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Corporate Finance, Financial Development, and Growth

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Introduction

A great deal of empirical work has convincingly shown that there is a positive association between financial development and economic growth, and some recent work has even provided evidence that the former causes the latter[1]. What is less clear is the identification of the actual transmission channel. This paper is an attempt in this direction, with particular emphasis placed on the role of the financial system in alleviating informational asymmetries. While research in this field has highlighted the benefits of well developed financial systems, the observation that internal funds (retained earnings plus depreciation) constitute by far the main source of funds of the corporate sector has not gained any attention.[2] We believe that the informational frictions that lie behind this phenomenon may be part of the missing empirical link between financial system and growth. In particular, we will show that such frictions create a financing constraint that reduces investment and growth.

Informational asymmetries stem from the fact that outside investors have less information than insiders to the firm. Under these circumstances, the potential demanders of funds might behave in ways that reduce the expected return for the providers of funds. Possible deceitful actions are the diversion of funds away from the productive project, the misrepresentation of profits, and the pursuit of value-destroying managerial actions. In any of these cases, external funds (bank loans, market debt, and outside equity) will no longer be perfect substitutes of internal funds. Specifically, outside investors may charge an "agency" or "lemons" premium on external funds, and may also ration the amount of financing, with the consequence that a positive relationship between investment and cash flow is likely to be observed at least for firms for which these informational asymmetries are more severe. Harris and Raviv (1991) is a thorough survey of contributions in this area. See also Hillier (1997) for a textbook presentation.

[1] For recent work using financial variables as explanatory variables in growth regressions, see King and Levine (1992, 1993) and De Gregorio and Guidotti (1995). Regarding causality in a cross-section study, see Levine et al. (1998); for time-series evidence and Granger-causality, see Neusser and Kugler (1998); and for industry and firm-level work, see Demirguc-Kunt and Maksimovic (1996) and Rajan and Zingales (1997).

[2] This applies to both developed countries and developing countries (see Bebczuk (1998)). To take a particular example, in the case of the United States, usually thought to have one of the better developed financial systems in the world, we have calculated from national accounts information that internal funds represented 73.1% of total sources in 1973-1992, up from 70.2% in 1945-1972. On the other hand, the size of the financial system, as measured by the ratio credit to the private sector to GDP, jumped from 42.3% in 1960 to 65.8% in 1996. An appendix to the present study presents previously unavailable information on the financing structure for Latin American countries, elaborated by the author, besides some data for OECD countries.

The role of information frictions to explain business cycles has been profusely studied in the last fifteen years. Following the pioneering work by Fazzari et al. (1988), a number of papers have found evidence that investment is sensitive to cash flow for some segments of firms[3], giving support to the notion that financial constraints are important (for a survey, see Hubbard (1998)). Likewise, some scholars have underlined agency costs of lending as a catalyst for the propagation of real and monetary shocks (see, for example, Bernanke et al. (1996, 1998)).

Establishing the theoretical relevance of financial markets for economic growth constitutes a prerequisite to claim any role for these information problems in growth theory. Financial markets perform several functions which in turn exert a positive influence on growth (see Levine (1997)): they reduce liquidity and idiosyncratic risks, enhance the allocation of resources towards to their more productive uses, improve monitoring and corporate control, mobilize savings, and facilitate specialization. Models have been built highlighting the effect of some of these different functions on growth.[4] The resurgence of growth modeling since the mid-80s brought about more rigorous approaches. Greenwood and Jovanovic (1990) stress the two-way relationship between financial intermediation and growth. While financial institutions are designed to collect and analyze information to channel funds to the highest yield activities, economic growth itself encourages financial development by reducing the costs involved in this process. Bencivenga and Smith (1991) focus on the role of the financial system in ameliorating liquidity risk management, avoiding as a consequence the need of prematurely realizing highly productive, illiquid projects. Saint-Paul (1992) and King and Levine (1993) concentrate on the diversification of individual risks induced by the financial system, which in turn may shift the technological choice towards more productive, riskier projects (see Berthelemy and Varoudakis (1996) for a thorough survey of the literature).

However, scarce effort has been devoted to the study of informational asymmetries regarding aggregate growth. Just three papers address this topic. Bencivenga and Smith (1993) formalize a situation where adverse selection of borrowers give rise to credit rationing with adverse consequences on the rate of growth, as riskier and more productive projects are the most likely to be rationed. Mattesini (1996) introduces a costly state verification framework to argue that monitoring costs may be detrimental to growth. Finally, Amable and Chatelain (1996) extend to a growth context an asymmetric information model standard in the literature on financial

[3] Kadapakkam et al. (1998) find evidence on investment-cash flow association for all listed firms (without segmenting according to any a priori expected financial constraints) in six OECD countries.

[4] Early seminal contributions are Goldsmith (1969), McKinnon (1973), and Shaw (1973).

markets and business cycles (see, for example, Gertler and Hubbard (1988), Gertler and Rogoff (1989), and Holmstrom and Tirole (1997)) to show that investment is constrained by the availability of internal funds. The only paper contributing some cross-country evidence is Mattesini (1996), who uses the spread between lending and deposit rate as a proxy for monitoring costs, finding a negative effect. Our model builds on Gertler and Hubbard (op.cit.) and Amable and Chatelain (op.cit.). While maintaining the basic structure of this branch of models, ours examines more in depth the static and dynamic properties of the solution, and also derives testable implications concerning the link between financial development and growth.

It is instructive to separate the effects of financial development on growth into changes in the quantity of resources directed to investment and changes in the quality (productivity) with which those resources are invested. In turn, the quantity effect can be decomposed into changes in total saving and changes in the amount of resources lost in the intermediation process from savers to borrowers.

The model that motivates the subsequent empirical work concentrates on this latter mechanism, by taking as granted the productive technology and assuming that the supply of foreign saving is perfectly elastic in the absence of asymmetric information.[5] Invoking the functional view adopted by Levine (1997, op.cit.), the financial system is thus left with the growth-promoting mission of mobilizing savings, that is, agglomerating savings from surplus economic units and transferring them to those seeking funds. The ability of the financial system in minimizing transaction costs and overcoming informational asymmetries increases the optimal investment level, and therefore constitutes a key to rationalize the connection between financial development and growth.

Exploiting the model insights, we find a positive relationship between growth and the proportion of private investment financed by bank debt, attributable to the existence of (directly unobservable) informational asymmetries. Since this ratio of debt financing is also explained by the project's productivity and the risk-free interest rate, these factors are controlled for. The estimation is carried out through dynamic panel data techniques applied on a cross-section, time-series data set for 59 countries over the period 1965-1994. The estimation and some robustness checks lend support to the model. As in related empirical papers, the size of the financial system

[5] As in the majority of the papers previously cited, attention focuses on financial intermediaries rather than market sources (outside equity and debt). This is usually justified by the overwhelming importance of banks as providers of external funding in most countries. Nevertheless, Demirguc-Kunt and Levine (1996) show that the development of stock markets and financial intermediaries is highly correlated with each other, and Levine and Zervos (1996) find that stock market development enters positively in a cross-country growth regression.

is positively correlated with the rate of growth. But in addition, the independent, positive significance of debt financing suggests, for the first time, that financing constraints may be relevant to explain aggregate long-run growth and private investment.

The organization is as follows: In Section 1, the theoretical model is developed and discussed. Section 2 is devoted to the econometric estimation. Some conclusions close.

