metals. In part this results from the technological characteristics of preindustrial countries, such as the slow cycle of production...; in part it results from the lack of investment opportunities...and the absence of suitable financial assets. With the creation of financial intermediaries...[it] becomes possible for savers to hold their wealth in more convenient forms,...thus releasing real resources for productive purposes... [Cameron (1967), p. 10]

This observation, and the observation that historically banks did not "finance innovation", motivate the modelling strategy employed below, in which banks are pure providers of liquidity. In particular, as put by Cameron (p. 12-13), "Occasionally...banks have consciously and deliberately financed technical innovations of promise from a very early stage. More often...bank finance of industrial innovation is either unconscious or at least incidental on the part of the banker." Thus it will be appropriate in the sequel to abstract from considerations of the role of banks in the efficient accumulation of information.

Finally, since much of the focus will be on why economies with well-developed intermediary sectors grow faster than economies lacking such sectors, it is appropriate to say a word about why the development of financial systems varies across countries. As will be emphasized below, such differences seem to be "shaped in large part by legislation" [Cameron, p. 5], and hence can be taken as exogenous in the analysis.

Having briefly discussed the role of intermediation in growth in general terms, some specific examples are now considered.

England

According to Cameron (p. 41), "the bulk of the evidence...testifies to the prominent role of credit in financing the Industrial Revolution." Cameron (p. 15) indicates the beginning of "country banking" in 1750 to be "the most important feature of English banking" from the point of view of a study of banking and early industrialization. 1750 also marks the beginning of the period of accelerated English growth, although growth was not nearly so rapid as it was to become later. From 1775 to 1844 the growth rate of the banking sector (measured in terms of total liabilities and net worth) was nearly equal (2.8% per year) to the growth rate of industrial production (3.1% per year). [Cameron, p. 34]. Such an equality will also obtain in the model below.

Finally, it deserves mention that "low capital requirements and the absence of legal impediments facilitated entry into banking..." [Cameron, p. 26]. This emphasizes the role of the legal environment in permitting the development of a competitive intermediation industry in England.

Scotland

"In 1750 the per capita income of Scotland was no more than half that of England, but...by 1845 it very nearly equalled England's...The comparison with France is even more telling in Scotland's favor...Given its many disadvantages and few positive advantages for growth compared with its neighbors, the superiority of its banking system stands out as one of the major determining factors." [Cameron, p. 94-7.] Scotland thus provides a prime example of the potential importance of intermediation in generating high rates of growth. It also possessed few of the features emphasized in the existing literature on endogenous growth, beginning the period of study with most of its population "engaged in near-subsistence agriculture." [Cameron, p. 60.] Thus Scotland provides an important counter-example to the prediction of models like Lucas' (1985, p. 54) that "economies that are initially poor will remain poor, relatively, though their long run rate of income growth will be the same as that of initially (and permanently) wealthier economies".[2]

The rate of growth of industrial production in Scotland is not directly available, but Cameron presents evidence from specific industries on the impressive nature of this growth. There is also a good deal of evidence on the growth of the Scottish banking system. In 1770 bank assets per capita were approximately equal in England and Scotland. By 1844 bank assets per capita in Scotland were nearly 2½ times as great as in England. Scottish banking was also far more extensive in scope than English banking, giving Scotland "the strongest, most efficient banking system of the times." [Cameron, p. 72.] This fact, along with Scotland's poor initial position and rapid growth "gives a great deal of support to the thesis that the Scottish banking system played a major role in Scotland's more rapid industrialization." [Cameron, p. 75].

Finally, the success of the Scottish banking system in promoting growth is attributed by Cameron (p. 98) to the "comparative immunity from legislative interference" before 1844.[3]

France

Whether France grew more or less slowly than England is a matter of some historical controversy, a review of which is beyond the scope of this paper.[4] However, the role (or lack thereof) of French financial intermediaries in promoting growth does not appear to be a part of the controversy.[5] As summarized by Cameron (p. 101-110):

> France entered the nineteenth century with a virtually clean slate as far as financial institutions were concerned...The new [post-Napoleonic] regime...had a free choice of financial institutions. Unfortunately for France, the regime's choice--and the effects of that choice, which were re-enforced in subsequent legislation--contributed little to economic development and may have been a positive hindrance...Comparison with English and Scottish data reveal that...bank facilities were too few, and bank resources pitifully inadequate.

This led Cameron to conclude in 1967 (p. 111) that available data indicated "an intimate correlation between the tardy development of the banking structure and the equally slow progress of industrialization in France."

After the coup of 1851 several new financial institutions were created. Simultaneously "the French economy entered the decade of its most rapid growth of the entire century. " [Cameron, p. 107] As argued by Cameron (p. 127), "the correlation between the rate of growth and changes in the financial structure before and after 1848 is striking, and cannot be laid to mere chance." Thus again historical evidence is provided on the close relationship between efficient intermediation and rapid growth.

To return briefly to an earlier theme, it is instructive to examine the components of the French "money supply". Specie was by far the largest component of this money supply. In fact, it was not until 1900 that the sum of banknotes and deposits exceeded specie in France.[6] In England banknotes plus deposits exceeded specie in circulation by 1800, and in Scotland this was probably the case even earlier. This serves to emphasize the issue of the composition of savings, which will play an important role in subsequent analysis.

