**FINANCIAL MARKETS, SPECIALIZATION,
AND LEARNING BY DOING**

Thomas F. Cooley
University of Rochester

Bruce D. Smith
Cornell University
and
Federal Reserve Bank of Minneapolis

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ABSTRACT

This paper considers three questions: (1) what is the role of financial markets in development, (2) why do some economies have such poorly developed financial markets, and (3) can government policy be used to promote financial market development? With respect to the first question, we formalize the widely-held notion that financial markets promote entrepreneurship, specialization, and learning-by-doing. However, if economic incentives for specialization are absent, financial markets may fail to form. This occurs when real interest rates are too low. We also discuss policies that can be used to promote financial market development. When these policies are successful, they will be growth promoting. Finally, we examine policies intended to manipulate returns on savings, which are often important components of "financial liberalizations." We describe conditions under which such policies will be conducive to growth.

This paper is concerned with three general questions. First, what role do financial markets play in the process of economic development? Second, assuming that they do play an important role, why is the state of financial market development so rudimentary in so many economies? And third, in economies with relatively undeveloped financial markets, are there policies that can be pursued by the government to promote the development of these markets?

The idea that well functioning financial markets are essential in the development process has been forcefully articulated by Patrick (1966), Cameron (1967), Goldsmith (1969), McKinnon (1973), Shaw (1973) and many others.¹ This literature heuristically identifies several channels by which capital markets promote development. Among them are the notions that financial markets are essential in the efficient allocation of investment capital, in addressing informational frictions and costs of transacting, and in providing liquidity -- which allows an economy to shift more of its savings into relatively illiquid capital investment. In spite of the apparent importance of these possibilities for economic development, neoclassical growth models have only recently been developed which integrate these features.²

Another role that financial markets might play was identified at an early date, but has received no modern theoretical and little empirical consideration. This is the idea that financial markets might promote specialization (especially entry into entrepreneurial activity), technological innovation, and learning-by-doing. This omission seems to be significant in light of the apparent importance of these factors for economic growth. North (1987, p. 422), for instance, has argued that "modern economic growth results from the development of institutions that permit an economy to realize the gains from specialization and division of labor, ..." and identifies financial market institutions as ones that are of significance from this perspective. In 1873, Walter Bagehot (p. 7) described the importance of English financial institutions in permitting entrepreneurial specialization and development:

¹For a survey of the development literature on this topic, as well as of some empirical evidence, see The World Development Report (1989).

²Examples include Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), and Bencivenga, Smith, and Starr (1992).

In a new trade English capital is instantly at the disposal of persons capable of understanding the new opportunities and making good use of them. In countries where there is little money to lend...enterprising traders are long kept back, because they cannot at once borrow the capital, without which skill and knowledge are useless.

Thus, in the absence of financial markets, entry into entrepreneurial development would be delayed, and any associated capital investment or learning-by-doing delayed along with it. And, writing exactly a century after Bagehot, McKinnon (1973, p. 8-9) asserted that without a well functioning financial system, "fragmentation in the capital market...suppresses entrepreneurial development, and condemns important sectors of the economy to inferior technology." He also argued that the development of capital markets was "necessary and sufficient" to foster "the adoption of best-practice technologies and learning-by-doing."

In developing economies many firms have little or no access to formal credit markets, and this restricted access limits both entrepreneurial development and capital formation. This problem is often particularly severe for smaller and (especially) younger firms, which have had little opportunity to establish reputations in capital markets.³ The result is that, "at least among small firms, internal funds generation is an important, perhaps often necessary, part of the investment process." [Tybout (1983), p. 606] And, in a survey of business owners in Nairobi, "obtaining liquid capital, tools, and equipment" was listed as one of "the most difficult problems they had to overcome in starting their business." [House (1984), p. 283]

One manifestation of this limited access to credit is in the career patterns of agents who ultimately become self-employed. While in the U.S. only about 5% of the labor force holds more than one job, in developing countries 15 - 30% of the labor force typically holds multiple jobs. Among longer spells of multiple job holding in Malaysia -- which has been most extensively studied - the majority "tend to be experienced by the self employed, and seem to be associated with a process of human and physical capital accumulation." [Anderson-Schaffner and Richmond-Cooper (1991), p. 27] In other words, agents first work for someone else in order to accumulate

³For a documentation of this problem in Columbia, see Tybout (1983, 1984). Tybout (1984, p. 484) shows that small firms have "relatively more difficulty financing fixed capital formation" than larger firms, and that small Columbian firms have (proportionately) less debt than large firms. In developed countries there is no correlation between firm size and leverage.

For a study of the same problem in Ecuador, see Faramillo, Schianterelli, and Weiss (1992).

savings, then start a business and continue to work for someone else in order to finance capital accumulation. The business becomes the sole occupation only relatively late. And, as suggested by Blau (1986) and Anderson-Schaffner and Richmond-Cooper (1991), part of the reason is that younger and smaller scale enterprises have poor access to capital markets.

If specialization results in higher productivity and increased learning-by-doing, these credit market frictions inhibit growth. Moreover, since it is plausible that learning-by-doing is most significant in younger enterprises, capital market imperfections in developing countries are likely to significantly interfere with learning-by-doing. This fact is well recognized by policy makers. Many developing countries conduct programs to channel credit to smaller and younger firms, as does the World Bank, with the idea that the payoff to encouraging entrepreneurial development in this way is high.⁴

These observations suggest the desirability of developing models which permit an understanding of how credit markets affect entrepreneurial development, specialization, and learning-by-doing; models which thus far do not exist. However, they also suggest the importance of addressing our second question: if capital markets are so important, why has their development often been so rudimentary? It seems natural to address simultaneously the questions of what role capital markets play, and why they may be underdeveloped.

We pursue these issues in a model where growth occurs endogenously via learning-by-doing. As in Arrow (1962), Stokey (1988), and Azariadis and Drazen (1990), learning-by-doing generates spill-overs, which permit permanent growth to occur.⁵ We further assume that some specialization of labor is conducive to learning, as argued by Arrow (1962). We then show that the presence of financial markets promotes permanent growth, but that financial markets may fail to form for endogenous reasons.

Our vehicle for exploring these ideas is an overlapping generations model, in which agents are three period lived. When young, agents can either sell labor, or engage in schooling. Only agents who engage in schooling can operate the production process.⁶ Middle-aged agents can

⁴For a discussion of some such programs in Columbia and Ecuador, see Tybout (1983) and Jaramillo, Schianterelli, and Weiss (1992).

⁵Obviously the idea that growth occurs due to the endogenous accumulation of knowledge, embodied in capital or otherwise, appears in a variety of places. Examples include Shell (1966, 1973), Romer (1986), Prescott and Boyd (1987), Lucas (1988), King, Plosser, and Rebelo (1988), and Rebelo (1990).

⁶This formulation is similar to that of Freeman and Polasky (1990).

either sell labor, or if they invested in education when young, they can operate a firm. Old agents cannot sell labor, but can operate firms if they were educated when young.

