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Internal Financial Constraints, External Financial Constraints, and Investment Choice: Evidence from a Panel of UK Firms

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Internal financial constraints, external financial constraints, and investment choice: Evidence from a panel of UK firms

by

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Abstract

This paper uses a panel of 24184 UK firms over the period 1993-2003 to study the extent to which the sensitivity of investment to cash flow differs at firms facing different levels of internal and external financial constraints. Our results suggest that when the sample is split on the basis of the level of internal funds available to the firms, the relationship between investment and cash flow is U-shaped. On the other hand, the sensitivity of investment to cash flow tends to increase monotonically with the degree of external financial constraints faced by firms. Combining the internal with the external financial constraints, we find that the dependence of investment on cash flow is strongest for those externally financially constrained firms that have a relatively high level of internal funds.

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1. Introduction

An intense debate has been taking place in recent years about the extent to which firms' investment is constrained by the availability of finance, and more specifically, about whether a positive and statistically significant relationship between investment and cash flow can be seen as an indicator of financial constraints (see Shiantarelli, 1995; Hubbard, 1998; and Bond and Van Reenen, 2005, for surveys). Some studies have questioned whether there is any significant financial constraint on investment at all.

The debate has been almost entirely based on data from firms quoted on the US stock market. Yet, financial constraints on quoted firms are likely to be relatively weak, especially in a country with highly developed financial markets like the United States. A sharper test of the effects of financial constraints on investment would be obtained from a sample that included a large number of unquoted firms. Moreover it seems likely that financial constraints are a bigger issue in Europe, where financial markets are in general less developed, and where there is more reliance on bank finance.

Accordingly, in the present study, we attempt to shed further light on the debate by using, for the first time, a large panel of financial data on UK firms, over 99 percent of which are not quoted on the stock market. Specifically, we estimate, both separately and jointly, the effects of "internal" financial constraints (availability of internal funds) and "external" financial constraints (access to external finance) on firms' investment. Using firms' cash flow as a measure of the former, and firms' size and age as proxies for the latter, we find that the sensitivity of investment to cash flow responds differently according to the type of constraint. The sensitivity is particularly large when external constraints are strong and internal constraints are weak. This suggests that investment by successful young, small firms may be significantly constrained by access to external finance, which has long been a matter of policy concern.

The remainder of the paper is laid out as follows. In Section 2, we summarize the main points of controversy about cash flow's role in determining firms' investment. We also present some theoretical arguments, supporting the hypothesis that internal and external financial constraints lead to different predictions relative to the sensitivity of firms' investment to cash flow. Section 3 provides a description of our data set, together with some summary statistics. Section 4 illustrates our baseline specification and our estimation methodology. Section 5 presents our main results and robustness tests, and Section 6 concludes.

2. Why does cash flow matter for investment? Economic background

2.1 Summary of the principal points of the controversy

The debate on whether high sensitivities of investment to cash flow can be interpreted as indicators of financial constraints started with Fazzari, Hubbard, and Petersen's (FHP hereafter) 1988 pioneering paper, according to which firms with low dividend payout ratios (i.e. firms that are more likely to face financial constraints) display a higher sensitivity of investment to cash flow. A number of papers followed, focusing not only on firms' investment behavior, but also on their inventory investment, their R&D investment, or their employment decisions. These studies generally supported FHP's (1988) main conclusion.

A significant challenge to FHP's (1988) work came with Kaplan and Zingales (hereafter KZ, 1997). Instead of using the dividend payout ratio as an indicator of financial constraints, these authors used other criteria, reclassifying FHP's low-dividend sub-sample of firms on the basis of information contained in the firms' annual reports as well as managements' statements on liquidity. They found that investment at firms that appeared *less* financially constrained by these criteria was *more*, rather than less, sensitive to cash flow than investment at other firms. They therefore concluded that higher sensitivities of investment to cash flow cannot be interpreted as evidence that firms are more financially constrained[1]. A heated debate followed (Cleary, 1999; FHP, 2000; KZ, 2000; Allayannis and Mozumdar, 2004; Cleary et al., 2004)[2].

The different conclusions reached by these two groups of authors can be explained by the different ways in which they measured financial constraints. Broadly, most

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[1] Kaplan and Zingales (1997) also presented a simple theoretical model according to which the degree of firms' financial constraints does not need to vary monotonically with their investment-cash flow sensitivities.

[2] An important theoretical challenge to the hypothesis that a significant coefficient on cash flow in an investment reduced form regression can be seen as an indication of the existence of financial constraints comes from Gomes (2001). Gomes (2001) shows that the existence of financial constraints is not sufficient to obtain significant cash flow effects, and that in some cases, cash flow can add some predictive power to investment equations even in the absence of financial constraints. This could happen in the presence of a persistent wedge between average and marginal Q, which could be a result of market power. Also see Boyle and Guthrie (2003); Cooper and Ejarque (2001, 2003); Dasgupta and Sengupta (2003); and Moyen (2004) for other theoretical challenges to the hypothesis that a high sensitivity of investment to cash flow can be seen as evidence of financial constraints.

studies that have found results in line with those of FHP (1988) defined financial constraints using criteria such as firms' size, age, dividend payout ratio, or information on whether they have a bond rating and/or access to commercial paper. These criteria can be seen as proxies of the extent to which firms are susceptible to the effects of information asymmetries, which translate themselves in difficulties in obtaining external funds[3] (i.e. as proxies for the degree of external financial constraints faced by the firms).

On the other hand, the majority of studies that have found results in line with KZ (1997), classified firms or observations on the basis of indicators related to the level of internally generated funds available to them, which can be seen as a proxy for their degree of internal financial constraints[4]. In particular, KZ (1997) based their sample separation criteria essentially on variables related to firms' liquidity (which is obviously strongly correlated with the level of internal funds available to firms). Similarly, Cleary (1999) used a number of variables strongly related to firms' internal funds (e.g. the current ratio, the coverage ratio etc.) to construct an index of firms' financial strength[5].

These considerations strongly suggest that internal and external financial constraints have different effects on the investment-cash flow relationship. One of the contributions of this paper is to investigate this issue more deeply.

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[3] Smaller and younger firms are particularly susceptible to information asymmetry effects, since little public information is available for them, and it is more difficult for financial institution to gather this information. Obtaining external finance is therefore likely to be particularly costly for smaller and younger firms (Bernanke and Gertler, 1995). Similarly, when seeking for external finance, firms with a low dividend-payout ratio are also likely to be subject to moral hazard and adverse selection problems. In an asymmetric information setting, dividends are in fact used by firms to convey information to shareholders, and more in general, to the outside world. Firms that pay high dividends signal that they have good long-term prospects, while the opposite holds for low-dividend paying firms (Bhattacharya, 1979; John and Williams, 1985; Miller and Rock, 1985). Once again, obtaining external finance will be more difficult for the latter. Finally, variables such as access to the commercial paper market and bond rating are used because firms must reach a minimum size, collateral level, and age before the additional risk associated with information asymmetries is low enough to make bond issuance feasible or to obtain access to the commercial paper market (Calomiris et al., 1995).

[4] It has to be noted that the concepts of internal and external financial constraints are obviously related. A firm with greater internal cash flow is in fact likely to find it easier to obtain external finance, as it will be perceived as less risky by lenders. A high internal cash flow can in fact be seen as evidence of the firm's managers' commitment to their investment projects (Leland and Pyle, 1977). Conversely, firms that are internally financially constrained will find it more difficult to obtain external finance.

[5] Exceptions are Kadapakkam et al. (1998) and Cleary (2005) who estimated investment equations for a number of developed countries, and found that the sensitivities of investment to cash flow are often higher for larger firms and firms with higher dividend payout ratios. Yet, as discussed in Islam and Mozumdar (2002), their results are likely to be driven by insufficient cross-sectional heterogeneity in within-country samples.

The work of Cleary et al. (2004) is most clearly related to ours in that it also attempts to distinguish between the effects of internal and external financial constraints on the sensitivity of investment to cash flow. However, our work differs from theirs in four important ways. First, and most importantly, while their sample is confined to quoted firms (in the United States), which are unlikely to display a wide enough range of financial constraints[6], ours also includes unquoted firms.

Second, our paper is based on a sample from the United Kingdom. The relative lack of corporate bond and commercial paper markets, the relative thin and highly regulated banking and equity markets, and the relatively small amount of venture capital financing, seem to make the idea of financial constraints that affect firm behaviour more plausible in a European context[7].

Third, we provide a richer analysis of the effects of internal and external constraints. Our analysis provides in fact estimates not only of the individual effects that internal and external financial constraints have on the sensitivities of firms' investment to cash flow, but also of the effects of various combinations of these two types of constraints, trying to identify those combinations leading to higher sensitivities.

Finally, instead of using a *Q* model framework to estimate our investment regressions, we use error-correction specifications[8]. The main advantage of using an error-correction model (ECM) is that it leads to a more flexible specification than the *Q* approach, which is consequently less likely to suffer from mis-specification problems. In particular, contrary to the *Q* model, the ECM specification maintains the long-run properties of value-maximising investment models, but does not impose the restrictions on short-run dynamics associated with particular adjustment cost specifications[9]. Moreover, using the ECM specification allows us to by-pass to a

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[6] Cleary et al. (2004) state: "It is difficult to find good proxies for capital market imperfections that vary enough across observations in the sample (especially with Compustat data, where all firms are publicly traded)." (p. 30).

[7] Recent studies that looked at the effects of financial constraints on investment in the UK include Bond et al. (2004) and Carpenter and Guariglia (2003). For studies focusing on firm investment and monetary policy transmission in the Euro area, see Chatelain et al. (2003), and Part II of Angeloni et al. (2003).

