european corporate governance institute

ecgi

Is Investment-Cash Flow Sensitivity Caused by the Agency Costs or Asymmetric Information? Evidence from the UK

Finance Working Paper N°. 69/2005

February 2005

Grzegorz Pawlina
Lancaster University

Luc Renneboog
Tilburg University and ECGI

ECGI Working Paper Series in Finance

Is Investment-Cash Flow Sensitivity Caused by the Agency Costs or Asymmetric Information? Evidence from the UK

Working Paper N°. 69/2005

February 2005

Grzegorz Pawlina
Luc Renneboog

Grzegorz Pawlina recognizes support from the European Union's Phare ACE Programme. Luc Renneboog is grateful for financial support by the Netherlands Foundation of Scientfic Research and to European Commission's FP6 project 'New Modes of Governance' (coordinated by the RSCAS of the European University Institute). The content of this paper is the sole responsibility of the authors and does not represent the views of the Commission or its services. The authors are grateful to John Doukas, Carles Gispert, Marc Goergen, Klaus Gugler, Harijono Harijono, Abe de Jong, Joe McCahery, Chris Veld, an anonymous referee and participants of the Investment and Corporate Governance Workshop in Cambridge and the European Financial Management Association Annual Meeting in Basle for helpful comments. All remaining errors are ours.

Abstract

We investigate the investment-cash flow sensitivity of a large sample of the UK listed firms and confirm that investment is strongly cash flow-sensitive. Is this suboptimal investment policy the result of agency problems when managers with high discretion overinvest, or of asymmetric information when managers owning equity are underinvesting if the market (erroneously) demands too high a risk premium? We find that the observed cash flow sensitivity results mainly from the agency costs of free cash flow. The magnitude of the relationship depends on insider ownership in a non-monotonic way. Furthermore, we obtain that outside blockholders, such as financial institutions, the government, and industrial firms (only at high control levels), reduce the cash flow sensitivity of investment via effective monitoring. Finally, financial institutions appear to play a role in mitigating informational asymmetries between firms and capital markets. We corroborate our findings by performing additional tests based on the stochastic efficient frontier approach and power indices.

Keywords: investment-cash flow sensitivity, ownership and control, asymmetric information, liquidity constraints, agency costs of free cash flow, large shareholder monitoring, Shapley values

JEL Classifications: D92, G31, G32

Grzegorz Pawlina*
Lancaster University
Department of Accounting and Finance
Lancaster, LA1 4YX
United Kingdom
e-mail: g.pawlina@lancaster.ac.uk

Luc Renneboog
Tilburg University
Department of Finance and CentER for Economic Research
Warandelaan 2
5000 LE Tilburg
The Netherlands
phone: +13-31-4668210 , fax: +13-31-4662875
e-mail: Luc.Renneboog@uvt.nl

* Corresponding Author

1. Introduction

In perfect and complete markets, investment decisions of a firm are independent from its financial situation (Modigliani and Miller, 1958). Firms undertake investment projects if and only if the present value of discounted cash flows exceeds the associated capital expenditure. In other words, firms invest as long as the marginal dollar of the capital expenditure generates at least one dollar of a present value of cash flows (Tobin, 1969). Moreover, there is no capital rationing since firms can always obtain external financing at a cost equal to their (true) cost of capital. However, in imperfect or incomplete markets the financial structure of a firm becomes relevant. For example, if the capital markets' participants face significant uncertainty about the firm's future prospects, the cost of external capital often exceeds the cost of internal financing.

In general, there are a number of factors that make a firm's investment policy depend on its financial position. According to Jensen and Meckling (1976), owners-managers of a levered firm tend to overinvest and choose too risky (and often negative NPV) projects due to their limited liability. Myers (1977) shows that capital structure can influence investment decisions even without apparent market imperfections: risky debt may lead to underinvestment due to the wealth transfer from shareholders to creditors that occurs upon investment. Myers and Majluf (1984) also discuss how investment policy depends on the way a firm is financed. They show that asymmetric information between a firm and the capital markets may result in the rejection of good investment opportunities because the providers of external capital include into the cost of capital a risk premium reflecting the risk of an average investment project. A similar rationale is developed by Stiglitz and Weiss (1981), who describe how asymmetric information may result in the rationing of debt finance (which can be viewed as an infinite cost of external financing beyond its certain level). Finally, according to Jensen (1986), suboptimal investment can occur due to agency costs between shareholders and management, when the latter's objective function does not reflect the interests of shareholders.

While the above shows that investment policy can be explained by many theories involving the choice of financing (debt versus equity, outside equity versus internally generated funds), agency costs (management versus monitoring blockholders), asymmetric information (between management and the providers of external equity) and moral hazard (the choice of risk of an investment project), we address a narrower research question in this paper. Namely, we intend to investigate why the level of corporate investments depends on the firm's available free cash flow. In other words, we examine the reasons why investment is sensitive to the firm's cash flow, as observed in their seminal work by Fazzari, Hubbard and Petersen (hereafter FHP, 1988). In principle, this sensitivity will be observed if (*i*) there is a wedge between the cost of internal and external financing, and (*ii*) the decision to spend a marginal unit of internally generated funds is consistent with the utility maximization problem of top management. Consequently, the observed sensitivity can be attributed either to asymmetric information problems (Myers and Majluf, 1984; Stiglitz and Weiss, 1981) or to agency costs of free cash flow (Jensen, 1986), for which conditions (*i*) and (*ii*) are satisfied.[1] In general, it is possible that some firms exhibit a high investment-cash flow sensitivity due to informational asymmetries (such firms would underinvest), whereas others may suffer from overinvestment attributable to the agency costs of free cash flow.

Asymmetric information may lead to the rejection of good investment opportunities because external financing may be deemed overly expensive by the management (whose information is mostly superior to that of outside investors, cf. Myers and Majluf, 1984; Myers, 1984). As the market is less well informed about the firm's or the project's quality, it may demand a premium on the capital provided that is equal to the premium charged to the median firm. This mechanism may lead to adverse selection among the firms applying for external financing. As a result, a relatively higher number of poorer quality firms may seek external financing as the relative cost of external funds (taking into account the project's quality) is lower than for high quality firms. Moreover, a fraction of good investment projects which are not profitable enough to compensate for the excessively high cost of external financing (compared to the perfect information situation) are foregone. Thus, asymmetric information leads to hierarchy of financing sources (*pecking order theory*): good firms choose in the first instance internal financing, then debt (as the least informationally sensitive form of external

[1] Asset substitution and debt overhang problems - analyzed by Jensen and Meckling (1976) and Myers (1977), respectively - are associated with distortions in investment policy not related directly to conditions (*i*) and (*ii*) and, therefore, do not have a straightforward impact on the investment-cash flow sensitivity.

financing), subsequently all kinds of hybrid debt with equity components, and finally external equity as a last resort. In this situation, asymmetric information leads to an *underinvestment* problem. A related problem of debt rationing is described by Stiglitz and Weiss (1981) and Greenwald, Stiglitz and Weiss (1984). Here, the only way for the creditors to break even is to limit debt financing in order to balance the proportions of credit granted to risky and safe companies. As a result of such a credit rationing, some positive NPV projects are not undertaken in the resulting capital market equilibrium.

