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Financial markets, specialization, and learning by doing

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Summary

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. © 1998 Academic Press

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1. Introduction

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 developmental process has been forcefully articulated by Patrick (1966), Cameron (1967), Goldsmith (1969), McKinnon

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(1973), Shaw (1973) and many others.† 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.‡

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: 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 significant from this perspective. In 1873, Walter Bagehot (1873: 7) described the importance of English financial institutions in permitting entrepreneurial specialization and development:

> In a 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: 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".

† For a survey of the development literature on this topic, as well as of some empirical evidence, see the *World Development Report* (1989). More recent empirical evidence is presented by King and Levine (1993*a, b*), and by Levine and Zervos (1998).

‡ Examples include Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), and Bencivenga, Smith and Starr (1996).

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.† 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: 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: 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 labour force holds more than one job, in developing countries 15–30% of the labour force typically holds multiple jobs. Among longer spells of multiple job holding in Malaysia—which has been 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 & Richmond-Cooper, 1991: 27). In other words, agents first work for someone else in order to accumulate 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 programmes to channel credit to smaller and younger firms, as does the World Bank, with the idea that the pay-off to encouraging entrepreneurial development in this way is high.‡

These observations suggest the desirability of developing models

† For a documentation of this problem in Columbia, see Tybout (1983, 1984). Tybout (1984: 484) shows that small firms have "relatively more difficulty financing fixed capital formation" than larger firms, and that small Colombian 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 Jaramillo, Schiantarelli, and Weiss (1992).

‡ For a discussion of some such programmes in Columbia and Ecuador, see Tybout (1983) and Jaramillo, Schiantarelli, and Weiss (1992).

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.† We further assume that some specialization of labour 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 labour, or engage in schooling. Only agents who engage in schooling can operate the production process.‡ Middle-aged agents can either sell labour, or if they invested in education when young, they can operate a firm. Old agents cannot sell labour, but can operate firms if they were educated when young.

There is a single consumption good, produced from capital and labour. 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 no 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

† Obviously 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), and Rebelo (1991).

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

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.

Central to our results is the notion that specialization and repetition of activities is essential to learning-by-doing. Arrow's (1962) description of learning-by-doing emphasized three features: (a) learning-by-doing is learning that takes place as an aspect of the production process, and it is therefore different from schooling; (b) learning-by-doing is associated with repetition of the same activity; and (c) continued learning-by-doing by the same agent requires that stimulus situations must evolve as opposed to being purely repetitive.

In practice it is often simply assumed that learning-by-doing is a by-product of production or capital accumulation, and the aspects stressed by Arrow are not explicitly modelled. In contrast, we explicitly emphasize that schooling and learning-by-doing are separate activities, and we insist that repetition of activities is essential to the process of learning-by-doing.† Thus, specialization by agents is a prerequisite of sustained growth.

Moreover, when agents do specialize in career paths some agents (those who work for others when young) become natural savers, while others (those who require credit to finance capital investments) become natural borrowers. This makes financial markets essential to the occurrence of specialization; some such markets are required to transfer funds from workers to entrepreneurs and conversely. Thus, realizing the gains from specialization requires financial activity, and the absence of financial activity precludes specialization. Since specialization generates learning-by-doing, it is unambiguous in this context that greater financial market development is necessarily associated with more rapid growth.

In this framework 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.‡ When this occurs, agents will

† We do not model the evolution of stimulus situations.

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

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 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 in the 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 2 describes the environment, and Section 3 describes equilibria when financial markets are exogenously precluded. Section 4 allows for the formation of financial markets. Section 5 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 6 discusses the effects of taxes on, or subsidies to savings for (positive) constant growth equilibria. Section 7 concludes.

