

## Equity Markets, Transactions Costs, and Capital Accumulation: An Illustration

Valerie R. Bencivenga, Bruce D. Smith, and Ross M. Starr

---

*Poorly developed equity markets inhibit the transfer of capital ownership. Moreover, the costs of transacting in equity markets affect not just the level of investment, but the kinds of investments that are undertaken. Once equity markets allow the ownership of capital to be transferred economically, reductions in costs tend to favor the use of longer-maturity investments. When there is a relationship between the maturity of an investment and its productivity, transactions cost reductions are conducive to observing certain kinds of increases in productive efficiency. This article analyzes savings, investment, and consumption decisions by using an overlapping generations model with two-period-lived agents. The analysis allows for several technologies for converting current output into future capital that vary by productivity and maturity, and it makes ownership of capital costly to transfer. A reduction in transactions costs will typically alter the composition of savings and investment, and have potentially complicated consequences for capital accumulation and steady-state output.*

---

There is a close—if imperfect—relationship between the effectiveness of an economy's capital markets and its level of real development.<sup>1</sup> Financial markets provide liquidity (Bencivenga and Smith 1991; Levine 1991), promote the acquisition and dissemination of information (Diamond 1984; Boyd and Prescott 1986; Williamson 1986; Greenwood and Jovanovic 1990), and permit agents to increase specialization (Cooley and Smith 1992). And yet, although a literature exists pursuing the contributions of each of these functions to increasing real activity, surprisingly little of that literature provides predictions about how the volume of activity in financial markets is related to the level or efficiency of an economy's productive activity. Indeed, surprisingly little research has investigated

1. For documentation of this claim in historical and modern development contexts, see Cameron (1967) and McKinnon (1973), and Shaw (1973), respectively. For quantitative analyses of the experiences of a variety of economies, see Goldsmith (1969), Antje and Jovanovic (1992), or King and Levine (1993a, 1993b).

Valerie R. Bencivenga is with the Department of Economics at Cornell University, Bruce D. Smith is with the Department of Economics at Cornell University and the Research Department at the Federal Reserve Bank of Minneapolis, and Ross M. Starr is with the Department of Economics at the University of California, San Diego. This article was originally prepared for the World Bank Conference on Stock Markets, Corporate Finance, and Economic Growth, held in Washington, D.C., February 16–17, 1995. The authors thank Aubhik Khan, Ross Levine, and two anonymous referees for their comments on an earlier draft.

the relation between an economy's efficiency in performing financial transactions and its efficiency in performing physical production. We pursue this relation in some detail. In the process, we also discuss how an economy's volume of financial transactions and its level of real activity are related.

In addition, we analyze why the connections between the development of an economy's financial markets and its level of real development, although close, are not perfect. Many prominent examples of successful growth—such as the Republic of Korea and Taiwan (China)—have experienced their success despite heavily regulated financial systems. And, all too often, attempts by governments to stimulate the development of financial markets in developing economies have been (apparently) counterproductive (for examples, see Galbis 1979, van Wijnbergen 1985, Diaz-Alejandro 1985, Khatkhate 1988, and Fry 1988). Why should this be the case if financial market development is, typically, conducive to real development? We also investigate this issue.

Section I sets the context of the article by discussing the importance of financial markets and transactions costs. Section II lays out the model economy we employ, and section III describes the nature of trade and transactions costs and sets out the conditions of a steady-state competitive equilibrium. Section IV examines how the level of transactions costs affects the choice of investment technology, the rate of return on savings, capital accumulation and output, steady-state welfare, and the volume of equity market activity when transactions costs represent true resource costs. Section V reconsiders these issues when transactions costs represent pure transfers. Section VI presents some final thoughts on issues that could be addressed in more complicated versions of this framework.

## I. FINANCIAL MARKETS AND TRANSACTIONS COSTS

We draw on two fairly fundamental insights. One is that the most productive capital investments often require the commitment of large amounts of funds for substantial periods, with investors facing relatively long times to payout (Bohm-Bawerk 1891). The other is that investors are unlikely to commit funds to such investments in the absence of well-functioning capital markets that can provide them with liquidity. The second point was made quite forcefully by Hicks (1969) in discussing the question of what made the industrial revolution revolutionary.

Hicks (1969) argued that the industrial revolution was not the consequence (or, at least, not the immediate consequence) of a set of new technological innovations, because most of the innovations that were exploited in the early phases of the industrial revolution had occurred some time earlier. Rather, according to Hicks, what was new was that the implementation of these particular innovations on an economical scale required that investments of large magnitude be made in highly illiquid and activity-specific capital for long periods. This would not have been possible in the absence of financial markets to provide liquidity. Thus, technological innovation by itself was insufficient to stimulate growth; another precondition for the implementation of new technologies was the exist-

ence of liquid capital markets. The industrial revolution therefore had to wait for the financial revolution—a term applied by Dickson (1967) to the rapid development of English financial markets in the first half of the eighteenth century—before it could occur. According to Hicks,

What happened in the Industrial Revolution . . . is that the range of fixed capital goods that were used in production . . . began noticeably to increase. . . . But fixed capital is sunk; it is embodied in a particular form, from which it can only gradually . . . be released. In order that people should be willing . . . to sink large amounts of capital, . . . it is the availability of liquid funds which is crucial. This condition was satisfied in England . . . by the first half of the eighteenth century. . . . The liquid asset was there, as it would not have been even a few years earlier. (Hicks 1969: 143–45).

In our view, Hicks asserted that individual investors face two important timing decisions with respect to their capital investments: the time to payout (or maturity) of the investment and its holding period. In poorly developed equity markets, the transfer of capital ownership is inhibited, and an individual investor will face a time to payout and a holding period that are identical. As Hicks argued, these conditions would prevent an array of investments from being undertaken. However, once equity markets allow the ownership of capital to be transferred economically, individuals can separate decisions involving the maturity of an investment from the length of time they will hold it themselves. Hence, equity markets permit investors to choose a maturity of investment that maximizes yield, and at the same time to choose a holding period to satisfy the desired timing of their own transactions. The maturity of an investment is no longer held hostage to the desired liquidation dates of wealth-holders.

These observations imply that the costs of transacting in equity markets are of great importance for affecting not just the level of investment, but the kinds of investments that occur. Which kinds of investments appear economical will depend not just on their productivities, but on the cost of transferring ownership of them, if necessary. Thus, the efficiency of an economy's financial system (measured by the costs of transacting in equity markets) has implications for the choice of which investments are undertaken. The issue of which investments are undertaken, in equilibrium, affects the productivity of investment, as well as capital formation. Moreover, as we will show, far-reaching implications arise from the relationship among the costs of transacting in capital markets, the choice of investment, and the composition of wealth-holding between existing equity claims and the initiation of new capital investment. These implications permit us to make some observations about why the association between financial market development and real development is not a perfect one.

In order to discuss the relationship among capital market efficiency (transactions costs), productive efficiency, and the composition of investment, we employ essentially the simplest model we can imagine. Many details of this model are generalized in Bencivenga, Smith, and Starr (1994, 1995, 1996). Savings,

investment, and consumption decisions are undertaken in an overlapping generations model with two-period-lived agents. In order to trivialize savings, labor supply, and production decisions, both preferences and the technology for producing final goods are assumed to be linear. The innovations of the analysis—which we highlight by heavily simplifying all other aspects of the model—are the presence of several technologies for converting current output into future capital and the fact that ownership of capital is costly to transfer. The first feature allows us to address the issue of the equilibrium choice of investment technology emphasized by Bohm-Bawerk and Hicks; the second allows us to index the effectiveness of an economy's capital markets by the costs of transacting in them.

In practice, some transactions costs represent a real social loss of resources, and others represent simple transfers between agents (for example, rents accruing to brokers or market makers, or taxes paid to the government). In previous research (Bencivenga, Smith, and Starr 1994, 1995, 1996), we have investigated transactions costs in secondary capital markets that represent a genuine resource loss, and examined their consequences for the determination of saving, investment, the composition of the capital stock, and asset pricing. We reconsider these issues here as well, using a particularly simple model designed to highlight the economic mechanisms at work. These simplifications permit us to obtain particularly sharp conclusions about the consequences of changes in the level of transactions costs.