Another source of the investment-cash flow sensitivity is the agency conflict between shareholders and management (Jensen, 1986, 2001; Bernanke and Gertler, 1989; Stulz, 1990). Corporate managers' interests may not be perfectly aligned to the interests of shareholders as the utility managers derive from managing firms has been shown to be an increasing function of the corporations' size. Many academic papers show that the pecuniary and non-pecuniary managerial benefits are higher in larger companies than in smaller ones (see e.g. Conyon, 1998; Conyon and Murphy, 2000; Renneboog and Trojanowski, 2004). Therefore, management's corporate objective may be growth rather than value. If this is the case, the free cash flow hypothesis predicts that investment projects are undertaken as long as there is a free cash flow in the firm (which is - from the managerial view point - *too inexpensive* in relation to the true cost of capital). As a consequence, negative net present value investments could also be undertaken resulting in *overinvestment*. It should be noted that both asymmetric information and agency problems may result in a positive relationship between liquidity and investment.

This study has the following aims. First, we investigate whether the widely-documented positive relation between corporate investment and liquidity (as demonstrated for the US in FHP, 1988, see also a survey by Hubbard, 1999) is also present in the UK. We do so by estimating the standard reduced-form investment q-model, which controls for firms' investment opportunities.

Second, unlike most past investment research (cf. Vogt, 1994; Hadlock, 1998; Morgado and Pindado, 2003), we use multiple criteria to identify whether suboptimal investment is triggered by asymmetric information or it results from the agency cost of free cash flow. To achieve our objective, we analyze the influence of ownership and control structures, growth opportunities and a firm's technical efficiency of deploying its assets on the relationship between the investment level and liquidity. More specifically, we focus on (*i*) the distribution of voting rights over different types of large shareholders, (*ii*) the interaction of the cash flow sensitivity and the firm's growth opportunities under different ownership and control patterns and (*iii*) the impact of technical efficiency (calculated using the 'optimal' Tobin's q – see infra) on this interaction. Our results provide strong support for the free cash flow theory as the main source of the observed investment-cash flow sensitivity. We also find some support for the asymmetric information hypothesis for a group of companies largely controlled by financial institutions.

We test our hypotheses on a large sample of 985 firms listed on the London Stock Exchange over period 1992-98. This period is interesting for two reasons. First, it corresponds to an economic boom period during which liquidity constraints may be binding for expanding firms. Second, it embeds a period of improving corporate governance standards. Since July 1993, all listed firms are obliged to comply with the recommendations of the Cadbury Committee (published in December 1992).[2]

Relatively few papers test the investment-liquidity relation in a corporate governance framework. Recent exceptions include Kathuria and Mueller (1995), Hadlock (1998), and Gugler and Yurtoglu (2003), for the US, Gugler (2003) for Austria, Haid and Weigand (2001) for Germany, Degryse and de Jong (2000) for the Netherlands, Pindado and de la Torre (2004) for Spain, and Goergen and Renneboog (2001) for the UK. This paper contributes to the existing literature by distinguishing between investment inefficiencies induced by agency cost of free cash flow and asymmetric information using an extensive set of ownership variables. Furthermore, a large sample covering more than 85% of the market capitalization of UK industrial firms is explored. In addition, some techniques such as the stochastic frontier approach (SFA) and the Shapley value methodology, are novel to or largely unexploited in the corporate investment research.

[2] The role of the Cadbury Committee was to prevent the reoccurrence of spectacular business failures characteristic for the decade of the 1980s. The committee, chaired by Sir Adrian Cadbury, was drawn from representatives from the top level of British industry, created a code of practice to assist UK corporations in defining and applying internal controls to limit their exposure to financial loss, from whatever cause. Whilst the recommendations themselves are not mandatory, all accounts of UK-listed companies must now clearly state whether or not the code has been followed and, if applicable, the reason for non-compliance has to be presented. For details, see Cadbury Committee (1992).

This paper presents some interesting findings. We find that the relationship between cash flow sensitivity and insider control is non-monotonic and reflects the interplay of managerial alignment of interests and entrenchment.[3] The interpretation of our results consistent with Jensen's (1986) free cash flow theory indicates that at increasing share stakes managers' interests become aligned with those of the shareholders and remain such for very high levels of insider ownership. At the same time, managerial entrenchment is likely to emerge at moderate to higher managerial equity stakes. Secondly, we find that the presence of large outside blockholders (and the related monitoring) mitigates the free cash flow problem. This is due to the blockholders' incentive to monitor being positively related to their equity participation since the benefits of monitoring are proportional to the shareholding whereas the costs are independent from it and are borne by the shareholder in their entirety (cf. Grossman and Hart, 1980; Demsetz, 1983).

Furthermore, we provide some support for the hypothesis that the presence of institutional blockholders facilitates the access to external financing, hence decreasing the reliance of a firm's investments on internal cash flow (cf. Hoshi, Kashyap and Scharfstein, 1991).

The use of the stochastic efficient frontier methodology to estimate a hypothetical 'efficient *q*', which the is the highest Tobin's *q* a firm can achieve using its resources optimally, yields some interesting results. We assume that firms with low technical efficiency are poorly managed and that efficient corporate governance is lacking. In such firms, agency problems may be important. In general, we find a negative relationship between the investment-cash flow sensitivity and corporate efficiency. This supports our earlier result that firms whose investment is sensitive to cash flow, suffer from agency problems, which is ultimately reflected in lower valuations. Finally, by analyzing firms pursuing different share repurchase and dividend policies, we provide evidence that observed cash flow sensitivity *does* reflect liquidity constraints.[4]

The remainder of the paper is organized as follows. In Section 2, we discuss the relevant literature, while in Section 3, we formulate our hypotheses. Section 4 includes the description of the data set and methodology. In Section 5, we present our main results and Section 6 concludes.

[3] As not only the impact of insider control in absolute numbers needs to be examined, we capture relative control exerted by insiders by calculating Shapley values.

2. Literature

Fazzari, Hubbard and Petersen (hereafter FHP, 1988) open the debate on the impact of financing constraints on the investment level.[5] They test the relationship between liquidity and capital expenditure for a sample of US manufacturing firms. The firms are classified into three categories based on the long-term dividend ratio, a proxy for financing constraints. FHP (1988) regress investment on cash flow and Tobin's *q* (the latter being a proxy for investment opportunities). The results show that the financial position in all the groups affects the firms' investment level, but the sensitivity of capital expenditures with respect to cash flow fluctuations is the highest in a subsample of low-dividend firms. Fazzari and Petersen (1993) provide further support for the liquidity constraints hypothesis of FHP (1988) by analyzing the role of working capital as a use of funds. Their study concludes that the investment of low-dividend firms appear to be more cash flow sensitive and that working capital does seem to compete with fixed investment for funds.

