

# Developing Country Borrowing and Domestic Wealth

by

Mark Gertler

and

Kenneth Rogoff

University of Wisconsin

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## ABSTRACT

*Across developing countries, capital market inefficiencies tend to decrease and external borrowing tends to sharply increase as national wealth rises. We construct a simple model of intertemporal trade under asymmetric information which provides a coherent explanation of both these phenomenon, without appealing to imperfect capital mobility. The model can be applied to a number of policy issues in LDC lending, including the debt overhang problem, and the impact of government guarantees of private debt to foreign creditors. In the two-country general equilibrium version of the model, an increase in wealth in the rich country can induce a decline in investment in the poor country via a "siphoning effect". Finally, we present some new empirical evidence regarding the link between LDC borrowing and per capita income.*

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## I. Introduction

This paper develops a model in which the efficiency of domestic capital markets influences the pattern of international capital flows. Our analysis is motivated by three general considerations: First, among developing countries, external debt per capita tends to rise sharply with per capita GNP. Second, capital markets operate less efficiently in poorer countries, as Goldsmith (1969), McKinnon (1973) and others have documented.<sup>1</sup> One manifestation of this phenomenon is that spreads between loan and deposit rates tend to be higher in LDCs. Third, world capital markets are becoming increasingly integrated so that, for example, covered interest differentials are now fairly small across a broad range of countries. There are a variety of theoretical models consistent with any one of these facts; our aim is to present the simplest framework consistent with all three.

Our starting point is to modify the standard frictionless model of intertemporal trade between countries by introducing informational asymmetries between borrowers and lenders.<sup>2</sup> At the micro level, these informational frictions introduce a wedge between the costs of internal (to a firm) and external finance. The size of the wedge is endogenously determined and depends inversely on the net asset position of the individual borrower. At the macro level, there emerges (*ceteris paribus*) a negative correlation between the net wealth of a country and the spread between the domestic loan

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<sup>1</sup>For an extensive recent discussion of capital market inefficiencies in developing countries see World Bank 1989.

<sup>2</sup>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 really as much a model of capital flows between Manhattan and the Bronx as between Japan and India.

rate and deposit rates. A corresponding result is that differences in marginal products of capital can persist across countries even in a world with perfectly integrated capital markets where riskless rates are equalized. We show that these results can help explain the strong positive correlation between country wealth and external borrowing among LDCs.

Section II presents a small-country model where investment finance is constrained by a moral hazard problem. This stripped-down version of the model is sufficient to illustrate our main results concerning developing-country borrowing and the efficiency of developing-country capital markets. In section III we extend the model to consider a number of applications involving private and public external borrowing by LDCs. These applications include (a) the impact of foreign indebtedness on domestic investment, (b) the effect of having the government guarantee private debt to foreign lenders, (c) the indexation of foreign debts, (d) explaining cross-country correlations between domestic wealth and external debt.

Whereas the main applications we have in mind involve developing countries, the analysis is also capable of providing insights into how financial factors may influence capital flows between developed countries.<sup>3</sup> Section IV provides a two-country general equilibrium version of the model, which yields an interesting new perspective on the classic transfer problem: Here, the cost to a country of having to transfer wealth is exacerbated by information-induced inefficiencies. In general, increased wealth in one country can improve the efficiency of its capital markets and thereby "siphon"

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<sup>3</sup> Kletzer and Bardhan (1987) discuss how differences in domestic financial market efficiency can influence patterns of trade. Our model differs in that the degree of the inefficiency is an endogenous product of the country's state of development, as summarized by its per capita wealth. Also, the structure of financial contracts is endogenous here.

investment funds from the other country.

Finally, in section V we present some empirical evidence aimed at verifying the positive link between external borrowing and country wealth. Using data from 1980 for a cross-section of seventy developing countries, we show that for each percentage point increase in per capital income, per capita external debt to private creditors tends to rise significantly more than one percent. Moreover, this relation between external debt and national income tends to hold across countries within the same region (Africa, Asia, and Latin America). In the conclusions, we explain why our theory is likely to be at least part of the explanation for this interesting fact.

## II. 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. Before turning to the two-country case, we first develop and analyze a small-country framework. We consider an open economy inhabited by a large number of identical individuals; the economy is small in the sense that it cannot affect the world interest rate. There are two periods and one good. The representative individual is risk neutral and cares only about consuming in period two:

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

where  $c$  is her second-period consumption.

Entering period one, each person is endowed with  $W$  units of the consumption good.<sup>4</sup> There exist two ways to convert this endowment into final period consumption. The first option is to lend abroad at the (gross) world

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<sup>4</sup>Later, we will amend the concept of wealth to include any collateralizable future income or illiquid assets.

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 one yield  $\theta$  units of second-period output with probability  $\pi(k)$ , and zero units with probability  $1 - \pi(k)$ . That is,

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

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  $r/\theta < \pi'(0) < \infty$ .<sup>5</sup> 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.<sup>6</sup> We assume that output realizations are independent across the projects of different individuals.

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

$$W + b \geq k \quad (3)$$

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

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<sup>5</sup>  $\pi'(0) > r/\theta$  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.

<sup>6</sup> 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.

lenders the market rate of return  $r$ , so that<sup>7</sup>

$$\pi(k)Z^g + [1 - \pi(k)]Z^b = rb \quad (4)$$

The left-hand side of (4) is the expected payment to lenders.

The individual's expected second period consumption is given by

$$E\{c\} = \pi(k)[\theta - Z^g] - [1 - \pi(k)]Z^b + r[W + b - k] \quad (5)$$

where the last term is the individual's return from risk-free investments abroad, and the first two terms represent the expected net return on her project.

The information structure is as follows: Lenders may observe a borrower's initial wealth and the total amount she borrows. What the borrower does with the funds, however, is her private knowledge. In particular, she may secretly lend abroad rather than invest in her project. Whereas investment is unobservable, lenders can freely observe realized output. The production function  $\pi(\cdot)$  is 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

$$\pi'(k^*)\theta = r \quad (6)$$

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.<sup>8</sup> Contracts can be conditioned only on

<sup>7</sup> It is not necessary to assume that lenders are risk neutral, but only that idiosyncratic project risk be diversifiable in world capital markets.

<sup>8</sup> The incentive problem emerging here is classified as moral hazard because the informational asymmetry arises after contracting. See Dixit (1987) for an

realized output  $y$ , and not on  $k$ . Given any output-contingent payoffs  $(Z^g, Z^b)$  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<sup>9</sup>

$$\pi'(k)[\theta - (Z^g - Z^b)] = r \quad (7)$$

So long as  $Z^g$  differs from  $Z^b$ ,  $k$  will differ from its first-best optimum value  $k^*$ , given by (6).<sup>10</sup> 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. We will subsequently refer to (7) as the "incentive constraint."