Finally, it might be mentioned that restriction of competition was important in inhibiting the development of the French financial sector. This issue is discussed in detail by Cameron (p. 124-125).

Belgium

The Belgian case is reminiscent of the discussion of Scotland. "At the beginning of the nineteenth century the Belgian Netherlands were...primarily agrarian...By 1870 Belgium was the most highly industrialized nation on the Continent...It also had one of the most highly developed banking systems." [Cameron, p. 129]

Belgian industrial growth was limited before the early 1830s by "the rudimentary state of the financial system." [Cameron, p. 130] But financial developments were rapid after 1835. This date coincides with the beginning of "Belgium's first industrial boom" [Cameron, p. 145]. Thereafter "something of the contribution of the banks to Belgian industry may be judged from the fact that the industries in which they were most deeply involved were also among the most important industries in the Belgian economy, quantitatively, and the ones which exhibited the highest rates of growth." [Cameron, p. 147]

B. Evidence From Modern Developing Countries[7]

An important literature in development economics draws a distinction between "shallow finance" and "deep finance". Shallow finance refers to a situation in which the "supply of loanable funds" is very limited, and much savings takes the form of investment in liquid, low-yielding assets. As was also discussed in the context of preindustrial nations prior to the development of intermediaries, a good deal of investment is in the form of inventories or other highly liquid (but not very productive) assets.[8] Under shallow finance, self-financed investments (unintermediated finance) are the predominant form of investment. Also, shallow finance is usually associated with considerable government intervention in financial markets.

"Deep finance" results, on the other hand, in the savings of the household sector being tapped by financial intermediaries. This reduces the need for self-financing of investment, and makes possible a more productive composition of savings. The importance of deep finance for sustained growth is discussed in detail by McKinnon (1973) and Shaw (1973). Also, it might be noted that even in developing countries with "deep financial markets", most of organized financial markets consist of intermediaries. [McKinnon, p. 38]

Many examples of the importance of "deep finance" in growth are given by McKinnon (1973). His examples include postwar Germany and Japan. In both countries the banking system dominated capital markets, with the consequence that direct finance of investment was less important than in other developed countries. After surveying the evidence on intermediation and growth [McKinnon, p. 91-6], McKinnon concludes that the evidence is "consistent with the banking-financial system's being a leading force in the rapid postwar growth of Japan and Germany."

Another impressive example is Korea. Before 1964 "a traditional curb market of small moneylenders was the principal, but limited, source of finance external to Korean business enterprise." [McKinnon, p. 107] In September 1965 there was a "major banking reform that raised the official ceiling on nominal interest rates....This financial reform was aimed at both increasing private savings and drawing private capital from the curb markets into the 'organized' financial system....The resulting increase in the size of the Korean banking system was quite spectacular." [McKinnon, p. 197-8] In addition, real GNP more than doubled in the next five years.

A fourth example is Taiwan. In 1960 Taiwan had a "normal LDC level of financial development." [McKinnon, p. 114] By 1970 "the 'real' lending capacity of the organized banking sector had risen almost seven times..." [McKinnon, p. 114] In addition, per capita real income nearly doubled between 1960 and 1970.

C. Summary

Both historically, and in modern developing countries, there has been a close connection between the development of a banking sector and the beginning of rapid economic growth. In both cases the relative absence of an intermediation industry results in "too much self-finance", and "too much" of savings being held in liquid, relatively unproductive forms. The development of banking, when it succeeds in reversing this situation, promotes growth.

Also, it has been seen that the most significant role of banks in growth has often been as providers of liquidity, rather than as generators of "information". It has also been seen that often the primary impediment to the development of a banking sector has been legislative. Thus it is not inappropriate to proceed from the perspective that whether or not an economy has a well-developed banking system is essentially exogenously determined.

II. A Model of Intermediation and Growth

In keeping with the previous discussion, a model is now developed in which there is a role for banks to provide liquidity. In this the analysis draws heavily on Diamond and Dybvig (1983). In order to make "savings matter" for growth, there is an externality in production of the kind introduced by Romer (1986). (For a discussion of the empirical plausibility of the importance of such an externality, see Romer (1987).) A similar technology is derived by Prescott and Boyd (1987) under the assumption that there are external effects associated with expertise. Finally, in order to emphasize that it is not necessary for banks to alter total savings out of income in order to stimulate growth, the first model is structured in such a way that there is no scope for varying the amount of savings out of income.

A. The Environment

The economy consists of a sequence of three period lived, overlapping generations. Time is indexed by $t = 0,1,\ldots$. At time $t = 0$ there is an initial old generation, endowed with an initial per capita capital stock of k_0. Also at $t = 0$ there is an initial "middle-aged" generation. At $t=1$ this generation will be endowed with a per capita capital stock of k_1 units.

There are two goods in this economy, a single consumption good and a single capital good. The consumption good can be produced from capital and labor. For reasons to be discussed, all capital is owned by a subset of old agents, henceforth called entrepreneurs. Entrepreneurs can use only "their own" capital in production; as in Romer (1986) it is important that there be no rental markets for capital. Letting k_t denote the capital held by an individual entrepreneur at t, and letting $\bar{k}_t$ denote the "average capital stock per entrepreneur" at t, an entrepreneur who employs L_t units of labor at t can produce output according to the production function $\bar{k}_t^{\delta} k_t^{\theta} L_t^{1-\theta}$, where $\theta \in (0,1)$, and $\delta = 1-\theta$. δ is distinguished from $1-\theta$ notationally, however, to emphasize that it represents an "external effect" in production. Finally, it is assumed that capital depreciates completely in one period, which is a simplifying assumption. Also, except for the initial old and middle-aged generations, agents have no endowment of the capital (or consumption) good at any date.