[8] Given that our panel includes mainly unquoted firms, it would in fact be impossible to estimate a *Q* model, as Tobin's *Q*, which is defined as the market value of the firm over the replacement value of its capital stock, cannot be calculated for unquoted firms.

[9] The *Q* model is in fact based on the assumption that adjustment costs are symmetric and quadratic. Yet, it is likely that adjustment costs take more complex forms. The *Q* model also imposes assumptions of perfect competition and constant return to scale, which might be inappropriate in some industrial sectors.

certain extent the criticism according to which cash flow might be an important determinant of investment, simply because it accounts for investment opportunities, which are poorly measured by Tobin's *Q*[10].

2.2 Theoretical arguments supporting a differential impact of internal and external financial constraints on the sensitivity of investment to cash flow

Cleary et al. (2004) developed a model of the optimal level of a firm's investment under financial constraints, distinguishing the latter into internal (i.e. based on the level of internal funds available to the firm) and external (i.e. based on the degree of capital market imperfections faced by the firm).

Their model involves a firm with a given level of internal funds, which requires, at times, additional funds to finance its investment projects. Asymmetric information plays an important role in the model: the firm earns revenues that are not observable to external investors, generating a moral hazard problem. A debt contract is optimal in this setup. Default on a promised repayment may be followed by liquidation of the firm[11]. Consequently, external funds are more expensive than internal funds.

Cleary et al.'s (2004) model develops previous theories (e.g. Bernanke and Gertler, 1989, 1999; Bolton and Scharfstein, 1990; Calomiris and Hubbard, 1990; Gale and Hellwig, 1985; Hart and Moore, 1998, etc.) in three significant ways. The first is by assuming that investment is scalable, i.e. that firms not only make the decision of whether to undertake an investment project, but can also decide the scale of their investment. The firm's optimal level of investment depends therefore on the marginal cost of external funds. The second way in which Cleary et al.'s (2004) model extends previous theories is by allowing negative levels of internal funds. The third is by determining the cost of borrowing funds endogenously[12].

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[10] A further challenge to FHP (1988) came in fact with Bond and Cummins (2001), Bond et al. (2004), and Oliner et al. (2005). Based on the *Q* model framework, these authors estimated equations of investment, using firm-specific earnings forecasts from securities analysts as measures of the fundamentals affecting the expected returns on investment. They found that when they controlled for expected profitability by using analysts' earnings forecasts, the correlation between investment spending and cash flow disappeared in all sub-samples of firms. Similar results were obtained by Erickson and Whited (2000) who regressed investment on a measure of *Q* adjusted for measurement error, and cash flow.

[11] Given that the firm's revenue is unobservable, the threat of liquidation is necessary to induce the firm to repay the investor.

[12] This is ensured by explicitly considering the investors' participation constraint. Cleary et al.'s (2004) model differs from existing theories mainly because all the three above mentioned assumptions hold

The trade-off between a cost and a revenue effect generates the main prediction of the model, i.e. that the investment-cash flow relationship is U-shaped. The cost effect arises because higher levels of investment are associated with higher repayment costs, a higher risk of default, and consequently a higher marginal cost of debt finance. This effect suggests a positive relationship between cash flow and investment. On the other hand, a revenue effect occurs because a higher level of investment generates higher revenue, which lowers the firm's risk of default and its marginal cost of debt finance. This effect suggests a negative relationship between cash flow and investment. The U-shaped relationship between investment and cash flow arises from the fact that the revenue effect is most powerful when cash flow is sufficiently negative, so that the survival of the firm is in doubt[13]. Otherwise the cost effect dominates.

Furthermore, according to Cleary et al.'s (2004) model, when those firms for which the cost effect dominates are classified according to the degree of external financial constraints that they face (i.e. on the basis of criteria such as size, age, their dividend-payout ratio or bond rating), then it is the most constrained firms which should display the highest investment-cash flow sensitivities.

3. Main features of the data and summary statistics

3.1 The data set

We construct our data set from the profit and loss and balance sheet data gathered by Bureau Van Dijk Electronic Publishing in the *Financial Analysis Made Easy* (FAME) database. This provides information on companies for the period 1993-2003[14]. Over 99 percent of the firms in the data set are not traded on the stock market[15]. Having access to financial variables for unquoted firms provides a unique opportunity to test the

simultaneously in their model. Other theories are based on one or two of the three assumptions, but never on all three contemporaneously (for instance, in Bernanke et al., 1999, investment is considered as scalable, but internal funds are not permitted to be negative).

[13] For firms in this situation, a large share of any loan would have to be used to pay existing debts or cover fixed costs, i.e. to try and make cash flow positive. Therefore, in the presence of a falling cash flow, these firms would have to increase their investment, in order to generate sufficient revenue to achieve this goal.

[14] A maximum of 10 years of complete data history can be downloaded at once. Our data were downloaded early in 2004: the coverage period is therefore 1993-2003.

[15] We only selected firms that have unconsolidated accounts: this ensures that the majority of the firms in our data set are relatively small. Moreover, it avoids the double counting of firms belonging to groups, which would be included in the data set if firms with consolidated accounts were also part of it.

financing constraints hypothesis[16]. This is because unquoted firms are obviously more likely to be characterized by adverse financial attributes such as a short track record, poor solvency, and low real assets compared to the quoted firms, which are typically large, financially healthy, long-established companies with good credit ratings. Unlike previous studies, our data allows us therefore to find proxies for financial constraints, characterized by a wide range of variation across observations in the sample.

The firms in our data set operate in all industrial sectors. This is also beneficial for us: the majority of studies that looked at the effects of financial constraints on firms' activities have in fact focused essentially on the manufacturing sector[17]. Yet, as explained in Bernanke et al. (1996), the share of sales by "small" firms is generally greater in other sectors.

We measure investment as the purchase of fixed tangible assets by the firm. Cash flow is obtained as the sum of the firm's after-tax profits and depreciation. Our measure of the replacement value of capital stock is derived from the book value of the firm's stock of tangible assets, using the investment data in a standard perpetual inventory formula.

We excluded companies that changed the date of their accounting year-end by more than a few weeks, so that the data refer to 12 month accounting periods. Firms that did not have complete records on investment, cash flow, or sales were also dropped, as well as firms with less than 3 years of continuous observations[18]. Finally, to control for the potential influence of outliers, we excluded observations in the 1% tails for each of the regression variables[19]. These types of rules are common in the literature and we employ them to ensure comparability with previous work (Bond et al., 2003; Oliner et al., 2005).

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[16] According to this hypothesis, if a financially constrained firm has a higher cash flow, then it will be able to afford to invest more and will do so. On the other hand, if an unconstrained firm has a higher cash flow, then its investment behavior is unlikely to change as this firm could have invested more anyway by using external sources of finance.

[17] A few exceptions are Schaller (1993) who estimated investment equations for manufacturing and non-manufacturing Canadian firms; Calem and Rizzo (1995) who focused on the US hospital industry; Zakrajsek (1997) and Benito (2005) who looked at inventory investment in the retail sector, respectively in the US, and in the UK and Spain; and Cleary (1999) and Cleary et al. (2004) who estimated investment equations for the entire US economy. To ensure comparability with the literature, in our empirical analysis, we will present separate results for manufacturing firms and for firms operating in the entire economy.

[18] At least three consecutive observations are needed for each firm, because our model will be estimated in first-differences using lagged values (dated t-2 and before) of the endogenous variables as instruments (see Section 4.2 for more details on our estimation methodology).

[19] More specifically, these cut-offs are aimed at eliminating observations reflecting particularly large mergers, extraordinary firm shocks, or coding errors.

The data sets that we use in estimation include a total of 39270 annual observations on 7534 companies, when we only focus on the manufacturing sector; and 124590 annual observations on 24184 companies, when we focus on the entire economy. Both samples cover the years 1996-2003 and have an unbalanced structure, with the number of years of observations on each firm varying between 3 and 8[20]. By allowing for both entry and exit, the use of an unbalanced panel partially mitigates potential selection and survivor bias.

3.2 Sample separation criteria

We use the level of cash flow available to firms as a proxy for the degree of internal financial constraints that they face[21]. Similarly, we consider the firms' size and age as proxies for the degree of external financial constraints that they face.

We first test whether cash flow has a differential impact on the investment of firms with different degrees of internal financial constraints. For this purpose, as in Cleary et al. (2004), we initially split firms on the basis of their cash flow to capital ratio. We therefore construct the following dummy variables:

i. $NEGCF_{it}$, which is equal to 1 if firm *i* has a negative cash flow to capital ratio at time *t*, and equal to 0, otherwise;

ii. $MEDIUMCF_{it}$, which is equal to 1 if firm *i* has a positive cash flow to capital ratio in year *t*, which falls below the 75th percentile of the distribution of the corresponding ratios of all the firms operating in the same industry as firm *i* in that particular year, and equal to 0, otherwise;

iii. $HIGHCF_{it}$, which is equal to 1 if firm *i* displays a positive cash flow to capital ratio in year *t*, which falls above the 75th percentile of the distribution

[20] See Appendix 1 for more information on the structure of our panel and more complete definitions of all variables used. Also note that because our estimation methodology (described below) uses lagged variables as instruments, the first three cross-sections of the data are used to construct the instruments: for this reason, although our original data set covers the period 1993-2003, the data set actually used in estimation only covers the years 1996-2003.