2. The model

The economy consists of an infinite sequence of three-period-lived, overlapping generations. At each date t, $t=0, 1, 2, \ldots$, 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 labour to a potential employer, or they can engage in an alternative activity that generates no young-period income or output (utility), but that permits them to run production 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.†

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

There is a production technology, available to all who were educated when young, for converting capital and labour, measured in efficiency units, into the single consumption good. Efficiency units are measured as follows. We let $h_t \varepsilon R_+$ denote the stock of "knowledge", or "human capital" at *t*. This is common to all agents.‡ One unit of actual time supplied at *t* delivers h_t units of "effective" labour. 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 $Y_t = \tilde{F}(K_t, h_t L_t, h_t)$, where the third argument of $\tilde{F}$ is managerial input, which is also measured in efficiency units. Each firm has exactly one manager. We restrict attention to the case in which§

$$\tilde{F}(K_t, h_t L_t, h_t) = F(K_t, h_t L_t + h_t). \tag{1}$$

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

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

We assume that the function φ is continuously differentiable with respect to its first argument, and that $\varphi_1\ [(\bar{Y}/h), \mu] > 0$ holds, $\forall \mu \neq 0$. We take no particular stand on how h_{t+1}/h_t varies with μ_t and, in particular, we would like to admit the possibility that

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

‡ The 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.

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

$$\varphi[(\bar{Y}/h),\mu]=\begin{cases}1;\mu=0\\ \tilde{\varphi}(\bar{Y}/h);\mu\neq 0\end{cases}. \tag{2a}$$

This specification implies that the gross rate of increase in the stock of knowledge, h_{t+1}/h_t, depends-potentially-on two factors. One is the level of current output, $\bar{Y}_t$, relative to the existing stock of knowledge. As is conventional, we assume that a higher level of current production, for a given stock of current knowledge, increases the amount of learning-by-doing that occurs. Notice that we also allow for a sort of "diminishing returns" associated with learning-by-doing: the higher the stock of current knowledge, the less learning-by-doing occurs as the result of producing a given quantity of current output.†

Second, we assume that learning-by-doing depends on μ_t, the division of agents between entrepreneurs and workers. 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, following Arrow (1962), we then assume that no learning-by-doing occurs. Thus in particular, we assume that $\varphi[(\bar{Y}/h),0]\equiv 1$.‡ We also assume that $\varphi[0,\mu]=1$, $\forall\mu$, so that if there is no production, no learning-by-doing occurs. Otherwise, we make no particular assumptions as to how φ depends on μ_t: we want only to emphasize the essential aspect of specialization. Finally, we note that here—as in Stokey (1988)—we assume that learning-by-doing "spills over" completely, so that no individual has an incentive to consider how his behaviour affects his knowledge relative to that of others. This assumption dramatically simplifies the analysis.

With respect to physical capital we make two assumptions. 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 $c_j \varepsilon R_+$ denote age j consumption, all young agents have preferences described by the additively separable utility function $u(c_2)+v(c_3)$. 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

† The significance of diminishing returns associated with learning-by-doing was emphasized by Arrow (1962).

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

markets. u and v are assumed to have standard properties, and in addition we impose a gross substitutes condition:

$$0 \geq cv''(c)/v'(c) \geq -1, \tag{3}$$

$\forall c \varepsilon R_+$. 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.

3. 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 markets fail to form endogenously is considered in Section 5.

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 $\mu_t \equiv 0$. To see this, suppose some agent did sell labour 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 $h_t \equiv 1$). Then

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

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

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

By Euler's Theorem and equation (4)

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

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:

$$s(w_1,w_2,r)\equiv \arg\max[u(w_1-s)+v(w_2+rs)]. \quad (7)$$

Under our assumptions, $s_1\geq 0\geq s_2$ and $s_3\geq 0$. Further, define $k_t\equiv K_t/(L_t+1)$ and $f(k_t)\equiv F(k_t,1)$. Then $f'(k_t)\equiv F_1(k_t,1)$ and from (4), $w_t=F_2(k_t,1)=f(k_t)-k_tf'(k_t)\equiv w(k_t)$.

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

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

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),

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

Equation (9) defines k_{t+1} as an increasing function of k_t, as depicted in Figure A. Under well-known conditions,† equation (9) has one or more non-trivial stationary solutions, and as in Figure A, 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.

4. 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

† See, for instance, Azariadis (1993).