Carpenter (1995) is one of the first authors who attempts to determine why liquidity constraints result in the cash flow sensitivity of investment. For a sample of big and mature low-*q* firms, he analyses debt-for-equity swaps, which can be viewed as a way to improve managerial efficiency by reducing free cash flow. A lower dependence of investment on available funds following the swap suggests the presence of overinvestment prior to the restructuring. Additional support for the free cash flow-based explanation is provided by Kadapakkam, Kumar and Riddick (1998), who use the sample of firms from 6 OECD countries. Kadappakkam et al. report that investment of larger firms exhibits higher cash flow sensitivity. This is consistent with a view that managers of large firms that experience more serious agency problems of free cash flow, tend to expand the firm size whenever internal funds are available.

In a paper on Japanese firms, Hoshi, Kashyap and Scharfstein (1991) extend the analysis by considering a corporate control framework, namely the firms' relations with large banks belonging to

---

[4] The assumption of liquidity constraints underlies both the free cash flow- and asymmetric information-based explanation of the positive relationship between cash flow and investment.

[5] A number of empirical contributions, though less directly related to our paper, are concerned with testing structural equations based on the Euler equations (cf. Abel, 1980; Bond and Meghir, 1994). In these models, the level of investment relative to the firm's capital is then expressed as a function of discounted expected future investment adjusted for the impact of the expected changes in the input prices and net marginal output.

large industrial groups (*keiretsu*). *Keiretsu* firms have closer ties to banks and hence easier access to external financing, which reduces liquidity constraints. Hoshi et al. confirm a lower investment-cash flow sensitivity of *keiretsu* members, which is in line with the asymmetric information hypothesis. Support for this hypothesis is also provided by Hadlock (1998), who studies the impact of insider shareholdings on the investment-cash flow sensitivity of US firms. The author finds an inverted U-shaped relationship, which indicates that *i*) management's participation in equity makes them more sensitive to the premium charged by the market on external financing, and that *ii*) entrenchment, which occurs at the higher ownership levels, reverses this relationship.

Kaplan and Zingales (hereafter KZ, 1997) present a critique of FHP (1988) and of related articles, which claim that the cash flow sensitivity of corporate investment reflects financing constraints faced by the firm. Using the subsample of firms used by FHP (1988), KZ (1997) analyze both quantitative and qualitative information on firms and find that less constrained companies exhibit significantly higher cash flow sensitivity of investment. FHP (2000) respond by indicating a number of inconsistencies in the KZ (1997) approach, such as ignoring "*firm's incentives to maintain debt capacity and precautionary cash stocks that can be used to partially offset shocks to the flow of internal finance*", using a small sample that is not sufficiently heterogeneous for drawing meaningful conclusions, and classifying firms with respect to the degree of financing constraints using fairly subjective set of criteria.

Cleary (1999) contributes to the FHP-KZ debate by proxying the level of financing constraints with the firms' creditworthiness measured by the Altman (1968) Z-score. He finds the highest investment-cash flow sensitivity for the subsample of non-constrained firms, which supports KZ (1996). More recent contributions, such as Alti (2003), and Gomes (2001) provide mixed conclusions about the role of financing constraints in generating high investment-cash flow sensitivities. Using a simulation approach, Moyen (2004) reconciles the results of FHP (1988) and KZ (1997) by using subsamples without and with, respectively, *a priori* imposed financial constraints. Almeida and Campello (2002) obtain that credit-constrained firms exhibit higher sensitivity than those with free access to capital markets. Using the real options framework, Boyle and Guthrie (2003) show that relatively unconstrained firms do overinvest, however, the magnitude of overinvestment in those firms is positively related to the degree of financing constraints.

To summarize, the existing literature confirms the existence of the positive investment-cash flow sensitivity, identifies that it can be based on the agency cost of free cash flow and/or asymmetric information, but fails to resolve under which circumstances it is related to the liquidity constraints. Since both agency theoretical and asymmetric information-based explanations of the cash flow sensitivity of investment rely on the assumption of a costly access to external capital, a properly designed empirical attempt to disentangle those two hypotheses should also verify that liquidity constraints are a driving force of the sensitivity observed in the sample.

3. Hypotheses

3.1. *Agency cost of free cash flow*

High free cash flows may tempt management to pursue an 'empire building'-strategy (Grossman and Hart, 1982) and, hence, to overinvest (Jensen, 1986). The reason for this agency problem is that management not only receives a higher remuneration in larger firms (Conyon and Murphy, 2000), but that management may also be able to extract private benefits of control (which may be non-pecuniary, like prestige) from managing larger firms (Dyck and Zingales, 2004). Thus, a high amount of corporate liquidity may encourage growth-maximizing management to pursue investment projects with an expected rate of return below the hurdle rate. In other words, internal financing is sufficiently *in*expensive from the managerial viewpoint so that even negative NPV, scale-increasing projects are undertaken. This free cash flow-agency problem reflected in a positive relation between cash flow and investment is expected to be more substantial in widely-held companies with low managerial ownership. The investment-cash flow sensitivity is likely to initially decrease with increasing managerial ownership as co-ownership is expected to turn the management's focus to shareholder value maximization. This is due to the fact that alignment of interests will prevent management from squandering extra cash flow on unprofitable projects. Hence, we expect *an initially negative* *relationship between the investment-cash flow sensitivity and insider ownership due to better alignment of interests and lower agency costs* (*Hypothesis 1a*).

The investment-cash flow sensitivity is not expected to decrease monotonically with rising insider control. At higher levels of managerial ownership, a second type of agency problem may arise: entrenched managers may expropriate the rights of minority shareholders (for examples see Johnson et al., 2000) and pursue too aggressive an investment policy. This may result in the investment-cash flow sensitivity increasing for moderate to high levels of managerial ownership. (Likewise, Morck, Shleifer and Vishny (1988) and McConnell and Servaes (1990) show that insider ownership has a non-linear impact on firm value.) Finally, if the managerial ownership becomes sufficiently high, that is, when management internalizes a large fraction of the changes in the firm's value resulting from suboptimal investments, the investment-cash flow sensitivity will decrease (cf. Morck et al., 1988). Hence, we expect *an S-shaped relationship between the investment-cash flow sensitivity and insider ownership due to the magnitude of the agency cost of free cash flow changing with insider ownership (Hypothesis 1b).*

Corporate monitoring by large outside shareholders and by non-executive directors is expected to attenuate the agency conflicts between management and shareholders. The costs of free cash flow may be reduced when shareholders perform an active monitoring role (Lai and Sudarsanam, 1997; Lasfer, 1995). Existing empirical evidence for the UK shows that industrial corporations as well as individuals (not related to the firm's top management) owning large share blocks discipline incumbent management in the wake of a performance decline and in the absence of managerial entrenchment (see Franks, Mayer and Renneboog, 2001). Since a shareholder internalizes the entire cost related to her control efforts but benefits only in proportion to her share stake (Grossman and Hart, 1980; Demsetz, 1983), monitoring will only be cost effective if this shareholder (or a coalition of shareholders) becomes sufficiently large.[6] Hence, we expect that *blockholder monitoring reduces agency costs and hence the investment-cash flow sensitivity (Hypothesis 1c*).

[6] Beyond a certain ownership level another problem may occur: the expropriation of minority shareholders by large blockholders more severe conflict between majority and minority shareholders (Shleifer and Vishny, 1997; Johnson et al., 2000.)

