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# EMERGING MARKET LENDING: IS MORAL HAZARD ENDOGENOUS?

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This paper shows how growth in financially open developing countries is affected when relations with international lenders suffer from the danger of moral hazard. We find that if entrepreneurs can gamble with foreign creditors' money, borrowing under standard debt contracts is constrained by a No-Gambling Condition similar to that in Hellmann, Murdock, and Stiglitz (2000). However, this incentive constraint is endogenous in the development process: growth increases entrepreneurs' own capital at risk and thus reduces incentives to gamble. But capital accumulation also decreases the profitability of investment, which has the opposite effect. General equilibrium under moral hazard shows a unique and stable steady state, but involves at least temporary rationing of profitable projects and possibly positive net investment by developing countries in international financial markets.

*Keywords*: Moral Hazard, Asymmetric Information, Open Economy Growth, International Finance
*JEL classification*: F43, O16, D82

## 1. INTRODUCTION

The literature on international finance has frequently highlighted the incentive problems associated with cross-border capital flows. Often, implicit guarantees to foreign creditors, by domestic governments or via the prospect of IMF bailouts, are seen to cause a moral hazard situation, where creditors have no incentives to make sure that their money is prudently invested.[1] One standard policy recommendation is thus to

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[1] Thus, Krugman (1998) argues that the main story behind the 1997 Asian crisis is that of moral hazard

eliminate guarantees in order to make foreign creditors bear the risk of their investment.

However, removing guarantees does of course not eliminate the problem of asymmetric information at the origin of moral hazard. As studies on domestic lender-borrower relations (such as Holmström and Tirole (1997), or Hellmann, Murdock and Stiglitz (2000)) show, moral hazard-type conflicts of interest arise under standard debt contracts whenever limited liability borrowers have insufficient own capital at risk, or insufficient prospective profits. In the absence of guarantees, international lenders will take into account these incentive problems for their lending policy if information asymmetries rule out contracts contingent on borrower behaviour. Creditors effectively impose a "No-Gambling Condition" (Hellmann, Murdock and Stiglitz (2000)), which constrains lending by minimum capital requirements for borrowers, conditional on the profitability of their projects. For poor countries that lack sufficient own capital but offer numerous investment opportunities, this may well be a severe constraint, with important consequences for the supposedly beneficial impact of international capital mobility.

This line of argument shows that incentive problems can affect the ability of poor countries to attract funds, and thus constrain growth. But conversely, capital accumulation and economic growth seem to play an important role for incentives. They provide countries more own capital to signal incentives for prudent investment, but presumably also reduce marginal returns to capital and thus profits. As opposed to partial equilibrium models of moral hazard in financial markets, which usually take the profit structure as given, this double role of capital accumulation for incentives - a beneficial "capital at risk effect" and a negative "profit effect" - requires an analysis that endogenises both capital and profits. Thus, only a dynamic general equilibrium model can show the reciprocal relation between incentives, which constrain capital accumulation, and growth, which determines incentives via capital and profits. This in fact is the endeavour of the present paper.

We analyse the consequences of moral hazard in financial markets for growth in open developing economies when international creditors impose a No-Gambling Condition à la Hellmann, Murdock and Stiglitz (2000). The two main determinants of this incentive constraint, entrepreneurs' own capital and expected profits from investment, are made endogenous in the growth process using a simple overlapping generations growth model of the Diamond (1965)-type. Adding our incentive constraint to the otherwise entirely neo-classical model yields results quite different from those of standard growth theory: despite international capital mobility, poor economies with low own capital will converge only slowly to a steady state, where output may be lower than it would have been without moral hazard. Moreover, not only the degree but also the existence of moral hazard is shown to be endogenous in the growth process: decreasing marginal returns to capital are crucial in that for high marginal productivity there is no

leading to "pangloss" overinvestment: without control by implicitly insured lenders, limited liability borrowers will invest international funds in excessively risky and unprofitable activities.

moral hazard problem, which only arises at some point in the development process. The net effect of further capital accumulation on incentives, combining the impact of rising capital at risk and falling marginal returns, is shown to be positive. We thus show a causal link from capital accumulation to moral hazard, as opposed to the reverse "pangloss" investment mechanism, where moral hazard leads to overaccumulation of capital.

Our paper draws on two main sources in the literature: we take our incentive structure from the Hellmann, Murdock and Stiglitz (2000) article on the danger of banks gambling after the liberalisation of domestic financial markets. But we endogenise profits as a function of aggregate capital in the economy while taking the opportunity costs of funds as exogenously determined in international capital markets. This yields a situation of capital-constrained borrowing not very different from that in Holmström and Tirole (1997). On the other hand, our overlapping generations framework is most similar to those in Boyd and Smith (1997), or Ma and Smith (1996) that are part of a small but growing literature on growth under asymmetric information in financial markets (see also Boyd and Smith (1992), Huybens and Smith (1998), Gertler and Rogoff (1990) or Sakuragawa and Hamada (2001)). However, this literature usually relies either on the assumption of pure credit constraints prevailing under costly state verification[2] (notably the work of Smith *et al.*) or on exogenous profitability of capital. Both assumptions are in our view quite restrictive, which is why we choose a simple moral hazard framework, where however both profits and moral hazard are endogenous in the growth process. Atkeson (1991) looks at a similar problem of incentive-constrained international lending, but in a context of infinitely-lived agents, and adds the possibility of debt repudiation.

The paper proceeds as follows: After presenting a simple small open economy growth model with moral hazard in financial relations (2), we analyse partial equilibrium in financial markets (3), as well as dynamic general equilibrium (4) and give some comparative static results (5). Our conclusion includes suggestions on policy responses and further research.

## 2. A SMALL OPEN ECONOMY MODEL WITH ASYMMETRIC INFORMATION

This section describes an overlapping generations growth model of a small open economy that faces moral hazard in an intermediate capital-investment sector. Entrepreneurs have the possibility to "gamble" with borrowed money by investing in a risky but inefficient asset. Their incentives to do so are governed by two factors: expected profits from successful investment projects increase incentives to avoid failure and thus to invest prudently. And entrepreneurs' own finance in their project discourages

[2] The seminal paper on pure credit constraints in a domestic costly state verification framework is Gale and Hellwig (1985).

gambling due to a "capital at risk" effect. When international creditors are aware of this incentive structure but cannot observe gambling unless a project fails, borrowing can be capital - constrained by a simple No-Gambling condition - a one-period version of that in Hellmann, Murdock and Stiglitz (2000) with endogenised profits. In fact, both incentive effects, the capital at risk and the "profit" effect, depend on aggregate capital in the economy and are thus endogenous in the development process.

### 2.1. Agents

The population of the economy consists of overlapping generations of two-period lived agents. Each generation is assumed to be large and of constant size, normalized to one for simplicity. Given the large population, agents neglect the influence of their individual decisions on the aggregate economy. Agents are endowed with one unit of labour when young, which they supply inelastically to earn the going wage rate in the economy, $w_t$, and retire at the beginning of period two. They are risk-neutral and care only about period 2 consumption. Thus

$$U(c) = C_{old} . \tag{A1}$$

This utility function is maximised by agents subject to the limited liability constraint that agents' wealth cannot be negative.

