

Financial Intermediation and Occupational Choice in Development¹

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This paper presents evidence that the spread between the marginal product of capital and the return on financial assets is much higher in poor than in rich countries. A model with costly intermediation is developed. In this economy, individuals choose at each instant whether to work or to operate a technology. Entrepreneurs finance their business with their own savings and, if necessary, by borrowing from banks. I find that in this framework intermediation costs are not equivalent to a tax on the return of capital. The equivalence fails because costly intermediation affects not only the capital accumulation decision but also the occupational choice decision. I show that intermediation costs have important effects on per capita output and average business size in the economy. I conclude that taxing financial intermediaries can be a very bad policy for development. *Journal of Economic Literature* Classification Numbers: E20, E60, O11, O16.

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1. INTRODUCTION

Many economists have argued extensively that government interventions in the domestic financial markets of developing countries, coupled with restrictions on international capital flows, lead to artificially low interest rates, discouraging saving, with detrimental effects on economic development (see McKinnon (1973) and Shaw (1973)). In this paper, I present evidence that the spread between the marginal product of capital and the

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return on financial assets is much higher in poor than in rich countries. In fact, the average cost of intermediating one unit of value is shown to be about four times higher in poor countries.² Using a quantitative general equilibrium model, I show that high intermediation costs can lead to very important inefficiencies in the allocation of productive resources in the economy.

Evidence suggests that differences in the effective rate of taxation of the financial system might account for the wide disparity in intermediation costs across countries. The World Bank reports that in many countries governments collect special taxes from financial institutions and that these taxes raise intermediation costs. For instance, in 1984, the taxes collected in the Philippines added more than 12 percentage points to the cost of intermediation (see the 1989 World Development Report, p. 64). Chamley and Honohan (1990) show that total financial intermediary taxation in some African countries amounted to 7% of GDP during the 1980s. They claim that few, if any, sectors in developing countries are taxed as heavily as the financial sector.

Given these observations, I compare two alternative tax regimes: taxes on financial intermediation versus taxes on capital income. Both taxes introduce a wedge between the marginal productivity of capital and the return on financial assets. It is a distinctive feature of the framework in this paper, however, that these taxes are not equivalent. The equivalence fails because taxes on intermediation affect not only the capital accumulation decision but also the occupational choice decision. To be more specific, individuals can avoid intermediation taxes by using their savings to operate their own businesses rather than buying financial assets and working for someone else.

I develop a framework in which costly intermediation has important consequences for individuals' occupational choice decisions and for the economy's average business size. Poor countries in my model are characterized by a large number of small businesses, in terms of number of workers and amount of capital used in production. The intuition for this result is simple: the return on financial assets is low in countries with high intermediation costs. Then a large fraction of the labor force chooses to become entrepreneurs and, in this way, avoid the low return on deposits by investing their savings in the operation of their own businesses. This, in turn, implies that businesses in poor countries have few workers and little capital. It also implies that self-financing is more important in economies with high intermediation costs. These findings are consistent with observa-

² Indeed, the average cost of intermediating one unit of value for one year is 0.15 in poor countries (countries with less than 2,000 1985 U.S.\$ of per capita income), while it is only 0.04 in rich countries (countries with more than 10,000 U.S.\$ of per capita income).

tions by Kuznets (1966) and Lucas (1978), who argue that the average business size tends to increase with development.

I show that costly intermediation has nontrivial effects on saving decisions. On the one hand, it discourages saving since it reduces the return on financial assets. On the other hand, costly intermediation, coupled with occupational choice decisions, implies that there are increasing returns to asset accumulation. In other words, those with sufficiently high assets to profitably operate a business receive higher returns on their savings than the interest rate paid on deposits. This, of course, encourages saving. In the quantitative experiments I found that aggregate saving rates are negatively associated with intermediation costs.

Banerjee and Newman (1993) also develop a model in which capital market imperfections have an important effect on occupational choice decisions. Their aim is to study the interplay between the distribution of wealth and occupational choice. They find that the initial distribution of wealth determines whether the economy converges to a steady state with widespread self-employment or factory production (employment contracts). This result depends on the crucial assumption that investment projects are indivisible. In my paper, I assume that investment projects are divisible so that I can study how the scale of operation of businesses affects production efficiency in the economy. While in Banerjee and Newman capital market imperfections do not affect saving decisions, I investigate how the presence of increasing returns to wealth accumulation affects saving behavior. A drawback to the complex structure of my model is that it only allows me to focus on steady-state analysis.

Acemoglu and Zilibotti (1999) provide an explanation for the association between business size and economic development that differs from the one in my paper. In their theory, information is accumulated as an economy develops. The lack of information in less developed economies makes it hard to evaluate the performance of managers. Small family businesses are a way to economize on information and for this reason are likely to prevail in poor countries. While their explanation relies on agency costs in delegating tasks, mine relies on the differential returns between financial assets and capital. I view the two arguments as complementary.

The organization of financial markets and the enforcement of contracts are resource-costly activities, as emphasized by Townsend (1978, 1983). Based on this observation, Greenwood and Jovanovic (1990) develop a framework in which individuals pay a once-and-for-all lump-sum fee to join a financial coalition. In their model, individuals face increasing returns to wealth accumulation, and, as in my paper, costly intermediation has nontrivial effects on saving behavior. Following the work of Diamond (1984), a number of researchers have built models in which intermediaries economize resources in verifying projects' returns. Azariadis (1999) shows

that, in a model of agency costs, the spread between borrowing and lending rates decreases with economic development if there are external economies in financial intermediation. Sussman (1993) studies a model in which the number and specialization of intermediaries increase with development, leading to a reduction in banks' profit margins and operating costs. My paper adds to this literature by measuring intermediation costs for a cross section of countries and by showing how costly intermediation, in the presence of occupational choice decisions, has interesting effects on the scale of operation of businesses and saving behavior. It also contributes by integrating the study of financial markets distortions into the public finance literature, as proposed by Giovannini and De Melo (1993) and Chamley and Honohan (1990).

The remainder of this paper is organized as follows. Section 2 explains how intermediation costs are measured for a cross section of countries; Section 3 describes the model economy and characterizes steady-state equilibrium; Section 4 presents some numerical experiments assessing the quantitative effects of intermediation costs; Section 5 compares taxes on financial intermediation with taxes on capital income; Section 6 concludes the paper. Proofs are included in an appendix.

2. MEASURING INTERMEDIATION COSTS

Following the pioneering work of Goldsmith (1969), researchers have collected ample empirical evidence illustrating the strong association between financial and economic development.³ In this section of the paper I contribute to this literature by proposing an indicator of the efficiency of financial intermediation and by applying this indicator to a cross section of countries.

Financial intermediation is viewed as a technology in which the output is the amount of assets intermediated. Intermediation is defined as being more efficient when fewer resources (inputs) are used up per unit of value intermediated. I measure the resources (inputs) used in intermediation as the total product of financial intermediaries, which is the value of the intermediate goods and services consumed plus the value added by financial institutions. I define the total amount intermediated as the value of financial assets held by financial institutions. Then, the annual cost of intermediating one unit of value is the ratio of the intermediaries' annual

³ In a study that covers 35 countries over the period 1888–1963, Goldsmith (1969) reports that the ratio of financial institutions' assets to GNP rises with development. King and Levine (1993) find that different indicators of economic development are strongly correlated with economic growth.

product to their holdings of financial assets. This is, essentially, the spread between lending and borrowing rates. The main finding reported in this paper is that the average cost of intermediating one unit of value is much larger in poor than in rich countries.

The empirical study in this paper focuses on a particular class of financial intermediaries that are denoted as banking institutions. These institutions comprise depository institutions such as commercial banks, savings banks, credit unions, and savings and loan associations. They also include building societies, mortgage institutions, and development banks. Due to data limitations, corporations are not included in this study. This study captures the most important form of external financing of businesses in less developed economies, given that publicly traded corporations are important only in some of the very rich countries.⁴ Furthermore, in many countries both loans and stocks are used to finance businesses, suggesting that, on the margin, these forms of financing have similar costs.

The International Monetary Fund publishes cross-country data about the consolidated banking institutions balance sheets (see International Financial Statistics or IFS for short). I use this information to compute, for a cross section of countries, the quantity of banking intermediation. This is defined as the amount of financial assets held by banking institutions in a given country at a point in time. Note that typically the ratio between banking institutions' financial assets and liabilities is close to 1. Therefore, the measure of the quantity of banking intermediation would not change by much if liabilities rather than financial assets were considered.

