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Financial Intermediation and Endogenous Growth

VALERIE R. BENCIVENGA
Cornell University

and

BRUCE D. SMITH
Cornell University and Rochester Center for Economic Research

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An endogenous growth model with multiple assets is developed. Agents who face random future liquidity needs accumulate capital and a liquid, but unproductive asset. The effects of introducing financial intermediation into this environment are considered. Conditions are provided under which the introduction of intermediaries shifts the composition of savings toward capital, causing intermediation to be growth promoting. In addition, intermediaries generally reduce socially unnecessary capital liquidation, again tending to promote growth.

1. INTRODUCTION

A large literature on development and early industrialization asserts that the extent of financial intermediation in an economy is an important determinant of its real growth rate.[1] However, to date relatively little progress has been made towards developing general equilibrium models in which financial intermediaries influence rates of growth.[2] The purpose of this paper, therefore, is to construct a model in which the equilibrium behaviour of competitive intermediaries (banks) affects resource allocations in ways that have implications for real rates of growth, and to provide a partial characterization of when economies with competitive intermediaries will grow faster than economies lacking such institutions.

The reasoning we employ proceeds from the following, fairly basic list of the activities of any bank. (i) Banks accept deposits from and lend to large numbers of agents. For us the most important implication of this is that the 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. In particular, by providing liquidity, banks permit risk averse savers to hold bank deposits rather than liquid (but unproductive) assets. The funds banks obtain are then available for investment in productive capital. Moreover, by exploiting the fact that they have large numbers of depositors, and hence predictable withdrawal demand, banks can

1. Early examples of the literature on intermediation and growth include Cameron (1967), Patrick (1966), Goldsmith (1969), McKinnon (1973), and Shaw (1973). A list of more recent contributions plus a survey of modern evidence appears in the World Development Report (1989). A survey of the literature on historical evidence appears in Bencivenga and Smith (1989*a*).

2. An exception to this statement is Greenwood and Jovanovic (1989), which emphasizes alternative channels by which intermediaries affect growth rates.

economize on liquid reserve holdings that do not contribute to capital accumulation. Or, more specifically, banks reduce investment in liquid assets relative to the situation in an economy lacking intermediaries where each individual must self-insure against unpredictable liquidity needs. And finally, by eliminating self-financed capital investment, banks also prevent the unnecessary liquidation of such investment by entrepreneurs who find that they need liquidity. In short, an intermediation industry permits an economy to reduce the fraction of its savings held in the form of unproductive liquid assets, and to prevent misallocations of invested capital due to liquidity needs.

The argument just given suggests that financial intermediaries may naturally tend to alter the composition of savings in a way that is favourable to capital accumulation. Then, if the composition of savings affects real growth rates, intermediaries will tend to promote growth. Here the analysis draws heavily on the contributions of the "endogenous growth" literature, as exemplified by Romer (1986), Prescott and Boyd (1987), Rebelo (1987), and Lucas (1988). One of the many insights of this literature is that savings behaviour will generally influence equilibrium growth rates. In particular, to the extent that intermediaries tend to promote capital investment, they will also tend to raise rates of growth.

We formalize this reasoning with a three-period-lived overlapping-generations model where all agents (including banks) have access to a "liquid" investment that is not directly productive, and an "illiquid" investment that yields productive capital. Capital, owned by old entrepreneurs, combined with the labour of young workers, is used to produce a single consumption good. Young agents, who make savings decisions, also face 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 exists for banks to form and provide "liquidity" to depositors, as in Diamond and Dybvig (1983).[3] If these banks are allowed to form, then, they will hold liquid reserves against predictable withdrawal demand. Relative to the situation in the absence of banks (financial autarky), banks reduce liquid reserve holdings by the economy as a whole, and also reduce the liquidation of productive capital. Then, with an externality in production of the type considered by Romer (1986) or Prescott-Boyd (1987), higher equilibrium growth rates will be observed in economies with an active intermediary sector.

Before presenting details, however, it is useful to conclude this section with a brief summary of several points that are emphasized in the development literature as important in analyzing growth and intermediation.[4] The following observations also motivate the modelling strategy and several assumptions that are important in the analysis. (i) The state of development of financial markets is typically viewed as exogenously determined by legislation and government regulation (or in the terminology of McKinnon (1973) and Shaw (1973), the degree of financial repression). (ii) In relatively undeveloped economies, banks constitute essentially the whole of organized financial markets. In particular, equity or bond markets play little role. (iii) Long delays between investment expenditures and receipts of profits from capital are emphasized. During these delays, capital investors may face unpredictable liquidity needs, leading to delays in further investment or liquidation of investment already undertaken. (Delays between capital expenditures and receipts are what Cameron (1967, p. 10) refers to as "the slow cycle of production.") (iv) It is generally argued that, in the absence of banks, too much investment

3. Hence the role of banks in overcoming informational frictions—as emphasized by Diamond (1984) or Boyd and Prescott (1986)—is not considered here, despite its obvious potential importance.