If the borrower could promise lenders a fixed payment  $Z^g = Z^b = r(k^* - W)$  then [by (7)] she would invest the first best amount  $k^*$ . This is not feasible, however, since the project yields nothing in the bad state. Since the borrower's consumption must be non-negative, an important constraint on the form of the contract is

$$Z^b \leq 0 \quad (8)$$

For the case where  $W < k^*$  the optimal incentive compatible contract is found by choosing  $Z^g$ ,  $Z^b$ ,  $b$ , and  $k$  to maximize (5) subject to (3), (4), (7)

application to international trade.

<sup>9</sup>The analysis would be qualitatively similar if the borrower had the option of secretly consuming in period one instead of secretly lending abroad.

<sup>10</sup>Note that the Miller-Modigliani theorem fails under asymmetric information because the investment decision depends on the structure of contract payoffs. The idea that informational asymmetries can affect an individual firm's investment strategies and financial structure originated with Jensen and Meckling (1976).

and (8). The solution is as follows<sup>11</sup>: The contract pays lenders zero in the bad state, so that (8) is binding. (More generally, the contract always pays lenders the maximum feasible amount in the bad state.) 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, equation (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 (5) 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  $Z^g$ :

$$\pi'(k)[\theta - Z^g] = r, \quad \text{IC curve} \quad (9)$$

$$Z^g = r(k - W)/\pi(k) \quad \text{MR curve} \quad (10)$$

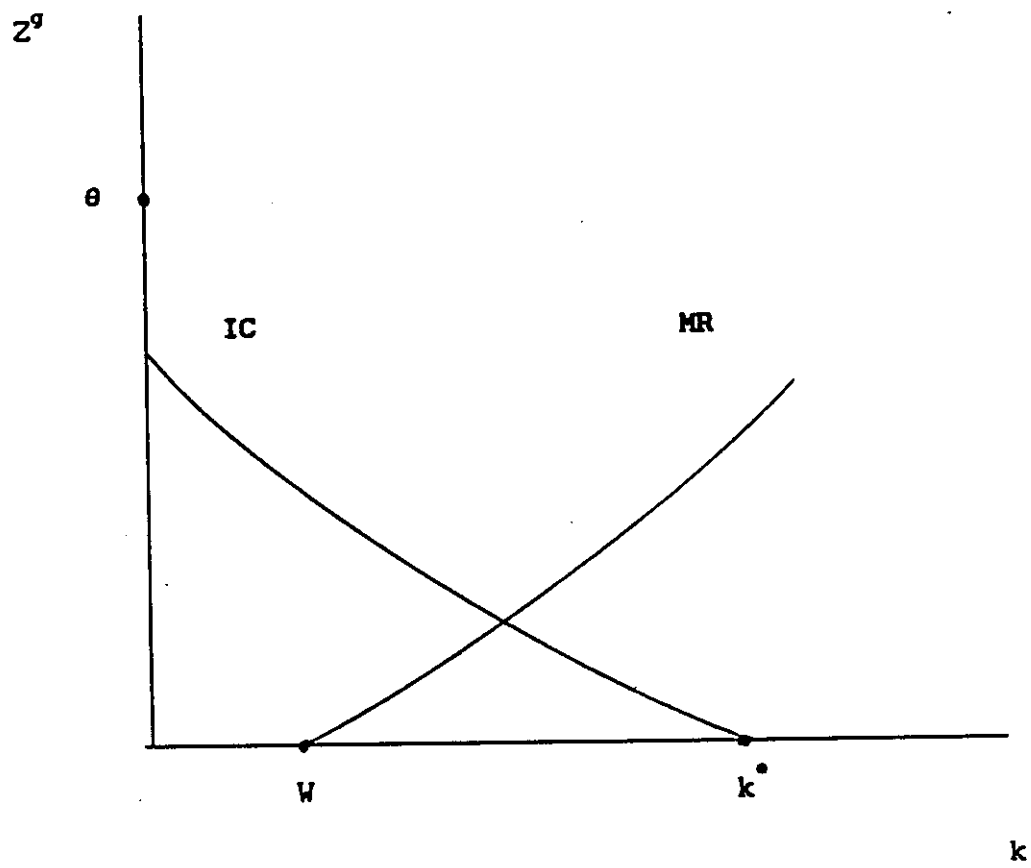
Equation (9) is the incentive constraint, and is drawn as the curve IC in Figure 1. It is downward sloping. A rise in  $Z^g$  lowers the borrower's expected marginal gain from investing and therefore must be offset by a decline in  $k$ . The curve intersects the vertical axis at a value of  $Z^g$  which lies between zero and  $\theta$  (recall that  $r/\theta < \pi'(0) < \infty$ ). It intersects the horizontal axis at  $k^*$  since eq. (9) resembles eq. (6) when  $Z^g$  equals zero. Equation (10) is the constraint that lenders must receive the market rate of return, and is labeled as the MR curve. It is upward sloping.<sup>12</sup> When  $k$  rises,

<sup>11</sup>See the Appendix for details.

<sup>12</sup>The slope of the MR curve equals  $[r/\pi(k)][1 - \phi(k)(1 - W/k)]$ ; 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  $W < k$  along the MR curve, the slope must be positive.



Figure 1  
EQUILIBRIUM IN THE SMALL COUNTRY CASE



borrowing goes up; this means  $Z^g$  must rise since  $Z^b$  cannot adjust. The curve intersects the horizontal axis at  $k$  equal to  $W$ . It lies above the horizontal axis at  $k^*$  since  $k^* > W$ .

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 Figure 1. If  $k$  is below  $k^*$ , then ex post per capita output,  $\theta\pi(k)$ , must lie below its first best value,  $\theta\pi(k^*)$ .<sup>13</sup> An implication is that both per capita investment and per capita output will depend on per capita wealth. A rise in  $W$  shifts the MR curve downward in Figure 1 and leaves the IC curve unchanged, thereby raising  $k$  and lowering  $Z^g$ .<sup>14</sup> Additional wealth increases the amount of internal funds available to the borrower; so for a given level of investment,  $Z^g$  declines, mitigating the incentive problem. Investment rises, in accordance with eq. (9), thus raising output as well.<sup>15</sup>

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

<sup>13</sup>Because the productivity risks are independent across investment projects, and because the number of projects is large, there is no aggregate risk.

<sup>14</sup>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).

<sup>15</sup>The effect of a change in  $W$  on  $k$  is given by

$$\frac{\partial k}{\partial W} = \pi'(k)Z_3^g / [(\pi''(k)/\pi'(k))r - \pi'(k)Z_2^g] > 0$$

where  $Z^g(r, k, W) = r(k - W)/\pi(k)$ , so that  $Z_2^g > 0$  and  $Z_3^g < 0$ .

perfectly integrated (the riskless rate is the same everywhere).<sup>16</sup> 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 is given by  $r/\pi(k)$ , which is decreasing in  $k$  and therefore decreasing in  $W$ .