The United Nations provides data on banking institutions' total product (see the national accounts statistics published by the United Nations). I use this information when measuring the amount of resources used in intermediation. The measurement of financial intermediaries' total product is a topic that has been widely discussed by national income accountants. The procedure followed by the United Nations in its system of national accounts is to compute financial intermediaries' total product as the sum of its operating expenses. These expenses are calculated as the sum of the cost of intermediate goods purchased, wages paid, depreciation incurred, provisions for bad debt, and profits received by these institutions, where profits are such that expenses equal receipts. Receipts are defined as the sum of fees charged and net interest received by banking institutions, net interest being the difference between interest received and

⁴ Using cross-country regressions, Atje and Jovanovic (1993) and Levine and Zervos (1996) found that stock market development is strongly associated and is a good predictor of economic growth. Stock markets are not included in the current study because of the lack of cross-country data on the resources spent in financing activities through stock markets.

interest paid by banks. Therefore, the banking industry product is equal to the amount of fees charged plus net interest received.

From the previous discussion it follows that the ratio of total product to quantity of banking intermediation measures the effective net interest and fees charged per unit of asset intermediated by banking institutions. Since data on the total product of the banking industry are available for a limited number of countries, I will also use data on net interest received by the banking industry. Note that net interest constitutes a lower bound to the amount of resources used up in intermediation. Therefore, the ratio of net interest to quantity of intermediation is a lower bound to the cost of intermediating one unit of value. The reason that this ratio is a lower bound is that it does not include the fees charged by banking institutions, which are part of the cost of intermediation.

The study covers a cross section of countries for the year 1985. A country is included in the study if it satisfies three conditions: (1) the balance sheet of the country's banking institutions is published by the International Monetary Fund; (2) net interest received by the country's banking sector or total product of financial institutions (excluding insurance companies and pension funds) is published by the United Nations; (3) the country's population exceeded 4 million people in 1985. Table I presents data for the 49 countries included in the study. Net interest data are available for 47 countries, while total product is restricted to 19 countries. The data on per capita income are measured in 1985 U.S. purchasing power parity dollars and are taken from the Summers and Hestons Data Set.

TABLE I
Intermediation Costs across Countries in 1985

Country	GDP	Net interest/ quantity	Total product/ quantity	Entrepreneurs/ labor force
United States	16,779	2.8		1.9
Canada	15,013	0.9	2.5	1.6
Norway	13,495	3.2	4.7	6.1
Australia	12,550	3.6		10.9
Sweden	12,382	3.3	4.2	3.7
Denmark	11,980	3.3	4.3	5.3
Germany	11,646	3.4	4.4	4.7
France	11,376	3.4		5.4
Finland	11,225	3.2	5.2	4.8
Netherlands	10,937	3.0	3.7	3.1
Japan	10,781	2.4		14.3
U. Kingdom	10,679	2.5		4.6

TABLE I—Continued

Country	GDP	Net interest/ quantity	Total product/ quantity	Entrepreneurs/ labor force
Italy	10,584	4.8		14.2
Belgium	10,458	2.3		5.9
Austria	10,291	3.3	3.7	5.2
Saudi Arabia	9541	1.4		
Israel	9293	2.9		16.8
Spain	6433	5.2	7.0	11.9
Venezuela	5660	3.5	5.3	30.0
Mexico	5332	2.7		36.9
Malaysia	4751	2.6		15.3
Portugal	4535	4.7	5.6	10.4
South Africa	4407	4.5		
Brazil	3995	33.1		12.7
South Korea	3858	3.4		16.9
Chile	3763	7.1		21.9
Iran	3558	1.0		46.6
Colombia	3300	5.6		23.2
Turkey	3204	4.6		26.3
Ecuador	2775	7.9		42.9
Peru	2730	11.5	16.6	32.9
Morocco	2013	6.2		10.9
Cameroon	1792	2.1	19.2	70.2
Bolivia	1566	13.7		47.6
Cote d'Ivoire	1447	8.5		
Zimbabwe	1434	7.5		
Benin	1103	4.4	6.7	
Nigeria	1066		13.0	81.8
Sudan	946	3.8	8.3	51.5
Ghana	852	17.3	30.9	84.2
Kenya	845	6.7		
Somalia	843	7.3		
Zambia	762	3.0		23.6
Rwanda	731		19.1	64.1
Niger	625	3.6		
Burkina Faso	510	7.0	7.8	
Malawi	499	6.9		36.8
Mali	486	3.6		77.2
Tanzania	480	5.6		39.0

Sources: *International Financial Statistics* CD-Rom (July 1994), *Summers and Hestons Data Set*, *National Accounts Statistics* (United Nations), *Yearbook of Labour Statistics* (International Labor Organization, 1988).

First Column: GDP per capita in purchasing power parity dollars.

Second Column: net interest/quantity of intermediation.

Third Column: total product/quantity of intermediation.

Fourth Column: share of entrepreneurs in the manufacturing labor force.

rich countries). It is interesting to note that the difference between the intermediation costs computed using data on total product and the lower bound computed using data on net interest is much larger for poor countries than for rich countries. This suggests that intermediation fees are more important in poor countries than in rich countries. The data in Table I confirm this view. It is possible to compute intermediation fees for those countries where both data on total product and net interest are available. These calculations suggest that fees per unit of value intermediated are about 0.08 in poor countries, while they are only 0.01 in rich countries.

Discussion

Admittedly, intermediation costs constitute a very narrow indicator of the efficiency of financial intermediation. Financial intermediaries perform a vast array of functions, such as mobilizing savings, diversifying risk, monitoring managers, acquiring information, and many others (see Levine (1997) for a discussion of the basic functions performed by financial systems). Intermediation costs do not provide information about how well the financial system allocates funds, provides liquidity services, and diversifies risk. Nevertheless, the findings reported in this paper do indicate that the costs of mobilizing resources are much higher in poor than in rich countries.

Sussman (1993) also documents that spreads are negatively associated with per capita income. His approach to measuring intermediation spreads differs from mine in that he uses interest rate data from the IFS (International Financial Statistics) rather than data on the total product of the banking industry. One problem with his approach is that the IFS data on interest rates are not comparable across countries. Furthermore, to measure the spread accurately, his approach would require information on the amount of each type of loan and deposit, the associated interest rates, and information on bad debt. Unfortunately, this information is not available. By using national income account data, I can circumvent the problem and measure the average effective spread without the need for detailed data on interest rates, deposits, loans, and bad debt.

In the next section of the paper I develop a model in which intermediation costs have important consequences for occupational choice decisions. Before formally describing the model, I present some empirical evidence showing that intermediation costs and occupational choice are associated in the data. To this end, I use data from the International Labor Organization to measure the share of entrepreneurs in the labor force for a cross section of countries. Entrepreneurs are defined as own account workers, unpaid family members, and self-employed individuals. That is, I count

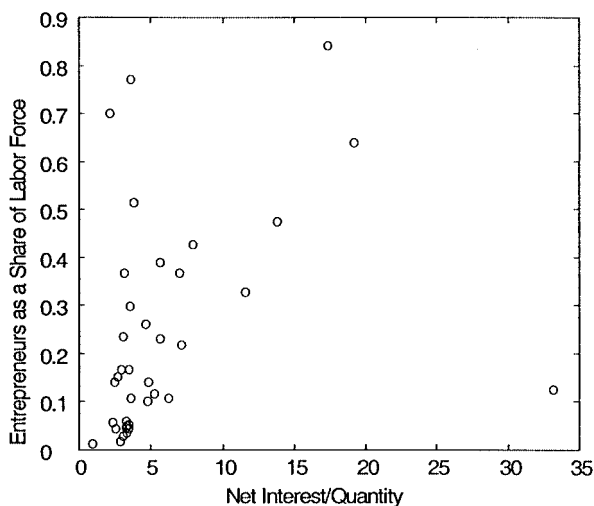


FIG. 3. Fraction of entrepreneurs in the manufacturing labor force and net interest/quantity.

nonwage employees as entrepreneurs. I only use data from the manufacturing industry to control for differences in sectorial composition across countries. Figures 3 and 4 show that intermediation costs are positively associated with entrepreneurship: using data on total product to measure intermediation costs, I find that the cross-country correlation between the

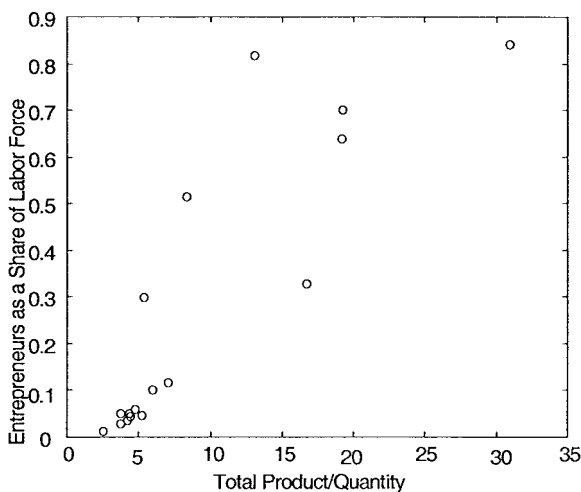


FIG. 4. Fraction of entrepreneurs in labor force and total product/quantity.

fraction of entrepreneurs in the labor force and intermediation costs is 0.859. When data on net interest are used, the correlation coefficient is given by 0.598.