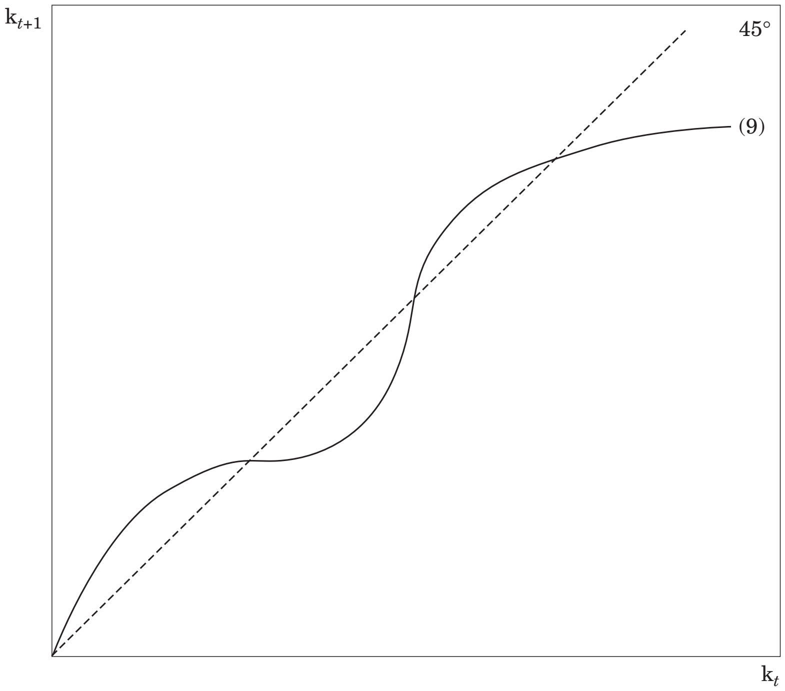

FIGURE A. Equilibrium law of motion without active financial markets.

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 of 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 $t+2$.† We now consider the economy of Section 2 when this specialization occurs.

4.1. WORKERS

Agents who work when young at t earn $h_t w_t$, all of which is saved.‡ Then middle-aged workers receive $r_t h_t w_t$ at $t+1$ as the proceeds of

† Our 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.

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

their savings when young. In addition, they earn $h_{t+1}w_{t+1}$ as labour 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

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

and

$$c_3 \leq r_{t+1}s. \tag{11}$$

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

4.2. ENTREPRENEURS

An agent who runs a firm at t has income equal to $\tilde{F}(K_t, h_t L_t, h_t) - w_t h_t L_t - r_{t-1}K_t$, 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,

$$F_2(K_t, h_t L_t + h_t) = w_t. \tag{12}$$

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

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

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 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.† 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

$$c_2 \leq h_{t+1}w_{t+1} - s \tag{14}$$

† Since entrepreneurs could earn $h_{t+1}w_{t+1}$ at $t+1$ from selling labour 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.

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

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

4.3. EQUILIBRIUM

In equilibrium, four conditions must be satisfied at each date. First, if $\mu_t \varepsilon (0,1)$, 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

$$r_t h_t w_t + h_{t+1}w_{t+1} = h_{t+1}w_{t+1} + \frac{h_{t+2}w_{t+2}}{r_{t+1}}. \tag{16}$$

Second, the labour 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 perfirm employment at t, L_t, must satisfy

$$L_t = \frac{\mu_{t-1} + \mu_t}{2 - \mu_{t-1} - \mu_{t-2}} \tag{17}$$

Third, saving 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 $(2-\mu_t-\mu_{t-1})K_{t+1}$. Savings by young workers at t is $\mu_t h_t w_t$, while savings by middle-aged workers is $\mu_{t-1}\tilde{s}(r_{t-1}h_{t-1}w_{t-1} + h_t w_t, r_t)$. 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

$$\begin{aligned}(2-\mu_t-\mu_{t-1})K_{t+1} &= \mu_t h_t w_t + \mu_{t-1}\tilde{s}(r_{t-1}h_{t-1}w_{t-1} + h_t w_t, r_t) \\ &\quad + (1-\mu_{t-1})s(h_t w_t, h_{t+1}w_{t+1}, r_t).\end{aligned} \tag{18}$$

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

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

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

We now transform these equilibrium conditions as follows. Define

$\hat{k}_t \equiv K_t/h_t$ 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

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

and

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

In addition, (16) reduces to

$$r_t r_{t+1} = h_{t+2}w_{t+2}/h_t w_t\,, \tag{22}$$

while (19) becomes

$$\frac{h_{t+1}}{h_t} = \varphi\left\{F\left[\hat{k}_t,\frac{2+\mu_t-\mu_{t-2}}{2-\mu_{t-1}-\mu_{t-2}}\right],\mu_t\right\}. \tag{23}$$

