Financial Constraints and Investment: A Critical Review of Methodological Issues and International Evidence

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In recent years there has been a resurgence of interest in the determinants of firms' investment decisions. The empirical shortcomings of existing models, developed mainly under the assumption of perfect capital markets, and theoretical advances in the field of information economics have stimulated an explosion of studies focusing on the effects of financial constraints on investment.

The purpose of this paper is to provide a critical assessment of the methodological issues involved in testing the implications of capital market imperfections for investment, and to offer a critical review of the econometric evidence on this topic. In particular, the paper will concentrate on the empirical contributions that have used firm-level panel data. It is the increased availability of panel data that has resulted in the burst of empirical work in recent years. With firm-level panel data, a researcher can examine how the incidence and severity of information and incentive problems vary across firms and over time and investigate the differential effects on investment. Finally, I will adopt an international perspective and comment on the econometric evidence on firm investment behavior available for both developed and less developed countries.

I begin with a brief review of the theoretical arguments that explain why information and incentive problems introduce a wedge between the costs of internal and external finance; the paper then outlines the implications for investment decisions. The following section explores

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the methodological issues involved in testing for the importance of financial constraints using Q models of investment. The tests for the presence of financing constraints have consisted mainly of adding proxies for the availability of internal funds and/or firms' net worth to the model derived under the assumption of perfect capital markets, and investigating whether these proxies are significant for the firms thought most likely to face information and incentive problems. The potential weaknesses of Q-based models will be discussed, in particular whether average Q adequately captures future profit prospects, and possible solutions to this problem will be reviewed. The most widely used alternative approach has been to estimate the Euler equation for the capital stock. Its advantages and drawbacks are reviewed as well.

In both the Q and the Euler equation approaches, it is necessary to partition the sample of firms (or firm-year observations) according to the likelihood that they will suffer from information or incentive problems. The next section, therefore, investigates the conceptual and econometric problems involved in the choice of the criteria used in splitting the sample. The main issue here is how to deal with the potential endogeneity of the sample stratification criteria commonly used. Another important problem is the choice between time-invariant and time-varying classifications, and between criteria based on single or multiple indicators of firms' financial status.

A critical assessment of the evidence available for several developed and developing countries follows. The discussion is organized around the various criteria used to classify the observations both cross-sectionally and over time (dividend payout behavior, association with business groups and banks, size, concentration of ownership, and the like). I also review the evidence on variations over time in the tightness of financial constraints due to changes in business cycle conditions or in the stance of monetary policy, and those due to financial markets reforms. In the final section, I offer some concluding remarks and suggestions for future work.

Information and Agency Problems, Substitutability between Internal and External Finance, and Investment

According to the Modigliani-Miller theorem (1958), a firm's capital structure is irrelevant to its value. Internal and external funds are perfect substitutes and a firm's investment decisions are independent of its financing decisions.

However, the irrelevance hypothesis fails in the presence of informational asymmetries and contract enforcement problems. These problems may give rise to agency costs. Myers and Majluf (1984) point out the informational asymmetry problems of equity financing. They show

that if outside investors are less well informed than managers about the value of the firm's assets, then, because of adverse selection, they will demand a premium to purchase the firm's shares, in order to offset the losses incurred from financing "lemons."

Stiglitz and Weiss (1981) show that informational asymmetries may cause credit rationing in the loan market. Since the project risk is unobservable, lenders cannot discriminate by price between good borrowers and bad. When the interest rate rises, relatively good borrowers drop out of the market, increasing the probability of defaults on loans made and, possibly, decreasing lenders' expected profits.[1] In equilibrium, lenders may set an interest rate that leaves an excess demand for loans. The possibility of credit rationing in the context of optimally designed contracts has also been suggested by Williamson (1987), using the costly state verification model in which profit outcomes can be observed only at a cost.[2]

Jensen and Meckling (1976) argue that the presence of limited liability debt will give rise to moral hazard problems, in the sense that a firm may have the incentive to opt for excessively risky investment projects, even if these projects are value-decreasing. When debt holders anticipate this behavior, they will demand a premium on the debt they purchase or covenants that restrict the firm's future use of debt. Moreover, Myers (1977) shows that when a firm is partly debt-financed, it may forgo projects with positive net present value because the returns from such investment may be captured by debt holders.

Jensen and Meckling also consider the potential conflict of interest that may arise between managers and outside shareholders. If managers have less than a 100 percent stake in the company, they may have an incentive to use firm resources in the form of perquisites or other wasteful activities. Such activities can be monitored, at a cost, and ultimately the insiders will bear the cost in terms of a reduced price that prospective shareholders are willing to pay for a stake in the firm.

The informational asymmetries, costly monitoring and contract enforcement, and incentive problems outlined above lead to an imperfect substitutability between internal and external funds. The consequences of these information and incentive problems for investment have been explored in a set of more recent papers by Bernanke and Gertler (1989, 1990), Gertler and Hubbard (1988), Calomiris and Hubbard (1990), Gertler (1992), Kiyotaki and Moore (1993), and Greenwald and Stiglitz (1988, 1993). Although the models differ in their details, two

[1] See also Jaffee and Russell (1976).

[2] See Townsend (1979) and Gale and Hellwig (1985).

main results emerge from this literature.[3] First, unless the loans are fully collateralized, external finance is more costly than internal finance. Second, the premium on external finance is an inverse function of a borrower's net worth (liquid assets plus the collateral value of illiquid assets). It follows that negative shocks to net worth lead to an increase in the premium and, therefore, to a reduction in investment and production. For this reason the initial impact of the shock will be amplified (the so-called "financial accelerator" effect).

All this has important consequences for the channels of transmission of monetary policy. An increase in the interest rate will work not only through the traditional impact on the user cost of capital, but also through the adverse impact on the present value of collateralizable net worth, widening the wedge between the costs of external and internal finance. Moreover, insofar as some borrowers are dependent upon banks because of information problems, monetary policy may restrict the supply of loans or increase their cost for this category of borrowers, inducing them to reduce their investment.[4] Finally, the existence of information and incentive problems means that tax policy will operate through both marginal and average rates. Although it is marginal rates that matter in calculating the tax benefits of an additional unit of capital spending in a world of perfect capital markets, it is the average tax rate on cash flow from existing assets that determines the (post-tax) availability of internal funds for investment.

Testing for Financial Constraints Using Q Models

The basic approach to testing for the importance of financial constraints has been to assess whether firms that suffer more from information and incentive problems experience significant departures from standard models derived under the assumption of perfect capital markets. Such models are more likely to be misspecified, and these firms' investment is likely to be more sensitive to fluctuations in the availability of internal finance and in proxies for internal net worth.

Many of the empirical tests of the importance of financial constraints for investment have used, as a point of departure, the standard model of investment based on the assumption of convex adjustment costs. Consider, for simplicity, a firm that can only finance itself either through retentions or new share issues. Under the assumptions of perfect competition, linear homogeneous technology, and capital as the

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[3] See Gertler (1988); Bernanke, Gertler and Gilchrist (1995); and Hubbard (1995) for another perspective on the set of issues discussed in this paper.

[4] See Bernanke (1993); Kashyap and Stein (1994); Hubbard (1994); and Cecchetti (1994) for a fuller discussion.

only quasi-fixed input, average Q is a sufficient statistic for investment. Conditional on Q, no other variable should matter when the firm is either paying positive dividends or issuing new shares. The investment equation under quadratic adjustment costs can be written as:

$$\frac{I_{it}}{K_{it}} = a + \frac{1}{b} Q_{it} + \varepsilon_{it}. \tag{1}$$

I_{it}/K_{it} denotes the investment rate. b is the multiplicative parameter in the adjustment cost function, a is the nonstochastic additive parameter. ε_{it} includes its stochastic additive component.

When the tax rate on dividends exceeds the tax rate on capital gains, it is well known that the standard formulation of Q models implies that firms will not pay dividends and issue new shares at the same time. Under retention financing, the definition of tax-adjusted Q_{it} is:

$$Q_{it} = \frac{\beta_{it}(V_{it} - H_{it})}{\gamma_t(1 - \tau_t)P_{it}(1 - \delta)K_{it}} - \frac{P^k_{it}(1 - \xi_t)}{P_{it}}, \tag{2}$$

where β_{it} is the firm discount factor, V_{it} the market value of the equity, H_{it} the present value of tax savings on existing capital goods, P_{it} the price of output, P^k_{it} the price of investment goods, τ_t the corporate tax rate, ξ_t the present value of the tax savings on new investment, and δ the depreciation rate. γ_t is the tax price of retentions in terms of dividends and equals $(1 - m_t)/(1 - z_t)$, where m_t is the tax rate on dividends and z_t is the tax rate on capital gains.[5] When the firm finances itself through new share issues, the only difference is that γ_t is replaced by one in the definition of Q_{it}. Let us think of the error term as containing a firm-specific, time-invariant component, ν_i, an idiosyncratic component, υ_{it}, and a common time component, η_t; that is, $\varepsilon_{it} = \nu_i + \upsilon_{it} + \eta_t$. We can eliminate the firm-specific, time-invariant component of the error term by appropriate transformations of the observations and include time dummies to account for time effects that are common across firms.[6] Even after these transformations, one should consider that Q_{it} is likely to be correlated with the idiosyncratic component of the error term, either because the latter is the stochastic additive component in the adjustment cost function or because of measurement error. For this reason, an Instrumental Variable (IV) or Generalized Method of Moments (GMM) procedure is appropriate, although many empirical contri-

[5] Tax parameters have been assumed constant across firms for simplicity. Moreover, it has been assumed that new investment becomes productive immediately.

[6] Taking first differences, deviation from firm means or orthogonal deviations would accomplish the desired effect.

butions rely on the Least Squares Dummy Variables (or Within) estimator.[7]

If dividends have been exhausted and yet it is not profitable to issue new shares today, or if this is expected to be the case in the future, marginal Q and average Q no longer are equal to each other, and it is not possible to find a relationship between average Q and the investment rate that does not involve present or future values of the unobservable non-negativity multiplier for dividends.[8] In this financing regime, investment simply equals cash flow. If a researcher estimates equation (1) using a definition of Q_{it} derived under the assumption that the firm either has not exhausted retentions or is issuing new shares, this will lead to misspecification. This model can be enriched by specifying the kind of capital market imperfection that firms may face. For instance, Fazzari, Hubbard, and Petersen (1988) in their seminal paper suggest that firms have to pay a lemon premium s_{it} for issuing new shares, as suggested by Myers and Majluf (1984). In this case, $1 + s_{it}$ should replace γ_{it} in the definition of Q_{it}. The existence of a premium on new equity issues increases the range of values of Q_{it} for which dividends have been exhausted, and yet it is not profitable to issue new shares.

Debt can also be introduced in the problem. Assume that incentive problems are more severe when the amount of debt is large relative to the value of collateral. If the premium above the safe rate increases linearly in leverage, the only change in the model is that the value of debt must be added to the market value of shares in the numerator of Q_{it} so that this form of imperfection per se does not call into question the validity of Q models. Obviously, in this case also the Q model is misspecified if the firm pays zero dividends and issues no new shares. Another form of misspecification can also be generated if a ceiling on the amount of debt a firm can issue is introduced, and such a ceiling is binding.[9] Even if the firm pays and is expected to pay dividends in the future, it is easy to show that additional linear and quadratic terms in the debt-to-capital ratio should appear in equation (1).

The implementation of the test for the presence of financial constraints has consisted, following Fazzari, Hubbard, and Petersen (1988), of adding proxies for the availability of internal funds and/or net worth to the equation and checking whether they are significant for the firms that a priori are thought more likely to face information and incentive

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[7] See Arellano and Bond (1992) for a discussion of the GMM estimator in the context of panel data. See also Hayashi and Inoue (1991) and Blundell, Bond, Devereux, and Schiantarelli (1992) for a discussion in the context of Q models. If a first-difference transformation is used, and the error term in the level equation is white noise, the investment rate or Q lagged twice would be legitimate instruments.