When transactions costs involve real resource losses, it is immediate, in this context, that reductions in transactions costs raise steady-state welfare. What does this observation imply about the desirability of imposing charges on, or subsidizing, secondary market transactions? To answer this question, we need to consider the situation where transactions costs represent pure fees or rents. An analysis of this issue goes beyond that in Bencivenga, Smith, and Starr (1994, 1995, 1996). In the case in which transactions costs represent pure fees or rents, such costs introduce a wedge between the buying and selling prices of capital. The structure of transactions costs still affects the composition of savings and investment, as in Bencivenga, Smith, and Starr (1994, 1995, 1996), and also has implications for the productivity of investment. On the basis of these implications from the efficiency effects of the pricing structure of transactions costs, we analyze how the pricing structure for financial transactions affects the allocative efficiency of the financial system.

Since agents are two-period lived, the use of technologies with more than one gestation period requires the ownership of immature capital to be transferred in capital resale—or equity—markets. For simplicity, we assume a proportional transactions cost structure in these markets. Agents will decide which investment technologies to use on the basis of their yields—at currently prevailing prices—net of transactions costs. Since transactions costs have a greater effect on the net-of-transactions-cost yields of longer-maturity investments (these investments are resold more times, and hence are more transactions intensive), high transactions costs imply that the equilibrium maturity of investments will

be relatively short (in order to economize on capital resale). As argued by Bohm-Bawerk and Hicks, this is likely to imply that the investments made are relatively unproductive.

We then investigate the consequences of (exogenous) reductions in transactions costs for steady-state equilibria. For the reasons we have described, transactions cost reductions tend to favor the use of longer-maturity investments, and hence are conducive to certain kinds of increases in productive efficiency. Reductions in transactions costs also necessarily raise the net-of-transactions-costs rates of return on (all) investments, and these reductions therefore raise the equilibrium rate of return on savings. However, transactions cost reductions have potentially complicated consequences for capital accumulation and steady-state output.

If transactions costs represent real resource costs, their reduction has two effects. First, such a reduction raises the—net-of-transactions-cost—productivity of all investment technologies. If the composition of investment remained constant, this effect would necessarily increase capital formation and steady-state output. However, the composition of wealth-holding—much less the equilibrium choice of investment technology—will not typically remain constant with an increase in the efficiency of equity markets. Such changes make the ownership of already-existing equity more attractive, other things being equal, and they can cause some fraction of agents' wealth to be transferred away from the initiation of new capital investment and into the ownership of existing equity. This effect is detrimental to capital formation and production. Moreover, as it turns out, either effect can dominate. We describe when each situation does dominate, and hence when increasing the efficiency of equity markets is and is not conducive to capital accumulation. Thus we can not only describe why equity market conditions are important determinants of both productive efficiency and real activity, but also why the relationship between equity market conditions and real development is an imperfect one. In particular, in analyzing the effects of an improvement in the functioning of equity markets, it is necessary to be fully cognizant of how such an improvement will affect the composition of wealth-holding.

We are also able to examine how the level of transactions costs affects the volume of financial market activity and steady-state welfare. We consider two polar cases: (a) transactions costs represent real resource costs, and (b) transactions costs are pure transfers (such as fees or rents to brokers or market makers or, possibly, taxes paid to the government). It is clear that, as a practical matter, a great deal of time and physical resources are devoted to the process of undertaking financial transactions. However, there are also additions to—or subtractions from—transactions costs that represent pure transfers between economic agents. For example, governments often subsidize the formation of exchanges or the transfer of funds. These types of activities represent actual transactions subsidies. By the same token, there are often taxes on financial transactions, and some prominent economists have even proposed that these taxes should be in-

creased. Such taxes or subsidies very clearly represent pure transfers. However, other types of transfers may occur. For example, it is not uncommon for some agents to obtain the monopoly rights to the provision of certain financial services. The existence of such monopoly power can result in rents accruing to the providers of these services. Such rents, which may themselves be regulated, are again pure transfers between agents.

Whether transactions costs represent either pure resource losses or pure transfers, a reduction in transactions costs increases the volume of equity market activity. However, since a transactions cost reduction may or may not lead to increased output levels, an increase in the volume of financial market activity can be, but need not be, associated with an increase in the level of real activity. In addition, when transactions costs represent genuine resource losses, their reduction necessarily leads to higher steady-state welfare. This result would need to be qualified in more general models, like those of Bencivenga, Smith, and Starr (1994, 1996).

The conclusion for resource losses must be substantially modified, however, if transactions costs simply represent transfers. Here transactions cost reductions may either raise or lower steady-state welfare. In particular, it is possible that an economy can undertake a socially excessive volume of financial market transactions. In this case, it will be desirable to raise the fees associated with equity market activity. This situation is particularly likely to occur in economies that have low real interest rates but large transactions volumes.

The case in which the transactions costs borne by individuals represent a genuine social resource loss seems to correspond to the situation envisioned by Hicks (1969), a situation that has been previously analyzed by Bencivenga, Smith, and Starr (1994, 1995, 1996). However, an alternative view of transactions costs in financial markets has often been put forward. In this view, many financial market transactions are purely speculative; they simply rearrange the ownership of existing capital without affecting its allocation in production. Under this view, if such transactions are costly, they are socially wasteful. Arguments of this type led Keynes (1964: 159) to conclude that "it is usually agreed that casinos should, in the public interest, be inaccessible and expensive. And perhaps the same is true of stock exchanges." Similar reasoning about currency markets led Tobin (1994) to propose the taxation of currency transactions. Attempts to artificially increase the costs of transacting, as proposed by Keynes and Tobin, clearly represent transactions costs to individuals, but not social costs. The formulation in section V allows what we believe is the first formal analysis of the effects of transactions costs of this type. In particular, we describe conditions under which Keynes's and Tobin's arguments have merit, as well as conditions under which they do not.

## II. THE MODEL

In this section we describe what we believe is the simplest model that can be used to illustrate the issues we have just discussed. This model confronts both

households and producers with what are essentially trivial decisions, and in so doing, it permits us to focus on what seems to us the most central issue: how transactions costs in equity markets affect the composition of savings and investment, and—through those channels—capital accumulation.

We consider a two-period-lived, overlapping generations model with production. Time is indexed by  $t = 1, 2, \dots$ , and in each period a new young generation is born with  $N$  identical members. (Note that we are abstracting both from heterogeneity and population growth, a simplification that reduces notational requirements.) Each agent is endowed with one unit of labor when young, which is supplied inelastically, and all agents are retired when old. No agents other than the initial old are endowed with capital or consumption goods at any date.

In each period there is a single consumption good produced, which can either be eaten or converted into capital. We assume that all agents care only about old-period consumption, which we denote simply by  $c$ . We thus abstract from any interesting labor supply or savings decisions on the part of households. Each agent will save their entire young-period income at each date.

The consumption good is produced according to a constant-returns-to-scale, in fact a linear, technology using capital and labor as inputs. Thus, a firm employing  $K_t$  units of capital and  $L_t$  units of labor at  $t$  can produce

$$F(K_t, L_t) = aK_t + bL_t$$

units of the final good. The use of a linear technology confronts the firm with an essentially trivial decision regarding the choice of factor inputs.

Capital is also produced from the final good using a set of linear capital investment technologies. We assume that there are  $J$  such technologies, indexed by  $j = 1, \dots, J$ . These technologies differ along two dimensions, productivity and gestation period. In particular, one unit of the final good invested in technology  $j$  at  $t$  yields  $R_j > 0$  units of capital (gross of transactions costs) at  $t + j$ . Thus  $j$  represents the gestation length of capital investments in the technology with that index, and  $R_j$  represents the (gross) productivity of that technology.