There is a single consumption good, produced from capital and labor. Capital must be put in place one period in advance of production. If there are no financial markets, so that borrowing is precluded, middle-aged agents cannot finance investments. Further, in the absence of financial instruments and rental markets in capital, the only way for agents to provide for old period consumption is to operate a firm when old. Then, when there are not financial markets, all agents invest in education when young, work when middle-aged, invest in capital, and operate a firm when old. There is no specialization over the life-cycle, and the career path of working for someone else to accumulate savings and then transiting into self-employment is observed.

We assume that some specialization is essential to the occurrence of learning-by-doing (and in particular agents must repeat activities). Then, without financial markets, no learning-by-doing occurs. We structure the model so that, in this event, it reduces to Diamond's (1965) model. When financial markets do exist, on the other hand, specialization is possible. In particular, young agents can invest in education, borrow to put capital in place, and then operate a firm in both middle and old age. We describe conditions under which an equilibrium exists where some agents do this, while others work in youth and middle-age (and are then retired). In this situation all agents repeat activities, so that learning-by-doing occurs. In the presence of spillovers, permanent growth is possible.

We then pose the following question. Suppose that agents behave competitively, and that financial markets can be formed costlessly. Will they be observed? We find that the answer may be no, and describe necessary and sufficient conditions for financial markets not to form. Essentially, financial markets can and will fail to form when equilibrium real interest rates are sufficiently low in their absence.⁷ When this occurs, agents will prefer not to specialize in activities, and there will be no need for credit. Thus financial markets are not needed, and their absence is consistent with an equilibrium. For some economies there will be either an equilibrium with financial markets and specialization, or an equilibrium without these features, but both types of equilibria will not exist. However, it is possible to construct economies in which both types of equilibria are possible. In this situation it is possible for an economy to become "stuck" in a low

⁷Not surprisingly, economies with underdeveloped financial markets typically have low observed real interest rates. On this point see McKinnon (1973) and Shaw (1973).

growth equilibrium, even though equilibria exist with higher real growth rates.

The fact that financial markets may fail to form brings us to our third question: can government policy be used to foster their development (and hence increase growth)? We provide conditions under which the answer is affirmative, and describe how subsidizing (or taxing) returns on savings can potentially avoid low growth equilibria. In a similar spirit, we also examine how subsidies to (or taxes on) savings affect equilibria displaying positive real growth. Such subsidies are often advocated as an important component of "financial liberalizations" [as defined by McKinnon (1973) and Shaw (1973)]. We show that these subsidies affect the incentives to choose certain career paths, and that they can easily be detrimental to real growth. This result potentially aids in understanding why financial liberalizations have not been uniformly growth promoting [as argued, for instance, by Diaz-Alejandro (1985)].

The remainder of the paper proceeds as follows. Section I describes the environment, and section II describes equilibria when financial markets are exogenously precluded. Section III allows for the formation of financial markets. Section IV considers the possibility that financial markets fail to form endogenously; i.e., that they do not form even if they can. It also describes policy actions that can potentially be employed to avoid this situation. Section V discusses the effects of taxes on, or subsidies to savings for (positive) constant growth equilibria. Section VI concludes.

I. The Model

The economy consists of an infinite sequence of three period lived, overlapping generations. At each date t ; $t=0,1,2,\dots$, a new young generation appears, consisting of a continuum of identical agents of measure one. Also, at each date there is a single produced commodity, which can either be consumed or converted into capital.

Young agents can engage in one of two activities: they can either sell labor to a potential employer, or they can engage in an alternative activity that generates no young period income or output (or utility), but that permits them to run production processes at a later date. In other words a young agent can either work or engage in some kind of "schooling." Only those agents who have this schooling can subsequently manage a production process (i.e., run a firm), and we will call these agents entrepreneurs.⁸

Middle aged agents can either sell labor to a potential employer, or run a firm if they were schooled when young. Old agents have no labor to sell, but if they were schooled when young, they can run a firm. Finally, when labor is supplied it is supplied inelastically (labor generates no disutility).

There is a production technology, available to all who were educated when young, for converting capital and labor, measured in efficiency units, into the single consumption good. Efficiency units are measured as follows. We let $h_t \in \mathbb{R}_+$ denote the stock of "knowledge," or "human capital" at t . This is common to all agents.⁹ One unit of actual time supplied at t delivers h_t units of "effective" labor. Then a firm operating at t , which employs L_t agents, each supplying one unit of time, and K_t units of capital produces output equal to $Y_t = \bar{F}(K_t, h_t L_t, h_t)$, where the third argument of $\bar{F}$ is managerial input, which is also measured in efficiency units. Each firm has exactly one manager. We restrict attention to the case in which¹⁰

$$(1) \quad \bar{F}(K_t, h_t L_t, h_t) = F(K_t, h_t L_t + h_t).$$

⁸Freeman and Polasky (1990) describe a formulation that is somewhat similar.

⁹The assumption of a freely available common stock of knowledge follows Stokey (1988) or Azariadis and Drazen (1990), who allow a common quantity of human capital to be augmented by individuals who engage in training.

¹⁰The assumption that entrepreneurial input is a perfect substitute for other labor input is commonly made in empirical work on self-employment income in developing countries. On this point see Blau (1985).

F is assumed to be increasing in each argument, strictly concave, homogeneous of degree one, and to satisfy standard Inada conditions.

In order to describe the process of human capital accumulation, let $\bar{Y}_t$ denote "average per-firm output" at t , and let μ_t denote the fraction of young agents who choose to become workers at t . Then h_t evolves according to

$$(2) \quad h_{t+1} = h_t \phi[(\bar{Y}_t/h_t), \mu_t] .$$

Thus the rate of growth of knowledge depends on the level of average output relative to current knowledge, and on the fraction of young agents working at t . The former effect represents the consequences of learning-by-doing. Here, as in Stokey (1988), learning-by-doing "spills over" completely, so that no individual has an incentive to consider how his individual behavior affects his knowledge relative to that of others. This dramatically simplifies the analysis. Note also that learning depends on production relative to the current state of knowledge. Thus producing a given amount results in more learning if the current stock of knowledge is relatively low. It seems plausible that more can be learned by producing a given amount for agents who are relatively less knowledgeable to begin with.

The dependence of ϕ on μ_t is meant to capture how learning is increased by specialization. If $\mu_t = 0$ no agents work when young, and hence agents are following the career path where they engage in schooling when young, work in middle-age, and run a firm when old. In this situation agents do not repeat activities, and we then assume that no learning-by-doing occurs. Thus, in particular, we assume that $\phi[(\bar{Y}/h), 0] = 0$.¹¹ We also assume that $\phi[0, \mu] = 0$, $\forall \mu$.

Notice that the formulation in (2) implies constant returns to scale in all dimensions, in that if all inputs are increased in proportion for a given degree of specialization ($\mu_t > 0$), all outputs (including future knowledge) are increased in the same proportion. We also impose that ϕ is continuously differentiable in its first argument, with $\phi_1[(\bar{Y}/h), \mu] > 0 \forall \mu \neq 0$. Lastly, note that we are admitting the possibility that

¹¹This exact specification is inessential to the analysis, but makes the model reduce to that of Diamond (1965) in the absence of financial markets.

$$(2.a) \quad \phi[(Y/h), \mu] = \begin{cases} 1 & ; \mu = 0 \\ \phi(Y/h) & ; \mu \neq 0 \end{cases}$$

Finally, we impose two assumptions on the use of capital. First, capital depreciates entirely after one period. Second, capital must be put in place one period in advance of production. In particular, each producer at t views himself as constrained by past investment decisions: there are no within period rental markets in capital.