The agency-related overinvestment problem is more serious in mature firms with low growth perspectives (Jensen, 1986; Carpenter, 1995). Those low-*q* firms suffer from a shortage of positive NPV projects. As a result, it may be that extra cash flow generated may be squandered by its managers on value-destroying projects (see Vogt, 1994). In other words, for low-*q* firms, the availability of additional cash flow may be associated with excess investment spending. Hence, we expect *a higher investment-cash flow sensitivity for low-q firms (Hypothesis 1d).*

If managers run companies efficiently, they do not exhibit empire-building behavior and their investment policies are not related to the internally generated cash flow. Consequently, in firms where the observed Tobin's *q* is close to the efficient *q*, the investment policy should not be sensitive to liquidity. High efficiency means that the firm resources are not wasted by overspending management. One should be able to observe this most clearly in the low-*q* firms, which are more prone to the free cash flow problem. Hence, we expect *a negative relation between cash flow sensitivity and technical efficiency for low-q firms, which reflects the diminishing agency costs of free cash flow (Hypothesis 1e).*

3.2. *Asymmetric Information*

A shortage of internally generated funds will lead to corporate underinvestment due to asymmetric information (Myers and Majluf, 1984). This occurs when a firm faces insufficient funds to finance an investment project and when the financial markets to which the management turns to attract additional funds, have less information about the true NPV of the project. Even for high quality projects, the less-informed financial markets demand a risk premium that reflects average project quality. This risk premium may be deemed excessively high for some projects that actually do pass the management's hurdle rate which correctly reflects the project's risk. Similarly, in the presence of informational asymmetries the firm may face credit rationing in the debt markets (Stiglitz and Weiss, 1981). Consequently, management may be forced to pass over some positive NPV projects as a consequence of asymmetric information. This underinvestment problem is expected to be more important when the management of an otherwise widely-held firm controls a large equity stake (Hadlock, 1998). The positive relationship between cash flow and corporate investment induced by asymmetric information will decrease with falling levels of insider ownership. When the management owns only a small stake in a widely held firm, it may accept the (excessive) risk premium of the financial markets and knowingly invest in, effectively, negative NPV projects (see Hadlock, 1998). Hence, we expect *an initially positive relationship between investment-cash flow sensitivity and insider ownership due to management internalizing a higher fraction of the premium on external capital (Hypothesis 2a).*

The underinvestment problem described in Hypothesis 2a will be attenuated if a block of the firm's shares is held by a financial institution. Kahn and Winton (1998) argue that the large blockholding of a financial institution reduces the informational asymmetry between the institution and the firm. Combined with the result of Shleifer and Vishny (1986), who state that a shareholder has an incentive to gather information about the firm if their stake is sufficiently large, blockholding by financial institutions is expected to reduce informational asymmetries between the firm and the capital market due to institutions' expertise and active capital market participation. In such a case, the firm could rely more heavily on external sources of financing, of which cost will be closer to the firm's true cost of capital (Hoshi, Kashyap and Scharfstein, 1991). Consequently, we hypothesize that the presence of a financial institution reduces the asymmetric information problem, underinvestment, and the resulting investment-cash flow sensitivity. Hence, we expect *a negative relationship between institutional blockholding and investment-cash flow sensitivity (Hypothesis 2b).*

When liquidity constraints are present, the underinvestment problem is expected to be more outspoken for high growth companies (with high Tobin's *q*). This is due to the fact that the informational asymmetry is more severe when a large proportion of the firm's value can be attributed to growth opportunities of which the quality is to a large extent unverifiable ex ante (cf. Myers and Majluf, 1984). Furthermore, a closely related argument is that the relative amount of collateral that those companies are able to pledge is limited (cf. Almeida and Campello, 2004). This makes the cost of external financing higher, which, in turn, results in a stronger relationship between the internally generated cash flow and investment. Hence, we expect *a higher investment-cash flow sensitivity of high-q firms (Hypothesis 2c).*

Finally, while high-*q* firms are in general more prone to asymmetric information problems, the problem of asymmetric information and the resulting high risk premium which causes the underinvestment problem, may be reduced in firms with investment opportunities recognized by the market. If corporate efficiency is somehow observed by the market (i.e. Tobin's *q* is close to the efficient *q*), we should observe a negative relationship between investment-cash flow sensitivity and technical efficiency as measured by the ratio of Tobin's *q* to efficient *q*. Hence, we expect *a negative relation between cash flow sensitivity and technical efficiency for high-q firms, reflecting diminishing informational asymmetry* (*Hypothesis 2d).*

The possible reasons for the observed investment cash-flow sensitivity – the agency cost of free cash flow and asymmetric information – are difficult to disentangle as both result in a positive sign of the relationship. Still, by analyzing the investment-cash flow sensitivity across samples with (*i*) different levels of insider ownership, (*ii*) different levels of outside block ownership, (*iii*) varying magnitudes of the monitoring activity of financial institutions, proxied by their block ownership, and (*iv*) changing levels of firms' efficiency (as measured by the degree to which the use of assets in place are efficiently translated in growth opportunities), one can determine the dominant reason of the observed relationship.

In the case of the agency cost of free cash flow, we expect to see high cash flow sensitivity at low levels of insider ownership, a reduction of this sensitivity at its rising levels, a subsequent increase at moderate levels of insider control, and a futher decline at its high stakes (Morck et al., 1988). Furthermore, the magnitude of overinvestment is likely to be initially reduced by enhanced monitoring by industrial corporations, and by individuals (not related to a director) or families.[7] Finally, agency costs may be lower in more efficient firms (with *q*'s closer to their efficient *q*'s) even if these firms have a low Tobin's *q*. We expect there to be a negative or insignificant relation cash flow sensitivity in such firms due to smaller agency problems

If asymmetric information is the main source of the observed suboptimal investment, we expect cash flow sensitivity to be strongest at low to moderate and very high levels of managerial

[7] We use the UK definition of a director: a director is a person serving on the board of directors and can have an executive or non-executive position.

ownership. Moreover, we hypothesize a negative relationship between institutional ownership and cash flow sensitivity due to financial institutions collecting information on the quality of management and their investment projects. Furthermore, if corporate efficiency is recognized by the market (which is captured by the firm's Tobin's q being close to its efficient q), the investment-cash flow sensitivity will be lower.

3.3. *Financing constraints*

Since both the free cash flow theory and asymmetric information hypothesis rely on the assumption that the (pre-contractual) cost of external financing exceeds the cost of internally generated funds, we test whether the observed relationship can be attributed to liquidity constraints. Firms that are the most likely candidates as being liquidity constrained are those firms that reduce dividends or refrain from repurchasing their shares (cf. FHP, 1988; Goergen and Renneboog, 2001; Correia da Silva et al. 2004). Evidence of a significantly higher cash flow sensitivity for liquidity constrained firms would support the hypothesis that the sensitivity is generated by a need of funds, and not other factors, such as cash flow proxying for investment opportunities failed to be captured by market-to-book value ratio, or the capital structure adjustments (Moyen, 2004). Hence, we expect a *negative relationship between dividend increases/share repurchases and investment-cash flow sensitivity (Hypothesis 3).*

4. Data and methodology

4.1. *Data sources and variable description*

Of all the firms listed on the London Stock Exchange, we exclude banks, insurance companies, and other financial firms as the type of corporate investments and accounting data differ from those of industrial and commercial firms. We also exclude utilities of which the investment behavior and access to external financing is regulated. We also only retain firms for which we have ownership data were available in the Worldscope Disclosure data set over the period 1992-1998. Our sample consists of 985 UK firms listed on the London Stock Exchange and includes 206 agricultural, mining, forestry, fishing and construction firms (SIC codes 1-1999), 407 manufacturing firms (SIC codes 2000-3999), 204 retail and wholesale firms (SIC codes 5000-5999) and 168 service firms (SIC codes 7000-8999).