Section 1: The Model

In this section we will develop an elementary model of long-run growth to motivate the subsequent empirical work. It is based on a partial equilibrium approach and focuses on the steady state of an economy with risk-neutral individuals living two periods. The model illustrates a possible mechanism through which the financial environment may influence economic growth. The expansion of the financial system increases the amount of resources a firm may dispose of to undertake profitable investment opportunities. It is well known that in perfect capital markets the financing structure is irrelevant, as firms are able to reach their optimal capital levels independently of how they finance them. To make financial and real decisions interdependent, we introduce an ex-post information asymmetry between the lender and the borrower. The device, standard in the literature on finance and macroeconomics, is that a portion of the project's investment is unobservable, creating an incentive for moral hazard behavior on the part of the borrower, which jeopardizes the ability of the lender to get the debt repaid in full.[6] As will be shown shortly, an incentive-compatible contract may resolve the conflict at the cost of setting an upper limit on the debt the borrower can take. In equilibrium, real investment will be a positive function of the firm's internal funds (retained earnings) and firms will be debt-constrained. A bequest motive is postulated to allow firms accumulate part of the profits instead of entirely devoting them to consumption.

The efficiency with which the financial system intermediates between savers and borrowers is also crucial. Financial markets emerge in part to minimize the transaction costs of collecting society's savings. The resources absorbed by the financial system in performing this intermediation task certainly increase the cost of capital. We account for this effect by breaking down the riskless interest rate into a "pure" interest rate and a transaction-cost component. This cost-of-capital effect should be distinguished from the wedge between the cost of internal and external funds induced by information asymmetries: Even if these asymmetries did not exist, the efficiency of the financial system would most probably affect the cost of capital detracting resources from investment activities.

[6] Other forms of informational friction would lead to the same qualitative results. For instance, some papers on

1.1 Description of the Model

The economy consists of a constant population of risk-neutral individuals who live two periods (t and t+1) and maximize a utility function of the form $U(c_{t,t+1}, b_{t,t+1}) = c^{d}_{t,t+1} b^{(1-d)}_{t,t+1}$, where the first subscript corresponds to the living generation and the second to the period of time. The central feature here is that utility depends on both consumption (c) and a bequest (b) to their one offspring in the second and final period, according to Cobb-Douglas preferences that divide lifetime wealth w into fixed proportions of consumption (δ) and bequest (1-δ).[7] As mentioned before, consumer decisions are only integrated into the analysis to rationalize the existence and evolution of retained earnings, which will play a central role later on. Individuals are identical in all aspects except for the wealth they inherit. Generations do not overlap, and they are linked through this bequest.

The production side is very simple as well. In the first period, the individual (hereafter, the borrower) invests, resorting to both her inherited wealth w_t and debt d_t. The borrower can borrow from a risk-neutral and competitive financial intermediary, but the production technology is such that a moral hazard problem is prone to arise because some capital is unobservable. Investment, which depreciates completely after each generation disappears, takes two forms: hard (which is observable by the lender) and soft capital (which is not observable). Hard capital k_t refers to machinery, whereas soft capital, s_t, includes any input which enhances the likelihood that a given level of hard capital will generate a good output realization. Expenditures in organizational competence, some types of research and development expenses, inventories, and marketing may enter this category.

While hard capital is easily observable, the soft kind may be more elusive. The probability of getting repaid in full partially depends on the application of the loan in the way agreed at the time of writing the debt contract. Since the borrower might obtain higher profits at the expense of the lender by changing ex-post (after receiving the money) the use of the funds,

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the financial accelerator are based on a costly state verification framework (see Bernanke et al. (1998, op.cit.)).

[7] To see why this Cobb-Douglas utility function implies risk neutrality, let us first maximize it, in log form, with respect to *c* and *b* subject to the wealth restriction $w=c+b$, where all variables are dated at $t+1$. This yields $c=dw$ and $b=(1-d)w$. Inserting these optimal values in the original utility function, we obtain $U(w)=jw$, with $j=d^{d}(1-d)^{(1-d)}$, which is linear in *w*, denoting that individuals are risk-neutral. It must be noted that since the logarithmic utility function is a monotonic, but not affine, transformation of the Cobb-Douglas function, it would not produce risk-neutral preferences. Expected utility functions are unique up to an affine transformation. For similar preferences over both consumption and bequests, see Aghion and Bolton (1997).

the lender may want to make sure that the borrower behaves as promised. In doing so, it is evident that expenditures in hard (physical) capital, say a machine, can be monitored much more easily than money spent in soft (mostly intangible) capital. The higher the proportion of soft capital agreed in advanced, the higher the ability to disguise a diversion of money for personal use as a project-related expenditure. For example, perks may be impossible to isolate from travel expenses. Similarly, the absence of a clearly defined market price for some intangibles, such as managerial skills and patents, paves the way for the borrower to incur in deceitful actions (say, overpay such services in order to get some personal gain). Conversely, the characteristics and price of a physical good are much easier to check, thus limiting the borrower's ability to take money for personal use without being caught -it is implicit that the cost of being caught is high enough to deter the borrower from cheating unless it is safe to do so, namely, she only takes for personal use the money originally devoted to soft capital.

The production function exhibits constant returns to k_t (letting saving matter for growth)[8], and takes the form:

$$y_t = a(s_t, u)k_t \qquad (1)$$

where a(.) is a technological parameter that depends on the amount of soft capital s_t and the state of nature u. There are two possible productivity states, whose realization is observed in t+1 when the project matures: a good state, u=1, which occurs with probability α, and a bad state, u=0, which occurs with probability (1-α). Let us impose that the actual value of $a(s_t, u)$ be summarized by the following matrix:

Investment in Soft Capital	Productivity State: Good	Productivity State: Bad	
$s_t < \beta_1 k_t$	$a(s_t,1)=\gamma a$	$a(s_t,0)=\gamma a$	
$s_t \geq \beta_1 k_t$	$a(s_t,1)=a$	$a(s_t,0)=\gamma a$	(2)

[8] The neoclassical growth model with constant returns to scale and diminishing returns to capital prescribes that the saving rate affects the rate of growth in the medium-, but not in the long-run. Since the mid-80s some endogenous growth models have assumed constant returns to capital, generating a long-run link between saving and growth. For a careful analysis on this literature, see Barro and Sala-i-Martin (1995).

with β_1 denoting the investment in soft capital as a fraction of k_t, and $1>\gamma>0$. Given these outcomes, the investment in soft capital will be either $\beta_1 k_t$ or nothing at all. The first row of the matrix suggests that no investment in soft capital leads to a low productivity parameter, γa, with probability one, whereas the high productivity a will be attained with probability α, and only after investing in soft capital an amount $\beta_1 k_t$.

Two assumptions are crucial. In the first place, to guarantee that the investment in soft capital is efficient, the condition $[\alpha+(1-\alpha)\gamma]/(1+\beta_1)>\gamma$ (the expected productivity when soft capital is employed is higher than otherwise) must hold. The ex-ante, expected gross income from using both kinds of capital is $[\alpha+(1-\alpha)\gamma]ak_t$ (see the second row in (2)), and the corresponding investment is $(1+\beta_1)k_t$ (k_t of hard capital and $\beta_1 k_t$ of soft capital); on the other hand, when soft capital is not used at all, the expected gross income is just γak_t (see the first row in (2)), as a result of an investment of k_t. In the second place, the project would not be undertaken unless the expected productivity is higher than the opportunity cost of capital, or $[\alpha+(1-\alpha)\gamma]/(1+\beta_1)>(R+\tau)$. This particular condition reflects the partial equilibrium nature of the model in that none of the variables in the inequality adjusts to close the gap. The equilibrium, therefore, will be reached via quantity adjustments, more specifically in the amount of debt. Note that these conditions refer to ex-ante productive choices, and have nothing to do with the eventual moral hazard situation.

