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North-South lending and endogenous domestic capital market inefficiencies*

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We develop an open-economy model of intertemporal trade under asymmetric information. Capital market imperfections are endogenous and depend on a country's stage of economic development. Relative to the perfect-information benchmark, North-South capital flows are dampened (and possibly reversed) and world interest rates are lower. Whereas riskless rates are equalized across borders, the domestic loan rate is higher in poorer countries. The model can be applied to a number of policy issues including the debt-overhang problem, the indexation of foreign public debts, and the effect of income distribution on growth.

1. Introduction

In this paper we present a simple framework that relates patterns of international capital movements and investment to cross-country differences in the efficiency of capital markets. A key feature is that domestic capital market imperfections are determined endogenously and depend on a country's wealth.[1] We show how these frictions can mute North-South capital flows and possibly even reverse them. Transfers can have a magnified effect on welfare in this framework due to their impact on relative capital market efficiencies, and therefore on capital flows.

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[1]Across countries, there is a strong correlation between the efficiency of capital markets and the stage of development. See Goldsmith (1969), McKinnon (1973), and the 1989 *World Bank Development Report*.

Our starting point is to modify the standard frictionless model of intertemporal trade between countries by introducing an incentive problem between lenders and borrowers, owing to informational asymmetries.[2] At the micro level, the net worth of the borrower becomes a key determinant of the cost of investment finance. At the macro level, there emerges a positive correlation between country wealth and investment. Marginal products of capital can thus differ across countries even if riskless rates are equalized. A related prediction is that the spread between the loan rate and the riskless rate is higher the poorer the country. Section 2 illustrates these basic results in the context of small-country model.

Section 3 discusses a number of policy applications. These include the effects on investment of public external debt, public guarantees of private external debt, indexation of foreign debts, and the distribution of wealth. We also derive the implication that across developing countries external borrowing should rise with country wealth. Section 4 presents a two-country general-equilibrium version of the model. In section 5 we show that some of the key predictions are broadly consistent with the facts.

2. A small-country model with agency costs of investment

Our goal throughout is to provide the simplest possible model capable of illustrating our main points. We first consider a small open economy; the economy is small in the sense that it cannot affect the world interest rate. (One might, for example, think of this as a country in the Southern cone borrowing from the North.) There are two periods, one good, and a large number of identical individuals. The representative individual is risk-neutral and cares only about consuming in period 2:

$$U(c) = c, \tag{1}$$

where c is her second-period consumption. She receives an endowment of W_1 units of the consumption good in period 1 and of W_2 units in period 2.

There are two ways of saving W_1. The first option is to lend abroad at the (gross) world riskless interest rate r; the alternative is to invest in a risky technology. In particular, each person in the country has a project. All projects are identical *ex ante*, and yield *ex post* returns as follows: k units invested in period 1 yield θ units of second-period output with probability

[2]Our analysis draws on recent developments in the closed economy literature on interactions between the real and financial sectors; see Gertler (1988) for a survey. To abstract from sovereign risk, we assume that there is a supranational legal authority, capable of enforcing contracts across borders. Hence our analysis is as much a model of capital flows between Manhattan and the Bronx as between Japan and India. (We are presuming, of course, that it is possible to enforce contracts in the Bronx.)

$\pi(k)$ and zero units with probability $1 - \pi(k)$. That is,

$$y = \begin{cases} \theta & \text{with probability } \pi(k), \\ 0 & \text{with probability } 1 - \pi(k), \end{cases} \tag{2}$$

where y is second-period output. The function $\pi(\cdot)$ is increasing, strictly concave, and twice continuously differentiable, with $\pi(0) = 0$, $\pi(\infty) = 1$, and $r/\theta < \pi'(0) < \infty$.[3] Thus, investment raises the probability that the individual's project will yield a high level of output, and the marginal expected return to investment is diminishing.[4] We assume that output realizations are independent across the projects of different individuals.

If an individual wants to invest more than her first-period endowment W_1 in her project, then she must raise funds from the world capital market; that is,

$$W_1 + b \geq k, \tag{3}$$

where b is the amount she borrows. In return for this amount, she issues a state-contingent security which pays Z^g in the event the project yields the good outcome, and Z^b in the event of the bad outcome. The security must offer lenders the market rate of return r, so that[5]

$$\pi(k)Z^g + [1 - \pi(k)]Z^b = rb. \tag{4}$$

The individual's expected second-period consumption is given by

$$E\{c\} = \pi(k)[\theta - Z^g] - [1 - \pi(k)]Z^b + r[W_1 + b - k] + W_2, \tag{5}$$

where the first two terms on the right represent the expected net return on her project, the third term is her return from risk-free investments abroad, and the last term is her second-period endowment.

The information structure is as follows: Lenders may observe a borrower's endowments and the total amount she borrows. What the borrower does with the funds, however, is her private knowledge. In particular, she may secretly

[3] $\pi'(0) > r/\theta$ is needed to guarantee that it is optimal to invest under perfect information. It is not essential that $\pi'(0)$ be finite, but introducing this restriction makes the exposition a bit simpler.

[4] It is easy to generalize the results to a technology with a large set of possible output realizations. We choose the two-point distribution for ease of exposition.

[5] It is not necessary to assume that lenders are risk-neutral, but only that idiosyncratic project risk be diversifiable in world capital markets.

lend abroad rather than invest in her project.[6] Whereas investment is unobservable, lenders can freely observe realized output. The production function $\pi(\cdot)$ and the borrower's future endowment W_2 are common knowledge.

If there were no information asymmetries, the individual would invest to the point where the expected marginal project return equals the world interest rate. Let k^* denote this first-best level of investment; thus

$$\pi'(k^*)\theta = r. \tag{6}$$

Under asymmetric information, however, it is not generally possible to implement the first-best allocation because the borrower's choice of investment k is not verifiable.[7] Contracts can be conditioned only on realized output y, and not on k. Given any output-contingent payoffs $(Z^{\mathrm{g}}, Z^{\mathrm{b}})$ specified by the contract, the borrower will pick k to maximize her expected consumption, given by (5). Thus she will equate her expected marginal gain from investing with her opportunity cost of (secretly) holding assets abroad,

$$\pi'(k)\left[\theta - (Z^{\mathrm{g}} - Z^{\mathrm{b}})\right] = r. \tag{7}$$

So long as Z^{g} differs from Z^{b}, k will differ from its first-best optimum value k^*, given by (6).[8] The problem is that the borrower's marginal benefit from investing depends not only on the marginal gain in expected output, but on the change in her expected obligation to lenders as well.