We assume further that if  $K_t$  denotes the total capital stock available at  $t$ ,  $K_t$  is simply the sum of maturing capital investments produced through all technologies. Thus, more specifically, all capital—produced by any investment technology—is perfectly substitutable as an input in final goods production. (The assumption that all capital, however produced, is perfectly substitutable in production is relaxed by Bencivenga, Smith, and Starr 1994.) Our assumptions here on capital production technologies imply that capital investments are completely unproductive until they mature. This can be thought of as an Austrian model of investment. It is possible to alter the analysis so as to allow all capital investments to mature in one period but at the same time have capital produced using different technologies with different productive lifetimes. This, however, is a more complicated model, and we do not pursue it here.

Since agents are two-period lived, the use of any investment technology with  $j > 1$  requires owners of capital in process (CIP) to transfer ownership of it in equity markets. This is true of CIP in all periods prior to maturity, so that ownership of CIP is transferred through a sequence of holders in equity—or capital resale—markets. We are interested in considering how the costs of transacting in these markets affect capital accumulation and per capita income, the equilibrium return on savings, the equilibrium choice of capital production technologies, and welfare in a steady-state equilibrium.

For simplicity, we assume a proportional transactions costs structure confronting agents who operate in equity markets. Our specific assumption is that transferring ownership of one unit of CIP produced using technology  $j$  that has been in process for  $h$  periods (that is, which is  $j - h$  periods from maturity), consumes  $\alpha^{j,h}$  units of CIP. Thus, after a sale of one unit of type  $(j, h)$  CIP,  $1 - \alpha^{j,h}$  units remain. Under this specification, transactions costs represent a pure resource loss. We consider below the alternative case in which transactions costs represent a pure transfer to market makers (or a tax paid to the government).

Finally, we assume that when CIP matures it is used in the production process and then depreciates completely. This assumption allows us to abstract from the existence of resale markets for mature—as opposed to maturing—capital.

### *Trade*

Three kinds of transactions occur in this economy: capital and labor are rented in competitive factor markets, final output is bought and sold, and agents trade ownership of CIP in competitive equity markets. We focus on transactions costs in equity markets and otherwise keep the model as close to standard as possible (see Diamond 1965 and Azariadis 1992, ch. 13). Therefore, we assume that there are no costs associated with transactions in output or factor markets. We also focus throughout on steady-state equilibria. We therefore omit time subscripts wherever possible.

Let  $w$  denote the (steady-state value of) the real wage rate, and let  $r$  denote the rental rate on capital. In a competitive economy, factor prices will equal marginal products of the appropriate factor, so that

$$(1) \quad r = a$$

$$(2) \quad w = b.$$

Each young agent earns the wage income  $w$ , all of which is saved. Let  $S$  denote savings by a representative young agent, measured in units of CIP. The only decision confronting such an agent is how to allocate savings among various alternative assets; the available assets are type  $j$  CIP ( $j = 1, \dots, J$ ) of vintage  $h$  ( $h = 1, \dots, j - 1$ ). Mature capital is simply rented to firms. Since there are no transactions costs in factor markets, this amounts to assuming that  $\alpha^{j,j} = 0$  ( $j = 1, \dots, J$ ).



Let  $S^{j,b}$  denote the amount of type  $j$  CIP that is  $b$  periods old acquired by a representative agent. Then, for example,  $S^{j,0}$  represents the amount of newly initiated investment in technology  $j$ , and  $S^{j,j-1}$  is the amount of type  $j$  CIP acquired that will mature in one period. Similarly, let  $P^{j,b}$  be the price—in units of current consumption—of one unit of technology  $j$  CIP that is  $b$  periods old. Since one unit of the final good invested in technology  $j$  at any date becomes one unit of technology  $j$  CIP (by choice of units),  $P^{j,0} = 1$ . Moreover, mature CIP is simply capital, which is rented to firms. As one unit of technology  $j$  CIP yields  $R_j$  units of rentable capital on maturity,  $P^{j,j} = rR_j$ , must hold. That is, the price of mature CIP is simply the rental value of the associated capital. For  $j > 1$  and  $0 < b < j$ ,  $P^{j,b}$  must be determined.

Without loss of generality, we can assume that transactions costs are borne by sellers of CIP. Then, since each agent consumes only when old, the budget constraints confronting an individual agent are

$$(3) \quad \sum_{j=1}^J \sum_{b=0}^{j-1} P^{j,b} S^{j,b} \leq w$$

$$(4) \quad c \leq \sum_{j=1}^J \sum_{b=0}^{j-1} P^{j,b+1} S^{j,b} (1 - \alpha^{j,b+1}).$$

Equation 3 imposes that the value of asset purchases does not exceed savings, and equation 4 asserts that old-age consumption is funded by the net-of-transactions-cost proceeds of asset sales. We also impose nonnegative asset holdings (no short sales) for all types of assets. Note that while agents take the transactions costs parameters  $\alpha^{j,b}$  as given, the total quantity of transactions costs incurred is a choice variable that responds not just to the values  $\alpha^{j,b}$  but to asset prices as well.

Agents here care only about the rates of return received on assets, since our model contains no motive for diversification. Thus, all assets actually held in equilibrium must bear a common (gross) rate of return, net of transactions costs, which we denote by  $\gamma$ . If technology  $j$  is actively used in a steady-state equilibrium, then technology  $j$  CIP of all possible times to maturity must be held by some agent. Thus, for all  $b = 0, \dots, j-1$ , the gross rate of return on type  $(j, b)$  CIP must equal  $\gamma$ . In other words, then, if technology  $j$  is active in a steady-state equilibrium,

$$(5) \quad \gamma = (1 - \alpha^{j,b+1}) P^{j,b+1} / P^{j,b}$$

for all  $b = 0, \dots, j-1$ .

When rates of return on all capital investments in use are equated, each young agent is indifferent to the composition of his portfolio. The aggregate composition of investment will, nevertheless, be determinate, as we will see shortly.

### *Long-Maturity Investments*

The assumption that agents are two-period lived implies that the number of times any investment changes hands is simply its gestation length minus 1. As a consequence, long-maturity investments are traded more times than short-maturity investments. Although this is a necessary consequence of our assumptions on agents' life cycles, we believe that it captures a feature that is generally true of reality.

A more general but much more complicated formulation would allow for longer-lived agents who make endogenous choices about the holding periods for each of their investments. These holding periods would typically depend on the patterns of agents' incomes and expenditures, as well as on the structure of transactions costs. Indeed, we could additionally add the feature that agents' incomes and expenditures are subject to some uncertainty. In this case, the occurrence of various shocks would motivate asset market transactions that agents could not perfectly predict in advance.

In either of these more realistic (and hence complex) formulations, we would expect agents to have determinate asset demand functions. These demand functions would, however, necessarily depend on the structure of transactions costs. So long as transactions costs are greatest for assets of longer maturities, reductions in transactions costs will be conducive to the transfer of savings from shorter- to longer-maturity instruments. It is this transfer that is central to our results. We therefore do not believe that the introduction of uncertainty or of richer life-cycle savings behavior into the analysis would tend to alter our main conclusions.

### III. STEADY-STATE EQUILIBRIUM

In order to describe the steady-state equilibrium capital stock, output level, and rate of return on savings, we need to know two things: first, which capital production technology (or technologies) will be in use in such an equilibrium; second, how savings will be divided among CIP of different gestation periods in this technology.

#### *The Equilibrium Choice of Investment Technology*

As intuition might suggest—and as Bencivenga, Smith, and Starr (1995, 1996) show formally—in equilibrium the capital production technology or technologies in use maximize the internal rate of return on investment, net of transactions costs. An investment of one unit in technology  $j$  at  $t$  yields  $\tilde{R}_j$  units of capital at  $t + j$ , net of transactions costs, where

$$(6) \quad \tilde{R}_j \equiv R_j \prod_{h=0}^{j-1} (1 - \alpha^{j,b+1}).$$

This capital is then rented at its competitive rental rate,  $r$ . With this “point input, point output” technology, the internal rate of return on technology  $j$  is

$(r\tilde{R}_j)^{1/j}$ . The equilibrium choice of capital production technology—in steady state—is that which maximizes this internal rate of return. Thus, if  $j^*$  is the equilibrium choice of capital production technology,

$$(7) \quad j^* = \arg \max_j [(a\tilde{R}_j)^{1/j}].$$

We assume throughout that  $j^*$  is unique, which will generically be the case.