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  $Z^g$ ,  $k$  must decline. The MR curve moves inward as well. Some combination of a rise in  $Z^g$  and a fall in  $k$  is necessary for lenders to continue to receive a competitive return. The interest-elasticity of investment in the information-constrained case may or may not be greater than in the full information case. It is greater if  $dZ^g/dr > 0$ . This will likely be the case if the initial amount borrowed,  $k - W$ , is large or if the production function is sufficiently concave so that the decline in  $k$  is not enough to offset the higher rate of interest.<sup>17</sup>

### III. Applications to Private and Public External Borrowing by LDCs

The model developed here can readily be extended to consider a number of issues involving developing-country borrowing:

#### APPLICATION 1: *Debt Overhang*

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<sup>16</sup>Thus our model is completely consistent with Frankel and MacArthur's (1988) finding that covered interest differentials are relatively small for many LDCs.

<sup>17</sup>The adjustment of  $k$  in response to a change in  $r$  is given by

$$\frac{dk}{dr} = [1 + \pi'(k)Z_1^g] / [(\pi''(k)/\pi'(k))r - \pi'(k)Z_2^g] < 0$$

where  $Z^g(r, k) = r(k - W)/\pi(k)$ , so that  $Z_1^g > 0$  and  $Z_2^g < 0$ .

Suppose the government has a debt outstanding to foreign lenders of  $rD$  per capita, payable at the end of the second period. The government finances the debt by taxing its citizens in period 2. Let  $\tau^g$  denote the tax on successful entrepreneurs, and  $\tau^b$  denote the tax on unsuccessful entrepreneurs; note that  $\tau^b$  must be zero since unsuccessful entrepreneurs have no resources. The government budget constraint is thus

$$rD = \pi(k)\tau^g \quad (11)$$

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  $Z^b$  are replaced by  $Z^g + \tau^g$  and  $Z^b + \tau^b$  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), the IC and MR curves can be written

$$\pi'(k)[\theta - (Z^g + \tau^g)] = r \quad \text{IC' curve} \quad (9')$$

$$(Z^g + \tau^g) = r(k - W + D)/\pi(k) \quad \text{MR' curve} \quad (10')$$

where  $\tau^g = rD/\pi(k)$ . In analogy with eqs. (9) and (10), one can think of eqs. (9') and (10') as determining  $Z^g + \tau^g$  and  $k$  as a function of  $W - D$ . Thus the

impact on investment of a rise in government debt to foreigners is the same as the effect of a decline in  $W$ . Since the debt tax is indexed to income, it reduces each entrepreneur's incentive to invest. *Note that this distortion ultimately arises from the information structure and not from ad hoc restrictions on the kinds of taxes the government can use.*

## APPLICATION 2: Government-Guaranteed Private Debt

In many LDCs, a considerable proportion of private foreign debt is government guaranteed. What effect does this have on investment? Suppose that the government guarantees a firm's creditors a payment of  $\sigma^b$  in the event of an unsuccessful outcome, and charges successful firms a tax of  $\tau^g$ . In this case, the government budget constraint is given by

$$\pi(k)\tau^g + [1 - \pi(k)]\sigma^b = 0 \quad (12)$$

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

By employing the government budget constraint (12), it is easy to show that the loan guarantee program has no impact on investment. The guarantee of a payment in the bad states reduces the amount entrepreneurs must pay in the good states,  $Z^g$ . 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,  $Z^g + \tau^g$  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, what is critical is the transfer of wealth across sectors and not the vehicle of a loan guarantee program.

### APPLICATION 3: *Wealth Shocks and Indexation*

We now further examine the impact of shocks to the country's wealth. First, it is useful to broaden the concept of wealth to include not just current liquid assets  $W$ , but also any collateralizable illiquid assets such as proven oil reserves or the secure portion of future earnings.<sup>18</sup> Changes in the value of illiquid assets are likely to account for a considerable portion of the volatility in a country's wealth. Let  $V$  denote the period-two payoff to each entrepreneur from collateralizable illiquid assets.<sup>19</sup> The entrepreneur's formal problem remains as before, except that  $V$  is added to the right-hand side of eq. (5) [the eq. for expected second-period consumption], and the limited liability constraint, eq. (8), is relaxed to be  $Z^b \leq V$ . It is easy to show that the determination of  $k$  is the same as before except that the relevant measure of wealth is now  $W + V/r$ .

Randomness in wealth can lower welfare even though all citizens are risk neutral. To see this, first note that because of the role of wealth in reducing agency costs, the shadow value of a unit of wealth may exceed  $r$ . Differentiating the entrepreneur's objective function (5) at the optimum

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<sup>18</sup> This generalized concept of borrower wealth arises in a dynamic setting. See Gertler (1988), who studies a closed-economy with repeated production and asymmetric information where entrepreneurs enter long-term financial contracts with lenders.

<sup>19</sup>  $V$  may be random so long as the distribution is common knowledge.

implies:

$$\partial E\{c\}/\partial(W + V/r) = [\theta\pi'(k) - r][\partial k/\partial(W + V/r)] + r \geq r \quad (13)$$

where the inequality holds strictly when the incentive constraint binds (where  $W + V/r < k^*$ ). One can show that given a very weak restriction on the third derivative of the production function  $\pi$ , the marginal gain in expected consumption diminishes as wealth rises; i.e.  $\partial^2 E\{c\}/[\partial(W + V/r)]^2 < 0$ .<sup>20</sup> Thus expected consumption is strictly concave in wealth (when the incentive constraint is binding).

Consider then, the problem of a country whose collateralizable "illiquid" wealth consists of proven oil reserves. From application 1, we know that it does not matter whether each entrepreneur owns a share of the oil directly, or whether the oil revenue is rebated to citizens by the government. Suppose that oil production is exogenous and that a manufactured good is produced in the entrepreneurial sector; this is the only good consumed locally. (All of the country's oil is exported.) A shock to the world price of oil (vis-à-vis the traded good) can then be interpreted as a shift in  $V$ . Note that in the presence of asymmetric information, fluctuations in the world price of oil will induce fluctuations in domestic manufacturing investment via their impact on entrepreneurial wealth. The investment fluctuations will be asymmetric, since a unit decline in wealth leads to a bigger absolute change in  $k$  than does a unit increase.<sup>21</sup> The effect of oil price shocks on GNP is similarly asymmetric.