The presence of constant returns to scale, coupled with the condition that the expected productivity always exceeds the marginal cost of capital, implies that there is no interior, optimal capital level. The borrower will invest as much as possible. This assumption ensures that, no matter the amount of retained earnings accumulated in the long-run, the borrower will always be debt-constrained. Otherwise, the interdependence of financial and real decisions may vanish.

The information asymmetry is present because lenders cannot observe perfectly how the borrower allocates the funds. They can fully observe expenditures in hard capital but not in the soft kind, owing to the difficulty to assess effort and money put into intangibles and some liquid assets. Aware of this, the entrepreneur may have incentives to divert funds intended for soft capital away from the project and keep them for personal use. We further assume that these funds cannot be deposited with the financial intermediary, which can be justified by the risk of being caught when cheating (not investing in soft capital as promised). Whenever the low output is obtained, the entrepreneur might be able to disguise the diversion of funds ($s_t=0$) blaming the low productivity γ on a bad state realization.

For our purposes, it is sufficient to identify the financial system with the rest of the world. The economy under analysis is small and open, in the sense that its residents can borrow and lend in the international markets at the riskless interest rate R+τ, provided there is no room for hidden actions. R is the interest rate that would prevail if intermediation was costless, while the parameter τ denotes the transaction costs incurred by the financial system per unit of loanable funds, and thus represents the inefficiency of the financial system in mobilizing savings.[9]

The model also encompasses the government sector, whose sole activity is to collect in the second period an income tax on nonfinancial borrowers with rate t and transfer the revenue to the borrowers obtaining a low output (and zero net income under the equilibrium to be described shortly), yielding a balanced fiscal budget. The tax base is net income (output minus debt service), including also the funds eventually not invested in soft capital. This tax guarantees that no borrower ends up with zero consumption and bequests, which in the long-run ensures that population remains constant and aggregation under the law of large numbers is possible. Letting alone this rationale, this feature is inconsequential to the model whatsoever. We will return to this point when dealing with the dynamic structure of the model.

1.2 Solution of the model

Since both the lender and the borrower are rational, the design of the debt contract will internalize all the above information. In particular, the lender is bound to set outcome-contingent lending rates, as explained below. The financial arrangement is designed so as to maximize the borrower's expected profit subject to four constraints: the flow-of-funds identity, the expected zero profit condition for the financial intermediary guaranteeing an expected return equal to the international risk-free interest rate, the incentive-compatibility constraint preventing the entrepreneur from diverting funds, and the limited liability conditions tying down the debt repayment to the available net wealth. These constraints can be written as:

$$d_t = [(1+b_1)k_t - w_t] \qquad (3)$$

[9] Of course, given the transaction costs per unit of loanable funds, the equilibrium international interest rate will depend on the elasticity of the desired world saving and investment curves. τ is the increase in the equilibrium interest rate induced by those costs. We ignore other potential costs such as reserve requirements and taxes. By the way, it is interesting to note that indebtedness in the model implies a current account deficit in the first period, reversed by a surplus in the second one.

$$[\alpha R^h + (1-\alpha)R^l] = R + \tau \quad (4)$$

$$\alpha(1-t)[ak_t - R^h d_t] + (1-\alpha)(1-t)[\gamma ak_t - R^l d_t] \geq (1-t)[\gamma ak_t - R^l d_t + \beta_2 k_t] \quad (5)$$

$$\gamma ak_t - R^l d_t \geq 0 \quad (6a)$$

$$ak_t - R^h d_t \geq 0 \quad (6b)$$

where R^h (the lending rate to be charged when the high outcome is realized), R^l (the lending rate to be charged when the low outcome is observed), and k_t (the amount of hard capital), are the variables to be determined within the model. All R^h, R^l, and a are defined as gross rates. Equation (3) shows that the debt d_t equals the difference between total investment (in both hard capital k_t and soft capital $\beta_1 k_t$) and initial wealth w_t, namely, $d_t=(1+\beta_1)k_t - w_t$. Equation (4) just makes explicit the constraint that the intermediary requires an expected return on the debt (the left-hand side) equal to the opportunity cost (the right-hand side). Equation (5) states that the expected (after debt service and tax) profit for the borrower under no cheating (left-hand side of the equation) must be greater than otherwise (right-hand side). In other words, investing an amount $\beta_1 k_t$ in soft capital must provide an expected payoff greater than under not investing in soft capital at all, which would result in a low output of γak_t with probability one, offering a safe income of $\gamma ak_t - R^l d_t$ (the net profit from producing the low output) plus $\beta_2 k_t$, the amount of money diverted from soft capital to personal use. Note here that the money diverted is referred to as $\beta_2 k_t$, while the amount of soft capital is $\beta_1 k_t$. In our model, we should expect that $\beta_2=\beta_1$, although in a more general model it may be the case that $\beta_2 \leq \beta_1$.[10] What is important, nonetheless, is to stress that the technological role of soft capital is completely subordinated to its informational role: The distinction between soft and hard capital is relevant here only because it helps rationalize and formalize the moral hazard situation.

Finally, the constraint that the borrower is unable to repay the lender beyond her output (limited liability condition) is formalized by Equation (6a) for the low outcome scenario, and Equation (6b) for the high outcome one.

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[10] In view of the fixed-coefficient technology, investing in soft capital anything less than $\beta_1 k_t$ yields the same observable output than not investing at all, that is, $y_t = \gamma ak_t$ (see (2)), so the borrower sets $\beta_1 = \beta_2$. In a more general case, it must be expected that the money taken for personal use be equal or less than the total, unobservable amount of soft capital investment, $\beta_2 k_t \leq \beta_1 k_t$.

The analytical solution to the model emerges by maximizing the borrower's expected profits:

$$\pi_t = (1-t)\{[\alpha + (1-\alpha)\gamma]ak_t - [\alpha R^h + (1-\alpha)R^l][(1+\beta_1)k_t - w_t]\}$$
$$= (1-t)\{[\alpha + (1-\alpha)\gamma]ak_t - (R+\tau)[(1+\beta_1)k_t - w_t]\} \qquad (7)$$

with respect to k_t, R^h, and R^l. Let λ_1, λ_2, and λ_3 be the Lagrange multipliers associated with the incentive compatibility constraint, Equation (5), and the limited liability constraints, Equations (6a) and (6b), respectively. Using the Kuhn-Tucker conditions, it can be found that $\lambda_1=\lambda_2\geq 0$, and $\lambda_3=0$, that is, in equilibrium the incentive compatibility constraint and the limited liability constraint under the low outcome bind, but the limited liability condition under the high outcome does not.

Since Equation (6a) binds, Equation (5) becomes:

$$\alpha(1-t)[ak_t - R^h d_t] = (1-t)\beta_2 k_t \qquad (8)$$

Now plugging the same binding constraint (6a) into (4) to determine R^h, and inserting it into (8), we find the following relationship between debt and capital:

$$d_t = \left[\frac{[\alpha + (1-\alpha)\gamma]a - \beta_2}{(R+\tau)}\right]k_t \qquad (9)$$

Now using the flow-of-funds identity of the borrower:

$$(1+\beta_1)k_t = d_t + w_t \qquad (10)$$

k_t can be expressed in terms of the initial wealth:

$$k_t = \frac{w_t}{\left[1+\beta_1 - \frac{[\alpha + (1-\alpha)\gamma]a - \beta_2}{(R+\tau)}\right]} \qquad (11)$$

Equation (11) makes clear that capital accumulation is constrained by the initial wealth. Since the incentive to cheat increases with the amount of uncollateralized funds borrowed, the availability of internal funds allows the borrower to invest more without violating the incentive constraint. The underlying reason for this link between investment and internal funds is that, by increasing her stake in the project, the benefit from investing in soft capital rises.