The equilibrium rate of return on savings is equal to the internal rate of return on the equilibrium capital production technology. Therefore, in equilibrium,

$$(8) \quad \gamma = (a\tilde{R}_{j^*})^{1/j^*}$$

holds.

To summarize, in choosing which technology to use, agents care only about the internal rate of return on investments, net of transactions costs. The costs of transacting in equity markets influence the equilibrium capital production technology through their influence on this rate of return. After characterizing the remaining aspects of an equilibrium, we will pursue the implications of this observation.

#### *The Capital Stock and the Composition of Savings*

The equilibrium level of the capital stock—as well as, by implication, the equilibrium level of output—depends very heavily on how savings is allocated between existing, but not yet mature, CIP and the initiation of new capital investment. Purchases of the former represent equity holdings so, in effect, the division of young people's saving between equity and new investment determines the steady-state capital stock.

Let  $\theta^{j,h}$  denote the fraction of per capita saving (of young people) invested in purchasing technology  $j$  CIP of vintage  $h$ .<sup>2</sup> In a steady state,  $\theta^{j,h} = 0$  holds for all technologies that do not maximize the internal rate of return on investment. Thus, only  $\theta^{j^*,h} > 0$  holds. We now consider the equilibrium value of these weights.

Since  $\theta^{j^*,h}$  is a fraction of total savings in the form of type  $(j^*, h)$  CIP,

$$(9) \quad \sum_{j=1}^J \sum_{h=0}^{j-1} \theta^{j,h} = \sum_{h=0}^{j^*-1} \theta^{j^*,h} = 1$$

must hold. In addition, the market for type  $(j^*, h)$  CIP must clear at each date. The demand for such CIP is the fraction of savings invested in this form,  $\theta^{j^*,h}$ , times savings,  $\omega$ , divided by the price of type  $(j^*, h)$  CIP. In other words, the demand for such CIP is given by  $\theta^{j^*,h} \omega / P^{j^*,h}$ .<sup>3</sup> The supply of type  $(j^*, h)$  CIP is the amount of new capital investments in technology  $j^*$  initiated  $h$  periods ago, less

2. If all households were behaving identically,  $\theta^{j,h} \equiv P^{j,h} S^{j,h} / \omega$  would hold.

3. Notice that  $\theta^{j^*,h} \omega$  gives the value, in real terms, of the demand for type  $(j^*, h)$  CIP. Division by  $P^{j^*,h}$  converts this demand into units of CIP.

the amount of CIP consumed by the transactions technology in the interim. Thus, the supply of type  $(j^*, h)$  CIP equals

$$\theta^{j^*,0} \omega \prod_{t=0}^{h-1} (1 - \alpha^{j^*,t+1}) / P^{j^*,0} = \theta^{j^*,0} \omega \prod_{t=0}^{h-1} (1 - \alpha^{j^*,t+1}),$$

since  $1 - \prod_{t=0}^{h-1} (1 - \alpha^{j^*,t+1})$  of the initial CIP created has been lost in the transactions process. The market for type  $(j^*, h)$  CIP clears, then, if

$$(10) \quad \theta^{j^*,h} \omega = P^{j^*,h} \theta^{j^*,0} \omega \prod_{t=0}^{h-1} (1 - \alpha^{j^*,t+1}).$$

We now observe that

$$(11) \quad P^{j^*,h} = P^{j^*,0} (P^{j^*,h} / P^{j^*,h-1}) (P^{j^*,h-1} / P^{j^*,h-2}) \dots (P^{j^*,1} / P^{j^*,0}) = (\gamma)^h / \prod_{t=0}^{h-1} (1 - \alpha^{j^*,t+1}).$$

Substituting equation 11 into equation 10, we obtain

$$(12) \quad \theta^{j^*,h} = (\gamma)^h \theta^{j^*,0}.$$

Loosely speaking, equation 12 asserts that the demand for (and the supply of) CIP of increasing maturity grows at the rate of interest. This is necessary in order for all vintages of CIP to bear a net-of-transactions-cost rate of return equal to the equilibrium interest rate.

Equations 9 and 12 imply that

$$(13) \quad \theta^{j^*,0} = (1 - \gamma) / [1 - (\gamma)^j].$$

In view of equation 8, equations 12 and 13 imply that the composition of savings is determined entirely by the internal rate of return on investments in the equilibrium capital production technology. In particular, equation 13 describes how this rate of return determines the amount of new capital investment, and equation 12 governs how the remainder of agents' savings are allocated to the purchase of already-existing CIP in equity markets.

The internal rate of return on savings depends on two factors: the marginal product of capital ( $a$ ), and the net-of-transactions-cost productivity of the equilibrium investment technology ( $\tilde{R}_j$ ). We now investigate how changes in  $\tilde{R}_j$  influence capital accumulation.

Let  $k$  denote the per capita capital stock in a steady-state equilibrium. Then

$$(14) \quad k = \tilde{R}_j \theta^{j^*,0} \omega.$$

Equation 14 simply notes that the steady-state equilibrium capital stock (per capita) equals the per capita initiation of new capital investments  $j^*$  periods earlier ( $\theta^{j^*,0} \omega$ ), times the amount of capital produced, per unit invested, net of

transactions costs ( $\tilde{R}_{j^*}$ ). The linearity of final goods production implies that  $w = b$ . Equation 13 implies that  $\theta^{j^*,0}$  depends entirely on  $\gamma$ , which in turn is the internal rate of return on technology  $j^*$ . Finally, which technology maximizes the internal rate of return depends on the productivities of the capital investment technologies, net of transactions costs. Thus, ultimately, the net-of-transactions-cost productivities of the various investment technologies, that is the values  $\{\tilde{R}_j\}$ , fully determine the steady-state capital stock. Later we will explore how the structure of transactions costs affects capital formation. Before doing so, however, we will characterize the equilibrium value of equity market activity.

#### *Equity Market Activity*

The real value of equity market transactions in each period—in per capita terms—is per capita saving less the real value of new capital investments initiated. In particular, all savings—other than what goes into new capital investments—is used to purchase existing CIP in equity markets. Thus, the real value of net purchases in equity markets is given by  $w(1 - \theta^{j^*,0})$ . As before, this quantity is largely determined by the structure of transactions costs.

#### IV. THE EFFECTS OF CHANGES IN TRANSACTIONS COSTS

To investigate how changes in the level of transactions costs affect all aspects of a steady-state equilibrium, it is convenient to have a simple representation of transactions costs. To that end, we henceforth assume a constant proportional transactions cost structure:

$$(15) \quad \alpha^{i,b} = \alpha \in (0,1); \quad b \neq 0, j.$$

Consistent with our earlier discussion, we assume that there are no costs associated with capital rental or with the initiation of new capital investment. Thus we impose  $\alpha^{j,0} = \alpha^{j,j} = 0$ , for all  $j$ . Under these assumptions,

$$(16) \quad \tilde{R}_j = R_j (1 - \alpha)^{j-1}$$

holds for all  $j$ .

Our assumptions imply that a reduction in transactions costs has the largest proportional effect on  $\tilde{R}_j$  for those investments with the longest maturities. The notion that transactions costs are most significant for long-maturity assets is certainly consistent with casual observation. For instance, *The Wall Street Journal* of July 23, 1993, reported a bid/ask spread on three-month treasury bills of the previous day equal to 0.005 percent of price. For a thirty-year treasury bond, this spread was 0.062 percent of price, but for a thirty-year treasury strip (a pure discount instrument, equivalent to a long-term bill), the spread was 0.7 percent of price. Thus, transactions costs vary by a factor of 100 with maturity

alone, despite the fact that these observations ignore the obvious likelihood that a long-term instrument will be rolled over many more times during its lifetime than a short-term instrument.