<sup>20</sup> A sufficient condition to assure that  $\partial^2 E\{c\}/[\partial(W + V/r)]^2 < 0$  is that  $[\pi''(k)\pi(k)/[\pi'(k)]^2]$  is increasing in  $k$ . (This condition guarantees that  $d^2 k/[d(W + V/r)]^2 < 0$ .)

<sup>21</sup> This is true because  $k$  is strictly increasing and concave in  $W + V/r$ .

Thus, even apart from the usual risk aversion arguments, a developing country may want to index its repayments to the price of its (collateralizable) commodity exports. By smoothing the impact of commodity price shocks on wealth, the country can reduce the impact of credit market inefficiencies on investment in other sectors of the economy.

To the extent that shocks to  $W$  reflect the impact of saving, then a correlation between saving and investment will emerge even though the country is small and 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 markets (Feldstein and Horioka's preferred rationale) or on particular patterns of technology shocks.<sup>22</sup>

#### APPLICATION 4: *Patterns of External Borrowing Across LDCs*

Our analysis suggests that there should exist a strong link between external borrowing  $b$  (equal to  $k - W$ ) and country wealth among the set of low wealth countries. The exact effect of wealth on patterns of external borrowing will depend on whether it is liquid assets,  $W$ , or illiquid assets,  $V$ , which differ most across LDCs. Clearly,  $db/d(V/r) = dk/d(V/r) > 0$ ; external borrowing rises with a rise in  $V/r$  since investment rises and the supply of internal (liquid) funds is unchanged. The net effect of a change in liquid assets  $W$  on  $b$  depends on the sensitivity of  $k$  to changes in  $W$ . Differentiating eqs. (9) and (10) implies

$$\frac{db}{dW} = \frac{dk}{dW} - 1 = \left[ 1 - \phi(k)(1-W/k) - \frac{\pi''(k)\pi(k)}{\pi'(k)^2} \right]^{-1} - 1 \quad (14)$$

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<sup>22</sup> Obstfeld (1986) shows how a strong savings-investment correlation could arise in a frictionless setting if technology shocks are dominant.



where

$$0 < \phi(k) = \pi'(k)/[\pi(k)/k] < 1$$

External borrowing will rise with  $W$  if a dollar increase in wealth induces more than a dollar increase in investment. This will be the case if diminishing returns set in slowly, i.e., if  $\pi''(k)$  is small relative to  $\pi'(k)$ . (Inspection of eq. (14) indicates that the magnitude of  $\frac{\partial b}{\partial W}$  varies inversely with the absolute value of  $\pi''(k)/\pi'(k)$ .)

Since illiquid assets represent the lion's share of wealth for most countries, the overall correlation between wealth and external borrowing across poor countries is likely to be positive.

#### IV. The Two-Country General Equilibrium Case

Thus far we have devoted our attention to the case of small developing countries. Although the capital market imperfections characterized here are likely to be most severe for poor countries, the model can also be applied to analyze how financial factors may influence capital flows between large developed economies. (An alternative interpretation of the two-country analysis below involves having the developing countries as one group, and the industrialized countries as the other.)

Suppose there are two countries of equal *population* size, country R ("rich") and country P ("poor"). In each country,  $\alpha$  percent of the individuals are "entrepreneurs" and  $1-\alpha$  percent are "lenders." All individuals have the same utility function, given by equation (1). That is, they are risk neutral and care only about second period consumption. Entering the first period, all entrepreneurs in the poor country are endowed with  $W^P$  units of the good, and all lenders are endowed with  $W^{PL}$  units. Similarly, entrepreneurs and lenders in the rich country are endowed with  $W^R$  and  $W^{RL}$

units, respectively. For the time being, the only restriction we need impose is that  $W^P < W^R$ . (For now, we abstract from collateralizable illiquid assets.)

Each entrepreneur owns and manages a risky investment project. The project technology is the same across entrepreneurs and across countries, and is given by equation (2) above. As before, if an entrepreneur wants to invest more than her endowment she has to borrow, so that equation (3) still applies. Lenders do not have projects; their only option is to lend to entrepreneurs.<sup>23</sup>

The information structure is the same as in the small-country case. Lenders observe a project's realized output, but cannot observe the capital input. They cannot directly see whether the entrepreneur is secretly lending to other entrepreneurs.<sup>24</sup>

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

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

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

$$\alpha(k^{R*} + k^{P*}) = \alpha(W^P + W^R) + (1-\alpha)(W^{PL} + W^{RL}) \quad (17)$$

where the P and R superscripts denote the countries, and the \*'s 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 total world endowment. Since the technologies are the

<sup>23</sup>Without lenders, entrepreneurs would not be borrowers in the world general equilibrium.

<sup>24</sup>Note that entrepreneurs may secretly rechannel their investment funds either directly, or through a (zero-profit) intermediary.

same,  $k^{P*}$  equals  $k^{R*}$ . Under perfect information, the pattern of investments is independent of the pattern of endowments.

Under asymmetric information, the following five equations characterize the world equilibrium:

$$\pi'(k^P)[\theta - Z^{gP}] = r \quad (18)$$

$$\pi'(k^R)[\theta - Z^{gR}] = r \quad (19)$$

$$Z^{gP} = r[k^P - W^P]/\pi(k^P) \quad (20)$$

$$Z^{gR} = r[k^R - W^R]/\pi(k^R) \quad (21)$$

$$\alpha(k^P + k^R) = \alpha(W^P + W^R) + (1-\alpha)(W^{PL} + W^{RL}) \quad \text{WW curve} \quad (22)$$

Equations (18) and (19) correspond to equation (9) for the small country case, and equations (20) and (21) correspond to equation (10). Equation (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 Figure 2.

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

$$r = \underset{-}{\rho}(k^P, \underset{+}{W^P})\theta = \underset{-}{\rho}(k^R, \underset{+}{W^R})\theta \quad \rho\rho \text{ curve} \quad (23)$$