It remains to describe the preferences and endowments of agents. Letting $c_j \in \mathbb{R}_+$ denote age j consumption, all young agents have preferences described by the additively separable utility functions $u(c_2) + v(c_3)$. Thus agents do not value period one consumption. This assumption is again inessential; it serves only to make the model reduce to that of Diamond (1965) in the absence of financial markets. u and v are assumed to have standard properties, and in addition we impose a gross substitutes condition:

$$(3) \quad 0 \geq cv''(c)/v'(c) \geq -1,$$

$\forall c \in \mathbb{R}_+$. With respect to endowments, all agents are endowed with one unit of time in youth and middle-age. Time when young is indivisible; agents can work or engage in schooling, but not both. Young agents have no endowment of goods or capital. The initial old have the initial capital stock K_0 .

II. Equilibrium: No Financial Markets

We begin by considering an equilibrium for this economy when financial markets are exogenously precluded. This could be a consequence of severe "financial repression," as defined by McKinnon (1973) and Shaw (1973). The possibility that financial markets fail to form endogenously is considered in Section IV.

The absence of financial markets implies that agents can neither borrow nor lend. As a consequence, no specialization will occur. In particular, no agent will choose to work when young, so that $\mu_1 = 0$. To see this, suppose some agent did sell labor when young at t , earning wage income $w_t h_t$. Consuming this income generates no utility, and income cannot be saved in the form of any financial instrument. Thus any saving would take the form of capital

accumulation. But a middle-aged agent who did not engage in schooling when young cannot operate a production process, and there are no rental markets in capital. This saving would simply be lost. If any value is placed on old age consumption, all agents will engage in schooling when young.

Since $\mu_t = 0$, h_t is constant, say $h_t = 1$. Then, middle-aged agents will work, earning the wage rate w_{t+1} at $t+1$. In particular, these agents cannot operate firms, since they had no young period income and they were precluded from borrowing. Thus they have no capital in place in middle-age, so that agents must wait until old age to become entrepreneurs.

Middle-aged agents consume some of their wage income, and save the remainder in the form of capital. These agents are old at $t+2$, and have a capital stock of K_{t+2} . They then operate firms, choosing L_{t+2} to maximize $F(K_{t+2}, L_{t+2} + 1) - w_{t+2} L_{t+2}$ (recall $h_t = 1$). Then

$$(4) \quad F_2(K_{t+2}, L_{t+2} + 1) = w_{t+2}.$$

A middle-aged agent at $t+1$, then, earns w_{t+1} , and chooses K_{t+2} to maximize

$$u(w_{t+1} - K_{t+2}) + v[F(K_{t+2}, L_{t+2} + 1) - w_{t+2} L_{t+2}],$$

taking account of the dependence of L_{t+2} on K_{t+2} , and taking w_{t+2} as given. Then K_{t+2} satisfies

$$(5) \quad u'(w_{t+1} - K_{t+2}) = F_1(K_{t+2}, L_{t+2} + 1) v' [F(K_{t+2}, L_{t+2} + 1) - w_{t+2} L_{t+2}].$$

By Euler's Theorem and equation (4),

$$(6) \quad F(K_{t+2}, L_{t+2} + 1) - w_{t+2} L_{t+2} = F_1(-) K_{t+2} + F_2(-) = F_1(-) K_{t+2} + w_{t+2}.$$

Now define $s(w_1, w_2, r)$ to be the savings function of an agent who has income w_1 when middle-aged, w_2 when old, and faces a gross rate of return of r on savings:

$$(7) \quad s(w_1, w_2, r) = \operatorname{argmax} [u(w_1 - s) + v(w_2 + rs)].$$

Under our assumptions, $s_1 \geq 0 \geq s_2$, and $s_3 \geq 0$. Further, define $k_t = K_t/(L_t + 1)$ and $f(k_t) =$

$F(k_t, 1)$. Then $f'(k_t) = F_1(k_t, 1)$ and from (4), $w_t = F_2(k_t, 1) = f(k_t) - k_t f'(k_t) = w(k_t)$.

Substituting (6) into (5) and using the previous definitions, it is apparent that

$$(8) \quad K_{t+2} = k_{t+2} (L_{t+2} + 1) = s[w(k_{t+1}), w(k_{t+2}), f'(k_{t+2})].$$

Furthermore, in equilibrium, there is one worker per firm. Thus $L_{t+2} = 1 \forall t$, and (8) can be written as (replacing t by $t-1$),

$$(9) \quad k_{t+1} = s[w(k_t), w(k_{t+1}), f'(k_{t+1})] / 2.$$

Equation (9) defines k_{t+1} as an increasing function of k_t , as depicted in Figure 1. Under well-known conditions,¹² (9) has one or more non-trivial stationary solutions, and as in Figure 1, no solutions in which $\{k_t\}$ is unbounded. Thus from any initial $k_0 \neq 0$, k_t will approach a non-trivial steady state value, and the economy will approach a situation of zero real growth. Also, convergence to the steady state equilibrium will be monotonic.

III. Financial Markets and Specialization

We now allow for the presence of financial markets, which can be represented as follows. A set of competitive intermediaries exists that takes deposits and makes loans, each paying the competitive gross return r_t at t . Intermediaries behave as if they can make arbitrary loans and raise any desired quantity of deposits at this rate.

In the presence of such intermediaries, it is feasible for agents to specialize. In particular, a fraction μ_t of young agents at t can become workers, earning the wage income $h_t w_t$. This can be saved as a bank deposit, returning $r_t h_t w_t$ at $t+1$. In middle-age the same agent can work again, now earning $h_{t+1} w_{t+1}$. Similarly, a fraction $1-\mu_t$ of agents can engage in schooling when young. Moreover, they can borrow in order to put capital in place at $t+1$, so that they can run firms at both $t+1$ and $t+2$.¹³ We now consider the economy of section I when this specialization occurs.

¹²See, for instance, Azariadis (1988), Chapter 2.

¹³Our formulation also allows these agents to work when middle-aged and run firms when old. It will be apparent that they have no incentive to do so in equilibrium.

A. Workers

Agents who work when young at t earn $h_t w_t$, all of which is saved.¹⁴ Then middle-aged workers receive $r_t h_t w_t$ at $t+1$ as the proceeds of their savings when young. In addition, they earn $h_{t+1} w_{t+1}$ as labor income. These agents then choose a value for middle-age and a value for old age consumption, and a savings level, s , to maximize $u(c_2) + v(c_3)$ subject to

$$(10) \quad c_2 \leq r_t h_t w_t + h_{t+1} w_{t+1} - s$$

and

$$(11) \quad c_3 \leq r_{t+1} s.$$

Notice that $s = s(r_t h_t w_t + h_{t+1} w_{t+1}, 0, r_{t+1}) = \bar{s}(r_t h_t w_t + h_{t+1} w_{t+1}, r_{t+1})$.