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,

$$\begin{aligned} r_{t-1}h_{t-1}w_{t-1}+h_tw_t-\tilde{s}(r_{t-1}h_{t-1}w_{t-1}+h_tw_t,r_t) \\ = h_tw_t - s(h_tw_t,h_{t+1}w_{t+1},r_t). \end{aligned} \tag{24}$$

Substituting (24) into (18) gives

$$\begin{aligned} (2-\mu_t-\mu_{t-1})K_{t+1} = \mu_th_tw_t-(1-\mu_{t-1})r_{t-1}h_{t-1}w_{t-1} \\ +\tilde{s}(r_{t-1}h_{t-1}w_{t-1}+h_tw_t,r_t). \end{aligned} \tag{25}$$

We henceforth assume that agents have homothetic preferences, so that

$$\tilde{s}(r_{t-1}h_{t-1}w_{t-1}+h_tw_t,r_t) \equiv \psi(r_t)(r_{t-1}h_{t-1}w_{t-1}+h_tw_t), \tag{26}$$

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

$$\begin{aligned} (2-\mu_t-\mu_{t-1})\hat{k}_{t+1} = \frac{\mu_th_tw_t}{h_{t+1}}-\frac{(1-\mu_{t-1})r_{t-1}h_{t-1}w_{t-1}}{h_{t+1}} \\ +\frac{\psi(r_t)(r_{t-1}h_{t-1}w_{t-1}+h_tw_t)}{h_{t+1}}. \end{aligned} \tag{27}$$

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 behaviour. However, in light of the apparent difficulty of describing general dynamic behaviour in this economy, we now turn our attention to characterizing "steady state" equilibria (equilibria with constant values of μ and $\hat{k}$).

4.4. STEADY STATE EQUILIBRIA

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

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

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

Then (23) becomes

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

and (22) reduces to

$$r = \frac{h_{t+1}}{h_t}. \tag{31}$$

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

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

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

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

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

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

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

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

$$f'(z) = \varphi[f(z)/(1-\mu),\mu] \tag{35}$$

and

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

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

Proposition: 2: *suppose that*

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

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

(iii) $g(z)\varepsilon(0,1)\forall z$

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

Proof: substituting (36) into (35) gives

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

(i)–(iii) imply that

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

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

$$\sigma \equiv [dz/d(w/r)]\ (w/r)\,/\,z$$

Proposition 3: *suppose that (i)–(iii) in proposition 2 are satisfied,*

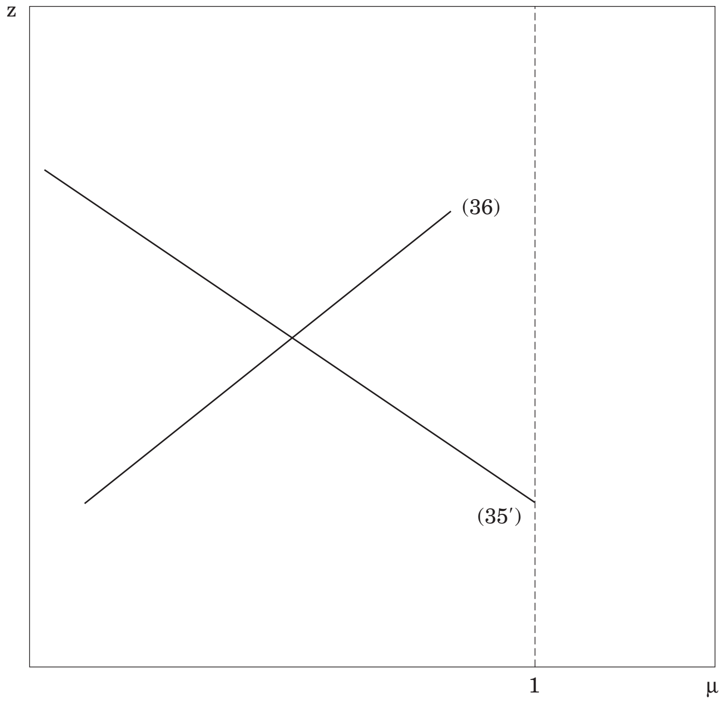

FIGURE B. Determination of equilibrium with active financial markets.

that $\sigma \geq 1$ and $\psi'(r) \geq 0$ hold, and that φ has the form given in equation (2a). Then (35) and (36) have a unique solution.