[8] It is assumed for simplicity that the minimum dividend payment is zero.

[9] This issue is discussed at length below in the context of the Euler equation approach.

problems. The measurement of net worth (liquid assets plus the collateralizable value of illiquid assets) is a very difficult problem in an intertemporal context, since it is related to the expectations of future returns. Typically, cash flow is used as a proxy for internal net worth in empirical work. Sometimes stock measures of liquidity are also included. Both cash flow and liquid assets not only act as proxies for net worth (which is inversely related to the premium to be paid for external finance), but also convey information about what proportion of investment spending can be internally financed. All the theories surveyed above suggest that internal funds are less costly than external finance, so that an increase in liquidity is likely to lead to greater investment.

The cross-sectional criteria most commonly used to identify firms for which information and agency problems are more severe are the dividend payout ratio (Fazzari, Hubbard, and Petersen 1988), the affiliation to industrial groups and to banks (Hoshi, Kashyap, and Scharfstein 1991), size and age (Devereux and Schiantarelli 1990), the presence of bond ratings (Whited 1992), degree of shareholder concentration, and one or more of the above (Oliner and Rudebusch 1992, Schaller 1993). The next section will discuss the issues involved in choosing the criterion for sample separation; then the international evidence will be reviewed in detail. On the whole, the evidence from both developed and developing countries suggests that, for a subset of firms, internal and external finance are not perfect substitutes and that, for these firms, investment decisions display excess sensitivity to the availability of internal resources.[10] Evidence also shows that cash flow is significantly related to investment for the group of firms that are thought a priori to be less likely to face financial constraints (although not as strongly as for constrained firms).

The basic problem with testing for financial constraints in the context of Q models is that average Q may be a very imprecise proxy for the shadow value of an additional unit of new capital. The model can be extended to allow for imperfect competition in output markets and for the presence of more than one quasi-fixed factor. This introduces a wedge between marginal and average Q that is a function of observable

[10] Chirinko (1994) argues that care must be taken in interpreting the difference in the cash flow coefficients as a sign that firms are differentially constrained. He produces a model based on the presence of flotation costs in which the size of the latter depends upon the ratio of the cash flow and Q coefficients. It is debatable, however, if one would want to summarize the degree of financial constraints faced by firms on the basis of the parameters of the flotation cost function. Nevertheless, there is a genuine difficulty in giving a "structural" interpretation to the cash flow coefficient, since one is forced to specify the precise form of the capital market imperfection to be included in the firm's optimization exercise. This problem had been noted by Devereux and Schiantarelli (1990), who had assumed that the interest rate paid by firms was a function of the cash flow rate, as well as leverage.

variables, and Q models can be reformulated to account for all this.[11] However, when stock markets are not efficient and stock prices are driven by fads and fashions, or when market expectations and insider expectations diverge, this problem is not easily fixed.[12] When Q does a bad job in measuring investment opportunities, the significance of cash flow may simply reflect the fact that it contains information about future profitability. This may be particularly true for firms that are classified a priori as more likely to suffer from information problems, so that differences in cash flow coefficients across firms cannot be interpreted as representing only the incidence and severity of such problems.

One way to address this issue is to estimate the Euler equation for the capital stock derived from the same underlying model. Although this is the prevalent solution found in the literature (see the next section), I will first discuss other approaches that have been used to isolate the role of cash flow as a proxy for a firm's net worth. An attempt to separate the liquidity and informational content of cash flow is contained in Gilchrist and Himmelberg (1994). Following Abel and Blanchard (1986), they use a simple VAR on the profit rate and sales-to-capital ratio (in addition to aggregate variables) to calculate an estimate of the present value of profits resulting from an additional unit of capital today (its shadow value). This proxy is used in place of average Q in an investment equation that also contains cash flow. If the information set used in generating this proxy adequately represents the one used by the agents, the cash flow coefficient in the investment equation should reflect only its role as a source of internal liquidity or as a proxy for net worth. The evidence suggests that, even controlling for future profits, the previous conclusion on the relative magnitude of cash flow sensitivities between constrained and unconstrained firms is not affected.

Another approach is to identify changes in cash flow that represent variations in internal net worth or liquidity and at the same time are not correlated with investment opportunities. Lamont (1993) analyzes the investment behavior of U.S. companies that operate both in oil-related

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[11] If imperfect competition exists in the output market, the shadow value of the capital stock also depends upon present and future values of the capital output ratio. See Schiantarelli and Georgoutsos (1990) on estimating Q models under imperfect competition and Galeotti and Schiantarelli (1991) for a model that allows also for adjustment costs for labor.

[12] Under the assumption of perfect and efficient markets, a relationship exists between the quasi-difference in investment and dividends. Galeotti and Schiantarelli (1994) show that when a proxy for stock market fads is added to this model, it is a significant determinant of investment. On this issue see also Blanchard, Rhee, and Summers (1993) and Mork, Shleifer, and Vishny (1990). Both papers find that cash-flow-based proxies for fundamentals play a bigger role than Q in explaining investment. Again, however, the problem remains of sorting out the informational and liquidity roles of cash flow.

and non-oil-related lines of business. He finds that variation in the oil-related cash flow has an effect on the investment in non-oil-related business. This likely reflects the fact that cash flow plays a role that goes beyond providing information about future profitability. Calomiris and Hubbard (1993) and Cummins, Hassett, and Hubbard (1994) use, instead, changes in tax policies to identify changes in cash flow not related to future profitability. In particular, they analyze how investment reacts to changes in the relative taxation of retentions relative to dividends. If internal and external funds are perfect substitutes, one would anticipate that such tax changes should affect payout behavior but not necessarily investment. Conversely, firms should respond to a reduction, for instance, in the tax rates on retained earnings by increasing investment only if they face financing constraints. The evidence here is somewhat mixed. Tax-related fluctuations in cash flow had an effect on investment in some U.S. firms in the 1930s, but not in Germany, France, and Japan in the 1980s and 1990s.

Fazzari and Petersen (1993) sidestep the multiple roles played by cash flow by analyzing the relationship between investment and the variation in (end-of-period) working capital. Under the assumption that working capital is less costly to adjust than fixed investment, one would expect a negative relationship between the latter and the former in the presence of capital market imperfections, because working capital is used as a buffer to avoid changing investment when external funds are more expensive than internal resources or impossible to obtain. Since changes in working capital are likely to be positively related to profit expectations, their expectational role would instead generate a positive correlation with fixed investment. The fact that working capital is significantly and negatively related to fixed investment for low-dividend-paying U.S. firms is suggestive of the importance of capital market imperfections.

Controlling for Profit Opportunities Using the Euler Equation Approach

The main alternative to using augmented Q models of investment consists in directly estimating the Euler equation for the capital stock. The advantage of the Euler equation approach is that it avoids relying on measures of profitability based on firms' market value. The Euler equation is a different way to rearrange the first-order conditions from the same maximization problem used to derive Q equations.[13] It states

[13] It should be clear that neither the Q nor the Euler equation approach yields an investment *rule*, in which investment is written as a function of predetermined variables and present and expected values of exogenous variables.

that the value of the marginal product of capital today, net of adjustment costs, must equal the cost of a new machine minus the cost savings due to the fact that the firm can invest less tomorrow and still maintain the capital stock on its optimal path. More precisely, allowing for imperfect competition in the output market:

$$\frac{1}{1+\mu}\left[F_K(K_{it}, L_{it}) - G_K(I_{it}, K_{it}) - G_I(I_{it}, K_{it})\right] = \frac{(1-\xi_t)P^k_{it}}{(1-\tau_t)P_{it}} -$$

$$E_t\left\{\psi_{i,t+1}\beta_{i,t+1}\frac{(1-\tau_{t+1})P_{i,t+1}}{(1-\tau_t)P_{it}}\cdot(1-\delta)\left[\frac{(1-\xi_{t+1})P^k_{i,t+1}}{(1-\tau_{t+1})P_{i,t+1}} + G_I(I_{i,t+1}, K_{i,t+1})\right]\right\}, \tag{3}$$

where output, Y_{it}, equals $F(K_{it}, L_{it}) - G(I_{it}, K_{it})$. $\psi_{i,t+1}$ represents $(\gamma_{t+1} + \lambda^D_{i,t+1})/(\gamma_t + \lambda^D_{i,t})$, where λ^D_{it} is the non-negativity multiplier for dividends. μ denotes the markup of prices over marginal costs assumed to be constant through time and $E_t(\cdot)$ the expectation formed at time t.[14]

For estimation purposes, under quadratic adjustment costs and linear homogeneity the equation can be written (omitting the constant term) as:

$$\frac{I_{it}}{K_{it}} = \left(\frac{I_{it}}{K_{it}}\right)^2 + \psi_{i,t+1}\beta_{i,t+1}(1-\delta)\frac{I_{i,t+1}}{K_{i,t+1}} + \left(\frac{1+\mu}{b}\right)\cdot\left[\frac{\pi_{it}}{P_{it}K_{it}} - \frac{(1-\xi_t)P^k_{it}}{(1-\tau_t)P_{it}} + \right.$$

$$\left. \psi_{i,t+1}\beta_{i,t+1}(1-\delta)\cdot\frac{(1-\xi_t)P^k_{i,t+1}}{(1-\tau_{t+1})P_{i,t+1}}\right] - \frac{\mu}{b}\left(\frac{Y_{it}}{K_{it}}\right) + v_{i,t+1} \tag{4}$$

π_{it} is net revenue minus variable costs and $v_{i,t+1}$ now also includes the error generated because expected future variables have been replaced by their realizations.[15]

Again, if the firm pays dividends in both periods, both λ^D_{it} and $\lambda^D_{i,t+1}$ will be zero. In this case $\psi_{i,t+1}$ will equal γ_t/γ_{t+1} and, conditional on defining a proxy for $\beta_{i,t+1}$, the Euler equation can be consistently estimated by IV or GMM techniques using, for instance, appropriately lagged values of the included variables as instruments. If no stochastic component is present in the adjustment cost function and there are no measurement error problems, $v_{i,t+1}$ is only an expectational error and variables dated $t-1$ are potentially legitimate instruments, after

[14] See the Appendix for details.

[15] Note that in equation (4), the term in square brackets is operating revenue minus Jorgenson's user cost of capital.

differencing to eliminate firm-specific, time-invariant components. Otherwise, variables lagged at least twice should be used as instruments. The test of the validity of the orthogonality conditions proposed by Hansen (1982) can be used as a general misspecification test. If the firm faces the zero dividend constraint in either of the two periods, the instruments will be invalid and the test of overidentifying restrictions should, in principle, lead to a rejection of the model.

When debt is introduced in the model, one has to make a choice on the source and form of the capital market imperfection. One possibility is to assume an exogenous limit on the amount of debt the firm can issue (Whited 1992; Hubbard and Kashyap 1992; Hubbard, Kasyap and Whited 1995). The Euler equation for capital is still equation (4). Using the first-order condition for debt, one can show that:

$$\beta_{i,t+1} = \frac{1 - \lambda_{it}^{B} + \omega_{i,t+1}}{\psi_{i,t+1}(1 + (1 - \tau_{t+1}))i_{t+1}}, \tag{5}$$

where λ_{it}^{B} is the multiplier associated with the debt ceiling and $\omega_{i,t+1}$ is the error in forecasting future variables in the first-order condition for debt. Substituting out $\psi_{i,t+1}$ in the Euler equation for capital using (5), and forgetting about $\omega_{i,t+1}$ for the moment, one can see that the firm discount rate equals the interest rate only when the firm is at an interior solution for debt. When the firm is at a debt ceiling, λ_{it}^{B} will differ from zero and this will invalidate the orthogonality conditions used in estimation; this will, hopefully, be detected by the test of overidentifying restrictions.