Agents have two saving opportunities to transfer their wage to the consumption period. They can either buy financial assets that yield the international gross rate of return $i$, or invest in investment projects as described below.

International lenders are numerous, risk-neutral and ready to lend any amount at the expected rate of return $i$. Since our economy is small, it has no influence on this going rate of interest.

### 2.2. Production of Capital Goods

There are two sectors in the economy. Capital for the production of final goods is produced in an intermediate investment sector with a linear technology that requires discrete investment in "projects." All agents are born with their specific project, say a technology or investment "idea," that they cannot sell but only carry out themselves. These intermediate sector projects need an indivisible financial investment of size $q$ at the end of period t in order to yield capital at the beginning of $t+1$. This capital is then used to produce final goods and paid the going rental rate $R_{t+1}$.

The investment projects play a crucial role in the analysis. Their size differs between some lower bound $\underline{q}$, and an upper bound $Q$. Before they are born, agents are randomly assigned a project by independent draws from the probability density function $g(q)$. Given the law of large numbers $g(q)$ is equal to the density of investment opportunities in the economy. Furthermore*, g(q)* is assumed to be differentiable and of mass 1 (i.e., $G(\underline{q})=0$ and $G(Q)=1$ with *G(q)* the associated cumulative distribution function). Also we assume

$$Q > w_t \quad for\ all\ \ t\ . \tag{A2}$$

Thus, there is always at least one project that needs outside finance to be realised.

The output of investment projects in terms of capital depends on which of two investment technologies is employed: agents can opt for a prudent investment technology that yields $q$ units of capital with probability one, or for a “gambling” technology that yields $\beta q > q$ units of capital with probability $\pi$, and zero otherwise. We make the following assumptions about $\beta$ and $\pi$,

$$\pi\beta < 1 < \beta\ . \tag{A3}$$

(A3) states that the gambling technology is less efficient since its expected return is lower than that of the safe technology. However, returns from gambling are higher if the project is successful.

The reason for this particular set-up of gambling in an intermediate investment sector is to show the effects of falling marginal productivity of capital on entrepreneurs' incentives to gamble. In fact, one important difference between our No-Gambling Condition and that of Hellmann, Murdock and Stiglitz (2000) is that in our model, profits are endogenous and thus affected by decreasing marginal returns.

“Gambling” can intuitively be interpreted in different ways. One interpretation of our model is of projects to be financial companies that provide capital services to firms. These financial companies would then have the possibility to gamble by engaging in risk-shifting, as in Hellmann, Murdock and Stiglitz (2000) or in Krugman (1998), or by borrowing in foreign currency against domestic assets without hedging the involved risk.[3]

### 2.3. Production of Consumption Goods

There is a single final consumption good in the economy that is produced by the production technology $F = F(K,N)$ using labour (*N*) and capital (*K*), the output from investment projects. The production technology satisfies $F_K(K) > 0$, $F_{KK}(K) < 0$ and Inada conditions, where capital-letter subscripts denote derivatives. Capital is assumed

[3] At least in the case of financial services companies, one would probably want to limit the possible number of these companies to some fraction of the population, which however only adds one parameter to our model without substantially affecting results.

to depreciate fully in production.

We thus have two production technologies: a binary investment technology that yields capital, and a well-behaved neo-classical technology that combines this capital with labour to produce consumption goods, a framework similar to those of Boyd and Smith (1997), or Ma and Smith (1996). Note that we do not include technological progress. Since also our population is assumed to be constant, there will be no steady state growth in the model. We choose this simplifying framework since we are primarily interested in the convergence process to the steady state, and the steady state level of capital and output per capita under asymmetric information with respect to the full information case.

### 2.4. Information Structure

Lenders are assumed to have ex ante information about agents' preferences, the proportion of their wealth (or, which is equivalent in this framework, the proportion of last period's wage) that entrepreneurs invest in their own projects and their investment technology options. However, ex post they have no information about de facto payoffs or the chosen production technology unless they see the project fail. Failure reveals the zero payoff and thus the investment technology employed (since the prudent technology never fails). But limited liability means that there cannot be any financial penalties in the failure case, since borrower wealth is zero (assuming full equity participation, an inssue which we will look at below). So lenders cannot ex post punish entrepreneurs for choosing the wrong technology: if gambling is successful they cannot observe the choice of technology, if it fails there is no possibility of punishment as entrepreneurs have no funds left.

One strong assumption is that lenders know the gambling technology. It is not immediate that lenders have a chance to observe this, as in equilibrium gambling will often be avoided. So one may want to interpret the gambling technology as a "worst case guess" by lenders, against which they try to be robust.

Note that this setup does not allow for monitoring of projects. Monitoring could be introduced by assuming that lenders can observe the chosen technology at a certain cost. Broer (2001) shows the effects this has in the current framework.

## 3. EQUILIBRIUM IN FINANCIAL MARKETS

We start by analysing the partial equilibrium in financial markets. The analysis is partial in the sense that it takes the expected return to capital and entrepreneurs' wages as given, to derive equilibrium investment as a function of the international interest rate and incentive constraints. In a general equilibrium analysis we will afterwards endogenise profits and wages to derive the impact of economic development on incentive constraints and vice versa.

### 3.1. Contracts, Incentive Constraints and Definition of Equilibrium

A contract in our setup is an agreement that specifies the size of a loan *b* that an international lender gives an entrepreneur in period t, and the repayments *T* made in period $t+1$. Payments are potentially a function of all observable characteristics of entrepreneurs (i.e., the size of their idiosyncratic project and their equity stake in the project) and those states of nature in period $t+1$ that are distinguishable ex post.

Since both entrepreneurs and lenders are assumed to be risk-neutral, individual rationality constraints simply require that both get, for every contract, at least expected returns equal to the opportunity costs of funds *i*, where expectations are taken conditional on information that may differ between lenders and entrepreneurs. The individual rationality constraint for lenders is thus

$$E[\Gamma] = pT + (1-p)*0 > ib \,, \qquad \text{(IR1)}$$

where $\Gamma$ are returns to the lender in different states of nature, *b* is the size of the loan, and *p* denotes the probability that the project is successful. (Note that for the remainder of this section we drop time subscripts for period t variables for convenience.)

The individual rationality constraint for entrepreneurs is equivalently

$$E[\Pi] = p[\tau R_{t+1}(w+b) - T(b)] \geq wi \,, \qquad \text{(IR2)}$$

where $\Pi$ indicates profits in different states of nature, $R_{t+1}$ is the rental rate on capital in the next period, $w$ is the amount of period *t* borrower wealth invested in the project and $\tau$ equals payoff in units of capital when the project goes through (and so equals 1 for prudent investors and $\beta > 1$ for gamblers).

To define equilibrium in financial markets, note that projects cannot be sold by entrepreneurs who are the only ones that have the knowledge to run them. It is thus the number of projects that adjusts to yield equilibrium in financial markets and not their prices.[4] Equilibrium is thus characterised by a set of optimal contracts, a set of projects that gets carried out and a technology chosen for each of these, such that individual rationality constraints and the limited liability constraint of borrowers hold.