4. A survey of the literature that motivates the following set of observations appears in Bencivenga and Smith (1989*a*).

is self-financed. Because of the slow cycle of production, this may lead to the problems in (iii). Also, without financial intermediaries, agents must self-insure against random liquidity needs. This results in excessive investment in unproductive liquid assets. Excessive holdings of consumption inventories are often singled out in the context of underdeveloped economies. Thus the absence of an intermediary sector results in a composition of savings that is unfavourable to capital accumulation. (v) As (iv) might suggest, the most important role of banks in promoting growth is often viewed as providing liquidity, and thereby improving the composition of savings. On the other hand, a role for banks in overcoming informational frictions is sometimes explicitly denied. (See, for instance, Cameron (1967, pp. 12–13).) (vi) Often (but by no means always), economies with well developed financial systems grow faster than otherwise similar economies lacking such systems. Sometimes economies at an apparent disadvantage in most dimensions other than their banking system grow faster than other economies.

With these observations in mind, the remainder of the paper proceeds as follows. Section II presents a model in which agents face 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 (as is sometimes argued). Section III extends the analysis to allow for a non-trivial savings decision, and demonstrates that intermediation can result in higher equilibrium growth rates without increasing savings rates. Section IV comments on some of the major assumptions. Section V concludes.

II. A MODEL OF INTERMEDIATION AND GROWTH

In keeping with previous discussion, a model is now developed with a role for banks in liquidity provision. Here the analysis draws heavily on Diamond and Dybvig (1983). In order to make "savings matter" for growth, there is an externality in production as in Romer (1986). (Romer (1987) discusses the empirical plausibility of such externalities.) 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 intermediation to alter total savings out of income in order to stimulate growth, the first model is structured so that there is no scope for the savings rate to vary.

A. *The environment*

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

There are two goods in this economy, a single consumption good and a single capital good. The consumption good is produced from capital and labour. For reasons to be discussed, all capital is owned by a subset of old agents, henceforth called entrepreneurs. Entrepreneurs use only "their own" capital in production; for simplicity it is assumed that there are no rental markets for capital.[5] Letting k_t denote the capital held by an individual entrepreneur at t and $\bar{k}_t$ the "average capital stock per entrepreneur" at t, an

5. It is readily verified that this assumption is innocuous.

entrepreneur who employs L_t units of labour at t produces the consumption good 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 to emphasize that it represents an "external effect" in production.)[6] For simplicity, it is assumed that capital depreciates completely in one period. 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 continuum of agents. Each young agent is endowed with a single unit of labour when young, which is supplied inelastically. There is no labour endowment at age 2 or 3. Finally, letting c_i denote age i consumption, all young agents have the utility function

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

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

$$\phi = \begin{cases} 0 & \text{with probability } 1-\pi \\ 1 & \text{with probability } \pi. \end{cases} \tag{2}$$

Since young agents do not value age-one consumption, 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 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 best thought of as inventories of the consumption good), where one unit of the consumption good invested at t returns $n > 0$ units of consumption at either $t+1$ or $t+2$. Thus the 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 t returns R units of the capital good at $t+2$. This delay represents the "slow cycle of production" discussed by Cameron.[7] If investment in the capital good is liquidated after one period (i.e. at $t+1$) its "scrap value" is x units of the consumption good; $0 \leqq x < n$.

B. *Labour 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 chooses a quantity of labour employed (L_t) to maximize profits; i.e. $L_t = \operatorname{argmax} \{\bar{k}_t^{\delta} k_t^{\theta} L_t^{1-\theta} - w_t L_t\}$, where w_t, the real wage rate, is taken as parametric. Then labour demand, as a function of k_t, $\bar{k}_t$, and w_t, is given by

$$L_t = k_t[(1-\theta)\bar{k}_t^{\delta}/w_t]^{1/\theta}. \tag{3}$$

6. Alternatively, one could set $\delta = 0$, in which case results retaining the flavour of those in the sequel could be obtained for the steady-state capital stock with and without intermediation. An example of this in a more complicated context with outside money and a government forced to monetize a deficit is given in Bencivenga and Smith (1989*b*).

7. The time interval involved between expenditures on inputs and the receipt of revenues is also commonly emphasized in the modern development literature. See, for instance, Buffie (1984), van Wijnbergen (1982), and Taylor (1980).