PROOF: under these conditions, (35) becomes

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

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

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

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

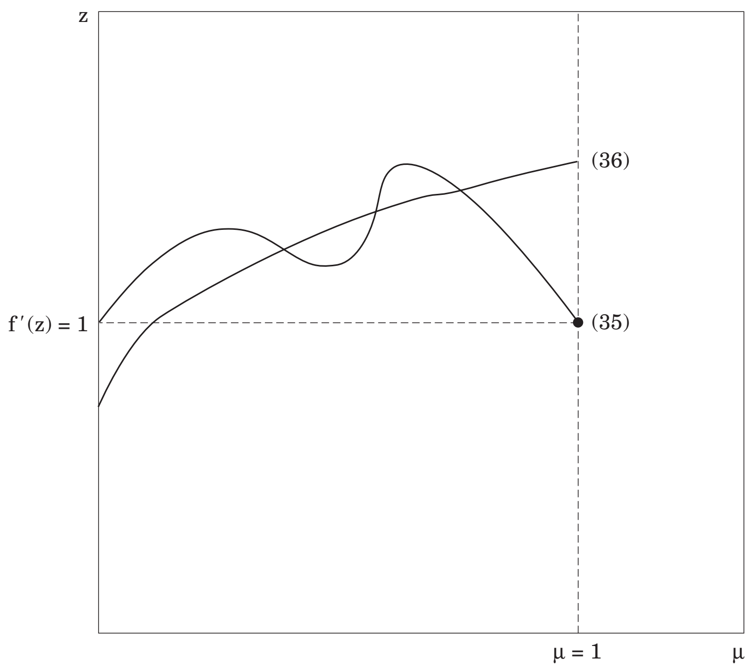

FIGURE C. Multiple equilibria.

φ is of the more general form given in (2), and if $\sigma>1$ and/or $\psi'>0$. This point is illustrated in Figure C.

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.

4.5. AN EXAMPLE

Let $u(c_2)+v(c_3)=1nc_2+\beta 1nc_3$, and let $F(K,hL+h)=AK^{\alpha}(hL+h)^{1-\alpha}$; $\alpha\varepsilon(0,1)$. Then $\psi(r)=\beta/(1+\beta)\equiv\psi\forall r$, and (36) reduces to

$$\mu = 1/2 - \psi + \alpha/(1-\alpha). \tag{39}$$

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

5. Endogenous absence of financial markets

We now pose the following question: can the equilibrium of Section 3 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 3 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 3 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 (1873: 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.

5.1. 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,

† In Diamond (1965), the condition $f'(k^*)<1$ would imply capital over-accumulation. Here, in contrast, the capital-labour ratio can be high—so that $f'(k^*) \leq 1$ holds—because the steady state stock of knowledge is low. Thus capital "overaccumulation" is not required for the existence of an equilibrium with no financial market activity here.

with tax proceeds rebated to middle-aged agents via lump-sum transfers.† 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

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

or equivalently to

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

For future reference we observe that

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

Clearly steady state equilibria satisfy

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

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

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

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

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

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

$$\begin{aligned} \rho'(\tau_r) &= (1-\tau_r)f''k'(\tau_r) - f' \\ &= \frac{-[1 - s_2 w' - \tau_r s_1 f']}{[1 - s_2 w' - (1-\tau_r)s_3 f''] - s_1[\tau_r f' - (1-\tau_r)k(\tau_r)f'']} \end{aligned} \tag{45}$$

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

† We 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.

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.

6. 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 5. 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.†
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 B.

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

6.1. 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.† 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

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

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

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

$$c_2 \leq h_{t+1}w_{t+1} + R_{t+1} - s\ , \tag{48}$$

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

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 discontinued present value. Therefore

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

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,

$$\begin{aligned} &s[h_{t+1}w_{t+1} + R_{t+1}, h_{t+2}w_{t+2}, (1-\tau_r)r_{t+1}] \\ &\quad = \tilde{s}[(1-\tau_r)r_t h_t w_t + h_{t+1}w_{t+1} + R_{t+1}, (1-\tau_t)r_{t+1}]\ - (1-\tau_r)r_t h_t w_t \\ &\quad = \psi[(1-\tau_r)r_{t+1}][(1-\tau_r)r_t h_t w_t + h_{t+1}w_{t+1} + R_{t+1}] - (1-\tau_r)r_t h_t w_t \end{aligned} \tag{51}$$

† For 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.