If the borrower could promise lenders a fixed payment across states then [by (7)] she would invest the first-best amount k^*. This may not be feasible, however, since the project yields nothing in the bad state. Since the borrower's consumption must be nonnegative, Z^{b} cannot exceed her second-period endowment W_2:

$$Z^{\mathrm{b}} \leq W_2. \tag{8}$$

Clearly, if the present value of the borrower's endowment stream V,

$$V \equiv W_1 + W_2/r,$$

is less than k^*, she cannot offer lenders a riskless security.

[6]The analysis would be qualitatively similar if the borrower had the option of secretly consuming in period 1 instead of secretly lending abroad.

[7]An equivalent assumption is that it is difficult for a third party such as a court to verify investment, making enforcement of an investment-contingent contract difficult. In developing countries, with poorly developed court systems, this problem is likely to be especially acute.

[8]Note that the Miller–Modigliani theorem fails under asymmetric information because the investment decision depends on the structure of contract payoffs.

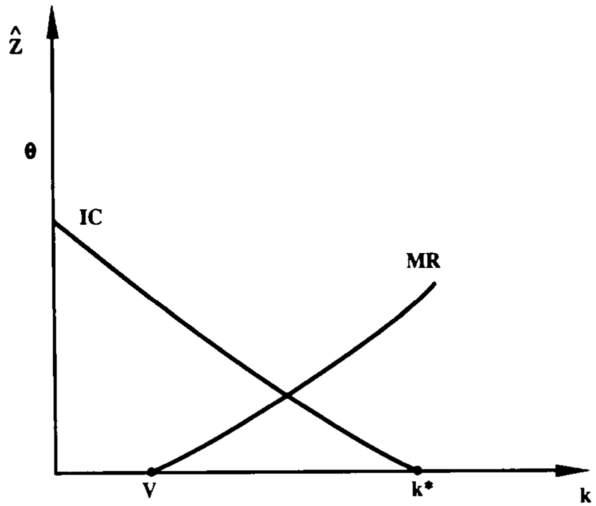

Fig. 1. Equilibrium in the small-country case.

For the case where $V < k^*$ the optimal incentive compatible contract is found by choosing Z^g, Z^b, b, and k to maximize (5) subject to (3), (4), (7), and (8). The solution is as follows:[9] The contract pays lenders W_2 in the bad state, so that (8) is binding. This serves to minimize the spread between Z^g and Z^b, thereby minimizing the difference between the borrower's decision rule for k [eq. (7)] and the socially efficient rule [eq. (6)]. Similarly, eq. (3) is binding, $W + b = k$. Thus, *in equilibrium*, the borrower does not secretly lend abroad. Borrowing more than is essential to finance k would raise the gap between Z^g and Z^b.

Since (3) and (8) hold with equality for the information-constrained case, one can use these equations to eliminate b and Z^b from (4) and (7). The result is the following two equations which determine k and $\hat{Z} \equiv Z^g - Z^b = Z^g - W_2$:

$$\pi'(k)(\theta - \hat{Z}) = r, \qquad IC \text{ curve}, \tag{9}$$

$$\hat{Z} = r(k - V)/\pi(k), \qquad MR \text{ curve}. \tag{10}$$

Eq. (9) is derived from the incentive constraint (7) and is drawn as the curve *IC* in fig. 1. It is downward-sloping. A rise in $\hat{Z}$ lowers the borrower's expected marginal gain from investing and therefore must be offset by a decline in k. The *IC* curve intersects the vertical axis at a value of $\hat{Z}$ which

[9] See the appendix for details.

lies between zero and θ [recall that $r/\theta < \pi'(0) < \infty$]. It intersects the horizontal axis at k^* since eq. (9) reduces to eq. (6) when $\hat{Z}$ equals zero. Eq. (10) is the constraint that lenders must receive the market rate of return, and is labeled as the *MR* curve. It is upward-sloping.[10] When k rises, borrowing goes up; this means Z^g (and therefore $\hat{Z}$) must rise since Z^b cannot adjust. The curve intersects the horizontal axis at $k = V$.

Investment in the information-constrained case must be below its first-best value k^*. The result that $k < k^*$ follows immediately from a comparison of (6) and (9), as well as from inspection of fig. 1. If k is below k^*, then *ex post* per-capita output, $\theta\pi(k)$, must lie below its first-best value, $\theta\pi(k^*)$.[11] An implication is that both per-capita investment and per-capita output will depend on per-capita wealth. A rise in V shifts the *MR* curve downward in fig. 1 and leaves the *IC* curve unchanged, thereby raising k and lowering $\hat{Z}$.[12,13] If the rise is due to an increase in W_1, then the borrower relies less on external funds, lowering Z^g and therefore $\hat{Z}$. If it is due to W_2, then the borrower is able to guarantee a larger payment in the bad state, similarly lowering $\hat{Z}$. A kind of 'permanent income' result emerges; the measure of wealth relevant to the investment distortion is the present value of the entrepreneur's endowment stream.[14]

Note that the spread between the marginal product of capital and the world riskless interest rate will vary across countries and, in particular, will be larger the poorer the country. Cross-country differences in marginal products of capital may arise here even though the world capital market is perfectly integrated (the riskless rate is the same everywhere).[15] A corresponding result is that the spread between the loan rate and the riskless rate will be higher in poor countries. The loan (risky debt) rate r^{L} is given by

$$r^{\mathrm{L}} = \frac{Z^g - W_2}{k - V} = \frac{r}{\pi(k)}, \tag{11}$$

[10]The slope of the *MR* curve equals $[r/\pi(k)][1 - \phi(k)(1 - V/k)]$, where $\phi(k)$ is the ratio of the marginal product of capital to the average product, given by $\pi'(k)/[\pi(k)/k]$. Since $0 < \phi(k) < 1$ and since $V < k$ along the *MR* curve, the slope must be positive.

[11]Because the productivity risks are independent across investment projects, and because the number of projects is large, there is no aggregate risk.