It remains to discuss labour-market-clearing. There are equal numbers of young and old agents at each date, and each young agent supplies one unit of labour. Not all old agents are entrepreneurs, however. In particular, a fraction $1-\pi$ of all 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 labour. Only a fraction π of old agents are entrepreneurs, each of whom hires L_t units of labour. Labour-market clearing, then, requires $L_t = 1/\pi$ for all t. Averaging (3) over firms and equating the result to $1/\pi$ gives the equilibrium real wage rate at t as

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

Finally, it is possible to derive the perceived return to capital for entrepreneurs. Substituting (4) into (3), and using the fact that per firm profits at t are just $\theta\bar{k}_t^{\delta}k_t^{\theta}L_t^{1-\theta}$,

$$\theta\bar{k}_t^{\delta}k_t^{\theta}L_t^{1-\theta} = \theta\bar{k}_t^{\delta}k_t[(1-\theta)\bar{k}_t^{\delta}/w_t]^{((1-\theta)/\theta)} = \theta\pi^{\theta-1}k_t \equiv \theta\psi k_t.$$

Thus each entrepreneur retains the "return to capital" $\theta\psi k_t$, where $\psi = \pi^{\theta-1}$.

C. *The model with financial intermediaries*

Financial intermediaries resembling those of Diamond and Dybvig (1983) are now introduced. These intermediaries accept deposits from young savers, and invest in both the liquid asset and the illiquid capital investment. Investment in the liquid asset is a form of reserve holding by banks. Then for each unit deposited at date t, banks place $z_t \in [0, 1]$ units in the liquid investment, and $q_t \in [0, 1]$ units in the illiquid investment, where

$$z_t + q_t = 1. \tag{5}$$

Some depositors withdraw from banks one period after making a deposit. These agents get r_{1t} units of the consumption good for each unit deposited. Agents who withdraw two periods after making a deposit receive r_{2t} units of the capital good, and $\tilde{r}_{2t}$ units of the consumption good per unit deposited.[8] These payments must, of course, satisfy a set of resource constraints. Let α_{1t} be the fraction of the bank's liquid assets liquidated after one period, and let α_{2t} be the fraction of the bank's illiquid assets liquidated after one period. Then the relevant resource constraints are

$$(1-\pi)r_{1t} = \alpha_{1t}z_t n + \alpha_{2t}q_t x \tag{6}$$

$$\pi r_{2t} = (1-\alpha_{2t})Rq_t \tag{7}$$

$$\pi\tilde{r}_{2t} = (1-\alpha_{1t})z_t n \tag{8}$$

since $1-\pi$ is the fraction of agents who withdraw one period after making a deposit.

8. 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 $\tilde{r}_{2t}$. (Parenthetically, this view of a bank as an "investment pool" receives some support in the literature on the history of early banking. See Lamoreaux (1986, p. 659).)

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 favour 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.

The bank is viewed as a cooperative entity (say a coalition formed by young agents at t),[9] 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 labour income w_t. At $t+1$, a fraction $1-\pi$ of these agents experience $\phi=0$, and liquidate all assets (withdraw their deposits). The consumption of these agents is then r_{1t} per unit deposited. The fraction π of agents with $\phi=1$ do not withdraw until $t+2$ (that this is equilibrium behaviour is demonstrated below). They receive r_{2t} units of the capital good each per unit deposited, along with $\tilde{r}_{2t}$ units of the consumption good. 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) $\theta\psi k_{t+2}$. These agents also receive $\tilde{r}_{2t}w_t$ units of the consumption good. The expected utility of a representative depositor, evaluated at t, then is

$$-\left(\frac{1-\pi}{\gamma}\right)(r_{1t}w_t)^{-\gamma}-\left(\frac{\pi}{\gamma}\right)[\theta\psi(r_{2t}w_t)+\tilde{r}_{2t}w_t]^{-\gamma} \tag{9}$$

where $k_{t+2}=r_{2t}w_t$ has been used in (9). Banks choose q_t, z_t, α_{1t}, α_{2t}, r_{1t}, r_{2t}, and $\tilde{r}_{2t}$ 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 fully characterizing an equilibrium, it will be useful to have a preliminary result about optimal bank behaviour.

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

A formal proof appears in Bencivenga-Smith (1989a), and is omitted here. However, Proposition 1 should be intuitively clear, since "premature" liquidation of capital can always be improved upon by increasing reserve holdings, while reserves held for two periods can always be profitably converted into capital. It is henceforth assumed, then, that $\theta\psi R>n$, implying of course that $\tilde{r}_{2t}=0$.