The reader may suspect that intermediation costs and the fraction of entrepreneurs in the labor force are positively associated in the data because each of these variables, in turn, is correlated with per capita income. To investigate this issue, I regress the fraction of entrepreneurs in the labor force on per capita income and intermediation costs. The first column in Table II reports the results when net interest data are used to measure the intermediation spread, while the second column presents similar findings for total product data. The results from the regression analysis clearly indicate that entrepreneurship is positively associated with intermediation costs in the data, even after controlling for differences in per capita income across countries.

3. THE MODEL ECONOMY

3.1. Preferences and Production Technology

The economy is populated by overlapping generations that are born continuously at a constant rate and live for T units of time. People born at

TABLE II
Intermediation Costs and Occupational Choice

	Regression 1	Regression 2
Constant	0.351	0.624
GDP per capita (p value)	-2.8E-05 (5.5E-06)	-4.5E-05 (1.39E-02)
Net interest (p value)	0.0149 (0.033)	
Total product (p value)		0.0111 (0.028)
Adj R^2	0.62	0.91
No. obs.	37	17

The dependent variable is the share of entrepreneurs in the manufacturing labor force.

Regression 1 uses net interest/quantity as the measure of intermediation costs.

Regression 2 uses total product/quantity as the measure of intermediation costs.

Regression 1 excludes Brazil (which is the outlier in Fig. 3). If Brazil were included, the coefficient of net interest would not be significantly different from zero (the p value is 0.83 in this case).

time t maximize the sum of discounted utility over their lifetime as

$$\int_0^T \exp[-\rho s] u[c(t+s)] ds, \quad (1)$$

where $u(\cdot)$ is a continuously differentiable strictly concave utility function, ρ is the time preference parameter, and $c(\cdot)$ is the individual's consumption, which is restricted to being nonnegative.

Individuals of the same age are identical. They are endowed with one unit of time until they retire at age R . At each instant of their working life they decide whether to be a worker or an entrepreneur. Workers provide labor services at the market wage. Entrepreneurs use capital and labor services to produce output according to $y = f(k, n)$, where k and n denote capital and labor inputs, respectively, y is the amount of output, and $f(\cdot)$ is a production function that is strictly concave, increasing, and continuously differentiable. It is also assumed that $f(\cdot)$ exhibits decreasing returns to scale on capital and labor inputs. Entrepreneurs are the claimants to the output that remains after they pay rents for the factor services hired.

At each point in time there is a single produced good. Capital at a given date is the output that has been accumulated up to that time. When capital is used in production it depreciates at a rate δ , with $0 < \delta < 1$.

3.2. Banks

In this model economy, banks play a major role since all lending between individuals is intermediated. People lend to banks (that is, deposit capital) and borrow from banks, with the interest rate on deposits lower than the interest rate on loans. Banks use resources in doing intermediation, and this resource cost is equal to a constant per unit intermediated. The intermediaries' problem is static. At each instant they solve

$$\text{Max}_{0 \leq l_b \leq d_b} i_l l_b - i_d d_b - \phi l_b,$$

where l_b denote loans issued by banks and d_b denotes deposits received by these institutions. Given that I assume that there is a large number of banks, in equilibrium banks' profits are zero. This implies that the intermediation cost is equal to the interest rate spread ($\phi = i_l - i_d$), and deposits received equal loans issued by banks.

3.3. Individual's Decision Problem

Individuals save by holding capital, which they use in production, or by making deposits at banks. They may borrow from banks to finance con-

sumption or the capital used in business. Their net worth is defined as the sum of the capital used in production and deposits at banks minus the amount borrowed from intermediaries. In other words, the balance sheet identity

$$k + d \equiv l + a$$

where k denotes capital used in production, d denotes deposits at banks, l stands for loans received from banks, and a represents net worth, is satisfied at each point in time.

I will focus on equilibria in which the state of economy, that is, the distribution of individuals' ages and assets across the population, is constant across time. For this type of equilibrium, prices do not change over time and, therefore, the decision problem of a newborn individual is independent of this person's date of birth. Since the definition of a steady-state competitive equilibrium is standard, it is omitted for brevity (Erosa, 1996).

A newborn individual maximizes lifetime utility by choosing the lifetime path for consumption, deposits, occupational choice, assets, loans, and labor and capital used in production. The optimization problem is

$$\text{Max}_{c, k, n, d, l, \dot{a}} \int_0^T \exp(-\rho s) u[c(s)] ds \quad (2)$$

subject to

$$\dot{a} = eI_R[f(k, n) - wn] + (1 - e)I_R w + i_d d - i_l l - \delta k - c,$$

$$k + d = a + l,$$

$$I_R(s) = \begin{cases} 1 & \text{if } s \leq R, \\ 0 & \text{if } s > R, \end{cases}$$

$$e \in \{0, 1\}, \quad a(0) = 0, \quad a(T) \geq 0, \quad c, d, l, k, n \geq 0,$$

where $I_R(s)$ is an indicator function that takes the value 1 if the individual is retired and zero otherwise. The control variable $e(s)$ takes the value 1 if the individual chooses to be an entrepreneur at age s and zero if the person chooses to be a worker at age s . The remaining constraints state that all control variables are restricted to being nonnegative and that individuals are born with zero assets and die with nonnegative net worth.

3.4. Discussion of Modeling Assumptions

The model just developed assumes that all borrowing and lending is intermediated without providing an underlying theory of intermediation.

There is a large literature on how information and transaction costs can explain the emergence of intermediaries. According to existing theory, financial institutions can have a vast array of functions: they economize on trading costs (Townsend, 1978), pool liquidity risk (Diamond and Dybvig, 1983), acquire information about investment projects (Boyd and Prescott, 1986), and reduce the cost of monitoring entrepreneurs (Diamond, 1984). Many researchers have built growth models where financial markets perform some of these functions. (See, for example, Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), King and Levine (1993), Acemoglu and Zilibotti (1997, 1999), and Levine (1997) for a recent survey of the literature.) In my paper, the role of banks in acquiring information, monitoring entrepreneurs, or pooling risk is not modeled. This modeling option allows me to focus on the main theme of the paper: intermediation costs introduce a spread between the return in financial assets and the marginal product of capital, and this spread, when coupled with occupational choice decisions, has nontrivial consequences for savings behavior and production efficiency.

Greenwood and Jovanovic (1990) develop a framework in which intermediation is resource costly. In their model, the resources used up by the finance industry are the sum of a variable component, which changes proportionally with the amount of assets intermediated, and a fixed, per individual, component. The introduction of fixed costs allows them to study the decision of when to become a member of a "financial coalition." Notice that this aspect could easily be incorporated into the framework in my paper. If individuals face a fixed cost of participating in a bank, they will make deposits only once they have accumulated a certain threshold amount of assets. In this case, individuals store capital before making deposits, and the amount of assets intermediated will be smaller than in the absence of fixed costs.⁵

To generate borrowing and lending, heterogeneity among agents is introduced with the overlapping generations setup. In this setup, intermediation costs affect the interest rates on both loans and deposits. The spread between borrowing and lending rates introduces a nonconvexity into the individual's maximization problem. When time is modeled as continuous, the mathematical structure of the framework is greatly simplified. The age at which individuals become entrepreneurs and at which they retire are continuous variables of the parameters in their decision prob-

⁵ The data suggest that this is an important issue: for all the financial development of the U.S. economy, Mulligan and Sala-i-Martin (2000) document that about 25% of households in the 1989 Survey of Consumer Finances do not hold a checking account with a positive balance!

lem. This proves useful in characterizing equilibria and in developing a computational algorithm for the numerical experiments.

