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CAPITAL-MARKET IMPERFECTIONS AND INVESTMENT

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ABSTRACT

Over the past decade, a number of researchers have extended conventional models of business fixed investment to incorporate a role for "financial constraints" in determining investment. This paper reviews developments and challenges in this empirical research, and uses advances in models of information and incentive problems to motivate those developments and challenges. First, I describe analytical underpinnings of models of capital-market imperfections in the investment process, and illustrate the principal testable implications of those models. Second, I motivate tests and describe and critique existing empirical studies. Third, the review considers applications of the underlying models to a range of investment activities, including inventory investment, R&D, employment demand, pricing by imperfectly competitive firms, business formation and survival, and risk management. Fourth, I discuss implications of this research program for analysis of effects of investment on monetary policy and tax policy. Finally, I examine some potentially fruitful avenues for future research.

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1. INTRODUCTION

Analysis of the investment decisions of firms occupies a prominent place in research programs in macroeconomics, public economics, industrial organization, and corporate finance. These research programs have been driven both by theoretical concerns (*e.g.*, debates over which model offers the best explanation of investment behavior) and policy questions (*e.g.*, how changes in monetary policy or tax policy affect investment).

Over the past decade, a number of researchers have extended conventional models of business fixed investment to incorporate a role for "financing constraints" in determining investment. This research program has proceeded in two steps. In the first, many models of asymmetric information and incentive problems in capital markets imply information costs and the internal resources of a firm influence the shadow cost of external funds for fixed investment, holding constant underlying investment opportunities. In the second, empirical studies have focused on ways to isolate effects of information costs and internal resources on investment, independent of changes in investment opportunities. The principal findings of these studies are that: (1) all else being equal, investment is significantly correlated with proxies for changes in net worth or internal funds; and (2) that correlation is most important for firms likely to face information-related capital-market imperfections.

This review concentrates on developments and challenges in the empirical research, and uses advances in models of information and incentive problems to motivate those developments and challenges. The paper is organized as follows. Section 2 describes the analytical underpinnings of contemporary models of capital-market imperfections in the investment

process, and illustrates the principal testable implications of those models. I motivate tests and describe empirical studies in section 3, which describes approaches used in historical case studies and studies using firm-level panel data. Problems raised by existing empirical studies are examined in section 4. Section 5 considers applications of the underlying models to a range of investment activities, including inventory investment, R&D, employment demand, pricing by imperfectly competitive firms, business formation and survival, and corporate risk management. Implications of the models for analyses of monetary and fiscal policy on investment are described in section 6. Section 7 concludes and offers questions for future research.

2. ANALYTICAL UNDERPINNINGS OF "EMPIRICAL TESTS"

2A. *Information and Incentive Problems in Capital Markets*

Interest by contemporary researchers in links between "internal funds" and investment decisions reflects two main concerns, one "macro" and one "micro." The "macro" concern is that cyclical movements in investment appear too large to be explained by market indicators of expected future profitability or the user cost of capital. This has led some macroeconomists to identify financial factors in propagating relatively small shocks, factors that correspond to "accelerator" models that explain investment data relatively well. Indeed, the term "financial accelerator" has been used to refer to the magnification of initial shocks by financial market imperfections (see, *e.g.*, Ben Bernanke, Mark Gertler, and Simon Gilchrist, 1996.) This current fashion actually has a long history among macroeconomists, with contributions by Irving Fisher (1933), John Gurley and Edward Shaw (1955, 1960), and Albert Wojnilower (1980). Some econometric forecasting models have also focused on financial factors in propagation

mechanisms (see, *e.g.*, the description for the DRI model in Otto Eckstein and Allen Sinai, 1986).

The "micro" concern relates to consequences of informational imperfections in insurance and credit markets. In this line of inquiry, problems of asymmetric information between borrowers and lenders lead to a gap between the cost of external financing and internal financing. This notion of costly external financing stands in contrast to the more complete-markets approach underlying conventional models of investment emphasizing expected future profitability and the user cost of capital as key determinants of investment.

While a review of the theoretical literature is beyond the scope of this paper, I want to point out common themes. Existing models have focused on costs of adverse selection and moral hazard in generating frictions in capital markets. With imperfect information about the quality or riskiness of the borrowers' investment projects, adverse selection leads to a gap between the cost of external financing in an uninformed capital market (which contains a "lemons" premium) and internally generated funds.[1] In the presence of incentive problems and costly monitoring of managerial actions, external suppliers of funds to firms require a higher return to compensate them for these monitoring costs and the potential moral hazard associated with managers' control over the allocation of investment funds.[2] To the extent that a firms's

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[1] Potential effects of adverse selection on market allocation have been addressed in important papers by George Akerlof (1970) and Michael Rothschild and Joseph Stiglitz (1976), and have been applied to loan markets by Dwight Jaffee and Thomas Russell (1976) and Stiglitz and Andrew Weiss (1981) and to equity markets by Stewart Myers and Nicholas Majluf (1984).

[2] Research on principal-agent problems in corporate finance has followed the contribution of Michael Jensen and James Meckling (1976). Bernanke, Gertler, and Gilchrist (1996) review related models of informational imperfections in capital markets.

managers supply the funds for investment projects, the shadow cost of funds for investment projects need not carry such a premium reflecting moral hazard.

2B. *Illustrating the Link Between Net Worth and Capital*

One can use a simple graphical analysis to illustrate the link between internal funds and capital investment in models of informational imperfections.[3] Figure 1 portrays the demand for capital by a firm and supply of funds to the firm. The quantity of capital is on the horizontal axis and the cost of capital is on the vertical axis. The demand curve, *D,* slopes down; an increase in the cost of funds reduces the firm's desired capital stock.

The supply curve, *S*, is generally depicted in the neoclassical investment model as a horizontal segment at *r*, the market real rate of interest (adjusted for risk).[4] In this case, the first-best capital stock, $K,^*$ is determined by the intersection of the *D* curve and the *S* curve at the interest rate *r*. This implies that, at the capital stock, K^*, the expected marginal profitability of capital equals the interest rate.

The location of the *D* curve is determined by the firm's investment opportunities (that is, expected future profitability of capital) . The location of the *S* curve is determined by the cost of capital (the market interest rate in the example). All else being equal, an improvement in investment opportunities shifts the *D* curve to the right, increasing the desired capital stock; a

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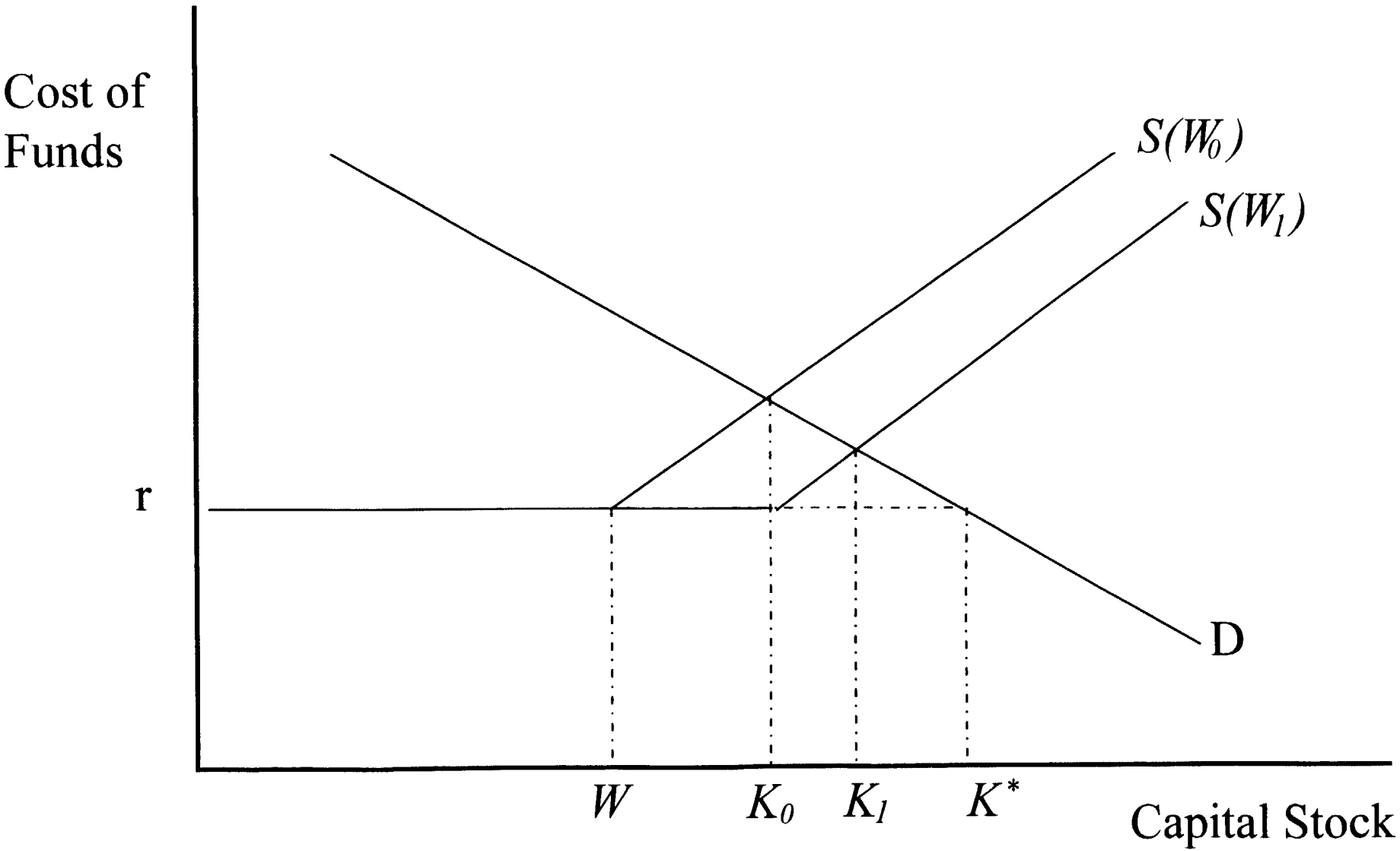
[3] While the illustration follows Gertler and Hubbard (1988), its implications are consistent with the approaches of a number of models. For simplicity, I ignore depreciation, taxes, and costs of adjusting the capital stock, which I discuss in section 3C.

[4] For ease of exposition, I am making a number of simplifying assumptions: Investment is fully reversible and the rate of depreciation and the expected rate of change in the price of capital goods equal zero. I reconsider these assumptions later.