Notice that in order to implement this approach, the somewhat unpalatable assumption must be made that the conditional covariance between $\omega_{i,t+1}$ and the future variables in the Euler equation for capital is constant. The restrictiveness of this assumption must be traded off against the necessity to choose, again somewhat arbitrarily, a proxy for $\beta_{i,t+1}$ when the latter is not substituted out of the estimating equation.

Since the power properties of the test of overidentifying restrictions may be poor in some circumstances, in order to sharpen the test for financial constraints, the three papers mentioned above also adopt a different approach and they allow the multiplier to depend in an ad hoc fashion on variables that capture firms' internal net worth, like cash flow or general macroeconomic conditions. The coefficients on these variables measure the responses of the firm's discount rate to micro or macro factors, when financial constraints are binding.

Another option in modeling the nature of the financial constraints is to assume that the premium paid over the safe rate is a function of the debt-to-capital ratio. If this premium is linear in the degree of leverage and equals

$$\frac{c}{2}\frac{B_{i,t-1}}{P^k_{i,t-1}K_{i,t-1}},$$

then one needs simply to add the following term to the right-hand side of equation (4) (see Bond and Meghir 1994):

$$\frac{c(1+\mu)}{2b}\frac{\psi_{i,t+1}\beta_{i,t+1}(1-\tau_{t+1})B^2_{it}P^k_{it}}{(1-\tau_t)(P^k_{it}K_{it})^2P_{it}}. \tag{6}$$

This term basically contains the squared value of leverage and reflects the fact that an increase in capital lowers the premium for debt finance. Its significance is suggestive of the existence of a premium on debt. The augmented Euler equation will still be misspecified if the dividend constraint is binding in any period. Note that the sign of the leverage term should be positive, which means that a negative partial correlation should exist between leverage (squared) at the beginning of the period and investment during that period.[16]

A combination of the two approaches illustrated so far allows for a premium over the safe rate and uses the first-order condition for debt in order to substitute out $\psi_{i,t+1}$ from equation (4). If the solution for debt is an interior one, then:

$$\beta_{i,t+1} = \frac{1+\omega_{i,t+1}}{\psi_{i,t+1}\left(1+(1-\tau_{t+1})\left(i_{t+1}+\frac{c}{2}\frac{B_{it}}{P^k_{it}K_{it}}\right)\right)}. \tag{7}$$

This introduces additional nonlinear interaction terms between leverage and future variables in the model (see Johansen 1994b for a linearized version of this model).[17]

The assumption of an exogenous ceiling on debt is rather unsatisfactory. The firm's accumulation of collateralizable assets is likely to affect the maximum amount that firms are allowed to borrow. A simple way to capture this is to assume that a ceiling exists on the debt-to-capital ratio, implying that the maximum amount of debt is proportional

[16] Both capital and debt are defined as end-of-period quantities, so that equation (4) implies that leverage at the end of period t is negatively related to investment in t+1.

[17] For evidence of the effect of leverage on investment in the context of a more ad hoc specification of the investment equation, see also Harris, Schiantarelli, and Siregar (1994) for Indonesia; Calomiris, Orphanides, and Sharpe (1994) and Lang, Ofek, and Stulz (1995) for the United States; and Schiantarelli and Sembenelli (1995) for Italy. For evidence of the impact of the degree of indebtedness on the response of employment to demand shocks in U.S. firms, see Sharpe (1994) and Calomiris, Orphanides, and Sharpe (1994). Nickell and Nicolitas (1994) analyze the effect of leverage on employment, productivity, and wages in U.K. companies.

to the capital stock; that is, $B_{it}/K_{it} \leq M_{it}$. Assume, moreover, that the firm has to pay a premium for debt that is linear in leverage. Then the following term should be added to the right-hand side of the Euler equation (Jaramillo, Schiantarelli, and Weiss 1994):

$$\frac{c}{2}\frac{(1+\mu)\psi_{i,t+1}\beta_{i,t+1}(1-\tau_{t+1})B_{it}^2P_{it}^k}{(1-\tau_t)(P_{it}^kK_{it})^2}+\frac{\lambda_{it}^BB_{it}}{\gamma_t(1-\tau_t)P_{it}P_{it}^kK_{it}^2}. \tag{8}$$

The term containing the multiplier associated with the ceiling reflects the fact that additional units of capital are beneficial because they relax the borrowing constraint. Even if dividends are strictly positive in both periods, the unobservable multiplier associated with the debt ceiling appears in the equation when the ceiling is binding, and this again would invalidate the orthogonality conditions. However, if dividends are strictly positive, the first-order condition for debt can be used to substitute λ_{it}^B out in the Euler equation. This leads to the inclusion in equation (4) of the terms:

$$-\frac{c(1+\mu)}{2b}\left[\frac{\gamma_{t+1}(1-\tau_{t+1})\beta_{t+1}B_{it}^2P_{it}^k}{\gamma_t(1-\tau_t)(P_{it}^kK_{it})^2P_t}\right]+\frac{(1+\mu)}{b}$$
$$\cdot\left\{\frac{\gamma_t-\beta_{i,t-1}\gamma_{t+1}(1-\tau_t)i_{i+1}B_{it}P_{it}^k}{\gamma_t(1-\tau_t)P_{it}^kK_{it}P_{it}}\right\}. \tag{9}$$

The presence of a term that is linear in leverage and the fact that the sign of the quadratic term has changed relative to the case of a nonbinding ceiling (see equation (6)) allow one to assess which form, if any, of the imperfection is consistent with the data.

A detailed critical summary of the results will be provided in a later section. The overall evidence, however, suggests significant departures from the perfect capital market paradigm. Tests of the overidentifying restrictions tend to be rejected for the subsample of firms thought a priori to face more severe information and agency problems. For those firms, leverage terms also tend to be significant, indicating the existence of a premium on external finance and sometimes the existence of binding credit constraints. In some cases, signs of misspecification are also present for the firms for which the perfect capital markets assumption is thought to be more reasonable.

The main advantage of the Euler equation approach is that it does not rely on average Q to measure expected profitability. The market value of the firm (relative to the replacement value of the capital stock) may be a poor proxy for investment opportunities and, moreover, it precludes an investigation of those firms that are not quoted on the stock market; it is likely that information problems are particularly

severe for this kind of firm. Notice that in many countries, a significant fraction of production takes place in private companies. This is certainly true for developing countries, but it also applies to many developed countries.

What are the drawbacks of the Euler equation approach? A first potential problem has been outlined by Zeldes (1989) in the context of liquidity constraints on consumption. The Euler equation approach may fail to detect the presence of financial constraints if the tightness of such constraints is approximately constant over time. This can easily be seen by focusing on the non-negativity multipliers for dividends. If λ_{it}^{D} and $\lambda_{i,t+1}^{D}$ are close in value, then the evolution of $\psi_{i,t+1}$ in equation (4) will be dominated by the changes in the tax parameters. In this case, tests of overidentifying restrictions may not be able to detect departures from the null hypothesis of no constraints. Although this is a risk in very short panels, it seems less of a problem when data are available over a period of time long enough to record changes in individual firms' financial strength and in overall macroeconomic conditions. Moreover, we have seen that if one is willing to formulate the nature of the alternative hypothesis to be the one of perfect capital markets, this may introduce additional financial variables (like leverage or cash flow) into the investment equation. The significance of their coefficients may provide a sharper test of the financial constraints hypothesis.

Furthermore, parameter estimates in Euler equations are often sensitive to the normalization rule (Mairesse 1994). Although the overall conclusions on the importance of capital market imperfections tend not to be affected, the change in parameter estimates across normalizations is somewhat worrisome. Although it could be simply the result of the poor small sample properties of the GMM estimators used, it may, instead, be suggestive of some general form of misspecification that goes beyond capital market imperfections.[18] Some studies also show evidence of instability over time in the underlying adjustment costs parameters for both Euler and Q models.[19] Obviously, parameter instability in models derived under the assumption of perfect capital markets may be the result of the existence of financing constraints. For instance, changes in the tightness of the non-negativity constraints for dividends lead to variations in $\psi_{i,t+1}$, while changes in the tightness of the exogenous ceiling on debt lead to a non-stable relationship between the interest rate and the firm's discount rate $\beta_{i,t+1}$ in equation (4). However, parameter instability might also have a different origin. Ideally, what is needed are

[18] In order to sort out the origin of the problem, it would be useful to estimate the Euler equation with a method that is not sensitive to the choice of normalization, like limited information maximum likelihood (LIML).

[19] See Demers, Demers, and Schaller (1993); Oliner, Rudebusch, and Sichel (1995); and Hayashi and Inoue (1991).

tests of parameter stability for different categories of firms. Evidence of instability for firms that are not likely to suffer from financial constraints would be suggestive of the existence of additional specification problems. Both the Euler equation and Q types of investment equations share the same underlying model based on the assumption of convex adjustment costs. If there are fixed or linear components to adjustment costs, irreversibility constraints on investment, or other forms of asymmetries in adjustment costs, both models would be misspecified in a fundamental way for both groups of firms. Still, it is comforting that the model tends to be rejected more often for firms classified as constrained. The possibility remains that one may also be picking up differences in adjustment technology. This topic certainly deserves further investigation.

A final issue with the specification of the standard model of investment is the choice of the maximand itself. The underlying assumption in the standard models discussed so far is either that ownership and control coincide or that the managers' objective is to maximize the market value of shares of existing shareholders. However, managers may have incentives to make the firm expand beyond its optimal size because this increases their power by increasing the resources under their control. Moreover, their compensation may be directly tied to growth, or their chances of promotion may be de facto related to an increase in the size of the organization. In this situation Jensen (1986) suggests that the availability of "free cash flow" (cash flow in excess of that required to fund positive net present value projects) will lead to an increase in investment spending.[20] For this reason, the association between cash flow and investment may not reflect the information problems associated with new share issues or debt. It may instead be a sign of the non-value-maximizing behavior of management. This issue of interpretation affects the tests of the imperfect substitutability of internal and external funds conducted using either the Q or the Euler equation approach. Both models, in fact, include cash-flow-type variables.

The main problem with the "free cash flow" hypothesis is that it is difficult, if not impossible, to test, since the variable central to the hypothesis is essentially unmeasurable. However, the merit of the "free cash flow" hypothesis is to reemphasize the importance of agency problems between management and outside shareholders, described originally in Jensen and Meckling (1976), and to focus on managers' incentives and behavior as a potential source of the correlation between investment and liquidity. The actions taken to control management behavior (audits, budgetary restrictions, design of compensation sys-

[20] See Grossman and Hart (1982), Stulz (1990), and Hart and Moore (1990) for formal models of financial structure based on the disciplinary role of debt.

tems) are costly and generate a cost premium for outside equity finance. It may be difficult to distinguish this cost from the information costs due to adverse selection problems, described by Myers and Majluf (1984). More generally, it is possible that the desire by managers not to be subject to the close scrutiny that may occur when they resort to external finance, or the fear of being replaced in case of bankruptcy or changes in ownership, may lead them to rely primarily on internal funds in order to finance investment spending. These are certainly open and difficult questions for which no definitive answers are available, and they deserve further investigation. I will review the empirical results that bear on some of these issues in a later section.

Sample Separation Criteria

The common feature in almost all the tests of the effects of capital market imperfections on investment is that they are based on the identification of a subset of firms (or firm-year observations) for which financial constraints are likely to be more important. In this section I want to examine some of the general issues and problems involved in deciding how to partition the sample.