[21] It is a sensible choice to use cash flow as a proxy for internal funds for two main reasons. First, cash flow can take negative values. This is particularly important as according to Cleary et al.'s (2004) theory, it is for those firms whose internal funds are sufficiently negative, that the revenue effect dominates, leading to a negative relationship between investment and internal funds. Second, cash flow has been widely used in the investment literature as a measure of internal funds (see Shiantarelli, 1995; Hubbard et al., 1998, and Bond and Van Reenen, 2005). Yet, cash flow is not a perfect measure of internal funds because it is a flow variable, which does not include the stock of funds accumulated in the past. One can, however, claim that since cash flow is the main source of variation in internal funds, firms with negative cash flow are likely to have a low or negative level of internal funds (Cleary et al., 2004).

of the corresponding ratios of all the firms operating in the same industry as firm *i* in that particular year, and equal to 0, otherwise.

We use these dummies in our investment regressions as interactions on the cash flow term[22]. In this way, we allow firms to transit between classes[23].

To check robustness, we also use firms' financial status dummies defined in a similar way as above, but based on their coverage ratio ($NEGCOV_{it}$; $MEDCOV_{it}$, $HIGHCOV_{it}$). The coverage ratio is defined as the ratio between firms' total profits before tax and before interest and their total interest payments, and indicates the availability of internal funds that firms can use to finance their real activities[24]. As the coverage ratio has been widely used in the literature on the effects of financial constraints on firms' activities (see Carpenter et al., 1998; Gertler and Gilchrist, 1994; Guariglia and Schiantarelli, 1998; Guariglia, 1999, 2000; and Whited, 1992), we have decided to use this variable as our second measure of firms' internal funds, instead of the working capital to capital ratio, which was used by Cleary et al. (2004).

We then investigate whether cash flow has a different impact on the investment of firms facing different degrees of external financial constraints. For this purpose, we first partition firms on the basis of their size, measured by their total real assets. Smaller firms are likely to face more severe problems of asymmetric information as they are more likely to suffer from idiosyncratic risk, and to have lower collateral values relative to their liabilities, as well as higher bankruptcy costs, and short track records (Schiantarelli, 1995). Each year, we consider a firm's size relative to the situation of other firms in the industry in which that firm operates. We define as small firm-years ($SMALL_{it}$=1) within an industry, those firms whose real assets in year *t* are in the lowest quartiles of the distribution of the assets of all the firms in that particular industry and year. Similarly, we define as medium-sized firm-years ($MEDIUM_{it}$=1) within an industry, those firms whose real assets in year *t* fall in the second and third quartiles of the distribution. Finally, large firm-years ($LARGE_{it}$=1) are those firm-years with assets in the highest quartile of the distribution.

[22] The equations that we estimate are described in detail in Section 4.1.

[23] For this reason, our empirical analysis will focus on firm-years rather than simply firms. See Kaplan and Zingales (1997), Guariglia and Schiantarelli (1998), and Guariglia (2000) for a similar approach.

[24] More specifically, the coverage ratio is a measurement of the number of times a company could make its interest payments with its earnings before interest and taxes.

To check robustness, we also define the degree of asymmetric information faced by our firms in capital markets on the basis of their age[25]. Younger firms are more likely to face problems of asymmetric information, as their short track record makes it more difficult to judge their quality. We consider as young firm-years ($YOUNG_{it}$=1) within an industry, those firms whose age in year *t* falls in the lowest quartiles of the distribution of the ages of all the firms in that particular industry and year. Similarly, we define as middle-aged firm-years ($MIDDLEAGED_{it}$=1) within an industry, those firms whose age in year *t* is in the second and third quartiles of the distribution. Finally, old firm-years (OLD_{it}=1) are those with age in the highest quartile of the distribution. In all cases, we interact the constructed dummies with the cash flow variable in our investment regressions, allowing firms to transit between classes[26].

3.3 Summary statistics

Table 1 presents the means and standard deviations of the variables used in our regressions. Panel A refers to the manufacturing sector only, whereas Panel B refers to the entire economy. In both panels of the Table, column (1) refers to the full sample, columns (2) to (4), to the sub-samples based on the cash flow to capital ratio, and columns (5) to (7), to the sub-samples based on firms' size[27].

We can see from both panels of the Table, that when firm-years are classified on the basis of their cash flow to capital ratio, both the investment to capital ratio, and sales growth tend to rise monotonically as we move from firm-years with negative cash flow to firm-years with high cash flow. On the other hand, assets tend to be highest for those firm-years in the middle category. When firm-years are divided on the basis of their assets, it is the smallest firm-years which tend to have the highest investment to capital ratios, as well as the highest cash flow to capital ratios.

Table 2 presents the behaviour of investment to capital ratios for different percentiles of the cash flow to capital ratio. Columns (1) and (2) refer to the manufacturing sector and columns (3) and (4), to the entire economy. In both cases, we can see that the investment-cash flow relationship is U-shaped: the investment to

[25] Age is defined as the time elapsed from the incorporation date of the company.
[26] Due to data constraints, we could not use the dividend payout ratio as a sample separation criterion.
[27] Summary statistics relative to the sub-samples based on the coverage ratio and on firms' age are reported in Table A1 in Appendix 2.

capital ratios reach in fact a minimum when the cash flow to capital ratio is around 0, and then increase both when cash flow becomes negative, and when it rises above 0.

It is noteworthy that the percentage of firm-years with negative cash flow is 12.9% in our manufacturing sector sample, and 12.7% in our entire economy sample[28]. The corresponding percentages for small, medium, and large firm-years are 14.5%, 12.7%, 12.6%; and 13.5%, 12.8%, 12.4%, respectively for the manufacturing sector and the entire economy. It appears therefore that the splits of firm-years on the basis of the cash flow to capital ratio and real assets are not strongly correlated, as a similar percentage of firms with negative cash flow can be found among the small, medium, and large firm-years, and as real assets do not grow monotonically with cash flow. Dividing firm-years on the basis of their cash flow to capital ratio and on the basis of their assets, will therefore not necessarily lead to equal patterns of the investment-cash flow sensitivities for financially constrained and unconstrained firm-years. In the section that follows, we will provide formal tests of how the sensitivities change with the degree of internal and external financial constraints faced by firms.

4. Baseline specification and estimation methodology

4.1 Baseline specification

We initially estimate the following error-correction specification (see Bond et al., 2003, for a similar specification):

$$I_{it} / K_{i(t-1)} = a_0 + a_1 I_{i(t-1)}/K_{i(t-2)} + a_2 \Delta s_{it} + a_3 \Delta s_{i(t-1)} + a_4(k_{i(t-2)} - s_{i(t-2)}) + + a_5\, CF_{it} / K_{i(t-1)} + v_i + v_t + v_{jt} + e_{it} \quad (1)$$

where I is the firm's investment; K, the replacement value of its capital stock, and k, its logarithm; s, the logarithm of real sales; and CF, the firm's cash flow. The subscript i indexes firms; j, industries[29]; and t, time, where t=1996-2003.

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[28] A negative cash flow might be caused by significant fixed costs paid for instance to undertake some large investment project. Alternatively, it might be caused by the failure of a R&D project, as the latter projects are typically very risky (Carpenter and Petersen, 2002b). Within the manufacturing sector, the majority of firms with negative cash flow can be found in the following sectors: metals and metal goods; chemicals; electrical engineering; and others. The former three are typically R&D intensive sectors.

[29] When only the manufacturing sector is considered, firms are allocated to one of the following nine industrial sectors: metals and metal goods; other minerals, and mineral products; chemicals and man made fibres; mechanical engineering; electrical and instrument engineering; motor vehicles and parts, other transport equipment; food, drink, and tobacco; textiles, clothing, leather, and footwear; and others (Blundell et al., 1992). When the entire economy is considered, firms are allocated to the following seven groups: agriculture, forestry, and mining; manufacturing; construction; retail and wholesale; hotels and restaurants; business services; others (which include education, health, social work, repairs

Error-correction behaviour enters the empirical framework because of adjustment costs. In their presence the firm will not immediately adjust its capital stock (*k*) to the target level (*s*), which is assumed to be a function of sales. We specify a dynamic adjustment mechanism between *k* and *s* (the details of which are contained in Appendix 3). To be consistent with error-correction behaviour, the coefficient associated with the term ($k_{i(t-2)}$-$s_{i(t-2)}$) should be negative: if capital is lower (higher) than its desired level, future investment should in fact be higher (lower).

The error term in Equation (1) is made up of four components: v_i, which is a firm-specific component; v_t, a time-specific component accounting for possible business cycle effects; v_{jt}, a time-specific component which varies across industries, accounting for industry-specific shifts in investment demand or expectations (Carpenter and Petersen, 2002a; and Carpenter and Guariglia, 2003); and e_{it}, an idiosyncratic component. We control for v_i by estimating our equations in first-differences, for v_t by including time dummies, and for v_{jt} by including industry dummies interacted with time dummies in all our specifications.

When focusing on the differential impact of cash flow on the investment of different categories of firms, instead of estimating our investment equations on separate sub-samples of firms as in Cleary et al. (2004), we interact the cash flow variable in all our specifications with dummy variables indicating the degree of internal and external financial constraints faced by the firm. This approach allows us to avoid problems of endogenous sample selection; to gain degrees of freedom; and to take into consideration the fact that firms can transit between groups. We estimate equations of the type:

$$I_{it} /K_{i(t-1)} = a_0 + a_1 I_{i(t-1)}/K_{i(t-2)} + a_2 \Delta s_{it} + a_3 \Delta s_{i(t-1)} + a_4(k_{i(t-2)}-s_{i(t-2)}) + \\ + a_{51} [CF_{it} /K_{i(t-1)}*CATEGORY1_{it}] + a_{52} [CF_{it} /K_{i(t-1)}*CATEGORY2_{it}] + \\ a_{53} [CF_{it} /K_{i(t-1)}*CATEGORY3_{it}] + v_i + v_t + v_{jt} + e_{it}, \qquad (2)$$

where $CATEGORY1_{it}$, $CATEGORY2_{it}$, and $CATEGORY3_{it}$ refer in turn to the dummy variables based on the firms' cash flow to capital ratio ($NEGCF_{it}$, $MEDCF_{it}$, $HIGHCF_{it}$); to those based on their coverage ratio ($NEGCOV_{it}$, $MEDCOV_{it}$;

entertaining, and renting). Following Cleary (1999), the following industries are omitted from the analysis: finance, insurance, and real estate; transport, communication, electricity, gas, sanitary services; and public administration.