Figure 1. Informational Imperfections and Underinvestment



decline in investment opportunities shifts the D curve to the left, decreasing the desired capital stock. An increase in the market interest rate reduces the desired capital stock, all else being equal, while a decline in the market interest rate increases the desired capital stock. This basic story allows no role for the firm's internal funds *per se* to affect its investment decision. The firm perceives the opportunity cost of internal funds to be the market interest rate, and it can borrow and lend at that interest rate in the capital market.

This familiar example assumes that decisionmakers in the firm and external suppliers of funds have the same information about the firm's choice and use of inputs, investment opportunities, riskiness of projects, and output or profits. These assumptions are very strong ones. In practice, firm decisionmakers have significantly better information than outside investors about most aspects of the firm's investment and production. Informational asymmetries can lead to adverse selection, moral hazard, or both. In what follows, I illustrate effects of informational asymmetries on investment in a moral hazard setting. Other costs of moral hazard or adverse selection arising from private information about project risk or quality have broadly similar consequences for the cost of funds and investment.

Suppose an entrepreneur with net worth W_0 can undertake a project to produce output one period hence. The required inputs are capital, K -- *e.g.*, plant and equipment -- and other inputs which improve the productivity of capital (such as organizational and maintenance expenditures -- "soft capital"). If the project is undertaken, it produces positive expected output. Expected output from an investment of capital increases with the use of soft capital, up to a point defined by a level proportional to the quantity of capital used. Actual output can be greater than or less than expected output (a "good" outcome and a "bad" outcome). Because the entrepreneur

invests his or her resources, W_0, in the project, payments to external investors in any state of world cannot be greater than the project's output in that state.

The entrepreneur has the choice of investing W at the interest rate, r. A risk-neutral entrepreneur will go ahead with investment projects only if output less payments to external investors exceeds $(1 + r)\, W_0$. If external investors are risk-neutral and competitive, their equilibrium required rate of return on funds supplied to entrepreneurs must be r.

At this point, consider a simple agency problem: Suppose that principals (holders of claims on the firm) cannot monitor perfectly the allocation of funds by the agent (the firm insider in the example). In this case, the financial contract between the principals and the agent will have to align incentives as well as arrange repayment. To fix ideas, suppose that expenditures on capital are observable by outside lenders, while expenditures on "soft capital" are not.[5] In this case, the entrepreneur may be tempted to divert soft capital funds to personal gain.[6] Such perquisite consumption can take a number of forms; for simplicity, suppose that the entrepreneur can invest the funds to yield r.

External investors understand this temptation and modify the financial contract to mitigate incentives to cheat. One consequence of this modification is desired capital, K^*, may exceed actual capital, K_0, and this gap will depend inversely on the entrepreneur's net worth.

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[5] A related problem often considered in the literature arises from costly state verification (Robert Townsend, 1979). In this case, an entrepreneur observes output costlessly, while an external investor must pay a cost to observe output.

[6] In a two-state example, the observation that the project yield the "bad" level of output would not permit an external investor to distinguish between bad luck or the diversion of funds intended for soft capital.

Formally, the contract between the entrepreneur and suppliers of funds includes an incentive constraint that the entrepreneur's gain from honest action exceeds the gain from diverting the soft capital funds to personal use.

When the incentive constraints binds, actual investment, K, increases with increases in net worth, W, holding constant investment opportunities. This is because an increase in net worth reduces the entrepreneur's incentive to misallocate funds. Once investment reaches K^*, further increases in net worth have no effect on the investment decision, and the frictionless neoclassical result obtains.[7]

Returning to the simple graphical analysis, we now allow the S curve to have two components. The first is a horizontal segment at r, up to a level of funds, W, the entrepreneur's net worth. In this range, no agency costs arise, and lenders' required rate of return equals the market real interest rate.

When the risk of opportunistic behavior is present, uncollateralized lending requires that lenders be compensated for information costs. Hence for levels of net worth greater than net worth W, the S schedule is upward-sloping. That is, the shadow cost to the entrepreneur of uncollateralized external financing exceeds that of internal financing. The slope of the S curve reflects the information costs in uncollateralized financing. The higher are the marginal information costs, the steeper is the upward-sloping portion of the S curve. In the presence of information costs, the equilibrium capital stock for the firm is determined by the intersection of the D and S curves at K_0. This capital stock is less than the first-best desired capital stock in a

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[7] Again, other models emphasizing screening and monitoring costs or costs of state verification yield a similar prediction.

frictionless setting, K^*; that is, there is under investment relative to the setting with no information costs.

Figure 1 describes these links among net worth, the cost of external financing, and investment. Again, the first-best desired capital stock is K^*. Given information costs, and net worth W_0, the equilibrium capital stock is K_0. Holding information costs constant, when net worth increases from W_0 to W_1, the supply-of-funds curve shifts from $S(W_0)$ to $S_1(W_1)$. If we hold investment opportunities constant, the demand curve remains at D. The increase in net worth, holding constant both information costs and investment opportunities, increases the capital stock from K_0 to K_1. Note that for a firm facing no information costs or with sufficient net worth (or internal funds) to finance its desired capital stock, the equilibrium capital stock remains at K^*. That is, for firms facing negligible information costs, an increase in net worth independent of changes in investment opportunities has no effect on investment. For firms facing high information costs, an increase in net worth leads to greater investment, all else being equal, while a decrease in net worth leads to lower investment.

Much of the empirical research in this literature reflects the intuition of Figure 1 and the formal conclusions of models of financial frictions in business investment decisions: (1) uncollateralized external financing is more costly than internal financing; and (2) holding constant investment opportunities, a reduction in net worth reduces investment for firms with facing information costs.

The framework also addresses how an "accelerator" mechanism may work in aggregate investment. During a boom, investment opportunities rise and the D curve in Figure 1 shifts to the right, raising the desired capital stock in the frictionless neoclassical model. Here, an

additional channel is at work. During a boom, when borrower net worth is high (either due to past accumulation of assets or to optimism about the future), the *S* curve shifts out to the right ; the cost of financing is relatively low, reducing the cost of external financing and stimulating the demand for capital by firms facing information costs. Conversely, the decline in entrepreneurs' net worth during a recession raises cost of external financing, further retarding investment.

The analytical description of the role of net worth in the investment decision can be straightforwardly applied empirically by incorporating costs of adjusting the capital stock (see the discussion in section 3C below). The empirical strategy is to assess whether the neoclassical investment criterion holds for firms facing low information costs, while failing for firms with high information costs, and to measure effects of changes in net worth on investment for firms with high information costs. The example presented here links the level of net worth to the choice of the capital stock. One can also think of this connection as between changes in net worth and changes in the capital stock -- investment.

Theoretical models of imperfections in capital markets imply that external financing is more costly than internal financing for many firms. Hence, for given levels of investment opportunities, information costs, and market interest rates, firms with higher net worth should invest more. Tests of effects of net worth on investment pose significant challenges for applied researchers, including the need to control for investment opportunities and the desirability of isolating the prediction of the theoretical research that effects of net worth on investment should be most important for firms facing high information costs.[8]

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[8] Over time, firms may adjust their internal funds to reduce financing costs; I return to this point in section 4 below.

3. TESTS OF MODELS INCORPORATING CAPITAL-MARKET IMPERFECTIONS

3A. *Early Research*

An emphasis on capital-market imperfections is not novel in empirical studies of investment decisions. Early applied research on investment, especially the work of John Meyer and Edwin Kuh (1957), stressed the significance of financing constraints in business investment. Indeed, financial effects on many aspects of real economic activity received broad attention during the early postwar period. Since the mid-1960s, however, most applied work isolated real firm decisions from purely financial factors. The intellectual justification for this shift in approach drew on the seminal work by Franco Modigliani and Merton Miller (1958), who demonstrated the irrelevance of financial structure and financial policy for real investment decisions under certain conditions. The central Modigliani-Miller result was that a firm's financial structure will not affect its market value in frictionless capital markets. As a result, if their assumptions are satisfied, "real" firm decisions (*e.g.*, fixed investment) motivated by the maximization of shareholders' claims, are independent of financial factors such as liquidity, leverage, or dividend payments.

Applied to capital investment, this basic result offers an underpinning of the neoclassical theory of investment, described earlier, in which the firm's choice of the optimal capital stock could be solved without reference to financial factors (see, *e.g.*, Dale Jorgenson, 1963; and Robert Hall and Jorgenson, 1967). In this approach, firms face a user cost of capital, the financial component of which was set in centralized securities markets, that does not depend on

the firm's particular financial structure. The q-theory approach, pioneered by James Tobin (1969) and extended to models of investment assuming convex costs of adjusting the capital stock by Fumio Hayashi (1982), offers another formulation of the neoclassical model. Investment opportunities could be summarized by the market valuation of the firm's capital stock, and, under certain assumptions, the ratio of the market value of the capital stock to its replacement cost is the basic variable explaining investment demand. As a consequence of the various neoclassical models, much empirical work, using aggregate and firm-level data, has been devoted to tests of the relative success of various investment demand models, generally without reference to the possible influence of financial factors.[9]

The assumption of representative firms (in the sense of facing a common S curve) is common to these research programs. That is, the same empirical model applies to all firms regardless of the specification. Therefore, tests could not ascertain whether the observed sensitivity of investment to financial variables differs across firms.[10] Contemporary empirical studies of information and incentive problems in the investment process have moved beyond the assumption of representative firms by examining: (1) historical episodes in which reductions in net worth, all else being equal, precipitated a decline in investment, and (2) firm-level panel data in which firms can be grouped into "high information cost" and "low information cost" categories.

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[9] See, for example, the review of studies in Robert Chirinko (1993). One exception is Clark (1979), whose study contained a cash flow model.

[10] An early exception is the study of firm-level data by Robert Eisner (1978), who found that the timing of investment in small firms is more sensitive to profits than it is in large firms.

Historical case studies offer potentially valuable laboratories to study the role played by low or declining levels of net worth -- often from episodes of debt deflation nationally or in certain sectors -- in explaining low or declining investment. Those episodes do not, however, generally make available detailed firm-level data with which to examine implications of asymmetric information and incentive models. Accordingly, I concentrate on the analysis in the second category of studies mentioned above.

3B. *Designing Tests Using Firm-Level Panel Data*

Three major challenges confront general empirical examination of effects of capital-market imperfections on investment decisions of individual firms. The first is the need to measure firms' investment opportunities. For example, changes in firms' net worth may be linked to investment and output simply because they are accounted for by shifts in firms' opportunities. The models illustrated in section 2 emphasize a role for internal net worth and information costs, holding investment opportunities constant. Accordingly, empirical tests must identify a proxy for underlying investment opportunities. That is, in Figure 1, an increase in investment opportunities would shift the demand curve to the right, raising investment. To the extent that current profitability rises as well, the supply curve would shift out to the right as net worth W rises.