First, in some papers, a firm's classification in the financially constrained group or the unconstrained group is fixed over the entire sample period.[21] However, it is possible for firms to face financial constraints of varying intensity at different points in time. For instance, if average firm characteristics over the sample (like dividend behavior or size) or pre-sample characteristics are used, one is neglecting the information that the financial constraints may be binding for the same firm in some years but not in others. It would be more advisable in these cases to allow firms to transit between different financial states.

A second observation concerns the endogeneity of the sample-splitting criteria. Some, if not most, of the criteria used to split the sample are likely to be correlated with the firm-specific, time-invariant component of the error term, as well as with the idiosyncratic component. This is certainly true when one uses contemporaneous or average dividend payout behavior or firm size. Correlation with the time-invariant component can be easily eliminated by appropriate transformations of the variables used in the model (taking deviations from the firm's mean, first-differencing, and so on). Correlation with the idiosyncratic component can also be addressed in most, but not all, cases.

[21] For instance, in the paper by Fazzari, Hubbard, and Petersen (1988), firms are classified as low-paying or high-paying using the prevalent dividend payout ratio over the entire period used for estimation (1970 to 1984). Whited (1992) uses the pre-sample existence of a bond rating to classify firms. Hubbard, Kashyap, and Whited (1995) split the sample on the basis of dividend behavior in the two years preceding the estimation period.

Probably the simplest strategy is to use contemporaneous information in partitioning the observations in the context of a single equation, and use lagged information as instruments in the context of IV or GMM procedures. For instance, one could interact the cash flow coefficient with a dividend (size) dummy depending upon whether dividends are high or low (the firm is above or below a certain size). Alternatively, if we think that the severity of financial constraints varies continuously with certain characteristics like size, we may simply want to interact a measure of size with cash flow. In any case, consistent estimates can then be obtained using appropriately lagged values of these interaction terms.[22] If the model is first-differenced and the idiosyncratic component of the error term in the level equation is white noise, endogenous variables lagged twice would be legitimate instruments.

Thus, it is not necessary to split the sample on the basis of predetermined criteria in order to obtain consistent estimates of the parameters. For instance, using pre-sample information is certainly legitimate but may lead to a misclassification of firms in the later years of the panel. However, it is much more difficult to obtain consistent estimates when past, present, and future values of endogenous variables are employed in defining the dummy used to partition the sample (unless truly exogenous instruments are available that are reasonably correlated with the endogenous variables). This is the case when average (or prevalent) endogenous characteristics are used as sample separation criteria, because even lagged values of the interaction terms between the dummy and other regressors are correlated with the error term.

The issue of getting consistent coefficient estimates may not appear to be that important. Even if the estimates are biased, it could be argued, the estimated difference is not, provided that the bias is the same for the two sets of firms. This is a potential rationale for using the Least Squares Dummy Variable estimator when estimating Q equations. However, even abstracting from the issue of measurement errors that would invalidate this procedure, not properly accounting for the endogeneity of the selection criteria is likely to generate different biases for the two sets of firms. For instance, firms classified as constrained may be those with a higher correlation between cash flow and the unobservable component of investment opportunities, which is likely to lead to a larger upward bias on the cash flow coefficient.[23]

Another issue should be discussed in relation to sample separation.

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[22] See Harris, Schiantarelli, and Siregar (1994); Jaramillo, Schiantarelli, and Weiss (1994); and Bond and Meghir (1994), among others.

[23] This problem is related to the one that occurs in the Q formulation of the investment equation, when the variable that is assumed to capture investment opportunities (Q and possibly sales) does a good job for unconstrained firms but not for the others.

A characteristic common to most of the work on financial constraints is that firms or observations are partitioned into groups on the basis of a single indicator that may or may not be a sufficient statistic for the existence of liquidity constraints. In some cases, two indicators are interacted, typically when a cross-sectional classification criterion is used in conjunction with period dummies that capture changes in macroeconomic conditions or structural characteristics of the financial system at different times. In theory, there is no reason not to use more than one cross-sectional characteristic in order to partition the sample. It is obvious, however, that the interaction terms and, consequently, the number of parameters to be estimated increase rapidly and this may lead to imprecise inferences.[24]

One possible way to address this issue, and at the same time allow the data to speak as to which firm-year observations belong to constrained or unconstrained regimes, is to use endogenous switching regressions methods with sample separation unknown (Hu and Schiantarelli 1994, using panel data for U.S. firms). In this case, the probability of being constrained or unconstrained is determined by a switching function that is written as a function of a vector of firm characteristics and macroeconomic conditions. Depending upon the switching function, the firm can be in either of two regimes ("constrained" and "unconstrained"), each characterized by different values of the coefficients on Q and cash flow in the investment function.[25] The model can be estimated by Maximum Likelihood. Using the data to endogenously determine which set of multiple characteristics determines the likelihood of financial constraints and how this set evolves over time is obviously attractive, but this gain comes at the cost of having to make precise assumptions about the distribution of the error term. This has to be contrasted with the absence of such needs when one uses IV or GMM procedures.

Another example of the use of switching regression models to assess the importance of financial constraints is given by Nabi (1989), who uses cross-sectional data for 119 firms in Pakistan to estimate an accelerator model of investment. In this case, the sample separation criterion is known (whether or not the firms have access to the formal credit market) and the estimation is carried out using standard two-step methods.

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[24] Faroque and Ton-That (1995) suggest the use of non-nested tests in order to select the "best" among different stratification criteria. Although the idea is interesting, it relies as well on the belief that a single criterion is adequate to partition the sample.

[25] Notice that the researcher does not observe which regime each firm is in, for a given year.

International Evidence on the Effects of Financial Constraints: Cross-Section and Time Series Variations

In this section I will review in detail the international evidence on the impact of capital market imperfections on investment decisions. The discussion is organized around the more commonly used criteria that have been employed to identify firms more likely to suffer from financial constraints.[26] Most of these criteria emphasize the cross-sectional differences that exist across firms. However, the importance of financial constraints is likely to vary over the course of the business cycle and with the stance of monetary policy. Moreover, structural changes in financial markets can potentially affect the degree of substitutability between internal and external finance. For these reasons, the evidence concerning the variation of the severity of financial constraints over time will be considered as well.

Most of the empirical contributions surveyed are based on individual-firm-level panel data. In some cases, the individual firm data are aggregated into size classes. Unless otherwise stated, the results are based on individual-firm-level data. In addition to evidence based on Q and Euler equations, results based on variations on the flexible accelerator model will be discussed as well. In this case, future profit prospects are summarized by changes in sales. These models can be rationalized as being derived from the standard neoclassical model of investment without adjustment costs (Jorgenson 1963) when the real user cost of capital is (relatively) constant, or from a putty clay model when the cost of labor relative to the purchase price of a machine does not change significantly (Nickell 1978, ch. 11).

Dividend Payout Behavior

The original contribution by Fazzari, Hubbard, and Petersen (1988) classified U.S. firms according to their prevalent payout behavior over the period used for estimation, and showed that firms with a low dividend-payout ratio were more sensitive to cash flow, in the context of Q models of investment. The use of payout behavior tries to identify the group of firms that have exhausted their retentions and are forced to rely on external financing that is an imperfect substitute for internal finance.

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[26] An interesting way used to partition U.S. companies has been the presence/absence or quality of a firm's bond rating. However, this information is not generally available for other countries. Whited (1992) finds that firms with a bond rating display less sensitivity of fixed investment to cash flow. Similarly, Calomiris, Himmelberg, and Wachtel (1995) find that inventory investment of firms with a commercial paper rating is less sensitive to cash flow fluctuations.

As we have argued above, the use of prevalent (or average) payout behavior does not take into account that firms may transit between states in which they face binding constraints and states in which they do not, and it is likely to make it virtually impossible to obtain consistent parameter estimates.[27]

Hubbard, Kashyap, and Whited (1995) produce evidence that the test of overidentifying restrictions in an Euler equation model points to a rejection for low-dividend-paying firms, but not for high-dividend-paying firms. Firms are sorted on the basis of average payout behavior in the two pre-sample years. This addresses the econometric issues of endogenous sample selection, but firms are still not allowed to transit between different financial states. Moreover, the classification criteria are less accurate for the later years compared to the earlier ones.

Bond and Meghir (1994) allow firms to transit between constrained and unconstrained states by defining a dummy variable that equals zero when dividends are positive in both adjacent periods, and one otherwise. They then interact this variable with all the regressors in the Euler equation for capital. Obviously, the dummy variable is endogenous, but appropriately lagged values of the interaction terms provide valid instruments. The results indicate that the cash flow coefficient is wrongly signed (negative, instead of positive, in the context of equation (4)) and significant for the constrained firms, while it is not significantly different from zero for the unconstrained firms.[28] This result is not as clearly supportive of the importance of financial constraints as the ones obtained for the United States. In fact, in terms of the sign and significance of the cash flow coefficient, the Euler equation for U.K. firms is not satisfactory for either group of firm-year observations, although it is less satisfactory for those in which the dividend constraint binds.

Alonso-Borrego (1994) follows Bond and Meghir (1994) using data for Spanish firms. He also finds that the standard Euler equation model is rejected by the test of overidentifying restrictions and that the coefficient of cash flow is wrongly signed when estimated over the entire sample, while it performs somewhat better for firms that are paying dividends.

In a recent paper, Kaplan and Zingales (1995) undertake a closer analysis of the 49 low-dividend firms identified by Fazzari, Hubbard, and Petersen (1988) as financially constrained. Using qualitative infor-

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[27] The econometric results in the paper are mostly obtained using the Least Square Dummy Variable (or Within) estimator.

[28] Basically, in equation (4), the data demand a positive correlation between the investment rate at time t and cash flow at $t-1$. A negative or, at best, nonsignificant coefficient for cash flow is also obtained by Rondi, Sembenelli, and Zanetti (1994), using a panel of large Italian companies.

mation in the companies' financial statements, including statements by managers, they suggest that only 15 percent of the firm-year observations can be classified in the constrained group. They then show that the sensitivity of investment to cash flow is greater for the unconstrained group, contrary to the implications of information-based stories. However, the Kaplan-Zingales classification is open to criticism because of its subjective nature. Moreover, it is likely to identify financially distressed firms, which had been excluded by design from the sample used by Fazzari et al., who had chosen firms with positive real sales growth during the sample period. It should not, therefore, be a surprise that only a small number of firm-year observations are included in the constrained group. As we have already argued, the original choice by Fazzari et al. of classifying firms on the basis of their prevalent dividend payout behavior has serious potential drawbacks. Indeed, many of the contributions that have followed have addressed these problems and the others mentioned in previous sections. Although for different reasons, the Kaplan and Zingales finer classification within the group of constrained firms is also open to criticism, and it is not clear what general conclusion can be derived from the econometric results they obtain.[29]

Association with Business Groups and with Banks

Business groups are a pervasive form of organization in several countries. Although this is certainly not the only way to look at them, business groups can be seen as an organizational form that helps to cope with information and contract enforcement problems in the capital markets. The knowledge by financial intermediaries or individual investors that individual firms may also rely, to a degree, on the financial resources of the group is likely to improve their access to external financial resources. Moreover, business groups allow the formation of an internal capital market that supplements the capital allocation function of the external market. Finally, in some countries, groups are organically linked with banks.