1.3 Discussion

Before turning to the dynamic prescriptions of the model, it is necessary to understand its structure. Two conditions must be met for the model to have equilibrium. The first one is that, at some point, the borrower be unable to repay the debt in full at the riskless interest rate when the low output is realized, meaning that eventually $\gamma a k_t = (R+\tau)d_t$. Since $k_t > d_t$ because w_t is positive, this condition can be expressed as $\gamma a < (R+\tau)$. This guarantees that a conflict of interest between the lender and the borrower actually exists, giving birth to a potential moral hazard problem. Taking a looking at the right-hand side of the incentive compatibility constraint, Equation (5), the moral hazard situation arises precisely because the borrower can divert money from the project ($\beta_2 k_t$) without taking full responsibility, due to the fact that the limited liability condition allows her to repay less than the total debt ($\gamma a k_t = R^l d_t < (R+\tau)d_t$). As debt and investment get larger, the conflict of interest gets more pronounced, as the borrower's benefit from misbehaving, $\beta_2 k_t$, grows, and the lender's loss, $[(R+\tau)\, d_t - \gamma a k_t]$, widens as well. Therefore, the borrower's temptation to cheat grows with the volume of debt.

Conversely, it is clear that if the limited liability constraints (6a) and (6b) did not bind at any point, the lender would be able to get full repayment in any state, so $R^h = R^l = R+\tau$, and the lender would show no concern about how the borrower invests. However, no equilibrium would be attained in such a case. To see this, recall first that the demand for debt is always positive, once the expected productivity $[\alpha+(1-\alpha)\gamma]a$ is greater than the marginal cost of capital $[(1+\beta_1)(R+\tau)]$, suggesting that, with full access to debt at the going interest rate $R+\tau$, the borrower finds it optimal to ever increase its leverage d/k. Of course, the incentive compatibility constraint would not bind either, and the interaction between productive and financial factors would vanish -as far as the project is productively profitable, it will be undertaken. To see why the incentive compatibility constraint is not binding, notice from (5) that $[\alpha+(1-\alpha)\gamma]a > \gamma a + \beta_2$, since these three sufficient conditions hold: i) $[\alpha+(1-\alpha)\gamma]a > \gamma a(1+\beta_1)$; ii) $\gamma a \geq (R+\tau)$, which is satisfied when the limited liability constraint in the low output scenario never binds; and iii) $\beta_1 \geq \beta_2$.

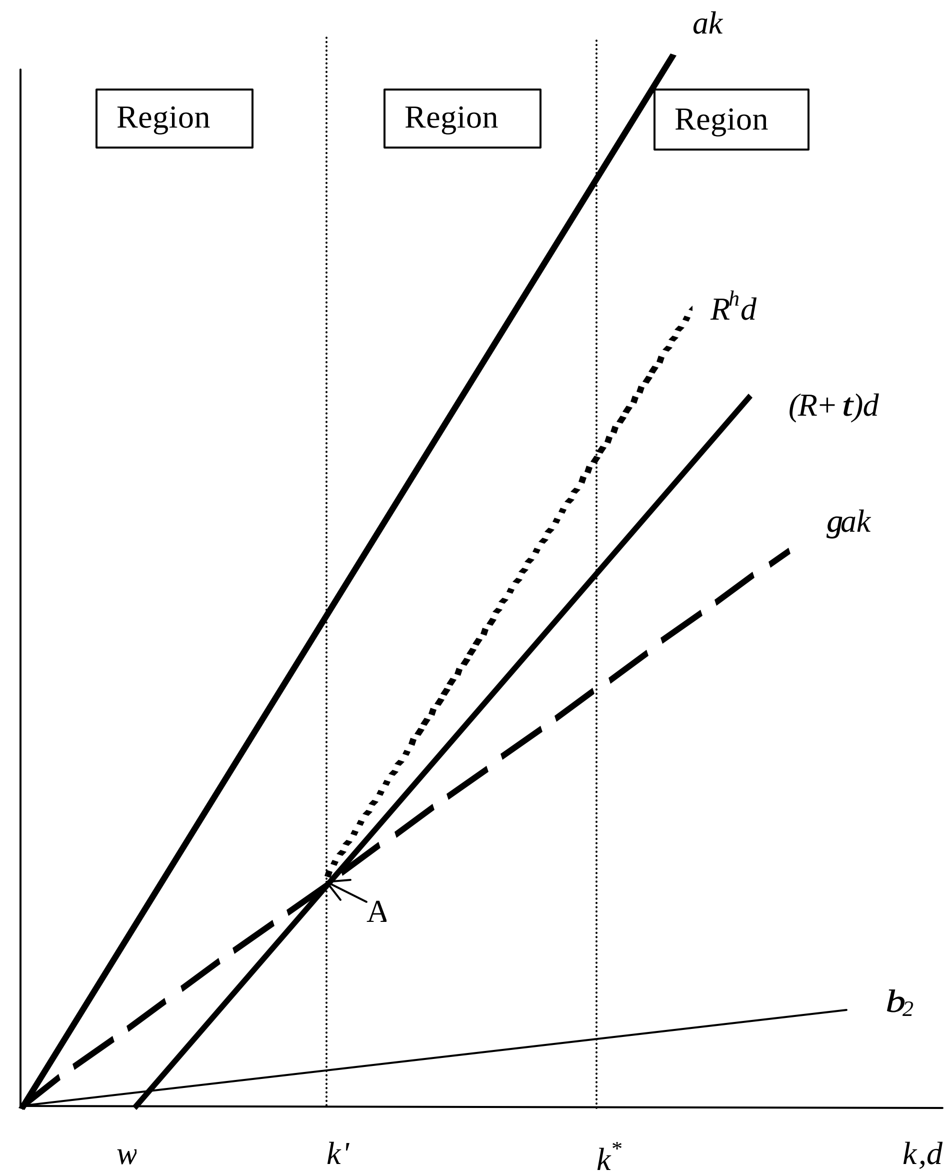
Setting two different lending rates contingent to the observed outcome, instead of a unique interest rate as in standard debt contracts, is a device to increase the borrower's expected profits without compromising the zero profit condition for the lender. We illustrate this and other features of the model using a diagram. We distinguish three regions in Figure 1. In Region 1, neither of the limited liability conditions binds at the riskless interest rate $(R+\tau)$, so the moral hazard problem is irrelevant and a perfect financial market prevails. As debt and investment increase, Region 2 is reached and the limited liability constraint in the low outcome realization now binds at the investment level k'. When the incentive compatibility constraint binds, as shown by Equation (8), the optimal k^* is identified (Equation 11)). In Region 3 the borrower is financially constrained, that is, she will not be able to raise additional debt.

Sticking to a unique interest rate $(R+\tau)$ would lead to no debt beyond Region 1 since $[\alpha(R+\tau)d_t+(1-\alpha)\gamma ak_t]<(R+\tau)d_t$, thus violating the lender's zero-profit condition, Equation (4). However, the analytical solution above was that $R^l d_t=\gamma ak_t$, that is, the lender retains the entire revenue whenever the low outcome is realized, which implicitly defines $R^h d=(1/\alpha)[(R+\tau)d_t-(1-\alpha)\gamma ak_t]$ via Equation (4). This all means that in equilibrium $R^l<(R+\tau)<R^h$, implying that the payoff structure for the lender is smoother than the borrower's (who gets nothing when the low outcome is obtained), but is not flat across risky outcomes, as it would be in the standard banking contract.