HIGHCOV$_{it}$); on their size (*SMALL$_{it}$*, *MEDIUM$_{it}$*; *LARGE$_{it}$*); and on their age (*YOUNG$_{it}$*, *MIDDLEAGED$_{it}$*, *OLD$_{it}$*).

4.2 Estimation methodology

We estimate Equations (1) and (2) using a first-difference Generalized Method of Moments (GMM) specification[30]. This technique takes unobserved firm heterogeneity into account by estimating the equation in first-differences, and controls for possible endogeneity problems by using the model variables lagged two or more periods as instruments[31].

In order to evaluate whether our model is correctly specified, we use two criteria: the Sargan test (also known as *J* test) and the test for second-order serial correlation of the residuals in the differenced equation (*m2*). If the model is correctly specified, the variables in the instrument set should be uncorrelated with the error term in Equations (1) and (2). The *J* statistic tests overidentifying restrictions. Under the null of instrument validity, it is asymptotically distributed as a chi-square with degrees of freedom equal to the number of instruments less the number of parameters. The *m2* test is asymptotically distributed as a standard normal under the null of no second-order serial correlation of the differenced residuals, and provides a further

[30] See Arellano and Bond (1991, 1998) on the application of the GMM approach to panel data. The program DPD for OX will be used in estimation (Doornik et al., 2003).

[31] An alternative estimator which could be used is the GMM system estimator, which combines in a system the original specification expressed in first-differences and in levels. This estimator, developed in Blundell and Bond (1998) is used when the simple first-differenced GMM estimator suffers from serious finite small sample biases. This generally occurs when the instruments used with the standard first-differenced GMM estimator (i.e. the endogenous variables lagged two or more periods) are not very informative, which is often the case in autoregressive models with persistent series, and in models where the variance of the fixed-effects is particularly high relative to the variance of the transitory shocks. A way to detect whether the simple first-differenced GMM estimator is affected by these finite sample biases is to compare the estimate of the coefficient on the lagged dependent variable obtained from the latter estimator with those obtained from the Ordinary Least Squares (OLS) and the within-groups estimators. As the OLS estimate is upward biased, whereas the within-groups estimate is downward biased, one would expect a consistent estimate of the coefficient on the lagged dependent variable to lie in between these two estimates. Should one find that the estimate obtained using the first-differenced GMM estimator lies close or below the within-groups estimate, then one could suspect the GMM estimate to be downward biased as well, possibly due to weak instruments (see Bond et al., 2001, for further discussion on this point). We therefore estimated Equation (1) using OLS, the within-groups estimator, and the GMM first-difference estimators. The coefficients associated with the lagged dependent variable were respectively 0.05, -0.33, and -0.09, when only the manufacturing sector was considered; and 0.04, -0.31, and -0.06, when the entire economy was considered. Because in both cases, the GMM first-difference estimate comfortably lies between the OLS and the within-groups estimates, we can conclude that the GMM first-difference estimates are unlikely to be subject to serious finite sample biases. Consequently, we do not report the estimates based on the system-GMM estimator. These, as well as the OLS and within-groups estimates, are however available from the authors upon request.

check on the specification of the model and on the legitimacy of variables dated *t*-2 as instruments in the differenced equation[32].

5. Empirical results

5.1 Investment equations without interactions

Table 3 presents the estimates of Equation (1). Column (1) refers to the full manufacturing sector sample. As expected the error-correction term attracts a negative sign, and the sales growth terms are both positive and statistically significant. The coefficient associated with the cash flow to capital ratio, 0.055, suggests that cash flow plays a positive and statistically significant effect on investment. Neither the Sargan test, nor the *m2* test for second-order autocorrelation of the differenced residuals indicate problems with the specification of the model or the choice of the instruments.

Column (2) reports the estimates relative to the full sample, for the entire economy. Once again, the coefficient associated with cash flow (0.038) is positive and precisely determined. Compared to the manufacturing sector, however, cash flow has a weaker effect on firms' investment. This might be explained by the fact that agency costs are more substantive for manufacturing firms, as their assets are "more specialized" and can less readily "serve as collateral" (Schaller, 1993).

In columns (3) and (4), we present the estimates of similar equations on samples, which exclude observations with negative cash flow to capital ratio[33]. For the manufacturing sector (column 3), the coefficient associated with the cash flow variable is now 0.085, whereas the corresponding coefficient for the entire economy is 0.043 (column 4). Both coefficients are precisely determined, and larger than those reported in columns (1) and (2), although the difference in the coefficients relative to the entire economy is rather small. This finding suggests that the observations with negative cash flow have lower (and possibly negative) investment-cash flow sensitivities than the other observations[34].

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[32] If the undifferenced error terms are *i.i.d.*, then the differenced residuals should display first-order, but not second-order serial correlation. Note that neither the *J* test nor the *m2* test allow to discriminate between bad instruments and model specification.

[33] Note that in some cases, after deleting observations with negative cash flow, a number of firms ended up having less than 3 observations. These firms were consequently deleted from the sample.

[34] Alayannis and Mozumdar (2004) also found that deleting from the sample observations with negative cash flow raised the coefficient on cash flow in their investment regressions.

Next, we will evaluate how exactly the investment-cash flow sensitivities differ across various sub-groups of firm-years.

5.2 Investment equations with interactions based on the degree of internal financial constraints faced by firms

Table 4 presents the estimates of Equation (2), where the interaction terms are based on the cash flow to capital ratio (columns 1 and 2, respectively for the manufacturing sector and the entire economy), and on the coverage ratio (columns 3 and 4, respectively for the manufacturing sector and the entire economy). Focusing on columns (1) and (2), we can see that the coefficient associated with cash flow is negative for firm-years with negative cash flow. Referring to the theoretical model described in Section 2.2, this can be explained considering that, for these firms, the revenue effect prevails over the cost effect: as cash flow falls, these firms have in fact to increase their investment in order to be able to deal with their financing gap, and to pay back their lenders. Columns (1) and (2) also suggest that cash flow does not have a precisely determined effect on the investment of those firm-years characterized by a moderate level of cash flow to capital. On the other hand, it plays a positive and significant effect on the investment of firm-years with high cash flow. These results are consistent with the idea that the relationship between investment and cash flow is U-shaped. They are also in line with the findings in KZ (1997), according to which the sensitivity of investment to cash flow is highest for the least financially constrained firms.

When the coverage ratio is used to differentiate the effects of cash flow on firms' investment, similar results as above take place in the manufacturing sector (column 3). Yet, when the entire economy is considered (column 4), cash flow attracts a positive and significant coefficient both for firm-years with middle-sized and high coverage ratio.

5.3 Investment equations with interactions based on the degree of external financial constraints faced by firms

Table 5 presents the results of the estimates of Equation (2) when firm-years are differentiated into small, medium, and large (columns 1 and 2, respectively for the manufacturing sector, and the entire economy) and into young, middle-aged, and old (columns 3 and 4, respectively for the manufacturing sector and the entire economy), i.e. on the basis of the degree of external financial constraints that they face.

In column (1), both small and medium-sized firm-years display a positive and precisely determined sensitivity of investment to cash flow, larger for the former (0.10) than for the latter (0.05). A similar pattern can be observed in column (2), where the coefficients are respectively 0.08 and 0.03 for small and medium-sized firm-years. For large firm-years, the coefficient associated with cash flow is poorly determined in both columns.

When firm-years are split on the basis of their age (columns 3 and 4), the coefficients associated with cash flow are once again only significant for the youngest and middle-aged firm years, and generally larger for the former.

It appears therefore that, although also significant for middle-sized and middle-aged firm-years, the sensitivity of investment to cash flow is larger for the smallest and youngest firm-years, which are more prone to facing asymmetric information problems. The estimates in this Table are in line with the findings in FHP (1988), according to which firms more likely to face financial constraints exhibit higher sensitivities of investment to cash flow[35].

These findings have significant policy implications: the fact that smaller and younger firms exhibit a higher sensitivity of investment to cash flow suggests that in order to make the small business community thrive, policies aimed at making the access to finance easier for small and medium-sized enterprises (SMEs) are likely to be particularly effective[36].

5.4 Summary

Overall, our results, based on a panel which includes a large number of unquoted UK firms over the period 1996-2003, can be summarized as follows. When firm-years are split on the basis of their level of internal funds, then those characterized by negative levels of these internal funds generally display a negative sensitivity of investment to

[35] The fact that in this Table the investment-cash flow sensitivities are never negative and precisely determined can be explained by the fact that the percentage of firms with negative cash flow is relatively small in all sub-groups of firms. Thus, in all sub-groups, the cost effect is likely to prevail over the revenue effect.

[36] In a recent report, the Government and Accountants Working Group (2004) states: "A thriving economy needs a thriving small business community and being able to access the right type of finance at the appropriate time is a crucial ingredient underpinning business success". Similarly, according to Bank of England (2004): "Ensuring that there is efficient intermediation of funds to small firms, based on a good understanding of risks and returns, is thus an important public policy objective".

cash flow, whereas those classified as having a middle-sized level of internal funds, exhibit a non-significant sensitivity, and those with high internal funds, a positive and precisely determined sensitivity. These results suggest that there is a U-shaped relationship between investment and cash flow. They are also in line with KZ (1997) and Cleary et al. (2004).