B. Entrepreneurs

An agent who runs a firm at t has income equal to $\bar{F}(K_t, h_t L_t, h_t) - w_t h_t L_t - r_{t-1} K_t$, where we assume without loss of generality that all capital investment is financed by borrowing. In particular, a loan of K_t was taken at $t-1$ to put K_t units of capital in place at t , so loan repayments are $r_{t-1} K_t$ at t .

Clearly when L_t is chosen to maximize profits,

$$(12) \quad F_2(K_t, h_t L_t + h_t) = w_t.$$

Equation (12) and Euler's Theorem imply that firm profits net of payments to labor (but gross of loan repayments) are $[F_1(-) - r_{t-1}]K_t + F_2(-)h_t$. Clearly, then, any equilibrium with $K_t \in (0, \infty)$ has

$$(13) \quad F_1(K_t, h_t L_t + h_t) = r_{t-1},$$

and entrepreneurial income at t is just $F_2(-)h_t = h_t w_t$ by (12).

Entrepreneurs engage in schooling when young, earning nothing and borrowing K_{t+1} units

¹⁴Note that w_t is a "per efficiency unit" wage rate.

of capital at t . They then earn income $h_{t+1}w_{t+1}$ at $t+1$ from operating a firm, and earn income $h_{t+2}w_{t+2}$ at $t+2$ from firm operation.¹⁵ Moreover, these agents have free access to capital markets. A middle-aged entrepreneur at $t+1$ chooses values for middle and old-aged consumption, and a value s for savings, to maximize $u(c_2) + v(c_3)$ subject to

$$(14) \quad c_2 \leq h_{t+1}w_{t+1} - s$$

$$(15) \quad c_3 \leq h_{t+2}w_{t+2} + r_{t+1}s.$$

Optimal savings for middle-aged entrepreneurs is given by $s = s(h_{t+1}w_{t+1}, h_{t+2}w_{t+2}, r_{t+1})$.

C. *Equilibrium*

In equilibrium, four conditions must be satisfied at each date. First, if $\mu_t \in (0,1)$, young agents must be indifferent between becoming workers or entrepreneurs. From (10), (11), (14), and (15), it is apparent that the required indifference obtains iff the two activities generate the same discounted present value of future income; that is, iff

$$(16) \quad r_t h_t w_t + h_{t+1}w_{t+1} = h_{t+1}w_{t+1} + (h_{t+2}w_{t+2}/r_{t+1}).$$

Second, the labor market must clear. At t there are μ_t young workers, and μ_{t-1} middle-aged workers. In addition there are $1-\mu_{t-1}$ middle-aged entrepreneurs, and $1-\mu_{t-2}$ old entrepreneurs. Then per-firm employment at t , L_t , must satisfy

$$(17) \quad L_t = (\mu_{t-1} + \mu_t) / (2 - \mu_{t-1} - \mu_{t-2}).$$

Third, savings must equal investment. Given our complete depreciation assumption, this requires that the time $t+1$ capital stock equals time t savings. Since K_{t+1} is the per firm capital stock at $t+1$, and since $2 - \mu_t - \mu_{t-1}$ is the mass of entrepreneurs at $t+1$, the capital stock at $t+1$ is $(2 -$

¹⁵Since entrepreneurs could earn $h_{t+1}w_{t+1}$ at $t+1$ from selling labor and still operate a firm at $t+2$, it is apparent that they are indifferent between doing so and running a firm in each period. It is easy to verify that, under constant returns to scale, it is irrelevant which any middle-aged entrepreneur chooses to do. To economize on notation we let all middle-aged entrepreneurs run firms.

$\mu_t - \mu_{t-1}) K_{t+1}$. Savings by young workers at t is $\mu_t h_t w_t$, while saving by middle-aged workers is $\mu_{t-1} \bar{s}(r_{t-1} h_{t-1} w_{t-1} + h_t w_t, r_t)$. Saving by middle-aged entrepreneurs is $(1 - \mu_{t-1}) s(h_t w_t, h_{t+1} w_{t+1}, r_t)$. Savings equals investment iff

$$(18) \quad (2 - \mu_t - \mu_{t-1}) K_{t+1} = \mu_t h_t w_t + \mu_{t-1} \bar{s}(r_{t-1} h_{t-1} w_{t-1} + h_t w_t, r_t) + (1 - \mu_{t-1}) s(h_t w_t, h_{t+1} w_{t+1}, r_t).$$

Fourth, since all firms are identical, $\bar{Y}_t = Y_t = F(K_t, h_t L_t + h_t)$ in equilibrium. Therefore,

$$(19) \quad h_{t+1}/h_t = \phi[F(K_t, h_t L_t + h_t)/h_t, \mu_t].$$

Finally, of course, (12) and (13) describe the determination of wage and interest rates.

We now transform these equilibrium conditions as follows. Define $\hat{k}_t = K_t/h_t$ to be the stock of physical relative to human capital. Using $1 + L_t = (2 + \mu_t - \mu_{t-2}) / (2 - \mu_{t-1} - \mu_{t-2})$, from (17), we have that

$$(20) \quad w_t = F_2[\hat{k}_t, (2 + \mu_t - \mu_{t-2}) / (2 - \mu_{t-1} - \mu_{t-2})],$$

and

$$(21) \quad r_{t-1} = F_1[\hat{k}_t, (2 + \mu_t - \mu_{t-2}) / (2 - \mu_{t-1} - \mu_{t-2})].$$

In addition, (16) reduces to

$$(22) \quad r_t r_{t+1} = h_{t+2} w_{t+2} / h_t w_t$$

while (19) becomes

$$(23) \quad h_{t+1}/h_t = \phi\{F[\hat{k}_t, (2 + \mu_t - \mu_{t-2}) / (2 - \mu_{t-1} - \mu_{t-2})], \mu_t\}.$$

Finally, it is possible to simplify (18) as follows. Since workers and entrepreneurs who are middle-aged at t have the same discounted present value of income and face the same interest rate, they have the same middle-aged consumption levels. Therefore,

$$(24) \quad r_{t-1}h_{t-1}w_{t-1} + h_t w_t - \bar{s}(r_{t-1}h_{t-1}w_{t-1} + h_t w_t, r_t) = h_t w_t - s(h_t w_t, h_{t+1}w_{t+1}, r_t).$$

Substituting (24) into (18) gives

$$(25) \quad (2 - \mu_t - \mu_{t-1}) K_{t+1} = \mu_t h_t w_t - (1 - \mu_{t-1}) r_{t-1} h_{t-1} w_{t-1} + \bar{s}(r_{t-1} h_{t-1} w_{t-1} + h_t w_t, r_t)$$

We henceforth assume that agents have homothetic preferences, so that

$$(26) \quad \bar{s}(r_{t-1} h_{t-1} w_{t-1} + h_t w_t, r_t) = \psi(r_t)(r_{t-1} h_{t-1} w_{t-1} + h_t w_t),$$

where $\psi(r) \in [0,1] \forall r$ and $\psi'(r) \geq 0$. Equation (25) becomes

$$(27) \quad (2 - \mu_t - \mu_{t-1}) \hat{k}_{t+1} = \mu_t h_t w_t / h_{t+1} - (1 - \mu_{t-1}) r_{t-1} h_{t-1} w_{t-1} / h_{t+1} + \psi(r_t)(r_{t-1} h_{t-1} w_{t-1} + h_t w_t) / h_{t+1}.$$

Equations (20)-(23) and (27) constitute the equilibrium conditions for this economy. It is straightforward to see that this system of equations can be collapsed into a pair of fourth order, non-linear difference equations in μ_t and $\hat{k}_t$. Thus, relative to the situation absent financial markets (in which dynamics are first order), the presence of financial markets allows for substantially richer dynamic behavior. However, in light of the apparent difficulty of describing general dynamic behavior in this economy, we now turn our attention to characterizing "steady state" equilibria (equilibria with constant values of μ and $\hat{k}$).