To derive the structure of the optimal contract, note that agents have complete monopoly power over their investment project, and that international capital markets are competitive. So without loss of generality we can assume that entrepreneurs propose a contract as a take-it-or-leave-it offer to creditors, thus maximising their profits subject to the constraints.

[4] Allen and Gale (2000) present a model where moral hazard and risk shifting under standard debt contracts lead to a bubble in asset prices. Krugman (1998) also presents a simple model in the same spirit.

### 3.2. Optimal Contracts and Equilibrium under Full Information

Note that in the described lending relation there are 3 possible states of the world that determine payoffs. The first corresponds to the prudent investment being chosen, the second to a risky investment that is successful, the third to a risky investment that has failed. In the benchmark case of full and free information, contracts can be contingent on all states of the world, plus borrower characteristics. If we assume full equity participation, i.e., entrepreneurs invest their entire wealth and only borrow what they need to carry out their project, the payment when the project fails is necessarily zero. The design of the optimal contract is equivalent to choosing payments in states one and two, such that (IR1) holds with equality for both technologies individually, and for all *b*. So transfers are simply $T = i * b$ and $T = i/\pi * B$ for the prudent and risky technologies respectively. In other words, the optimal contract is a standard debt contract. Entrepreneurs pay a constant interest rate *r*, with $r = i$ or $r = i/\pi$ for safe and risky projects respectively, unless they go bankrupt. Note that interest rates are independent of entrepreneur characteristics, i.e., do not depend on their wealth or the size of their project.

Given standard debt contracts, the resulting equilibrium is very simple and emerges from the two individual rationality constraints: Entrepreneurs will invest as long as expected returns to their projects net of interest payments are greater than their opportunity costs.

However, expected profits $\Pi$ from gambling are with $r = i/\pi$.

$$\begin{aligned} E[\Pi_{gambling}] &= p[\tau E[R_{t+1}](w+b) - rb] \\ &= \pi[\beta E[R_{t+1}](w+b) - i/\pi b] = \pi\beta E[R_{t+1}](w+b) - ib \\ &\leq \Pi_{prudent} = E[R_{t+1}](w+b) - ib, \end{aligned} \tag{1}$$

where the inequality follows from assumption (A3) that the gambling technology has lower expected output.

(1) shows two things: first, under full information it is never optimal for agents to gamble. And second, in equilibrium all projects get realised as long as $R_{t+1}$ is greater than *i*.

### 3.3. Optimal Contracts and Equilibrium under Asymmetric Information

We first show that even under asymmetric information, the optimal contract is simply a standard debt contract. In a second step, we derive the conditions for the projects that get finance in equilibrium.

*Standard Debt Contracts*

Under asymmetric information, payments from entrepreneurs to lenders can only be made contingent on the technology if the project fails, as lenders cannot distinguish "success" states one and two. Again, payments if the project fails are necessarily zero, so the design of the optimal contract reduces to choosing an amount $T$ that borrowers transfer to lenders when the project is successful. To see that the optimal contract is simply a standard debt contract, note first that the payment $T$ can be conditioned on the amount of their own wealth that entrepreneurs invest. Furthermore, for a given $T$ expected profits to entrepreneurs from prudent and risky investment projects are respectively.

$$\begin{aligned} &E(\Pi_{prudent}) = R_{t+1}(w+b) - T, \\ &E(\Pi_{gambling}) = \pi[\beta R_{t+1}(w+b) - T]. \end{aligned} \tag{2}$$

The important thing to note is that for given $T$ profits increase linearly with $w$, but at different rates: profits from prudent investment increase faster than profits from risky investment as $\pi\beta < 1$. Thus, for a given level of borrowing and transfers, there is a level $w^*$ (not necessarily positive) that makes profits from gambling equal to those from prudent investment. Entrepreneurs that invest less own capital will prefer to gamble, entrepreneurs that invest more will invest prudently. This means entrepreneurs with enough equity can obtain the same contracts as those for the prudent technology under full information, as lenders know they will never gamble. But the best contract that entrepreneurs with little equity can obtain is that for the risky technology and involves a hefty external finance premium. Thus, under asymmetric information we get the same standard debt contracts as under full information. But interest rates are conditional on the funds that entrepreneurs invest in their projects, not on the chosen technology which is unobservable.

*No-Gambling Condition and Maximum Project Size*

Conditional on a standard debt contract with interest rate $i$, we can express the condition that agents' (pure) profits from investing prudently must be higher than expected profits from gambling as follows[5]

$$\begin{aligned} &\Pi_{prudent} > E(\Pi_{gambling}) \\ &\Leftrightarrow (R_{t+1} - i)(w+b) > \pi[(\beta R_{t+1} - i)(w+b)] + (1-\pi)(-iw). \end{aligned} \tag{3}$$

Taken $w$ and $R_{t+1}$ as given, and again imposing maximum equity participation, we can solve this for $b$, which yields an upper bound on borrowing, the *No-Gambling Condition*

[5] In the following, it turns out to be convenient to phrase the discussion in terms of pure profits, i.e., there is always an opportunity cost of $wi$ to own funds invested in projects.

$$b < w \frac{(1-\pi\beta)R_{t+1}}{(\pi\beta-1)R_{t+1}+i(1-\pi)} \quad \text{for} \quad (\pi\beta-1)R_{t+1}+i(1-\pi)>0\ . \qquad (NGC)$$

From NGC we get the maximum project size $q*$ as the sum of period 1 wage income and the maximum loan size

$$q* = w + b_{MAX} = w \frac{i(1-\pi)}{(\pi\beta-1)R_{t+1}+i(1-\pi)} \quad \text{for} \quad (\pi\beta-1)R_{t+1}+i(1-\pi)>0\ . \qquad (NGC')$$

NGC makes borrowing of entrepreneurs constrained by $w$, their own capital in projects, the expected return $R_{t+1}$ and international interest rates. Intuitively, own capital mitigates the moral hazard problem because the entrepreneur faces the whole down-side risk on this invested capital: His opportunity cost in the bad state is $wi$, the gains from the alternative investment in the safe asset yielding safe return $i$. That means that his net expected loss from gambling with his own capital equals the difference in expected payoffs between the two technologies, $-wR(1-\pi\beta)<0$. These losses are opposed to expected gains from gambling with borrowed money of $b[\pi(\beta R-i)-(R-i)]$. NGC then says that for prudent investment to be optimal, the expected gains from gambling with borrowed capital have to be smaller than the expected losses from gambling with the amount of own capital employed in the project.

Thus, entrepreneurs with little own capital will pay a potentially large external finance premium of $(1-\pi)/\pi$, as they are assumed to gamble with creditors' funds. If we interpret the gambling technology as a "worst case" scenario for creditors, implying a small probability of payoff $\pi$, then this external finance premium might be too large for the project to go through. Entrepreneurs with great ideas but no capital will then never be able to borrow and realise their project. The condition for this to be the case is

$$E(\Pi_{gambling}) = \pi[\beta R_{t+1}(w+b) - i/\pi * b] - iw < 0$$
$$\Leftrightarrow R_{t+1} < R_{risky} = i/(\pi\beta).$$

In our model, information asymmetries can thus cause some entrepreneurs with profitable investment opportunities to get rationed in equilibrium. However, it is interesting to note that for those projects that do get financing, there is no external finance premium - they can borrow at the international riskless rate $i$. This is different for example to models such as Bernanke, Gertler and Gilchrist (1999), where a variable external finance premium drives most of the results. This is because in our model projects do not fail in equilibrium, as entrepreneurs that meet NGC always invest prudently and the return to prudent investment is non-stochastic. This differs from a costly state verification setup such as that in Bernanke, Gertler and Gilchrist, where the probability of failure of investment projects, and thus the expected auditing costs that need to be covered by an external finance premium, is a function of economic conditions.