9. Note that banks are assumed to be entities consisting entirely of members of the same generation. Thus banks cannot borrow from the current young in order to make payments to older agents engaged in withdrawals. Nor can banks formed at t take deposits at $t+1$ or $t+2$ from young agents at those dates. This assumption is necessary under the formulation of banks as coalitions of agents since, as is well known, cooperative equilibria will typically not exist under standard definitions in overlapping-generations models. (See, e.g. Hendricks, et al. (1980).) In fact, it is easily shown that any allocation other than the one derived below is blocked under usual blocking notions if banks are coalitions consisting of members of multiple generations. Thus, as in Hendricks, et al., the generational structure of coalitions must be restricted to ensure existence, as we have done here.

An alternative formulation would allow banks to be privately-owned continuing entities, and hence to have trade in bank shares. However, if this formulation were to result in an equilibrium different from that derived below, the equilibrium would have the feature that bank shares would supplant the liquid asset as reserves for banks; i.e. banks would hold each others' shares as reserves. This would, in addition to being highly unrealistic, introduce modelling complications without yielding additional insights.

Also, we note that banks are not permitted to sell shares to capital in process. In fact, we have implicitly assumed throughout that markets in which claims to capital in process can be traded do not exist. Reasons for ruling out such markets are discussed in Section IV. And finally we note that, so long as ownership shares in them have no value, there would be no problem caused by thinking about there being a fixed finite number of banks at each date that are Nash competitors.

Proposition 1 substantially simplifies the problem of the bank. Setting $\alpha_{1t}=1$ and $\alpha_{2t}=0$ in(6)-(8), and substituting the resulting equations along with (5) into (9), we obtain the following problem for the bank at t:

$$\max_{0\leqq q_t\leqq 1} -\left(\frac{1-\pi}{\gamma}\right)\left[\frac{(1-q_t)nw_t}{1-\pi}\right]^{-\gamma} -\left(\frac{\pi}{\gamma}\right)[\theta\psi(Rq_tw_t/\pi)]^{-\gamma}. \tag{10}$$

The solution to (10) sets[10]

$$q_t=\Phi/(1+\Phi) \tag{11}$$

where

$$\Phi\equiv\left(\frac{\pi}{1-\pi}\right)^{1/(1+\gamma)}\left[\frac{\pi n}{(1-\pi)\theta\psi R}\right]^{\gamma/(1+\gamma)}. \tag{12}$$

It remains to verify that agents with $\phi=1$ will prefer to withdraw from the bank after two periods rather than one, and that all savings are intermediated. To obtain the first result, observe that equilibrium consumption for agents who withdraw at $t+2$ (having deposited w_t) is $\theta\psi r_{2t}w_t=\theta\psi Rq_tw_t/\pi$. Agents who withdraw at $t+1$ have time $t+1$ consumption equal to $r_{1t}w_t=(1-q_t)nw_t/(1-\pi)$. Then agents with $\phi=1$ will withdraw at time $t+2$ iff

$$\left(\frac{\theta\psi R}{\pi}\right)\left(\frac{\Phi}{1+\Phi}\right)\geqq\left(\frac{n}{1-\pi}\right)\left(\frac{1}{1+\Phi}\right) \tag{13}$$

where (11) has been used to obtain (13). Substituting (12) into (13) and re-arranging terms yields the equivalent expression $\theta\psi R\geqq n$, which has been assumed to hold. Thus only agents with $\phi=0$ withdraw after one period. That all savings are intermediated is immediate, since intermediaries choose returns to maximize the expected utility of young savers.

Equilibrium

In equilibrium, of course,

$$\bar{k}_{t+2}=r_{2t}w_t=Rq_tw_t/\pi=k_{t+2}. \tag{14}$$

Then (4) and (14) imply that

$$\bar{k}_{t+2}/\bar{k}_t=R(1-\theta)\pi^{\theta-1}q_t=R(1-\theta)\psi\Phi/(1+\Phi)\equiv\mu. \tag{15}$$

Since per firm output at time t, denoted y_t, equals $\bar{k}_t^{\delta}k_t^{\theta}\psi=\psi\bar{k}_t$ (in equilibrium), and since the number of firms is constant over time, (15) also gives the equilibrium rate of growth of output. In particular,

$$\bar{k}_t=\begin{cases}\mu^{t/2}k_0; & t \text{ even,}\\ \mu^{(t-1)/2}k_1; & t \text{ odd.}\end{cases} \tag{16}$$

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.