[12]The result that increases in borrower net worth stimulate investment when informational problems are present is quite general; see Bernanke and Gertler (1989). For some empirical support, see Fazzari, Hubbard, and Petersen (1988).

[13]The effect of a change in V on k is given by

$$\mathrm{d}k/\mathrm{d}V = \pi'(k)\hat{Z}_3/\left[(\pi''(k)/\pi'(k))r - \pi'(k)\hat{Z}_2\right] > 0,$$

where $\hat{Z}(r, k, V) = r(k - V)/\pi(k)$, so that $\hat{Z}_2 > 0$ and $\hat{Z}_3 < 0$.

[14]For a model in which collateralizable future earnings are endogenous, see Gertler (1990). The setting studied there has repeated production, and entrepreneurs who enter long-term financial contracts with lenders.

[15]Thus our model is completely consistent with Frankel and MacArthur's (1988) finding that covered interest differentials are relatively small for many LDCs.

which is decreasing in k. Note that r^{L} is the rate on the uncollateralized component of borrowing.

Finally, consider how changes in the world interest rate influence investment. As r goes up, the *IC* curve shifts to the left. The borrower's opportunity cost of investing rises, so for any given value of $\hat{Z}$, k must decline. The *MR* curve moves inward as well, since some combination of a rise in $\hat{Z}$ and a fall in k is necessary for lenders to continue to receive a competitive return. Overall, k must decline.[16]

3. Applications to private and public external borrowing

The model developed here can readily be extended to consider a number of policy issues involving the distribution of wealth and international capital flows.

Application 1: Debt overhang

Suppose the government has a debt outstanding to foreign lenders of D per capita, payable at the end of the second period. The government finances the debt by levying a per-capita tax of τ on successful entrepreneurs in period 2. (Note that it cannot tax unsuccessful entrepreneurs, since after paying their creditors, they have no remaining resources.) The government budget constraint is thus

$$\pi(k)\tau = D. \tag{12}$$

Under perfect information, the introduction of the debt tax has no bearing on an entrepreneur's investment decision, which is still governed by eq. (6). The debt tax is effectively a lump-sum tax on entrepreneurial rents. Under asymmetric information, however, the tax leads to a decline in investment because of its impact on entrepreneurial wealth.

The existence of the debt tax modifies the entrepreneur's problem as follows: Eqs. (1)–(4) remain unchanged. In eqs. (5), (7), (8), and (9), Z^{g} and $\hat{Z}$ are replaced by $Z^{\mathrm{g}} + \tau$ and $\hat{Z} + \tau$, respectively; the entrepreneur's state-contingent obligations now include payments to the government as well as to private lenders. Eq. (10), however, remains as before because the introduction of taxes does not affect the restriction that lenders must receive a competitive return. Making use of the government's budget constraint (12),

[16]The interest-elasticity of investment in the information-constrained case may or may not be greater than in the full-information case:

$$\mathrm{d}k/\mathrm{d}r = \left[1 + \pi'(k)\hat{Z}_1\right] \Big/ \left\{\left[r\pi''(k)/\pi'(k)\right] - \pi'(k)\hat{Z}_2\right\} < 0,$$

where $\hat{Z}(r, k, W_1, W_2) = r[k - (W_1 + W_2/r)]/\pi(k)$, so that $\hat{Z}_1 > 0$ and $\hat{Z}_2 > 0$. $\mathrm{d}k/\mathrm{d}r$ is greater than $\mathrm{d}k^*/\mathrm{d}r$ if $\hat{Z}_1$ is sufficiently large relative to $\hat{Z}_2$.

the *IC* and *MR* curves can be written as

$$\pi'(k)\left[\theta - (\hat{Z} + \tau)\right] = r, \qquad IC' \text{ curve}, \tag{9'}$$

$$\hat{Z} + \tau = r(k - V^{\mathrm{D}})/\pi(k), \qquad MR' \text{ curve}, \tag{10'}$$

where

$$V^{\mathrm{D}} \equiv W_1 + W_2/r - D/r = V - D/r$$

is the present value of the borrower's after-tax endowment stream. In analogy with eqs. (9) and (10), one can think of eqs. (9′) and (10′) as determining $\hat{Z} + \tau^{\mathrm{g}}$ and k as functions of V^{D}. Thus the impact on investment of a rise in government debt to foreigners is the same as the effect of a decline in V. Since the debt tax is indexed to income, it reduces each entrepreneur's incentive to invest. This debt-overhang-induced distortion ultimately arises from the information structure and not from *ad hoc* restrictions on the kinds of taxes the government can use.

If their government's foreign debt D is sufficiently large, private borrowers may be shut out of international credit markets entirely. As D rises, V^{D} shrinks, eventually becoming negative. In fig. 1, the *MR* curve shifts leftward to the point where it no longer intersects the *IC* curve at a positive value of k.

Application 2: Government-guaranteed private debt

In many LDCs, a considerable proportion of private debt to foreigners is government-guaranteed. What effect does this have on investment? Suppose that the government guarantees a firm's creditors a payment of σ in the event of an unsuccessful outcome and charges successful firms a tax of τ. In this case, the government budget constraint is given by

$$\pi(k)\tau = \left[1 - \pi(k)\right]\sigma. \tag{13}$$

In eq. (4), the condition that lenders earn a competitive rate of return, Z^{b} is replaced by $Z^{\mathrm{b}} + \sigma$. In eqs. (5) and (7), Z^{g} is replaced by $Z^{\mathrm{g}} + \tau$, reflecting the tax successful entrepreneurs must pay to finance the loan guarantees.

By employing the government budget constraint (13), it is easy to show that the loan-guarantee program has no impact on investment. The guarantee of a payment in the bad state reduces the amount entrepreneurs must pay in the good state, Z^{g}. This lowers the spread between the entrepreneur's payoffs to lenders in different states and thus, other things equal, tends to mitigate the incentive problem. However, this positive effect is completely offset by the tax successful entrepreneurs must pay. Due to the government budget constraint, $Z^g + \tau$ adjusts to equal what Z^g would have been in the absence of the loan-guarantee program.

The key to this neutrality result is that the government loan-guarantee program involves no redistribution. The guarantee program, which benefits the entrepreneurial sector, is completely financed by it. Obviously, if the program is partly financed by other citizens, it will stimulate investment. However, this effect comes entirely from the transfer of wealth across sectors and not the vehicle of a loan guarantee program.