In Japan, banks provide a large proportion of a firm's financing, own shares, and sit on the board of directors of industrial firms. In Germany, relationships between banks and firms are also close, through board representation and the control of voting rights for their own shares and for the shares left in bank custody. However, contrary to common belief, bank financing does not represent a large share of corporate financing in the postwar era (see Mayer 1990). Even though

[29] See Fazzari, Hubbard, and Petersen (1995) for a detailed discussion of the Kaplan and Zingales paper, including the econometric reasons that may explain the differences observed in the estimated value of the cash flow coefficient.

formal ties between banks and firms are absent in Italy, banks represent the dominant source of outside finance. Moreover, the dominant large business groups have special informal relationships with national financial institutions. Some of the latter play an important role not only in the financing of enterprises, but also in acting as exclusive clubs where mutual share holdings are organized and strategic decisions on corporate control are taken. Notice that Italian business groups are often organized around a family nucleus, and in most cases the controlling group owns a large stake of total equity. Business groups also play an important role in developing countries like Korea and Indonesia.

Whatever the form, strong ties between banks and certain firms represent a way to reduce information costs.[30] In this sense we would expect firms affiliated to a business group to be less sensitive to cash flow, both because of the mitigation of information problems in accessing external finance (especially if there are bank links) and because of the creation of an internal capital market. The use of affiliation to industrial groups, particularly in situations in which such affiliation is a stable characteristic, is probably less subject to the problems generated by

dispersed share ownership structure. Since a more dispersed ownership is, everything else equal, associated with greater agency problems between management and outside investors, it would be interesting to use the two characteristics simultaneously in partitioning the sample. Finally, Schaller (1993) and Chirinko and Schaller (1995) provide evidence that members of major Canadian conglomerates do not display excess sensitivity to cash flow. Canadian conglomerates often contain distinct enterprises with their own publicly traded shares, and they have points of similarity with business groups in Japan or Italy. However, no suggestion is made in the two papers just mentioned that conglomerates have a special relationship with banks.

On balance, all of these results are consistent with the idea that group membership relaxes financial constraints. How much this is due to the role of banks' ties and how much is due to the creation of an internal capital market is a matter of conjecture, and the answer is likely to differ across countries. Detailed information on both consolidated and unconsolidated balance sheets, and on intra-group loans and equity issues, in theory at least could help in assessing the relative importance of these two effects. While data on these financial flows may be available, it is likely to be difficult to assess intra-group flows of funds achieved through transfer pricing.

So far the discussion has focused on the differences between types of firms within each country, in order to draw inferences on the importance of bank affiliation. Another possible way to assess the importance of financial intermediaries in minimizing the adverse consequences of informational asymmetries can be obtained by analyzing the cross-country differences in the excess sensitivity to cash flow. The empirical study on financing patterns in developed countries by Mayer (1990), based on flow of funds data, suggests that retentions are the dominant source of finance in all countries, and in general banks are more important than market sources of external finance.[32] However, bank finance is particularly important in France, Italy, and Japan, while it is relatively less important in the United Kingdom and the United States. Surprisingly, the proportion of total finance provided by German banks is closer to the U.K. and U.S. figures.

Bond et al. (1995) estimate various versions of the investment equation (in its Euler equation form, flexible accelerator, and so on) on panel data for the United Kingdom, France, Belgium, and Germany. They conclude that the sensitivity to cash flow is greater for the United

[32] All international comparisons are fraught with difficulties, and any conclusions reached must be treated with care. The Bond, Elston, Mairesse, and Mulkay (1995) paper contains a detailed discussion of these issues and of the efforts made to render the international comparisons as meaningful as possible.

Kingdom than for all the other countries. This suggests that the availability of internal finance may be more important in financial systems that are more market-based.[33] However, caution is needed before jumping to this conclusion, because it is also possible that the different roles of cash flow reflect differences in the nature of the data for each country. In particular, while the U.K. data are consolidated accounts, the main data available for the other countries are not. Although the purpose of their study was not an inter-country comparison of cash flow sensitivity, Cummins, Hassett, and Hubbard (1994) find that, out of a set of 14 countries included in the Global Vantage data base, the cash flow coefficient is significant in Q equations only for Japan, Norway, the United Kingdom, and the United States. Obviously, these four countries differ greatly in terms of the market or bank orientation of the system of external finance. Again, the results may be driven by the vastly different composition (and numbers) of the firms included in the data base for each country.

Size of Firms

One criterion frequently used to identify firms that are more likely to be financially constrained has been size, on the presumption that size is highly correlated with the fundamental factors that determine the probability of being constrained. Smaller firms are more likely to suffer from idiosyncratic risk and, insofar as size is positively correlated with age, are less likely to have developed a track record that helps investors to distinguish good firms from bad. Moreover, small firms may have lower collateral relative to their liabilities, and unit bankruptcy costs are likely to decrease with size. Finally, it is likely that transaction costs for new share issues decrease with size. However, size also may be inversely related to concentration of ownership, and concentrated share ownership is likely to mitigate agency problems between managers and outside investors. This last consideration is probably more important when dealing with samples of relatively large quoted companies.

The evidence is indeed mixed. When the size criterion is applied to large data sets that include quoted and unquoted companies and cover a broad spectrum of the size distribution, then the results tend to suggest that smaller firms face significantly higher hurdles in accessing external funds. This is true both for developed countries (see Galeotti, Schiantarelli, and Jaramillo (1994) for Italy, and Johansen (1994b) for Norway) and for developing countries (see Jaramillo, Schiantarelli, and Weiss (1994) using data on Ecuadorian firms, and Harris, Schiantarelli,

[33] Notice that Q is likely to be more informative in countries in which the provision of external finance is (relatively) more market-based.

and Siregar (1994) using panel data for Indonesia). Carpenter, Fazzari, and Petersen (1994) find that the impact of internal finance on inventory investment is greater for small U.S. firms relative to large firms, although internal finance is economically important for large firms. Time series data disaggregated by firm size confirm the greater sensitivity to cash flow (relative to interest payments) of inventory investment in the United States (see Gertler and Gilchrist (1994), using Quarterly Financial Report data); of fixed investment and inventory investment in Italy (see Rondi, Sack, Schiantarelli and Sembenelli 1993); and of investment in Colombia (Tybout 1983).[34] However, Devereux and Schiantarelli (1990), using a sample of relatively large quoted firms, find that large firms are more sensitive than small firms to cash flow fluctuations.[35]

The fact that a firm must be quoted to be included in the sample means that there probably is a selection bias in favor of picking only the best of the small firms. However, it may also be the case that larger firms have more dispersed share ownership (see below). Unfortunately, the U.K. panel does not contain enough information to assess whether this explanation is correct. Results on the role of size for a small sample of U.S. firms listed on the New York Stock Exchange or traded in the over-the-counter market suggest no significant differences between size classes (see Oliner and Rudebusch 1992). Hu and Schiantarelli (1994) find that, everything else equal, size is positively related to the probability of being financially constrained for quoted companies present continuously between 1978 and 1987 in the Compustat Annual Industrial File and in the Over-the-Counter File. The probability of being constrained increases with stock and flow measures of leverage and decreases with the stock of liquid assets. In sum, size seems to be a useful criterion to identify firms that are more likely to be financially constrained, but only when the sample used for estimation includes at least a portion of the lower tail of the size distribution and is not limited to the successful young firms that have survived the competition in the marketplace.

Agency Problems and Concentration of Ownership

The interests of inside shareholders are likely to be aligned more closely to those of outside shareholders when the former have a large

[34] Hall (1992) finds that R&D expenditure by U.S. firms responds significantly to cash flow. Himmelberg and Petersen (1994) provide similar evidence for a panel of smaller firms. The cash flow effect is stronger for their sample than for the sample of larger firms used in Hall's paper.

[35] Athey and Laumas (1994) find that large Indian firms are more sensitive to cash flow than small firms, and they explain their result as a reflection of the Indian government credit policies for promoting small enterprises.

equity stake in the company. Moreover, more efficient monitoring of management will occur when outside shareholding is highly concentrated. In this case, the agency cost premium for equity finance should be smaller. Oliner and Rudebusch (1992) do not find evidence that the structure of shareholding for a small sample of U.S. firms affects the sensitivity of cash flow in Q-type equations. Results for Canada suggest, instead, that cash flow is less important for companies that have more concentrated share ownership and are on average smaller. (See, for example, Schaller (1993); Chirinko and Schaller (1995), using Q models; and Ng and Schaller (1991), using the Euler equation approach.)

Additional evidence on the source of the premium for external finance is contained in Hubbard, Kashyap, and Whited (1995) for the United States. Within the group of low-dividend-payout firms, they separate those in mature industry sectors. These are the firms for which the problems outlined by Jensen and Meckling (1976) and Jensen (1986) should be the most important, yet the test of overidentifying restrictions does not suggest a rejection of the model for this subgroup, while it does for the other low-dividend-paying firms. However, using a similar data set, Vogt (1994) divides the low-dividend-paying firms into four size classes and shows that the cash flow coefficient is greater for larger firms, which presumably are more likely to suffer from this type of agency problem. Summarizing, the evidence is mixed, and more research work is needed in order to identify the relative importance of the various sources of the discrepancy between the costs of internal and external finance.

Variations over Time in the Tightness of Financial Constraints: Asymmetric Cash Flow Effects, Business Cycle Conditions, and Monetary Policy

One implication of the information-based models of investment is that the severity of financial constraints is likely to vary with overall macroeconomic conditions and with the stance of monetary policy, because they influence the value of firms' net worth. Therefore, during recessions or after a monetary tightening, the cost of external finance could be expected to increase and/or the access to it to decrease.

The evidence for time variation in the severity of financial constraints is quite robust for the United States. Gertler and Hubbard (1988) provide empirical evidence for the United States that the cash flow coefficient for firms with low payout ratios, in a Q type of investment equation, is greater in recessions. Kashyap, Lamont, and Stein (1994), using panel data, find that inventories for firms without a bond rating are sensitive to measures of the stock of liquidity during years of recession, but not during the subsequent boom years. They do not detect any excess sensitivity in any period for firms with a bond rating.

Similar results for investment are obtained by Oliner and Rudebusch (1994) using the QFR data set. The interesting twist in their paper is that the cash flow coefficient increases in the four quarters following a monetary contraction, defined either on the basis of the Romer dates (see Romer and Romer 1989 and 1990) or on the basis of the behavior of the spread between the federal funds rate and a long-term government bond rate.

All the contributions mentioned above are based on classifying firms cross-sectionally and temporally, prior to estimation. In the endogenous switching regression approach of Hu and Schiantarelli (1994), macroeconomic conditions affect the probability of a firm being constrained or unconstrained, through both the balance sheet variables (stock and flow measures of indebtedness, stock of liquid assets, and size) and the year dummies included in the switching function. This allows the data to speak about the determinants of the probability of facing constraints and the evolution of such a probability. As a summary measure of the effect of macroeconomic conditions, they use the parameter estimates to calculate the average probability (across firms) of being constrained in each year. This probability varies substantially over time; it reaches its highest value in the recession of 1982 and in its aftermath, and its movements closely follow (with a lag of approximately two years) the behavior of the federal funds rate.[36]

Gross (1994) provides a theoretical and empirical analysis of the dynamics of U.S. firms' investment and financing decisions. In his paper, firms decide about fixed and liquid assets in order to protect themselves against bankruptcy, while assuring themselves of the availability of resources to undertake profitable investment. Rather than assuming exogenously that some firms are constrained, Gross shows that the tightness of financial constraints varies over time, depending upon the amount of internal financial resources. Kernel regression estimates of the policy function for capital and debt suggest that the capital stock is not sensitive to the amount of internal financial resources when the latter are large. When the firm is somewhat constrained, a large portion of each extra dollar of internal funds is invested. When firms are very constrained, they resort to borrowing in order to prevent the capital stock from falling further.