D. Steady State Equilibria

When μ and $\hat{k}$ are constant, equations (20) and (21) imply that

$$(28) \quad w_t = F_2[\hat{k}, 1/(1-\mu)] \forall t,$$

$$(29) \quad r_{t-1} = F_1[\hat{k}, 1/(1-\mu)] \forall t.$$

Then (23) becomes

$$(30) \quad h_{t+1}/h_t = \phi\{F[\hat{k}, 1/(1-\mu)], \mu\}$$

and (22) reduces to

$$(31) \quad r = h_{t+1} / h_t.$$

Finally, using (31) and (27), we obtain

$$(32) \quad 2(1 - \mu) \hat{k} = [2\psi(r) - (1 - 2\mu)] w/r$$

as the final steady state equilibrium condition.

From (31) it is immediate that:

Proposition 1. Any constant growth rate equilibrium has the real interest rate equal to the real growth rate.

We now proceed to state conditions under which a (positive) constant growth rate equilibrium exists.

Substituting (29) and (30) into (31) yields

$$(33) \quad F_1[\hat{k}, 1/(1-\mu)] = \phi\{F[\hat{k}, 1/(1-\mu)], \mu\}.$$

Similarly, substituting (28) and (29) into (32) and rearranging yields

$$(34) \quad (1 - \mu) \hat{k} F_1[\hat{k}, 1/(1-\mu)] / F_2[\hat{k}, 1/(1-\mu)] = \psi\{F_1[\hat{k}, 1/(1-\mu)]\} + \mu - 1/2.$$

Equations (33) and (34) constitute two conditions determining μ and $\hat{k}$.

Now define $z = (1 - \mu) \hat{k}$ to be the capital-labor ratio, with labor measured in efficiency units, and define $f(z) = F(z, 1)$. Then $f'(z) = F_1(z, 1)$ and $F_2(z, 1) = f(z) - zf'(z)$. Using these relations in (33) and (34) respectively gives

$$(35) \quad f'(z) = \phi[f(z)/(1-\mu), \mu]$$

and

$$(36) \quad \mu = 1/2 + \{zf'(z)/[f(z) - zf'(z)]\} - \psi[f'(z)] = g(z).$$

We now state sufficient conditions for (35) and (36) to have a solution with $\mu \in (0,1)$ and $z > 0$.

Proposition 2. Suppose that

$$(i) \quad \lim_{z \rightarrow 0} f'(z) = \infty$$

$$(ii) \quad \lim_{z \rightarrow \infty} f'(z) = 0$$

$$(iii) \quad g(z) \in (0,1) \quad \forall z$$

hold, and that ϕ is continuous in each argument for $\mu \neq 0,1$. Then (35) and (36) have a solution with $\mu \in (0,1)$ and $z > 0$.

Proof. Substituting (36) into (35) gives

$$(37) \quad q(z) = f'(z) - \phi\{f(z)/[1-g(z)], g(z)\} = 0.$$

(i)-(iii) imply that

$$\lim_{z \rightarrow 0} q(z) > 0 > \lim_{z \rightarrow \infty} q(z).$$

Then, since q is continuous, (37) has at least one solution, say z^* , with $z^* > 0$. Further, $\mu = g(z^*) \in (0,1)$, by (iii).

Clearly (i) and (ii) are standard conditions, while (iii) is not. We demonstrate by an example in the sequel that (iii) can easily be violated, and hence must be imposed by assumption.

We now state conditions under which (35) and (36) have a unique solution. To do so, we

define the elasticity of substitution, σ , in a conventional way:

$$\sigma = [dz/d(w/r)] (w/r)/z.$$

Proposition 3. Suppose that (i)-(iii) in proposition 2 are satisfied, that $\sigma \geq 1$ and $\psi'(r) \geq 0$ hold, and that ϕ has the form given in equation (2.a). Then (35) and (36) have a unique solution.

Proof. Under these conditions, (35) becomes,

$$(35') \quad f'(z) = \tilde{\phi}[f(z)/(1-\mu)]$$

which defines a downward sloping relationship between z and μ , as shown in Figure 2. Equation (36) defines a locus in Figure 2 which has a positive slope if $g'(z) \geq 0 \forall z$. From (36),

$$(38) \quad g'(z) = \{[ff' + zff'' - z(f')^2] / [f(z) - zf'(z)]^2\} - \psi'f''.$$

Since

$$\sigma = -f'(z) [f(z) - zf'(z)] / zf(z) f''(z) \geq 1,$$

each term on the right-hand side of (38) is non-negative, giving the desired result.

Clearly (35) and (36) will not generally have a unique solution if ϕ is of the more general form given in (2), and if $\sigma > 1$ and/or $\psi' > 0$. This point is illustrated in Figure 3.

Under reasonable conditions the model supports a steady state equilibrium with a positive constant growth rate when financial markets are present. These markets permit specialization to occur, which in turn makes learning-by-doing possible. This provides an obvious sense in which the presence of financial markets fosters growth. Moreover, while our assumptions are designed to illustrate this point, they are stronger than necessary to do so. The main point is that financial markets prevent investment from being delayed (relative to what would occur in the absence of financial markets). To the extent that there is some learning-by-doing associated with this investment, it occurs earlier when financial markets exist. Agents are more productive over more

of their lifetimes, increasing output and savings. In an endogenous growth context, the latter effect will promote growth.

E. An Example

Let $u(c_2) + v(c_3) = \ln c_2 + \beta \ln c_3$, and let $F(K, hL + h) = AK^\alpha (hL + h)^{1-\alpha}$; $\alpha \in (0,1)$. Then $\psi(r) = \beta/(1+\beta) = \psi \forall r$, and (36) reduces to

$$(39) \quad \mu = 1/2 - \psi + \alpha/(1-\alpha) .$$

Then if $1/2 - \psi + \alpha/(1-\alpha) \in (0,1)$, (39) gives $\mu \in (0,1)$ and (35) gives a unique solution for $z > 0$. Notice that, if $1/2 - \psi + \alpha/(1-\alpha) \notin [0,1]$, then no equilibrium exists displaying a constant, positive real growth rate. Since this is exactly $g(z) \in [0,1]$, it is clear that (iii) must be imposed in Proposition 2.