The literature on financial intermediation and economic development has typically focused on models of endogenous growth. King and Levine (1993) and Levine (1997) have shown that indicators of financial development are positively associated with economic growth (after controlling for a host of variables). Although this avenue is not pursued, it should be emphasized that the model developed in this paper can easily be modified so that it features endogenous growth. For instance, learning by doing can be introduced into the framework so that the productivity of a business depends on the average productivity in the economy. Then, financial intermediation would have an impact on the economy's growth rate through both its effects on saving rates and average business productivity (see Bencivenga and Smith (1991) for a result along these lines). Since countries in my framework only differ on intermediation costs, the presence of endogenous growth would lead to the result that countries with high intermediation costs would grow at lower rates than other economies. This contradicts the lack of persistence in growth rates observed in the data, and for this reason I do not incorporate endogenous growth (see Easterly *et al.* (1993), Parente and Prescott (2000), and Restuccia and Urrutia (2001)).

4. CHARACTERIZATION OF EQUILIBRIUM

This section presents some propositions on the characterization of equilibrium. The first proposition says that individuals choose to be entrepreneurs only when their savings are no less than a certain amount (determined in equilibrium). Proposition 2 shows that an individual's working life is divided into at most three stages according to whether that person is a worker or an entrepreneur. The length of each of these stages is endogenously determined. Individuals are first workers, then entrepreneurs, and finally they may be workers again.

PROPOSITION 1. *The individual's occupational choice is related to net worth according to*

$$\begin{aligned} e(s) &= 1 && \text{when } a(s) \geq a^*, \\ e(s) &= 0 && \text{when } a(s) < a^*, \end{aligned}$$

for some constant a^* .

This proposition shows that individuals' occupational choices are determined by the amount of savings accumulated during their life. At each

instant, people choose the occupation that maximizes their current income. They operate a technology only when their savings are high enough to run a business with a relatively low need for external financing. This happens when an individual's net worth is not less than a^* (see Fig. 5).

Figure 5 represents an individual's income flow as a function of this person's net worth and occupational choice at a given instant. Since workers deposit all their savings at banks, an additional unit of savings increases their income by the interest rate on deposits. Figure 5 distinguishes three regions of asset levels according to how entrepreneurs' incomes vary with a unit change in their net worth. In the first region ($a < a_1$), entrepreneurs have so little savings that they need to borrow to operate their business efficiently. A one unit increase in entrepreneurs' savings reduces their need for external financing and increases their income by the interest rate on loans. In the second region ($a_1 < a < a_d$), entrepreneurs' net worth is sufficient to self-finance their business, but it is low enough that they use all their savings in operating their technology. This occurs when the return of operating their technology with one more unit of capital is below the interest rate on loans and above the interest rate on deposits. In this region the change in individuals' income associated with an increase in assets is related to the marginal productivity of capital in their businesses. In the third region ($a > a_d$), entrepreneurs' net worth is so high that it is optimal for them to deposit part of their savings at banks. When the marginal productivity of capital equals the interest rate on deposits, entrepreneurs deposit any additional savings in banks. Then income changes with assets according to the interest rate on deposits.

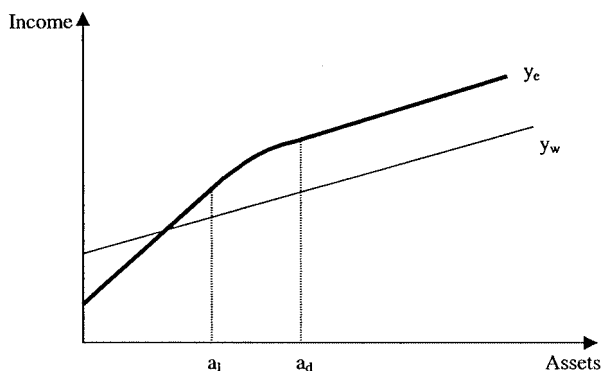


FIG. 5. Entrepreneurs' (y_e) and workers' (y_w) income.

PROPOSITION 2. *Individuals' lifetimes can be divided into at most three stages according to their occupational choice,*

$$e(s) = 0 \quad \text{when } s < s_e \text{ and } s > s_w,$$

$$e(s) = 1 \quad \text{when } s_e \leq s \leq s_w,$$

for some ages s_e, s_w , and $s \in [0, R]$.

This proposition says that it is optimal for individuals to start their lives as workers, switch to being entrepreneurs at age s_e , and switch back to being workers at age s_w if their net worth is sufficiently low before they retire. The length of each of these stages is such that an individual's utility is maximized. Individuals are born with zero assets, then they work and accumulate capital until their savings are high enough so that it is optimal for them to operate a business.⁶ Given that people have finite lives and they like to smooth consumption, there is some age when individuals' net worth starts decreasing smoothly down to zero when people die. Then there may be a final stage in people's lives when it is optimal for them to be workers. This occurs when people retire with a net worth which is less than a^* .

4.1. Intermediation Costs versus Taxes on the Return of Capital

Intermediation costs introduce a wedge between the return realized by households and the marginal productivity of capital. An interesting feature of this model is that this wedge is not equivalent to a tax on the return of capital. The equivalence fails because the spread affects not only the capital accumulation decision but also the occupational choice decision.

In this general equilibrium framework, intermediation costs affect the occupational choice decision because they affect the incomes of workers and entrepreneurs differently. While a flat tax on the return of capital applies to all capital income, the intermediation "tax" does not apply to the capital owned and used by entrepreneurs in their own businesses. Therefore, costly intermediation has consequences for the number and average size of businesses and thus for the economy's production efficiency. This is an interesting finding because evidence suggests that business size is associated with development (see next section). Costly intermediation may be important in understanding this connection.

⁶ If the interest rate on loans is below the rate of time preference, individuals will borrow to finance consumption at the beginning of their life and, therefore, net worth will be negative during some initial period.

In this framework, intermediation costs affect savings differently from a flat tax on capital income. Costly intermediation causes the rate of return on capital to depend on the amount of individuals' asset holdings. Workers (individuals with assets below a^*) receive the interest rate on deposits of their savings. Entrepreneurs that borrow (individuals with assets on the interval $[a^*, a_1]$) face a rate of return on their savings equal to the interest rate on loans (see Fig. 5). This wedge between rates of returns explains why intermediation costs affect savings in a different way than a tax on capital income. On the one hand, costly intermediation discourages savings because it reduces the return on deposits. On the other hand, costly intermediation creates strong incentives to save, given that the rate of return on assets increases after a threshold level. This second effect is not present with a flat tax on capital income.

It is interesting to note that Greenwood and Jovanovic (1990) obtain a similar result. In their framework, individuals who are members of a "financial coalition" obtain a higher (expected) return on their savings than those who are not members. To join a financial coalition, individuals must have sufficient wealth to afford a fixed fee. Consequently, there is a threshold level of assets above which the return on savings increases. They thus found that individuals have a higher saving rate before joining a financial institution.

Intermediation costs also differ from a flat tax on capital income in that they create a wedge between the intertemporal marginal rates of substitution in consumption across individuals. Marginal rates of substitution vary among people because the returns on their savings differ. Also, given that individuals switch occupations, the return on their savings varies over their lives. The variability of the savings' return affects the smoothness of individuals' consumption profiles along their life cycle. It also has consequences for the age-income and age-asset profiles.

5. SOME LESSONS FROM NUMERICAL EXPERIMENTS

In this section, I explore the quantitative effects of intermediation costs for development. I proceed as follows: I assume that the world consists of a large number of economies which are identical with regard to preferences and production technology. Countries differ in the efficiency of the financial intermediation system. Intermediation costs are assumed to vary across countries according to the observations documented in Section 2 of this paper. I compute some statistics associated with the steady-state equilibrium of these economies. These statistics are used to quantitatively assess the effects of intermediation costs on per capita output, quantity of intermediation, and average business size.

To perform a computational experiment it is necessary to select a particular economy, that is, preferences and production technology must be fully specified. I choose standard forms for the utility and production functions. The parameters of these functions are selected so that for an intermediation cost of 0.04 the steady state of the model mimics the U.S. economy in some specified dimensions.