Descriptive statistics of the data are included in Table 1 (currency denominated items are in GBP '000s). The average and median investment of our sample firms amount to, respectively, 9.7% and 4.4% of the capital stock while the median cash flow standardized by capital is 42%. Average leverage is almost 40%. The median current ratio is about 1.4 and the median firm manages to service its debt well as the median interest coverage amounts to 5.3. Our proxy for Tobin's *q*, market-to-book value of assets averages 1.87 with a median of 1.45. The optimally attainable or efficient *q* is higher with an average of 3.61 and a median of 1.67 (for the calculation methodology, see infra). The median return on equity is 12.9% whereas the median operating margin amounts to 7.1%. UK companies pay out about 20% of earnings in dividends. On average, dividends increase by 47% over the sample period of 1992-98 (with a median of 9.2%), 70.1% of firms increase dividends, whereas 16.2% of firms do not change dividends. 5.8% of our sample repurchased equity, but the average percentage of equity bought back remained very small at 8.3% of equity. New equity issues using rights or open offers were undertaken by 52.1% of firms with an average of 10.8% of equity capital. The variables used in the regression analysis are defined as in the Worldscope database unless stated otherwise.

[Insert Table 1 about here]

Table 2 shows the evolution of investment levels over the sample period. Both the median and mean levels fluctuate over time. As of 1995, a buoyant economy is further stimulated by increasing investments, which median level amounts to GBP 0.96 million.

[Insert Table 2 about here]

The ownership data, including the name and the percentage of shares held by a given shareholder are collected from Worldscope. We categorized ownership stakes by class of shareholder: (*i*) institutional investors consisting of banks, investment and pension funds, insurance companies, and real estate firms; (*ii*) industrial and commercial companies; (*iii*) individuals and families not related to a director; (*iv*) government; and (*v*) insiders consisting of: the CEO and his family, the chairman and his family, executive directors (excluding CEO and chair) and their families, and non-executive directors (excluding the chair) and their families. To distinguish between more than 5000 insider and outsider individual shareholders, we consulted the London Stock Exchange Monitor and the Who's Who-guides. To identify institutional shareholders, we consulted Datastream, Institutional Investors Annual Guides and the world wide web.

The largest owner in the median UK firm owns about 15.5% (with a mean of about 21%, see panel A of Table 3). Accumulating all large shareholders who own share stakes of at least 5%, we find that the average shareholder coalition controls almost 40% of the voting rights. Panel B also shows that there is little variability in accumulated ownership across time. The low median and average Herfindahl index of Panel C shows that control is not concentrated in the hands of one or two large shareholders but that equity stakes are held by about six large shareholders in most firms.

[Insert Tables 3 and 4 about here]

Table 4 gives a detailed analysis of ownership by type of owner. Financial institutions are clearly the strongest shareholder class: they are present in most UK firms but their individual stakes are usually smaller than 10%. Corporations control the largest equity stake in only 10% of listed UK firms, but when they do this shareholding is large (about 30%). Likewise, families and individuals (not related to a director) own share stakes in a minority of sample firms but usually have a large control stake. Since the privatizations of the 1980s, the government only rarely holds a (small) equity stake in listed firms. An important shareholder class comprises inside shareholders, consisting of the CEO, the chairman, executive and non-executive directors. Their large equity stake is partly explained by the fact that yearly a number of firms are floated on the stock exchange, amounting to 4% of all listed companies. At floatation, the initial (pre-IPO) shareholders retain an average accumulated shareholding of 62% (Goergen and Renneboog, 2001), which is gradually diluted over time.

The one-share-one-vote principle is upheld in listed UK companies as there are no dual class voting shares and as regulation has impeded cascade ownership structures. Still, the percentage of ownership does not necessarily reflect the degree of control as 50% of equity plus 1 vote yields absolute control. Given that most UK companies are characterized by diffuse ownership structures, a measure needs to be used which captures the true degree of shareholder control. Therefore, we resort to Shapley (1953) values (SVs), which assign a power index to each shareholder that reflects their relative importance in forming winning voting coalitions.

The Shapley value is a way to distribute the total surplus from cooperation to blockholders, assuming that they all collaborate. The amount that blockholder i receives if the value function v is being used is given by

$$\phi_i(v) = \frac{1}{n!} \sum_{i \notin S \subseteq N} |S|!(n - |S| - 1)!(v(S \cup \{i\}) - v(S)). \quad (1)$$

In Eq. (1), n is the number of blockholders and the sum extends over all subsets S of the grand coalition N not containing blockholder i. Eq. (1) implies that the compensation of blockholder i is proportional to their contribution $v(S \cup \{i\}) - v(S)$ scaled with all the possible different combinations of N in which a coalition can be formed.

Shapley and Shubik (1954) introduce the concept of 'P-power' which posits an office-seeking motivation of voting behavior and which is reflected in the Shapley values. If a given blockholder coalition wins, it gains collective possession of a fixed amount of transferable utility and each of the winning votes receive a non-negative payoff, all adding up to the total prize, which we normalize to 1. The remaining blockholders get zero as a pay off (Felsenthal and Machover, 1998). Consequently, v(S) = 1 if the coalition S represents more than 50% of votes and v(S) = 0 otherwise. In the context of this study, the winning coalition influences the investment decision. As differential voting behavior is motivated by different conceptions of future performance and private benefits under the incumbent management, the resisting blockholders (among which the equity owning incumbent management) are expected will suffer a reduction in financial returns and private benefits.[8,9]

Table 4 (Panels D and E) shows the Shapley value of the largest shareholder by category of owner and the relative voting power (SV) of a shareholder category. Note that SVs are not additive, but by calculating the SV of a shareholder category we assume that the shareholders of specific categories are more prone to collaborate and to vote together (Crespi and Renneboog, 2002). In other words, in this case we assume that each category (e.g. the executive directors) vote together. In such a two-stage game, the relative voting power of categories (here considered as ex ante coalitions) can be calculated. The average SV of the financial institutions is high: 0.566 (i.e. a financial institution participating in the wining coalition would receive slightly above the half of the surplus from cooperation). The second most important shareholder class in terms of relative voting power is that of the insider shareholders. Table 4 also shows that the SVs of the largest shareholders relatively quickly converge to 1.

4.2. *Methodology*

4.2.1. *Panel data methodology*

Since our data set contains both cross-sectional and time-series observations, we apply a panel data methodology. We estimate the random-effects model (EGLS) that gives the most efficient parameter estimates (Greene, 2002). Since the EGLS estimator requires for consistency that the vector of explanatory variables be uncorrelated with the error term, we use Hausman (1978) test to verify the

[8] Felsenthal and Machover (1998) also discuss several alternative power indices like the Deegan-Packel index and the Johnston index but illustrate the ”extremely counter-intuitive ‘pathological’ behavior of these indices” (p. 211).