Given the specification of transactions costs in equation 15, technology  $j$  has a higher internal rate of return than technology  $j - 1$  if and only if

$$(17) \quad 1 - \alpha \geq a(R_{j-1})^i / (R_j)^{i-1}$$

is satisfied. Therefore, for a given set of technological parameters  $a$  and  $(R_1, R_2, \dots, R_j)$ , the level of the transactions cost parameter  $\alpha$  determines which technology will be in use. Long-gestation technologies—which may intrinsically be highly productive—are also transactions intensive; that is, their ownership must be transferred many times. This will only be economical if transactions costs are sufficiently low.

To put some structure on the parameters  $(R_1, R_2, \dots, R_j)$ , we henceforth assume that

$$(18) \quad (R_j)^{i+1} / (R_{j+1})^i > (R_{j-1})^i / (R_j)^{i-1}$$

holds for all  $j \geq 2$ . The conditions imposed in expression 18 are essentially technical: they guarantee that, for each capital production technology, some value of  $\alpha$  exists at which that technology maximizes the internal rate of return to investment, net of transactions costs. We comment later on what happens if the assumption in 18 is relaxed.

Expression 18 is compatible with a variety of different configurations of the values  $(R_1, R_2, \dots, R_j)$ . For example, if  $J = 3$ , setting  $(R_1, R_2, R_3) = (2, 1, 1/3)$  satisfies expression 18, as does setting  $(R_1, R_2, R_3) = (1/3, 1, 2)$ .

#### *The Dependence of Equilibrium Values on Transactions Costs*

Here we consider how exogenous changes in the transactions cost parameter  $\alpha$  affect (a) the steady-state capital stock, (b) the rate of return on savings, and (c) the volume of activity in equity markets. In order to analyze these issues, we need to begin with the effect of  $\alpha$  on the equilibrium maturity of capital investments,  $j^*$ .

Suppose first that

$$(19) \quad 1 - \alpha < a(R_1)^2 / R_2$$

holds. Then expressions 17 and 18 imply that  $j^* = 1$ ; in other words, transactions costs are so high that technology 1—which requires no transactions—maximizes the internal rate of return on investments, net of transactions costs. In this case, there is no equity market activity, and  $\theta^{1,0} = 1$ . The equilibrium per capita capital stock (see equation 14) is  $k = R_1 b$ , and the equilibrium return on savings is  $R_1 a$ .

Small reductions in  $\alpha$ —and, more specifically, reductions that leave expression 19 satisfied—do not change the equilibrium choice of capital production technology. Hence, there continues to be no equity market activity, and both the capital stock and the real return on savings are unaffected.

Suppose that  $\alpha$  is now reduced enough so that expression 19 ceases to hold and, instead,

$$(20) \quad a(R_2)^3/(R_3)^2 > 1 - \alpha > a(R_1)^2/R_2$$

is satisfied. For this lower level of transactions costs, expressions 17 and 18 imply that  $j^* = 2$ : transactions costs are now low enough for agents to view making longer-gestation investments that require some resale as economical. The equilibrium rate of return on savings is  $[aR_2(1 - \alpha)]^{0.5}$ ; expression 20 guarantees that this return exceeds  $aR_1$ . Hence, the lower level of transactions costs has resulted in a higher equilibrium rate of return on savings.

Once  $j^* = 2$  holds, it must be the case that  $\theta^{2,1} > 0$  also obtains. In particular, agents must sell ownership claims in CIP that is not yet mature. As a consequence,  $\theta^{2,0} < 1$ . Thus, activity in equity markets diverts some saving away from capital formation. Indeed, the steady-state capital stock is now  $k = R_2(1 - \alpha)\theta^{2,0}b$ . If  $R_2(1 - \alpha) > R_1$  holds, the reduction in transactions costs has two competing effects on the capital stock. First, the net-of-transactions-costs productivity of investment has risen [ $R_2(1 - \alpha) > R_1$  holds], which is conducive to increased capital formation. However  $\theta^{2,0} < \theta^{1,0} = 1$  also holds, so that some savings has been transferred from the initiation of new capital investment to the purchase of existing equity. Which effect dominates?

The answer depends on the magnitude of  $\alpha$ . Equation 13 implies that

$$\theta^{2,0} = \{1 + [aR_2(1 - \alpha)]^{0.5}\}^{-1}.$$

Hence,  $R_2(1 - \alpha)\theta^{2,0} \geq R_1$  holds if and only if

$$(21) \quad R_2(1 - \alpha)/\{1 + [aR_2(1 - \alpha)]^{0.5}\} \geq R_1.$$

If equation 21 holds, transactions costs are low enough so that the use of technology 2 actually leads to a higher steady-state capital stock than the exclusive use of technology 1. In this case, reductions in transactions costs (that is, more-efficient capital markets) lead to a higher long-run level of real activity. However, if equation 21 fails—as is perfectly compatible with expression 20 being satisfied—then lower transactions costs divert enough saving away from capital formation into equity so that the long-run capital stock and the level of real activity are actually reduced. Thus to summarize, reductions in transactions costs that raise the equilibrium gestation period of capital investment must increase the real return on saving and the volume of equity market activity. How-

ever, the latter fact implies that long-run real activity may fall as a result of an increase in the efficiency of equity markets.

Once transactions costs are low enough to satisfy expression 20, further reductions in  $\alpha$  that leave expression 20 satisfied have very unambiguous effects. The internal rate of return on investments (net of transactions costs) rises as transactions costs fall. The same is true for the value of equity market activity. It is also straightforward to show that  $R_2(1 - \alpha)\theta^{2,0}$  is increased by such a reduction in transactions costs; as transactions costs fall, the steady-state capital stock and level of real activity necessarily increase.

Even further reductions in  $\alpha$  can cause expression 20 to be violated, and

$$(22) \quad a(R_3)^4/(R_4)^3 > 1 - \alpha > a(R_2)^3/(R_3)^2$$

to hold. Here expressions 17 and 18 imply that  $j^* = 3$ . The effects of such a transition are exactly analogous to those of a transition from  $j^* = 1$  to  $j^* = 2$ . The steady-state rate of return on savings must rise, as a reduction in transactions costs raises the internal rate of return (net of transactions costs) on all investment technologies. The volume of equity market activity also rises, or, in other words,  $\theta^{3,0} < \theta^{2,0}$  necessarily holds.<sup>4</sup> The steady-state capital stock is given by  $k = R_3(1 - \alpha)^2\theta^{3,0}b$ . If  $R_3(1 - \alpha)^2 > R_2(1 - \alpha)$ , then again the implications for the capital stock are ambiguous. The reduction in transactions costs is itself conducive to capital formation, but, as before, savings are diverted away from initiation of new capital investment into the purchase of existing equity. For transactions cost levels that make technology 3 just marginally preferred to technology 2, the latter effect must dominate. The former effect may dominate for yet lower levels of transactions costs.

As long as  $\alpha$  satisfies expression 22, further reductions in  $\alpha$  raise the internal rate of return on investment, increase the level of equity market activity, and raise  $R_3(1 - \alpha)^2\theta^{3,0}$ . Thus, the steady-state capital stock rises with reductions in the costs of financial transactions.

As  $\alpha$  is reduced further, the equilibrium maturity of capital investments can continue to rise, and all of the factors we have noted previously will come into play. However, if  $1 > a(R_{j-1})^j/(R_j)^{j-1}$  holds, low enough transactions costs imply that  $j^* = j$ . Here further reductions in transactions costs cannot raise the gestation period of investments, and therefore necessarily increase the capital stock. Although the increase in equity market activity means that less savings is being placed in new capital investment, this effect never dominates the increased efficiency of capital markets as long as  $j^*$  is unaltered.