10. Equation (11) implies that $r_{1t}=n/(1+\Phi)(1-\pi)$. $r_{1t}\geqq n$ holds iff $\gamma\geqq 0$. Thus $\gamma\geqq 0$ is sufficient to imply that intermediaries do, in fact, provide liquidity here since, under autarky, the return on agents' portfolios (if liquidated after one period) is a weighted average of n and x.

In general the growth rate 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 labour'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 is also possible to consider the effects of varying one parameter at a time, so that Φ will change along with the change in the relevant parameter. For instance, it is easy to show that $\partial\mu/\partial R=(\mu/R)\times[1-\gamma/(1+\gamma)(1+\Phi)]>0$, so that as capital becomes easier to produce, real growth rates increase (even though q_t will decrease with increases in R whenever $\gamma>0$).

D. *The model without financial intermediaries*

The situation just described is now contrasted with one 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".[11] Then at t young agents save their entire income w_t, choosing only how to allocate their savings between the liquid asset and investment in capital. Let q_t^* denote the fraction of savings invested in capital, and $1-q_t^*$ the fraction invested in the liquid asset. Then young agents at t choose q_t^* to solve the problem

$$\max_{0\leqq q_t^*\leqq 1} -\left(\frac{1-\pi}{\gamma}\right)[xq_t^*+n(1-q_t^*)]^{-\gamma}w_t^{-\gamma}-\left(\frac{\pi}{\gamma}\right)[\theta\psi Rq_t^*+(1-q_t^*)n]^{-\gamma}w_t^{-\gamma} \quad (17)$$

since $k_{t+2}=Rq_t^*w_t$ if $\phi=1$. The solution to this problem sets

$$q_t^*=\frac{(\lambda-1)n}{\theta\psi R-n+\lambda(n-x)}, \quad (18)$$

where

$$\lambda=\left[\frac{\pi(\theta\psi R-n)}{(1-\pi)(n-x)}\right]^{1/(1+\gamma)}. \quad (19)$$

It is henceforth assumed that $\theta\psi R/x\geqq\lambda\geqq 1$, so that (18) satisfies $0\leqq q_t^*\leqq 1$.

Equilibrium

As previously, in equilibrium

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

The difference between (20) and (14) is that here all agents who experience $\phi=0$ 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 capital stock:

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

11. Again, in keeping with the discussion of Section I, we view this as a consequence of "financial repression" by the government.

As before, the level of per-firm output is $y_t = \psi \bar{k}_t$ in equilibrium, so (21) also describes the growth rate of output in the absence of intermediaries, or more generally, of organized financial markets. The question of interest, of course, concerns the relationship between μ and μ^*. From (15), (18), (21), and $\psi = \pi^{\theta-1}$, $\mu > \mu^*$ is equivalent to the condition

$$\frac{\Phi}{1+\Phi} > \frac{\pi n(\lambda - 1)}{\theta\psi R - n + \lambda(n-x)}. \tag{22}$$

(22) 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 (22) will be satisfied. However, it is possible to state sufficient conditions that guarantee satisfaction of (22). One such condition is as follows:

Proposition 2. *Given any set of values for π, θ, R, n and x, if γ is chosen sufficiently large,* (22) *will hold.*

Proof. 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, (22) will be satisfied. ||

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

Under some additional restrictions on parameter values, it is possible to obtain much sharper results than this one. For instance, from (15) and (21), $\mu > \mu^*$ iff $q_t/\pi > q_t^*$. Then, whenever $q_t \geqq q_t^*$, intermediation will result in higher real growth rates. We now state

Proposition 3. *For sufficiently small values of x, $q_t > q_t^*$ if $1 \geqq [(1-\pi)/\pi]^\gamma$.*

Proof. We prove Proposition 3 for $x = 0$. The full proposition then follows from the continuity of q_t^* in x, and the fact that q_t is independent of x.

To begin, $q_t > q_t^*$ iff $1/q_t^* > 1/q_t$. From (11) and (18), $1/q_t^* > 1/q_t$ iff $(\theta\psi R - \lambda x)/(\lambda - 1)n > 1/\Phi$. Then, if $x = 0$, this condition reduces to $\theta\psi R\Phi > (\lambda - 1)n$. Using the definitions of Φ and λ, and rearranging terms, the condition $\theta\psi R\Phi > (\lambda - 1)n$ is equivalent to

$$\left(\frac{\pi}{1-\pi}\right)^{1/(1+\gamma)} \left(\frac{\pi n}{1-\pi}\right)^{\gamma/(1+\gamma)} (\theta\psi R)^{1/(1+\gamma)}$$
$$> \left[\left(\frac{\pi}{1-\pi}\right)^{1/(1+\gamma)} \cdot \left(\frac{\theta\psi R - n}{n}\right)^{1/(1+\gamma)} - 1\right] n. \tag{23}$$