[9] A problem in calculating the relative shareholder power is induced by the fact that the owners of a substantial proportion of the equity capital (on average about 60%) are unknown. These anonymous shareholders do not have to comply to the disclosure regulation because their share stakes do not exceed the notification threshold of 3%. Although assumptions on potential coalition formation and voting behavior could be quantified for this ‘ocean’ of atomistic shareholders, we assume that they do not participate in voting coalitions (to discipline management) as it is in practice difficult to organize minuscule share stakes into voting blocks (Chung and Kim, 1999). During protracted hostile take-over battles, coalitions of large shareholders may solicit votes of atomistic shareholders to buttress a coalition, but influencing corporate investment policy seems to be more the competence of large shareholders due to free riding behavior of small shareholders. Therefore, prior to calculating the SVs, rescaling the sum of the large share blocks to 100% is a fair assumption. The resulting SVs reflect the relative voting power whereby a winning coalition is expected to reach absolute control (50%+1 of the rescaled vote).

null hypothesis that this correlation equals zero. If the null hypothesis is rejected, we use a less efficient but consistent fixed-effects estimator. In each case, we report which estimator is used.

4.2.2. *Stochastic efficient frontier methodology*

We use the stochastic frontier model to obtain a theoretical measure for Tobin's q under the assumption that a firm utilizes the optimal combination of its inputs. To obtain efficiency estimates we apply package FRONTIER 4.1 written by Tim Coelli (see Coelli, 1996). Our approach is similar to Habib and Ljungqvist (2005), who calculate the difference between efficient and actual q to measure the extent to which agency problems prevail in the analyzed companies. We apply the Battese and Coelli (1995) model, which assumes that that part of the error term which reflects poor management is drawn from a truncated normal distribution. The way we model the efficient q differs from the approach of Habib and Ljungqvist (2005) with respect to the choice of the set of explanatory variables.

The stochastic frontier model we estimate is

$$MV_t/BV_t = \beta_0 + \beta_1\, lnSales_t + \beta_2\, (lnSales_t)^2 + \beta_3\, I_t/K_{t\text{-}1} + \beta_4\, K_{t\text{-}1}/Sales_t$$
$$+\beta_5\, OperMar_t + \beta_5\, LEV_t - v_t + \varepsilon_t, \qquad (2)$$

where MV_t/BV_t is the market-to-book ratio, $lnSales_t$ is the natural logarithm of revenues, $I_t/K_{t\text{-}1}$ represents the investment-to-capital ratio, $K_{t\text{-}1}/Sales_t$ is the capital intensity, $OperMar_t$ is the operating margin, and LEV_t denotes market leverage. To prevent the loss of information when there is missing data in any firm-year, we set the value of the missing observation to zero and set the value of the related dummy variable to one. In Eq. (2), ε_t is a random error distributed according to $N(0, \sigma_\varepsilon^2)$ and v_t is a non-negative random component that reflects the inefficiencies in operating the company by the management. The random component v_{it} is distributed according to $N(Z_t m, \sigma_v^2)$, where Z_t denotes the vector of variables affecting the inefficiency level of a given firm, and m is a vector of unknown parameters. In our case, the inefficiency contribution v_t is estimated as

$$v_t = \alpha_0 + \alpha_1\, INS_t + \alpha_2\, (INS_t)^2 + \alpha_3\, Block_t + \alpha_4\, (Block_t)^2 + u_t. \qquad (3)$$

INS_t is the insiders' share of stock, and $Block_t$ denotes the other blockholders' (not insiders) ownership.

Equations (2) and (3) are estimated in the following three steps: (*i*) running an OLS regression in order to obtain an unbiased estimate of the vector of parameters of (2), (*ii*) applying a grid search procedure determining the fraction of $\sigma_v^2/(\sigma_\varepsilon^2+ \sigma_v^2)$ corresponding to the best fit of the OLS model, and (*iii*) performing an iterative procedure leading to the final joint maximum likelihood estimation of (2) and (3).

Applying the stochastic frontier methodology to MV_t/BV_t leads to the estimate of the difference between the stock market valuation and the hypothetical value of a firm if its assets are put to the best possible use. The parameter estimates and their *t*-statistics, are presented in Table 5 (Panels A and B). The signs of the coefficients of the stochastic frontier seem to be plausible. The positive impact of capital expenditure, and the negative impact of capital intensity and market leverage on the firm's value are consistent with Habib and Ljungqvist (2005).

[Insert Table 5 about here]

The estimated coefficients in the inefficiency model are also of interest. The coefficient of INS_t is positive, which indicates that the firms subject to managerial entrenchment are on average less efficient. However, at high levels of ownership the presence of other blockholder may exacerbate this problem. Despite the fact that both variables taken in isolation are on the brink of statistical significance, the likelihood ratio (LR) test indicates the significance of the set of explanatory variables of the one side-error component (which is equivalent to rejecting null hypothesis that $\alpha_k = 0$ $\forall k \in \{0,1,2,3,4\}$).

The average level of efficiency, denoted by EFF_t and obtained by estimating model (2)-(3), equals 0.846.[10] This implies that the market value of an average firm could be increased by 18.2% ((1-0.846)/ 0.846) if all its resources were used efficiently. In absolute terms this percentage

[10] Habib and Ljungqvist (2005) report the average efficiency of the 1992-1997 sample of 1487 US firms to be equal to 0.907.

correspond to the difference in value of GBP 99.04 million. Descriptive statistics are presented in Table 5 (Panel C). Equipped with an estimate of technical inefficiency for every firm, we introduce a new measure, *efficient q*, defined as $Q^{eff}_t \equiv MV_t/BV_t * (EFF_t)^{-1}$.

The technical efficiency parameter allows us to predict the degree to which firms suffer from the agency costs of free cash flow and the high premium for external financing, which makes them unable to utilize their resources fully efficiently. To do so, we estimate the cash flow-investment models after categorizing the firms according into the low-*q* firms (where agency problems are expected to be more prominent) and high-*q* firms (in which asymmetric information may create underinvestment), and including interaction term $CF_t/K_{t-1}*EFF_t$.

4. Results

The estimation results of the basic investment model $I_t/K_{t-1} = b_0 + b_1\, CF_t/K_{t-1} + b_2\, MV_{t-1}/BV_{t-1} + \varepsilon_t$ for all 3445 firm-years are presented in Table 6.[11] We observe a significantly positive relationship (at the 1% level) between corporate investment and cash flow (see Panel A) after controlling for the firms' investment opportunities captured by Tobin's *q* (proxied by the beginning-of-the-period market-to-book value ratio). The positive cash flow sensitivity may result from an overinvestment problem (related to the agency cost of free cash flow) or an underinvestment problem (as a consequence of asymmetric information). If agency problems are the predominant reason, we expect the cash flow sensitivity to be higher in the subsample of low insider ownership. With rising levels of managerial ownership, we expect the correlation to decrease because management will be more focused on value creation. If in contrast, asymmetric information is a serious problem, we expect a high cash flow sensitivity at higher levels of insider ownership. In this case, management will be reluctant to attract external funding for high quality projects when this quality is not recognized by the market. The resulting underinvestment will decrease with falling levels of insider ownership.