Second, because models of informational imperfections stress cross-sectional predictions -- *i.e.*, that net worth effects on investment should be concentrated among borrowers for which information costs are very high, empirical research should examine industry case studies or panel data to discriminate between the decisions at any point in time of "constrained" and "unconstrained" firms.

Third, empirical researchers must identify both proxies for "net worth" and shifts in net worth not correlated with shifts in investment opportunities. That is, in Figure 1, one must isolate shifts in W (and hence $S(W)$) which are independent of shifts in the demand curve (D).

These challenges are related, of course. A finding of a strong link between changes in net worth and investment need not support the validity of models of costly external financing. Suppose, for example, that one uses "cash flow" as a proxy for changes in net worth, where cash flow is approximately current revenues less expenses and taxes. If cash flow is correlated with future profitability, a link between cash flow and investment for a given firm over time could reflect the link between expected profitability and investment emphasized by frictionless neoclassical models. At a point in time, a cross-sectional link between cash flow and investment is similarly suspect: Firms with high cash flow have successful investments or low costs and face incentives to expand production. Again, a link between cash flow and investment could reflect the conventional neoclassical mechanism.

In principle, the appropriate measure of investment opportunities is the expectation by the entrepreneur or firm managers of the present value of future profits from additional capital investment. In the neoclassical model of the choice of the capital stock by a value-maximizing firm, this expectation is captured by the value of marginal q, the shadow value to the firm of an additional unit of physical capital. If one could observe the marginal q facing firm decisionmakers, one would have a sufficient statistic summarizing the firm's investment opportunities. If financial frictions are unimportant, internal and external financing are perfect substitutes, and information about changes in net worth which is dated contemporaneously with q should be irrelevant for the investment decision. Hence a change in net worth should have no

direct effect on investment, holding constant marginal q.

The informational requirements of such a test are high, however. First, one must derive a proxy for marginal q, an unobservable variable. Second, one must specify some form of costs of adjusting the capital stock to yield a model of investment (as opposed to the equilibrium choice of the capital stock, which is pegged by equating marginal q and the after-tax cost of a unit of capital). Third, one must identify exogenous shocks to firms' net worth that are uncorrelated with changes in investment opportunities.

The static example presented in section 2 makes clear the second challenge: to identify "constrained" and "unconstrained" firms at a particular point in time. As noted in section 2, an intuitive beginning is given by selecting *a priori* groupings of "constrained" and "unconstrained" firms, as in studies of effects of liquidity constraints on households' consumption. As Figure 1 suggests, to be useful in empirical tests, sorting criteria should focus on a firm's characteristics that are associated with information costs. That is, these criteria should attempt to identify firms likely to face a significant spread between the cost of external financing and internal financing. Plausible characteristics in grouping strategies include the firm's size, its age, its close relationships with industrial or financial groups, the presence of a bond rating or commercial paper program, or the firm's dividend policy.

Third, net worth is not generally observable in data. (I return to this point later.) Most empirical studies use a firm's cash flow as a proxy for the change in net worth. The maintained assumption in such an approach is that the component of shifts in net worth accounted for by changes in expected future profitability should be captured in a measure of investment opportunities (*e.g.*, q).

Such an *a priori* grouping strategy does not yield an ideal test of the underlying models for at least two reasons. First, the strategy relies on only imperfect and imprecise proxies for net worth and the magnitude of information costs. Second, information costs of screening and monitoring vary over time for a given firm. That is, problems in ascertaining the quality or riskiness of a firm's projects presumably become less severe as a firm matures and its reputation develops (reducing the slope of the *S* curve in Figure 1). The severity of agency costs may also fluctuate as insiders' net worth fluctuates (changing the length of the horizontal segment in of the *S* curve in Figure 1). I return to the issue of variation over time in the cost of external financing later in this review.

3C. *Tests Using Panel Data*

To motivate empirical tests in the neoclassical setting, I begin by developing a proxy for the expected present value of future profits from fixed capital. Let capital be the only quasi-fixed factor, and assume that there are convex costs of adjusting the capital stock. The value of the firm is given by:

$$V(K_{it},\theta_{it}) = \max E\{ \sum_{s=t}^{\infty} \beta_i^s [\pi(K_{is},\theta_{is}) - C(I_{is}, K_{is}, \lambda_{is}) - p_s I_{is}]\} | \Omega_{it}, \qquad (1)$$

subject to the capital accumulation constraint

$$K_{is} = (1-\delta_i)K_{is-1} + I_{is} \quad .$$

In this setup, i and t denote the firm and time period, respectively; $K_{i,s}$ is the beginning-of-period capital stock; π is the profit function; θ_{is} is an exogenous shock to the profit function; C is the cost-of-adjustment function; I_{is} is investment; p_s is the (tax-adjusted) relative price of capital goods; λ_{is} is an exogenous shock to the adjustment cost function; δ is the constant rate of depreciation; and $E(\bullet|\Omega_{it})$ is the expectations operator conditional on the information set Ω

available to firm i at time t. New capital resulting from investment becomes productive within the year.

The first-order condition for maximizing (1) with respect to investment yields the familiar marginal q specification (see, *e.g.*, Hayashi, 1982):

$$p_t + C_I(I_{it}, K_{it}) = q_{it}, \tag{2}$$

where

$$q_{it} = E\sum_{s=0}^{\infty} \beta_i^s (1-\delta)^s [\pi_K(K_{i,t+s}, \theta_{i,t+s}) - C_K(K_{i,t+s}, \lambda_{i,t+s})]. \tag{3}$$

The right-hand term in equation (2) is just marginal q. Equation (3) defines q as the present discounted value of profits from new fixed capital investment.

To obtain an investment specification from the first-order condition in (2), one must posit a functional form for the adjustment cost function, C. The tradition in the q literature is to specify adjustment costs that are linearly homogeneous in investment and capital (so that marginal and average q will be equal, as in Hayashi, 1982). A convenient parameterization that adheres to these constraints is:

$$C(I_{it}, K_{it}) = (\alpha/2)\ [I_{it}/K_{it} - a_i - \lambda_{it}]^2\ K_{it}\ . \tag{4}$$

The adjustment cost function allows for a technology shock, λ, which may be correlated with the production shock, θ. Substituting the adjustment cost specification in (4) into equation (2) yields an investment specification:

$$\left(\frac{I}{K}\right)_{it} = a_i + \frac{1}{\alpha}[q_{it} - p_t] + \lambda_{it} + \varepsilon_{it}\ , \tag{5}$$

where ε_{it} is an optimization error.

Under certain assumptions, average Q constructed from financial market data may be used as a proxy for marginal q (less the price of investment goods), where average Q substitutes expected average returns to capital each period for marginal returns. The assumptions include perfect competition in the factor and product markets, homogeneity of fixed capital, linear homogeneity of technologies for production and adjustment costs, and independence of financing and investment decisions. When these assumptions hold, one can express the relation between investment and Q as:

$$\left(\frac{I}{K}\right)_{it} = a_i + bQ_{it} + \lambda_{it} + \varepsilon_{it} \quad , \tag{6}$$

where $b = (1/\alpha)$ and Q is the tax-adjusted value of Tobin's q (as in Lawrence Summers, 1981).

Returning to the theoretical predictions in section 2, the specification in (6) -- as a representative of a model under frictionless capital markets -- should explain investment for firms with a low premium in the cost of external relative to internal financing. In addition, the model of section 2 predicts that, for firms for which information cost are high (and only for such firms), changes in net worth affect investment. Hence one might expect the residuals from a projection of (I/K) on Q to be correlated with changes in net worth for such firms. Such a correlation would reject the frictionless Q model, while offering a suggestion of -- though not a test of -- an alternative model in which financing constraints play a role.

These two implications were pursued by Steven M. Fazzari, Hubbard, and Bruce C. Petersen (1988a) -- hereafter FHP. FHP attempt to group firms according to whether they are in the region of Figure 1 in which changes in net worth affect investment, after controlling for

investment opportunities. That is, they try to test whether determinants of investment differ between firms for which, *a priori*, the cost of internal financing and external financing are similar and firms for which the cost of external financing exceeds the cost of internal financing. In particular, to identify a group of firms that are most likely to face binding financing constraints, FHP extend a model from the public economics literature, in which dividends are a residual in firm decisions.[11] This logic can be explained as follows. Suppose that the cost of adjusting the capital stock is high relative to the cost of adjusting dividend payouts. Then, if the cost of external financing exceeds that of internal financing -- because of tax factors, transactions costs, or information costs -- paying substantial dividends in the presence of promising investment opportunities would not be consistent with value maximization. Therefore, if financing constraints are important, the investment of firms with good investment opportunities that retain all or nearly all of their earnings will likely be more sensitive to cash flow than that for high-payout firms with a large (dividend) cushion of funds to finance investment.

In their empirical tests, FHP estimate a version of (6) in which λ_{it}, the technology shock, is assumed to be zero (*i.e.*, the error term ε reflects only an optimization error). As long as the optimization error is assumed to be white noise and Q approximates marginal q, any correlation

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[11] The idea that dividends are a residual in a firm's decisions is exposited in the tax capitalization, model of the dividend decision in the public economics literature (see Alan Auerbach, 1979; David Bradford, 1981; and Mervyn King, 1977). In that model, internal funds are cheaper to the firm than external funds because dividends are more highly taxed than capital gains. Building on the intuition of models of adverse selection problems with new equity issues (see, *e.g.*, Myers and Majluf, 1984; and Bruce Greenwald, Stiglitz, and Weiss, 1984), one may argue that the cost differential between internal and equity finance is larger for non-dividend-paying firms than that suggested by tax considerations alone. To the extent that firms smooth dividends, "financing constraints" on investment are even more likely.

between changes in net worth and investment, given Q, violates the frictionless model.[12] However, if information costs are high, profitable investment opportunities (measured by high value of q seen by firm insiders) may attract only very costly external financing -- either because firm insiders cannot communicate the true opportunities or because incentive problems require a commitment of internal financing to carry out investment. Accordingly, for a given true value of marginal q, high information costs imply that an increase in Q do not bring forth the increase in investment predicted by the frictionless model (in (6)). Returning to Figure 1, high information costs imply a steeply sloped supply curve. In this case, an expansionary shift in investment opportunities shifts the demand curve to the right, leading to a significant increase in the shadow cost of funds and a small increase in investment. (In the limit, if the supply curve were vertical for values of K beyond W, changes in investment opportunities would induce no corresponding change in the actual capital stock.)