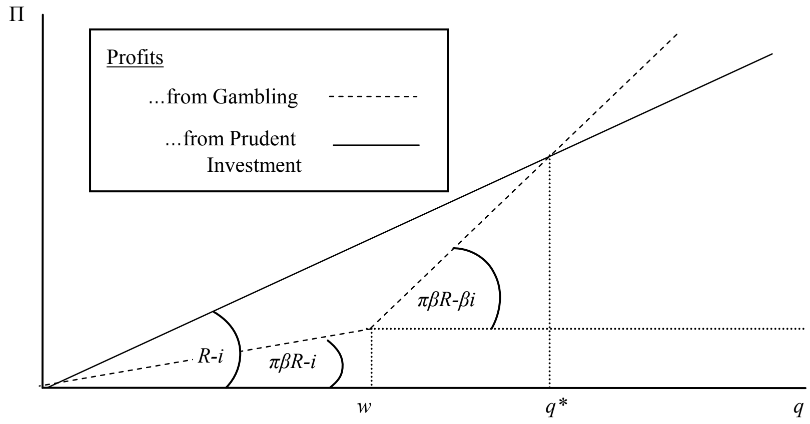


**Figure 1.** Profits from Gambling and Prudent Investment for Given Wealth
Above $q*$ gambling yields higher profits for entrepreneurs

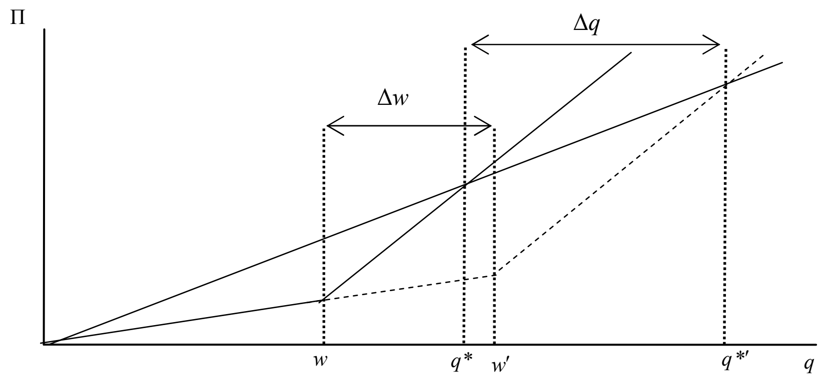


**Figure 2.** Increasing Wealth by $\Delta w$ Increases the Maximum Project Size by $\Delta q > \Delta w$

*A Graphical Representation of the Equilibrium*

Figure 1 shows how for fixed *w* and *R* entrepreneurs' expected profits are higher from gambling than from investing prudently above the threshold size $q^*$ given by $NGC'$. Figure 2 shows how higher wages, or wealth at the end of period 1, increase $q^*$ by more than the change in *w*. This is the *capital at risk effect* of rising entrepreneur own capital on borrowing limits. This can also be shown by differentiating $NGC'$ with respect to *w*

$$\frac{\partial q^*}{\partial w} = \frac{i(1-\pi)}{(\pi\beta - 1)R_{t+1} + i(1-\pi)} > 1\,, \tag{4}$$

assuming for now that $(\pi\beta - 1)R_{t+1} + i(1-\pi) > 0$.

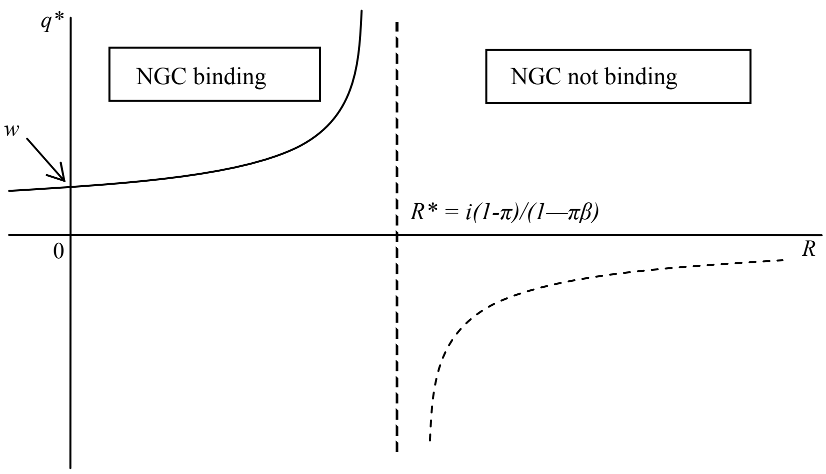


Figure 3. Maximum Project Size $q^*$ as a Function of the Rental Rate R
NGC is not binding for high rates of profit

Figure 3 shows how the maximum project size for debt finance $q^*$ rises with profitability, i.e., the rental rate of capital *R*. This is because the effect of a marginal rise in *R* on profits from prudent investment, equal to 1, is bigger than its impact on profits from gambling, $\pi\beta < 1$, thus reducing incentives to gamble as *R* rises. Intuitively, as entrepreneurs only make profits in good states, they like high probabilities of success the more, the higher the possible gains in success states. Creditors who know this will thus be willing to lend more money when profits are high, leading to a positive relation between $q*$ and $R$. This is the *profit effect*, equivalent to the franchise value effect in a multi-period setting, such as Hellmann, Murdock and Stiglitz (2000). It can be obtained algebraically by differentiating NGC' with respect to $R_{t+1}$:

$$\frac{\partial q_t *}{\partial R_{t+1}} = w \frac{i(1-\pi)}{\left[(\pi\beta - 1)R_{t+1} + i(1-\pi)\right]^2}(1-\pi\beta) > 0 \quad \text{for} \quad (\pi\beta - 1)R_{t+1} + i(1-\pi) > 0\,. \quad (5)$$

Profits thus relax gambling incentives. In fact, they can even eliminate them altogether as we show now.

*High profits eliminate incentive problems: The Moral Hazard Condition*

Note that all our results so far have been conditional on

$$\begin{aligned}&(\pi\beta - 1)R_{t+1} + i(1-\pi) > 0\\ &\Leftrightarrow R_{t+1} < R_{NGC} = i(1-\pi)/(1-\pi\beta).\end{aligned} \quad \text{(MHC)}$$

Figure 3 shows why this is the case: NGC' is not binding for values higher than $R_{NGC}$, since in this case the denominator in NGC becomes negative and the inequality is reversed, such that NGC holds for all positive values of borrowing. In other words, agents' borrowing is not incentive-constrained for high values of $R$. The intuition for this is that entrepreneurs gain from gambling since under limited liability they need not (and cannot) pay the contractual interest in the bad state. This leads to an expected gain from lower interest payments of $bi(1-\pi) > 0$. However, the borrower loses from the lower expected payoffs on the borrowed capital, equal to $-bR(1-\beta\pi) < 0$. NGC only applies when the sum of the two is positive, i.e., when there are gains from gambling with borrowed money. This yields the *Moral-Hazard-Condition* (MHC) that NGC only binds for a rental rate of capital below $R_{NGC}$. In our general equilibrium analysis this is the reason why incentives to gamble arise endogenously in the development process as the rental rate and thus profits fall.