All young generations are identical (no population growth), and contain a countable infinity of agents. Each young agent is endowed with a single unit of labor when young. There is no labor endowment at age 2 or 3. The single unit of young period labor is supplied inelastically (it is not an argument of agents' utility functions). Finally, letting c_i denote age i consumption, all young agents have the utility function

$$(1)\quad u(c_1,c_2,c_3) = -\frac{(c_2 + \phi c_3)^{-\gamma}}{\gamma}$$

where $\gamma > -1$, and where ϕ is an individual-specific random variable that is realized at the beginning of age 2. ϕ has the probability distribution

$$(2)\quad \phi = \begin{cases} 0 \text{ with probability } 1-\Pi \\ 1 \text{ with probability } \Pi. \end{cases}$$

The assumption that young agents do not care about young period consumption means that all young period income is saved. Hence financial structure trivially cannot affect agents' decisions about how much of their income to save. Finally, the formulation of preferences in (1) and (2) implies a "desire for liquidity" on the part of savers that is familiar from Diamond and Dybvig (1983).

There are two assets in this economy. There is a "liquid investment" (which in view of the previous discussion is probably best thought of as holding inventories of the consumption good), where one unit of the consumption good invested at time t returns $n > 0$ units of the consumption good at either date t+1 or t+2. Thus the gross return on the liquid investment does not depend on the date of liquidation. There is also an "illiquid" capital investment, in which one unit of the consumption good invested at time t returns R units of the capital good at time t+2. This delay represents the "slow cycle of production" discussed by Cameron. If investment in the capital good is liquidated after one period (i.e., at t+1), the "scrap value" of the investment is x units of the consumption good; $0 \leq x < n$.

B. Labor Markets

All capital, then, resides in the hands of age 3 entrepreneurs at each date. As mentioned above, there is no rental market in capital. Thus, given an inherited (from past decisions) capital stock of k_t, and an average "per entrepreneur" capital stock of $\bar{k}_t$, a representative entrepreneur simply chooses a quantity of labor employed (L_t) to maximize profits,

$$L_t = \operatorname{argmax} \{\bar{k}_t^{\delta} k_t^{\theta} L_t^{1-\theta} - w_t L_t\}$$

where w_t is the real wage rate. w_t is taken as parametric by each entrepreneur. Then clearly

(3) $w_t L_t = (1-\theta)k_t^{-\delta} \bar{k}_t^{\theta} L_t^{1-\theta}$

so that each entrepreneur retains the "return to capital" $\theta k_t^{-\delta} k_t^{\theta} L_t^{1-\theta}$.

It remains to discuss labor market clearing. There are equal numbers of young and old agents at each date, and each young agent supplies one unit of labor. Not all old agents are entrepreneurs, however. In particular, a fraction $1-\Pi$ of all old agents have a realized value of zero for the random variable ϕ. These agents, not caring about old age consumption, liquidate all assets at age two, and hence have no capital. In other words, these agents are not entrepreneurs, and obviously hire no labor. Only a fraction Π of old agents are entrepreneurs, and each of these agents hires L_t units of labor. Labor market clearing, then, requires that $L_t = 1/\Pi$ for all t. Substitution into (3) yields the equilibrium wage rate

(4) $w_t = \Pi^{\theta}(1-\theta)k_t^{-\delta} k_t^{\theta}$.

Finally, since all entrepreneurs are identical, in equilibrium $k_t = \bar{k}_t$, so that (4) can be rewritten (using $\delta = 1-\theta$) as

(4') $w_t = \bar{k}_t(1-\theta)\Pi^{\theta}$.

C. <u>The Model with Financial Intermediaries</u>

Financial intermediaries that resemble those familiar from Diamond and Dybvig (1983) are now introduced. The behavior of intermediaries is as follows. Banks take deposits from young savers, and invest in both the liquid asset and the illiquid capital investment. Investment by banks in the liquid asset is a form of reserve holdings by these agents. The focus throughout will be on stationary equilibria. Hence for each unit deposited at date t, banks place $z \in [0,1]$ units in the liquid investment, and $q \in [0,1]$ units in the illiquid investment, where z and q do not depend on t. z and q satisfy

(5) $z+q = 1.$

Some depositors withdraw from banks one period after making a deposit. These agents get r_1 units of the consumption good for each unit deposited. Other agents withdraw two periods after making a deposit. These agents get r_2 units of the capital good, and $\tilde{r}_2$ units of the consumption good per unit deposited.[9] These payments must, of course, satisfy a set of resource constraints. Let α_1 be the fraction of the bank's liquid assets liquidated after one period, and let α_2 be the fraction of the bank's illiquid assets liquidated after one period. Then the relevant resource constraints are

(6) $(1-\Pi)r_1 = \alpha_1 zn + \alpha_2 qx$

(7) $\Pi r_2 = (1-\alpha_2)Rq$

(8) $\Pi\tilde{r}_2 = (1-\alpha_1)zn,$

since $1-\Pi$ is the fraction of agents who withdraw one period after making a deposit.[10]