Application 3: Wealth shocks and indexation

Even though everyone is risk-neutral, variability in wealth $(W_1 + W_2/r)$ that occurs prior to contracting reduces welfare.[17] Factors that may contribute to wealth fluctuations include terms-of-trade shocks, world interest-rate shifts, changes in foreign aid, discovery of natural resources, and technological changes affecting future profit flows.

Randomness in wealth reduces welfare because, due to agency costs, expected consumption is concave in wealth. Differentiating the entrepreneur's objective function (5) at the optimum yields

$$\mathrm{dE}\{c\}/\mathrm{d}V^{\mathrm{D}} = [\theta\pi'(k) - r]\,\mathrm{d}k/\mathrm{d}V^{\mathrm{D}} + r \geq r, \tag{14}$$

where the inequality holds strictly when $V^{\mathrm{D}} < k^*$. [Of course, under perfect information (or when $V^{\mathrm{D}} \geq k^*$), $\mathrm{dE}\{c\}/\mathrm{d}V^{\mathrm{D}} = r$ and expected consumption is linear in wealth.] One can show that $\mathrm{d}^2\mathrm{E}\{c\}/(\mathrm{d}V^{\mathrm{D}})^2 < 0$ given a very weak restriction on the third derivative of the production function $\pi(k)$.[18]

Suppose W_2 consists of proven copper reserves and that copper does not enter the domestic production technology. Then, even apart from the usual risk-aversion arguments, individuals may want to privately insure against fluctuations in copper prices. To the extent they are unable to – possibly due to limited horizons – the government may indirectly provide this insurance by indexing its foreign obligations. That is, by indexing debt D to W_2, the government can smooth out the variation in after-tax domestic wealth V^{D}, thus raising welfare.

If shifts in V^{D} reflect the impact of saving, then a correlation between saving and investment will emerge even though the country is small and

[17] Optimal contracts written in period 1 will include contingencies for shocks that occur in period 2. Because lenders are risk-neutral, they care only about the mean of W_2, conditional on first-period information. Under the optimal contract, lenders will absorb all the post-contracting risk to W_2.

[18] A sufficient condition to assure that $\mathrm{d}^2\mathrm{E}\{c\}/(\mathrm{d}V^{\mathrm{D}})^2 < 0$ is that $(\pi''(k)\pi(k)/[\pi'(k)]^2$ is increasing in k. [This condition guarantees that $\mathrm{d}^2k/(\mathrm{d}V^{\mathrm{D}})^2 < 0$.]

capital markets are perfectly integrated. Thus the model provides a somewhat different explanation of the Feldstein–Horioka (1980) puzzle. The usual explanations rely either on imperfect capital market integration (Feldstein and Horioka's preferred rationale) or on the patterns of technology shocks.[19]

Application 4: Implications of an unequal distribution of wealth

Until now we have assumed that all individuals have the same initial wealth. Due to the fact that each individual's expected consumption is concave in wealth (see Application 3), per-capita consumption must fall when wealth is distributed unevenly. Thus the agency problem considered here provides some motivation for why an unequal distribution of wealth may hinder development.

Application 5: Patterns of external borrowing across LDCs

Our analysis suggests that there should exist a strong link between external borrowing b (equal to $k - W_1$) and per-capita wealth among poor countries. The exact effect of wealth on patterns of external borrowing will depend on whether it is current 'cash' assets, W_1, or future 'collateralizable' assets, W_2, which differ most across LDCs. Clearly, $\mathrm{d}b/\mathrm{d}W_2 = \mathrm{d}k/\mathrm{d}W_2 > 0$; external borrowing rises with a rise in W_2 since investment rises and the cash available for internal finance, W_1, is unchanged. The effect of a change in W_1 on b is ambiguous since internal funds rise along with k. External borrowing will rise with W_1 if a dollar increase in wealth induces more than a dollar increase in investment.[20]

Internal funds W_1 are typically small relative to collateralizable assets W_2. The latter, for example, could include a good fraction of a country's capital stock, land, and natural resources. Thus, one would expect the overall correlation between wealth and external borrowing across poor countries to be positive. Clearly, this correlation does not hold for rich countries; once V exceeds k^*, the country becomes a net lender and its net asset position rises with wealth. More generally, as k rises diminishing returns set in, and as V rises agency problems diminish. Eventually the correlation between wealth and external borrowing turns negative. This discussion helps motivate the need to explore a world general-equilibrium model, which we consider next.

[19]Obstfeld (1986) shows how a strong savings–investment correlation could arise in a frictionless setting if technology shocks are dominant.

[20]$\mathrm{d}b/\mathrm{d}W_1 = \mathrm{d}k/W_1 - 1 = \mathrm{d}k/\mathrm{d}V - 1$, where $\mathrm{d}k/\mathrm{d}V$ is given in footnote 13 above. Inspection of footnote 13 indicates that $\mathrm{d}k/\mathrm{d}V > 1$ if diminishing returns set in slowly, i.e., if $\pi''(k)$ is small relative to $\pi'(k)$.

4. The two-country general-equilibrium case

We now specify a two-country model in which the world interest rate is determined endogenously. Relative to the perfect-information benchmark, North-South capital flows are muted and possibly even reversed. The unequal distribution of wealth across countries makes world output and the world interest rate lower than they would be otherwise. One implication of the analysis is that a rise in wealth in the rich country can actually hamper investment in the poor country. Rich-country capital markets become more efficient, siphoning investment funds out of the poor country.

Suppose there are two countries of equal *population* size, country R ('rich') and country P ('poor'). In each country, α percent of the individuals are 'entrepreneurs' and $1-\alpha$ percent are 'lenders'. All individuals have the same utility function, given by eq. (1). Everyone in the poor country is endowed with W_1^{P} units of the consumption good in period 1 and W_2^{P} units in period 2. Rich-country citizens receive W_1^{R} $(>W_1^{\mathrm{P}})$ and W_2^{R} $(>W_2^{\mathrm{P}})$. Finally, we assume the poor-country government inherits a per-capita debt to the rich country of $D<W_2^{\mathrm{P}}$. The debt is financed by a second-period tax of $\tau^{\mathrm{L}}=D$ on lenders and a tax of $\tau=D/\pi(k^{\mathrm{P}})$ on successful entrepreneurs (see Application 1). The rich country rebates the proceeds equally to all its citizens (i.e., everyone receives a transfer of D).