IV. Endogenous Absence of Financial Markets

We now pose the following question: can the equilibrium of Section II continue to be observed even if financial intermediaries are free to form? To answer this question, we assume that a steady state equilibrium obtains in the Section II economy, and now allow intermediaries to form. In order to attract any funds intermediaries must offer a rate of return $r \geq f'(k^*)$, where k^* is the (a) stationary solution of (9), while to make any loans, $r \leq F_1$ must hold. Thus let $r = f'(k^*)$.

At this interest rate and the wage rate $w(k^*)$, young agents are content to engage in schooling when young, work when middle-aged, and run a firm when old iff this career path delivers no less income, in a discounted present value sense, than any other career path. If $\mu_t = 0$, $h_{t+1}/h_t = 1$, so an agent who does not specialize has income with a discounted present value of $w(k^*)/r + w(k^*)/r^2 = w(k^*)(1+r)/r^2$. An agent who works in youth and middle-age has income with a discounted present value of $w(k^*) + w(k^*)/r = w(k^*)(1+r)/r$. Finally, an agent who runs a firm in middle and old age receives income with a discounted present value of $w(k^*)/r + w(k^*)/r^2 = w(k^*)(1+r)/r^2$. Consequently, non-specialization is always weakly preferred to specializing as an entrepreneur, while non-specialization is (weakly) preferred to working in each period iff $w(k^*)(1+r)/r^2 \geq w(k^*)(1+r)/r$.

Proposition 4. When intermediaries are free to form, there is an equilibrium with no specialization iff $r = f'(k^*) \leq 1$, where k^* is a stationary solution to (9).

If the steady state capital stock of the section II economy is no less than the "golden rule" capital stock (with no specialization), then there is an equilibrium in which no agents specialize. In the absence of specialization there is no need for financial markets, so there is also an equilibrium with no financial markets, even though intermediaries are free to form. In this event an economy can get stuck in a low (zero) growth equilibrium, even though other equilibria with positive growth rates may exist.

The possibility of equilibria in which there is no growth, and also in which there is no lending, is reminiscent of Bagehot's (1873) discussion of financial markets in England and elsewhere. For instance, Bagehot (p.3-4) argued that

We have entirely lost the idea that any undertaking likely to pay, and seen to be likely, can perish for want of money; yet no idea was more familiar to our ancestors, or is more common now in most countries. A citizen of London in Queen Elizabeth's time... would have thought that it was of no use inventing railways (if he could have understood what a railway meant), for you would not have been able to collect the capital with which to make them. At this moment, in colonies and all rude countries, there is no large sum of transferable money; there is no fund from which you can borrow, and out of which you can make immense works.

Or, in other words, it seemed to Bagehot that it was entirely possible (and in fact common) to attain a situation in which there were no financial markets, and for that situation to persist.

Proposition 4 describes when this situation can arise and persist in the model.

In view of proposition 4 it is natural to ask whether policies exist that can be employed by a government in order to avoid these "low growth trap" equilibria. We now consider one such policy.

A. Policies Affecting Rates of Return

It is often argued that the formation of active capital markets should be stimulated by what McKinnon (1973) and Shaw (1973) term financial liberalizations. Such liberalizations often involve policies intended to raise the perceived after-tax return on savings. We now consider tax/subsidy policies for income from savings, and describe conditions under which such policies will result in the development of active financial markets and be growth promoting. It should be

apparent that, at the level of abstraction of the model, the policies we examine stand in more generally for any policies that raise the perceived returns on savings.

Suppose, then, that capital income, which is $k_t f'(k_t)$ at t , is taxed (or subsidized, if the tax is negative) at the constant rate τ_r , with tax proceeds rebated to middle-aged agents via lump-sum transfers.¹⁶ Letting R_t denote these transfers at t , clearly $R_t = \tau_r k_t f'(k_t)$ holds, $\forall t$. The equilibrium condition (9) must be amended to

$$(40) \quad k_{t+1} = s[w(k_t) + R_t, w(k_{t+1}), (1-\tau_r)f'(k_{t+1})],$$

or equivalently to

$$(40') \quad k_{t+1} = s[w(k_t) + \tau_r k_t f'(k_t), w(k_{t+1}), (1-\tau_r)f'(k_{t+1})].$$

For future reference we observe that

$$(41) \quad \frac{dk_{t+1}}{dk_t} = \frac{s_1(\cdot)[\tau_r f' - (1-\tau_r)k_t f'']}{1 - s_2 w' - (1-\tau_r)s_3 f''}$$

Clearly steady state equilibria satisfy

$$(42) \quad k = s[f(k) - (1-\tau_r)kf'(k), w(k), (1-\tau_r)f'(k)].$$

Let $k(\tau_r)$ denote a solution to (42) for a given value of τ_r . Implicit differentiation of (42) gives

$$(43) \quad k'(\tau_r) = \frac{[s_1 k(\tau_r) - s_3]f'}{[1 - s_2 w' - (1-\tau_r)s_3 f''] - s_1 [\tau_r f' - (1-\tau_r)k(\tau_r)f'']}$$

¹⁶We do not allow this income to be rebated to young agents, as this violates the spirit of the model; young agents who do not work have no income. It is easy to see how the analysis must be modified if tax income is rebated to old agents.

It is easy to modify earlier arguments to show that there is a steady state equilibrium with no specialization iff

$$(44) \quad \rho(\tau_r) = (1-\tau_r)f'[k(\tau_r)] \leq 1$$

holds. We are now interested in the properties of $\rho(\tau_r)$, the after tax rate of return on capital. Again, straightforward differentiation establishes that

$$(45) \quad \rho'(\tau_r) = (1-\tau_r)f''k'(\tau_r) - f' - \frac{-[1-s_2w' - \tau_r s_1 f']}{[1-s_2w' - (1-\tau_r)s_3f''] - s_1[\tau_r f' - (1-\tau_r)k(\tau_r)f'']}$$

For values of τ_r that are not too large algebraically, the numerator on the right-hand side of (45) is negative. The denominator is positive (negative) if $dk_{t+1}/dk_t < (>) 1$ in (41). Thus we have

Proposition 5. If $k(\tau_r)$ is an asymptotically stable (unstable) steady state equilibrium, $\rho'(\tau_r) < (>) 0$.

If $\rho(0) = f'(k^*) \leq 1$ holds, the economy has a zero growth equilibrium with no specialization. However, if $\rho(0)$ is sufficiently close to one, Proposition 5 implies that $\rho(\tau_r) > 1$ for some τ_r , and hence that some policy can be used to avoid such an equilibrium. In particular, if $\rho'(\tau_r) < (>) 0$ holds, a policy of subsidizing (taxing) returns to savings will eliminate the zero growth equilibrium. Of course if $\rho(0)$ is too small, it may be impossible to find a value τ_r with $\rho(\tau_r) > 1$, and hence impossible to avoid a "low growth trap" equilibrium.