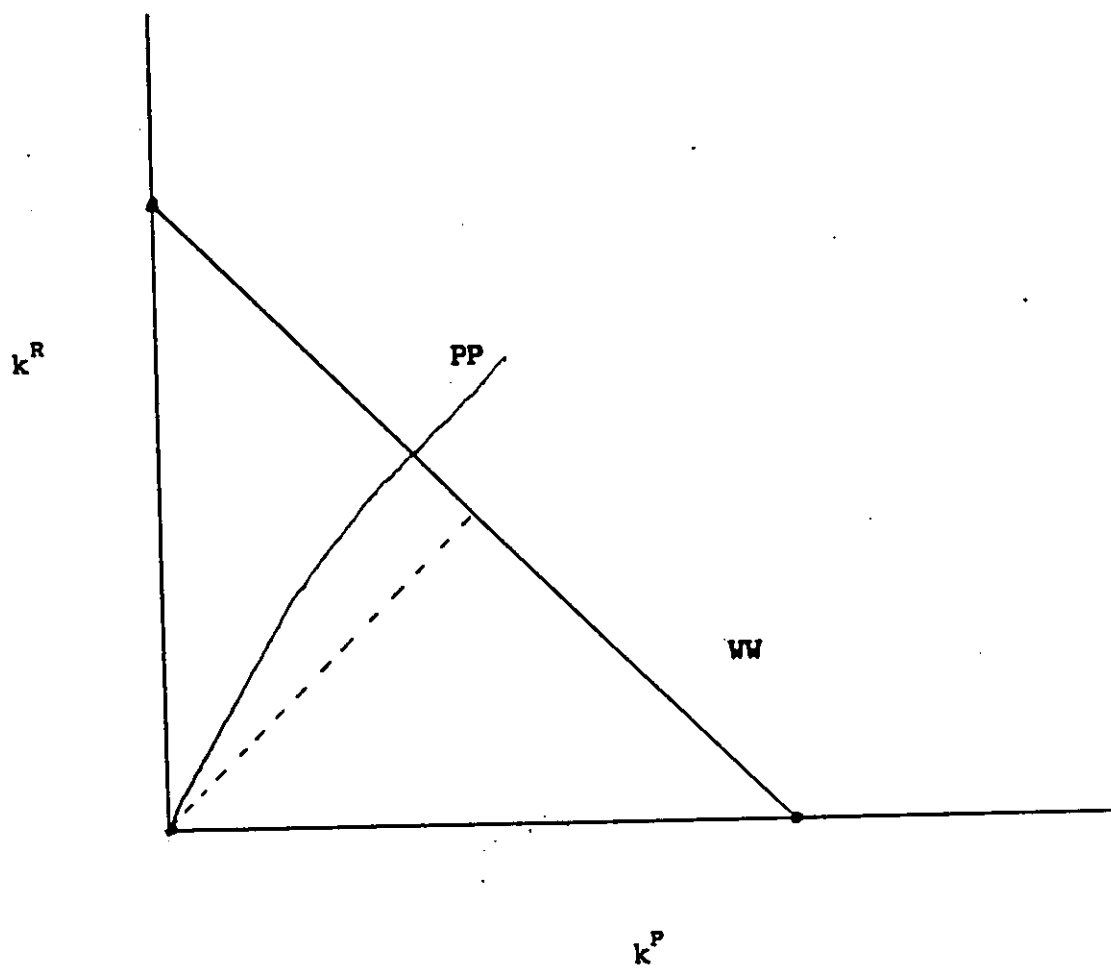
where the function  $\rho(\cdot, \cdot)$  is given by

$$\rho(k^J, W^J) = \frac{\pi'(k^J)}{1 + \pi'(k^J)[k^J - W^J]/\pi(k^J)}, \quad J = P, R \quad (24)$$

As indicated in equation (23),  $\rho_1 < 0$  and  $\rho_2 > 0$ . It follows immediately that  $k^P < k^R$ , since  $W^P < W^R$ . 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),

Figure 2

EQUILIBRIUM IN THE TWO COUNTRY CASE



and noting that  $k^R > k^{R*}$ , and that  $Z^g > 0$ . Thus lenders must be worse off under asymmetric information. Equation (23) is drawn as the positively-sloped  $\rho\rho$  curve in Figure 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 depends on the net asset positions of entrepreneurs across countries.<sup>25</sup> To illustrate this point, suppose that the wealth of rich country entrepreneurs improves, but that both total world endowment and the endowments of poor country entrepreneurs remain unchanged. Consider, for example, a redistribution of wealth in the rich country from lenders to entrepreneurs. This corresponds to an upward rotation in the  $\rho\rho$  curve in Figure 2; the  $WW$  curve remains unchanged.  $k^R$  rises and  $k^P$  falls. The decline in the agency costs of finance in the rich country induces a "siphoning" of investment funds from the poor country.<sup>26</sup> The increased demand for funds by rich country entrepreneurs drives up the world interest rate, drawing capital out of the poor country. [Inspection of eq. (23) indicates that  $\partial r / \partial W^R > 0$  since  $k^P$  declines and  $W^P$  is unchanged.] Entrepreneurs in the poor country lose rents as a result of the capital flight. This loss of rents is aggravated by the rise in the world interest rate. Lenders in the poor country benefit from the rise in interest rates but as long as the poor country is a net borrower, its national income must fall.

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<sup>25</sup> 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. Another related paper is Samolyk (1988), who studies the transmission of regional disturbances in financial markets.

<sup>26</sup> See the appendix for an analytical derivation.

A fall in the wealth of poor country entrepreneurs similarly induces siphoning of capital from the poor to the rich country. The reduced efficiency of lending in the poor country causes funds to flow out to the world capital market. In contrast to the previous case, the world interest rate declines. [Inspection of eq. (23) indicates that  $\partial r / \partial W^P < 0$  since  $k^R$  increases while  $W^R$  remains unchanged.] The shift of investment funds from the high marginal product of capital poor country to the low marginal product of capital rich country depresses the equilibrium interest rate.

Now consider a transfer of wealth from the poor country to the rich. In particular, suppose that  $\tau$  units of wealth are taken from each citizen of the poor country and are distributed evenly among the citizens of the rich country. This transfer can also be graphed as an upward rotation of the  $\rho\rho$  curve in Figure 2. However, for a given change in  $W^R$  the  $\rho\rho$  curve shifts by more than for our earlier example in which the transfer came from rich country lenders. Both the increase in  $W^R$  and the decline in  $W^P$  induce  $k^R$  to rise and  $k^P$  to fall. The net effect on the world interest rate is ambiguous; greater  $W^R$  tends to move the interest rate up while less  $W^P$  moves it down, as discussed earlier. Note that under perfect information a similar transfer of wealth would affect neither investment nor the interest rate [see eqs. (15) - (17)].

The wealth transfer naturally imposes a direct cost on the poor country. But there may be indirect costs as well. Holding constant the world interest rate, entrepreneurs in the poor country lose additionally because their project rents decline due to the reduction in investment. Thus, to the extent that the movement in the world interest rate is not large, the indirect effects always magnify the costs of the transfer. If the change in the interest rate is large (owing to highly concave production functions) then the

exact effect on the poor country's national income depends on whether it is a net debtor or creditor in the world capital market. However, if the poor country is small, the movement in  $r$  is negligible so that the capital market problems always magnify the costs of wealth transfers.

This 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. Here the transfer problem relates to intertemporal trade rather than contemporaneous trade, as in the classic debate between Keynes (1929) and Ohlin (1929). It arises because the distribution of wealth affects the allocation of investment, due to information asymmetries. The more general point is that any factor causing a redistribution of wealth between countries (e.g., due to exchange rate movements) will tend to make capital flow from the losing to the winning country.