For firms with low levels of net worth and for which information costs are high, shifts in net worth can affect investment. Returning to Figure 1, for a given level of investment opportunities (that is, for a given demand curve), an increase in net worth increases the capital stock. The FHP framework can be interpreted as using cash flow to measure the change in net worth.

Firm cash flow is an imperfect proxy for the change in net worth. For example, cash flow -- earnings and depreciation allowances -- represents a series of accounting -- timing and financial -- decisions, reducing the correlation between cash flow and the change in net worth.

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[12] These restrictions are not innocuous, as I discuss further below, because technology shocks can induce a correlation between investment and profits, and residual effects of profits on investment may reflect a mismeasurement of the true Q seen by firms.

Such caveats notwithstanding, most studies have used cash flow as a proxy for the change in net worth because it is virtually the only such measure available for many firms. In addition, under certain conditions (discussed below), cash flow should have no predictive power for investment if included in equation (6), so that it may be useful in exploring rejections of (6) even if cash flow is not a perfect proxy for the change in net worth.

Using cash flow, *CF*, FHP estimate:

$$\left(\frac{I}{K}\right)_{it} = a_i + bQ_{it} + c\left(\frac{CF}{K}\right)_{it} + \varepsilon_{it} \quad . \tag{7}$$

Absent capital-market frictions, the estimated coefficient c should be zero as long as Q controls adequately for investment opportunities; a significantly positive value of c corresponds to a rejection of the frictionless model and a suggestion of the presence of financing constraints.[13]

The authors use panel data on 421 manufacturing firms over the period from 1970 to 1984 constructed from Value Line sources. To implement the firm classification by retention

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[13] There is an obvious simultaneity among contemporaneous values of a firm's income statement and balance sheet items. For example, investment and cash flow are determined simultaneously by profitability. The logic of the test implied by equation (7) is akin to that in tests in studies of consumption of whether consumption is excessively sensitive to current income. With the null hypothesis of efficient financial markets and the setup of the Q model, under Hayashi's (1982) assumptions, Q is a sufficient statistic for investment opportunities. Hence predetermined cash flow -- known when financial markets formed expectations of future value in Q -- should have no effect on investment once Q is controlled for. Some studies have used an instrumental variables approach. I revisit the strength of the underlying assumptions in section 4 below.

An additional concern in estimating (2) arises when K is measured with error; measurement error could induce a spurious correlation between (I/K) and (CF/K). One can address this problem by estimating the model using first differences and second differences, following Zvi Griliches and Jerry Hausman (1986), as opposed to conventional fixed effects; estimated coefficients on cash flow are similar in all cases. Kevin Hassett and Hubbard (1997) discuss other measurement error problems in the conventional Q formulation.

behavior, they group firms into three fixed categories (in decreasing likelihood of being constrained) -- low dividend payout, medium dividend payout, and high dividend payout. FHP find significantly larger estimated cash flow coefficients, c, for the low-dividend-payout firms than for the high-dividend-payout firms. It is this cross-sectional difference that led FHP to conclude that financing constraints are likely to be important in many firms' investment decisions. The cross-sectional differences in cash flow effects on investment found in the basic Q model remained when sales or user cost of capital variables were introduced (as additional controls for investment opportunities) and when the data were further decomposed by two-digit S.I.C. industry groups. This set of findings is broadly consistent with the illustration of the effect of a change in net worth on investment illustrated in section 2.[14] Nonetheless, the findings are only suggestive of the alternative financing constraint interpretation; FHP's estimate of c was statistically significantly different from zero in all three classes of firms they investigated.

4. PROBLEMS RAISED IN PANEL DATA TESTS

While the cross-sectional differences in FHP's results support an important role for information-related frictions in firms' financing and investment decisions, there are potential

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[14] The basic finding that *a priori* groupings of "constrained" and "unconstrained" firms have different determinants of investment, with cash flow being an important explanatory variable only for the former group, has been corroborated in studies of firms for Japan (Takeo Hoshi, Kashyap, and David Scharfstein, 1991), the United Kingdom (Michael Devereux and Fabio Schiantarelli, 1990; Richard Blundell, *et al.*, 1992; Stephen Bond and Costas Meghir, 1994), Canada (Huntley Schaller, 1993), Germany (Julie A. Elston, 1993), and Italy (Schiantarelli and Alessandro Sembenelli, 1995). FHP used full-sample dividend payout data in constructing their classifications. To be more consistent with the theoretical intuition, one should use pre-sample information. Using panel data on U.S. manufacturing firms, Hubbard, Anil Kashyap, and Toni M. Whited (1995) find similar results to those of FHP using a pre-sample dividend classification.

problems in matching the intuition sketched in section 2 with the empirical implementation by FHP and others. Much subsequent research has addressed problems relating to: (1) the *a priori* classification of firms, (2) the extent to which Q is a good proxy for underlying investment opportunities, (3) whether the tests identify changes in net worth which are independent of changes in investment opportunities, (4) whether classifications of firms simply capture risk-related differences in the cost of funds, and (5) whether the observed link between cash flow and investment reflects non-value-maximizing behavior by managers as opposed to financing constraints.

4A. *A Priori Classification of Firms*

Tests of the form described in section 3 emphasize cross-sectional differences in effects of internal funds (as a proxy for changes in net worth) on firms' investment. This emphasis raises two issues: whether different sample splits lead to consistent results, and whether any fixed grouping is reasonable.

Using different approaches from that of FHP, a number of studies have grouped firms by dividend payouts to analyze cross-sectional differences in the sensitivity of investment to cash flow. In particular, that failures of perfect-markets models in micro data are a feature of firms with low or zero dividend payout has been confirmed by researchers in variety of settings (see Simon Gilchrist, 1991; Hubbard, Kashyap, and Whited, 1995; and Calomiris and Hubbard, 1995).

Other *a priori* groupings of firms have focused on sorting firms by more direct proxies for information costs, rather than proxies for net worth. For example, firms' underwriting costs -- a component of the cost of external financing related in part to information

costs -- decline monotonically with dividend payout (see Calomiris and Charles Himmelberg, 1995). In addition, if informational imperfections are important, relationships with financial intermediaries specializing in reducing information costs may reduce the sensitivity of investment to changes in net worth. Returning to Figure 1, if intermediaries reduce information costs, the slope of the supply curve of funds to borrowers with relationships with intermediaries would be less steep than that firms not raising funds from intermediaries. Hence for a given level of investment opportunities (say, measured by Q), an increase in net worth affects investment more for firms without intermediary ties. In the investment-cash flow tests, then, holding Q constant, investment should be more sensitive to cash flow for firms without intermediary relationships.

Japanese industrial arrangements offer an interesting case in point. In particular, one might use membership in a *keiretsu*, or large industrial group, as a sorting device. The idea is that *keiretsu* firms have access to external financing from the group "main bank," which monitors member firms closely and reduces information costs in external financing. As a consequence, cash flow should have a smaller effect on investment, holding constant investment opportunities (measured by Q), for member firms than for firms not affiliated with *keiretsu* groups.[15] While liquidity effects on investment are (at least historically) important for nongroup firms, they are much less important for *keiretsu* firms (see Hoshi, Kashyap, and Scharfstein, 1991).

Other groupings in this spirit may be useful to the extent that they are based on

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[15] One can illustrate this test using Figure 1. If intermediary relationships eliminate information costs, the S curve is horizontal at r. For firms with intermediary relationships, then, changes in net worth have no effect on investment. For firms without intermediary relationships, changes in net worth can affect investment.

characteristics of a firm and tied to problems of asymmetric information -- for example, young versus mature firms (to capture likely differences in the cost of external equity financing), firms with dispersed versus concentrated ownership (a proxy for potential agency costs), and firms that are members of industrial groups compared with those that are not (following the approach of Hoshi, Kashyap, and Scharfstein, 1991). Again, with *a priori* differences in information costs, changes in net worth have different effects on investment for high-information-cost and low-information-cost firms.

In this spirit, one could estimate variants of the specification in equation (7) for such groups. For Canadian firm data, for example, there is evidence that cash flow effects on investment (holding constant Q) are more pronounced for young firms, firms with dispersed ownership, and non-group firms (see Schaller, 1993). For U.S. data, there is evidence that the perfect-markets Q model can be rejected for several *a priori* classifications of constrained firms--identified as small firms, or those with no bond rating or commercial paper program; each constrained group displays an excess sensitivity of investment to cash flow, while the unconstrained group does not (see Gilchrist and Himmelberg, 1995).[16]

The assumption that only a particular group of firms faces costly external financing is analytically and empirically convenient. However, it is more plausible that firms switch between "constrained" and "unconstrained" regimes depending upon shifts in investment opportunities and the availability of internal or external financing. Also, it is important to consider investment and financial policy jointly; firms may, for example, accumulate liquidity as a buffer against

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[16] Gilchrist and Himmelberg do not use the conventional average Q as a proxy for marginal q; see the discussion in the next subsection.

future constraints.

Such considerations require modeling investment and financing decisions jointly, investigating longitudinal as well as cross-sectional implications of financing constraints. For example, firms might manage investments in physical capital and liquid assets to mitigate bankruptcy risk, while availing themselves of the resources necessary to undertake capital investment projects. Working with a framework used in the "buffer stock" literature on consumption, one could attempt to derive a link between changes in net worth and investment, consistent with the intuition of the example presented in section 2. In principle, one could solve for the firm's optimal policy functions for investment, financing, dividend policy, and liquid assets; optimal policy functions can be compared to firms' decisions in real data to evaluate the economic importance of financing constraints. Following the intuition of section 2, a firm with significant financial resources should be unconstrained; it should invest until its capital stock attains the desired level. For such situations, the estimated policy function for fixed capital is flat. In periods in which a firm is constrained, a significant fraction of each incremental dollar of internal funds is invested, so that the policy function is increasing. In one implementation of such an approach, nonparametric estimation of the policy functions for firm decisions matched closely the nonlinearities predicted by the optimal policy function in the presence of financing constraints (see David Gross, 1994).

One study whose findings run counter to the usefulness of *a priori* groupings of firms emphasized by FHP to test predictions of models of financing constraints is that of Steven Kaplan and Luigi Zingales (1997) -- KZ. KZ argue that when they examine in greater detail some of the firms studied by FHP, the data do not support the presence of financing constraints.

In particular, they reexamine the sample of (49) low-dividend-payout firms from FHP, scrutinizing annual reports to find statements indicating whether or not financing constraints are a problem. Based on statements contained in annual reports, they divide the firms into categories: "not financially constrained," "possibly financially constrained," and "financially constrained."[17] They find that the "financially constrained" group actually displays the *lowest* sensitivity of investment to cash flow of the three groups, counter to the intuition of the tests outlined in section 2. Based on this finding, they claim that investment-cash flow sensitivities provide no evidence of the presence of financing constraints.