Let us demonstrate the optimality of this solution. Recall that changes in R^l must be compensated by changes in the opposite direction in R^h such that $[\alpha R^h+(1-\alpha)R^l]=(R+\tau)$, and that the goal is to maximize the borrower's expected profits, which depend linearly on the debt level. While it is unfeasible to set $R^l d_t>\gamma ak_t$, it is possible to establish $R^l d_t<\gamma ak_t$, but this would require a higher R^h. As a result, the expected payment to the lender lowers under cheating (not investing in soft capital and taking the money for own use) and remains the same, $(R+\tau)d_t$, under no cheating. This increased incentive to cheat leads the incentive compatibility constraint to bind at a lower level of investment than k^*, thus reducing the borrower's expected profits. We may replicate the argument graphically, by introducing a "$R^l d$" line in Figure 1, beginning at the pivotal point A with a smaller slope than the "γak" line, and moving the "$R^h d$" line leftward around the same pivotal point A. We do not report such (somewhat messy) diagram.[11]

[11] The result $R^h>(R+\tau)>R^l$ depends crucially on the condition that eventually $\gamma ak_t=(R+\tau)d_t$. If the productivity in the bad state were high enough to prevent this from occurring, not only could the riskless interest rate be charged in any state, but also $R^l>(R+\tau)>R^h$ would be feasible (with a sufficiently high γa, even a negative R^h might be charged).

Figure 1



The second condition required for equilibrium concerns the parameter values that satisfy Equation (8). We can rewrite this equation as:

$$\{[\alpha+(1-\alpha)\gamma]a-(R+\tau)(1+\beta_1)-\beta_2\}k_t+(R+\tau)w_t=0 \qquad (8')$$

A necessary condition for this to hold is that $[\alpha+(1-\alpha)\gamma]a-(R+\tau)(1+\beta_1)]<\beta_2$, meaning that the expected profit per dollar must be smaller than the unit gain from dishonesty, β_2. Condition (8') guarantees that the denominator in Equation (11) is positive, giving rise to a positive and finite investment level. Otherwise, if the expected productivity were sufficiently high relative to the interest rate, the opportunity cost of not investing in soft capital and just taking the money would become prohibitively high. Under these circumstances, incentives would be aligned at any debt level, and no equilibrium would be reached. Graphically, there would not exist Region 3.[12]

Finally, note in (8') the positive relationship between w_t and k_t. In Figure 1, an increase in w_t would show as a parallel rightward shift of the "$(R+\tau)d$" line, which will bring about a higher equilibrium level of debt and investment. As explained above, when the borrower's stake in the project is high, the dishonesty is more like "robbing oneself" at the cost of rejecting a valuable investment opportunity. As long as dishonesty is tempting enough (in the sense that, for each dollar borrowed, the amount kept for personal use exceeds the return on the productive use, $\{[\alpha+(1-\alpha)\gamma]a-(R+\tau)(1+\beta_1)]<\beta_2\}$), the investment level will be constrained by the availability of internal funds.

1.4 Dynamic Implications for Long-Run Growth

In order to obtain the implications of this model for growth, we must calculate the evolution of wealth for the aggregate. Capital letters will denote aggregate variables. There exist two types of agents, according to the realization of the state of nature. Recalling that preferences are such that a fraction δ of lifetime wealth is consumed and $(1-\delta)$ is given away as bequest for the one offspring, agents whose parents had a good state have initial wealth:

$$w_t=(1-\delta_{t-1})(1-t)\beta_{2,t-1}k_{t-1}/\alpha \qquad (12)$$

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[12] Even with default risk as in the present case, the model would have no equilibrium point if the moral hazard problem were absent $(\beta_2=0)$.

where the left-hand side is the bequest portion of the parents' profit, defined by Equation (8). As in (12), we will be dating δ and β_2 to distinguish the current and the previous generations, t and t-1, respectively. The omission of the subscript means that the variable corresponds to the current generation t. As with the values of β_1 and β_2 for the current generation, there is no reason to predict, within this particular model, a change in these parameters across generations. However, the notational distinction is important for interpreting the model correctly, as we will see shortly. Agents whose parents had a bad state have initial wealth:

$$w_t = (1-\delta_{t-1})\tau\beta_{2,t-1}k_{t-1} / (1-\alpha) \tag{13}$$

since the lender appropriates the full outcome, and each agent receives a transfer financed with the income tax charged on the agents with positive profits.[13] By invoking the law of the large numbers, the aggregation of wealth yields:

$$W_t = (1-\delta_{t-1})\beta_{2,t-1}K_{t-1} \tag{14}$$

Using a similar aggregation for Equation (11):

$$K_t = \frac{W_t}{\left[1+\beta_1 - \frac{[\alpha+(1-\alpha)\gamma]a-\beta_{2,t}}{(R+\tau)}\right]}$$

(15)

the gross rate of growth of the economy $g=K_t/K_{t-1}$ is obtained by plugging Equation (15) into (14):

$$g = \frac{(1-\delta_{t-1})\beta_{2,t-1}}{1+\beta_1 - \frac{[\alpha+(1-\alpha)\gamma]a-\beta_{2,t}}{(R+\tau)}} \tag{16}$$

[13] Without the government transfer, these agents would have no wealth and no consumption. Furthermore, their descendants would have no initial wealth to invest. The government sector, introduced in Section 1.1, has as its sole task to avoid such situation. As can be noted, the tax is neutral regarding investment and expenditure decisions by the private sector.

It can be observed that the rate of growth of the economy depends negatively on the degree of information asymmetry, as depicted by $\beta_{2,t}$, the proportion of soft capital β_1, and the riskless interest rate $(R+\tau)$, and positively on the inherited fraction of investment k_{t-1} transferred as a bequest by the previous generation, $[(1-\delta_{t-1})\beta_{2,t-1}]$, and the expected productivity. Although β_2 and β_1 (both for generation t) are equal in the model, their effects must be analytically separated. An increase in β_2 makes dishonesty more attractive and thus induces the incentive compatibility constraint to bind at a lower level of debt and investment. Given the initial wealth, this reduces growth. The parameter β_1, on the other hand, represents technological efficiency: the higher β_1, the higher the investment required to obtain a given value of $a(s_t,u)$, and the lower the intrinsic return of the project. Had not $\beta_{2,t-1}$ be distinguished from $\beta_{2,t}$ (even though they may display identical values), one may be led to think that the informational asymmetry might have a dual effect on growth, when in fact the presence of $\beta_{2,t-1}$ in the numerator of (16) is just suggesting that the previous generation's profits, and thus the initial wealth, are high. It is also important to stress the role of the transaction costs summarized in τ. As far as borrowers are debt-constrained, these costs increase the riskless interest rate inducing a higher lending rate (via Equation (4)), which reduces both the initial and the final wealth and, consequently, the investment level.[14]

An interesting property of this solution is that the amount of internal funds W_t does not have any influence on the growth rate, but it does on the volume of investment (see Equation (15)). An increase in W_t instantaneously generates a higher output, but it does not accelerate growth. This contrast between the dynamic and the static effect does not imply that financial factors play no role in the economy. The growth rate depends on the amount of external financing (debt) made available by the financial system to complement the initial wealth (retained earnings), and the access to debt is in turn a function of the extent of informational symmetries, the opportunity cost, and the expected productivity. In fact, the importance of internal funds is depicted in the growth equation by $[(1-\delta_{t-1})\beta_{2,t-1}]$, the proportion of investment transferred from one generation to the next. Changes in these parameters determining initial wealth do have a growth effect, because they change K_t for a given value of K_{t-1}. Equations (14) and (15) illustrate the process of growth: given the investment of the previous generation, $[(1-\delta_{t-1})\beta_{2,t-1}]$ sets the