On the other hand, when firm-years are split on the basis of the degree of external financial constraints that they face, we find that the relationship between investment and cash flow is generally non-negative and monotonically increasing with the degree of the constraints. These results are in line with the empirical results in FHP (1988)[37].

These results suggest that the different conclusions reached by FHP (1988) and KZ (1997) about whether higher sensitivities of investment to cash flow can be interpreted as evidence that firms are more financially constrained, are probably due to the to the different criteria used in their studies to partition their sample.

We next analyze the sensitivities of investment to cash flow when the sample is split on the basis of combinations of various degrees of internal and external financial constraints.

5.5 Investment equations with interactions based on various combinations of internal and external financial constraints faced by firms

Columns (1) and (2) of Table 6 present the results of the estimation of Equation (1) when the effects of cash flow on investment are differentiated across firm-years facing various combinations of internal and external financial constraints, i.e. small, medium, and large firm-years with negative cash flow; small, medium, and large firm-years with medium cash flow; and small, medium, and large firm-years with high cash flow.

Column (1) reports the estimates relative to the manufacturing sector. It appears that cash flow attracts a positive and statistically significant effect only for those small and medium-sized firm-years with relatively high cash flow. The coefficient for the former (0.14) is higher than that for the latter (0.09), and higher

[37] All our results were generally robust to interacting all the regressors with the dummies relative to the level of internal funds available to the firms, or the dummies relative to the degree of asymmetric information faced by the firms. We also estimated more general versions of Equation (2) which included two of the *CATEGORY* dummies. Since the latter variables were never precisely determined,

than the corresponding coefficient on cash flow for small firm-years reported in column (1) of Table 5 (0.10). The *J* and *m2* tests do not indicate problems with the specification of the model and/or the instruments chosen.

Column (2) reports the estimates for the entire economy. Once again, it is the small firm-years with relatively high cash flow that display the highest sensitivity of investment to cash flow (0.07). As in column (1), cash flow attracts a positive and significant coefficient also for the medium-sized firm-years with relatively high cash flow. This coefficient (0.04) is however smaller than that for small firm-years. Finally, in this specification, we can also observe a negative and significant coefficient for medium-sized firm-years with negative cash flow.

Columns (3) and (4) of Table 6 presents robustness tests in which cash flow and size are respectively replaced with the coverage ratio and age as sample separation criteria. Column (3) presents estimates for the manufacturing sector. Like in column (1), it is only those young and middle-aged firm-years with relatively high coverage ratio that display positive and significant sensitivities of investment to cash flow. The sensitivities amount to 0.16 and 0.09 respectively for the two types of firm-years. Column (4) refers to the entire economy. The results are similar to those reported in column (2).

The results in this Table can be interpreted as follows. As external and internal financial constraints often have opposite effects on the sensitivities of investment to cash flow, when the two types of constraints are combined, the sensitivities are the highest when the two types of constraints affect firms' investment in the same direction. As high cash flow firm-years have the highest sensitivities when firm-years are split on the basis of the degree of internal financial constraints that they face (Table 4), and small and medium-sized firm-years display the highest sensitivities when a split based on the degree of external financial constraints is used (Table 5), it is not surprising to see that it is those firm-years that are both constrained externally, and unconstrained internally, which display the highest sensitivities.

The fact that investment at firm-years which are constrained both internally and externally does not seem to be affected by cash flow can be explained considering that negative cash flow leads to negative sensitivities, whereas being small leads to positive sensitivities. These two contrasting effects are likely to offset each other,

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we omitted them from our preferred specification. The inclusion of the dummies did not change the leading to a poorly determined coefficient for small firm-years with negative cash-flow. From an economic viewpoint, this result could also be explained considering that small firm-years with negative cash flow are particularly likely to be financially distressed. They might therefore have reached the minimum level of investment necessary to carry on production: further reductions in investment would therefore be impossible, even in response to declines in cash flow. Financially distressed firms might also be required by their creditors to use their cash flow to meet interest payments and/or improve the liquidity of their balance sheet (Fazzari et al., 2000; Huang, 2002; Allayannis and Monumbar, 2004; Cleary et al., 2004).

Finally, the fact that investment at firm-years with medium-sized cash flow does not seem to be affected by changes in cash flow, whatever the degree of external financial constraints faced by the firms can be explained considering that having a medium-sized cash flow generally leads to a poorly determined sensitivity. It is possible that this effect prevails over the positive effect that being externally financially constrained should play on the sensitivities.

In the light of these results, in order to make an economy thrive, public policies should endeavour to make access to finance easier especially for those SMEs characterized by relatively high levels of internal funds. It is in fact only those SMEs that will convert this additional finance into additional investment.

6. Conclusions

In this paper, we have tested whether internal and external financial constraints faced by firms have different effects on their sensitivity of investment to cash flow. Our test is based on a panel of UK firms, operating in all industrial sectors, a large number of which are unquoted. This allows our measures of financial constraints to display a wide degree of variation across observations. Furthermore, instead of using the traditional *Q*-model of investment in estimation, we have used an error-correction specification, which allows us to by-pass to a certain extent the criticism according to which cash flow might affect investment, simply because it picks up investment opportunities, not properly accounted for by *Q*. Finally, in addition to analyzing how the sensitivities of investment to cash flow differ at firms facing different degrees of internal financial constraints on the one hand, and different degrees of external

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magnitude and significance of the coefficients associated with the other regressors.

financial constraints, on the other, we have also focused on the effects of various combinations of internal and external financial constraints on the sensitivities, trying to identify the combinations leading to the highest sensitivities.

Our results, which are generally robust to considering only the manufacturing sector or the entire economy, suggest that when the sample is split on the basis of the level of internal funds available to the firms, the relationship between investment and cash flow is U-shaped. On the other hand, the sensitivity of investment to cash flow tends to increase monotonically with the degree of external financial constraints faced by firms. These findings suggest that the different conclusions reached by FHP (1988) and KZ (1997) about whether higher sensitivities of investment to cash flow can be interpreted as evidence that firms are more financially constrained, are probably due to the to the different criteria used in their studies to partition their sample.

Finally, combining the internal with the external financial constraints, we find that the sensitivities are the highest for those externally financially constrained firms that have a relatively high level of internal funds. The latter result is particularly important from a policy viewpoint: it suggests in fact that policies aimed at increasing a nation's investment should make the access to finance easier especially for those SMEs with a sufficiently high level of internal funds.

Whether similar patterns also hold when one focuses on other types of firms' activities such as inventory investment, R&D, or employment, remains an open question, which is on the agenda for future research.

Appendix 1: Data

Structure of the unbalanced panel for the manufacturing sector:

Number of observations per firm	Number of firms	Percent	Cumulative
3	1000	13.27	13.27
4	883	11.72	24.99
5	766	10.17	35.16
6	704	9.34	44.50
7	1230	16.33	60.83
8	2951	39.17	100.00
Total	7534	100.00	

Structure of the unbalanced panel for the entire economy:

Number of observations per firm	Number of firms	Percent	Cumulative
3	3514	14.53	14.53
4	2850	11.78	26.31
5	2506	10.36	36.68
6	2393	9.89	46.57
7	3429	14.16	60.73
8	9497	39.27	100.00
Total	24184	100.00	

Definitions of the variables used:

Investment. It is constructed as the difference between the book value of tangible fixed assets (which include land and building; fixtures and fittings; and plant and vehicles) of end of year *t* and end of year *t*-1 adding depreciation of year *t*.

Replacement value of the capital stock. It is calculated using the perpetual inventory formula (Blundell et al., 1992; Mizen and Vermeulen, 2005). We use tangible fixed assets as the historic value of the capital stock. We assume that replacement cost and historic cost are the same in the first year of data for each firm. We then apply the perpetual inventory formula as follows:

replacement value of capital stock at time *t*+1 =

replacement value at time t*(1-dep)*(p_{t+1} /p_t)+ investment at time *t*+1, where *dep* represents the depreciation rate, which we assume to be constant and equal to 5.5% for all firms; and p_t is the price of investment goods, which we proxy with the implicit deflator for gross fixed capital formation.

Cash flow. It is defined as the sum of after tax profit and depreciation.

Coverage ratio. It is defined as the ratio between the firm's total profits before tax and before interest and its total interest payments.

Total assets. It is defined as the sum of fixed assets and current assets.

Deflators. Investment, the capital stock, and contracted capital expenditures are deflated using the implicit price deflator for gross fixed capital formation. Other variables are deflated using the aggregate GDP deflator.

Appendix 2: Additional summary statistics

Table A1 presents the mean and standard deviations of the variables used in our regressions when firm-years are split on the basis of their coverage ratio and their age. Panel A refers to the manufacturing sector, and Panel B to the entire economy.

Appendix 3: The error-correction model

The error-correction model for investment was initially proposed by Bean (1981). It has been subsequently used by Hall et al. (1999), Bond et al. (2003), and Mizen and Vermeulen (2005) to test the financing constraints hypothesis[38].

In order to derive Equation (1) in the main text, we initially assume that in the absence of adjustment costs or barriers to immediate adjustment, the firm's desired capital stock takes the form:

$$k_{it} = s_{it} - \sigma j_{it} + v_i, \qquad \text{(A.1)}$$

where k_{it} represents the logarithm of the firms' capital stock; s_{it}, the logarithm of the firms' sales; j_{it}, the real user cost of capital; and v_i, a firm-specific effect[39].

[38] This Appendix draws on Hall et al. (1999) and Bond et al. (2003).

[39] As discussed in Hall et al. (1999) and Bond et al. (2003), this is consistent with a neoclassical model of a profit maximizing firm, with no adjustment costs, a single type of capital, and a CES or Cobb-Douglas production function.