When reductions in transactions costs increase  $j^*$ , however, they result in discrete increases in the volume of equity market activity.<sup>5</sup> Thus, even though the net-of-transactions-cost productivity of all capital investment technologies

4. See Bencivenga, Smith, and Starr (1996) for a formal proof of this assertion.

5. Under the assumptions made here,  $j^*$  is nonincreasing in  $\alpha$ . This result does not depend on any of the current simplifying assumptions. See Bencivenga, Smith, and Starr (1996) for a more general treatment.



risers, enough savings can be diverted away from new capital investment so that lower transactions costs are actually—over some range—detrimental to capital formation.

Admittedly, this result has been obtained by imposing a variety of assumptions, for example the condition on the parameters  $(R_1, R_2, \dots, R_j)$  stated in expression 18. However, the same conclusions survive when many of our assumptions are generalized. For example, if expression 18 is relaxed for some capital production technologies, it will still be true that the equilibrium maturity length of capital investments is nonincreasing with transactions costs, and that reductions in transactions costs necessarily raise the rate of return on savings and increase the volume of equity market activity. The primary consequence of relaxing expression 18 is merely that, when expression 18 fails, some capital investment technologies could never be used in a steady-state equilibrium. Indeed, if expression 18 fails to hold for all capital production technologies, then either  $j^* = 1$  or  $j^* = J$  must hold. The former will obtain for high enough transactions costs and the latter will obtain for low enough transactions costs.

#### *Steady-State Welfare*

All young agents save their young-period wage, which, under our assumptions, is independent of the capital stock. These agents then consume their interest income, so that steady-state welfare is proportional to the rate of return on savings. Transactions cost reductions always increase the internal rate of return on savings, net of transactions costs, and hence always raise this rate of return. Thus, transactions cost reductions necessarily increase steady-state welfare.<sup>6</sup>

### V. TRANSACTIONS COSTS AS PURE RENTS

In this section we analyze the same set of issues we did earlier under the assumption that transactions costs represent pure fees paid to a broker, a market maker, or the government. Thus, although the fees associated with transactions represent costs to equity market participants, these fees no longer represent a social resource loss. For simplicity, we assume that the fees collected are simply rebated to old agents as a lump sum; we can think of this as corresponding to a situation where all old agents are given equal shares in a brokerage firm or where the government rebates the revenue it collects as a lump sum.

The assumption that resources collected in the form of fees or taxes are rebated to old agents prevents a transfer of the proceeds from those who bear these costs—by assumption, sellers (or old agents)—to those who do not—by assumption, buyers (or young agents). A transfer of resources from old to young agents would, under our assumptions, raise the aggregate savings rate and, in and of itself, constitute a stimulus to capital formation. Instead, we wish to isolate the effects of transactions costs alone. Therefore we rebate the proceeds

6. This assertion would not hold so generally if the wage rate depended on the capital stock. See Bencivenga, Smith, and Starr (1996).

of fee or tax collections to those who pay the fees or taxes. Given our preference assumptions, the result is that savings patterns are unaltered by the existence of fees or taxes.

If the transactions fees we analyze are interpreted as payments received by a broker or market-maker, we assume that none of the labor of these agents is diverted away from goods production when young. This reinforces the notion that there are (in this section) no social resource costs associated with the transactions process. If the fees paid are received by the government, then it is permissible to think of them as negative, a situation corresponding to that in which the government subsidizes activity in capital markets. Many developing country governments do act to subsidize the formation of equity markets (Fry 1988); we analyze the consequences of this activity in this section.

As we did in the previous section, we assume that there is a constant fee  $\alpha \leq 1$  levied on transactions. (We no longer impose  $\alpha \geq 0$ .) We also assume—in consonance with our earlier formulation—that there are no fees associated with the initiation of new capital investments, or with transactions in factor markets. Thus,  $\alpha^{j,0} = \alpha^{j,j} = 0$ , for all  $j$ .

#### *Steady-State Equilibrium Conditions*

The fact that transactions costs may not represent a social resource loss does not affect most of the steady-state equilibrium conditions. Indeed, these remain as above, with two exceptions. First, since transactions costs no longer consume capital, equation 14 must be replaced by

$$(23) \quad k = R_j \cdot \theta^{j,0} b.$$

Second, transactions costs no longer erode the supply of CIP. Thus, equation 10 is supplanted by the condition

$$(24) \quad \theta^{j^*,h} P^{j^*,h} = \theta^{j^*,0}; \quad h = 0, \dots, j^* - 1.$$

Note that equations 11 and 24 imply that

$$(25) \quad \theta^{j^*,h} = \theta^{j^*,0} [\gamma/(1 - \alpha)]^h; \quad h = 0, 1, \dots, j^* - 1.$$

Equation 25 is equation 12, corrected for the fact that transactions costs now represent a transfer between agents, rather than a social resource loss. Equations 9 and 25 now determine  $\theta^{j^*,0}$ , and equation 23 gives the steady-state equilibrium capital stock.

As before, technology  $j$  bears a higher internal rate of return than technology  $j - 1$  if and only if equation 17 is satisfied. Thus, the level of transactions costs determines the equilibrium choice of investment technology, as well as the internal rate of return on savings. From equations 9 and 25, the internal rate of return on savings determines the fraction of savings going into the initiation of

new capital investment ( $\theta^{j^*,0}$ ), which in turn determines the steady-state capital stock ( $k$ ). Note that when transactions costs do not represent social resource costs, they affect the steady-state capital stock and output level only through their effects on the equilibrium maturity of capital investment ( $j^*$ ) and the portfolio weight ( $\theta^{j^*,0}$ ) attached to new capital investment.

We now wish to investigate how the steady-state capital stock, as well as other equilibrium quantities, vary with the transactions cost parameter  $\alpha$ . To simplify the exposition, we focus on the case  $J = 2$ . When there are only two technologies for producing capital, equation 17 implies that  $j^* = 2$  holds if and only if

$$(26) \quad 1 - \alpha \geq a(R_1)^2/R_2.$$

Equation 26 describes how the equilibrium choice of capital production technology varies with  $\alpha$ .

When equation 26 fails,  $j^* = 1$  holds, as does  $\theta^{1,0} = 1$ . Equation 23 implies that  $k = bR_1$ . When equation 26 holds,  $j^* = 2$ , and equations 9 and 25 imply that

$$(27) \quad \theta^{2,0} = \{1 + [aR_2/(1 - \alpha)]^{0.5}\}^{-1}.$$

In this case, equations 23 and 27 determine  $k$ .

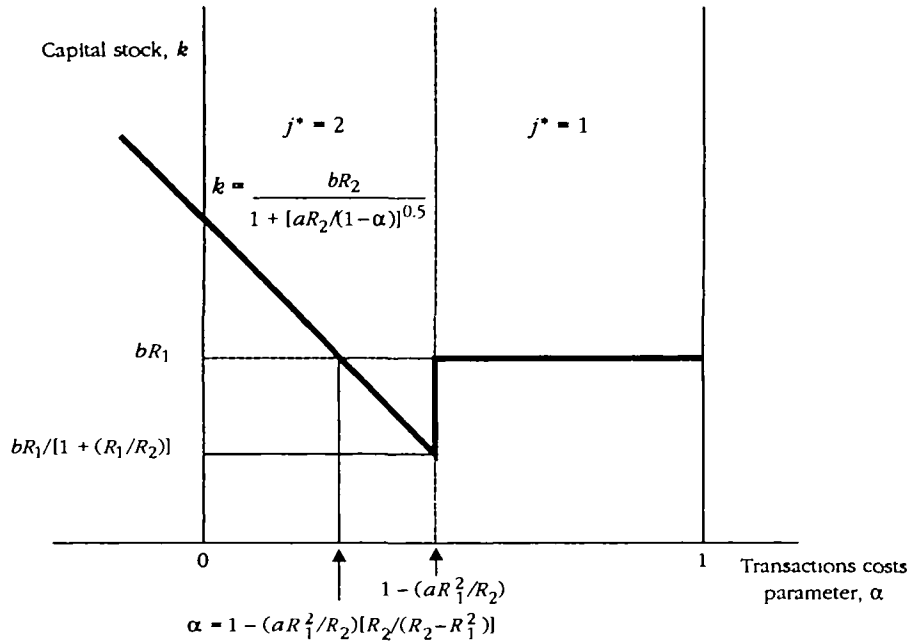
Evidently, for all values of  $\alpha$  violating equation 26, the steady-state capital stock is independent of the level of transactions costs, there is no equity market activity, and the rate of return on savings is simply  $aR_1$ . When  $\alpha$  satisfies equation 26, by contrast,  $j^* = 2$  holds. Now we can see that  $\theta^{2,0} < 1$ , so that equity markets are active, and that  $\theta^{2,0}$  is decreasing in  $\alpha$ . Thus, when transactions costs are pure fees, a reduction in transactions costs raises the fraction of savings invested in the initiation of new capital investments. As is apparent from equation 23, reductions in transactions costs—once equation 26 is satisfied—necessarily raise the steady-state capital stock.