The bank is viewed as a cooperative entity (say a coalition formed by young agents at t)[11], which maximizes the expected utility of a representative depositor evaluated as of time t. Anticipating the result that in equilibrium all savings are intermediated, expected utility is evaluated as follows. At date t, all young agents deposit their entire labor income w_t. At t+1, a fraction $1-\Pi$ of these agents will experience $\phi=0$, and liquidate all assets (withdraw their deposits). The consumption of these agents is then r_1 per unit deposited. The fraction Π of agents with $\phi=1$ do not withdraw until t+2 (that this is equilibrium behavior is demonstrated below). They receive r_2 units of the capital good each per unit deposited, along with $\tilde{r}_2$ units of the consumption good per unit deposited. Taking $\bar{k}_{t+2}$ (the "average per entrepreneur capital stock" at t+2) as given, each agent who withdraws at t+2 becomes an entrepreneur, and earns the profit (or return on capital) $\theta k_{t+2}^{-\delta}(r_2 w_t)^{\theta}\Pi^{\theta-1}$, since $L = 1/\Pi$. These agents also receive $\tilde{r}_2 w_t$ units of the consumption good. The expected utility of a representative depositor, evaluated at t, then is

$$(9)\quad -(1-\Pi)\frac{(r_1 w_t)^{-\gamma}}{\gamma} - \frac{\Pi[\theta k_{t+2}^{-\delta}(r_2 w_t)^{\theta}\psi + \tilde{r}_2 w_t]^{-\gamma}}{\gamma},$$

where $\psi \equiv \Pi^{\theta-1}$. Banks choose q, z, α_1, α_2, r_2, and $\tilde{r}_2$ to maximize (9) subject to (5) - (8). In doing so they take $\bar{k}_{t+2}$ as given, or in other words, each bank views itself as being unable to influence the "average per entrepreneur capital stock."

Before attempting to fully characterize an equilibrium, it will be useful to have a preliminary result about optimal bank behavior.

Proposition 1. Suppose that $\theta^2\psi R > n$. Then $\alpha_1 = 1$ and $\alpha_2 = 0$. (Reserves are entirely liquidated after one period, while none of the capital investment is liquidated "prematurely".)

Proof. First consider the result $\alpha_2 = 0$. Suppose to the contrary that $\alpha_2 > 0$. Then accompanying this choice of α_2 are optimal choices for q, z, α_1, r_1, r_2, and $\tilde{r}_2$. Now consider replacing these values with $\hat{\alpha}_2 = 0$, $\hat{z} = z + \alpha_2 q$, $\hat{q} = (1-\alpha_2)q$, and $\hat{\alpha}_1 = 1-(1-\alpha_1)z/\hat{z}$. These choices imply a higher value for r_1 (from (6)), and the same values of r_2 and $\tilde{r}_2$ as previously. But this results in a higher expected utilty level for depositors, contradicting the assumed optimality of the original choices.

Similarly (given that $\alpha_2 = 0$), suppose that $\alpha_1 < 1$ for any given choices of q and z. Then consider the consequences of an infinitesimal increase in the value of α_1(to $\hat{\alpha}_1$), with z and q replaced by $\hat{z} = (\alpha_1/\hat{\alpha}_1)z$ and $\hat{q} = q + [1-(\alpha_1/\hat{\alpha}_1)]z$. This change leaves r_1 unaffected (since $\alpha_2 = 0$). From (7) it increases r_2 by an amount $dr_2 = R[1-(\alpha_1/\hat{\alpha}_1)]z/\Pi$. This increase in r_2 raises the profits of entrepreneurs (for a given value

$\bar{k}_{t+2}$) at time t+2 by $\theta[\theta \bar{k}_{t+2}^{-\delta} \psi w_t^{\theta} r_2^{\theta-1}]dr_2 = \theta^2 \psi w_t dr_2$, since in equilibrium $\bar{k}_{t+2} = r_2 w_t$, and since $\delta = 1-\theta$. Thus the increase in profits is $\theta^2 \psi R w_t [1 - (\alpha_1/\hat{\alpha}_1)]z/\Pi$. The reduction in $\tilde{r}_2 w_t$ is, from (8), equal to $z[1 - (\alpha_1/\hat{\alpha}_1)]nw_t/\Pi$. Therefore, if $\theta^2\psi R > n$, this change increases the expected utility of depositors. But this contradicts the optimality of the original choice $\alpha_1 < 1$, proving the result.

It is henceforth assumed that $\theta^2\psi R > n$. It follows immediately that $\tilde{r}_2 = 0$.