The project technology is the same across entrepreneurs and across countries and is given by eq. (2) above. As before, if an entrepreneur wants to invest more than her endowment she has to borrow, so that eq. (3) still applies. Lenders do not have projects; their only option is to lend to entrepreneurs.[21] Finally, the information structure is the same as in the small-country case.

If there were no information asymmetries, the following three equations would characterize the world equilibrium:

$$\pi'(k^{\mathrm{P}*})\theta=r^*, \tag{15}$$

$$\pi'(k^{\mathrm{R}*})\theta=r^*, \tag{16}$$

$$\alpha(k^{\mathrm{R}*}+k^{\mathrm{P}*})=W_1^{\mathrm{P}}+W_1^{\mathrm{R}}, \tag{17}$$

where the asterisks (*) denote the full-information equilibrium. The main difference from the small-country case is, of course, that the world interest rate r is endogenous. It depends on technology and the supply of investment funds, given by the first-period world endowment $W_1^{\mathrm{P}}+W_1^{\mathrm{R}}$. Since the technologies are the same, $k^{\mathrm{P}*}$ equals $k^{\mathrm{R}*}$ and, therefore, the rich country

[21] One could introduce the fiction of zero-profit intermediaries to facilitate lending.

lends to the poor country. Under perfect information, the pattern of investments is independent of the cross-country distribution of wealth.

Let

$$\Omega_2^P \equiv W_2^P - D, \qquad \Omega_2^R \equiv W_2^R + D,$$

$$\Gamma^P \equiv Z^{gP} + \tau - W_2^P, \qquad \Gamma^R \equiv Z^{gR} - \Omega_2^R.$$

Under asymmetric information, the following five equations then characterize the world equilibrium, determining k^P, k^R, r, Γ^R, and Γ^P,

$$\pi'(k^P)(\theta - \Gamma^P) = r, \tag{18}$$

$$\pi'(k^R)(\theta - \Gamma^R) = r, \tag{19}$$

$$\Gamma^P = r\left[k^P - \left(W_1^P + \Omega_2^P/r\right)\right]/\pi(k^P), \tag{20}$$

$$\Gamma^R = r\left[k^R - \left(W_1^R + \Omega_2^R/r\right)\right]/\pi(k^R), \tag{21}$$

$$\alpha(k^P + k^R) = W_1^P + W_1^R, \qquad WW \text{ curve}. \tag{22}$$

Eqs. (18) and (19) correspond to eq. (9′) in Application 1, and eqs. (20) and (21) correspond to eq. (10′).[22] Eq. (22) is the condition that the total demand for investment capital must equal the world supply, and is drawn as the negatively-sloped *WW* curve in fig. 2.

Investment in the poor country is now less than in the rich country. Combining eqs. (18) through (21) yields

$$r = \rho\left(k^P; W_1^P, \Omega_2^P, \theta\right) = \rho\left(k^R; W_1^R, \Omega_2^R, \theta\right), \qquad \rho\rho \text{ curve}, \tag{23}$$

where the function $\rho(\cdot)$ is given by

$$\rho\Big(\underset{-}{k^J}; \underset{+}{W_1^J}, \underset{+}{\Omega_2^J}, \underset{-}{\theta}\Big) = \frac{\pi'(k^J)\left[\theta + \Omega_2^J/\pi(k^J)\right]}{1 + \pi'(k^J)\left[k^J - W_1^J\right]/\pi(k^J)}, \qquad J = P, R. \tag{24}$$

[22] $\tau = D/\pi(k^P)$ appears in Γ^P for reasons discussed in Application 1. Debt D appears in the definition of Γ^R since the second-period 'after-transfer' endowment for rich-country entrepreneurs is $W_2 + D$. Our results would be unchanged if the rich-country government paid successful entrepreneurs a transfer of $D/\pi(k^R)$ and gave unsuccessful entrepreneurs nothing. In this case $D/\pi(k^R)$ would replace D in the definition of Γ^R.

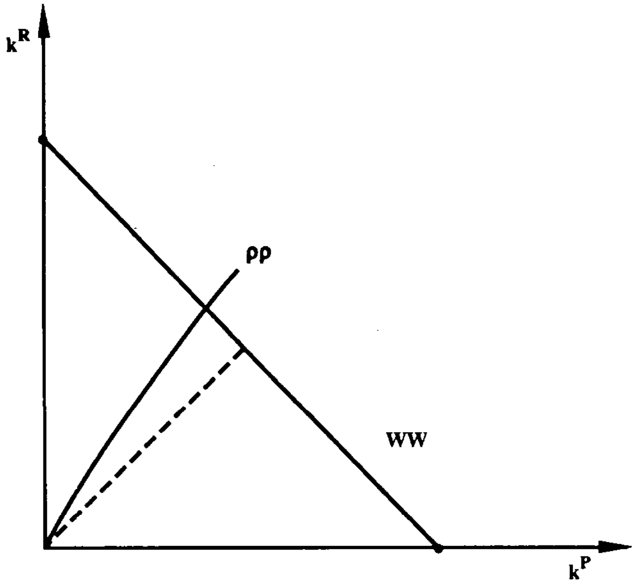

Fig. 2. Equilibrium in the two-country case.

As indicated in eq. (24), $\rho_1 < 0$ and $\rho_2 > 0$. It follows immediately that $k^P < k^R$, since $W_1^P < W_1^R$ and $\Omega_2^P < \Omega_2^R$. Because investment is distorted, world output is lower than in the perfect-information case. The world interest rate must also be lower; this is easily demonstrated by comparing conditions (19) and (16), and noting that $k^R > k^{R*}$ and that $\Gamma^R > 0$. Thus lenders are unambiguously worse off under asymmetric information. Eq. (23) is drawn as the positively-sloped $\rho\rho$ curve in fig. 2.