5.1. Parameterization of the Economy

The utility function is of the standard form $u(c) = c^{1-\sigma}/(1-\sigma)$, where $1/\sigma$ is the intertemporal elasticity of substitution in consumption. Following Lucas (1978), the production function is defined as

$$y = A\{\alpha k^\gamma + (1-\alpha)n^\gamma\}^{\theta/\gamma},$$

where $1/(1-\gamma)$ is the elasticity of substitution between capital and labor and θ is the share of the nonentrepreneurial inputs (capital and labor).

To fully specify the model economy, I choose values for the population parameters, T and R , preference parameters, ρ and σ , and the technology parameters, A , α , γ , and θ . I assume that individuals live for 55 years and that their retirement age is 46. As in Hubbard *et al.* (1995), I assume a value for σ of 3, which is consistent with many empirical studies. Moreover, given the other parameters, $\sigma = 3$ and $\rho = 0.02$ lead to a realistic capital-output ratio and interest rate on deposits for the baseline economy. In effect, when $\phi = 0.04$ the capital-output ratio is 3.3 and the (real) return on deposits is 2.4%. These numbers are roughly consistent with observations for the U.S. economy.⁷

With regard to the technology parameters, I make the standard assumption that the elasticity of substitution between capital and labor is 1 ($\gamma = 0$). In this way, the model will be consistent with the growth facts that led Solow to construct his growth model. The units in which output is measured are picked so that A is equal to 1. In addition, by choosing θ to be 0.95, the share of employees in the labor force of the base case is set at 90%, which is the value of this statistic for the U.S. economy in the year 1985. The capital income share (net of profits) is set at 36% ($\alpha = 0.36$) to

⁷ Cooley and Prescott (1995) estimate a return on capital in the business sector of 6.9%. Their calculations treat all of indirect taxes as factor payments and abstract from intermediation costs. Considering intermediation costs and treating part of indirect business taxes as business payments for government services will certainly lower this return to a number not far from 2.4%.

mimic the actual data of the U.S. economy. Finally, I assume capital depreciates at a 5% annual rate.

5.2. Some Lessons

The main lesson from this experiment is that intermediation costs have important effects on per capita output and business size. Indeed, a reduction of the spread from 0.15 to 0.04 is associated with an increase in per capita output of 40% and with a twofold increase in the average size of businesses. The main findings are summarized in Tables III and IV. These tables present selected statistics for economies representing high, medium, and low efficiency of the financial intermediation system. These countries are denoted as rich (spread = 0.04), middle-income (spread = 0.08), and poor (spread = 0.15). To facilitate comparisons, the data on per capita income are normalized so that the output of a poor country is set to one. A similar normalization is done with capital per worker data.

Intermediation Costs and Development

There is a strong negative association between intermediation costs and per capita output. Table III shows that improving the efficiency of the financial system has very significant effects on output. In effect, a poor

TABLE III
Spreads and Development

Spread	0.04	0.08	0.15
Output	1.39	1.19	1
Loans/output	2.7	2.2	1.6
Dep. interest rate (i_d)	2.4%	0.4%	-4.4%
Capital/output	3.3%	3.0%	2.7%
Gini assets	0.37	0.43	0.53

TABLE IV
Number and Size of Businesses

Spread	0.04	0.08	0.15
Entrep./labor force	10%	13%	20%
Workers per business	10	7	5
Capital per worker	1.5	1.2	1
Entrep. equity/capital	18%	27%	35%

country (spread = 0.15) can increase its capita income by 20% by reducing its intermediation costs to 0.08. The increase in income can be 40% if the spread decreases to 0.04.

Intermediation Costs and Quantity of Intermediation

There is a strong negative association between the quantity of intermediation and the magnitude of the spreads. Table III shows that a reduction of the spread from 0.15 to 0.04 is associated with an increase in the amount of loans relative to output by one. This is consistent with the findings reported in the data analysis in Section 2. Note that the rate of return on financial assets is much higher in rich than in poor countries. This situation of low returns on the domestic financial markets has been labeled as “financial repression” by early development economists (McKinnon, 1973; Shaw, 1973). According to the World Bank, there have been episodes of capital flight associated with repressive financial policies that maintain low real interest rates on savings (World Development Report, World Bank, 1985, p. 63). Therefore, it is not surprising that these policies are usually accompanied by restrictions on international capital flows (see Giovannini and De Melo (1993)).

Measure of Entrepreneurs and Development

There is a strong negative association between the measure of entrepreneurs and GDP across countries. Table IV shows that the measure of entrepreneurs as a percentage of the labor force is twice as high in poor countries (spread = 0.15) than in rich countries (spread = 0.04). Therefore, the model implies that the percentage of employees in the labor force is positively associated with development. This is consistent with observations made by Kuznets (1966) and with the evidence reported in Figs. 3 and 4. In addition, in all the experiments performed entrepreneurs are older than workers. This is in accordance with the finding of Evans and Leighton (1989) that the probability of individuals being entrepreneurs increases with their age. The model developed in this paper is also consistent with the findings by Evans and Jovanovic (1989). These authors estimate a model of entrepreneurial choice with data for the U.S. economy. They report that wealthy individuals are more likely to become entrepreneurs. They conclude that entrepreneurship may not be an option for young individuals because they have had less time to build up the capital needed to start a business.

Average Size of Businesses and Development

A poor country is characterized by a large number of businesses that operate with few workers and little capital relative to richer countries.

Indeed, with a reduction of the spread from 0.15 to 0.04, the average size of businesses more than doubles, in terms of both number of workers and capital (capital per worker increases 50%). On the other hand, the importance of the entrepreneurs' own equity relative to the capital stock used by businesses is reduced by a half. The idea that economic development is associated with business size is not new. Kuznets (1966) and Lucas (1978) argue that as a country develops the average business size tends to increase.⁸ A contribution of my research is to show that costly intermediation might well be important in understanding this connection.

Intermediation Costs and Saving Rates

Although capital per worker increases substantially with economic development, the range of variation of capital-output ratios is small. Table III shows that this ratio is 3.3 for rich countries, while it is 2.7 for poor countries. This implies that intermediation costs are negatively associated with saving rates. Intermediation costs discourage savings because they reduce the return on financial assets. This effect proves quantitatively more important than the incentives to save introduced by the increasing returns to wealth associated with costly intermediation (see Section 4.1).

Spread and Asset Profiles

Given that the equilibrium computed is a steady state, an individual's lifetime path for assets also represents the distribution of assets across generations. Table III presents the Gini coefficients for the distribution of assets across cohorts. According to these measures, asset holdings are almost twice as concentrated in the poor country as they are in the rich country (the Gini coefficients are 0.53 and 0.37, respectively). Thus, increasing returns to wealth accumulation leads to a significant concentration in the distribution of assets. Figure 6 contains two graphs. The first graph represents the assets' profiles for individuals living in rich, middle-income, and poor countries. The second graph shows the Lorenz curve for the distribution of assets for each economy. As the spread rises, the graphs show that young individuals own a smaller fraction of the aggregate capital stock and the Lorenz curve shifts to the right.

⁸ Proctor (1990) comes to the same conclusion using census data on the manufacturing industries for a cross-section of countries. Davis and Haltiwanger (1989) report a similar finding in a time series study of establishment size in the U.S. economy. See Gollin (1996) for a review of some of the available evidence.

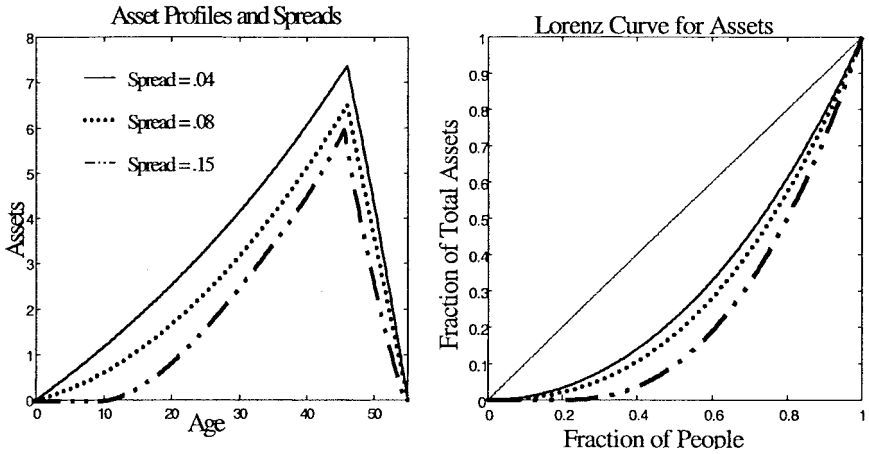


FIG. 6. Intermediation cost and asset profiles.