The KZ conclusions do not appear to be well supported by their tests (though this author is not an impartial participant in this debate). First, it is difficult to distinguish so finely the degree of financing constraints, especially in such a small sample. In addition, the classification criteria employed by KZ are also debatable. In particular, the criteria rely on managerial statements about liquidity and problematic operational definitions of what it means for a firm to be financially constrained. KZ argue that a firm does not face financing constraints if it can invest more at a point in time. In addition to ignoring the possibility of dynamic financing constraints, this definition ignores uses of cash for purposes other than fixed capital -- that is, for inventories, working capital, or precautionary cash stocks to offset shocks to the flow of internal funds.

KZ argue that they identify different degrees of financing constraints across the

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[17] To justify their use of managerial statements, KZ rely on SEC Regulation S-K, which they state "explicitly requires firms to disclose whether or not they are having difficulty financing their investments" (page 10). In fact, Regulation S-K addresses spending commitments, not desired investment, and therefore need not induce managers to reveal information about the presence or absence of financing constraints.

subgroups. Fazzari, Hubbard, and Petersen (1996) note that the FHP firm-years KZ classify as most *financially constrained* are actually observations from years when firms are *financially distressed.* (The criteria for inclusion in their most constrained group include the violation of debt covenants and renegotiation of debt payments.) KZ themselves note that financially distressed firms may be restricted by creditors from using internal funds for investment and might therefore have a relatively low responsiveness of investment to internal funds. At the same time, the growth opportunities available to healthy firms (which KZ classify as unconstrained) may exhaust their low-cost internal financing and make their investment relatively more sensitive to internal financing if they must pay a premium for internal financing. Finally, because the sample that KZ study was designed to exclude financially distressed firms, very few observations fall into the categories KZ label as "constrained." As a result, the sample lacks sufficient heterogeneity to identify meaningful differences across their samples.

4B. *Investment Opportunities and Q*

In framing the thought experiment in section 2, I noted the importance of controlling for investment opportunities (captured in the D curve in Figure 1) in order to focus on shifts in net worth (captured in the S curve in Figure 1). The Q model's usefulness in this literature stems from its ability to link investment to the increase in the firm's value from an increment to the capital stock. By specifying a functional form for costs of adjustment, one can solve for an investment function that relates the rate of investment to Q.

An important potential problem with this approach is that average Q may be a poor proxy

for marginal Q, the theoretical construct.[18] Such a problem could materialize with a violation of any of the assumptions required to equate average Q and marginal q in setting up equation (6). Two possibilities are particularly troubling in the present context: (1) imperfect competition in the product market, and (2) interrelationship of firms' investment and financing decisions.

In the presence of imperfect competition in the firm's product market, the shadow value of capital and its market valuation are no longer equal. Maintaining the rest of Hayashi's assumptions, the difference is represented by the present discounted value of future average products of capital weighted by discount and depreciation rates and multiplied by the negative inverse price elasticity of demand for the firm's output. While FHP showed that their cross-sectional differences in the effect of cash flow on investment were robust to the inclusion of lagged sales-capital ratios, their experiment did not match the exact requirements suggested by imperfect competition. Indeed, additional assumptions about the time-series properties of firms' average products of capital are required to obtain a revised Q-type estimating equation. The derivation of Q used by FHP follows Hayashi's assumptions, so that , in equation (3),

$\pi_K = (\pi/K)$.[19]

An additional problem with using Q as a measure of investment opportunities is that it may be a poor proxy *precisely because* of a breakdown traceable to efficient markets or capital-

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[18] Chirinko's (1993) survey also reviews problems in using average Q as a proxy for investment opportunities in empirical investment models.

[19] In the presence of market power, $\pi_K(K)$ is no longer homogeneous of degree one, and $\pi_K = (\pi / K) + \eta (Y/K)$, where Y is output and η depends on the price elasticity of demand. Hence equation (3) (and hence equation (5)) contains an additional term representing the discounted presented value of (Y/K). This inclusion can, however, be straightforwardly handled by estimating the Euler equation, as I discuss below.

market imperfections.[20] Virtually all research in this literature has acknowledged this problem. In particular, the Q model may be a questionable framework for analysis under an asymmetric-information alternative to the conventional perfect-capital-markets model to the extent that expectations will not in general reflect insiders' valuations of opportunities. For example, under certain conditions, the firm's discount rate rises (β falls) according to the shadow cost of external financing relative to internal financing. In this case, the market Q may "capitalize" financing constraints; the true q used by the managers absent information costs uses only the risk-adjusted discount rate in constructing β. As with the introduction of imperfect competition, an Euler equation approach can circumvent some of the problems in the conventional Q estimation (see below). Within the Q setting, cash flow may simply measure investment opportunities better than Q. Moreover, this problem is likely to be most acute in the younger, low-dividend-payout firms considered by such researchers as FHP.

One way to mitigate such problems is to depart from the strategy of using proxies for marginal q and rely on the Euler equation describing the firm's optimal capital stock to model the investment decision. (As long as one makes the same assumptions about technology and adjustment costs, the Euler equation can be derived from the value-maximization problem as the conventional Q model.) The basic idea is this: Following the spirit of the illustration in section 2, the usual Euler equation describing the choice of the capital stock should hold across adjacent periods. Alternatively, if firms face costly external financing due to financing constraints, the standard Euler equation is misspecified, and other variables, such as proxies for changes in net

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[20] Endogenous corporate financial policy can also undermine the information content of Q for investment (see Hayashi, 1985), though Chirinko (1987) concludes that this modification improves by very little the empirical performance of the Q model.

worth, may play a role in the investment decision. Investment will also depend on collateralizable resources, with investment opportunities held constant. This approach addresses two of the concerns with the Q framework. First, by not relying on the "investment function" representation, one can sidestep problems of measuring marginal Q. Second, by allowing the effect of changes in net worth on investment to vary systematically, one can model more directly its role in an alternative model of the investment process.

Tests following this approach use panel data on manufacturing firms to estimate the Euler equation. Studies using Compustat data for the United States are unable to reject the frictionless neoclassical model for firms with significant dividend payouts, and the estimated adjustment cost parameters are more reasonable than those found in estimates of Q models (see Gilchrist, 1991; Whited, 1992; and Hubbard, Kashyap, and Whited, 1995). The frictionless neoclassical model is easily rejected, however, for firms with low dividend payouts prior to the estimation period. These findings are consistent with the cross-sectional differences noted by FHP styled tests. In Hubbard, Kashyap, and Whited (1995), the restrictions imposed by the model are not rejected, however, for the high-dividend-payout ("unconstrained") sample. Marginal adjustment costs are estimated to be \$0.21 per dollar of investment, and the markup of price over marginal cost is estimated to be about 1.3.

The Euler equation framework can also be extended to specify an alternative model with a borrowing constraint. Possibilities include allowing the shadow cost of external financing to depend on the firm's debt-to-assets ratio and interest coverage (as in Whited, 1992), or permitting a firm's shadow cost of funds to depend on firm-specific cash flow and a measure of tightness in aggregate credit conditions (as in Hubbard, Kashyap, and Whited, 1995). In empirical

applications, the additional variables affect investment for the sample of firms for which the neoclassical model is rejected, and the Euler equation based on the alternative model is not rejected when both additional variables are included. The estimated effect of cash flow on the shadow price of funds is economically important. All else being equal, a 25 percent decline in cash flow implies an increase in the discount rate of more than 40 percent.

Researchers applying Euler equation techniques to panel data on U.K. firms have found similar results. Using data on manufacturing corporations provided by Datastream International, Bond and Meghir (1994) reject the perfect-capital-markets model. Current investment is positively related to lagged cash flow even after controlling for output fluctuations and leverage. While this role for cash flow is inconsistent with frictionless models, it is consistent with an alternative model with financing constraints posed by the authors. In addition, this violation of the frictionless model is most prominent for low-dividend-payout firms.

While estimating Euler equations offers important benefits in testing the implications of neoclassical investment models with and without information-related capital-market imperfections, the approach relies on the period-by-period restriction derived from the firm's first-order conditions. This test may not pick up the effect of capital-market imperfections on decisions by firms for which the overall level of investment is constrained by internal financing but which do not appear constrained this period relative to next.

An alternative approach bypasses using financial variables as proxies for marginal q by forecasting the expected present value of the current and future profits generated by an incremental unit of fixed capital -- that is, the expected value of marginal q -- an idea developed for time-series data by Andrew Abel and Olivier Blanchard (1986). One can extend this setup to

a panel-data setting by constructing investment fundamentals using a vector autoregression (VAR) forecasting framework to decompose the effect of cash flow on investment into two distinct components -- one that forecasts future profitability under perfect capital markets (analogous to q) and a residual component that may be attributable to financial frictions. By including lags of cash flow in the vector of observed fundamentals in the forecasting equations, one can ensure that any information about future marginal profitability of capital contained in cash flow is reflected in the proxy for marginal q. One can then test whether cash flow is an independent "fundamental" variable explaining investment. This is a test of the restricted model against the alternative that current profits have explanatory power beyond their ability to predict future profits. The theoretical models predict that one should find both that the change in net worth is an independent fundamental and that excess sensitivity of investment to changes in net worth is a characteristic of firms identified as constrained (facing high information costs) -- *e.g.*, measured by size, bond rating, commercial paper rating, or dividend payout.

Indeed, this approach has yielded more successful distinctions between the investment - Q relations of constrained and unconstrained firms than those found in the FHP tests. Gilchrist and Himmelberg (1995) construct a measure they call fundamental Q using VAR forecasts. Using Compustat data on manufacturing firms, they estimate larger Q coefficients (smaller costs of adjusting capital stock) for unconstrained samples -- large firms, firms with a commercial paper rating, and firms with a bond rating -- than for the unconstrained counterparts. Consistent with the prediction of differences in the sensitivity of investment to changes in net worth, they estimate generally significantly higher coefficients on cash flow for constrained samples than for

unconstrained samples.[21]

4C. *Independent Changes in Internal Funds*

A related issue to the problem of measuring investment opportunities is the problem of measuring changes in net worth uncorrelated with those opportunities. Tests based on the intuition sketched in Figure 1 require a shift in the S curve that is independent of determinants of capital demand. In the case of the panel data studies, which use cash flow as a proxy for changes in net worth, it is difficult to identify independent changes in net worth.