Proposition 1 can be used to substantially simplify the problem of the bank at time t. In particular, using $\alpha_1 = 1$ and $\alpha_2 = 0$ in (6) - (8), and substituting the resulting equations along with (5) into (9), it is possible to obtain the following unconstrained problem for the bank at date t:

$$(10) \quad \max_{0 \le q \le 1} \; -\left(\frac{1-\Pi}{\gamma}\right)\left[\frac{(1-q)nw_t}{1-\Pi}\right]^{-\gamma} - \left(\frac{\Pi}{\gamma}\right)\left[\theta \bar{k}^{-\delta} \psi \left(\frac{Rqw_t}{\Pi}\right)^{\theta}\right]^{-\gamma}$$

where for brevity the time subscript on $\bar{k}$ has been omitted. The first order condition associated with the problem (10) is

$$(11) \quad (nw_t)^{-\gamma}\left(\frac{1-q}{1-\Pi}\right)^{-(1+\gamma)} = \left(\frac{\theta\Pi}{q}\right)\left[\theta \bar{k}^{-\delta} \psi \left(\frac{Rqw_t}{\Pi}\right)^{\theta}\right]^{-\gamma}.$$

Equilibrium

In equilibrium, of course,

$$(12)\quad \bar{k}_{t+2} = r_2 w_t = Rqw_t/\Pi .$$

In addition, from (4'), $w_t = \bar{k}_t(1-\theta)\Pi^{\theta}$. It is then immediate from (4') and (12) that

$$(13)\quad \bar{k}_{t+2}/\bar{k}_t = R(1-\theta)\Pi^{\theta-1}q = R(1-\theta)\psi q$$

Since output at time t, denoted y_t, is given by $y_t = k_t^{-\delta}k_t^{\theta}\psi = \psi\bar{k}_t$ (in equilibrium), (13) also gives the equilibrium rate of growth of output. In particular, if $\mu \equiv R(1-\theta)\psi q$, then

$$\bar{k}_t = \begin{cases} \mu^{t/2}k_0 ; & t \text{ even} \\ \mu^{(t-1)/2}k_1 ; & t \text{ odd} \end{cases}$$

and $y_t = \psi\bar{k}_t$. The fact that the time t+2 capital stock depends on the time t wage rate derives, of course, from the fact that capital formation takes two periods.

It is now straightforward to derive the equilibrium value of q. First substitute (12) into (11) to obtain

$$(14)\quad n^{-\gamma}\left(\frac{1-q}{1-\Pi}\right)^{-(1+\gamma)} = \left(\frac{\theta\Pi}{q}\right)(\theta\psi Rq/\Pi)^{-\gamma}$$

Then solving (14) for q yields

(15) $q = \Phi/(1+\Phi)$

where

$$\Phi \equiv \left(\frac{\theta\Pi}{1-\Pi}\right)^{\frac{1}{1+\gamma}} \left[\frac{\Pi n}{(1-\Pi)\theta\psi R}\right]^{\frac{\gamma}{1+\gamma}}.$$

Substitution of (15) into (13) then gives the equilibrium rate of growth for this economy in the presence of competitive intermediaries. For future reference this value is

(16) $$\mu = \frac{\psi R(1-\theta)\Phi}{1+\Phi}.$$

In general μ can be greater or less than one. Hence positive or negative real growth can be predicted, depending on parameter values. Notice that equilibrium growth rates will increase as labor's share in output $(1-\theta)$ increases (with Φ held fixed), as capital becomes "easier" to produce (higher values of R, with Φ held fixed), or as Φ increases (with R, θ and ψ held fixed), so that a greater fraction of savings is invested in the accumulation of productive capital.

It remains to verify that agents with $\phi = 1$ will prefer to withdraw their assets from the bank after two periods rather than one, and that all savings is intermediated. To obtain the first result, observe that equilibrium consumption for agents who withdraw at t+2 (having deposited w_t)

is $\theta k_{t+2}^{-\delta}(Rqw_t/\Pi)^{\theta}\psi = \theta\psi Rqw_t/\Pi$. Agents who withdraw at t+1 (having deposited w_t) have time t+1 consumption equal to $(1-q)nw_t/(1-\Pi)$. Then agents with $\phi = 1$ will withdraw at time t+2 iff

$$(17) \quad \left(\frac{\theta\psi R}{\Pi}\right)\left(\frac{\Phi}{1+\Phi}\right) \geq \left(\frac{n}{1-\Pi}\right)\left(\frac{1}{1+\Phi}\right)$$

where (15) has been used to obtain (17). Substituting the definition of Φ into (17) and manipulating yields the equivalent expression $n \leq \theta^2\psi R$, which has been assumed to hold. Thus only agents with $\phi = 0$ withdraw after one period.

That all savings is intermediated is immediate, since intermediaries choose returns to maximize the expected utility of young savers.

D. <u>The Model Without Financial Intermediaries</u>

The situation just described is now contrasted with an economy where there are no intermediaries or other financial markets. Thus the economy is exactly as described above, except that now all capital accumulation must be "self-financed", and there are no opportunities for young savers to pool "liquidity risks". Then at time t young agents save their entire income w_t, choosing only how to allocate their savings between the liquid asset and investment in the capital good. Let q* denote the fraction of savings invested in capital, and 1-q* is then the fraction of savings invested in the liquid asset. Young agents at t choose q* to solve the problem

$$(18) \quad \max_{0\leq q^*\leq 1} -(1-\Pi)\frac{[xq^* + n(1-q^*)]^{-\gamma} w_t^{-\gamma}}{\gamma} - \left(\frac{\Pi}{\gamma}\right)[\theta k^{-\delta}\psi(Rq^*w_t)^{\theta} + (1-q^*)nw_t]^{-\gamma}.$$

The problem (18) has the associated first order condition

$$(19)\quad (1-\Pi)(n-x)w_t^{-\gamma}[xq^* + n(1-q^*)]^{-(1+\gamma)}$$

$$= \Pi\{\theta[\theta k^{-\delta}\psi(Rw_t)^{\theta}(q^*)^{\theta-1}] - nw_t\}[\theta k^{-\delta}\psi(Rq^*w_t)^{\theta} + (1-q^*)nw_t]^{-(1+\gamma)}$$

where obviously $\bar{k}$ is taken as parametric.