The international evidence on this issue is not as rich. Rondi, Sack, Schiantarelli, and Sembenelli (1993), using annual firm data for Italy aggregated into two size classes (large and small), also find that both fixed and inventory investments at small firms respond more to changes

[36] When the federal funds rate is included directly in the switching function in place of the year dummies, it has a positive and significant impact on the probability of being financially constrained.

in cash flow relative to interest payments in periods following monetary tightening. The same occurs for large firms, although their sensitivity is found to be less than that of smaller firms in all subperiods. Schiantarelli and Sembenelli (1995), using Italian panel data, obtain the result that the effect of cash flow is asymmetric, particularly for firms that are not associated with business groups. They allow the cash flow coefficient to differ depending on whether cash flow increases or decreases, and find that it is greater when cash flow decreases. This means that lack of availability of internal resources causes a decrease in investment, while an increase in such availability has a weaker positive effect. Preliminary results by Guariglia (1994), using U.K. panel data to estimate finished goods inventory equations, also suggest greater sensitivity to cash flow during recessions.

Variations over Time in the Tightness of Financial Constraints: The Effects of Structural Changes in Financial Markets

The tightness of financial constraints over time may vary, not only following changes in business cycle conditions and monetary policy, but also because of structural changes in financial markets. During the 1980s, several developing countries introduced financial reforms to facilitate capital accumulation and growth. These reforms consisted mainly of the removal of administrative controls on the interest rate and the elimination or scaling down of directed credit programs. Barriers to entry in the banking sector were also lowered, and the development of securities markets was stimulated. The main objective of the banking deregulation was to provide higher returns to depositors and to increase the supply of funds for investment, although whether this happens at the economy-wide level is a matter of controversy. It is likely, however, that the amount of saving intermediated by the banking system will increase. To the extent that economies of scale exist in information-gathering and in monitoring, it is possible that banking intermediaries may have an advantage over the curb (informal) market in allocating investment funds, and this may lead to a reduction in the premium of external finance over internal finance. On the other hand, the elimination of subsidized credit programs will increase the financing constraints on those firms that previously benefited from the system of administrative allocation of credit. This means that programs of financial liberalization have distributional conseqences, and whether they relax financing constraints for different categories of firms is ultimately an empirical question.

Evidence about the effects of financial liberalization is provided by Harris, Schiantarelli, and Siregar (1994) for Indonesia, and by Jaramillo, Schiantarelli, and Weiss (1994) for Ecuador. Harris et al. find that cash flow is large and significant in an accelerator type of equation for small firms, but not for large firms. However, the cash flow coefficient

decreases dramatically in the second half of the 1980s, in the post-liberalization period.[37] Moreover, the coefficient on the beginning-of-period degree of leverage, meant to capture the marginal cost of debt, also becomes less negative, suggesting that the cost-of-funds schedule increases less rapidly as a function of leverage. It is interesting that these results still hold if the next period's profits are included in the equation in order to control for the informational role of cash flow. One can therefore conclude that banking deregulation has indeed relaxed financial constraints for small firms in Indonesia. No significant changes are detected for large firms. There is evidence that large firms that had been beneficiaries of subsidized credit have been able to replace directed credit with borrowing on the foreign markets. Note that many large firms are members of conglomerates or are owned by ethnic Chinese with connections to the financial markets in Hong Kong and Singapore.

The results for Ecuador by Jaramillo, Schiantarelli, and Weiss (1994), based on estimating Euler equations for capital that allow for both an interest rate that increases with the degree of leverage and a ceiling on leverage, suggest that small firms face constraints, while large firms do not. However, no changes occurred in the structural coefficients over time. This may be because financial liberalization was less profound in Ecuador than in Indonesia, or because some of the subsidized credit programs benefited small firms in the pre-reform period. Moreover, while financial liberalization is a process that may take time before its effects can be felt, the panels used for estimation are rather short. Additional years of data will be necessary to pass final judgment, particularly on the effect of the introduction of securities markets at the end of the 1980s and the beginning of the 1990s in Ecuador, Indonesia, and other developing countries.

Financial deregulation is not a phenomenon limited to developing countries; it has taken place also in a set of developed countries. The paper by Hoshi, Kashyap, and Scharfstein (1991) provides some evidence on the consequences of financial reforms that increased the financing options for Japanese corporations. The reforms basically involved the repeal of regulations that hampered the issuance of bonds in the domestic and the international markets and the elimination of interest ceilings that reduced the demand for bonds. The analysis focuses on firms that had strong bank ties during the 1977–82 period (the focus of their previous work). It shows that firms that reduced those ties after 1982 show much stronger sensitivity to cash flow than firms that maintained bank ties in the later period. The decrease in the proportion

[37] Note that the decrease in the value of the cash flow coefficient is not likely to be explained by the fact that the economy was more buoyant after banking deregulation. GDP fell steadily, in fact, until it reached the trough in 1987.

of borrowing from banks within the group, relative to total borrowing between 1977 and 1986, is used as a sample-separation criterion.

Their finding is consistent with the idea that benefits result from intermediation, but at the same time it raises the issue of why a firm would choose to weaken its bank ties. Presumably if a firm decides to do so, it is because of net benefits from emancipating itself from the group's main bank. Moreover, it is possible that the correlation between cash flow and unobserved investment opportunities may be greater for firms that have decided to weaken their bank ties. In this case, a greater upward bias would be found on the cash flow coefficient for such firms.[38] Finally, given the nature of the sample-split criterion, which uses future information, an instrumental variable procedure based on lagged values of the regressors would not lead to consistent estimates of the cash flow coefficients. Note that sorting by bank association is probably less of an issue for the estimation period preceding financial deregulation, a period characterized by stable and long-lasting group links. Moreover, while the growth opportunities for group and independent firms in the 1977–82 period do not differ greatly, the group firms that weakened their ties after 1982 are characterized by better investment opportunities.

In conclusion, the evidence concerning the benefit of bank ties, derived from documenting the consequences of financial deregulation, is less convincing for Japan. More work is needed in order to assess the consequences for financial constraints of moving to a more market-oriented (or less bank-oriented) financial system, including the analysis of deregulation episodes in other developed countries.

Conclusions

The weight of the evidence I have reviewed suggests that, for a substantial subset of firms, informational asymmetries and incentive problems generate significant departures from the model derived under the assumption of perfect capital markets. This conclusion is derived from both Q models and Euler equations for capital. It holds, independent of the specific cross-sectional criteria used in classifying firms, and it is supported by most of the empirical evidence for a number of countries. Moreover, substantial support is also available for the proposition that the severity of financial constraints varies over the business cycle and with the stance of monetary policy. For some developing countries, evidence suggests that financial liberalization and the ensuing process of financial re-intermediation have led to a relaxation of constraints for those firms that had restricted access to finance in the

[38] The econometric results in the paper are obtained using OLS in differences.

pre-reform period. More research is needed on the comparative performance of market-based and bank-based financial systems, as well as on the consequences of those forms of financial deregulation that have led to an increased role for security markets, vis-à-vis banks. Some panel data evidence within individual countries suggests that bank association is beneficial, but the cross-country evidence is still too weak to draw definitive conclusions.

Several other problems remain open at this stage, some of them quite general in nature. Quite a few of the results reviewed here suggest evidence of excess sensitivity to internal funds or of misspecification of the estimated equations, even for firms that are thought a priori not to suffer from severe information problems (for instance, large, mature companies). Moreover, a simple look at the data reveals that retentions are their prevalent source of finance (just as for most other companies). This may be because even large, mature firms cannot costlessly and credibly communicate their real investment opportunities to lenders and investors and consequently suffer from adverse selection problems. Alternatively, the agency problems may be severe between managers and the providers of external finance (both outside shareholders and suppliers of loan capital). The research agenda for the future should include efforts to identify more carefully the nature of the information and agency problems that make external finance more expensive than internal finance. More generally, it would be useful to investigate in depth how managerial preferences and incentives may generate a close association between firms' investment and the availability of internal resources.

Another direction for future research is provided by the desirability of moving away from the standard assumption of convex adjustment costs underlying the model used so far for econometric testing. The evidence of misspecification, including the change in parameters across normalizations and their instability over time (in some studies), may not be wholly explained by capital market imperfections. Other forms of misspecification may also exist, related, perhaps, to the irreversibility of investment and to non-convexities in adjustment costs. The simultaneous treatment of capital market imperfections and of more complex forms of adjustment costs is likely to be very fruitful.

Appendix

The Firm's Optimization Problem

Denote R_{it} by the required rate of return; then the following standard arbitrage condition must hold for a firm's shareholder:

$$R_{it} = \frac{(1 - m_t)D_{it} + (1 - z_t)E_t(V_{i,t+1} - V_{it} - S^n_{it})}{V_{it}}, \tag{A1}$$

where D_t denotes dividends, V_{it} the value of the firm, S^n_{it} the nominal value of new shares, m_t the personal tax rate, z_t the tax rate on capital gains, and E_t the conditional expectations operator. Solving (A1) recursively gives:

$$V_{it} = E_t \sum_{j=0}^{\infty} \beta^j_{it}[\gamma_{t+j}D_{i,t+j} - S^n_{i,t+j}]. \tag{A2}$$

V_{it} is the value of the firm for existing shareholders. Assume this is the objective function that is maximized, subject to the following constraints:

$$\begin{aligned} D_{i,t+j} = (1 - \tau_{t+j})[&p_{i,t+j}(F(K_{i,t+j}, L_{i,t+j}) - G(I_{i,t+j}, K_{i,t+j})) \\ &- w_{t+j}L_{t+j} - (i_{i+j} + A(B_{t+j-1}, p^k_{t+j-1}K_{t+j-1})/B_{t+j-1})B_{t+j-1}] \\ &+ (B_{t+j} - B_{t+j-1}) - p^k_{t+j}I_{t+j} + S^n_{t+j} + C_{i,t+j}, \end{aligned} \tag{A3}$$

$$K_{t+j} = (1 - \delta)K_{t+j-1} + I_{t+j}, \tag{A4}$$

$$D_{t+j} \geq 0, \tag{A5}$$

$$B_{t+j} \geq 0, \tag{A6}$$

$$S^n_{t+j} \geq 0, \tag{A7}$$

$$M_{i,t+j} - \frac{B_{i,t+j}}{p^K_{i,t+j}K_{i,t+j}} \geq 0, \tag{A8}$$

where

$$\beta^j_{i,t} = \prod_{i=0}^{j} (1 + R^*_{i,t+i})^{-1},$$

$$R^*_{i,t+j} = \frac{R_{i,t+j}}{(1 - z_{t+j})},$$

$$\gamma_{i,t+j} = \frac{(1 - m_{t+j})}{(1 - z_{t+j})},$$

τ_{t+j} = corporate tax rate,
$p_{i,t+j}$ = output price,
$K_{i,t+j}$ = capital stock,
$L_{i,t+j}$ = labor,
$I_{i,t+j}$ = investment,
$w_{i,t+j}$ = wage rate,
i_{t+j} = riskless interest rate,
$B_{i,t+j}$ = stock of debt,
$P^k_{i,t+j}$ = price of investment goods,
$C_{i,t+j}$ = tax savings associated with depreciation allowances on existing capital goods, and
δ = depreciation rate.