One way to express the problem is to note that the error term in the investment rate - Q relation can represent a technology shock to the profit function that subsumes adjustment costs -- as in equation (5). In this interpretation, realizations of variables such as cash flow are influenced by this shock, and may have statistically significant estimated regression coefficients in a conventional Q specification. One could attempt to reduce this problem by combining the structure of the Q model and an assumed serial correlation structure of the error term, while using lagged and/or future endogenous variables as instruments to circumvent the correlation between the temporary component and Q — see, *e.g.*, Hayashi and Tohru Inoue (1991). Cash flow still has significant explanatory power beyond that from Q in the test proposed by Hayashi and Inoue (1991) even after removing simultaneity bias; they do find somewhat larger and more precisely estimated Q coefficients than those estimated for U.S. firms by FHP, however.

One candidate source of independent variation in firms' cash flow arises from variation in

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[21] In contrast to FHP, they find no statistically significant difference in the estimated coefficients on cash flow for zero-dividend and positive-dividend firms. Their classification is not the same as that used by FHP, however, who specified a dividend payout cutoff of 10 percent and who eliminated financially distressed firms from their sample.

tax payments. Owing to such factors as tax-loss carry forwards and carry backs, tax payments are often imperfectly correlated with firm profitability and tax payments can be used as an instrumental variable for cash flow (as in Hubbard, Kashyap, and Whited, 1995).

A second experiment offered by tax considerations occurs when retained earnings are taxed more heavily than distributed profits. In frictionless capital markets, firms would take advantage of the incentive to change their payout policies, as long as the difference in the taxation of dividends and retained earnings is significant. Working against this response for some firms is the potential difference in the cost of internal and external financing. To the extent that the marginal cost of external financing is high, a growing firm with profitable investment opportunities might choose to pay the undistributed profits tax and invest its internal funds, rather than distribute funds and then reacquire them in the capital market. U.S. history offers a useful experiment in this respect, the Undistributed Profits Tax of 1936-1937, which imposed a graduated surtax on corporate retentions over and above normal corporate taxes.[22]

Because the maximum marginal tax rate on corporate retentions was 27 percent, most firms had large incentives to alter their payout policies. Tests based on equation (7) using firm-level panel data from the 1930s indicate that a neoclassical investment model with no explicit capital-market frictions cannot be rejected except for firms with high *ex ante* surtax margins (see Calomiris and Hubbard, 1995). The investment spending only of those firms displayed excess sensitivity to internal funds. In addition, working capital accumulation was responsive to cash flow only for high-surtax-margin firms, suggesting the use of working capital to smooth fixed

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[22] The marginal surtax rate is, of course, endogenous. Calomiris and Hubbard used lagged earnings and dividend data to forecast dividend payout rates, and then used the retention tax schedule to estimate the firm's first-dollar marginal tax rate.

capital investment when external finance is costly. Finally, the high-surtax-margin firms are concentrated in the growth industries of their day, making it unlikely that the link between cash flow and investment in low-dividend-payout firms reflects "free cash flow" considerations.

In addition to research using tax experiments, five other lines of inquiry have suggested ways to identify changes in net worth independent of shifts in investment opportunities. The first are the studies of historical debt-deflation episodes. In a debt deflation, a fall in the general price level increases the real value of borrowers' liabilities, reducing their net worth. In the analytical framework of section 2, firms experience a fall in net worth (shifting the S curve to the left) but no change in their individual investment opportunities (captured in the D curve). The increase in real debt burdens weakens borrowers' capacity to finance any given set of potential investments.[23]

Second, firms with multiple lines of business offer an opportunity to assess how shocks to internal funds generated from activities unrelated to a given line of business affect investment in that line of business. For example, one could examine investment decisions of oil firms operating in oil and non-oil lines of business, and assess effects of cash flow shocks from the oil businesses on investment in the non-oil businesses. Using just such an approach, Owen Lamont (1997) finds a positive effect of oil-related cash flow on non-oil-related investment, holding constant investment opportunities, lending support to an independent channel for cash flow as a proxy for changes in net worth. In a more general study, Hyun-Han Shin and René Stulz (1996) study investment decisions in multi-segment firms in Compustat. They find that investment of

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[23] This idea has been subjected to empirical scrutiny by Bernanke and Harold James (1991) and Calomiris and Hubbard (1989), among others.

the smallest division of a diversified firm is significantly related to the cash flow of other segments.[24]

Third, legal settlements offer an opportunity to identify how firms respond to the receipt of a windfall (uncorrelated with investment opportunities) from court judgments. Evidence that managers retain such windfalls could be consistent with the presence of agency costs (as in Blanchard, Florencio Lopez-de-Silanes, and Andrei Shleifer, 1994), or with "precautionary saving" to finance promising future investment projects (as in Fazzari, Hubbard, and Petersen, 1996).

Fourth, revaluations of foreign multinational firms' internal resources in overseas subsidiaries owing to exchange rate fluctuations offer shocks to internal funds uncorrelated with firm-specific investment opportunities. Available evidence is consistent with the idea that increases in internal funds on account of exchange rate shifts affects foreign multinational firms' cost of funds for acquisitions in the United States (see Kenneth Froot and Jeremy Stein, 1991).

Finally, adding changes in working capital (current assets minus current liabilities) to the Q specification in (7) may provide an opportunity to separate omitted shifts in investment demand from effects of profitability on financing constraints. On the one hand, if effects of cash flow on investment represent omitted shifts in investment demand (*e.g.*, sales and profits), then

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[24] Such tests are not wholly unambiguous, however, because presumably firms have a reason for housing multiple divisions and lines of business within a single "firm." One could build on the intuition of Lamont and Shin and Stulz by considering whether non-operating or extraordinary cash flows affect investment, *ceteris paribus*. Returning to the intuition of equation (1) above, one could, for example, test whether changes in non-operating income affect operating income (π), all else being equal. If not, one could assume that operating and non-operating income are orthogonal. If non-operating income affects investment -- holding constant fundamentals in a conventional Q, Gilchrist-Himmelberg Q, or Euler equation specifications -- financing constraints are likely to be operative.

changes in working capital, which are themselves positively correlated with sales and profits, should have a positive coefficient in the investment regression.[25] On the other hand, suppose that costs of adjusting the stock of working capital are lower than costs of adjusting the stock of fixed capital. Then, financially constrained firms (for which the costs of external financing are high) may draw down working capital to mitigate the effect of an adverse shock to cash flow on investment (that is, use working capital to smooth fixed capital investment). In this case, investment in working capital should have a negative coefficient when included in equation (7). Using panel data on U.S. manufacturing firms, Fazzari and Petersen (1993) estimate that the working-capital-investment coefficient is indeed negative for the low-payout firms studied by FHP, casting some doubt on the notion that the estimated effect of cash flow on investment largely reflects omitted shifts in investment demand.

4D. *Risk-Related Differences in the Cost of External Finance*

As noted above, because the micro data studies generally emphasize cross-sectional differences in the importance of changes in net worth for firms' investment, it is important that groupings of firms represent distinctions attributable to financing constraints. One problem is that proxies used in empirical studies (*e.g.*, dividend payout ratio, leverage, access to public debt markets, or firm size) may simply capture differences in default risk; accordingly, required rates of return should be higher for investment by "constrained" firms.

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[25] This intuition requires an addition to equation (7) a term representing the ratio of the change in working capital (net working capital investment) to the fixed capital stock. This variable is, of course, endogenous. Plausible instrumental variables include lagged Q, CF/K, firm and year effects, and the beginning-of-period stock of working capital divided by the fixed capital stock. The rationale for including the last variable is that, in the "fixed investment smoothing" interpretation, the firm's working capital investment should depend negatively on the size of the initial stock, because the marginal values of working capital for this purpose declines as the stock increases.

There are two difficulties with this argument. First, in the Q framework, the firm's Q value incorporates publicly available information about default risk (among other things), so that effects of net worth on investment, holding Q constant, should not convey information about differences in risk. Second, even if one takes seriously the problems with the Q framework discussed earlier -- particularly the possibility that financing constraints are "capitalized" in the market-assigned Q -- Euler equation studies have found that the implied shadow cost of funds varies significantly *over time* for "constrained firms." While alternative models based on risk differences across firms may help to explain cross-sectional differences in implied discount factors, the estimated variation over time in those discount factors for "constrained" firms is too large to represent shifts in default risk (see Whited, 1992; and Hubbard, Kashyap, and Whited, 1995).

4E. *Links Between Cash Flow and Investment in Non-Value-Maximizing Firms*

The empirical tests discussed thus far treat the effect of cash flow on investment as mitigating a higher shadow cost of external funds. Alternatively, management's use of internal funds for non-value-maximizing projects may suggest a connection between changes in net worth and corporate expenditures (including capital spending), holding constant investment opportunities. For example, the availability of "free cash flow" -- the difference between cash receipts and the sum of cash disbursements and spending on profitable investment opportunities -- may raise corporate investment independent of underlying signals about expected future profitability (see the discussion in Jensen, 1986). The argument is difficult to test directly owing to the unobservability of free cash flow. In the cases for which the theory is correct, for example, one could not use reported data on investment to construct the measure.

One can, however, offer an indirect test of the free cash flow model's prediction for capital spending by examining characteristics of firms with excess sensitivity of investment to cash flow -- provided one can classify some sample of firms as "mature," with high average profitability. Available evidence rejects the notion that mature, low-payout firms (those emphasized by the free cash flow approach) account for the rejection of the frictionless neoclassical model among low-dividend payout firms (see Hubbard, Kashyap, and Whited, 1995). This evidence does *not* imply that agency-cost considerations are unimportant in firms' decision making. Rather, such findings suggest that the free cash flow story does not appear to explain the link between net worth and investment in plant and equipment.

5. INVESTMENT IN A RANGE OF ACTIVITIES

Expanding upon the intuition of the net worth models of investment, a firm facing a high cost of external financing is likely to reduce its "investment" in a broad range of activities, with relative reductions determined by relative adjustment or liquidation costs. Below I consider briefly applications of models emphasizing capital-market imperfections to inventory investment, R&D, employment, pricing and investment in market share, business formation and survival, and risk management.[26]

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[26] Though not discussed here, analogous modeling techniques could be developed to link *household* net worth to the demand for consumer durables. If consumers need to self-insure against shortfalls in earnings because of incomplete insurance markets, the requirement of "precautionary" asset holdings may induce an excess sensitivity of durables spending to asset position. Indeed, there is evidence linking household spending on durables to balance sheet variables (see, *e.g.*, Frederic Mishkin, 1978; and Eun Young Chah, Valerie Ramey, and Ross Starr, 1995).