A sufficient condition for (23) to hold, clearly, is that $\theta\psi R/(\theta\psi R - n) > [(1-\pi)/\pi]^\gamma$. However, this condition itself must be satisfied if $1 \geqq [(1-\pi)/\pi]^\gamma$, establishing the result. ||

E. *Discussion*

Propositions 2 and 3 give fairly restrictive sufficient conditions for financial intermediation to result in higher equilibrium rates of growth. However, they do adequately illustrate how intermediaries can promote growth here. First, in the case of Proposition 2, as γ

becomes sufficiently large, $q_t = \Phi/(1+\Phi)$ is bounded below by some $\varepsilon > 0$. $q_t^* = (\lambda-1)n/[\theta\psi R - n + \lambda(n-x)]$ goes to zero as γ becomes sufficiently large. Thus as young agents become sufficiently risk-averse q_t will exceed q_t^*, 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. Moreover, Proposition 3 shows that this must occur for any γ if x is small, and $1 \geqq [(1-\pi)/\pi]^{\gamma}$. This result should be clear intuitively, since if x is small capital investments are highly illiquid. Thus financial autarky is likely to result in relatively large holdings of liquid assets by individual savers.

Second, as noted above, (22) is equivalent to the requirement that $q_t/\pi > q_t^*$ hold. Thus even if $q_t > q_t^*$ 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.

Finally, it is possible to say something about the dynamics of transition from an economy that lacks financial intermediaries to one that has a fully functioning banking system. In particular, within two periods the growth rate will rise from μ^* to μ if a freely operating banking system is introduced. For one period there will be no consequences, since capital invested during the period of transition takes two periods to accrue. Thus an absence of immediate effects from a financial liberalization cannot be taken to imply that such a liberalization will not ultimately raise growth rates. (Such an observation is relevant to a number of empirically motivated criticisms of McKinnon (1973) and Shaw (1973); see for instance Diaz-Alejandro (1985).) Moreover, this statement is independent of whether the liberalization is anticipated or not, as the perceived return to capital is technologically fixed here, and consequently is not affected by financial liberalizations. Of course the relatively simple effects of financial liberalizations in this model are heavily dependent on the specification of technology. If $\delta = 0$, for instance, the dynamics of transition will be non-trivial. An alternative formulation that allows for endogenous growth and non-trivial transition dynamics is discussed in section IV.

III. INTERMEDIATION AND GROWTH WITH VARIABLE SAVINGS

In order to demonstrate that our results do not depend on young agents saving their entire income (or a fixed fraction of their income), these agents are now given a non-trivial savings decision. Thus the previous specification of preferences is replaced with $u(c_1, c_2, c_3; \phi) = \ln c_1 + \ln (c_2 + \phi c_3)$, 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 here, as does the reasoning implying that all savings are intermediated. Thus at date t young agents earn the labour income w_t, and choose how much of it to save. All savings are deposited in a bank. Banks choose a value r_{1t} for the quantity of consumption goods received (per unit deposited) by agents who withdraw after one period, and a value r_{2t} for the quantity of capital 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) $\theta\psi k$. Each young agent chooses a quantity of savings (deposits) taking as given the values w_t, r_{1t}, r_{2t}, and $\bar{k}_{t+2}$.

Savings behaviour

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 maximize $\ln(w_t - d_t) + (1-\pi)\ln(r_{1t}d_t) + \pi \ln(\theta\psi r_{2t}d_t)$. The solution sets $d_t = w_t/2$.

The behaviour of intermediaries

As above, intermediaries take deposits (viewing the quantity of deposits as exogenous). For each unit deposited, the intermediary acquires $q_t \in [0, 1]$ units of the capital investment, and $z_t \in [0, 1]$ units of the liquid asset, with $q_t + z_t = 1$. In addition, since Proposition 1 continues to be valid, $r_{1t} = nz_t/(1-\pi) = (1-q_t)n/(1-\pi)$, and $r_{2t} = Rq_t/\pi$. Then the problem of the intermediary is to choose $q_t \in [0, 1]$ to maximize the indirect utility of a representative depositor, i.e. to solve

$$\max \ln(w_t/2) + (1-\pi)\ln[(1-q_t)nw_t/2(1-\pi)] + \pi \ln(\theta\psi R q_t w_t/2\pi)$$

taking w_t as given. The solution to this problem is to set $q_t = \pi \forall t$.