The denominator in NGC, $i(1-\pi) - R(1-\pi\beta)$, can thus be interpreted as the "degree of moral hazard": the higher $i$, the higher incentives to gamble (since gambling reduces interest payments in bad states), the higher $R$, the lower these are since entrepreneurs expected gains from high profitability are less under gambling.

Note in passing that the impact of the international interest rate on the maximal project size under debt finance is given by

$$\frac{\partial q *}{\partial i} = -w \frac{(1-\pi)(1-\pi\beta)R_{t+1}}{\left[(\pi\beta - 1)R_{t+1} + i(1-\pi)\right]^2} < 0\,. \quad (6)$$

This also shows that the effect of rising interest rates on $q^*$ is smaller the higher the interest rate.

*Maximum Equity Participation*

So far we have assumed that entrepreneurs invest all of their wealth in their project, and only borrow the difference between own funds and the required investment. To see that this is optimal for risk-neutral entrepreneurs note that by investing an additional unit of their wealth in their own project, entrepreneurs never get less (but sometimes more) than the opportunity cost *i*. So they always weakly prefer to invest in their own enterprise than in the safe international financial asset. In the following we will thus assume maximum equity participation for all projects.[6]

## 4. DYNAMIC GENERAL EQUILIBRIUM

The previous section showed how a moral hazard problem can lead to a No-Gambling constraint that limits borrowing by a function of entrepreneurs' own capital and expected profits of their projects. However, both these variables depend crucially on the per capita capital stock in the economy, which makes it natural to proceed to a dynamic general equilibrium analysis. More specifically, the number of realised projects is affected in two ways in the development process: first of all labour's surplus and wages rise when capital is accumulated, thus leading to more own finance and a less constraining No-Gambling Condition (the capital at risk effect). On the other hand, capital accumulation leads to a falling marginal productivity of capital, thus a falling rental rate and less profits to entrepreneurs. The danger of moral hazard arises when profitability falls below the level where gambling with borrowed money suddenly becomes optimal, indicated by MHC above. That is, moral hazard arises as a by-product of development. Further capital accumulation alleviates the No-Gambling Condition by higher capital at risk, but aggravates it by falling marginal returns. In this section, we look at the resulting net effect of capital accumulation in general equilibrium, and analyse the existence, stability and uniqueness of a steady state in the economy, as well as the process of convergence.

It turns out to be straightforward to derive general equilibrium properties for our model, characterised by the competitive market clearing rates for wages and the rental rate on capital, the individual rationality conditions (IR1) and (IR2), as well as the

[6] In a more general costly state verification framework, Gale and Hellwig (1985) show more formally that standard debt contracts with maximum equity participation (i.e., where a risk-neutral borrower puts up all his own wealth to co-finance a loan) are indeed optimal. But note that the assumption of risk-neutral agents is key for this result.

No-Gambling Condition.

### 4.1. Equilibrium in Markets for Labour and Capital

We first derive the equilibrium in the markets for labour and capital to get expressions for the wage *w*, equal to the equity stake of entrepreneurs, and the marginal productivity of capital *R* that determines profits. As both markets are competitive, in equilibrium capital and labour are simply paid their marginal product. Therefore

$$F_N = [F(K_t) - K_t R_t] = w_t \,,$$

and

$$F_{K,t} = R_t \,.$$

We also assume

$$F_K(K_{\max}) < i \,, \tag{A4}$$

where $K_{MAX}$ is the capital output when all investment projects get realised. According to (A4), it is not efficient to run all projects in the economy, since in that case the marginal productivity of capital would be lower than the international rate of return *i*.

### 4.2. Benchmark General Equilibrium with Full Information

We have seen above that under full information, it is never optimal for agents to gamble. Agents borrow funds and invest these in the prudent technology such that the marginal productivity of capital in period *t*+1, which is the expected return to period *t* investment projects, equals returns from financial assets. Thus

$$\begin{aligned} &\Pi_{prudent} = E[R_{t+1}](w' + b) - ib = w'i \\ &\Leftrightarrow R_{t+1} = i = F_{K,t+1}(K'). \end{aligned} \tag{7}$$

(7) implicitly defines a unique level of full information capital $K'$, since $F_K$ is a monotonically decreasing function by assumption. So with full information there is no convergence process: in line with other simple neoclassical growth models, under full information the economy jumps to its steady state capital level $K'$ between period *t* and *t*+1. Also, under full information entrepreneurs do not earn rents in equilibrium, as the profitability of their projects is equal to the international interest rate.

### 4.3. General Equilibrium under Asymmetric Information

The equilibrium conditions under asymmetric information are more complicated, as there are three constraints which may be binding in some stages of the convergence process, but not in others. First, we saw that the No-Gambling Condition constrains borrowing only below a threshold level of productivity given by the Moral Hazard Condition (i.e., for later stages of convergence where capital is more abundant). Second, depending on the parameters of the gambling technology, inefficient gambling projects may still get financing if they are able to pay the necessary premium (which is more likely to be the case in earlier stages where capital is scarce). And finally, the individual rationality constraints of creditors and entrepreneurs put a binding upper limit on capital intensity, corresponding to a lower limit on the marginal productivity of capital equal to the international rate of return.

Assume for now that the economy is in the region where NGC binds, and where the external finance premium is too large for gambling projects to be profitable (i.e., $R = F_K(K) < \min\{i(1-\pi)/(1-\pi\beta), i/\pi\beta)\}$) and that $K_t$ is less than the full information capital stock. Under these assumptions the period $t+1$ capital stock under asymmetric information is simply the output of investment projects that get financing according to the No-Gambling Condition. Capital output per invested unit of finance is one, since when NGC holds no agents gamble.

The assignment of projects to agents is done by independent draws from the distribution *g(q)* which is normalised to one as well as the number of agents in the economy. So the amount of capital in period $t+1$ is simply the expectation of the project size conditional on the project being realised, i.e., being smaller than $q_t*$ given by $NGC'$. This yields

$$K_{t+1} = \int_{\underline{q}}^{q_t*} qg(q)dq\,, \tag{8}$$

where $q_t*$ is a function of $K_t$, via period *t* wages, and of $K_{t+1}$, via expected returns on capital $E[R_{t+1}]$.

(8) implicitly defines $t+1$ capital as a function of capital in period *t* implicitly since the right hand side depends on expected $t+1$ profitability. Since *K* is the only state variable in the model, (8) is the law of motion for the economy.