As another variation on this theme, consider a shock which increases the initial endowment of all individuals in the rich country, thus increasing the total supply of investment funds available to the world capital market. Under perfect information, capital investment would rise the same in each country. But under asymmetric information, there will be a siphoning effect since the wealth of rich country entrepreneurs rises as well. Thus the increase in investment will be greater in the rich country, and it is even conceivable that investment may decline in the poor country.

As discussed earlier, the relevant measure of a borrower's wealth,  $W$ , includes not only liquid assets, but any collateralizable expected future profits as well (see Application 3). Thus good news about future business conditions in the rich country can also induce the "siphoning" effect described above.

Finally, we consider a shock to world productivity,  $\theta$ . By inspection of

of equation (23), we see that a world productivity shock has no effect on the distribution of investment capital, since  $\theta$  factors out of both sides. As in the full information case, the rise in  $\theta$  increases per capita world output and the world interest rate  $r$ .

## V. External Debt and GNP for Developing Countries

Perhaps the most direct evidence one could provide in support of our model would be to show that across developing countries, the marginal 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 supporting evidence for a related prediction of our model, which is that the spreads between the risk-free rate and the risky-debt rate should be larger in poor countries.<sup>27</sup> Some of these differences may be due to differences in the tax treatment of banks and in bank regulation across countries, but the kinds of financial market imperfections considered here may also be important.

In this section we investigate another empirical implication of our model, which is that per capita external borrowing should be increasing in per capita wealth across developing countries. There are other models which can also explain the evidence presented below. However, one factor in favor of our general story is that it is also consistent with the broad range of

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<sup>27</sup> See Goldsmith (1969), Hansen (1986) and Rocha (1986). Obviously, differences in spreads across countries also depend on differences in the tax and regulatory treatment of banks. Spreads in industrialized countries tend to be two to three percent. They are nominally the same in non-inflationary LDCs but are effectively much higher when the added transactions costs facing borrowers and depositors are taken into account. In inflationary LDCs spreads typically exceed ten percent. See World Bank 1989.



TABLE 1

Measures of External Borrowing Versus GNP: 1980

## DOLLARS PER CAPITA

	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
Cen. Afr. Rep.	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 A.R.	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 Gui.	831	169	243
Morocco	859	240	483
Botswana	1028	11	190
Congo	1036	663	1096

TABLE 1 (Continued)

Dominican Rep.	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
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

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

Notes: Total external debt includes public and publicly guaranteed long-term debt, private non-guaranteed 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 non-guaranteed 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, Zimbabwe and Malaysia are excluded due to insufficient data.

evidence that capital markets are less efficient in poorer countries (see, for example, Goldsmith (1969) and McKinnon (1973)).

In Table 1, we present 1980 data on income and external borrowing for seventy developing countries, listed in order of GNP per capita. 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). A casual comparison of column one with either column two or three indicates a strong correlation between GNP and external borrowing. It is important to note that most of the external borrowing for countries in Table 1 took place over a relatively short period (during the seventies). This rules one explanation of the correlation, which is that the poorer countries are simply at an earlier phase of their borrowing and development cycle. Another possibility is that the countries that borrowed the most were the ones with the most favorable productivity shocks. No doubt this is part of the explanation; we will make a crude effort to control for productivity differentials. (Note though that a pure productivity story is not capable of explaining differences in capital market efficiency across countries.)

Table 2 contains two sets of regressions, both using the log of GNP per capita as the explanatory variable. In the first, the dependent variable is the log of total external debt per capita. Over the entire sample,<sup>28</sup> the coefficient on GNP was 1.05, with a standard error of .08. Separate regressions for Asia, Africa, and Latin America yield similar results. The regional regressions can be interpreted as one crude attempt to control for

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<sup>28</sup> Nepal, which had zero private debt per capita, had to be excluded when the regressions were run in logs. Because it is poor, Nepal's exclusion biases the estimated coefficients downwards.

TABLE 2

OLS Regressions of Debt/Capita on GNP/Capita for Developing Countries: 1980

<i>log Total External Debt per Capita</i>	<i>Constant</i>	<i>log GNP per Capita</i>	<i># Observations</i>	<i>R<sup>2</sup></i>
All countries	-1.29	1.05 (.08)	68	.73
Sub-Saharan Africa	-1.40	1.08 (.16)	30	.60
Latin America and Caribbean	-.78	.97 (.21)	19	.56
Asia	-2.36	1.20 (.19)	10	.83

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<i>log External Debt to Private Lenders per Capita</i>	<i>Constant</i>	<i>log GNP per Capita</i>	<i># Observations</i>	<i>R<sup>2</sup></i>
All Countries	-5.84	1.60 (.12)	68	.73
Sub-Saharan Africa	-5.20	1.51 (.25)	30	.55
Latin America and Caribbean	-5.16	1.51 (.29)	19	.62
Asia	-9.77	2.22 (.30)	10	.87

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*Africa:* Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Cote D'Ivoire, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Tanzania, Togo, Uganda, Zaire, Zambia.

*Latin America and the Caribbean:* Argentina, Bolivia, Brazil, Chile, Columbia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Panama, Paraguay, Peru, Uruguay, Venezuela.

*Asia:* Bangladesh, Burma, India, Indonesia, Korea, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand.

*Other:* Algeria, Egypt, Jordan, Morocco, Portugal, Syria, Tunisia, Turkey, Yemen Arab Republic.

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.

One problem with using total external debt to measure country borrowing is that the component consisting of official (public) debt is probably best viewed as foreign aid. Whereas most official debt is senior in principle, it is junior to private debt in practice. Though technically, developing-country debtors have promptly repaid official debt, in most cases official creditors have made new loans in excess of any principal and interest repayments due. [See Bulow and Rogoff (1988)].

In the second set of regressions reported in Table 2, the dependent variable includes only external debt owed to private creditors. Note that the coefficients are always larger than one and the difference is significant over the full sample.<sup>29</sup> Again, this simple relation explains a very large share of the variation in external borrowing across countries, and the coefficients are relatively stable across regimes. We also ran a regression that included the 1980-1986 growth rate of per capita GNP as a proxy for expected productivity change. This variable, however, was unimportant.<sup>30</sup>

We chose the year 1980 because after the debt crisis began in 1982, the correspondence between book value and the market value of loans becomes much weaker.<sup>31</sup> There did not exist a secondary market for bank loans as of 1980,

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<sup>29</sup>The results are quite robust to excluding trade credits and/or short term debt from the regressions. However, when "Micronesian" countries with populations under one million are included, the coefficients become smaller and the standard errors larger.

<sup>30</sup> Obviously, it would be desirable to explore the dynamics of the external debt-GNP relation more fully, but unfortunately short-term debt data for years prior to 1980 is suspect.