However, as  $(1 - \alpha)$  transits from being just below  $a(R_1)^2/R_2$  to being just above it, the economy moves from a situation with  $\theta^{1,0} = 1$  to a situation with  $\theta^{2,0} < 1$ . Hence, transitions in the equilibrium choice of investment technology will be associated with diversions of savings away from investment and, as before, it is possible to show that if technology 2 is only slightly preferred to technology 1, the steady-state capital stock will be smaller than it could be if technology 1 were in use. Figure 1 depicts the steady-state relationship between  $k$  and  $\alpha$ . The steady-state equilibrium capital stock with  $j^* = 2$  is no less than that with  $j^* = 1$  if and only if

$$(28) \quad \alpha \leq 1 - (aR_1^2/R_2) [R_2/(R_2 - R_1)]^2 < 1 - (aR_1^2/R_2).$$

Expression 28 describes how low  $\alpha$  must be in order for the use of technology 2 not to be associated with a reduction in the steady-state equilibrium capital stock.

Figure 1. *The Steady-State Relationship between the Capital Stock and the Transactions Costs Parameter*



Note. At low transactions costs, long-gestation investment technologies are used. The lower the transactions costs (for  $j^* = 2$ ), the higher the capital stock. However, for transactions costs just below those that make technology 1 preferred to technology 2, the capital stock is lower than it would be with  $j^* = 1$ . When  $\alpha > 1 - (aR_1^2/R_2)$ ,  $j^* = 1$ . When  $\alpha < 1 - (aR_1^2/R_2)$ ,  $j^* = 2$ . Here  $k$  is decreasing in  $\alpha$ .

### Steady-State Welfare

We want to know how the choice of  $\alpha$ , which might reflect a conscious policy decision, affects the level of steady-state welfare. The analysis of this issue requires the consideration of two factors. First, since the real wage rate is just  $b$ , and since all young-period income is saved, one component of old-period consumption is simply  $\gamma b$ . Moreover, since  $\gamma = \max \{aR_1, [aR_2(1 - \alpha)]^{0.5}\}$ , the choice of a transactions fee can affect  $\gamma$ . Second, the choice of  $\alpha$  can affect the lump-sum transfer received by old agents. Recall that the real value of financial transactions per capita is given by  $b(1 - \theta^{*,0})$ . In addition, all agents pay a fee of  $\alpha$  per transaction, with transactions measured in real terms. Thus, the transfer received by an old agent in real terms is given by  $\alpha b(1 - \theta^{*,0})$ , and steady-state welfare is then

$$U = b \max \{aR_1, [aR_2(1 - \alpha)]^{0.5}\} + \alpha b(1 - \theta^{*,0}).$$

If  $j^* = 1$ , that is, if  $\alpha > 1 - (aR_1^2/R_2)$ , then no financial transactions occur,  $\theta^{*,0} = \theta^{1,0} = 1$ , and steady-state utility is just  $U_1 = baR_1$ . Alternatively, if  $j^* = 2$ , some

financial transactions occur (as described by equation 27), and transactions fees are paid. The net result is that steady-state welfare is described by the expression

$$(29) \quad U_2(\alpha) \equiv b[aR_2(1 - \alpha)]^{0.5} + \alpha b(1 - 1/[1 + [aR_2/(1 - \alpha)]^{0.5}]) \\ = b(aR_2)^{0.5} \{1 + [aR_2(1 - \alpha)]^{0.5}\} / \{(1 - \alpha)^{0.5} + (aR_2)^{0.5}\}.$$

It is straightforward but tedious to show that steady-state welfare is increasing in the cost of transacting—that is,  $U_2'(\alpha) \geq 0$  holds—if and only if the internal rate of return on technology 2 is lower than the steady-state rate of growth (that is,  $aR_2 \leq 1$  holds). When the latter condition is satisfied, higher transactions fees actually lead to higher steady-state welfare levels, so long as any secondary market transactions are undertaken. (Such transactions will be undertaken if and only if  $1 - \alpha > aR_1^2/R_2$ .) Such a result should be intuitive, since higher transactions costs in this case discourage low-return investments. In particular, then, if  $j^* = 2$  and  $aR_2 < 1$  hold, there is a socially excessive volume of equity market activity. It is therefore desirable to reduce the amount of this activity, as argued by Keynes and Tobin. However, there remains the issue of whether it is desirable to drive the level of financial transactions to zero, which requires setting  $\alpha > 1 - (aR_1^2/R_2)$ . At levels of  $\alpha$  this high,  $j^* = 1$ , and there are no financial market transactions.

We now describe when it is and is not desirable to eliminate secondary capital markets in the case  $aR_2 < 1$ . We then show what happens when the internal rate of return on technology 2 exceeds the steady-state growth rate, which obtains when  $aR_2 > 1$ .

CASE 1:  $aR_2 < 1$ . In this case,  $U_2(\alpha)$  is maximized by setting  $\alpha = 1 - (aR_1^2/R_2)$ ; this is the largest value of  $\alpha$  consistent with  $j^* = 2$ . Evaluating equation 29 at this value of  $\alpha$  yields

$$(30) \quad U_2[1 - (aR_1^2/R_2)] = b(1 + aR_1)/[1 + (R_1/R_2)].$$

Then  $U_2[1 - (aR_1^2/R_2)] \geq U_1 = baR_1$  holds if and only if

$$(31) \quad 1 \geq aR_1^2/R_2,$$

or, that is, if and only if the value of  $\alpha$  that maximizes steady-state welfare with  $j^* = 2$  is positive. Thus, if  $aR_2 < 1$  and equation 31 holds, steady-state welfare is maximized by setting  $\alpha = 1 - (aR_1^2/R_2) \geq 0$ , or, in other words, by setting fees as high as possible without eliminating secondary capital markets. In particular, when  $aR_2 < 1$  and equation 31 holds, there is a socially excessive volume of transactions because capital is overaccumulated, in the standard Diamond (1965) sense. It is then attractive from a policy perspective to reduce capital formation, which can be done by increasing transactions fees (see figure 1). However, tech-

nology 2 still has a higher internal rate of return than technology 1, and hence it should be used. Secondary capital markets are therefore required.

When  $aR_2 < 1$  and equation 31 fails, the use of technology 2 is socially inefficient in and of itself. Agents can be induced to use the more efficient technology by taxing equity market activity at a high enough rate and, indeed, one which eliminates this activity altogether.

When  $aR_2 < 1$  holds, and if technology 2 is in use when  $\alpha = 0$ , our analysis indicates that there will be a socially excessive amount of financial market activity. Under these conditions, the arguments made by Keynes and Tobin for taxing this activity would have merit.

We might note that the context in which this situation arises is somewhat unconventional. The internal rate of return to physical investment is negative, but investment is still attractive because it represents the principal private means of saving. An implication of this observation is that there is, socially speaking, oversaving, which can be partially corrected by taxing financial transactions.