If we assume rational expectations of next period's rental rate, we can derive the slope of the law of motion by differentiating (8) implicitly[7]

[7] This is admissible since (8) is an identity.

$$\frac{\partial K_{t+1}}{\partial K_t}=\frac{-q^*_t\, g(q^*_t)K_t F_{KK,t}\dfrac{i(1-\pi)}{(\pi\beta-1)F_{K,t+1}+i(1-\pi)}}{1-q^*_t\, g(q^*_t)[F_t-K_t F_{K,t}]\dfrac{i(1-\pi)(1-\pi\beta)F_{KK,t+1}}{[(\pi\beta-1)F_{K,t+1}+i(1-\pi)]^2}}>0 \quad \text{for} \quad K_t>0\,. \quad (9)$$

Thus, assuming Inada conditions and that $NGC'$ is binding, (8) is always upward-sloping. This is equivalent to saying that under asymmetric information the positive capital at risk effect on borrowing constraints from rising wages is always larger than the negative profit effect from falling profitability of investment as the economy accumulates capital. However, for a general distribution of projects *g(q)* and a general production function, we cannot say very much about the curvature of the law of motion, required to draw conclusions about uniqueness and stability of a steady-state of the economy.

Intuitively, the importance of the distribution *g(q)* is evident: the more concentrated projects are in the lower region of possible *q*s, the less severe is the rationing of investment due to borrowing limits. On the other hand the more large potential projects there are in the economy, the higher the benefits from measures that relax the rationing.

It seems plausible that the number of projects in an economy decreases with size, i.e., that there are less large-scale projects than small-scale projects, which is equivalent to *g(q)* being a decreasing function. However, the distribution of *capital* as a function of project size, *qg(q)*, may still be increasing or decreasing. For analytical tractability, we choose here the intermediate case, a uniform distribution of capital with respect to project size, which requires

$$g(q)=1/q\,. \quad \text{(A5)}$$

(A5) yields a simplified law of motion

$$K_{t+1}=\int_{\underline{q}}^{q_t^*} q\frac{1}{q}dq=q\Big|_{\underline{q}}^{q^*_t}=q^*_t-\underline{q}=w_t\frac{i(1-\pi)}{(\pi\beta-1)E(R_{t+1})+i(1-\pi)}-\underline{q}\,, \quad (10)$$

with

$$\frac{\partial K_{t+1}}{\partial K_t} = \frac{-K_t F_{KK,t} \dfrac{i(1-\pi)}{(\pi\beta-1)F_{K,t+1}+i(1-\pi)}}{1-[F_t - K_t F_{K,t}]\dfrac{i(1-\pi)(1-\pi\beta)F_{KK,t+1}}{[(\pi\beta-1)F_{K,t+1}+i(1-\pi)]^2}} > 0 \quad \text{for} \quad K_t > 0. \qquad (9')^{8}$$

Still, the curvature of the law of motion depends on the third derivative of the production function, which is not pinned down by our assumptions. Galor and Ryder (1989) show that Inada conditions do not suffice to ensure existence of a unique and stable non-trivial equilibrium in the Diamond (1965) model, and develop a set of strengthened Inada conditions that are sufficient. The conditions in our model are likely to be very different, given the additional link between periods due to the role of expected productivity for incentive constraints and thus current output. Therefore, we take a short-cut and assume a Cobb-Douglas production technology for our economy

$$F = F(K,N) = K^{\alpha}N^{1-\alpha}. \qquad \text{(A6)}$$

Remembering that labour supply is inelastic and normalised to one, and setting $\underline{q} = 0$ for simplicity, we get the steady state capital stock, where $K_{t+1} = K_t = K^*$, as[9]

[8] Note, however, that the result about the slope of (10) and (8) depends on the way expectations are made about future productivity. If expectations are rational, i.e., $K_{t+1}$ is derived by agents using the true model of the economy (10), the above result holds. If however, expectations are completely naive, a simplifying assumption with respect to the more general case of adaptive expectations, i.e., $E(R_{t+1}) = F_{K,t}$, then we get

$$\frac{\partial K_{t+1}}{\partial K_t} = \frac{-KF_{KK,t}i(1-\pi)[(\pi\beta-1)F_{K,t}+i(1-\pi)]+[F_t - K_t F_{K,t}]i(1-\pi)(1-\pi\beta)F_{KK,t}}{\left[(\pi\beta-1)F_{K,t}+i(1-\pi)\right]^2}, \qquad \text{(F1)}$$

which can be negative or positive. The intuition for this is that with rational expectations an increase in period *t* capital affects period *t*+1 capital directly only by the wealth effect i.e., via period *t* wages that mitigates borrowing constraints, whereas the effect of diminishing returns in *t*+1 due to increased capital is second order and only shows up in the denominator. However, with naive expectations the diminishing return effect shows up directly as a downward effect on gains from higher capital as of period *t*, which is first order. Its magnitude depends on the bowedness of the production function ($F_{KK}$ being large or small) and of the stage of development (the amount of capital and therefore the magnitude of $F_K$).

[9] Note that $g(q)$ is not defined for $q = 0$. However, since the probability of any particular value of *q* occurring is 0 for any continuous probability density function we implicitly exclude $q = 0$ without affecting the results.

For general $\underline{q}$, the expression that defines $K^*$ in terms of the ratio between minimum project size and

$$K^* = \left[ \frac{\alpha(1-\pi\beta)}{i(1-\pi)} + (1-\alpha) \right]^{\frac{1}{1-\alpha}}, \tag{11}$$

and

$$\frac{\partial^2 K_{t+1}}{\partial^2 K_t} < 0 . \tag{12}$$

So with Cobb-Douglas technology, the law of motion is concave in $K_t$ and thus has a stable and unique steady state given by (11).

However, to characterise the law of motion for capital completely we have to bear in mind the assumptions made at the beginning of this section. First, we assumed NGC to bind and risky projects not to get finance, i.e., $R_t = F_{K,t} < \min\{i(1-\pi)/(1-\pi\beta), i/\pi\beta\}$ for all *t*. Due to Inada conditions, this is certainly not the case for low values of *K*, where marginal productivity is high. Thus both of these conditions put a lower bound on capital in the economy even with financial frictions. Intuitively, even when $K_t = w_t = 0$, entrepreneurs obtain outside finance until both the non-gambling condition and the individual rationality constraint for entrepreneurs with risky projects are binding. The corresponding lower bound on the capital stock of our open economy is thus

$$K_{\min} = \max\{K_{NGC}, K_{risky}\} = \max\left\{ \left[ \frac{i(1-\pi)}{\alpha(1-\pi\beta)} \right]^{1/(\alpha-1)}, \left[ \frac{i(1-\pi)}{\alpha(1-\pi\beta)} \right]^{1/(\alpha-1)} \right\}. \tag{13}$$

So there is a jump in the law of motion at $K_t = 0$ to $K_{NGC}$ or $K_{risky}$, the level corresponding to a return of $R_{risky}$. For all $t > 0$ the borrowing constraint NGC will be binding (this is since from the second period, *K* will always be greater than $K_{NGC}$ and $K_{risky}$, as the law of motion is increasing in $K_t$ for all $K_t > 0$).