In general, the pattern of world investment depends on the agency costs of lending in one country relative to the other, which in turn depend on the net asset positions of entrepreneurs across countries.[23] From fig. 2, one can definitely say that fewer funds flow from the rich country to the poor country than under full information. It is even conceivable that the poor country lends to the rich one. To illustrate this point, consider the impact of a rise in D, the debt owed by the poor country to the rich country. This corresponds

[23]An important difference between our model and earlier frameworks emphasizing capital market frictions [e.g., Persson and Svenson (1989)] is that the imperfections and the forms of the financial contracts are derived endogenously. An important exception is Greenwood and Williamson (1989) who develop a monetary model of international business fluctuations under incomplete information. Other related papers are Samolyk (1988), who studies the transmission of regional disturbances in financial markets, and Kletzer and Bardhan (1987), who discuss how differences in domestic capital market efficiency can influence patterns of trade.

to an upward rotation in the pp curve in fig. 2; the WW curve remains unchanged. k^{R} rises and k^{P} falls. The wealth transfer lowers the agency costs of finance in the rich country and raises them in the poor country, inducing an outflow investment funds from the poor country. While we have focused on the impact of a change in D, it should be obvious that any factor that redistributes wealth between countries (e.g., a permanent terms of trade shock) will have similar effects.

Thus a wealth transfer can impose important indirect costs on the poor country. Holding constant the world interest rate, poor-country entrepreneurs see their project rents decline due to the reduction in investment. Therefore, to the extent that the induced movement in the world interest rate is not large, the indirect effects of a transfer always magnify its costs. Otherwise, the exact effect depends on the direction of the interest-rate change and on which country is the net debtor.[24] If the poor country is small, however, then the movement in r is negligible so that the capital market problems always magnify the costs of wealth transfers. The present model accordingly produces a 'transfer' problem in the sense that the cost to a country of paying a foreign debt may exceed the face value of the payments. Note that the transfer problem here relates to intertemporal trade rather than to contemporaneous trade, as in the classic debate between Keynes (1929) and Ohlin (1929).

Even a unilateral rise in wealth in the rich country can hinder investment in the poor country. Suppose W_2^{R} increases (so that Ω_2^{R} increases). Again the WW curve remains unchanged and the pp curve rotates upwards. The shift is less than in the previous case since wealth in the poor country remains fixed. The impact on capital flows is qualitatively the same as above. The only difference is that the world interest rate unambiguously rises, due to the increased demand for investment funds by rich-country entrepreneurs. [Inspection of eqs. (23) and (24) reveals that $\mathrm{d}r/\mathrm{d}\Omega_2^{\mathrm{R}} > 0$ since k^{P} declines while W_1^{P} and Ω_2^{P} remain unchanged.] If the poor country is a net debtor ($\alpha k^{\mathrm{P}} > W_1^{\mathrm{P}}$), its national income,

$$y^{\mathrm{P}} \equiv \alpha\left[\pi(k^{\mathrm{P}})\theta - r\left(k^{\mathrm{P}} - W_1^{\mathrm{P}}\right)\right] + (1-\alpha) r W_1^{\mathrm{P}} + \Omega_2^{\mathrm{P}},$$

definitely declines.

5. Empirical evidence

Perhaps the most direct evidence one could provide in support of our model would be to show that, across developing countries, the marginal

[24] The overall impact of the wealth transfer on the world interest rate is ambiguous. This is due to the offsetting effects of the transfer on rich- versus poor-country entrepreneurs' demands for investment funds.

return on investment is higher the poorer the country. Although such an exercise is clearly feasible, it is a very significant undertaking which involves estimating production functions across a broad range of developing countries. However, there does exist some evidence to support the related prediction that the spreads between the risk-free rate and the risky-debt rate should be larger in poor countries [see eq. (11)].[25] Spreads in industrialized countries tend to be 2 to 3 percent. They are nominally the same in noninflationary LDCs, but are effectively much higher when the added transactions costs facing borrowers and depositors are taken into account.[26]

Another empirical implication of our model is that, across developing countries, per-capita external borrowing should be increasing in per-capita wealth (see Application 5). In table 1, we present 1980 data on income and external borrowing for seventy developing countries, listed in order of GNP per-capita.[27] The second column lists external debts owed to private lenders; the third column also includes debts owed to other governments and to multilateral credit agencies (e.g., the International Monetary Fund and the World Bank). Scatter plots of column 1 against column 2 and of column 1 against column 3 are presented in figs. 3 and 4. Fig. 4 suggests a roughly unit-elastic relationship between total external debt and GNP, whereas fig. 3 suggests that external debt to private lenders rises more than proportionately with GNP.[28]

As one moves up the country income scale, borrowing from private sources displaces borrowing from public sources, much as one observes across individuals within a country. Since a substantial component of official loans is simply foreign aid in drag [see Bulow and Rogoff (1990)], the relevant measure of borrowing for our model is probably external debt to private lenders. The upshot is that as fig. 3 suggests, external borrowing rises more than percent for percent with GNP.

A number of other stories are, of course, potentially consistent with fig. 3. One possibility is that poorer countries are simply at an earlier stages of their borrowing and development cycle. But the bulk of the external borrowing reported in table 1 took place over a relatively short period (during the seventies), ruling out this explanation. Another candidate explanation is

[25]See Goldsmith (1969), Hansen (1986), and Rocha (1986).

[26]In inflationary LDCs spreads typically exceed 10 percent. [See *World Bank Development Report* 1989.] Clearly, differences in spreads across countries also depend on differences in the tax and regulatory treatment of banks, and not just on differences in agency costs.

[27]We chose the year 1980 because after the debt crisis began in 1982 the correspondence between the book value and the market value of loans becomes much weaker. However, one obtains similar results using data for 1986. [See Gertler and Rogoff (1989).]

[28]Note that the scale of the vertical axes is roughly twice that of the horizontal axes. A regression of the log of external debt to private creditors per capita on a constant and the log of GNP per capita yields a slope coefficient of 1.60 with a standard error of 0.12. When total external debt per capita is used, the slope coefficient is 1.05 with a standard error of 0.08. See Gertler and Rogoff (1989).