Yet, in the presence of adjustment costs, the firm will not be able to immediately adjust its capital stock to the target level. We therefore specify a dynamic adjustment mechanism between *k* and *s* as an autoregressive-distributed lag of length two, in which Equation (A.1) is nested as a long-run equilibrium. Also assuming that all variations in the user cost of capital are subsumed in the time-specific components of the error term, we obtain:

$$k_{it} = \alpha_1 k_{i(t-1)} + \alpha_2 k_{i(t-2)} + \alpha_3 s_{it} + \alpha_4 s_{i(t-1)} + \alpha_5 s_{i(t-2)} + v_i + v_t + v_{jt} + e_{it}, \qquad \text{(A.2)}$$

where v_i is a firm-specific effect; v_t, a time-specific component; v_{jt}, a time-specific effect that varies across industries; and e_{it}, an idiosyncratic error term. Re-parameterizing this model in an error-correction form, and imposing the restriction that in the long-run $(\alpha_3 + \alpha_4 + \alpha_5)/(1- \alpha_1 - \alpha_2)$ is equal to 1[40], we obtain:

$$\Delta k_{it} = (\alpha_1 - 1)s_{i(t-1)} + \alpha_3 \Delta s_{it} + (\alpha_3 + \alpha_4)\Delta s_{i(t-1)} - (1- \alpha_1 - \alpha_2)(k_{i(t-2)} - s_{i(t-2)}) + \\ + v_i + v_t + v_{jt} + e_{it}. \qquad \text{(A.3)}$$

Using the approximation $\Delta k_{it} \approx I_{it} / K_{i(t-1)} - \delta_i$, where δ_i stands for firm-specific depreciation and is subsumed in the v_i component of the error term, and including the cash flow to capital ratio to capture effects associated with financial constraints, yields Equation (1) in the text. To be consistent with error-correction behavior, the coefficient associated with the term $(k_{i(t-2)} - s_{i(t-2)})$ should be negative: if capital is lower (higher) than its desired level, future investment should in fact be higher (lower).

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[40] This restriction ensures that in the long-run, returns to scale are constant.

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Table 1: Descriptive statistics

Panel A: Manufacturing sector

	All firm-years	Firm-years such that $NEGCF_{it}$=1	Firm-years such that. $MEDCF_{it}$=1	Firm-years such that $HIGHCF_{it}$=1	Firm-years such that $SMALL_{it}$=1	Firm-years such that $MEDIUM_{it}$=1	Firm-years such that $LARGE_{it}$=1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Real assets	388.30 (4294.0)	325.29 (1652.6)	417.26 (4173.5)	347.44 (5424.0)	11.782 (4.70)	51.533 (31.61)	983.18 (7038.2)
$I_{it} / K_{i(t-1)}$	0.168 (0.26)	0.119 (0.27)	0.145 (0.21)	0.255 (0.36)	0.179 (0.28)	0.169 (0.27)	0.162 (0.25)
Δs_{it}	0.030 (0.22)	-0.096 (0.27)	-0.004 (0.19)	0.072 (0.22)	0.009 (0.23)	-0.00003 (0.21)	0.004 (0.21)
$(k_{i(t-2)}-s_{i(t-2)})$	-1.576 (0.89)	-1.587 (0.88)	-1.330 (0.76)	-2.201 (0.88)	-1.976 (0.94)	-1.601 (0.87)	-1.376 (0.81)
$CF_{it} / K_{i(t-1)}$	0.371 (0.71)	-0.331 (0.45)	0.219 (0.13)	1.134 (1.00)	0.481 (0.89)	0.357 (0.68)	0.342 (0.66)
Number of observations	39270	5096	24599	9575	6063	18753	14454

Notes: The Table reports sample means. Standard deviations are presented in parentheses. The subscript i indexes firms, and the subscript t, time, where t=1996-2003. I represents the firm's investment; K, the replacement value of its capital stock; s, the logarithm of its sales; k, the logarithm of its capital stock; and CF, its cash flow. $NEGCF_{it}$ is a dummy variable equal to 1 if firm i has a negative cash flow to capital ratio at time t, and equal to 0, otherwise. $MEDCF_{it}$ is a dummy variable equal to 1 if firm i has a positive cash flow to capital ratio in year t, which falls below the 75th percentile of the distribution of the cash flow to capital ratios of all firms belonging to the same industry as firm i in year t. $HIGHCF_{it}$ is a dummy equal to 1 if firm i's cash flow to capital ratio is positive in year t, and above the 75th percentile of the distribution of the cash flow to capital ratios of all firms belonging to the same industry as firm i in year t, and equal to 0 otherwise. $SMALL_{it}$ is a dummy variable equal to 1 if firm i's total real assets are in the lowest quartile of the distribution of the total assets of all firms belonging to the same industry as firm i in year t, and 0, otherwise. $MEDIUM_{it}$ is a dummy variable equal to 1 if firm i's total assets are in the second and third quartiles of the distribution of the total assets of all firms belonging to the same industry as firm i in year t, and 0, otherwise. $LARGE_{it}$ is a dummy variable equal to 1 if firm i's total assets are in the highest quartile of the distribution of the total assets of all firms belonging to the same industry as firm i in year t, and 0, otherwise.

Panel B: Entire economy

	All firm-years	Firm-years such that $NEGCF_{it}$=1	Firm-years such that. $MEDCF_{it}$=1	Firm-years such that $HIGHCF_{it}$=1	Firm-years such that $SMALL_{it}$=1	Firm-years such that $MEDIUM_{it}$=1	Firm-years such that $LARGE_{it}$=1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Real assets	323.806 (4639.1)	287.43 (4396.0)	331.81 (3912.0)	321.739 (6303.0)	8.542 (4.21)	37.453 (21.92)	880.307 (7855.6)
$I_{it} / K_{i(t-1)}$	0.194 (0.36)	0.158 (0.39)	0.158 (0.27)	0.310 (0.52)	0.207 (0.40)	0.192 (0.36)	0.190 (0.35)
Δs_{it}	0.030 (0.26)	-0.074 (0.32)	0.024 (0.22)	0.103 (0.27)	0.034 (0.26)	0.024 (0.26)	0.036 (0.25)
$(k_{i(t-2)}-s_{i(t-2)})$	-1.789 (1.34)	-1.811 (1.30)	-1.445 (1.23)	-2.714 (1.20)	-2.220 (1.16)	-1.778 (1.30)	-1.571 (1.42)
$CF_{it} / K_{i(t-1)}$	0.548 (1.43)	-0.586 (0.96)	0.261 (0.20)	1.951 (2.30)	0.688 (1.61)	0.522 (1.41)	0.508 (1.36)
Number of observations	124590	15873	79612	29105	23045	58426	43119

Notes: The Table reports sample means. Standard deviations are presented in parentheses. The subscript i indexes firms, and the subscript t, time, where t=1996-2003. I represents the firm's investment; K, the replacement value of its capital stock; s, the logarithm of its sales; k, the logarithm of its capital stock; and CF, its cash flow. $NEGCF_{it}$ is a dummy variable equal to 1 if firm i has a negative cash flow to capital ratio at time t, and equal to 0, otherwise. $MEDCF_{it}$ is a dummy variable equal to 1 if firm i has a positive cash flow to capital ratio in year t, which falls below the 75th percentile of the distribution of the cash flow to capital ratios of all firms belonging to the same industry as firm i in year t. $HIGHCF_{it}$ is a dummy equal to 1 if firm i's cash flow to capital ratio is positive in year t, and above the 75th percentile of the distribution of the cash flow to capital ratios of all firms belonging to the same industry as firm i in year t, and equal to 0 otherwise. $SMALL_{it}$ is a dummy variable equal to 1 if firm i's total real assets are in the lowest quartile of the distribution of the total assets of all firms belonging to the same industry as firm i in year t, and 0, otherwise. $MEDIUM_{it}$ is a dummy variable equal to 1 if firm i's total assets are in the second and third quartiles of the distribution of the total assets of all firms belonging to the same industry as firm i in year t, and 0, otherwise. $LARGE_{it}$ is a dummy variable equal to 1 if firm i's total assets are in the highest quartile of the distribution of the total assets of all firms belonging to the same industry as firm i in year t, and 0, otherwise.

Table 2: Is the investment curve U-shaped?

$CF_{it}/K_{i(t-1)}$ *percentiles*	*Manufacturing*	*Manufacturing*	*Entire economy*	*Entire economy*
	Mean $CF_{it}/K_{i(t-1)}$ (1)	Mean $I_{it}/K_{i(t-1)}$ (2)	Mean $CF_{it}/K_{i(t-1)}$ (3)	Mean $I_{it}/K_{i(t-1)}$ (4)
<=1%	<= (-1.03)	0.23	<= (-2.02)	0.36
2%-5%	(-1.03) – (-0.24)	0.15	(-2.02) – (-0.34)	0.22
6%-10%	(-0.24) – (-0.048)	0.12	(-0.34) – (-0.005)	0.14
11%-25%	(-0.048) – 0.11	0.10	(-0.005) – 0.10	0.10
26%-50%	0.11 – 0.24	0.13	0.10 – 0.26	0.14
51%-75%	0.24 – 0.49	0.20	0.26 – 0.63	0.22
76%-90%	0.49 – 0.99	0.25	0.63- 1.52	0.31
90%-95%	0.99 – 1.53	0.33	1.52 – 2.66	0.41
95%-99%	1.53 – 3.54	0.37	2.66 – 7.29	0.49
>99%	> 3.54	0.40	>7.29	0.57

Notes: The subscript i indexes firms, and the subscript t, time, where t=1996-2003. I represents the firm's investment; K, the replacement value of its capital stock; and CF, its cash flow.