<sup>31</sup> However, the appendix presents similar regressions for the 1986 data, with similar results.

but most of the private loans were indexed to short-term interest rates. Thus any capital gains or losses would mainly have to involve sovereign risk. The fact that most debtor nations were still receiving new funds in 1980 suggests that expectations of default were still quite low. Almost all sovereign debt to private creditors is of equal priority (for a rationale see Bulow and Rogoff (1988)), so countries can generally only get new loans only if their old loans are valued near par.<sup>32</sup>

## VI. Conclusions

Across developing countries, capital market inefficiencies tend to decrease and external borrowing tends to sharply increase as wealth rises. We have shown that a simple model of intertemporal trade under asymmetric information can provide a coherent explanation of both these phenomenon, without appealing to imperfect capital mobility.

Our empirical results that the elasticity of external borrowing [from private creditors] with respect to income exceeds unity contradict the conventional presumption that capital should flow from low marginal product of capital rich countries to high marginal product of capital poor countries. To explain this result in isolation one can, of course, appeal to a number of other theories. For example, the Marshall-Romer model of growth under increasing returns to scale is consistent with this phenomenon [see Romer (1989)], and sovereign risk may also be part of the explanation.<sup>33</sup>

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<sup>32</sup> Our results do not include direct investment, since including this would not be in the spirit of the asymmetric information model of section II. However, we note that within Africa and Asia, direct investment was small relative to debt. For South America, it was somewhat larger, though still small relative to debt.

<sup>33</sup> For recent bargaining-theoretic models of sovereign risk, see Bulow and Rogoff (1989) or Fernandez and Rosenthal (1988). For a model combining

Cross-country differences in productivity may also be relevant (although in our empirical work we made a rough effort to control for this factor.) A virtue of our explanation is that it is also consistent with evidence that domestic capital markets operate less efficiently in developing countries. Specifically, our model suggests that low-income countries should have higher spreads between loan and deposit rates.

Finally, we note 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. In a world of 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.

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sovereign risk and moral hazard, see Atkeson (1988).

## APPENDIX

The formal problem which 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

$$\max \pi(k)(\theta - Z^g) - [1 - \pi(k)]Z^b + r(W + b - k) \quad (A1)$$

subject to

$$\pi(k)Z^g + [1 - \pi(k)]Z^b = rb \quad (A2)$$

$$\pi'(k)[\theta - (Z^g - Z^b)] = r \quad (A3)$$

$$0 \geq Z^b \quad (A4)$$

$$W + b - k \geq 0 \quad (A5)$$

Let  $\mu$ ,  $\gamma$ ,  $\nu$ , and  $\psi$  be the (non-negative) multipliers associated with (A2) - (A5), respectively. Then the first-order necessary conditions with respect to  $k$ ,  $b$ ,  $Z^g$  and  $Z^b$  are given by

$$\mu\pi'(k)(Z^g - Z^b) + \gamma r\pi''(k)/\pi'(k) - \psi = 0 \quad (A6)$$

$$\psi = r(\mu - 1) \quad (A7)$$

$$\pi(k)(\mu - 1) - \gamma\pi'(k) = 0 \quad (A8)$$

$$[1 - \pi(k)](\mu - 1) + \gamma\pi'(k) - \nu = 0 \quad (A9)$$

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



$$\pi'(k^*)\theta - r = 0 \quad (A10)$$

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

PROPOSITION 1: (i) If  $W \geq k^*$ ,  $k = k^*$ ; (ii) if  $W < k^*$ ,  $k < k^*$ .

PROOF: Part (i) is obvious; since if  $W \geq k^*$  the entrepreneur has sufficient wealth to undertake the unconstrained optimal investment without borrowing; she will lend any residual wealth. Part (ii) can be proven by contradiction. Suppose  $W < k^*$  and  $k \geq k^*$ . Then (A5) implies  $b > 0$ . If  $b > 0$ , then (A2) and (A4) imply  $Z^g > Z^b$ . If  $Z^g > Z^b$  then (A3) and (A10) imply  $k < k^*$ , which leads to a contradiction. Q.E.D.

PROPOSITION 2: If  $W < k^*$ ,  $k$  and  $Z^g$  are given jointly by

$$\pi'(k)(\theta - Z^g) = r \quad (A11)$$

$$Z^g = r(k - W)/\pi(k) \quad (A12)$$

where (A11) and (A12) correspond to eqs. (9) and (10) in the text.

PROOF: If  $W < k^*$  then  $k < k^*$ , from Proposition 1. If  $k < k^*$  then  $Z^g > Z^b$ , from (A3) and (A10). It follows from (A6) - (A8) that  $\mu > 1$ . This in turn implies that  $\gamma$ ,  $\nu$ , and  $\psi$  are positive. Thus (A4) and (A5) hold with equality. Using (A4) and (A5) to eliminate  $Z^b$  and  $b$  from (A2) and (A3) yields (A11) and (A12). Q.E.D.

COROLLARY: If  $W < k^*$ ,  $W < k < k^*$ .

PROOF:  $W < k^*$  implies  $k < k^*$ , from Proposition 1. Proposition 2 then implies  $Z^b = 0$ . If  $k < k^*$  and  $Z^b = 0$ , then  $Z^g > 0$  from (A3). It follows from (A12) that  $k > W$ . Q.E.D.

# COMPARATIVE STATICS OF THE TWO-COUNTRY CASE

From eqs. (22) and (23) in the text,  $k^R$  and  $k^P$  are determined jointly by the following two conditions:

$$\rho(k^R, W^R) = \rho(k^P, W^P) \quad (B1)$$

$$\alpha(k^R + k^P) = \alpha(W^R + W^P) + (1-\alpha)(W^{RL} + W^{PL}) \quad (B2)$$

where

$$\rho(k^J, W^J) \equiv \rho^J = \frac{\pi'(k^J)}{1 + \pi'(k^J)[k^J - W^J]/\pi(k^J)} \quad J = P, R \quad (B3)$$

so that  $\rho_1^J < 0$  and  $\rho_2^J > 0$ .

Initially we assume that world wealth is held constant at  $\bar{W}$  (think of the experiments as being wealth redistributions) so that (B4) temporarily replaces (B2):

$$\alpha(k^R + k^P) = \bar{W}, \quad (B4)$$

where  $\bar{W}$  is a fixed number. Then,

$$\frac{\partial k^R}{\partial W^R} = - \frac{\partial k^P}{\partial W^R} = - \rho_2^R / (\rho_1^R + \rho_1^P) > 0 \quad (B5)$$

$$\frac{\partial k^R}{\partial W^P} = - \frac{\partial k^P}{\partial W^P} = \rho_2^P / (\rho_1^R + \rho_1^P) < 0 \quad (B6)$$

Inspection of eq. (23) indicates that  $\frac{\partial r}{\partial W^R} > 0$  (since  $k^P$  declines and  $W^P$  is unchanged), and similarly  $\frac{\partial r}{\partial W^P} > 0$ .