The third assumption we made when deriving the law of motion was $K_t < K'$, i.e., that capital was lower than the full information level. This was necessary since the full information capital stock is a binding upper limit for $K$: otherwise the capital output of investment projects would not be sufficient to meet (IR1) and (IR2), i.e., entrepreneurs and outside investors would not get their required rate of return. The period $t+1$

steady state capital per capita is $K^* = \left[ \dfrac{\alpha(1-\pi\beta)(1-q/K^*) + (1-\alpha)(1-\pi)i}{(1-q/K^*)(1-\pi)i} \right]$.

capital stock thus stays at $K'$ for all periods when the law of motion (8) attains this upper limit.

Under Cobb-Douglas technology the full information capital stock is simply

$$K' = \left[\frac{i}{\alpha}\right]^{\frac{1}{\alpha-1}}. \tag{14}$$

This yields proposition 1.

*Proposition 1: Steady State Convergence*

*With asymmetric information, the economy never jumps to its full information capital stock. Rather, there is always some process of convergence if the initial capital of the economy is low.*

*Proof*

*From (13) and (14) it is evident that max* $\{K_{NGC}, K_{risky}\} < K'$*, i.e., the lower bound of the capital stock is smaller than the full information capital stock for all parameter values and interest rates, since*

$$\max\left\{\left[\frac{(1-\pi)}{(1-\pi\beta)}\right]^{1/(\alpha-1)}, \left[\frac{(1-\pi)}{(1-\pi\beta)}\right]^{1/(\alpha-1)}\right\} < 1. \tag{QED}$$

Incorporating incentive constraints under international debt finance thus eliminates the usual instantaneous convergence of standard neoclassical growth models under international mobility of capital.

However, this result might not be too relevant as long as we are sure that the economy eventually converges to the same long-run equilibrium. This is not necessarily the case, however, as long as the minimum project size is large enough. To show this, we express the minimum project size in terms of the steady state level of capital per capita, to get at least some idea of its magnitude.

*Proposition 2: Non-Convergence to the Full Information Steady State*

*There is non-convergence in our economy if the minimum project size is sufficiently large. In other words, under asymmetric information capital stock and output are lower than those under full information even when the economy has converged to a steady state if*

$$\underline{q} > \left( \frac{(1-\pi)(1-\alpha)i}{\alpha\pi(\beta-1)} - 1 \right) K^* . \tag{15}$$

*Proof*

*The proposition is easily derived from setting $K^* < K'$ and solving for $\underline{q}$ from (11) and (14). Note that since (10) is an increasing function for all parameter values, it never crosses $K'$ as long as the steady state capital stock $K^*$ is lower than $K'$.*
*(QED)*

From proposition 2 it is immediate that agents that obtain funding for their project can earn rents in equilibrium, since whenever (14) holds marginal producitivity is strictly higher than *i* and (IR1) holds with equality. For specific parameter values the minimum $\underline{q}$ to get non-convergence may be greater than zero, but will often be significantly smaller than steady state capital per head. However, this result of course depends crucially on the simplifying assumption about the distribution of capital.

Finally, since total (prudent) investment in the economy in period t is equal to period $t+1$ capital, and savings are equal to wage payments, we get the possibility of South-North net investment, whenever savings are greater than domestic investment, a result known from Gertler and Rogoff (1990), or Boyd and Smith (1997). This is stated in proposition 3.

*Proposition 3: South-North "Capital Flight"*

*The economy will experience net capital outflows, whenever*

$$\underline{q} > \frac{w_t E[R_{t+1}](1-\pi\beta)}{(\pi\beta-1)E[R_{t+1}] + i(1-\pi)} . \tag{16}$$

*Proof*

*The proposition follows from setting $w_t > K_{t+1}$ by solving for $\underline{q}$.* *(QED)*

It is straightforward to substitute the steady state values for wages and capital in (16) to derive a condition for net outward investment in steady state. There is thus the possibility of transitory capital flight in the economy, if (16) holds in the initial stages of development, where wages are low, but not in steady state.

Figure 4 summarises our results for the law of motion graphically for a Cobb-Douglas production technology, for a case where $K_{\min} = K_{NGC}$. Note that $K_{t+1}$ is bounded below by $K_{NGC}$ and above by $K'$. The dotted curves indicate laws of motion for different values of minimum project size $\underline{q}$ in (8) when (15) holds only for large $\underline{q}$[10].

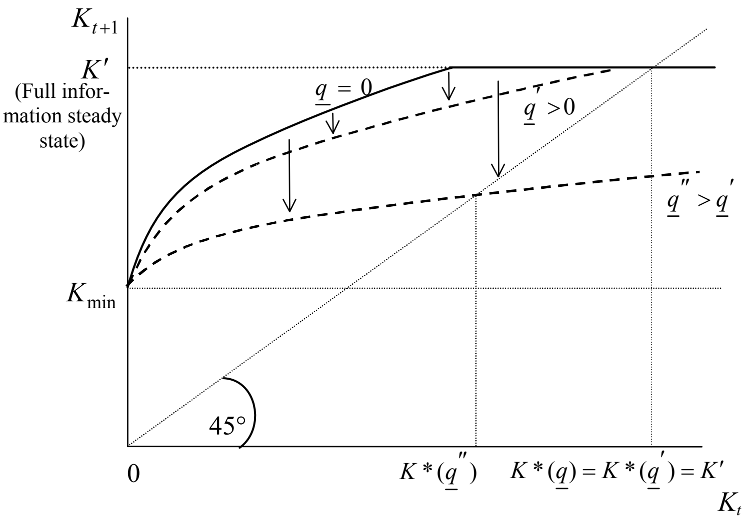


Figure 4. The Law of Motion for Different Values of $\underline{q}$

This section thus yields the main results of the paper: as long as we accept the assumptions on technology and the distribution of investment opportunities, there exists a single and unique steady state for our financially open model economy, despite

[10] Note that even for $\underline{q}$ very large, the *t*+1 capital stock at $K_t = 0$ stays $K_{NGC}$. Intuitively this is because at $K_{t+1} = K_{NGC}$ the maximum project size is in fact infinite according to NGC' (since the denominator is zero). The behaviour *of* $K_{t+1}$ for rising $\underline{q}$ with $K_t$ held constant can be seen by differentiating (8) with respect to $\underline{q}$, which yields

$$\frac{\partial K_{t+1}}{\partial \underline{q}} = \frac{-1}{1-[F_t - K_t F_{K,t}]\dfrac{i(1-\pi)(1-\pi\beta)F_{KK,t+1}}{\left[(\pi\beta-1)F_{K,t+1}+i(1-\pi)\right]^2}} < 0 \quad \text{for} \quad F_{K,t+1} < i(1-\pi)/(\pi\beta-1)\,. \qquad \text{(F2)}$$

This derivative is always negative when NGC is binding, but it goes to zero as $K_{t+1}$ approaches $K_{NGC}$ (since the denominator goes to plus infinity). Thus rising $\underline{q}$ moves the law of motion downwards but the effect dampens out near $K_{NGC}$, i.e., the laws of motion start at the same point (0, $K_{NGC}$) but are flatter than that for $\underline{q} = 0$, as drawn.

incentive constraints. Equivalently, the positive capital at risk effect strictly dominates the negative profit effect, of falling profitability of capital that tightens borrowing constraints. However, contrary to the full information case, incentive compatibility constraints always lead to a time-consuming process of convergence and possibly to net outward investment from developing countries. Steady state output and capital are for sufficient minimum project size strictly lower than the full-information level. That is, some entrepreneurs can be rationed in equilibrium: they have projects that could generate the required rate of return, but they do not obtain funds to finance the investment due to incentive constraints.