Table 3: The effects of cash flow on investment: an error-correction approach

Dependent Variable: $I_{it} / K_{i(t-1)}$	Full sample	Full sample	Excluding obs. with $CF_{it} / K_{i(t-1}$<0	Excluding obs. with $CF_{it} / K_{i(t-1}$<0
	Manuf.	Entire econ.	Manuf.	Entire econ.
	(1)	(2)	(3)	(4)
$I_{i(t-1)} / K_{i(t-2)}$	-0.093**	-0.056**	-0.131**	-0.073**
	(0.04)	(0.02)	(0.05)	(0.03)
Δs_{it}	0.357**	0.425**	0.564***	0.451**
	(0.17)	(0.18)	(0.19)	(0.21)
$\Delta s_{i(t-1)}$	0.241***	0.205***	0.279***	0.215***
	(0.06)	(0.04)	(0.07)	(0.05)
$(k_{i(t-2)}-s_{i(t-2)})$	-0.218***	-0.159***	-0.254***	-0.178***
	(0.06)	(0.04)	(0.08)	(0.05)
$CF_{it} / K_{i(t-1)}$	0.055***	0.038***	0.084***	0.043***
	(0.02)	(0.01)	(0.03)	(0.01)
Sample size	39270	12459	30788	97551
m2	-0.91	-0.08	-1.37	-0.02
J (*p*-value)	0.81	0.02	0.79	0.11

Notes: All specifications were estimated using a GMM first-difference specification. The figures reported in parentheses are asymptotic standard errors. Time dummies and time dummies interacted with industry dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity. *m2* is a test for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The *J* statistic is a test of the overidentifying restrictions, distributed as chi-square under the null of instrument validity. Instruments in both columns are $(k_{i(t-2)}-s_{i(t-2)})$; and $I_{i(t-2)} /K_{i(t-3)}$, $\Delta s_{i(t-2)}$, $CF_{i(t-2)} /K_{i(t-3)}$ and further lags. Time dummies and time dummies interacted with industry dummies were always included in the instrument set. Also see Notes to Table 1. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 4: The effects of cash flow on investment: distinguishing firm-years on the basis of the degree of internal financial constraints that they face

Dependent Variable: $I_{it} / K_{i(t-1)}$	*CF*-interactions	*CF*-interactions	*COV*-interactions	*COV*-interactions
	Manuf.	Entire econ.	Manuf.	Entire econ.
	(1)	(2)	(3)	(4)
$I_{i(t-1)} / K_{i(t-2)}$	-0.070**	-0.064**	-0.105**	-0.048
	(0.03)	(0.02)	(0.05)	(0.03)
Δs_{it}	0.212**	0.509***	0.322**	0.422***
	(0.09)	(0.13)	(0.15)	(0.14)
$\Delta s_{i(t-1)}$	0.222***	0.214***	0.255***	0.187***
	(0.04)	(0.04)	(0.07)	(0.05)
$(k_{i(t-2)}-s_{i(t-2)})$	-0.198***	-0.165***	-0.228***	-0.135**
	(0.05)	(0.04)	(0.07)	(0.06)
$(CF_{it}/K_{i(t-1)})*NEGCF_{it}$	-0.152**	-0.047*		
	(0.07)	(0.027)		
$(CF_{it}/K_{i(t-1)})*MEDCF_{it}$	-0.056	-0.046		
	(0.07)	(0.06)		
$(CF_{it}/K_{i(t-1)})*HIGHCF_{it}$	0.065***	0.045***		
	(0.02)	(0.01)		
$(CF_{it}/K_{i(t-1)})*NEGCOV_{it}$			-0.195**	-0.062**
			(0.097)	(0.03)
$(CF_{it}/K_{i(t-1)})*MEDCOV_{it}$			0.021	0.078**
			(0.04)	(0.03)
$(CF_{it}/K_{i(t-1)})*HIGHCOV_{it}$			0.097***	0.065***
			(0.04)	(0.02)
Sample size	39270	124590	30087	91886
m2	-0.89	-0.28	-0.37	-0.85
J (*p*-value)	0.522	0.132	0.30	0.05

Notes: All specifications were estimated using a GMM first-difference specification. The figures reported in parentheses are asymptotic standard errors. Time dummies and time dummies interacted with industry dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity. *m2* is a test for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The *J* statistic is a test of the overidentifying restrictions, distributed as chi-square under the null of instrument validity. Instruments in columns (1) and (2) are $(k_{i(t-2)}-s_{i(t-2)})$, $I_{i(t-2)} / K_{i(t-3)}$, $\Delta s_{i(t-2)}$, $CF_{i(t-2)}/K_{i(t-3)} *(NEGFC_{i(t-2)})$, $CF_{i(t-2)}/K_{i(t-3)} *(MEDCF_{i(t-2)})$, and $CF_{i(t-2)}/K_{i(t-3)} *(HIGHCF_{i(t-2)})$ and further lags. Instruments in columns (3) and (4) are $(k_{i(t-2)}-s_{i(t-2)})$, $I_{i(t-2)} / K_{i(t-3)}$, $\Delta s_{i(t-2)}$, $CF_{i(t-2)}/K_{i(t-3)} *(NEGCOV_{i(t-2)})$, $CF_{i(t-2)}/K_{i(t-3)} *(MEDCOV_{i(t-2)})$, and $CF_{i(t-2)}/K_{i(t-3)} *(HIGHCOV_{i(t-2)})$ and further lags. Time dummies and time dummies interacted with industry dummies were always included in the instrument set. Also see Notes to Table 1. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 5: The effects of cash flow on investment: distinguishing firm-years on the basis of the degree of external financial constraints that they face

Dependent Variable: $I_{it} / K_{i(t-1)}$	Size-interactions	Size-interactions	Age-interactions	Age-interactions
	Manuf.	Entire econ.	Manuf.	Entire econ.
	(1)	(2)	(3)	(4)
$I_{i(t-1)} / K_{i(t-2)}$	-0.133***	-0.074***	-0.134***	-0.062**
	(0.05)	(0.02)	(0.04)	(0.02)
Δs_{it}	0.561***	0.509***	0.506***	0.388**
	(0.19)	(0.16)	(0.143)	(0.16)
$\Delta s_{i(t-1)}$	0.285***	0.231***	0.291***	0.218***
	(0.06)	(0.04)	(0.06)	(0.04)
$(k_{i(t-2)}-s_{i(t-2)})$	-0.261***	-0.188***	-0.268***	-0.175***
	(0.06)	(0.04)	(0.06)	(0.04)
$(CF_{it}/K_{i(t-1)})*SMALL_{it}$	0.105***	0.076***		
	(0.03)	(0.02)		
$(CF_{it}/K_{i(t-1)})*MEDIUM_{it}$	0.052***	0.031***		
	(0.02)	(0.01)		
$(CF_{it}/K_{i(t-1)})*LARGE_{it}$	0.005	0.018		
	(0.03)	(0.01)		
$(CF_{it}/K_{i(t-1)})*YOUNG_{it}$			0.065**	0.048***
			(0.03)	(0.01)
$(CF_{it}/K_{i(t-1)})*MIDDLEAGED_{it}$			0.053**	0.040***
			(0.02)	(0.01)
$(CF_{it}/K_{i(t-1)})*OLD_{it}$			-0.016	-0.001
			(0.03)	(0.01)
Sample size	39270	124581	39270	124581
m2	-1.17	-0.20	-0.93	0.019
J (*p*-value)	0.88	0.03	0.76	0.05

Notes: All specifications were estimated using a GMM first-difference specification. The figures reported in parentheses are asymptotic standard errors. Time dummies and time dummies interacted with industry dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity. *m2* is a test for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The *J* statistic is a test of the overidentifying restrictions, distributed as chi-square under the null of instrument validity. Instruments in columns (1) and (2) are $(k_{i(t-2)}-s_{i(t-2)})$, $I_{i(t-2)}/K_{i(t-3)}$, $\Delta s_{i(t-2)}$, $CF_{i(t-2)}/K_{i(t-3)} *(SMALL_{i(t-2)})$, $CF_{i(t-2)}/K_{i(t-3)} *(MEDIUM_{i(t-2)})$, and $CF_{i(t-2)}/K_{i(t-3)} *(LARGE_{i(t-2)})$ and further lags. Instruments in columns (3) and (4) are $(k_{i(t-2)}-s_{i(t-2)})$, $I_{i(t-2)}/K_{i(t-3)}$, $\Delta s_{i(t-2)}$, $CF_{i(t-2)}/K_{i(t-3)} *(YOUNG_{i(t-2)})$, $CF_{i(t-2)}/K_{i(t-3)} *(MIDDLEAGED_{i(t-2)})$, and $CF_{i(t-2)}/K_{i(t-3)} *(OLD_{i(t-2)})$ and further lags. Time dummies and time dummies interacted with industry dummies were always included in the instrument set. Also see Notes to Table 1. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 6: The effects of cash flow on investment: distinguishing firm-years on the basis of combinations of different degrees of internal and external financial constraints