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

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

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

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

while (52) may be written as

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

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)],

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

or equivalently, in steady state,

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

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

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

$$(1-\tau_r)f'(z)=\varphi[f(z)/(1-\mu),\mu], \tag{57}$$

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

$$\mu=\frac{1}{2}+\left[\frac{zf'(z)}{f(z)-zf'(z)}\right]\{1-\tau_r-\tau_r\psi[(1-\tau_r)f'(z)]\} \\ -\psi[(1-\tau_r)f'(z)]. \tag{58}$$

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

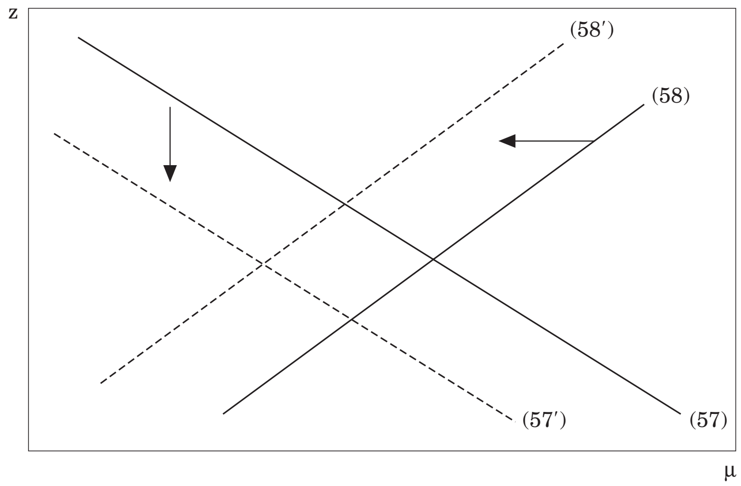

FIGURE D. A tax on interest income.

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

$$\left.\frac{\partial z}{\partial \tau_r}\right|_{(57)} = \frac{f'}{(1-\tau_r)f'' - \varphi_1 f'/(1-\mu)} < 0$$

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_t is

$$\left.\frac{\partial \mu}{\partial \tau_r}\right|_{(58)} = r\psi'[(1-\tau_r)r] - \{zf'(z)/[f(z)-zf'(z)]\}\{1+\psi(.)-\tau_r r\psi'(.)\}$$

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

$$\left.\frac{\partial \mu}{\partial \tau_r}\right|_{(58)} < 0. \tag{59}$$

This situation is depicted in Figure D.

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 behaviour.

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 $w/(1-\tau_r)$, 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.

7. 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 sustained 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.

The essential point that we have emphasized, of course, is that specialization tends to make some agents natural savers, and other agents natural borrowers. In our model, competitive intermediaries stand between borrowers and lenders. Of course in practice not all financial markets are competitive: an important topic for future investigation concerns how the industrial organization of the banking system might affect equilibrium rates of growth. Here we content ourselves with two admittedly unsubstantiated conjectures. First, intermediaries with market power on the liability side of their balance sheets would be likely to depress the rates of return received by savers. Other things equal, this would increase the likelihood that equilibria without specialization, and with low levels of financial market activity, would be observed. Second, intermediaries with market power in loan markets would likely tend to depress the level of credit extension. Again, other things being equal, this would tend to reduce capital formation and make entry into entrepreneurship more difficult. Even if specialization were possible, a natural consequence would be that this exercise of market power would have negative consequences for growth.

Clearly our analysis abstracts from many other considerations. For instance, we have had little to say about the role of internal finance in the establishment of firms. Since internal finance is important in practice, this omission deserves some comment. If we were to introduce some financial market frictions into the analysis, for instance costly state verification or moral hazard, the provision of internal finance would be important to external investors since internal finance tends to mitigate these problems. It is then natural to conjecture that agents who can provide the most internal finance will also be the agents who can obtain credit. In a world with these features, potential entrepreneurs might have to delay entry into entrepreneurship until they could accumulate sufficient levels of internal finance. This delay would operate much like the delay we analysed in Section 3. Financial market improvements that mitigate problems of costly state verification or moral hazard might then act much like the financial market development we described in Section 4. Thus, we think that our essential points will survive generalization to much richer environments than just the one we have described here.

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