V. Taxation and Growth

The preceding section demonstrates how policies that affect the return on savings, which are frequently a component of more general policies aimed at financial liberalization, can potentially be used to avoid equilibria with low growth rates. In this section we consider how such policies affect the real growth rate in equilibria displaying positive growth. Again, our interest in this topic stems from the fact that subsidization (or increasing subsidization) of savings is often advocated as a major component of financial liberalizations. Such subsidization can take

many forms in practice, including the reduction of reserve requirements in inflationary environments, or the paying of interest on reserves, as well as more direct subsidies to savings. Of course increasing reserve requirements or reductions of interest paid on reserves represent increased taxation (reduced subsidization) of savings, and our analysis applies to this as well.

The main result of this section is that the consequences of policies that alter the return on savings in equilibria with positive growth are generally very ambiguous, and in a way which is not observed in section IV. In particular, subsidies to savings can easily be detrimental to real growth. Such a result is of interest in so far as financial liberalizations in practice have had very mixed success.¹⁷ Our analysis indicates that subsidization of savings can easily either raise or lower real growth rates, and in this sense offers an explanation for the widely varying outcomes observed in financial liberalizations.

Finally, throughout this section we assume that the conditions of Propositions 2 and 3 hold, so that there is a unique equilibrium, and the equilibrium loci appear as depicted in Figure 2.

A. Interest Rate Policy

We now assume that income from savings is taxed (subsidized if negative) at the constant rate τ_r , and that all income from this tax is rebated as a lump-sum to middle-aged agents at t .¹⁸ We let R_t denote the value of this rebate at t . The budget constraints for workers who are middle-aged at $t+1$, equations (10) and (11), must be replaced by

$$(46) \quad c_2 \leq (1-\tau_r)r_t h_t w_t + h_{t+1} w_{t+1} + R_{t+1} - s$$

$$(47) \quad c_3 \leq (1-\tau_r)r_{t+1} s,$$

and the optimal savings of these agents is given by $s^*[(1-\tau_r)r_t h_t w_t + h_{t+1} w_{t+1} + R_{t+1}, (1-\tau_r)r_{t+1}]$. Similarly, the budget constraints for entrepreneurs who are middle-aged at $t+1$, equations (14) and (15), must be replaced by

¹⁷See, for instance, the discussions in Galbis (1979), Diaz-Alejandro (1985), or Khatkhate (1988).

¹⁸For the same reason as before we want to avoid rebates to young agents. We comment below on how the analysis is affected if tax proceeds are rebated to old agents.

$$(48) \quad c_2 \leq h_{t+1}w_{t+1} + R_{t+1} - s$$

$$(49) \quad c_3 \leq h_{t+2}w_{t+2} - (1-\tau_r)r_{t+1} s.$$

The optimal savings level for these agents is then $s[h_{t+1}w_{t+1} + R_{t+1}, h_{t+2}w_{t+2}, (1-\tau_r)r_{t+1}]$.

As before, in an equilibrium with $\mu_t \in (0,1)$, workers and entrepreneurs must obtain income streams with the same discounted present value. Therefore

$$(50) \quad (1-\tau_r)r_t h_t w_t = h_{t+2}w_{t+2} / (1-\tau_r)r_{t+1}$$

must hold $\forall t$. Moreover, since workers and entrepreneurs have the same incomes, in discounted present value terms, and face the same after tax interest rate, they must have the same middle-aged consumption levels. Therefore

$$(51) \quad s[h_{t+1}w_{t+1} + R_{t+1}, h_{t+2}w_{t+2}, (1-\tau_r)r_{t+1}] = \bar{s}[(1-\tau_r)r_t h_t w_t + h_{t+1}w_{t+1} + R_{t+1}, (1-\tau_r)r_{t+1}] \\ - (1-\tau_r)r_t h_t w_t = \psi[(1-\tau_r)r_{t+1}] [(1-\tau_r)r_t h_t w_t + h_{t+1}w_{t+1} + R_{t+1}] - (1-\tau_r)r_t h_t w_t$$

holds $\forall t$, where the last line employs the assumption that preferences are homothetic. Finally, in equilibrium, per firm employment must satisfy (17) $\forall t$, while in addition savings must equal investment. Using (51), the latter condition requires that

$$(52) \quad (2-\mu_t-\mu_{t-1})K_{t+1} = \mu_t h_t w_t - (1-\mu_{t-1})(1-\tau_r)r_{t-1}h_{t-1}w_{t-1} + \psi[(1-\tau_r)r_t] [(1-\tau_r)r_{t-1}h_{t-1}w_{t-1} + h_t w_t + R_t]$$

We henceforth restrict our attention to equilibria with constant values of μ and $\hat{k} = K_t/h_t$. For such equilibria, (50) becomes

$$(53) \quad (1-\tau_r)r = h_{t+1}/h_t ; \forall t,$$

while (52) may be written as

$$(54) \quad 2(1-\mu)\hat{k} = \{2\mu-1+2\psi[(1-\tau_r)r]\} w/(1-\tau_r)r + \psi[(1-\tau_r)r] (R_t/h_{t+1}),$$

where (53) has been used to obtain (54). Moreover R_t must equal per capita tax proceeds at t . These proceeds are simply τ_r times r_{t-1} times net savings at $t-1$. But in equilibrium these net savings equal the time t capital stock, so that [from (52)],

$$(55) \quad R_t = \tau_r(2-\mu_{t-1} - \mu_{t-2})K_t r_{t-1},$$

or equivalently, in steady state,

$$(56) \quad R_t/h_{t+1} = 2\tau_r(1-\mu)\hat{k}/(1-\tau_r)r,$$

where again (53) has been used to obtain (56).

Now recall that $z = (1-\mu)\hat{k}$ is the capital-labor ratio, with labor measured in efficiency units, and that $r=f'(z)$ while $w = f(z)-zf'(z)$. Then (53) may be written as

$$(57) \quad (1-\tau_r)f'(z) = \phi[f(z)/(1-\mu), \mu],$$

while (56) can be used in (54) to obtain (after rearranging terms)

$$(58) \quad \mu = 1/2 + \{zf'(z)/[f(z) - zf'(z)]\} \{1-\tau_r - \tau_r\psi[(1-\tau_r)f'(z)]\} - \psi[(1-\tau_r)f'(z)].$$

Equations (57) and (58) constitute the steady state equilibrium conditions, for any given value of τ_r .

Under the assumptions of Propositions 2 and 3, these equilibrium conditions define loci as depicted in Figure 4. The effects of a change in τ_r are then easy to analyze. In particular, the vertical shift in equation (57), associated with any change in τ_r is given by

$$(57) \quad \left. \frac{\partial z}{\partial \tau_r} \right| = - \frac{f'}{(1-\tau_r)f'' - \phi_1 f'/(1-\mu)} < 0.$$

Thus increases in taxation shift (57) down and to the left in the figure. Similarly the horizontal shift in equation (58) induced by a change in τ_r is

$$\frac{\partial \mu}{\partial \tau_r} \Big| = - r \psi' [(1-\tau_r)r] - \left\{ z f'(z) / [f(z) - z f'(z)] \right\} \left\{ 1 + \psi(\cdot) - \tau_r r \psi'(\cdot) \right\}, \quad (58)$$

which is of ambiguous sign. However, if ψ' is sufficiently small (which would obviously be the case for a constant savings rate), then

$$(59) \quad \frac{\partial \mu}{\partial \tau_r} \Big| < 0. \quad (58)$$

This situation is depicted in Figure 4.