### 4.4. Monitoring Contracts

Section 4.3 is based on the assumption that lenders cannot observe the technology chosen by entrepreneurs at any cost. So it seems worthwhile to ask whether the results are robust to the introduction of costly monitoring of entrepreneurs by lenders. The answer to this question depends on the cost structure of monitoring. This section briefly discusses two polar cases: proportional and fixed monitoring costs.

In the simplest case, monitoring costs are proportional to the size of the loan. This introduces an external finance premium for projects that cannot meet NGC equal to the per unit monitoring cost. If the latter are high enough, entrepreneurs that fail to meet NGC will prefer to invest in safe international financial assets and the results are unchanged. With intermediate monitoring costs, some risky projects will get realised (and monitored) in the initial stages of development when expected returns are high, but not when the marginal productivity of capital decreases towards the international interest rate during the development process.

Broer (2001) considers the opposite case of fixed monitoring costs. In this case there are returns to scale from monitoring large projects, so the external finance premium of projects that cannot meet NGC declines with their size. The companion paper shows that this can lead to a “gap in the credit supply”, where small projects get standard debt, very large projects get monitoring contracts (interpreted as foreign direct investment in Broer (2001)), but medium-sized projects are rationed in equilibrium.

## 5. RESPONSE TO PRODUCTIVITY SHOCKS

In order to get the response of the economy to productivity shocks, we add a stochastic shock term $\theta_t$ to the production function

$$G(K_t) = \theta_t F(K_t)\,. \tag{17}$$

We thus get the responses of $t+1$ capital to productivity shocks by implicitly differentiating (8):

$$\frac{\partial K_{t+1}}{\partial \theta_t} = \frac{[F_t - KF_{K,t}]\dfrac{i(1-\pi)}{(\pi\beta - 1)E(R_{t+1}) + i(1-\pi)}}{1-\theta_t[F_t - K_t F_{K,t}]\dfrac{i(1-\pi)(1-\pi\beta)F_{KK,t+1}}{\left[(\pi\beta-1)E(R_{t+1}) + i(1-\pi)\right]^2}} > 0\,. \tag{18}$$

A negative shock to period $t$ productivity and thus to the wage rate at time $t$ inevitably reduces period $t+1$ capital and wealth by tightening the NGC and thus the borrowing limit.

This gives rise to the following proposition:

*Proposition 4*

*If an economy is borrowing constrained due to limited wealth, one-time negative shocks to productivity are propagated to future periods by a credit crunch.*

*Proof*

*From (9) and (18) we get*

$$\frac{\partial K_{t+n}}{\partial \theta_t} = \prod_{i=1}^{n-1} \frac{\partial K_{t+i+1}}{\partial K_{t+i}} \frac{\partial K_{t+1}}{\partial \theta_t} > 0\,. \tag{20}$$

*The effect thus dampens out in future periods whenever*

$$\frac{\partial K_{t+i+1}}{\partial K_{t+i}} < 1 \quad \textit{for all} \quad i > 0\,. \qquad (QED)$$

Thus, our model predicts financial conditions (here entrepreneur wealth) to have real effects by causing lasting consequences of one-time shocks, as in the “financial accelerator” models of for example Bernanke and Gertler (1989).

Concerning the response to the expected profits of projects we can state the following.

*Proposition 5*

*An expected negative shock to the economy is anticipated by a credit crunch.*

*Proof*

*To prove proposition 5 it is sufficient to show that t+1 capital inputs ( $K_{t+1}$ ) depend positively on expected shocks to t+1 output, or productivity ( $E[\theta_{t+1}]$ ), i.e., that there is a credit crunch at the end of period t as a result of lower expected profits in t+1.*

$$\frac{\partial K_{t+1}}{E[\partial\theta_{t+1}]} = \frac{\left[ w_t \frac{i(1-\pi)(1-\pi\beta)F_{K,t+1}}{\left[(\pi\beta-1)E[\theta_{t+1}]F_{K,t+1}+i(1-\pi)\right]^2} \right]}{1-\theta_t[F_t - K_t F_{K,t}]\frac{i(1-\pi)(1-\pi\beta)F_{KK,t+1}}{[(\pi\beta-1)E[\theta_{t+1}]F_{K,t+1}+i(1-\pi)]^2}} > 0 . \tag{21}$$

(*QED*)

## 6. CONCLUSION

This study has shown that moral hazard, resulting from information asymmetries in financial markets, may have important consequences for growth in financially open developing countries. We showed that if domestic entrepreneurs can gamble with creditors' money, standard debt finance is constrained by their own capital at risk in their project, as indicated by a No-Gambling Condition similar to that of Hellmann, Murdock, and Stiglitz (2000). This can be an important constraint for capital-poor developing economies.

The constraint was shown to be endogenous in the development process via the effect of growth on capital at risk and profits to capital investment: first of all, there is a threshold for returns to capital above which entrepreneurs never have incentives to gamble. Capital accumulation, by reducing marginal returns to capital and investment, was thus shown to give rise to moral hazard at some point of the development process. However, we also showed that once one takes into account the positive effect of capital accumulation on wealth and thus entrepreneurs' capital at risk, further development alleviates the No-Gambling constraint. The steady state was shown to be unique and stable under Cobb-Douglas production technology, and may involve rationing of potentially profitable projects. Depending on the minimum scale of investment projects, there can be positive net investment from developing countries in international financial markets. Also, one period shocks to our economy have lasting effects in the future, and expected future shocks are anticipated by lenders' behaviour today.

In summary, our study suggests that while there might be other benefits of international financial liberalisation, the effect of international capital mobility on capital accumulation in poor countries is not unambiguously beneficial as simple models would suggest. Even our limited amendment of an otherwise very neo-classical framework, to include limited information about investment choices, has led to a much more pragmatic picture of the effects of international financial liberalisation on development.

What could be the appropriate policy responses to the described consequences of moral hazard in emerging market lending? One reason for the problem is clearly the lack of entrepreneurs' own capital. A domestic equity market where agents can pool wealth to provide equity for investment projects can have positive consequences, at least if information asymmetries within countries are less severe than internationally. Also, using the idea of "non-pecuniary penalties" put forward by Diamond (1984), governments could use their discretion over the non-financial inconveniences associated to bankruptcy (preclusion from starting a new business, imprisonment for financial fraud, etc.), to ease the effect of limited financial liability.

Inevitably, our simple analytical framework gives rise to several possible extensions. First of all, the assumption of unobservable technology choices is a strong one. As mentioned above, a companion paper (Broer (2001)) looks at the role of costly monitoring in this context, where outside investors have the possibility to observe entrepreneurs' investment decisions at a certain cost.

Also, ideally we would like to relax the specific assumption on the probability distribution of projects over size, to show the conditions under which our results continue to hold, or more interestingly under which development dynamics present unstable or multiple equilibria. Furthermore, a more general production function with human capital might be able to show the trade-off between capital-at-risk-increasing accumulation of production capital and productivity-increasing accumulation of human capital that cannot serve as collateral.

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