5A. *Investment in Inventories*

One might easily argue that inventory investment should respond more to fluctuations in net worth than fixed investment. As long as the costs of adjusting the stock of inventories are low relative to the cost of adjusting the stock of fixed capital, inventory reductions will be larger than the decline in fixed investment in response to a fall in net worth. One could explore this possibility using quarterly firm-level panel data available from Compustat. In this setting, one could divide the sample by firm size (as a proxy for information costs) and investigate whether there are larger effects of changes in net worth on inventory investment, holding constant other determinants of inventory investment, for small firms than for large firms. Alternatively, following the fixed investment studies, one could classify firms according to more direct indicators of information costs -- such as whether the firms have a bond rating. Findings that fluctuations in internal funds have a larger effect on inventory investment, all else being equal, for small firms or firms without bond ratings (as in Robert Carpenter, Fazzari, and Petersen, 1994) help explain why inventory investment may appear relatively insensitive to direct changes in open market real interest rates (as in Blinder and Louis Maccini, 1991), while responding significantly to changes in net worth.

Other researchers have also explored cross-sectional differences in the response of inventory investment to shifts in net worth, using Compustat data to study determinants of inventory investment by firms with or without bond ratings. Focusing on the 1982 recession, a "low net worth" period, it appears find that inventory investment by non-rated firms with no bond ratings was influenced by the firms' own cash holdings, while inventory investment by

rated firms was not (Kashyap, Lamont, and Stein, 1994).[27] In subsequent "boom" years, they find little effect of cash holdings on inventory investment for either non-rated or rated companies. These results are consistent with predictions of models in which low-net-worth firms face more costly external finance in downturns (recall the analysis in section 2).

Finally, as noted earlier, one can argue that access to commercial paper markets is an indicator of low information costs and high net worth. One could, then, compare the responsiveness of inventory investment to profits, all else being equal, of manufacturing firms with commercial paper programs to manufacturing firms without public debt or commercial paper programs. A finding that profits have a statistically significant and economically important impact on inventories only for firms with no public debt is consistent with models in which information costs are important (for such a test and finding, see Calomiris, Himmelberg, and Wachtel, 1995).

5B. *R&D Investment*

In contrast to the low costs of adjusting inventories, estimated costs of adjusting R&D are very high, even relative to physical capital. In addition, informational asymmetries are likely to be particularly important for the case of R&D. Because of high adjustment costs for R&D, R&D may not respond much to transitory fluctuations in cash flow, thereby reducing the value of the conventionally estimated within-firm coefficient. One could investigate this possibility for small manufacturing firms' R&D expenditures. Available evidence suggests that within-firm variation

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[27] The bond rating classification could be an indicator of whether the firm is likely to be dependent upon banks for external finance (as in Kashyap, Lamont, and Stein). One can also interpret the split as capturing roughly the low net worth/high net worth distinction emphasized here (see, *e.g.*, Calomiris, Himmelberg, and Paul Wachtel, 1995).

in R&D spending is explained substantially by the within-firm variation in internal finance (see the study of small -- arguably financially constrained -- firms' manufacturing expenditures during the 1980s by Himmelberg and Petersen, 1994). Independent evidence that internal funds affect R&D spending, all else being equal, can be found in studies using a broader panel of R&D spending in a panel of U.S. manufacturing firms (see Bronwyn Hall, 1992).

5C. *Employment Demand*

Under certain assumptions, one can extend the results for investment demand to employment demand. For example, to the extent that labor is a quasi-fixed factor (as in Roger Farmer, 1985) or there is a lag between labor input and production (as in Greenwald and Stiglitz, 1988), firms may need to raise external financing to finance labor input. As a result, fluctuations in net worth can lead to accelerator effects on employment demand in ways similar to their effect on fixed investment demand.

There is some evidence of net worth effects (using measures of leverage as a proxy) on employment demand.[28] One type of evidence finds negative effects of leverage and debt service on employment, holding constant other determinants of labor demand (see the studies using panel data on U.S. firms by Richard Cantor, 1990; or on U.K. firms by Stephen Nickell and Sushil Wadhwani, 1991, and Nickell and Daphne Nicolitsas, 1994). Another type of evidence finds that highly leveraged firms, all else equal, exhibit larger estimated elasticities of employment with respect to sales over the business cycle (*i.e.*, indicated attenuated labor

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[28] All else being equal, more highly levered firms have lower net worth relative to their desired capital stock. Hence such firms may be more likely to be in the range of net worth in which changes in net worth affect investment, holding constant investment opportunities. One difficulty with such tests is that one must isolate changes in leverage that are uncorrelated with changes in investment opportunities.

hoarding) than less leveraged firms (see the study of U.S. firms by Steven Sharpe, 1994).

5D. *Pricing and Investment in Market Share Under Imperfect Competition*

For imperfectly competitive firms, pricing embodies another type of investment decision. One line of inquiry considers that raising prices may bolster current profits at the expense of lost future sales and profits.[29] Whether it is in the firm's interest to do so depends on the firm's discount rate. A higher discount rate implies that the firm places lower weight on future cash flows relative to current cash flows. In this context, a firm facing a high cost of external finance discounts future profits more heavily, leading it to raise current prices. This reduction in investment in market share in the presence of capital-market imperfections is analogous to the reduction in investment in fixed capital and inventories by financial constrained firms. A corollary prediction is that markups for constrained firms should be "countercyclical" -- rising in periods when cash flow falls and falling in periods of rising cash flow (see, *e.g.*, Judith Chevalier and Scharfstein, 1994, 1996).

A number of recent empirical contributions have provided evidence bolstering the idea that financing constraints affect pricing decisions of imperfectly competitive firms. In industries in which leveraged buyouts occurred most frequently (as a proxy for the degree of financial constraints), prices rose, all else being equal, subsequent to the leveraged buyouts (Gordon Phillips, 1995). Focusing on a single industry, one could study pricing during a recession (implicitly assumed to be a period of low net worth). Evidence that prices rise more in highly leveraged firms than in others would be consistent with the financing constraint channel (see the

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[29] It is also possible that firms facing financing constraints cut prices (*i.e.*, run a "fire sale") during periods of low demand. This alternative channel has been less explored in the literature.

study of pricing by supermarket chains during the 1990-1991 recession by Chevalier and Scharfstein). Such tests collectively suggest the importance of net worth for firms' intertemporal decisions about pricing (investment in market share) as well as investment in fixed capital or inventories.

5E. *Business Formation and Survival*

Most of the empirical studies of links between changes in net worth and investment have used data on publicly traded firms that have operated for some time. To the extent that information costs are highest for young firms, it is desirable to examine the role of financing constraints in influencing entrepreneurship and business formation. Potential research programs here include: (1) developing and estimating behavioral models of entrepreneurial choice under financing constraints; and (2) estimating effects of net worth on entrepreneurial choice and entrepreneurs' investment.

In the first case, evidence based on data from the National Longitudinal Survey of Young Men suggests that borrowing constraints bind for entrepreneurs, who are limited to a capital stock that is no more than approximately one and one-half times their net worth (see David Evans and Boyan Jovanovic, 1989).

In the second case, researchers must identify a change in net worth not correlated with a change in entrepreneurial opportunities. Inheritances approximate a "natural experiment" in which a potential entrepreneur's net worth changes with no corresponding shift in investment opportunities. It is possible to use household tax return data (including Schedule C information on unincorporated business income) to study the connection between the receipt of an inheritance and the decision to start an investment in a sole proprietorship. Available evidence suggests that,

consistent with models of financing constraints, the receipt of an inheritance has a significant effect on the likelihood of becoming an entrepreneur (see the study of data for 1981 and 1985 for a group of household heads receiving inheritances in 1982 and 1983 by Douglas Holtz-Eakin, David Joulfaian, and Harvey Rosen, 1993). In addition, once the individual becomes an entrepreneur, an inheritance has both a statistically significant and economically important impact on the amount of capital used by the business.

5F. *Risk Management*

To the extent that information and incentive problems lead to costly external financing, firms have an incentive to manage fluctuations in net worth (*e.g.*, in internally generated cash flows), which can be used to make value-enhancing investments. That is, a firm's exposure to idiosyncratic risk is no longer innocuous for investors. One direct means of insuring the availability of internal funds is through precautionary retention of funds in stocks of working capital or "slack" (see also the discussion in section 5A above).

Another route is the development of "risk management" strategies, using derivative markets to hedge fluctuations in cash flows. Hedging strategies can be used, for example, to reduce exposure to interest rate risk (and resulting fluctuations in debt service burdens and internal net worth) or exchange rate risk (and resulting fluctuations in profits earned abroad).[30]

Finally, informational imperfections and costly external financing may suggest a role for internal capital markets in the capital allocation process. Internal capital markets differ from external capital markets because the internal capital markets provide the senior managers with

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[30] Such strategies for firms facing costly external financing for investment programs have been analyzed by Froot, Scharfstein, and Stein (1993, 1994) and Froot (1995).

residual rights of control over the firm's assets (see Robert Gertner, Scharfstein, and Stein, 1994). These control rights provide the firm's senior managers with increased monitoring incentives, as they get more gains from monitoring. Accordingly, one would expect higher firm value when the internal capital market has a significant informational advantage over the external market. Empirical evidence indicates that returns to acquirers from acquisitions were higher in the 1960s (when external capital markets were arguably less developed) than in the 1980s (Hubbard and Darius Palia, 1996).

6. IMPLICATIONS FOR ANALYSIS OF MONETARY AND FISCAL POLICY

The significance of differences in the costs of external and internal financing in a range of investment decisions has implications for the ways in which we evaluate effects of monetary and fiscal policy. Conventional analysis of how monetary or tax policy actions influence investment decisions follows the logic of the frictionless neoclassical model: To the extent that policy actions affect the user cost of capital, they affect investment demand. The models analyzed here suggest an additional channel: To the extent that policy actions affect the net worth of borrowers facing information costs, they may produce an amplified effect on investment.

6A. *Monetary Policy*

The crux of models of information-related financial frictions is a gap between the cost of external and internal financing for many borrowers. In the traditional "money channel" analysis, monetary policy implemented through open market operations affects real interest rates (in the short run) and the user cost of capital, thereby influencing interest-sensitive spending. An increase in real interest rates raises the height of the supply-of-funds schedule in Figure 1. In the

absence of information costs, the increase in interest rates increase the user cost of capital, and marginal investment projects are foregone. Models incorporating information-related capital-market imperfections highlight in addition distributional consequences of policy actions, because the shadow costs of financing respond differently for different types of borrowers. It is no longer necessarily the case that investment projects foregone as a result of a higher user cost are the least efficient. Two such channels have been emphasized beyond the conventional money channel: financing constraints on borrowers (balance sheet channel) and the existence of "bank-dependent" borrowers (bank lending channel).