5.3. Discussion

The reader should notice that intermediation costs in my model can account only for a very small fraction of the huge disparities in per capita income across countries in the data. A promising avenue for future research is to introduce heterogeneity in entrepreneurial ability into the framework developed in this paper. In this case, savings will be more important in determining who operates a business in economies with high intermediation costs than in economies with low spreads. Therefore, the average quality of entrepreneurs operating businesses will decrease with intermediation costs. This will certainly expand the effects of costly intermediation on development. In addition, the findings in this paper suggest that costly intermediation can have important consequences for the distribution of wealth (see Table III). A framework with heterogeneous agents may prove useful in studying these effects.

The previous discussion notwithstanding, Parente and Prescott (2000) emphasize that accounting for the large disparities in income levels across countries requires a theory of total factor productivity. The role of financial markets in pooling risk, acquiring information, and monitoring entrepreneurs can be crucial for an efficient allocation of resources (see Bencivenga and Smith (1991), Acemoglu and Zilibotti (1997), Greenwood and Jovanovic (1990), and King and Levine (1993)). In this regard, as suggested by Greenwood and Smith (1997), it would be important to develop a theory to investigate the interaction between financial markets and the adoption of new technologies.

6. TAXES ON FINANCIAL INTERMEDIATION VS. TAXES ON CAPITAL INCOME

In this section, I argue that governments in most countries tax financial intermediaries and that differences in these taxes might account for the wide disparity in intermediation costs across countries. Given that intermediation costs have significant effects for development, it is important to answer the following question: can developing countries do better by taxing economic activities other than financial intermediation?

To answer this question I compare two tax regimes: taxes on financial intermediation and taxes on capital income. Note that most of the public finance literature has addressed issues of taxation in models with an aggregate production technology. An interesting feature of my model is that I explicitly model the operations of businesses. In this framework, taxes on capital income and on intermediation reduce the return on capital realized by households; however, they distort individuals' decisions in many different ways (see Section 4.1).

6.1. Implicit and Explicit Taxes on Financial Intermediation

Early development economists noticed that government regulations impose significant distortions on activities of financial intermediaries and that these distortions have substantial negative consequences for development (for instance, see McKinnon (1973) and Shaw (1973)). These observations raise the following question: why do governments in many developing economies "repress financial intermediation"? One possible answer is that these regulations constitute taxes on financial intermediaries and are, hence, an important source of government revenue.

Taxes on financial intermediation can be either explicit or implicit. Explicit taxes, such as taxes on gross receipts of banks, on value added, on loan balances, and on bank profits, are included in the tax code. Implicit taxes are not treated as taxes in budget accounting. They arise from government interventions such as interest rate ceilings, reserve requirements, and forced lending to government or preferred sectors.

The World Bank reports that, in many countries, governments collect special taxes from financial institutions and that these taxes raise intermediation costs. For instance, in 1984, the taxes collected on banks in the Philippines added more than 12 percentage points to the cost of intermediation (see the World Development Report, World Bank, 1989, p. 64). Chamley and Honohan (1990) show that total financial intermediary taxation in some African countries amounted to 7% of GDP during the 1980s. They claim that by any reckoning it is difficult to find in developing countries any sector that is taxed as heavily as the financial intermediation

sector. Similarly, in a study that included 24 developing countries during the period 1972–87, Giovannini and De Melo (1993) found that government regulations of domestic financial markets raised a tax revenue of about 2% of GDP (see also Chamley (1991)).

6.2. A Public Finance Experiment

To compare a tax on financial intermediation with a tax on capital income I consider two economies. The two economies are identical regarding preferences and technologies. Intermediation is assumed to be a costless activity; that is, banks do not use resources when borrowing or lending. The two economies differ in the way the government collects taxes. In one economy, the government taxes a fixed amount (ϕ) per unit of value intermediated. In the other economy, the government imposes a proportional tax on capital income (τ).⁹ The tax rate on capital income is chosen so that the tax revenues in the two economies coincide. In both cases, I assume that tax receipts are used to finance government consumption, which enters in an additively separable fashion into individuals' preferences.

The two economies are parameterized as in Section 5.1. The experiment is performed for three tax rates on financial intermediation. These rates are 0.04, 0.08, and 0.15. Each of these intermediation tax rates has a corresponding tax rate on capital income that gives the same revenue to the government. The revenue-equivalent tax rates on capital income are 0.51, 0.71, and 0.78, respectively. Note that these rates are quite high and that they increase less than proportionally with intermediation taxes. The last observation is due to the fact that when intermediation taxes rise, the quantity of intermediation goes down, and therefore the tax revenue increases less than proportionally.

Taxes and Development

Taxing financial intermediaries can be a very bad policy for development. In effect, by switching to capital income taxation a country in which banks are taxed at a rate of 0.15 can increase its output by 18%, without reducing government revenues (see Table V). This increase in output is associated with a reduction of one-half in the number of businesses and with a threefold increase in the average business size in the economy (both in terms of workers and capital). It is worth noting that production

⁹ This capital income tax is actually a tax on both interest income and property income. Property income is defined to be the revenue from operating a business minus total wage payments (to both employees and entrepreneurs), interest payments, and depreciation of capital.

TABLE V
Intermediation Taxes, Capital Taxes, and Development

	Intermediation tax			Capital income tax		
	0.04	0.08	0.15	0.51	0.71	0.78
Output	55.6	47.5	40.0	56.1	50.0	47.1
Normalized output	1.39	1.19	1	1.40	1.25	1.18
Entrep./labor force	10.2%	13.5%	20.3%	7.6%	7.6%	7.6%
Capital per business	38.9	22.9	11.5	53.2	44.7	40.7
Worker per business	8.8	6.4	3.9	12.2	12.2	12.2

efficiency also increases with a switch from intermediation taxes to capital income taxes. Indeed, output would increase by 5% even if the capital stock is maintained at the level of the initial steady state.¹⁰

Intermediation taxes are extremely harmful for development because they distort production efficiency. These taxes do not apply to the capital owned and used by entrepreneurs in their own businesses. Therefore, they distort the individuals' occupational choice decision and, hence, the number and average size of businesses in the economy. This finding is not surprising, given standard results in the public finance literature. Diamond and Mirrlees (1971) show that the tax system should not distort production decisions. The tax revenue should be raised by affecting the choice of consumption bundle along the production frontier rather than by shifting this frontier inward.

Discussion

In a sense, the findings provide a lower bound to the effects of intermediation taxes on production efficiency. Intermediaries in my model do not provide risk diversification services, monitoring of managers, or information generation. These services, as indicated by many researchers, contribute to a better allocation of resources (see Levine (1997)).

The result that intermediation taxes lead to an increase in the number of entrepreneurs will still hold if there are nonconvexities in the process of setting up a business. Suppose that a firm can start operating only if capital exceeds a certain threshold. The intermediation tax, at the margin, creates

¹⁰ The differences in steady-state welfare between the two tax regimes are enormous. The welfare of a newborn individual is much higher with a capital income tax rate of 0.78 than with an intermediation tax rate of 0.15. The welfare difference is equivalent to 12% of the lifetime consumption associated with an intermediation tax of 0.15.

incentives for individuals to invest savings in their own businesses rather than making deposits in a bank. Then, individuals will strive harder to accumulate the exogenous level of assets that allows them to operate a business. Therefore, even though the threshold is not affected by tax policy, individuals will increase their savings and the number of entrepreneurs will rise.

It is interesting to note that the gains in production efficiency associated with the elimination of intermediation taxes are not a free lunch. Entrepreneurs with sufficiently high savings are likely to be hurt by the introduction of capital income taxes. By using savings to finance the operation of their own businesses, they can avoid taxes on intermediation, but they cannot avoid capital income taxes. On the other hand, workers cannot escape the intermediation tax since they save by making deposits. I conclude that the intermediation tax is a fairly regressive tax. The political economy in developing countries might preclude the introduction of capital income taxes because wealthy entrepreneurs do not like such taxes. These issues are left for future research.

7. CONCLUDING COMMENTS

This paper presents evidence that intermediation costs are much higher in poor than in rich countries. I show that costly intermediation, when individuals choose occupations, has important effects on saving behavior and the scale of operation of businesses. Given that developing countries tax the financial system very heavily, I compare intermediation taxes with capital income taxes. I conclude that the two taxes are not equivalent: taxes on intermediation are more distortionary because they affect the occupational choice decision and, hence, production efficiency. This finding is consistent with standard results in the public finance literature. As Diamond and Mirrlees (1971) show, the tax system should not distort production decisions.