Table 1

Measures of external borrowing versus GNP, 1980: dollars per capita.[a,b]

	GNP	External debt to private lenders	Total external debt
Ethiopia	107	3	21
Uganda	131	16	56
Nepal	142	0	15
Bangladesh	144	3	45
Chad	162	14	49
Burma	171	9	45
Malawi	190	51	136
Burundi	222	5	40
Rwanda	226	6	37
Mali	231	8	101
Burkina Faso	234	9	54
India	256	3	29
Sri Lanka	271	25	125
Tanzania	276	46	138
Pakistan	283	16	120
Haiti	289	7	60
Sierra Leone	321	51	131
Benin	331	69	120
Central African Republic	343	30	82
Sudan	358	78	268
Somalia	361	13	191
Madagascar	370	68	144
Zaire	380	71	183
Ghana	384	24	114
Kenya	412	117	210
Mauritania	412	122	511
Togo	435	208	408
Niger	471	111	163
Lesotho	481	14	53
Senegal	504	106	225
Yemen Arab Republic	508	17	165
Indonesia	511	78	143
Egypt	514	149	470
Bolivia	516	263	482
Liberia	591	131	383
Zambia	617	226	558
Honduras	648	201	400
Thailand	686	124	178
Philippines	729	284	360
El Salvador	780	87	202
Cameroon	803	150	296
Papua New Guinea	831	169	243
Morocco	859	240	483
Botswana	1028	11	190
Congo	1036	663	1096
Dominican Republic	1096	212	368
Jordan	1122	259	601
Guatemala	1128	91	168
Peru	1139	373	578
Jamaica	1157	318	885
Cote D'Ivoire	1206	557	703

Table 1 (continued)

	GNP	External debt to private lenders	Total external debt
Nigeria	1236	98	110
Turkey	1256	190	428
Columbia	1285	176	268
Tunisia	1332	243	554
Ecuador	1373	577	739
Paraguay	1467	174	304
Syria	1518	111	315
Korea	1584	414	773
Panama	1754	1235	1565
Brazil	1912	525	582
Argentina	1987	894	962
Costa Rica	2044	846	1216
Algeria	2203	851	1001
Chile	2391	951	1084
Portugal	2431	750	982
Mexico	2726	763	828
Uruguay	3448	235	570
Gabon	3584	1108	1462
Venezuala	3961	1929	1963

[a]*Sources:* World Bank, World Debt Tables: *External Debt of Developing Countries*, Vol. II, 1988–89 ed., and International Monetary Fund, *International Financial Statistics*.

[b]Total external debt includes public and publicly guaranteed long-term debt, private nonguaranteed long-term debt, IMF credit, and short-term debt. External debt to private lenders includes long-term public and publicly guaranteed debt to private creditors, long-term private nonguaranteed debt, and short-term debt. All of the World Bank's list of developing countries are included above, except those with 1986 populations under one million and/or GNP per capita over $3,000. Communist countries are also excluded; Bhutan, Lebanon, Guinea, Zimbawe, and Malaysia are excluded due to insufficient data.

that capital flows into countries where technology is more advanced.[29] This, no doubt, is an important part of the story. However, the general relation between private external borrowing and GNP also holds up within regions (Africa, Asia, and Latin America).[30] Examining these regional relationships is a crude way to control for differences in expected productivity across countries. The idea is that whereas technology shocks may differ across Brazil and Nigeria, they are less likely to differ between Brazil and Argentina.

[29]For example, Romer's (1989) growth and human-capital model provides a nice explanation of why capital may flow to rich countries. A virtue of our model is that it is also consistent with low-income countries having higher spreads between risky and riskless debt rates.

[30]Regressing the log of external debt to private lenders per capita versus a constant and the log of GNP per capita yields a slope coefficient of 1.51 for sub-Saharan Africa (with standard error 0.25), of 1.51 for Latin America and the Caribbean (with standard error 0.29), and of 2.22 for Asia (with standard error 0.30); see Gertler and Rogoff (1989).

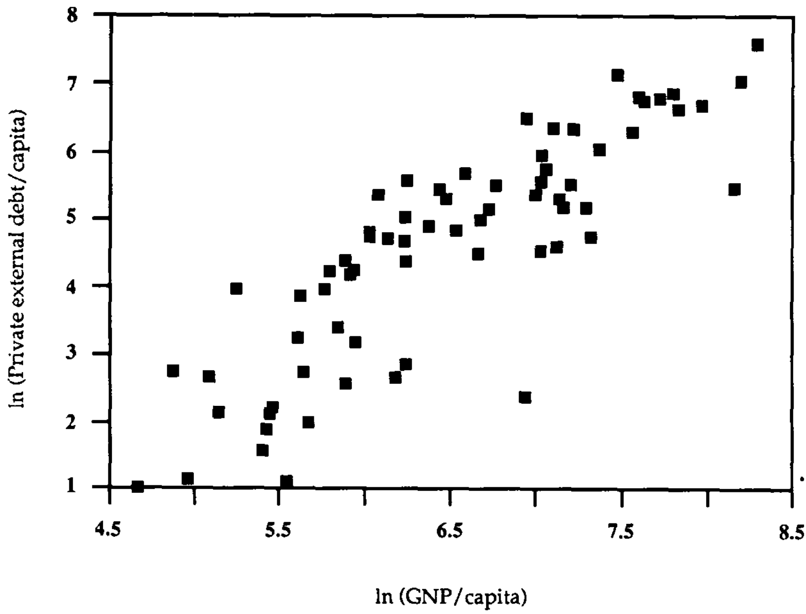

Fig. 3. External debt to private creditors versus GNP.

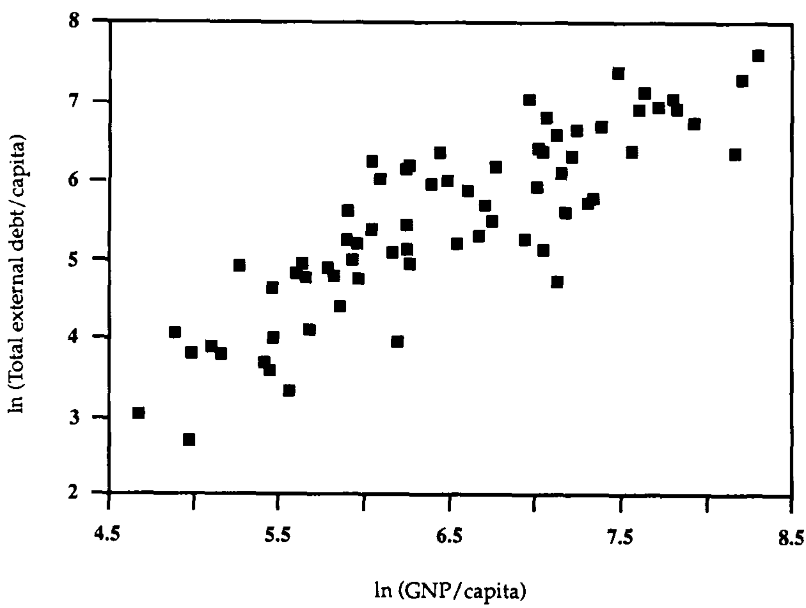

Fig. 4. Total external debt versus GNP.