The first channel follows directly from the intuition of models emphasizing net worth : An increase in the real interest rate raises borrowers' debt-service burdens and reduces the present value of collateralizable resources, thereby reducing net worth and increasing the marginal cost of external financing. This diminishes firms' ability to carry out desired investment and employment programs. This balance sheet channel describing effects of rising interest rates on investment through effects on borrowers' net worth has a long pedigree, and was discussed originally by Fisher (1911).

Contractionary monetary policy raises the cost of external financing more for constrained firms -- which experience both a higher real interest rate and an increase in the spread between the cost of external and internal funds -- than for unconstrained firms -- which experience only the higher real interest rate. Accordingly, investment by constrained firms should fall relative to that by unconstrained firms, all else being equal. Quarterly data are more likely to capture the timing of policy shifts than the annual data contained in Compustat or Value Line data sets. The Bureau of the Census' *Quarterly Financial Reports* data report income and balance sheet

information similar to that in Compustat for various size classes of firms.

Studies grouping firms according to size can be thought of as sorting firms by net worth (associating larger firms with higher levels of net worth) or by information costs (associating larger firms with lower information costs of uncollateralized lending). Such size class data make it possible to consider differences in "small" firm and "large" firm classes' responses to a monetary contraction, measured, for example, by federal funds rate innovations. Using a small firm/large firm distinction to represent differences in the cost of external financing, Gertler and Gilchrist (1994) employ as a cutoff for small firms the 30th percentile of the distribution of sales. They find that small firms' sales, inventories, and short-term debt appear to decline relative to those for large firms over a two-year period following a monetary tightening, results consistent with the financial accelerator approach. Effects of shifts in monetary policy on the small-firm variables are more pronounced in periods when the small-firm sector as a whole is growing more slowly, also consistent with the analytical approach in section 2. Such results, which are very much in the spirit of tests of cross-sectional differences in financing costs in studies of fixed investment, have borne out for fixed investment using the same data (see Stephen Oliner and Glenn Rudebusch, 1996).

The model presented in section 2 suggests that changes in information costs of screening and monitoring affect the cost of external financing and investment. To the extent that banks are the low-cost monitors for certain kinds of lendings, the ability and willingness of banks to lend may influence the level of investment. The bank lending channel to which I referred stresses that some borrowers depend upon banks for external funds, and that monetary policy actions can have a direct impact on the supply of loans. A review of studies analyzing this question is beyond the

scope of this paper.[32]

6B. *Tax Policy*

Contemporary analysis of effects of tax policy on investment emphasizes channels through which tax parameters affect the marginal user cost of capital. Likewise in the q theory, changes in investment tax credits or depreciation allowances alter the equilibrium value of marginal q. In the context of the simple model illustrated in section 2, when a firm's net worth is "high," these same channels are operative in models emphasizing information costs.

However, tax policy can have additional effects on decisions of firms with low levels of net worth.[33] In particular, the quantity of internal funds available for investment is supported by the average tax on earnings from existing projects. In this sense, average as well as marginal tax rates faced by a firm will affect its investment decision (see Fazzari, Hubbard, and Petersen, 1988b). In the model of section 2, an increase in the firm's average tax rate lowers the firm's collateralizable internal resources, shifting the upward-sloping portion of the S curve in Figure 1 back to the left and increasing the shadow cost of financing additional investment.

While much of the empirical literature studying the link between internal funds and investment indirectly supports the idea that average tax burdens affect investment, some studies

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[32] In these models, the health of financial intermediaries can be important for long-run growth. Ronald McKinnon (1973) and others have suggested that the health of financial intermediaries influences both the quantity and quality of investment and hence economic growth. Just as the short-run implications require the difficult task of identifying exogenous changes in intermediated lending, it is difficult for researchers to identify an exogenous increase in the development of the financial system. There is some empirical evidence, however, to indicate that financial development contributes to economic growth (see Robert King and Ross Levine, 1993).

[33] For theoretical discussion, see Greenwald, Stiglitz, and Weiss, (1988), Gertler and Hubbard (1988), and Calomiris and Hubbard (1990).

have addressed tax considerations more directly. Again, one strategy is to use firm tax payments as an instrumental variable for cash flow, because corporate tax payments are only imperfectly correlated with current profits. Second, I noted earlier that in the experiment offered by the undistributed profits tax in 1936-1937 in the United States, firm investment is sensitive to cash flow, holding Q constant, only for firms paying high *ex ante* rates of surtax on retained earnings.

The literature investigated here does not suggest that policy makers should bias the tax code in favor of internal financing for all firms. For example, policies that augment internal funds may encourage managers concerned, say, with corporate size as well as the value of shareholders' claims (recall the discussion of agency problems in section 4). As long as the market for corporate control is efficient, however, overinvestment in low-marginal-q projects should lead to takeovers and the elimination of wasteful investment.

7. CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

Empirical studies of firm investment provide strong support for the basic predictions of links between changes in net worth and investment arising from information problems in financial markets. For many firms in the economy, available evidence is consistent with: (1) a gap between the cost of external and internal financing; and (2) a positive relationship between the borrower's spending and net worth, holding constant underlying investment opportunities. While much of the literature analyzes determinants of investment in plant and equipment spending, these implications have been examined in research on inventory investment, research and development, employment, business formation and survival, pricing, and corporate risk management.

While there is relatively widespread agreement on the role of financial frictions in the investment decisions of some firms, there is less agreement on the magnitude of that role. Three challenges are likely to figure prominently in the extension of this line of research: (1) analyzing the link between internal resources and the shadow cost of external financing in models of decisions in individual firms and industries; (2) estimating the importance of the financial accelerator for aggregate investment fluctuations; and (3) incorporating financing constraints in models of irreversible investment to explore their incremental effect on firms' required rates of return on investment.

Models emphasizing a role for internal funds in the investment process, holding constant investment opportunities, describe decisions by individual firms. Most of the empirical studies reviewed here rely on firm-level panel data to analyze the models' implications. Given the debate over whether these studies have adequately controlled for investment opportunities in attempting to isolate links between internal net worth and investment, the first key area for extension is the development of a greater body of evidence on decisions by individual firms and firms within a given industry. For the former, firm-level case studies of determinants of required rates of return ("hurdle rates") are likely to be instructive. For the latter, studies of the role played by financing constraints in the development of an industry would be useful.[34]

Going the other direction in level of aggregation, the second principal area for future research addresses implications of internal funds models of investment for aggregate investment fluctuations. While much of the applied research on these models has been conducted by

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[34] Earlier industry-level studies include those for agriculture (Hubbard and Kashyap, 1992); and oil (Peter Reiss, 1990).

specialists in industrial economics or public economics, macro economists have long been interested in approaches describing accelerator effects in the investment process. Recent empirical studies suggest that a significant fraction of manufacturing fixed investment or inventory investment is likely accounted for by firms argued to be financially constrained (see Fazzari, Hubbard, and Petersen, 1988a; Gertler and Gilchrist, 1994; Bernanke, Gertler, and Gilchrist, 1995; and Gilchrist and Zakrajšek, 1995.) Future research could productively examine the role of financial factors beyond the influences on manufacturing firms (the focus of most of the studies using micro data) -- in housing, construction, or wholesale and retail trade (for preliminary efforts see, *e.g.*, Bernanke and Gertler, 1995).

The third area of future research is methodological. The empirical literature studying effects of capital-market imperfections on investment has relied on formulations of the basic neoclassical model, usually assuming convex costs of adjusting the capital stock. The q, user cost of capital, and Euler equation approaches can all be derived from the same intertemporal maximization problem, given common assumptions about technology, competition, and adjustment costs. An important recent line of inquiry focuses on modeling and testing the effects of irreversibility and uncertainty on firms' investment decisions (see, for example, the excellent survey by Robert Pindyck, 1991). Neoclassical models implicitly assume that there is an efficient secondary market for capital goods, so that irreversibility is not a problem. In addition, investment opportunities facing the neoclassical firm are once-and-for-all opportunities. To the extent that investment is irreversible, making an investment extinguishes the value of the call option of delay. In this approach, the value of the lost option is a component of the opportunity cost of investment. In the terminology of the q framework, the threshold criterion for investment

requires that q exceed unity, by the value of maintaining the call option to invest. As a consequence, high hurdle rates may be required by corporate managers making investment decisions.

Indeed, at least part of the interest in option-based investment models is the problem raised in many empirical studies that the response of investment to changes in q or the user cost of capital are implausibly small (or, equivalently, that adjustment costs are implausibly large). As with the option-based models, the models of financing constraints reviewed here predict ranges of inaction; that is, q can fluctuate in a given range with no (or an attenuated) response of investment. As discussed earlier, the "range of inaction" in this case can be explained as follows. For firms with high levels of net worth relative to investment opportunities, the neoclassical model holds, and shifts in q or the user cost of capital change desired investment. For firms with low levels of net worth, costs of external financing vary inversely with the level of net worth: When a borrower's net worth improves, lenders become more willing to lend, and additional investment can be financed. Hence, while shifts in net worth affect investment in such firms, observed movements in q or the user cost of capital may not.

Additional research on firm-level investment decisions could attempt to distinguish between the prediction of neoclassical models augmented by informational imperfections on the one hand and option-based models on the other hand. Such an integration might proceed in two steps: (1) analyzing effects of financing constraints in the continuous-time stochastic-process models employed in the options-based models; and (2) deriving empirical tests to discriminate between the "range of inaction" predictions of the two classes of models. In the latter case, for example, one could study industries in which investments are largely irreversible and examine

whether firms' hurdle rates still vary according to predictions of models emphasizing financing constraints on investment. Conversely, one could examine whether, in industries in which investment is not irreversible (*e.g.*, industries in which equipment investment is dominated by machine tools for which efficient secondary markets exist), hurdle rates vary in the ways predicted by the models surveyed here. Finally, matching plant-level and firm-level data would help researchers discriminate between ranges of inaction for investment predicted by models of irreversible project investment and models of financing constraints on firms.

To summarize, the existing empirical literature analyzing financial factors in investment decisions has produced a number of findings suggesting the significance of capital-market imperfections for firm decisions. Nonetheless, more research is needed to isolate the sources of capital-market imperfections that affect firm decisions. Progress in this regard is likely to require careful analysis of individual firms' decisions. Such analysis, as well as consideration of results from the areas for future research discussed above, will likely determine the extent to which researchers in macroeconomics, corporate finance, and industrial organization apply and extend the predictions of the literature.

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