Assume that the firm is imperfectly competitive. Denote with μ_t the markup of prices over marginal cost. To simplify notation, set $\beta^0_{i,t+1} = \beta_{i,t+1}$. Assume that the firm always issues a positive amount of debt. The first-order conditions are:

$$(\gamma_t + \lambda^D_t)(1 - \tau_t)[(1 + \mu_t)^{-1}P_{it}(F_K(it) - G_K(it))] - E_t[(\gamma_{t+1} + \lambda^D_{i,t+1})$$

$$(1 - \tau_{t+1})\beta_{t+1}A_K(it)] - \lambda^k_{it} + \lambda^B_t B_{it}/(p^k_{it}K^2_{it}) + E_t[\lambda^k_{i,t+1}\beta_{i,t+1}(1 - \delta)] = 0, \tag{A9}$$

$$(\gamma_i + \lambda^D_{it})[-(1 - \tau_t)p_{it}(1 + \mu_t)^{-1}G_I(it) - (1 - \xi_t)p^k_{it}] + \lambda^k_{it} = 0, \tag{A10}$$

$$(\gamma_t + \lambda^D_{it})(1 - \tau_t)[p_{it}(1 + \mu_t)^{-1}F_L(it) - w_{it}] = 0 \tag{A11}$$

$$(\gamma_t + \lambda^D_{it}) - E_t[\beta_{t+1}(\gamma_{t+1} + \lambda^D_{i,t+1})(1 + (1 - \tau_{t+1})i_{t+1})] \tag{A12}$$

$$- E_t[\beta_{t+1}(\gamma_{t+1} + \lambda^D_{i,t+1})(1 - \tau_{t+1})A_B(it)] - \lambda^B_{it}/(p^k_{it}K_{it}) = 0,$$

$$\gamma_t + \lambda^D_{it} - 1 + \lambda^s_{it} = 0. \tag{A13}$$

where ξ_t is the present value of tax savings associated with depreciation allowances on investment, and λ^k_t, λ^D_t, λ^s_t and λ^B_t are the Lagrange multipliers associated with the capital accumulation equation, with the non-negativity constraint on dividends, new share issues, and the ceiling on the debt to capital ratio. $A(B_{t+j-1}, P^k_{t+j-1}K_{t+j-1})/B_{t+j-1}$ denotes the premium that must be paid over and above the safe interest rate. Equations (A9) through (A13), in addition to the complementary slackness condition (not reported here for brevity's sake) define the firm's optimal plan.

Assume that the gross production and the adjustment cost function are linear homogenous. Assume, moreover, that adjustment costs are quadratic.

$$G(I_{it}, K_{it}) = \frac{b}{2}\left(\frac{I_{it}}{K_{it}} - a - \varepsilon_{it}\right)^2 K_{it}. \tag{A14}$$

When debt is omitted entirely from the problem, and perfect competition is assumed ($\mu_t = 0$), then it is easy to show that (A9), (A10), (A11), and (A12) and the complementary slackness conditions imply:

$$\lambda^k_{it} = \frac{\beta_{it}(V_{it} - H_{it})}{P_{it}(1 - \tau_t)(1 - \delta)K_{i,t-1}} \tag{A15}$$

in the case when dividend payments are strictly positive. H_{it} is the present value of tax savings associated with the depreciation allowances on past investment. Equations (1) and (2) in the main text and variations thereof, follow immediately from (A10) and (A15). To derive the basic Euler equation for the case of no debt, simply omit the $(\lambda^B_{it} B_{it})/(P^k_{it}K^2_{it})$ term

from (A9). Using (A10) to substitute out λ_{it}^{K} and $\lambda_{i,t+1}^{K}$ from (9), one obtains equation (3) in the main text (assuming μ_t is constant). The extensions due to the inclusion of debt can also be easily derived. Note that when the ceiling on debt is exogenous, i.e. $B_{it} \leq \overline{B}_{it}$, $(\lambda_{it}^{B} B_{it})/(P_{it}^{k} K_{it}^{2})$ should be omitted from (A9) and $\lambda_{it}^{B}/(P_{it}^{k} K_{it})$ is replaced by λ_{it}^{B} in (A12).

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Discussion

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This conference considers the question: "Is bank lending important for the transmission of monetary policy?" For the answer to this central policy question to be "Yes," and for the magnitude of lending effects to be empirically significant, fluctuations in bank loans must cause some changes in the real economy. The most obvious place to look for effects of this kind is investment. In business circles, and especially in the business press, it seems to be taken for granted that restrictions in bank lending prevent firms from undertaking investment projects, owing to a lack of finance.

Economists, however, are not necessarily convinced that reduced bank lending constrains firms' investment. In a world of perfect capital markets, the Modigliani-Miller theorem implies, firms could replace bank financing with other sources of funds at low cost. If, for example, tight monetary policy causes bank lending to decline, firms could issue directly marketed debt (like commercial paper or corporate bonds) or sell new equity to raise funds. For bank lending to affect investment, some kind of capital market imperfection must be present that prevents firms from costlessly substituting other sources of finance for bank loans when the supply of loans is restricted.

In the past decade, much new research has tested for the existence of such capital market imperfections that affect investment. The findings reported in this work, in most cases, support the presence of economically significant financial constraints on investment. Fabio Schiantarelli has put together an extensive and insightful survey of this literature, to

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which he has contributed many important papers. With a variety of co-authors, I have also participated in this research. It is, therefore, not surprising that I agree with Schiantarelli about the importance of this work, and I also broadly agree with the conclusions he reaches. I will, however, expand on a few of the points made in the paper and offer some different interpretations of the findings.

Schiantarelli's paper focuses primarily on the empirical literature linking financial factors and investment. The theoretical issues are surveyed only briefly. I begin this comment by expanding on some of the conceptual issues involved in understanding how finance, and ultimately monetary policy, affect investment. In particular, I identify three distinct channels through which financial effects operate—the collateral, bank lending, and internal finance channels. I will then consider some of the empirical issues at the core of Schiantarelli's paper and conclude with a comment on the directions that research in this area might take in the future.

Channels of Financial Influence: Collateral, Bank Lending, and Internal Finance

Most modern research studies on financing constraints start from one of three complementary channels through which financial factors affect real economic activity. All the approaches have historical roots that date back, for example, to the work of Fisher (1916) and Mitchell (1951). The "bank lending channel" is the premise for the title of this conference. Schiantarelli's paper, however, motivates the empirical research in this area by referring to what has been called the "collateral channel" in some of the recent literature. In addition, a distinct "internal finance channel" also has historical roots and has potential importance for monetary policy transmission. In this section, I summarize each channel and discuss how the differences between them are relevant for understanding investment and the transmission of monetary policy.[1]

The collateral view (the primary channel discussed by Schiantarelli) begins from the hypothesis that asymmetric information creates imperfections in capital markets. Asymmetric information causes moral hazard and adverse selection problems that raise the cost of debt above the risk-free rate of interest. Firms can reduce the premium they pay for new debt, however, if they can offer collateral for loans. In this context, collateral is thought of in very broad terms. It includes not only tangible assets, but also the expected present value of future cash flows that will

[1] See Carpenter, Fazzari, and Petersen (1995) for a discussion of these three channels and empirical research that compares the ability of each approach to explain various facts about inventory investment.

be available to service debt. With this definition of collateral, suppose that tight money raises interest rates. The present value of future cash flows will fall and the value of collateral will decline, reducing firms' access to debt and lowering investment.[2]

The bank lending channel has particular relevance for monetary policy. Again, its starting point is asymmetric information and the associated moral hazard and adverse selection problems in financial markets. But the bank lending channel emphasizes the special role played by banks in overcoming these problems through intermediation. Firms that face severe asymmetric information problems may depend on banks for access to debt. The intermediation service banks offer is special, and the cost of providing this service depends on the stance of monetary policy. Tight money reduces bank reserves and forces banks to shrink the asset side of their balance sheets. The result is less bank lending. But, because of capital market imperfections, bank-dependent firms cannot simply replace bank loans with direct open market borrowing. For example, the small start-up company will not be able to issue commercial paper if its bank decides to reduce its credit line. As a result, less bank lending reduces investment for bank-dependent firms.

The third channel for financial influence, the internal finance channel, is perhaps the most straightforward. It also relies on the idea that capital market imperfections increase the cost of external finance, including both new debt and new share issues. Then, the opportunity cost of internal funds as a source of finance will be less than the cost of external funds. When the supply of internal finance goes up, say because a firm's profits or cash flows increase, the firm will have more low-cost finance available and investment will rise. This view has a long history in the literature. It was invoked as the "cash flow model" in some of the early empirical work on investment.[3]

All three of the financial channels can generate what Schiantarelli calls a "financial accelerator" for policy. That is, these financial mechanisms will magnify the real effect of monetary shocks on investment. But the relative empirical strength of the different financial channels matters for evaluating the importance of the financing constraint literature for policy. The bank lending view focuses on how changes in the reserve base and capital requirements affect the ability of banks to make loans. The collateral view, in contrast, emphasizes the financial position of firms, that is, borrowers rather than lenders. Policy analysis links monetary shocks to changes in firms' "balance sheets." For example, as

[2] See Gilchrist and Zakrajšek (1995) in this volume for further discussion.
[3] See, for example, Meyer and Kuh (1957) and Minsky (1975).

mentioned above, increases in interest rates could erode firms' collateral position and increase the cost of borrowing.

The internal finance view, like the collateral approach, focuses on the financial condition of firms. But, in contrast with both the collateral and bank lending views, the key financial variable is the flow of internal as opposed to external finance. Monetary effects are magnified through this channel in ways analogous to the standard Keynesian multiplier. Suppose that monetary tightening caused a decline in spending for interest-sensitive sectors of the economy. Firms producing in these sectors would experience a decline of internal cash flow. This effect is magnified by the empirical fact that a large portion of firm costs are fixed in the short run. Relatively small shocks to demand, sales, and revenue translate into large shocks to profits and cash flow.[4] Low cash flow reduces the supply of low-cost internal finance and causes affected firms to cut back on investment in all assets, including both fixed investment and inventories. This fall in investment further magnifies the effect of the initial monetary shock and causes the internal finance shortage to propagate further through the economy.

In summary, the financial mechanisms linking monetary policy to investment are quite diverse. This diversity is not reflected to a large degree in Schiantarelli's paper. Yet, recognition of the diversity of financial channels is important for the topics considered by this conference. As this discussion shows, the bank lending channel is not the only way that the empirical work surveyed in Schiantarelli's paper is relevant for understanding the impact of monetary policy on the real economy.

Empirical Identification of Financial Effects

As a veteran of many empirical studies on the finance-investment link, I agree with Schiantarelli that the main challenge for empirical work that tests the importance of these channels is to separate the financial influence of variables on investment from their role as signals of future profits, signals that matter for investment whether or not financial channels operate. One way to address this problem, widely used in the research Schiantarelli reviews, is to exploit heterogeneity in disaggregated data. Researchers split their data according to criteria that they believe affect access to finance. They then test to determine if the investment of groups of firms considered a priori more likely to face financial constraints is more sensitive to financial variables such as cash flow, debt leverage, interest coverage, and the like. The maintained hypothesis is that if financial variables signal future profits, this signal-

[4] This point is emphasized in Carpenter, Fazzari, and Petersen (1994).

ing will not differ systematically across groups of firms. Therefore, the heterogeneity of estimated financial effects across firms with different access to finance indicates the importance of financial constraints.

Schiantarelli discusses concerns, however, that the variables used to split samples of micro data might themselves be endogenous, and that this might cause misleading results in tests for firm heterogeneity. I believe Schiantarelli's point is correct. It is useful, however, to push the point further to consider the direction of the bias induced. Recognizing this bias might actually strengthen the evidence presented in the financing constraints literature.

The easiest example to consider is a test based on the size of firms, although similar logic likely applies to other sample-splitting criteria used in the literature (dividend payout and bond ratings, for example). Suppose that a firm gets a positive investment shock over the sample period of a research study. This firm will be larger as a result, and it will more likely be classified in the large-firm segment of the sample. Symmetrically, firms with negative investment shocks are more likely to be classified into the small-firm category. Now, suppose that the expected value of size is a true signal of firms' access to finance. The endogeneity described here suggests that some financially constrained firms are misclassified as large firms and some unconstrained firms are put into the small-firm category. This misclassification will likely blur the difference in regression coefficients on financial variables estimated for big and small firms. The endogeneity, in this case, works *against* tests that look for heterogeneity between groups of firms expected to experience different financial effects on their investment.