<u>**Equilibrium**</u>

As previously, in equilibrium

$$(20)\quad \bar{k}_{t+2} = k_{t+2} = Rq^*w_t.$$

The difference between (20) and (12) is that here all agents who realize $\phi = 0$ at t+1 liquidate their capital investment. Thus a fraction $1-\Pi$ of all capital investment undertaken at time t is liquidated at t+1, before it becomes productive. This is why the right-hand side of (20) is not divided by Π.

It continues to be the case that w_t is given by (4') in equilibrium. Substituting (4') into (20) gives the equilibrium growth rate of the economy:

$$(21)\quad \bar{k}_{t+2}/\bar{k}_t = R(1-\theta)\Pi^{\theta}q^* \equiv \mu^*.$$

As before, $y_t = \psi\bar{k}_t$ in equilibrium, so (21) also describes the equilibrium growth rate of output.

It is now possible to derive the equilibrium value of q^*. Substituting (20) into (19) yields

$$(22) \quad (1-\Pi)(n-x)[n-(n-x)q^*]^{-(1+\gamma)} = \Pi(\theta^2\psi R-n)[n + (\theta\psi R-n)q^*]^{-(1+\gamma)}.$$

(22) can in turn be solved for q^*:

$$(23) \quad q^* = \frac{(\lambda-1)n}{\theta\psi R-n + \lambda(n-x)}$$

where

$$\lambda \equiv \left[\frac{\Pi(\theta^2\psi R-n)}{(1-\Pi)(n-x)}\right]^{\frac{1}{1+\gamma}}.$$

$\theta\psi R/x \geq \lambda \geq 1$ is henceforth assumed, so that (23) yields a solution for q^* in the unit interval.

(21) and (23) give the equilibrium growth rate for this economy in the absence of intermediaries, or more generally, in the absence of organized financial markets. The question of interest, of course, concerns the relationship between μ and μ^*. Recalling that

$$\mu = \frac{\psi R(1-\theta)\Phi}{1+\Phi}$$

with $\psi \equiv \Pi^{\theta-1}$, and that

$$\mu^* = \Pi^{\theta} R(1-\theta)\left[\frac{(\lambda-1)n}{\theta\psi R-n + \lambda(n-x)}\right],$$

$\mu > \mu^*$ is equivalent to the condition

$$(24) \quad \frac{\Phi}{1+\Phi} > \frac{\Pi n(\lambda-1)}{\theta\psi R-n + \lambda(n-x)}.$$

(24) is necessary and sufficient for the development of financial intermediation to result in higher equilibrium growth rates for this economy. In general it seems difficult to say much about when (24) will be satisfied. However, it is possible to state sufficient conditions that guaranteee satisfaction of (24). One such condition is as follows:

<u>Proposition 2</u>. Given any set of values for Π, θ, R, n and x, if γ is chosen sufficiently large, (24) will hold.

<u>Proof</u>. Fix Π, θ, R, n, and x. As γ approaches infinity, $\Phi/(1+\Phi)$ is bounded below by some constant $\varepsilon > 0$. Moreover, as γ tends to infinity, λ tends to one. Then for γ sufficiently large, (24) will be satisfied.

Thus if young agents are sufficiently risk averse, the presence of competitive intermediaries results in higher equilibrium growth rates.

E. <u>Discussion</u>

Proposition 2 gives a fairly restrictive sufficient condition for financial intermediation to result in higher equilibrium rates of growth. However, it does adequately illustrate how intermediaries can promote growth here. First, as γ becomes sufficiently large, $q = \Phi/(1+\Phi)$ is bounded below by some $\varepsilon > 0$. $q^* = (\lambda-1)n/[\theta\psi R-n+\lambda(n-x)]$ goes to zero as γ becomes sufficiently large. Thus as young agents become sufficiently risk averse q will exceed q*, or in other words, an economy with a financial sector will invest more of its savings in capital goods, and less of its savings in unproductive but liquid assets. This is one of the channels emphasized in section I.

Second, equation (24) is equivalent to the requirement that $q/\Pi > q^*$ hold. Thus even if $q > q^*$ fails, an economy with intermediaries can grow faster than one without a significant financial sector. This is because intermediaries reduce the reliance on "self-finance". In the model, this reduced reliance takes the following very stylized form. In the absence of intermediaries, clearly all capital (and other) investments are self-financed. For agents with $\phi = 0$ in middle-age, these capital investments will be liquidated. When investment is intermediated these liquidations are avoided, as intermediaries can (by exploiting the law of large numbers) meet all withdrawal demand after one period by holding an appropriate level of reserves. This prevents the "premature" liquidation of productive capital assets, and promotes higher equilibrium growth.

III. Intermediation and Growth with Variable Savings

In order to demonstrate that the results obtained above do not depend on young agents saving their entire income (or a fixed fraction of their income), the model is now amended to give young agents a non-trivial savings decision. Thus the previous specification of preferences is now replaced with

$$u(c_1, c_2, c_3) = \ln c_1 + \ln(c_2 + \phi c_3),$$

where c_j is age j consumption as before. All other aspects of the environment are unaltered.