[14] It is instructive to think about the role of these costs in the standard growth model of a closed economy with diminishing returns to capital and symmetric information. In such an environment, the costs incurred by the financial system will reduce equilibrium saving and investment only if savings are responsive to the interest rate. It is known that this would reduce growth along the transition path but not in the steady state.

initial wealth of the current generation, while the information asymmetries, the opportunity cost, and the expected productivity jointly determine the new investment level, financed by new debt and initial wealth.[15]

In view that our goal is to visualize the growth effect of financial development, the comparison with an economy with self-financed firms is called for. Let us then suppose that firms are strictly restricted to rely on their own resources, although they still are allowed to make deposits at the interest rate $(R+\tau)$. As far as the conditions $[\alpha+(1-\alpha)\gamma]a\ /(1+\beta_1) \geq (R+\tau)$ (the expected marginal productivity is equal or greater than the opportunity cost) and $[\alpha+(1-\alpha)\gamma]\ /(1+\beta_1) \geq \gamma$ (the use of soft capital is efficient) hold, it is possible to replicate the last aggregation exercise in order to find the growth rate under financial autarky:

$$g = (1-\delta)\left[\frac{[\alpha+(1-\alpha)\gamma]a}{1+\beta_1}\right] \qquad (17)$$

It is worth noting that by subtracting Equation (17) from Equation (16), we find that the growth rate when firms have access to debt is higher than the one under self-financing as long as:

$$\beta_{2,t-1}(1+\beta_1) - [\alpha+(1-\alpha)\gamma]a\{1+\beta_1 - [(\alpha+(1-\alpha)\gamma)a - \beta_{2,t}](R+\tau)^{-1}\} > 0 \qquad (18)$$

which happens to hold under the parameter values that guarantee that real investment in general and in soft capital in particular are efficient. This result implies that the availability of debt, even under conditions of asymmetric information and its associated deadweight loss, improves the economy's growth rate compared with the self-financing situation, as it increases the amount of funds directed towards real investment for firms with profitable opportunities and insufficient retained earnings to finance them. As expected, the lower $\beta_{2,t}$, β_1, and τ, and the higher the expected productivity, the wider the difference in favor of the debt economy.

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[15] From Equation (15), it can be seen that internal funds W_t exert a multiplier effect on K_t since the expression accompanying W_t is greater than one. Rewriting (13) as $K_t=\theta W_t$, the capital accumulation beyond the initial resources is just the debt, $D_t = (1+\beta_1)\ K_t - W_t = (1+\beta_1)\ \theta W_t - W_t = [\theta(1+\beta_1) - 1]\ W_t$.

Section 2: Testable Implications of the Model and Empirical Evidence

2.1 Testable Implications of the Model

The model offers clear prescriptions on the link between financial variables and growth. In particular, the flow-of-funds identity, Equation (10), combined with the constrained-optimal investment level, Equation (15), and then plugged into the growth function, Equation (16), yields:

$$g = (1-\delta)\left[\frac{\beta_{2,t-1}}{1+\beta_1 - \frac{D_t}{K_t}}\right] \tag{19}$$

Equation (19) posits a positive relationship between economic growth and the aggregate proportion of investment financed by debt, D_t/K_t. This means that the financing structure may be a predictor of economic growth, the null hypothesis being that the way investment is financed is irrelevant, as stated by Modigliani and Miller (1958) in a microeconomic context. But it can be observed from Equations (10) and (15) that:

$$\frac{D_t}{K_t} = \frac{[\alpha + (1-\alpha)g]a - \beta_{2,t}}{(R+\tau)} \tag{20}$$

Equation (20) reveals that the ratio new debt to investment declines with the degree of asymmetric information and the riskless interest rate, and increases with the expected productivity of the economy. This formulation uncovers a potential problem of including the ratio new debt to investment as an explanatory variable in a growth equation: this variable may be a proxy for productivity rather than an additional engine of growth. The intrinsic problem with this and other financial variables (credit to product, for instance) is that they are the resulting equilibrium of demand and supply forces, which raises the question about the joint endogeneity of many variables involved in growth regressions and inhibits any sound causality judgement.

Since our model revolves around the ability of the financial system in mobilizing savings, Equation (20) can be interpreted under this light. Quoting Levine (1997), "Mobilizing savings involves (a) overcoming the transaction costs associated with collecting savings from different individuals and (b) overcoming the informational asymmetries associated with making savers feel comfortable in relinquishing control of their savings". Rajan and Zingales (1997) restate the same idea by arguing that financial development fosters growth by (a) reducing the transactions costs of saving and investing, thus lowering the overall cost of capital for the economy as a whole, and (b) alleviating informational problems, thus reducing the differential cost of external funds relative to internal ones.

Following similar criterion, our testing strategy to justify the validity of D_t/K_t as an explanatory variable for economic growth will rely on two assumptions: first, the initial size of the financial system (measured by the ratio credit to the private sector to GDP) is an indicator of the efficiency of the intermediation process in that the coefficient τ is inversely correlated to the transaction costs per unit of intermediated funds, whereas the riskless interest rate net of transaction costs, R, is similar in all countries via arbitrage; and second, the growth regression is correctly specified, in the sense that the financial variables are not capturing the effect of omitted variables[16]. Under these conditions, the proportion of investment financed with bank credit is a proxy for the ability of the financial system in overcoming (directly unobservable) informational asymmetries. Again, the inclusion of D_t/K_t as a growth explanatory variable capturing information problems in the financial system makes sense once the null hypothesis, under perfect information, is that the financing structure should be irrelevant.

2.2 Data

The estimation will be based on 5-year averages over 1965-1994 with a sample of 59 countries. Country information for all variables, with the exception of credit and investment data, is taken from Barro's growth database (available on Internet at www.worldbank.org), updated until 1994. Details on sources and construction can be consulted at the above website.

[16] These omitted variables may be predictors of either productivity or saving. In endogenous growth models, saving is important to long-run growth, and even in the neoclassical models, saving is relevant in the transition towards the steady state. Since the convergence process has been found to be very slow, this is a significant consideration, especially because the size of the financial system, which collects part of society's savings, may be a proxy of national saving rather than a variable with explanatory power of its own. Additionally, the inclusion of the ratio credit to GDP in the regression reassures that D_t/K_t is not proxying for other potential growth effects of the financial system.

The main variable of interest is D_t/K_t, the change in credit over gross private investment. D_t/K_t is defined hereafter as the change in the ratio credit to GDP over the sum of investment to GDP over each 5-year period.[17]

Two reasons lead us to use private, rather than total, investment and credit for estimation purposes. First, the model is not well suited to interpret public investment and indebtedness. The nature of public projects is particular, not only because social and private profitability may differ, but especially because credit extension to the government may be based on a whole different set of criteria regarding implicit and explicit guarantees, compulsory credit, contract enforcement, and so on. Second, public investment is not negligible in the aggregate, so total domestic investment is not a good approximation to the private component, as shown shortly.

This poses the difficulty that information on private investment is way less abundant than total investment. Most previous growth studies work with total investment. To construct our series of private investment, two sources were employed: Glen and Muslinski (1997) for developing countries, and OECD (various issues) for industrial countries. In total, we were able to gather annual data for 59 countries over the period 1970-1994, although information for the whole period was available in only 40 cases.[18] The data on credit to the private sector and nominal GDP come from the IMF's International Financial Statistics (lines 32d and 99).

Now we present some summary statistics:

[17] This can be written as $\frac{D_t}{K_t} = \frac{[(Credit/GDP)_t - (Credit/GDP)_{t-5}]}{\sum_{i=t-4}^{t}(Investment/GDP)_i}$, where t represents the end of years 1974, 1979, 1984, 1989, and 1994 (later including also 1969).