Subsequently, we analyze how the investment-cash flow sensitivity changes between firms with insider ownership above the median and below median and between firms with high versus low

[11] For the sake of transparency, we suppress the cross-section subscript *i*.

outside block ownership. The interaction dummies of Panel B of Table 6 test for the difference in coefficients across the different subsamples. In the case of weak insider control in widely-held firms (with no blockholder monitoring) the cash flow sensitivity is relatively high and equals 0.096. When insiders own large share blocks, the investment-cash flow sensitivity is much smaller and amounts to 0.096 - 0.035 = 0.061 (panel B). This corroborates the free cash flow Hypothesis 1a: investment is less dependent on cash flow when management participates in the equity and is thus more focused on value creation. At the same time, these findings do not support Hypothesis 2a which states that increasing insider ownership induces a positive relation between investment and cash flow. The reason is that management may pass over some positive investment projects as their equity ownership makes them internalize a higher fraction of the premium on external capital which may be too high due to asymmetric information between the external capital markets and the management.

The model of panel B also allows us to investigate the impact of large blockholders on a firm's investment decision. In firms with strong blockholders but low insider ownership, the cash flow coefficient goes down substantially to 0.048 (0.096-0.048). This shows that even when management does not hold any equity stakes, liquidity-dependent investment will be reduced as a result of reduced agency costs due to increased blockholder monitoring. This strongly supports Hypothesis 1c. Finally, taking into account all interaction dummies (this corresponds to high levels of managerial and outside shareholdings) shows that both types of ownership act as substitutes in reducing the investment-cash flow sensitivity. Consequently, the sensitivity in this group equals to 0.065 and is lower than of widely-held firms but does not seem to be a further improvement beyond what is obtained when a single type of blockholdings is present. To summarize, the results presented in Table 6 support the hypothesis that the observed investment-cash flow sensitivity is driven by Jensen's (1986) overinvestment problem.

[Insert Table 6 about here]

Hypothesis 1b states that the relation between cash flow sensitivity and insider ownership is non-monotonic (S-shaped) due to a change in magnitude of the interests' alignment of management and shareholders and due to the possible emergence of managerial entrenchment. To test this hypothesis, we first estimate an investment model which includes interactive terms of (insider) ownership and cash flow.[12] The cubic form of the model for insider ownership is designed to provide sufficient flexibility to capture the hypothesized S-shaped cash flow sensitivity-ownership relationship (Hypothesis 1b). The quadratic form of the model for other types of blockholdings is flexible enough to detect potential expropriation effects at the high ownership levels (Shleifer and Vishny, 1997; Johnson et al., 2000). Panel A of Table 7 shows the results of this model. The estimated coefficients indicate a non-monotonic between insider ownership and investment-cash flow sensitivity, consistent with McConnell and Servaes (1990). However, only the linear term in on the brink of statistical significance, whereas the quadratic and cubic terms do not significantly differ from zero. Therefore, the results of the model provide weak support for Hypothesis 1a.

One of the reasons for the weak performance of the cubic regression is that it implicitly relies on the assumption that observations are uniformly distributed across the domain of the explanatory variable. Consequently, when many observations are clustered over a small interval of ownership levels, this interval would have a disproportionately high weight in determining the curvature of the ownership-sensitivity relationship. As a consequence, other regions of ownership (those with a relatively smaller number of observations) will be given a smaller weight, which can distort the curvature and result in the estimated equation failing to pick up the true relationship.

Given that the distribution of ownership levels is highly skewed (cf. Table 4, Panel B), we also estimate a piecewise linear regression model that relates investment-cash flow sensitivity to insider ownership. The choice of the cut-off points in the estimated piecewise linear equation is based

---

[12] In general, it is possible to determine first the regions of interest alignment/entrenchment (in case of insiders) and of monitoring (for other types of blockholders) by regressing the firm's value on the ownership variables (and finding the cutoff points by calculating the local extrema of the polynomial functions). Subsequently, one can use these regions in the investment equation (see e.g. Morgado and Pindado, 2003). An alternative approach is to directly regress investment on cash flow and interaction dummies with cash flow and ownership variables and to interpret the results as (in)consistent with alignment/entrenchment and monitoring hypotheses (see Hadlock, 1998, for some theoretical motivation). We adopt the latter approach since it does not rely on the assumption that ownership affects the value of the firm only via alignment/entrenchment (for insider ownership) and monitoring (for block ownership). In fact, such an assumption is likely to be violated due to a number of other factors that result in the change of the firm value as (insider) ownership rises: higher takeover premia (Burkart, 1995), reduced market liquidity (Holmström and Tirole, 1993), lower diversification benefits (Demsetz and Lehn, 1983), changes in productivity (Köke and Renneboog, 2004) and reduced managerial initiative (Burkart et al., 1997).

on a grid search technique (we elect the specification with the highest goodness-of-fit). We obtain cut-off points of 16% and 22% (see Panel B of Table 7).[13] The piecewise linear model is sufficiently flexible to capture the changes in the slopes of the investment-cash flow sensitivity for weak, medium and strong insider ownership. The results of the model are as follows. When the levels of managerial ownership increase in the range [0-16%), the sensitivity decreases by on average 0.005 for every additional percent of managerial ownership. This reduction is undone due to an increase in suboptimal investing when insider control increases further (within the range [16-22%]). This implies that overinvestment problems are exacerbated by managerial entrenchment. The change in signs are in line with Hypothesis 1b which states that cash flow sensitivity initially decreases with rising levels of insider ownership, but that entrenchment may lead to more suboptimal investment decisions for moderate insider ownership levels. At very high insider control levels of 22% or more (which is substantially above the median of the largest share stake, which equals 15%), the negative impact of entrenchment disappears and investment decisions become again less dependent on the firm's liquidity. The fact that the cash flow sensitivity of investment initially decreases with rising insider ownership and subsequently increases, is consistent with the alignment/entrenchment hypotheses on insiders formulated by Morck, et al. (1988) and McConnell and Servaes (1990) in the context of corporate valuation. The reduction in the sensitivity beyond 22% is consistent with Morck, et al., 1988), as it reflects further alignment of managerial interests beginning to exceed existing entrenchment effects. The results of the regression model of Panel B support Hypothesis 1b that the agency costs of free cash flow result in an S-shaped relationship between insider ownership and investment-cash flow sensitivity. A negative sign of the block ownership interaction term is consistent with Hypothesis 1c that the presence of outside blockholders attenuates the agency cost of free cash flow.