Dependent Variable: $I_{it} / K_{i(t-1)}$	Cash flow and size interactions Manuf. (1)	Cash flow and size interactions Entire econ. (2)	Coverage ratio and age interactions Manuf. (3)	Coverage ratio and age interactions Entire econ. (4)
$I_{i(t-1)} / K_{i(t-2)}$	-0.100** (0.05)	-0.093*** (0.03)	-0.076 (0.06)	-0.095*** (0.03)
Δs_{it}	0.323** (0.15)	0.460*** (0.14)	0.157 (0.19)	0.505*** (0.14)
$\Delta s_{i(t-1)}$	0.247*** (0.06)	0.262*** (0.04)	0.220** (0.08)	0.257*** (0.06)
$(k_{i(t-2)}-s_{i(t-2)})$	-0.239*** (0.07)	-0.232*** (0.05)	-0.201** (0.08)	-0.225*** (0.06)
$(CF_{it}/K_{i(t-1)})*(NEGCF_{it}/NEGCOV_{it})*$ $(SMALL_{it}/YOUNG_{it})$	-0.194 (0.18)	-0.077 (0.09)	-0.106 (0.16)	0.014 (0.11)
$(CF_{it}/K_{i(t-1)})*(NEGCF_{it}/NEGCOV_{it})*$ $(MEDIUM_{it}/MIDDLEAGED_{it})$	-0.167 (0.13)	-0.090** (0.03)	-0.177 (0.13)	-0.04 (0.04)
$(CF_{it}/K_{i(t-1)})*(NEGCF_{it}/NEGCOV_{it})*$ $(LARGE_{it}/OLD_{it})$	-0.079 (0.14)	0.049 (0.06)	-0.050 (0.20)	-0.132 (0.10)
$(CF_{it}/K_{i(t-1)})*(MEDCF_{it}/MEDCOV_{it})*$ $(SMALL_{it}/YOUNG_{it})$	0.271 (0.21)	0.196 (0.17)	0.043 (0.07)	0.048 (0.04)
$(CF_{it}/K_{i(t-1)})*(MEDCF_{it}/MEDCOV_{it})*$ $(MEDIUM_{it}/MIDDLEAGED_{it})$	-0.024 (0.12)	-0.091 (0.07)	0.018 (0.05)	0.071** (0.03)
$(CF_{it}/K_{i(t-1)})*(MEDCF_{it}/MEDCOV_{it})*$ $(LARGE_{it}/OLD_{it})$	0.089 (0.10)	-0.102 (0.07)	-0.014 (0.13)	0.018 (0.05)
$(CF_{it}/K_{i(t-1)})*(HIGHCF_{it}/HIGHCOV_{it})*$ $(SMALL_{it}/YOUNG_{it})$	0.143*** (0.03)	0.074*** (0.02)	0.158** (0.06)	0.088*** (0.03)
$(CF_{it}/K_{i(t-1)})*(HIGHCF_{it}/HIGHCOV_{it})*$ $(MEDIUM_{it}/MIDDLEAGED_{it})$	0.091*** (0.03)	0.040*** (0.01)	0.095** (0.04)	0.058** (0.02)
$(CF_{it}/K_{i(t-1)})*(HIGHCF_{it}/HIGHCOV_{it})*$ $(LARGE_{it}/OLD_{it})$	0.059 (0.04)	0.019 (0.016)	-0.010 (0.06)	-0.0006 (0.02)
Sample size	39270	124590	30083	91877
m2	-0.893	0.542	-0.123	0.090
J (*p*-value)	0.967	0.542	0.609	0.418

Notes: All specifications were estimated using a GMM first-difference specification. The figures reported in parentheses are asymptotic standard errors. Time dummies and time dummies interacted with industry dummies were included in all specifications. Standard errors and test statistics are asymptotically robust to heteroskedasticity. *m2* is a test for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The *J* statistic is a test of the overidentifying restrictions, distributed as chi-square under the null of instrument validity. Instruments in all columns are $(k_{i(t-2)}-s_{i(t-2)})$, $I_{i(t-2)} / K_{i(t-3)}$, $\Delta s_{i(t-2)}$ and further lags, together with the relevant multiple interaction terms lagged twice or more. Time dummies and time dummies interacted with industry dummies were always included in the instrument set. Also see Notes to Table 1. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table A.1: Descriptive statistics when firm-years are divided on the basis of their coverage ratio and their age

Panel A: Manufacturing sector

	Firm-years such that $NEGCOV_{it}$=1	Firm-years such that. $MEDCOV_{it}$=1	Firm-years such that $HIGHCOV_{it}$=1	Firm-years such that $YOUNG_{it}$=1	Firm-years such that $MIDDLEAGED_{it}$=1	Firm-years such that OLD_{it}=1
	(1)	(2)	(3)	(4)	(5)	(6)
Real assets	342.910 (1700.9)	499.790 (7239.9)	362.53 (1678.9)	283.676 (2300.0)	249.24 (1777.4)	657.72 (6977.8)
$I_{it} / K_{i(t-1)}$	0.121 (0.26)	0.176 (0.26)	0.188 (0.26)	0.204 (0.31)	0.174 (0.27)	0.141 (0.23)
Δs_{it}	-0.088 (0.25)	-0.023 (0.19	0.038 (0.21)	0.028 (0.24)	0.007 (0.22)	-0.016 (0.20)
$(k_{i(t-2)}-s_{i(t-2)})$	-1.411 (0.83)	-1.479 (0.86)	-1.741 (0.88)	-1.719 (0.97)	-1.637 (0.90)	-1.414 (0.80)
$CF_{it} / K_{i(t-1)}$	-0.120 (0.41)	0.304 (0.40)	0.716 (0.78)	0.443 (0.89)	0.390 (0.73)	0.307 (0.55)
Number of observations	5892	17424	6771	5874	20522	12874

Notes: The Table reports sample means. Standard deviations are presented in parentheses. The subscript *i* indexes firms, and the subscript *t*, time, where *t*=1996-2003. *I* represents the firm's investment; *K*, the replacement value of its capital stock; *s*, the logarithm of its sales; *k*, the logarithm of its capital stock; and *CF*, its cash flow. $NEGCOV_{it}$ is a dummy variable equal to 1 if firm *i* has a negative coverage ratio at time *t*, and equal to 0, otherwise. $MEDCOV_{it}$ is a dummy variable equal to 1 if firm *i* has a positive coverage ratio in year *t*, which falls below the 75^{th} percentile of the distribution of the coverage ratios of all firms belonging to the same industry as firm *i* in year *t*. $HIGHCOV_{it}$ is a dummy equal to 1 if firm *i*'s coverage ratio is positive in year *t*, and above the 75^{th} percentile of the distribution of the coverage ratios of all firms belonging to the same industry as firm *i* in year *t*, and equal to 0 otherwise. $YOUNG_{it}$ is a dummy variable equal to 1 if firm *i*'s age is in the lowest quartile of the distribution of the ages of all firms belonging to the same industry as firm *i* in year *t*, and 0, otherwise. $MIDDLEAGED_{it}$ is a dummy variable equal to 1 if firm *i*'s age is in the second and third quartiles of the distribution of the ages of all firms belonging to the same industry as firm *i* in year *t*, and 0, otherwise. OLD_{it} is a dummy variable equal to 1 if firm *i*'s age is in the highest quartile of the distribution of the ages of all firms belonging to the same industry as firm *i* in year *t*, and 0, otherwise.

Panel B: Entire economy

	Firm-years such that $NEGCOV_{it}$=1	Firm-years such that. $MEDCOV_{it}$=1	Firm-years such that $HIGHCOV_{it}$=1	Firm-years such that $YOUNG_{it}$=1	Firm-years such that $MIDDLEAGED_{it}$=1	Firm-years such that OLD_{it}=1
	(1)	(2)	(3)	(4)	(5)	(6)
Real assets	310.74 (4454.9)	407.84 (5253.9)	376.03 (6275.4)	223.35 (1797.5)	186.92 (1313.2)	594.44 (7863.3)
$I_{it} / K_{i(t-1)}$	0.155 (0.38)	0.191 (0.34)	0.215 (0.36)	0.264 (0.46)	0.202 (0.37)	0.154 (0.31)
Δs_{it}	-0.074 (0.30)	0.045 (0.23)	0.066 (0.25)	0.061 (0.29)	0.037 (0.26)	0.006 (0.23)
$(k_{i(t-2)}-s_{i(t-2)})$	-1.600 (1.21)	-1.656 (1.34)	-1.973 (1.22)	-2.127 (1.38)	-1.848 (1.34)	-1.569 (1.28)
$CF_{it} / K_{i(t-1)}$	-0.408 (0.86)	0.408 (0.82)	1.066 (1.67)	0.698 (1.76)	0.594 (1.51)	0.418 (1.12)
Number of observations	15307	55831	20748	13810	70155	40616

Notes: The Table reports sample means. Standard deviations are presented in parentheses. The subscript *i* indexes firms, and the subscript *t*, time, where *t*=1996-2003. *I* represents the firm's investment; *K*, the replacement value of its capital stock; *s*, the logarithm of its sales; *k*, the logarithm of its capital stock; and *CF*, its cash flow. $NEGCOV_{it}$ is a dummy variable equal to 1 if firm *i* has a negative coverage ratio at time *t*, and equal to 0, otherwise. $MEDCOV_{it}$ is a dummy variable equal to 1 if firm *i* has a positive coverage ratio in year *t*, which falls below the 75^{th} percentile of the distribution of the coverage ratios of all firms belonging to the same industry as firm *i* in year *t*. $HIGHCOV_{it}$ is a dummy equal to 1 if firm *i*'s coverage ratio is positive in year *t*, and above the 75^{th} percentile of the distribution of the coverage ratios of all firms belonging to the same industry as firm *i* in year *t*, and equal to 0 otherwise. $YOUNG_{it}$ is a dummy variable equal to 1 if firm *i*'s age is in the lowest quartile of the distribution of the ages of all firms belonging to the same industry as firm *i* in year *t*, and 0, otherwise. $MIDDLEAGED_{it}$ is a dummy variable equal to 1 if firm *i*'s age is in the second and third quartiles of the distribution of the ages of all firms belonging to the same industry as firm *i* in year *t*, and 0, otherwise. OLD_{it} is a dummy variable equal to 1 if firm *i*'s age is in the highest quartile of the distribution of the ages of all firms belonging to the same industry as firm *i* in year *t*, and 0, otherwise.

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