CASE 2:  $aR_2 > 1$ . When  $aR_2 > 1$  holds,  $U_2(\alpha)$  is decreasing in  $\alpha$ , and is therefore maximized by setting  $\alpha$  arbitrarily small. From equation 29,

$$\lim_{\alpha \rightarrow 0} U_2(\alpha) = baR_2.$$

If  $R_2 > R_1$ , then steady-state welfare maximization dictates setting  $j^* = 2$ , and maximally subsidizing equity market activity. In particular, technology 2 is more productive than technology 1, and incentives should be created to use it as intensively as possible. If, instead,  $R_1 > R_2$  holds, it is technology 1 that is socially most productive. In this event, transactions fees should be set high enough to discourage secondary market activity, along with the use of technology 2. That outcome can be attained, as in case 1, by setting  $\alpha > 1 - (aR_1^2/R_2)$ . Note that the case for taxing secondary market activity need not rely on either technology's having a particularly low internal rate of return.

SUMMARY. As the examples just given indicate, it can be desirable to either subsidize or heavily tax agents transacting in equity markets. It will be optimal to confront agents undertaking such transactions with relatively heavy fees when  $aR_2 < 1$  or, in other words, when the internal rate of return on technology 2 (at a zero transactions cost level) is lower than the real growth rate of the economy. It will also be optimal to impose high fees in these markets when  $aR_2 > 1$  and  $R_1 > R_2$  both hold. Thus, even if the internal rate of return on technology 2 exceeds the rate of growth (with no transactions costs), it is undesirable to use technology 2 if it is less productive than technology 1. By contrast, when  $aR_2 > 1$  (the internal rate of return on technology 2 exceeds the growth rate) and  $R_2 > R_1$  (technology 2 is more productive than technology 1), there is good reason to subsidize equity market activity.

These observations suggest a criterion for determining when it is desirable to tax (or raise the costs faced by) equity market participants. A socially excessive volume of financial market transactions is undertaken in economies with relatively high levels of equity market activity ( $j^* = 2$ , so that  $\theta^{2,0} < 1$ ), and with real interest rates (gross of transactions costs) lower than the long-run real rate of growth of the economy ( $aR_2 < 1$ ).

## VI. SOME FINAL THOUGHTS

How does the efficiency of an economy's capital resale or equity markets—as measured by the costs of transacting in them—affect the economy's efficiency in producing physical capital and, through this channel, final goods and services? In order to propose an answer to this question, we have followed Hicks (1969) in emphasizing the role of equity markets in providing liquidity to holders of long-lived and inherently illiquid capital. As the efficiency of an economy's capital markets increases (that is, as transactions costs fall), the general effect is to cause agents to make longer-term, and hence more transactions-intensive, investments. The result is a higher rate of return on savings, as well as a change in its composition. These general equilibrium effects on the composition of savings cause agents to hold more of their wealth in the form of existing equity claims and to invest less in the initiation of new capital investments. As a result, a reduction in the resource losses suffered in the transactions process can cause the capital stock either to rise or to fall, and we have described conditions under which each situation will obtain. However, a general point that bears emphasis is that a reduction in transactions costs will typically alter the composition of savings and investment, and that any analysis of the consequences of such changes must take these effects into account.

It has also often been proposed that a significant fraction of financial market transactions are socially unproductive, and that transactions taxes should be imposed to reduce the level of financial market activity. We have put forward a criterion for verifying when such taxes might be imposed, and we have indicated that to tax financial market transactions when long-gestation investments are relatively productive and when real interest rates are relatively high is not desirable.

One topic that we have not addressed is the role for financial intermediation in the kind of environment we have considered. If intermediation does not allow transactions to be undertaken at a lower cost, then clearly it has no role here. However, if intermediaries can issue liabilities that are traded more cheaply than their underlying assets, then clearly there can be a role for banks. These banks would hold relatively illiquid, long-maturity assets, and would issue relatively liquid, short-maturity liabilities. This is obviously a natural function of banks. The integration of financial intermediaries into the analysis is an important topic for future investigation.

## REFERENCES

The word "processed" describes informally reproduced works that may not be commonly available through library systems.

- Antje, Raymond, and Boyan Jovanovic. 1992. "Stock Markets and Development." Draft. New York University, Department of Economics, New York. Processed.
- Azariadis, Costas. 1992. *Intertemporal Macroeconomics*. London: Basil Blackwell.
- Bencivenga, Valerie R., and Bruce D. Smith. 1991. "Financial Intermediation and Endogenous Growth." *Review of Economic Studies* 58(2, April):195-209.
- Bencivenga, Valerie R., Bruce D. Smith, and Ross M. Starr. 1994. "Liquidity of Secondary Capital Markets, Capital Accumulation, and the Term Structure of Asset Yields." Draft. Cornell University, Department of Economics, Ithaca, N.Y. Processed.
- . 1995. "Transactions Costs, Technological Choice and Endogenous Growth." *Journal of Economic Theory* 67(1, October):153-77.
- . 1996. "Liquidity of Secondary Capital Markets: Allocative Efficiency and the Maturity Composition of the Capital Stock." *Economic Theory* 7(1):19-50.
- Bohm-Bawerk, E. von. 1891. *Positive Theory of Capital*. Translated by W. Smart. London: Macmillan.
- Boyd, John H., and Edward C. Prescott. 1986. "Financial Intermediary Coalitions." *Journal of Economic Theory* 38(2):211-32.
- Cameron, Rondo. 1967. *Banking in the Early Stages of Industrialization*. New York: Oxford University Press.
- Cooley, Thomas F., and Bruce D. Smith. 1992. "Financial Markets, Specialization, and Learning by Doing." Draft. University of Rochester, Graduate School of Business, Rochester, N.Y. Processed.
- Diamond, Douglas W. 1984. "Financial Intermediation and Delegated Monitoring." *Review of Economic Studies* 51(3, July):393-414.
- Diamond, Peter. 1965. "National Debt in a Neoclassical Growth Model." *American Economic Review* 55(5):1126-50.
- Diaz-Alejandro, Carlos. 1985. "Good-Bye Financial Repression, Hello Financial Crash." *Journal of Development Economics* 19:1-24.
- Dickson, P. G. M. 1967. *The Financial Revolution in England*. London: Macmillan.
- Fry, Maxwell. 1988. *Money, Interest, and Banking in Economic Development*. Baltimore: Johns Hopkins University Press.
- Galbis, Vicente. 1979. "Inflation and Interest Rate Policies in Latin America, 1967-76." *IMF Staff Papers* 26:334-66.
- Goldsmith, Raymond W. 1969. *Financial Structure and Development*. New Haven, Conn.: Yale University Press.
- Greenwood, Jeremy, and Boyan Jovanovic. 1990. "Financial Development, Growth, and the Distribution of Income." *Journal of Political Economy* 98(5, October):1076-1107.
- Hicks, John. 1969. *A Theory of Economic History*. Oxford, U.K.: Clarendon Press.
- Keynes, John Maynard. 1964. *The General Theory of Employment, Interest, and Money*. New York: Harcourt, Brace and World.



- Khatkhate, Deena R. 1988. "Assessing the Impact of Interest Rates in Less Developed Countries." *World Development* 16:577-88.
- King, Robert G., and Ross Levine. 1993a. "Finance, Entrepreneurship, and Growth: Theory and Evidence." *Journal of Monetary Economics* 32(3, December):513-42.
- . 1993b. "Finance and Growth: Schumpeter Might Be Right." *Quarterly Journal of Economics* 108(3, August):717-38.
- Levine, Ross. 1991. "Stock Markets, Growth, and Tax Policy." *Journal of Finance* 46(4):1445-65.
- McKinnon, Ronald I. 1973. *Money and Capital in Economic Development*. Washington, D.C.: Brookings Institution.
- Shaw, Edward S. 1973. *Financial Deepening in Economic Development*. Oxford, U.K.: Oxford University Press.
- Tobin, James. 1994. "A Tax on International Currency Transactions." In United Nations, *Human Development Report, 1994*. New York: United Nations.
- van Wijnbergen, Sweder. 1985. "Macroeconomic Effects of Changes in Bank Interest Rates: Simulation Results for South Korea." *Journal of Development Economics* 18:541-54.
- Williamson, Stephen D. 1986. "Costly Monitoring, Financial Intermediation, and Equilibrium Credit Rationing." *Journal of Monetary Economics* 18(2):159-79.