The equilibrium growth rate

In equilibrium $\bar{k}_{t+2}$ is given by

$$\bar{k}_{t+2} = r_{2t}d_t = Rq_t w_t/2\pi = Rw_t/2 = k_{t+2}. \tag{24}$$

Since w_t continues to be given by (4), (24) can be rewritten as

$$\bar{k}_{t+2}/\bar{k}_t = (1/2)R(1-\theta)\pi^{\theta} \equiv \mu \tag{25}$$

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 is now convenient to change the notation slightly. Let q_t^* denote the fraction of income a young saver holds in the form of the capital investment, and let z_t^* denote the fraction of income a young saver holds in the form of the liquid asset. Then q_t^* and z_t^* are chosen by a young saver at t to maximize $\ln[w_t(1-q_t^*-z_t^*)] + (1-\pi)\ln[w_t(xq_t^* + nz_t^*)] + \pi \ln(\theta\psi R q_t^* w_t + z_t^* n w_t)$. The solution to this problem sets $z_t^* = bq_t^*$, where

$$b \equiv \frac{\theta\psi R(1-\pi)(n-x) - \pi x(\theta\psi R - n)}{n\pi(\theta\psi R - n) - n(1-\pi)(n-x)}. \tag{26}$$

q_t^* then satisfies

$$\frac{1}{1-(1+b)q_t^*} = \frac{(1-\pi)n}{(x+bn)q_t^*} + \frac{\pi n}{(\theta\psi R + bn)q_t^*} \tag{27}$$

Of course in order to satisfy $z_t^* \geqq 0$, $b \geqq 0$ must hold. This condition is satisfied iff

$$\frac{\theta\psi R}{x} \geqq \frac{\pi(\theta\psi R - n)}{(1-\pi)(n-x)} > 1. \tag{28}$$

(28) is henceforth assumed to hold.

Equilibrium growth rates

Again, in equilibrium

$$\bar{k}_{t+2} = Rq_t^* w_t. \tag{29}$$

Then, from (29) and (4),

$$\bar{k}_{t+2}/\bar{k}_t = R(1-\theta)\pi^\theta q_t^* \equiv \mu^*, \tag{30}$$

with q_t^* given by (27). Again the question of interest is, when will $\mu > \mu^*$ hold, with μ defined by (25)? As previously, only a partial answer will be provided to this question. However, it is immediate from (25) and (30) that $\mu > \mu^*$ iff $0{\cdot}5 > q_t^*$. Thus we have

Proposition 4. *$\mu > \mu^*$ if*

$$0{\cdot}5 \geqq n/(x+n+2bn). \tag{31}$$

Proof. From (27), it is immediate that $q_t^* < n/(x+n+2bn)$. The result then follows. ||

Condition (31) will clearly be satisfied whenever $b \geqq 0{\cdot}5$, for instance. 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.

As in Section II, sharper results are available when x is small. First we have

Proposition 5. *For sufficiently small x,* (28) *implies that $q_t^* < 0{\cdot}5$.*

Proof. Again we prove the proposition for $x = 0$, and the full proposition follows from the continuity of q_t^* in x. For $x = 0$, then,

$$q_t^* = \frac{\pi\theta\psi R}{\theta\psi R + nb + (1+b)\pi\theta\psi R} \tag{32}$$

The value of q_t^* given by (32) is less than $0{\cdot}5$ iff $\pi\theta\psi R < (1+\pi b)\theta\psi R + nb$. But this must always hold if $b \geqq 0$, and $b \geqq 0$ is implied by (28). ||

The intuition underlying Proposition 5 is straightforward: when x is small, investments in capital are very illiquid. Thus under financial autarky a relatively small fraction of income will be invested in capital accumulation. This is exactly the situation where the development of intermediation will tend to promote growth.

An interesting question is whether the model predicts that the role of intermediation in promoting growth must occur because intermediation increases savings rates. As argued by many authors (see, e.g. Diaz-Alejandro (1985)), it is far from clear that economies with better developed banking systems necessarily have higher savings rates than other economies. For the economy of this section, half of income is saved when intermediaries are present. In the absence of intermediaries, the fraction of income saved is $z_t^* + q_t^* = (1+b)q_t^*$. We conclude by establishing

Proposition 6. *If* $x = 0$, $(1+b)q_t^* = 0{\cdot}5$.

Proof. From (32),

$$(1+b)q_t^* = \frac{\pi\theta\psi R(1+b)}{\pi\theta\psi R(1+b) + \theta\psi R + nb}$$

Then $(1+b)q_t^* = 0{\cdot}5$, iff $\theta\psi R + nb = \pi\theta\psi R(1+b)$. Rearranging terms, the latter condition reduces to $b = (1-\pi)\theta\psi R/(\pi\theta\psi R - n)$. But this is exactly (26) for $x = 0$. ||

Thus intermediation can result in higher equilibrium growth rates, even though its development need not tend to raise savings rates.