Next note that national income per capita for country J,  $y^J$ , is given by

$$y^J = \alpha[\pi(k)\theta - r(k^J - W^J)] + (1-\alpha)rW^{JL},$$

$$= \alpha\pi(k)\theta + r[(\alpha W^J + (1-\alpha)W^{JL}) - \alpha k^J] \quad (B7)$$

Using the previous results in conjunction with (B7), one can readily determine the impact of changes in  $W^R$  and  $W^P$  on the national income of each country. For example, it is straightforward to show that a rise in  $W^R$  may lower the national income of the poor country, and definitely does so if the poor country is a net debtor in the world capital market (i.e., if  $\{[\alpha W^J + (1-\alpha)W^{JL}] - \alpha k^J\} < 0$ ).

Now suppose the total stock of world endowment is permitted to change. For simplicity, let  $W^R = W^{RL}$  and  $W^P = W^{PL}$ , so that (B2) becomes

$$\alpha k^R + \alpha k^P = W^R + W^P \quad (B8)$$

Then,

$$\frac{\partial k^R}{\partial W^R} = (-\alpha\rho_2^R + \rho_1^P)/\alpha(\rho_1^R + \rho_1^P) > 0 \quad ; \quad \frac{\partial k^P}{\partial W^R} = (\alpha\rho_2^R + \rho_1^R)/\alpha(\rho_1^R + \rho_1^P) \quad ? \quad (B9)$$

Under perfect information, (B8) together with eqs. (15) and (16) imply that

$\frac{\partial k^R}{\partial W^R} = \frac{\partial k^P}{\partial W^R} = 1/2\alpha$ . Equation (B9) indicates that under asymmetric information

$\frac{\partial k^R}{\partial W^R} > 1/2\alpha$  if  $\rho_1^P$  is not too much smaller than  $\rho_1^R$  or if  $\rho_2^R$  is sufficiently

large.<sup>34</sup> The term  $-\alpha\rho_2^R$  in the numerator of (B9) reflects the influence of the

siphoning effect. If the siphoning effect is very strong ( $\rho_2^R$  is large),  $\frac{\partial k^P}{\partial W^R}$

may be negative.

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<sup>34</sup>Note that  $\rho_1^R = \rho_1^P$  when  $W^R = W^P$ .

TABLE A1

Measures of External Borrowing Versus GNP: 1986

## DOLLARS PER CAPITA

	GNP	External Debt to Private Lenders	Total External Debt
Ethiopia	116	9	49
Bhutan	132	0	16
Bangladesh	152	3	78
Chad	157	13	46
Nepal	158	3	44
Malawi	162	20	155
Zaire	164	38	220
Mali	183	16	206
Tanzania	199	35	181
Zambia	204	232	815
Burma	206	3	96
Burkina Faso	235	7	99
Madagascar	236	46	285
Burundi	257	10	114
Uganda	275	9	79
Guinea	282	31	249
Niger	285	87	230
India	297	13	54
Rwanda	304	6	70
Sudan	308	142	431
Togo	313	56	349
Kenya	327	69	233
Benin	332	122	226
Pakistan	336	27	149
Lesotho	343	8	119
Cen. Afr. Rep.	344	19	166
Sierra Leone	345	40	165
Sri Lanka	389	61	252
Somalia	395	54	485
Ghana	398	32	189
Mauritania	400	70	934
Zimbabwe	415	190	669
Haiti	415	21	130
Indonesia	429	145	258
Liberia	456	143	633
Nigeria	468	179	248
Senegal	531	88	456
Philippines	543	344	515
Bolivia	590	401	844
Yemen A.R.	619	46	328
Morocco	619	274	830
Egypt	660	233	763
Papua New Gui.	706	525	705
Dominican Rep.	774	194	548
El Salvador	779	58	349
Thailand	786	200	356
Honduras	792	223	662

TABLE A1 (Continued)

Cote D'Ivoire	852	715	1097
Guatemala	857	142	337
Botswana	874	38	345
Congo	907	1382	2079
Jamaica	918	315	1709
Paraguay	937	204	535
Cameroon	989	168	351
Ecuador	1050	641	956
Turkey	1123	331	652
Tunisia	1129	282	788
Columbia	1155	293	526
Chile	1211	1286	1641
Jordan	1214	596	1179
Peru	1314	480	790
Mexico	1540	1072	1270
Costa Rica	1540	958	1696
Syria	1756	178	416
Brazil	1940	634	814
Uruguay	2000	986	1277
Panama	2159	1462	2213
Portugal	2248	1314	1604
Korea	2288	822	1124
Argentina	2397	1353	1602
Gabon	2569	1009	1374
Venezuala	2723	1903	1951
Algeria	2752	723	857

Sources: World Bank, World Debt Tables: External Debt of Developing Countries, Vol. II, 1988-89 ed., and International Monetary Fund, International Financial Statistics.

Notes: 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, private non-guaranteed long-term 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 1986 GNPs over \$3,000. Communist countries are excluded; Lebanon and Malaysia are excluded due to insufficient data.

TABLE A2

OLS Regressions of Debt/Capita on GNP/Capita for Developing Countries: 1986

<i>log Total External Debt per Capita</i>	<i>Constant</i>	<i>log GNP per Capita</i>	<i># Observations</i>	<i>R<sup>2</sup></i>
All countries	-.68	1.04 (.09)	73	.67
Sub-Saharan Africa	-.21	.99 (.19)	33	.69
Latin America and Caribbean	-1.10	1.11 (.23)	19	.58
Asia	-3.09	1.38 (.20)	12	.82

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<i>log External Debt to Private Lenders per Capita</i>	<i>Constant</i>	<i>log GNP per Capita</i>	<i># Observations</i>	<i>R<sup>2</sup></i>
All Countries	-6.35	1.74 (.13)	72	.72
Sub-Saharan Africa	-5.05	1.54 (.29)	33	.47
Latin America and Caribbean	-8.08	2.00 (.29)	19	.73
Asia	-10.90	2.45 (.36)	11	.83

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*Africa:* Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Cote D'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Tanzania, Togo, Uganda, Zaire, Zambia, Zimbabwe.

*Latin America and the Caribbean:* Argentina, Bolivia, Brazil, Chile, Columbia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Panama, Paraguay, Peru, Uruguay, Venezuela.

*Asia:* Bangladesh, Burma, India, Indonesia, Korea, Nepal, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand.

*Other:* Algeria, Egypt, Jordan, Morocco, Portugal, Syria, Tunisia, Turkey, Yemen Arab Republic.

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