Another problem that Schiantarelli examines in his paper is that firms may switch groups during the sample period, which could bias estimates of regressions based on fixed sample splits. One approach to this problem is econometric: The classification into constrained and unconstrained groups can be modeled endogenously in a switching regression. This approach has the advantage that it provides a data-determined estimate of what puts firms into different regimes. Hu and Schiantarelli (1994) present interesting results along these lines.

Another approach to mitigating the problem of firms that switch groups over time is to work with short time periods, over which relatively few switches occur. This may not be possible with the annual data used in most studies in this literature because of the limited number of degrees of freedom available in the time dimension. Carpenter, Fazzari, and Petersen (1994), however, had success working with short panels of high-frequency quarterly data from Compustat to study financial effects on inventory investment. The use of quarterly data and short panels also permits comparisons of results across time periods with different macroeconomic conditions or monetary policy regimes.

Schiantarelli also discusses how different econometric specifications

can be used to identify financial effects on investment. In particular, he discusses the relationship between typical "reduced-form" investment regressions and research based on "Euler equations." In the reduced-form approach, firm investment is regressed on a variety of variables, including some that capture financial effects. Euler equations are derived directly from the firm's first-order conditions for optimization, and then the parameters of these conditions are estimated.

As Schiantarelli indicates, the variables available to control for investment opportunities in reduced-form regressions are certainly not perfect. The most widely used variable, some form of the Brainard-Tobin Q, is associated with a variety of measurement problems. Therefore, potential problems arise with testing the importance of financial variables in a reduced-form investment regression, because financial variables may proxy for investment fundamentals that are not adequately captured by Q or other controls.

The Euler equation approach does not require a control for investment opportunities directly and, therefore, as Schiantarelli points out, it sidesteps this problem. But the Euler equation approach has other problems, as Schiantarelli also recognizes. In its simplest form, the Euler equation method leads to a hypothesis test. One specifies the first-order condition that would hold for the optimal intertemporal allocation of capital under perfect capital markets and then checks to see if the condition is consistent with the data. Most of the literature looks to see if the condition is rejected for groups of firms that are most likely to face financial constraints. But to construct an Euler equation, one must impose a lot of structure on the problem. A rejection of the perfect capital markets hypothesis may occur for reasons that have nothing to do with capital market imperfections. For example, rejections could occur because the technology or expectations process was misspecified or unstable.[5]

Furthermore, rejection of the perfect capital markets null hypothesis does not tell us anything about the economic magnitude of financial constraints. Progress has been made in estimating this economic significance by setting parameters for Euler equations with financial variables. The results are interesting, but this approach must also face the criticism that financial variables may be correlated with measurement or misspecification errors in the Euler equation.

This is not to say that we cannot learn important things from research on financial constraints based on Euler equations. My claim is more modest. I believe that the Euler equation and reduced-form research on financial constraints are complements. While potential problems exist with both approaches, I agree with Schiantarelli that strong

[5] Oliner, Rudebusch, and Sichel (1992) find evidence of instability in Euler equations.

support for the existence of significant capital market imperfections, and their effect on investment, comes from the fact that extensive research using these two very different methods reaches the same conclusion in most cases.

Future Research

I will conclude with one brief comment on future directions for research in this area. I agree with Schiantarelli that one intriguing question that deserves more attention is the importance of capital market imperfections and financial constraints for large, mature firms. While financial variables have larger and more significant effects for small, young firms, many researchers find non-negligible effects for big firms. Recent stories in the financial press have provided anecdotal evidence for financial constraints on large firms. Mammoth auto companies such as Toyota and Chrysler claim the need to hold on to huge stocks of cash to buffer their investment and R&D activities against declining cash flow in coming recessions.

The source of these effects is an interesting question. They might come from agency problems that give managers the ability to divert firm resources to serve their own private interests. Or, perhaps the frictions in capital markets are so severe that even well-established firms must pay a premium for external funds and therefore choose to rely on internal finance. When a downturn comes, and internal cash flow falls, these firms may be reluctant to cut dividends, so in the absence of large buffer stocks of cash, they may cut back on investment activities.

This issue has importance for macroeconomics and policy analysis because, while small firms constitute a significant part of the aggregate economy, much of the employment, investment, and R&D is carried out by large firms. It will therefore be interesting to explore how financial channels are relevant, if at all, for the investment of larger, more mature companies in the U.S. economy.

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Discussion

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Fabio Schiantarelli's paper is a comprehensive survey of a very large literature, one that includes many of his own papers and those of others at this conference. Because he does such a good job, I find my position as second-order discussant unenviable. He reports results for many countries, but his emphasis is on differences in modeling techniques rather than international comparisons.

At the outset he states: "The tests for the presence of financing constraints have consisted mainly of adding proxies for the availability of internal funds and/or firms' net worth to the model derived under the assumption of perfect capital markets, and investigating whether these proxies are significant for the firms thought most likely to face information and incentive problems" (p. 178). I will argue that a big difference exists between these tests and deciding the importance of bank lending for the transmission of monetary policy.

Schiantarelli reports that two principal results emerge from this literature: (i) "unless the loans are fully collateralized, external finance is more costly than internal finance" and (ii) "the premium on external finance is an inverse function of a borrower's net worth (liquid assets plus the collateral value of illiquid assets)" (p. 180). I have no difficulty accepting the first, but the second is a confusing and unhelpful construction that apparently first appeared in a paper by Bernanke and Gertler (1989). Net worth is an accounting concept that suffers enough from being the difference between sums of arbitrarily valued assets and liabilities.

The collateralizable value of illiquid assets is not well defined, nor

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does it capture the notion of a firm's access to credit. A firm partly controls its collateralizable value when it chooses to expand inventories or accounts receivable. As Schiantarelli persuasively argues in a later section of his paper, a firm that belongs to formal or informal groups has access to credit, irrespective of its own balance sheet. Furthermore, banks and other creditors are not so witless as to ignore the *promise* of future returns from loan applicants, and they recognize, as did Bulow and Shoven (1978), that potentially valuable options are on the table when a borrower gets in trouble.

I certainly agree that firms' access to banks and other lenders may vanish when real interest rates soar, when prices in goods markets collapse, or when substantial amounts of idle capacity, unemployment, and vacant buildings appear. Further, a little of any of these changes is likely to lead to a little less access to credit. However, I doubt that a well-behaved function exists that maps small changes in access, and surely none that could be estimated using conventional balance sheets of firms, which do not mark assets to market.

Moreover, firm-level data are seriously incomplete for interpreting macroeconomic relations. Firms with shaky balance sheets can and increasingly do lease equipment and structures. Companies that provide equipment through leases can invest, even if their clients cannot. Also, a merger between a capital-starved firm and another with access to credit gets around the problem at a "macroeconomic" level. Finally, as the example of Barings amply testifies, firms are not eternal. Such crises are resolved through involuntary mergers and successor firms have or soon regain access to capital markets.

Schiantarelli's useful survey observes that most empirical work can be viewed as employing variations of either Q or Euler-equation models; this is also my interpretation of this literature. Both models are designed to represent a borrowing firm in a world with perfect capital markets. He provides a very valuable discussion of essential assumptions and how different specifications qualify conclusions, especially techniques that dichotomize firms according to whether they are credit-constrained or not. The test then is whether firms scored as credit-constrained deviate predictably from unconstrained firms. The section of his paper on "International Evidence" indicates that many departures from perfect markets are detected, and not a few indicate that supposedly capital-starved firms act as if they are *not* especially credit rationed.

I agree with Schiantarelli that firms vary in their ability to borrow, but would like to suggest a different interpretation. Firms are extremely heterogeneous in what they make, in their style of management and aversion toward risk, in their histories of financial flows, and in the promise of their prospective product lines. It requires an extraordinary leap of faith to believe that this heterogeneity can be represented by independent and identically distributed shocks that are not correlated

with various surrogates for credit constraint. Therefore, while I can readily accept Schiantarelli's conclusion that "the overall evidence suggests significant departures from the perfect capital market paradigm" (p. 189), what is missing in his paper is a model of firm investment decision-making. He candidly acknowledges this in his footnote 13. Much of his discussion in the section "Sample Separation Criteria" seems to skirt this question, but he gets the cart before the horse when he focuses on estimation rather than identification. Suppliers and demanders in imperfect capital markets are both active players; the strategy of neither can be inferred (or identified) from the Q or the Euler-equation approaches without more structural assumptions.

This is not the place to provide an analytical framework for describing the bargaining between potential borrowers and lenders in imperfectly competitive markets. Such a framework would need to be dynamic and to incorporate learning and intertemporal optimization. Because of continuing financial and organizational innovations, Euler-equation techniques are not likely to be illuminating. I refer to the recent rapid growth of foreign bank commercial and industrial (C&I) lending, medium-term notes, new forms of commercial paper, just-in-time production technologies, and especially the changing structure of industrial organization. I was persuaded of the importance of endogenizing working capital by a recent paper by Fazzari and Petersen (1993). However, once that step is taken, the validity of cross-sectional or panel studies is called into question, because firms interact strategically and cannot be viewed as independent draws from an urn.

Changes in the stock of inventories nicely illustrate why I believe that failure to identify demand and supply functions prevents inferences about the role of bank lending in transmitting monetary policy. It has repeatedly been noticed—see, for example, Hester (1994)—that a strong positive correlation exists between changes in inventories and changes in C&I loans. Correlation, of course, does not imply causation. The stock of inventories as a percentage of GDP fell monotonically from 22.4 percent to 16.6 percent between 1985 and 1993; inventories as a fraction of domestic wealth fell irregularly from 6.3 percent to 5.9 percent in the same period.[1] The steady decline in the ratio of the stock of inventories to GDP occurred during a period when interest rates and C&I loans as a percentage of bank assets were both trending downward. It seems difficult to characterize firms in such an environment as being credit constrained. When both quantity and price are falling, a more plausible

[1] Sources: Board of Governors of the Federal Reserve System, "Balance Sheets for the U.S. Economy 1945–93," September 20, 1994; *Economic Report of the President*, February 1995.

interpretation is that demand for credit was shifting down relative to loan supply.

Schiantarelli's summary of empirical results in the section "International Evidence on the Effects of Financial Constraints: Cross-Section and Time Series Variations" confirms that there is little linkage between rejecting the perfect market paradigm and finding evidence of binding financial constraints, when studying dividend payouts, size, and concentration of ownership. His discussion of the results of association with business groups and banks is very interesting and suggests that group membership mitigates financial constraints. These relationships should be a hot topic for future research.

His interpretation in his section "International Evidence" of the time variation of tightness of financial constraints and structural changes in financial markets seems particularly vulnerable to the identification question I raise above. Therefore, I cannot accept his conclusion that "substantial support also is available for the proposition that the severity of financial constraints varies over the business cycle and with the stance of monetary policy" (p. 206).

Surely, rising real interest rates reduce the attractiveness of investment projects and the value of existing assets. Both borrowers and lenders will respond accordingly and less investment will occur. Short-maturity bank loans secured by inventories and accounts receivable are not likely to be affected as much as new issues of securities. One does not require cyclically sensitive credit rationing by short-term lenders to understand why monetary policy works.

Finally, firms with weak credit ratings offer commercial banks far more in the way of profit potential than large firms with access to commercial paper and medium-term note markets. It is hard to believe that banks would bite the hand that feeds them. Rather, they will nurture and provide for promising dependent enterprises, just as ants look after aphids and shepherds tend their flocks.

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