[18] The countries are: Argentina, Australia, Burundi, Belgium, Benin, Bangladesh, Bolivia, Brazil, Central African Republic, Canada, Chile, Cote D'Ivoire, Colombia, Costa Rica, Germany, Denmark, Dominican Republic, Ecuador, Egypt, Spain, Finland, France, United Kingdom, Greece, Guatemala, Indonesia, India, Ireland, Iran, Iceland, Italy, Japan, Kenya, Morocco, Mexico, Mauritania, Mauritius, Malawi, Malaysia, Netherlands, Norway, New Zealand, Pakistan, Panama, Peru, Philippines, Papua New Guinea, Paraguay, Rwanda, El Salvador, Sweden, Togo, Thailand, Tunisia, Turkey, Uruguay, United States, Venezuela, and South Africa. The database is available from the author upon request.

Table 1

Summary Statistics

Variable		Mean	Std.Dev.	Observations
Private Investment / GDP	overall	14.9	5.0	N=231
	between		4.9	n=59
	within		2.1	T-bar=3.92
Public Investment / GDP	overall	6.4	3.2	N=231
	between		3.0	n=59
	within		1.5	T-bar=3.92
Gross Domestic Investment / GDP	overall	21.3	5.2	N=231
	between		4.7	n=59
	within		2.8	T-bar=3.92
New Credit / Private Investment (D_t/K_t)	overall	4.3	20.0	N=230
	between		18.5	n=58
	within		16.5	T-bar=3.97
Credit / GDP	overall	31.0	24.0	N=568
	between		23.9	n=98
	within		10.4	T-bar=5.80

(*) N is the total number of observations, n is the number of countries, and T-bar is the average number of periods for which the variable was observed in each country.

The table clearly displays the fact that, on average, gross private investment is just 70% of the gross domestic rate. Also important to note is the fact that the ratio private to public investment is relatively stable over time (the mean is 0.692 with a within -around country means-standard deviation of 0.05). We will exploit this to add a new observation for 1965-1969, in view that the limited number of time-series observations would impede the dynamic panel data program to run. We will assume that private investment in each year between 1965 and 1969 is the same proportion of total investment as in 1970. When practicing sensitivity analysis and robustness checks, this observation will not be considered. Regarding the new variable, D_t/K_t, the table suggests that, on average, a 1 percentage point of GDP increase in investment is financed by an increase of 0.043 percent points of GDP in banking credit, ratifying the presumption that internal sources of funds are the most important ones.[19] The variability of this indicator is also high, a point to which we will return later on. The following table shows the correlation among some of the variables involved. In particular, D_t/K_t is positive and significantly correlated to the growth rate and credit to GDP, while the association with the investment rate is positive but statistically not significant.

Table 2
Correlation Matrix

	Private Investment	Public Investment	Total Investment	D_t/K_t	Credit	Growth Rate
Private Investment	1.00					
Public Investment	-0.26 (0.000)	1.00				
Total Investment	0.81 (0.000)	0.36 (0.000)	1.00			
D_t/K_t	0.07 (0.277)	0.05 (0.472)	0.10 (0.139)	1.00		
Credit	0.47 (0.000)	-0.24 (0.000)	0.30 (0.000)	0.15 (0.023)	1.00	
Growth Rate	0.45 (0.000)	0.09 (0.179)	0.49 (0.000)	0.20 (0.003)	0.22 (0.000)	1.00

(*) P-values in parenthesis.

2.3 Econometric Estimation[20]

The estimation will be carried out using a dynamic panel data procedure. This method has two evident advantages: first, it allows to deal with the inconsistency created by the presence of the lagged dependent variable as a regressor; second, it allows to relax the assumption of strict exogeneity of the explanatory variables. Our basic regression will be of the form:

$$y_{i,t} - y_{i,t-1} = (\delta - 1) y_{i,t-1} + \lambda' x_{i,t} + \mu_i + \varepsilon_{i,t} \qquad i = 1, ..., N \qquad t = 1, ..., T \tag{21}$$

or

$$y_{i,t} = \delta y_{i,t-1} + \lambda' x_{i,t} + \mu_i + \varepsilon_{i,t} \tag{21'}$$

[19] Since $D_t/K_t=[(1+\beta_t)K_t-W_t]/K_t$, D_t/K_t may be even higher than one.

where i stands for each of the N cross-section units, t represents each of the T time-series units, y stands for the log of real GDP, δ is a scalar, λ' is a $k\times 1$ vector of coefficients, x is a $1\times k$ vector of other explanatory variables, μ_i and $\varepsilon_{i,t}$ are an individual-specific effect and an error term, respectively, with zero mean and constant and finite variance and independent of each other.

A major drawback with this specification is that the introduction of the lagged dependent variable as an explanatory variable, warranted by a conditional convergence effect, gives rise to biased and inconsistent estimators. The reason is that both $y_{i,t}$ and $y_{i,t-1}$ are functions of μ_i. By first-differencing Equation (21), it is possible to account for the unobserved individual effects to obtain:

$$y_{i,t} - y_{i,t-1} = \delta(y_{i,t-1} - y_{i,t-2}) + \lambda'(x_{i,t} - x_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \qquad (22)$$

It can be observed that there still is correlation between the lagged dependent variable and the new error term. If the error $\varepsilon_{i,t}$ is serially uncorrelated [$E(\varepsilon_{i,t}\varepsilon_{i,s})=0$ for $t\neq s$], values of y lagged two periods or more valid instruments in Equation (22), so for $t \geq 3$ the following linear moment restrictions are satisfied:

$$E[(\varepsilon_{i,t} - \varepsilon_{i,t-1})y_{i,t-j}] = 0 \qquad j = 2, ..., t-1 \qquad t = 3, ..., T \qquad (23)$$

Furthermore, we can relax the assumption that the set of explanatory variables x is strictly exogenous, as required by OLS consistency. Simultaneity and reverse causality are often thought to be problems plaguing growth regressions. We will assume that the x variables are weakly exogenous, meaning that future, but not necessarily contemporaneous and lagged, realizations of the error term (that may capture the effect of the growth rate on the explanatory variables) are uncorrelated with the x set. Formally, $E(x_{i,t}\varepsilon_{i,s})\neq 0$ for $t\geq s$ and $E(x_{i,t}\varepsilon_{i,s})=0$ otherwise. This suggests that values of x lagged two periods or more serve as instruments in Equation (22), with the associated additional linear moment restrictions:

$$E[(\varepsilon_{i,t} - \varepsilon_{i,t-1})x_{i,t-j}] = 0 \qquad j = 2, ..., t-1 \qquad t = 3, ..., T \qquad (24)$$

[20] This brief exposition on dynamic panel data follows Baltagi (1995), Schmidt-Hebbel and Serven (1997), and Levine et al. (1998). More rigorous presentations are Arellano and Bond (1991) and Judson and Owen (1996).

Arellano and Bond (1991) develop a consistent Generalized Method of Moments (GMM) estimator from these moment restrictions. This method has the additional advantage that does not rely on any particular probability distribution. To conduct the dynamic panel data estimation, we will use the statistical package Ox 1.20 (see Doornik (1996)).

The estimation of Equation (22), with the lagged levels of the corresponding explanatory variables as instruments, yields the following result (coefficients on the conditioning set of variables are omitted):

Table 3

Dependent Variable: Per capita Growth Rate

Change in New Credit to the Private Sector/ Private Investment	0.00103 (2.764)
Change in Initial Credit to the Private Sector / GDP	0.00272 (1.979)

Estimation Method: Dynamic Panel Data
Number of observations=142 (40 countries)
Wald test (joint) = 118.79 (p-value=0.000)
Wald test (dummy) = 19.68 (p-value=0.001)
Sargan test = 10.839 (p-value=0.457)
(*) T-statistics in parenthesis. The other variables in the regression are: logarithm of initial per capita GDP, public expenditure in education as a share of GDP, logarithm of black market premium, government consumption as a share of GDP, initial years of secondary schooling, life expectancy, initial trade openness, and time dummies. The instruments are the lagged values of the explanatory variables in levels.