A promising avenue for future research is to study occupational choice decisions in a dynamic contracting framework. Smith and Wang (1999) investigate the impact of private information in an economy where individuals choose whether to be an entrepreneur or a worker in the first period of their lives. They found that the allocations that are achieved with dynamic contracts are close to those of an economy with no private information (first best efficient). I suspect that two assumptions in their analysis are crucial for this result: first, the principal can commit to utility promises; second, the agent cannot contract outside the principal-agent relationship.

APPENDIX

The production function $f: \mathfrak{R}^2 \rightarrow \mathfrak{R}$ is assumed to be continuously differentiable, strictly increasing, and concave in each of its arguments. Capital and labor are assumed to be complementary inputs into production. The utility function is restricted to the class of continuously differentiable, strictly increasing, and concave functions. Standard Inada conditions are assumed for both the production and utility functions.

I define the functions $y_e, y_w, y: \mathfrak{R}_+ \rightarrow \mathfrak{R}$ as

$$y_e(a) = \underset{k \leq K, n \leq N}{\text{Max}} \{f(k, n) - wn + i_d \max\{a - k, 0\} - i_l \max\{k - a, 0\} - \delta k\},$$

for suitable large values of K and N , $y_w(a) = w + i_d a$, and $y(a) = \max\{y_e(a), y_w(a)\}$. Note that $y_e(\cdot)$ is a well-defined function. It is the maximum of a concave function on a nonempty, convex, and compact set. By the theorem of the maximum it is a continuous function. The function $y_e(y_w)$ gives the income of entrepreneurs (workers) as a function of their asset holdings. Define the threshold level of assets $\tilde{a} = \inf\{a \in \mathfrak{R}_+ : y_e(a) \geq i_d a\}$. Entrepreneurs with asset holdings above this threshold will use a positive amount of capital (and labor) when operating a business.

Proof of Proposition 1. Given prices (w, i_d, i_l) , denote by (k_j, n_j) the pair of capital and labor that satisfies the equations $(f_1(k_j, n_j) = i_j + \delta$ and $f_2(k_j, n_j) = w$, where $j = l, d$ and f_j denotes the derivative of f w.r.t. to the j th argument. Using the envelope theorem it is easy to show that $y_e(\cdot)$ is a differentiable function on (\tilde{a}, ∞) and satisfies

$$\frac{dy_e(a)}{da} = \begin{cases} i_l & \text{if } \tilde{a} \leq a \leq k_l \\ \frac{\partial f}{\partial k}(a, \hat{n}(a)) - \delta & \text{if } k_l < a < k_d \\ i_d & \text{if } a \geq k_d \end{cases} \quad \text{or } a < \tilde{a},$$

where $\hat{n}(a)$ denotes the optimal number of workers used by an entrepreneur with asset holdings a . The function y_e is also concave. Its derivative is bounded below by i_d (that is, the marginal return on savings for entrepreneurs is at least equal to the interest on deposits). This implies that the function $h(\cdot)$, defined above as $y_e(\cdot) - y_w(\cdot)$, is a nondecreasing function of assets. Since both workers and entrepreneurs are necessary for production, $h(0) < 0$. Otherwise, no individuals would choose to be a worker. Similarly, in equilibrium there exists a sufficiently high level of assets for which $h(a) \geq 0$. Otherwise, no individual would choose to be an

entrepreneur. Since $h(\cdot)$ is a continuous function, the intermediate value theorem guarantees that there exists some level of assets a^* such that $h(a^*) = 0$. The statement of the proposition follows from the definition and monotonicity of $h(\cdot)$.

Proof of Proposition 2. The proof is done by contradiction. Suppose without loss of generality that there are two disjoint intervals, say $[s_0, s_1]$ and $[s_2, s_3]$, where it is optimal for individuals to be entrepreneurs (see Fig. 7). I will show that this assumption implies that there exists a second solution to the consumer's problem, but that this solution violates some necessary conditions for maximization obtained from the Maximum Principle.

Step 1. Apply the Maximum Principle. To this end I rewrite the individuals' problem in a convenient way. Consider the problem of a retired individual,

$$v(a_R) = \text{Max}_{c(\cdot), a(\cdot)} \int_R^T \exp(-\rho s) u[c(s)] ds$$

s.t. $\dot{a}(s) = i_d a(s) - c(s), \quad a(R) = a_R, \quad a(T) = 0.$

Note that $v(\cdot)$ is a differentiable function (see Seierstad and Sydsæter (1987, Theorem 9, p. 213)). Using the definition of $v(\cdot)$, $y_e(\cdot)$, and $y_w(\cdot)$, the maximization problem of a newborn individual becomes

$$\text{Max}_{c(\cdot), a(\cdot)} \int_0^R \exp(-\rho s) u[c(s)] ds + v(a_R)$$

s.t. $\dot{a}(s) = e(s) y_e[a(s)] + (1 - e(s)) y_w[a(s)] - c(s),$
 $a(0) = 0, \quad a(R) = a_R.$

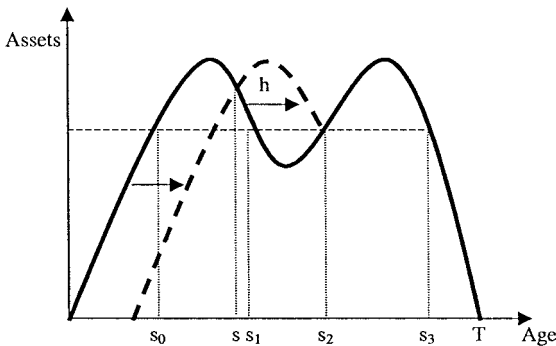


FIG. 7. Proof of Proposition 2.

Given that all the functions involved in the above maximization problem are continuous differentiable I can apply the Maximum Principle: Let $e(s)$ and $c(s)$ be piecewise continuous control functions defined on $[0, R]$ that solve the above maximization problem, and let $a(s)$ be the associated optimal path. Then there exists a continuous and piecewise differentiable function $p(s)$ such that for all $s \in [0, R]$: $e(s) = 0$ if $y_e[a(s)] < y_w[a(s)]$ and $e(s) = 1$ otherwise, $p(s) = \exp(-\rho s) \frac{du}{dc}$. Furthermore, except at discontinuity points of the controls $e(s)$ or $c(s)$, $\dot{p}(s) = -p(s)\{e(s)dy_e/da + (1 - e(s))dy_w/da\}$, and the condition also needs to be satisfied: $p(R) = p(0)dv(a_R)/da$. It follows that $c(\cdot)$ is a continuous function on $[0, R]$ (given that $p(\cdot)$ and $\frac{du}{dc}$ are continuous). Also, $\dot{a}(\cdot)$ is a continuous function on $[0, R]$ (given that $c(\cdot)$ and $y[a(\cdot)]$ are continuous).

Step 2. I find two periods in an individuals' life with the following properties: (1) asset holdings at the beginning and end of periods are equal across the two periods; (2) the two periods have the same length.

Let $h = s_2 - s_1$. Define the function $g(\cdot): [h, s_2] \rightarrow \Re$ as $g(s) = a(s) - a(s - h)$. Note that (1) $g(\cdot)$ is a continuous function; (2) $g(h) = a(h) - a(0) > 0^{11}$; (3) $g(s_2 - \varepsilon) = a(s_2 - \varepsilon) - a(s_1 - \varepsilon) < 0$. By the intermediate value theorem there exists $\hat{s} \in [h, s_2]$ such that $g(\hat{s}) = 0$, that is, $a(\hat{s}) = a(\hat{s} - h)$ (see Fig. 7). The intervals $(\hat{s} - h, s_1)$ and (\hat{s}, s_2) satisfy the three properties mentioned at the beginning of Step 2: (1) $a(\hat{s} - h) = a(\hat{s}) = \hat{a}$; (2) $a(s_1) = a(s_2) = a^*$; (3) $s_1 - \hat{s} + h = s_1 + h - \hat{s} = s_2 - \hat{s}$ (see Fig. 7).