A. The Model with Intermediation

The reasoning underlying proposition 1 continues to be valid when young agents face a non-trival savings decision. So does the reasoning that implies that all savings are intermediated. Thus at date t young agents receive the labor income w_t, and choose how much of it to save. All savings are deposited in a bank. Banks choose a value r_1 for the quantity of consumption goods received (per unit deposited) by agents who withdraw after one period, and a value r_2 for the quantity of capital goods received (per unit deposited) by agents who withdraw after two periods. Agents who own k units of capital when old continue to receive the profit (or return on capital) $\theta k^{-\delta} k^{\theta} \psi$, where as above, $L = 1/\Pi$ and $\psi = \Pi^{\theta-1}$. Each young agent chooses a quantity of savings (deposits) taking as given the values w_t, r_1, r_2, and $\bar{k}_{t+2}$.

Savings Behavior

Anticipating the result that, in equilibrium, agents will withdraw after one period iff $\phi = 0$, young agents choose a level of savings (deposits) d_t to solve the problem

(25) $$\max \ell n(w_t - d_t) + (1-\Pi)\ell n(r_1 d_t) + \Pi \ell n[\theta k^{-\delta} \psi(r_2 d_t)^{\theta}].$$

The solution to (25) is to set

(26) $$d_t = \left[\frac{1-\Pi(1-\theta)}{2-\Pi(1-\theta)}\right] w_t \equiv \beta w_t$$

where clearly $\beta < 1$.

The Behavior of Intermediaries

As above, intermediaries take deposits (viewing the quantity of deposits as exogenous). For each unit deposited, the intermediary acquires $q \in [0,1]$

units of the capital investment, and $z \in [0,1]$ units of the liquid asset. As above the focus is on stationary equilibria, so q and z are not time dependent. z and q satisfy $z+q = 1$. In addition, since proposition 1 continues to be valid, $r_1 = nz/(1-\Pi) = (1-q)n/(1-\Pi)$, and $r_2 = Rq/\Pi$. Then the problem of the intermediary is to choose $q \in [0,1]$ to maximize the indirect utility of a representative depositor, i.e. to solve

$$(27)\quad \max\ \ln[(1-\beta)w_t] + (1-\Pi)\ln\left[\frac{\beta w_t(1-q)n}{1-\Pi}\right] + \Pi\ln[\theta \bar{k}^{-\delta}\psi(\beta w_t)^{\theta}(Rq/\Pi)^{\theta}]$$

taking w_t and $\bar{k}$ as given. The solution to the problem (27) is to set

$$(28)\quad q = \frac{\Pi\theta}{1-\Pi+\Pi\theta}.$$

<u>**The Equilibrium Growth Rate**</u>

As above, in equilibrium $\bar{k}_{t+2}$ is given by

$$(29)\quad \bar{k}_{t+2} = r_2 d_t = \beta R q w_t/\Pi$$

Since w_t continues to be given by (4'), (29) can be rewritten as

$$(30)\quad \bar{k}_{t+2}/\bar{k}_t = \frac{R\theta(1-\theta)\Pi^{\theta}}{2-\Pi+\Pi\theta} \equiv \mu,$$

where (28) has been used to obtain (30). μ is the "two-period rate of growth" for both output and the capital stock. As previously, $\mu > (<) 1$ can hold depending on parameter values.

B. **The Model Without Intermediation**

It will now be convenient to change the notation slightly. Let q^* denote the fraction of income a young saver holds in the form of the capital investment, and let z^* denote the fraction of income a young saver holds in the form of the liquid asset. Then q^* and z^* are chosen by a young saver at t to solve the problem

$$(31)\quad \max\ \ln[w_t(1-q^*-z^*)] + (1-\Pi)\ln[w_t(xq^*+nz^*)] + \Pi\ln[\theta k^{-\delta}\psi(Rq^*w_t)^{\theta} + z^*nw_t].$$

The first order conditions associated with this problem are

$$(32)\quad \frac{1}{1-q^*-z^*} = \frac{(1-\Pi)x}{xq^* + nz^*} + \frac{\theta^2\Pi k^{-\delta}\psi(Rw_t)^{\theta}(q^*)^{\theta-1}}{\theta k^{-\delta}\psi(Rq^*w_t)^{\theta} + z^*nw_t}$$

$$(33)\quad \frac{1}{1-q^*-z^*} = \frac{(1-\Pi)n}{xq^* + nz^*} + \frac{\Pi nw_t}{\theta k^{-\delta}\psi(Rq^*w_t)^{\theta} + z^*nw_t}.$$

Equilibrium Growth Rates

Again, in equilibrium

$$(34)\quad \bar{k}_{t+2} = Rq^*w_t.$$

Substitution of (34) into (32) and (33) yields

$$(32') \quad \frac{1}{1-q^*-z^*} = \frac{(1-\Pi)x}{xq^* + nz^*} + \frac{\Pi\theta^2\psi R}{\theta\psi Rq^* + nz^*}$$

and

$$(33') \quad \frac{1}{1-q^*-z^*} = \frac{(1-\Pi)n}{xq^* + nz^*} + \frac{\Pi n}{\theta\psi Rq^* + nz^*}$$

(32') and (33'), in turn, can be manipulated to obtain

$$(35) \quad z^* = bq^*$$

with

$$(36) \quad b \equiv \frac{\theta\psi R(1-\Pi)(n-x) - \Pi x(\theta^2\psi R-n)}{n\Pi(\theta^2\psi R-n) - n(1-\Pi)(n-x)}$$

and

$$(37) \quad \frac{1}{1-(1+b)q^*} = \frac{(1-\Pi)n}{(x+bn)q^*} + \frac{\Pi n}{(\theta\psi R+bn)q^*}$$

Of course for (35) to satisfy $z^* \geq 0$, $b \geq 0$ must hold. This condition is satisfied iff

$$(38) \quad \frac{\theta\psi R}{x} \geq \frac{\Pi(\theta^2\psi R-n)}{(1-\Pi)(n-x)} > 1.$$

(38) is henceforth assumed to be satisfied.