IV. DISCUSSION

Several of the preceding assumptions merit some comment. For instance, the state of development of financial markets has been taken as exogenously imposed. In this the analysis follows the suggestions of Cameron (1967), McKinnon (1973), and Shaw (1973) that differences in the extent of financial markets across countries seem to depend primarily on legislation and government regulation. In addition, we have assumed that share markets to capital in process, and other markets allowing for intergenerational exchange, do not exist. Here we offer the following comments. First, in the context of developing economies, such an assumption is apparently realistic, and is standard in the development literature (see Taylor (1980) or McKinnon and Mathieson (1981)). Second, as in Diamond-Dybvig (1983), a role for intermediaries in the model depends on restricting the trading of shares to the ownership of capital in process (see Jacklin (1987)). Thus, the use of the Diamond-Dybvig model of liquidity provision by banks obliges us to restrict such trading. In practice the trading of shares has sometimes been legally prohibited exactly because such trading tended to undermine the banking system. (See Arnold (1937, pp. 8–9) for an example.)

Suppose, then, that we are justified in abstracting from share markets (and other markets for inter-generational exchange) because legal restrictions hinder the formation of such markets in developing economies. Why might such legal restrictions be imposed? We believe that one answer to this question would be provided by reinterpreting the liquid asset of the model as outside money, and by considering the problem of a government forced to monetize a persistent deficit. Such a government would need to preclude the existence of share markets in capital (and other markets that allow for "non-monetary" inter-generational trade) in order to prevent such markets from "undermining" the demand for money. The possibility would also be open that such a situation would induce the government to repress (or drive out of existence altogether) the banking system as we have defined it. This is left as a topic for future research, but does suggest why financial repression might naturally be observed.

As a second comment, the role for financial intermediaries in promoting permanent changes in growth rates hinges in our model on the presence of "spillover externalities" leading to social increasing returns to scale in production. Since other "endogenous growth" formulations, such as those of King, Plosser, and Rebelo (1988) or Jones and

Manuelli (1988), are available, our choice of formulation deserves comment. One point of note is that the development literature commonly asserts the importance of increasing returns-to-scale in the development process.[12] A second is that externalities of exactly the form examined are often argued to provide a justification for government intervention in financial markets (Johnson (1983)) in developing countries. It thus seems natural to include these features when modelling the role of financial markets in the early development process. However, our analysis by no means requires such externalities to be present. Here we offer two observations. One is that, in our specification of technology, we could simply set $\delta=0$, and then the analysis would apply to steady states. Secondly, other closely related specifications of technology are possible. For instance, we can let per-firm output at t be given by $k_{t-2}^{\delta}k_t^{\theta}L_t^{1-\theta}$. Such a technology has a learning-by-doing interpretation, in which per-firm output at t depends on data t inputs, and the amount of capital in use at date $t-2$ (when the current old were young workers engaged in production). Then the analysis of Section II could be repeated almost exactly. In this case (and under the assumption that $\gamma=0$), the economy converges to a constant growth rate asymptotically, both in the presence of intermediaries and under financial autarky. The paths converging to this steady-state growth rate necessarily display damped oscillation, so growth rates are not monotone. Finally, one can show that intermediation results in a higher steady-state growth rate if $(1-\pi)n>x$. Such a result has exactly the flavour of Proposition 3, in that for small x (recall that $\gamma=0$ here), intermediation must eventually result in higher rates of growth.

V. CONCLUSIONS

Some conditions have been displayed which imply that the development of financial intermediation will increase real growth rates. The model thus validates a common assertion in the development literature. Moreover, our results suggest the possibility of examining, in a rigorous theoretical construct, policies that are often considered in developing countries. For instance, the effects of various regulations on the financial system (reserve requirements or interest rate ceilings) can be examined in terms of their consequences for growth. It is also possible to reinterpret the "liquid asset" of the model as outside money, and to examine the co-determination of inflation and real growth rates.[13] In the current context these are left as topics for future research. Finally, it is the case that we have focused only on banks that view themselves as being unable to influence the aggregate capital stock ($\bar{k}_t$). This focus would clearly be inappropriate for an economy with a small number of banks. It is also possible to examine the consequences for growth of the "industrial organization" of the banking system. All of these topics are important policy questions for developing countries.

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12. See, for instance, the discussion in Bhatt (1988) or McKinnon (1973, p. 121). Some empirical confirmation is presented by Williams and Laumas (1984).

13. Both issues are considered by Bencivenga and Smith (1989*b*) in an economy with no production externality, and in which the government is faced with monetizing a deficit.

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