Step 3. In this step I find a new optimal path for assets that violates necessary conditions for optimization. Define the following consumption profiles: $c_1(\cdot), c_2(\cdot): [\hat{s}, s_2] \rightarrow \Re$, $c_1(\cdot) = y[a(s)] - \dot{a}(s)c_2(\cdot) = y[a(s - h)] - \dot{a}(s - h)$, where $y(\cdot) = \min\{y_w(\cdot), y_e(\cdot)\}$. Note that $\int_{\hat{s}}^{s_2} \exp(-\rho s) u[c_1(s)] ds = \int_{\hat{s}}^{s_2} \exp(-\rho s) u[c_2(s)] ds$. In effect, if the integral on the RHS of the equality were strictly bigger than the one on the LHS, the $c(\cdot)$ would not be optimal on $[\hat{s}, s_2]$. If the integral on the RHS of the equality were strictly smaller than the one on the LHS, then $c(\cdot)$ would not be optimal on $[\hat{s} - h, s_1]$.

This implies that the following paths for consumption and assets are optimal: $\bar{a}(\cdot), \bar{c}(\cdot): [0, T] \rightarrow \Re$, $\bar{a}(s) = a(s)$ if $s \leq \hat{s}$ or $s \geq s_2$; $\bar{a}(s) = a(s - h)$ if $s \in [\hat{s}, s_2]$; $\bar{c}(s) = y[\bar{a}(s)] - \frac{d\bar{a}(s)}{ds}$. Note that $d\bar{a}(s_1^-)/ds < 0$ and $d\bar{a}(s_2^+)/ds > 0$ (at age s_1 (s_2) individuals switch from entrepreneur (worker) to worker (entrepreneur)). Then, $d\bar{a}(s_1^-)/ds > d\bar{a}(s_2^+)/ds$, which implies that $\bar{c}(\cdot)$ is discontinuous at s_2 . This violates a necessary condition for optimality. Therefore, it contradicts the claim that $(\bar{c}(\cdot), \bar{a}(\cdot))$ is optimal.

¹¹ For simplicity I consider the case where $i_d > \rho$ so that $a(s) > 0$ for all $s \in (0, T)$. The proof can easily be extended to the case $\rho > i_1$ (in this case there is an initial period with negative assets) and to the case $i_1 > \rho > i_d$ (there may be an initial period with zero assets).

REFERENCES

- Acemoglu, D., and Zilibotti, F. (1997). "Was Prometheus Unbound by Chance?," *Journal of Political Economy* **105**(4), 709–751.
- Acemoglu, D., and Zilibotti, F. (1999). "Information Accumulation in Development," *Journal of Economic Growth* **4**(1), 5–38.
- Atje, R., and Jovanovic, B. (1993). "Stock Markets and Development," *European Economic Review* **37**(2/3), 632–640.
- Azariadis, C. (1999). "Agency Cost in Dynamic Economic Models," *The Economic Journal* **109**, 222–241.
- Banerjee, A. V., and Newman, A. F. (1993). "Occupational Choice and the Process of Development," *Journal of Political Economy* **101**, 274–298.
- Bencivenga, V. R., and Smith, B. D. (1991). "Financial Intermediation and Endogenous Growth," *The Review of Economic Studies* **58**, 195–209.
- Boyd, J., and Prescott, E. C. (1986). "Financial Intermediary-Coalitions," *Journal of Economic Theory* **38**, 211–232.
- Chamley, C. (1991). "Taxation of Financial Assets in Developing Countries," *The World Bank Economic Review* **5**, 513–533.
- Chamley, C., and Honohan, P. (1990). "Taxation of Financial Intermediation: Measurement Principles and Application to Five African Countries," World Bank Working Paper 421.
- Cooley, T., and Prescott, E. C. (1995). "Economic Growth and Business Cycles," in *Frontiers of Business Cycle Research*, Princeton, NJ: Princeton Univ. Press.
- Davis, S., and Haltiwanger, J. (1989). "The Distribution of Employees and Establishments by Establishments Size: Patterns of Change and Comovement in the United States," mimeo.
- Diamond, D., and Dybvig, P. (1983). "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy* **91**(3), 401–419.
- Diamond, D. (1984). "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies* **51**, 393–414.
- Diamond, P. A., and Mirrlees, J. A. (1971). "Optimal Taxation and Public Production," *American Economic Review* **61**, 8–27.
- Easterly, W., Kremer, M., Prichett, L., and Summers, L. H. (1993). "Good Policy or Good Luck? Country Growth Performance and Temporary Shocks," *Journal of Monetary Economics* **32**, 459–483.
- Erosa, A. (1996). "Financial Intermediation and Economic Development," Ph.D. Dissertation, University of Minnesota.
- Evans, D. S., and Jovanovic, B. (1989). "An Estimated Model of Entrepreneurial Choice under Liquidity Constraints," *Journal of Political Economy* **97**, 808–827.
- Evans, D. S., and Leighton, L. S. (1989). "Some Empirical Aspects of Entrepreneurship," *American Economic Review* **79**, 519–535.
- Giovannini, A., and De Melo, M. (1993). "Government Revenue from Financial Repression," *American Economic Review* **83**, 953–963.
- Goldsmith, R. (1969). *Financial Structure and Development*, New Haven, CT: Yale Univ. Press.
- Gollin, D. (1996). "From Entrepreneur to Worker: Small Firms and Own-Account Labor in Economic Growth," mimeo, University of Minnesota.
- Greenwood, J., and Jovanovic, B. (1990). "Financial Development, Growth and the Distribution of Income," *Journal of Political Economy* **98**, 1076–1107.

- Greenwood, J., and Smith, B. (1997). "Financial Markets in Development and the Development of Financial Markets," *Journal of Economic Dynamics and Control* **21**, 145–181.
- Hubbard, R. G., Skinner, J., and Zeldes, S. P. (1995). "Precautionary Savings and Social Insurance," *Journal of Political Economy* **103**, 360–399.
- International Labor Office (1988). *Yearbook of Labor Statistics*, Geneva: International Labor Organization.
- King, R. G., and Levine, R. (1993). "Finance, Entrepreneurship, and Growth. Theory and Evidence," *Journal of Monetary Economics* **32**, 513–542.
- Kuznets, S. (1966). *Modern Economic Growth: Rate, Structure, and Spread*, New Haven, CT: Yale Univ. Press.
- Levine, R. (1997). "Financial Development and Economic Growth: Views and Agenda," *Journal of Economic Literature* **XXXV**, 688–726.
- Levine, R., and Zervos, S. (1996). "Stock Markets, Banks, and Economic Growth," World Bank Policy Research Working Paper 1690.
- Lucas, R. E., Jr. (1978). "On the Size Distribution of Business Firms," *Bell Journal of Economics* **9**, 508–523.
- McKinnon, R. I. (1973). *Money and Capital in Economic Development*, Washington, DC: Brookings Institution.
- Mulligan, C., and Sala-i-Martin, X. (2000). "Extensive Margins and the Demand for Money at Low Interest Rates," mimeo, University of Chicago.
- Parente, S., and Prescott, E. C. (2000). "Barriers to Riches," Third Walras–Pareto Lecture, University of Lausanne, October 1999.
- Proctor, J. C. (1990). "On the Size Distributions of Plants and Firms," Ph.D. Dissertation, University of Minnesota.
- Restuccia, D., and Urrutia, C. (2000). "Relative Prices and Investment Rates," *Journal of Monetary Economics* **47**(1), 93–121.
- Seierstad, A., and Sydsæter, K. (1987). *Optimal Control Theory with Economic Applications*, Amsterdam: North-Holland.
- Shaw, E. S. (1973). *Financial Deepening in Economic Development*, New York: Oxford Univ. Press.
- Smith, A., and Wang, C. (1999). "Dynamic Credit Relationships in General Equilibrium," mimeo, Carnegie Mellon University.
- Sussman, O. (1993). "A Theory of Financial Development," in *Finance and Development: Issues and Experience* (Alberto Giovannini, Ed.), Cambridge, UK: Cambridge Univ. Press.
- Townsend, R. M. (1978). "Intermediation with Costly Bilateral Exchange," *Review of Economic Studies* **45**, 417–425.
- Townsend, R. M. (1983). "Financial Structure and Economic Activity," *American Economic Review* **73**, 895–911.
- Williamson, S. (1986). "Costly Monitoring, Financial Intermediation, and Equilibrium Credit Rationing," *Journal of Monetary Economics* **18**, 159–179.
- World Bank (1985). *World Development Report 1985*, New York: Oxford Univ. Press.
- World Bank (1989). *World Development Report 1989*, New York: Oxford Univ. Press.