When (59) holds, an increase in taxation reduces μ , the proportion of workers in the population. The effect on z is ambiguous. The equilibrium rate of growth is equal to $(1-\tau_r)f'(z)$, so the effect on the growth rate is also ambiguous. If z is not reduced, then clearly an increase in τ_r reduces real growth. However, if an increase in τ_r does reduce z , then the growth rate can be increased by this policy. Evidently, this potential for ambiguity would be enhanced if the locus defined by (57) were not upward sloping, or if equation (59) failed to hold.

The ambiguity associated with the direction of shift for equation (58) may appear to derive from the fact that tax proceeds are rebated to middle-aged agents. Thus higher taxes reduce after tax rates of return on savings, *ceteris paribus*, but they also transfer income from old agents, who do not save, to middle-aged agents, who do. There are thus two opposite effects on savings behavior.

While the above is correct, so far as it goes, it is easy to verify that the ambiguity remains even if tax proceeds are rebated to old agents. The reason why is apparent from (56). If tax proceeds were rebated to the old, R_t/h_{t+1} would not appear in (56). However, increases in τ_r (*ceteris paribus*) would still tend to reduce $(1-\tau_r)r$, thereby reducing savings, while increasing $w/r(1-\tau_r)$, thereby increasing saving. Thus the ambiguity with respect to the effects of increasing τ_r does not depend particularly on how tax proceeds are rebated.

VI. Conclusions

The preceding analysis is based upon the following simple ideas: learning-by-doing requires repetition of activities, and specialization is conducive to repetition. Then if financial markets promote specialization, they promote learning-by-doing. In the presence of spillovers, financial markets will also promote growth.

The model presented here is a formalization of these ideas. In addition, it provides a condition under which the (after tax) real rate of interest must equal the growth rate, and a condition under which growth may not be observed. It also indicates that financial liberalizations can potentially be used to avoid low growth equilibria. However, when a positive growth equilibrium obtains, the effects of financial liberalizations will be less straightforward. This observation potentially explains why experiences with financial liberalizations have been so mixed in nature.

References

- Anderson-Schaffner, Julie and Joyce Richmond-Cooper, "Multiple Job Holding in Developing Countries: the Case of Malaysia," manuscript, 1991.
- Arrow, Kenneth J., "The Economic Implications of Learning by Doing," *Review of Economic Studies*, 29, June 1962, p. 155-73.
- Azariadis, Costas, "Intertemporal Macroeconomics," manuscript, 1988.
- Azariadis, Costas, and Allan Drazen, "Threshold Externalities in Economic Development," *Quarterly Journal of Economics*, 105, May 1990, p. 501-26.
- Bagehot, Walter, *Lombard Street*, Richard D. Irwin, Inc., Homewood Illinois, 1962 edition, 1873.
- Bencivenga, Valerie R. and Bruce D. Smith, "Financial Intermediation and Endogenous Growth," *Review of Economic Studies*, 1991.
- Bencivenga, Valerie R., Bruce D. Smith, and Ross M. Starr, "The Liquidity of Secondary Financial Markets: Allocative Efficiency and the Maturity Composition of the Capital Stock," manuscript, 1992.
- Blau, David M., "Self-Employment and Self-Selection in Developing Country Labor Markets," *Southern Economic Journal*, 52, Oct. 1985, p. 351-63.
- Blau, David M. "Self-Employment, Earnings, and Mobility in Peninsular Malaysia," *World Development*, 14, 1986, p. 839-52.
- Cameron, Rondo, *Banking in the Early Stages of Industrialization*, New York, Oxford University Press, 1967.
- Diamond, Peter, "National Debt in a Neoclassical Growth Model," *American Economic Review*, 1965, p. 1126-50.
- Diaz-Alejandro, Carlos, "Good-Bye Financial Repression, Hello Financial Crash," *Journal of Development Economics*, 19, 1985, p. 1-24.
- Freeman, Scott, and Stephen Polasky, "Knowledge-Based Growth," manuscript, 1990.
- Galbis, Vicente, "Inflation and Interest Rate Policies in Latin America, 1967-76," *IMF Staff Papers*, 26, 1979, p. 334-66.
- Goldsmith, Raymond W., *Financial Structure and Development*, New Haven, Yale University Press, 1969.

- Greenwood, Jeremy, and Boyan Jovanovic, "Financial Development, Growth, and the Distribution of Income," *Journal of Political Economy*, 1990.
- House, William J., "Nairobi's Informal Sector: Dynamic Entrepreneurs or Surplus Labor?" *Economic Development and Cultural Change*, 32, Jan. 1984, p. 277-302.
- Jaramillo, F., F. Schianterelli, and A. Weiss, "Financial Liberalization and Credit Allocation: Evidence from a Panel of Ecuadorian Firms," manuscript, 1992.
- Khatkhate, Deena R., "Assessing the Impact of Interest Rates in Less Developed Countries," *World Development*, 16, 1988, p. 577-88.
- King, Robert G., Charles I. Plosser, and Sergio Rebelo, "Production, Growth, and Business Cycles II: New Directions," *Journal of Monetary Economics*, 21, 1988, p. 309-41.
- Lucas, Robert E. Jr., "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22, 1988, p. 3-42.
- McKinnon, Ronald I., *Money and Capital in Economic Development*, Washington, Brookings Institute, 1973.
- North, Douglass C., "Institutions, Transaction Costs, and Economic Growth," *Economic Inquiry*, 25, July 1987, p. 419-28.
- Prescott, Edward C., and John H. Boyd, "Dynamic Coalitions, Growth and the Firm," in *Contractual Arrangements for Intertemporal Trade*, Minneapolis, University of Minnesota Press, edited by E.C. Prescott and Neil Wallace, 1987.
- Rebelo, Sergio, "Long-run Policy analysis and Long-run Growth," *Journal of Political Economy*, 1990.
- Romer, Paul M., "Increasing Returns and Long-run Growth," *Journal of Political Economy*, 94, 1986, p. 1002-37.
- Shaw, Edward S., *Financial Deepening in Economic Development*, New York, Oxford University Press, 1973.
- Shell, Karl, "Toward a Theory of Inventive Activity and Capital Accumulation," *American Economic Review*, May 1966, p. 62-68.
- Shell, Karl, "Inventive Activity, Industrial Organization and Economic Growth," in *Models of Economic Growth*, Halsted Press, edited by J.A. Mirrlees and N. Stern, 1973.
- Stokey, Nancy L., "Learning by Doing and the Introduction of New Goods," *Journal of Political Economy*, 96, 1988, p. 701-17.

Tybout, James R., "Credit Rationing and Investment Behavior in a Developing Country," *Review of Economics and Statistics*, 65, Nov. 1983, p. 598-607.

Tybout, James R., "Interest Controls and Credit Allocation in Developing Countries," *Journal of Money, Credit and Banking*, 16, Nov. 1984, p. 474-87.

World Bank, *World Development Report 1989*, New York, Oxford University Press.

Figure 1

Figure 2

Figure 3

Figure 4

A Tax on Interest Income