Yet another possibility is that developing countries borrowed in the seventies to smooth out the effects of the oil shocks. One problem with this view is that, at the time, it was not obvious that the oil shocks were temporary. Even so, the intertemporal smoothing hypothesis might have some difficulty capturing the greater than unit-elastic relation suggested by fig. 3.[31] While there are other explanations of fig. 3, it is worth noting that these alternatives are silent on the inverse relation between development and capital market efficiency, something which our story captures.

6. Conclusions

A standard tenet of development economics is that capital market efficiency is important in growth. Our analysis instead suggests a symbiotic relationship between these two variables.[32] Increased wealth in a country tends to mitigate agency problems in lending, enhancing capital market efficiency and thereby facilitating further growth. In an open economy, this relationship is magnified as countries with more efficient capital markets draw in funds from abroad.

The way in which domestic capital market inefficiencies influence international capital flows has a number of policy implications. External public debt, for example, crowds out investment by lowering the collateralizable wealth of domestic entrepreneurs. Also, indexing of foreign debts to terms-of-trade shocks can raise welfare. This is true even if individuals are risk-neutral, because capital market frictions cause expected consumption to be concave in wealth. A related implication is that aggregate income is lower when wealth is distributed unevenly. Finally, in a general-equilibrium setting investment in poor countries may suffer as rich countries get richer. The improved efficiency of foreign capital markets causes investment funds to be siphoned away from poor-country entrepreneurs.

It is worth noting that the present analysis suggests an alternative explanation for the Feldstein–Horioka (1980) puzzle that savings and investment tend to be highly correlated across countries. Under perfect information if a small country's endowment increases without any corresponding increase in its productive opportunities, it will invest any increased savings abroad. In a world where borrowing is subject to informational problems, however, a large part of the increase in savings may be invested domestically.

[31] Sovereign risk can also explain a positive relationship between external debt and per-capita income, though standard models yield only a proportional relationship. See Atkeson (1988), Bulow and Rogoff (1989), and Fernandez and Rosenthal (1990).

[32] Greenwood and Jovanovic (1990) have independently suggested a similar theme, but emphasize the role of intermediation.

Appendix

The formal problem that jointly determines how much the entrepreneur invests and her contractual arrangement with lenders is as follows: Choose k, b, Z^g, and Z^b to solve

$$\max \pi(k)(\theta - Z^g) - [1 - \pi(k)]Z^b + r(W_1 + b - k) + W_2, \qquad \text{(A.1)}$$

subject to

$$\pi(k)Z^g + [1 - \pi(k)]Z^b = rb, \qquad \text{(A.2)}$$

$$\pi'(k)[\theta - (Z^g - Z^b)] = r, \qquad \text{(A.3)}$$

$$W_2 \geq Z^b, \qquad \text{(A.4)}$$

$$W_1 + b - k \geq 0. \qquad \text{(A.5)}$$

Let μ, γ, ν, and ψ be the (non-negative) multipliers associated with (A.2)–(A.5), respectively. Then the first-order necessary conditions with respect to k, b, Z^g, and Z^b are given by

$$\mu\pi'(k)(Z^g - Z^b) + \gamma r\pi''(k)/\pi'(k) - \psi = 0, \qquad \text{(A.6)}$$

$$\psi = r(\mu - 1), \qquad \text{(A.7)}$$

$$\pi(k)(\mu - 1) - \gamma\pi'(k) = 0, \qquad \text{(A.8)}$$

$$[1 - \pi(k)](\mu - 1) + \gamma\pi'(k) - \nu = 0. \qquad \text{(A.9)}$$

Recall that k^* is the first-best level of capital investment, given by

$$\pi'(k^*)\theta - r = 0 \qquad \text{(A.10)}$$

[which corresponds to eq. (6) in the text]. Then we have:

Proposition. (i) *If* $V \equiv W_1 + W_2/r \geq k^*$, $k = k^*$; (ii) *if* $V < k^*$, $k < k^*$, *and the following two equations jointly determine* k *and* $\hat{Z} \equiv Z^g - W_2$:

$$\pi'(k)(\theta - \hat{Z}) = r, \qquad \text{(A.11)}$$

$$\hat{Z} = r(k - V)/\pi(k), \qquad \text{(A.12)}$$

where (A.11) and (A.12) correspond to eqs. (9) and (10) in the text.

Proof. Part (i) is obvious; if $V \geq k^*$, the entrepreneur can undertake the unconstrained optimal investment either because he has sufficient funds to self-finance (if $W_1 > k^*$) or because he is able to fully collateralize his debt. Part (ii) can be proven by contradiction. Suppose $V < k^*$ and $k \geq k^*$. Then (A.5) implies $b > 0$. If $b > 0$, then (A.2) and (A.4) imply $Z^g > Z^b$. If $Z^g > Z^b$, then (A.3) and (A.10) imply $k < k^*$, which leads to a contradiction. Thus $k < k^*$. It follows that the incentive constraint (A.3) must be binding, implying $\gamma > 0$. Therefore, (A.8) and (A.9) imply $\mu > 1$ and $\nu > 0$, which implies in turn that (A.4) is binding. Using (A.4) to eliminate Z^b in (A.2) and (A.3) yields (A.11) and (A.12). ■

Corollary. If $V < k^*$, $V < k < k^*$.

Proof. $V < k^*$ implies $k < k^*$, from the above Proposition, which also implies $Z^b = W_2$. If $k < k^*$ and $Z^b = W_2$, then $Z^g > W_2$ from (A.3). It follows from (A.12) that $k > V$. ■

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