From (34) and (4'),

$$(39)\quad \bar{k}_{t+2}/\bar{k}_t = R(1-\theta)\Pi^{\theta}q^* \equiv \mu^*,$$

with q^* given by (37). Again the question of interest is, when will $\mu > \mu^*$ hold, with μ defined by (30)? As previously, only a partial answer will be provided to this question. However, it is immediate from (29) and (39) that $\mu > \mu^*$ iff $\beta q/\Pi > q^*$. Since $\beta q/\Pi = \theta/(2-\Pi+\Pi\theta)$ (from (26) and (28)), a sufficient condition is now stated for $\theta/(2-\Pi+\Pi\theta) > q^*$ to hold.

<u>Proposition 3</u>. Suppose that

$$(40)\quad \frac{\theta}{2-\Pi+\Pi\theta} \geq \frac{n}{x+n+2bn}.$$

Then $\mu > \mu^*$.

<u>Proof</u>. From (37), it is immediate that $q^* < n/(x+n+2bn)$. The result follows at once, since $\beta q/\Pi = \theta/(2-\Pi+\Pi\theta)$.

(40) will clearly be satisfied whenever b is sufficiently large. Since b can be made quite large without violating any assumptions on parameter values, there are non-trivial sets of economies where intermediation increases the equilibrium rate of growth.

IV. <u>Conclusions</u>

Some model economies have been displayed in which it is possible to produce conditions that imply the following statement: development of a banking sector will increase the rate of economic growth. This is of interest, since this statement has been widely made in the literature dealing with the history of industrialization, and in the modern development literature.

Moreover, the result suggests the possibility of examining in a rigorous theoretical construct policies that are common in developing countries. In particular, the effects of various regulations imposed on banks can be examined in terms of their consequences for economic growth. For example, it is possible to examine the effects of imposing (or relaxing) reserve requirements or deposit interest rate regulations. There are also several other possibilities. For instance, it is straightforward to reinterpret the "liquid asset" of the model as money, and to examine the consequences of inflation for economic growth. At this point these are left as topics for future research.

It is also the case that the analysis has focused only on banks that view themselves as being unable to influence the aggregate "per entrepreneur" capital stock. Such an assumption would clearly be inappropriate for economies with a small number of banks. It should be possible to examine the consequences of the "industrial organization" of the banking system for equilibrium rates of growth as well. All of these topics are important policy questions for developing countries.

Notes

1. This section draws heavily on Cameron (1967).

2. It might be mentioned that Scotland's other distinguishing feature was its superior educational system [Cameron, p. 97], suggesting the importance of human capital production, as emphasized by Lucas (1985). For further discussion of the role of human capital differences in early industrialization see Cameron (1985).

3. At this point Cameron is quoting from A.W. Kerr's <u>A History of Banking in Scotland</u>, p. 69-70.

4. For a discussion of this controversy see Cameron and Freedeman (1983) and Kindleberger (1984).

5. For a discussion of this point see Kindleberger (1984).

6. See Cameron, p. 116.

7. The subsequent discussion draws heavily on McKinnon (1973).

8. See Patrick (1966) for a detailed discussion of these points.

9. As in Diamond and Dybvig (1983), depositors who withdraw after two periods are residual claimants on the assets of the bank, which can be viewed as a cooperative entity established by young agents at each date. These agents thus receive the proceeds of all investments that accrue in the form of capital goods, and any proceeds from liquid assets not liquidated after one period. The latter accrue in the form of consumption goods, which accounts for the term $\tilde{r}_2$.

   Also, it bears mentioning that equilibria associated with bank runs are ignored here. This is not because such equilibria are uninteresting in the context of studying growth. Much to the contrary, Simons (1948) based much of his argument in favor of 100% reserve requirements on the detrimental effects of having productive capital investments liquidated because of heavy withdrawal demand (runs) on banks. However, simplicity dictates that such equilibria be ignored here. Such equilibria can be safely ignored if it is assumed that banks observe each individual's realization of ϕ, and can ration payments accordingly.

10. Note that it is assumed that banks at time t cannot borrow from the current young at t in order to make payments to depositors. This assumption can be relaxed. However allowing banks to borrow (for instance to meet withdrawal demand by middle-aged agents) would not alter the conceptual issues being addressed here. It would also raise issues about the existence of a stationary equilibrium (and convergence to a stationary equilibrium if one exists) that are not central to the discussion. Hence for the sake of simplicity it is assumed that banks are not permitted to borrow in order to meet withdrawal demand.

11. There would be no problem caused by thinking about there being a fixed finite number of banks at each date that are Nash competitors.

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