The coefficients are positive and statistically significant, thus giving empirical support to our hypothesis. Moreover, the Wald test for the joint significance of the explanatory variables and for the time dummies reinforce this presumption. The Sargan test for overindentifying restrictions (whose null hypothesis is that the instruments are uncorrelated with the errors) suggests that no misspecification appears to be driving the results.

2.4 Sensitivity and Robustness Analysis

Two caveats make it advisable to look at the previous regression with caution. On one hand, some estimated coefficients displayed an undesirable instability before changes in the set of explanatory variables. Second, the method considerably reduces the usable sample size by eliminating the two first time-series observations and excluding country units with less than four consecutive time-series values.

In order to test the robustness of the previous model, we run a standard panel data growth regression. The main advantage is that the number of observations jumps to 205, up from 140 in the previous regression (an increase of 46% in the effective sample), providing, as a by-product, an out-of-sample robustness test. The result, under both a fixed- and a random-effects model, is the following:

Table 4

Dependent Variable: Per capita Growth Rate

Variable	Fixed-Effects	Random-Effects
New Credit to the Private Sector/ Private Investment	0.000338 (3.281)	0.000240 (2.896)
Initial Credit to the Private Sector / GDP	0.000571 (2.354)	0.000311 (2.766)

Estimation Method: Panel Data
Number of observations=205 (52 countries)
F-statistic (Fixed-Effects)=7.03 (p-value=0.000)
Within R-Squared (Fixed-Effects)=0.352
Chi Squared- Statistic (Random-Effects)=117.93 (p-value=0.000)
Hausman test = 16.35 (p-value=0.129)
(*) T-statistics in parenthesis. The other variables in the regression are: initial per capita GDP, public expenditure in education as a share of GDP, logarithm of black market premium, government consumption as a share of GDP, initial years of secondary schooling, and time dummies.

The estimated coefficients maintain their sign and significance, and are robust to various sets of controlling variables.[21] As explained earlier, this specification may generate inconsistent estimators. However, it is possible to test the hypothesis that the explanatory variables are correlated with the error (the root of the inconsistency) through the Hausman test. As reported at the bottom of the table, we cannot reject the null hypothesis that that correlation is zero, implying that the random-effects model is consistent.

Since the model claims that the growth effect of the financial system runs through the volume of investment, another interesting check is to use the private investment rate as the dependent variable. The outcome is once again highly favorable to our starting hypothesis:

[21] The quantitative effect, as measured by the estimated coefficients, appears to be important. If the credit financing went from the average 4.3% to 14.3%, the increase in the annual growth rate would range between 1.03 percentage points in the original estimation to 0.24 percentage points in the latter case. It must be noticed the wide variation in the estimated coefficient, which calls for further investigation -the change in the sample and the instruments may be responsible for the coefficient variation in this case. Below we show that a 10-percentage point increase in credit financing would elevate the average private investment rate (14.9%) by 1.9% to 15.2% of GDP.

Table 5

Dependent Variable: Private Investment Rate

Variable	Fixed-Effects	Random-Effects
New Credit to the Private Sector/ Private Investment	0.0283 (2.823)	0.0248 (2.453)
Initial Credit to the Private Sector / GDP	0.0884 (3.867)	0.0854 (4.293)

Estimation Method: Panel Data
Number of observations=205 (52 countries)
F-statistic (Fixed-Effects)=6.17 (p-value=0.000)
Within R-Squared (Fixed-Effects)=0.301
Chi Squared- Statistic (Random-Effects)=1086.9 (p-value=0.000)
Hausman test = 35.32 (p-value=0.0001)
(*) T-statistics in parenthesis. The other variables in the regression are: initial per capita GDP, public expenditure in education as a share of GDP, logarithm of black market premium, government consumption as a share of GDP, initial years of secondary schooling, and time dummies.

It should be noted that this specification gets rid of the econometric problems of including the lagged dependent variable as a regressor. However, we cannot reject the hypothesis that the random-effects model is inconsistent. Finally, we were unable to detect any influential observations (outliers) that may have been driving the results.[22]

[22] In the standard panel data estimations we included the annual standard deviation of D_t/K_t around each 5-year period average as an additional regressor. The estimated coefficient turned out to be significantly negative. Although this is not a direct prediction from the model, it lends support to it if we believe that this variability is caused by changes in the supply of funds, which in turn affect corporate investment. If the variability were provoked by changes in the demand for funds, implying a profit-maximizing change, this variable would display a positive sign (or no effect at all).

Conclusions

The paper has examined the relevance of informational asymmetries in the transmission process from financial development to growth. A simple growth model has highlighted the hypothesis that firms with valuable investment opportunities but insufficient internal funds may grow faster should their access to external sources be enhanced. In turn, the alleviation of informational asymmetries between lenders and borrowers is bound to increase the amount of debt and investment, thus promoting a higher rate of growth.

One testable implication of the model was that the proportion of investment financed by new debt is positively related to growth. In turn, this ratio is partially explained by the degree of informational asymmetry. Controlling for expected productivity and the opportunity cost of capital, this financial variable was included in a growth regression, yielding a positive and significant sign. A dynamic panel data technique and some additional checks were practiced to confirm the robustness of the finding.

The contribution of the paper can be evaluated in the light of the voluminous literature on financial system and economic activity. Previous studies have found a noticeable impact of financial asymmetric information on business cycles. The present work finds a similar relationship between information frictions and long-run growth.

Appendix: Financing sources in some OECD and Latin American countries (*)

Sources of funds of non-financial firms in some OECD countries,
1990-1995
In percent of total sources

Country	Debt	Stock	Retained Earnings	Total
Austria	-2,7	9,6	93,1	100,0
Canada	31,0	11,8	57,1	100,0
Italy	24,9	9,1	66,0	100,0
Japan	41,6	5,2	53,2	100,0
Netherlands	17,1	17,6	65,3	100,0
Sweden	20,5	-1,0	80,4	100,0
Spain	26,9	11,4	61,7	100,0
USA	-7,9	15,6	92,2	100,0
Simple Average	18,9	9,9	71,1	100,0

Source: Author's calculations from OECD Financial Statistics.

Sources of funds of non-financial firms in some Latin American countries,
1990-1995
In percent of total sources

Country	External Debt	Stock	Domestic Bonds	Bank Credit	Retained Earnings	Total
Argentina	4,1	3,7	6,4	6,9	79,0	100,0
Brazil	5,7	2,6	5,5	10,1	76,1	100,0
Chile	11,2	5,6	14,2	9,0	60,2	100,0
Colombia	2,2	1,9	4,0	12,4	79,6	100,0
Mexico	3,0	3,3	4,6	4,4	84,7	100,0
Peru	1,4	0,3	2,2	8,4	87,8	100,0
Venezuela	-4,5	0,4	4,4	0,8	96,8	100,0
Simple Average	3,3	2,5	5,9	7,4	80,6	100,0

Source: Author's
Calculations.

(*) These estimations of financing sources are part of another study by the same author, which also discusses the relationship between corporate and personal saving, and the existence of financial constraints at both corporate and personal level. The method and assumptions behind the calculations for Latin American countries are also presented there, along with more detailed time series information for each country. The paper is available upon request from the author.

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