Panel C of Table 7 also investigates the impact of outside blockholders on the non-monotonic relation. When outside blockholders do not own large equity stakes (their ownership is below the median), the non-monotonic relation is conserved: (*i*) there is a decreasing cash flow

---

[13] In the UK literature, we find that the following cut off points are chosen: 14% and 42% in Short and Keasey (1999), 13% and 30% in Mudambi and Nicosia (1998), and 20% and 54% in Faccio and Lasfer (1999).

sensitivity at low levels of managerial ownership, (*ii*) cash flow sensitivity is substantially amplified when insider ownership rises further above 16%, and (*iii*) cash flow sensitivity begins to decrease again when insiders' ownership is close to a blocking minority. The presence of large equity stakes owned by outsiders has three effects. First, it reduces the cash flow sensitivity in firms with no managerial ownership and in firms with high levels (more than 22%). Second, it exacerbates the investment cash flow sensitivity in the region of managerial entrenchment (between 16% and 22%), which may indicate either that large outside blockholders are not able to curb managerial suboptimal investing or that they somehow extract private benefits of control at the expense of minority shareholders. Third, the presence of blockholders reduces the negative impact of insider ownership on the sensitivity of investment to internally generated cash flow for low levels of insider control. The latter result suggests that inside and outside ownership act in the relevant interval as substitutes in reducing the agency costs of free cash flow.

[Insert Table 7 about here]

Panels A and B of Table 7 confirm that the presence of major outside shareholders reduces the investment-cash flow sensitivity. As different types of outside blockholders may have different abilities and incentives to monitor management and influence the firm's investment decisions, Table 8 shows the impact on the investment-cash flow sensitivity of insiders, institutions (banks, investment and pension funds, insurance companies, real estate firms), industrial and commercial companies, non-executive directors, the government and other blockholders (mainly families and individuals not related to a director).[14] The table enables us to draw the following conclusions. Firstly, the non-monotonic relationship between insider ownership and cash flow sensitivity is confirmed. In other words, we still observe the effects of a growing alignment of managerial interests with those of shareholders at a low ownership level, entrenchment at its moderate level, and a further

[14] The chosen 25% threshold, which allows for changing slope of the cash flow sensitivity-ownership relationship for outside blockholders, represents a blocking minority. A shareholder controlling a blocking minority has an important say (holds a veto right) on changes in the acts of incorporation, changes in the voting rights composition etc.

alignment at high stakes. Secondly, we show that blockholdings (by the government, financial institutions, and of more than 25% by industrial and commercial companies) attenuate the agency costs of free cash flow, which results in a lower investment-cash flow sensitivity. Surprisingly, non-executive directors owning substantial share stakes do not seem to influence the investment decision. If they were monitoring management dutifully, the fact that the corporate investment policy depends on the amount of cash flow generated would be reduced. If they support the incumbent management's decisions (even in the wake of poor performance as Franks et al., 2001, claim), we would have expected to see a higher degree of cash flow sensitivity. The non-significance of those parameter estimates in Table 8 may result from the fact that, across the sample, both effects may neutralize one another. Our findings of Table 8 do not contradict the free cash flow-based explanation as formulated by Hypotheses 1b and 1c. The evidence also does not reject Hypothesis 2b: the negative relationship between investment-cash flow sensitivity in the presence of major blockholdings held by financial institutions is consistent with the asymmetric information theory.

[Insert Table 8 about here]

In Table 9, we analyze the impact of corporate growth perspectives on cash flow sensitivity for firms with and without insider control. In the absence of insider control, the investment-cash flow sensitivity more than triples (from 0.031 to 0.099) in companies with high growth perspectives. This finding contradicts Hypothesis 1d, which states that the sensitivity is expected to be more outspoken in mature, firms with relatively low market-to-book values. The fact that there is a higher cash flow sensitivity is in line with Hypothesis 2c, which relates high sensitivity in high-q firms to underinvestment problems. The reason why underinvestment is a problem especially in high-q firms results from asymmetric information between the firm and the capital markets and from the fact that the fact that high growth firms have fewer tangible assets as collateral (Almeida and Campello, 2004).

We also document that insider ownership reduces the investment sensitivity to corporate liquidity both in high-q and low-q firms by about one third. In an agency framework, we would have expected to see the declining cash flow sensitivity along with rising insider ownership more clearly in firms with low growth since in mature firms it may be more difficult to generate positive NPV investment opportunities. As tables 7 and 8 document that the presence of blockholders can also have an effect on the investment decision. Consequently, in order to further investigate the impact of Tobin's on the investment-cash flow sensitivity, we analyze relative managerial voting power as measured by Shapley values for high and low growth firms in Table 10 (Panel C), that is, when we apply the SV approach.

[Insert Table 9 about here]

A high Shapley value (see section 4.1) for the management indicates that insiders have large ownership stakes and are pivotal in the formation of shareholder coalitions. Panel A of Table 10 exhibits that the investment decision of firms in which the management has no voting power is significantly positively related to the internally generated funds of the firm. The (initially) negative relationship between insiders' relative voting power and investment-cash flow sensitivity is sustained. However, these results do not provide evidence of managerial entrenchment as there is no statistical difference between the effect of SVs being between 0 and 1, and the effect of those equal to 1 (respectively, intermediate and strong relative voting power). These findings corroborate Hypothesis 1a. At low levels of control, investments are strongly influenced by available cash flow. At increasing levels, cash flow sensitivities decrease substantially (from 0.070 to 0.023 or 0.027).

Table 10 also tests in Panel B how cash flow sensitivities change with rising insider relative ownership for firms with a high probability of being liquidity constrained (they neither increase dividends nor repurchase equity). Henceforth, we label such firms as 'liquidity constrained' although Kaplan and Zingales (1997) show that more restrictive definitions could be used.[15] We find a low positive correlation between investment and cash flow in firms which are not liquidity constrained and in which there is no insider control. In liquidity constrained firms, the investment-cash flow

[15] In the definition of liquidity constraints, Kaplan and Zingales also include qualitative information about the firm. Still, their study is based on a tiny sample and their approach cannot be imitated for large samples of long time windows.

sensitivity is almost four times stronger than in firms increasing the payout (0.135 versus 0.036). This evidence fails to reject Hypothesis 3, according to which investment is sensitive to cash due to liquidity constraints. This suggests that management faces a wedge between the costs of internal and external financing and this wedge makes them forgo some investments when the amount of internally generated funds is insufficient. The panel also shows that intermediate and strong relative voting power exerted by insiders reduces the investment cash-flow sensitivity primarily in the subsample of the liquidity constrained firms (as the coefficients of the interaction terms of cash flow, liquidity constraints and insider control classes are significant and negative). The latter result is consistent with the free cash flow theory.

Finally, Panel C of Table 10 examines the investment decisions for high and low growth firms subject to differing levels of relative insider voting power. We find that in both high and low growth firms without insider control, the investment decision is closely related to firms' cash flow. Still, in the former firms, the investment-cash flow sensitivity is three times stronger. Relative insider voting power reduces the sensitivity substantially, which indicates that the agency costs theory of free cash flow appears, in general, to be a more plausible explanation than the asymmetric information hypothesis. The latter hypothesis, however, may partially explain the observed high cash flow sensitivity of investment of high-*q* firms.

[Insert Table 10 about here]

In order to corroborate the results specified above, we further examine whether or not efficient firms invest more when the available internally generated funds are abundant. Efficient firms are firms for which the growth perspectives measured by Tobin's *q* are close to the optimally achievable (hypothetical) *q,* which we call *efficient q*. In the methodology subsection 4.4.2, we describe that the stochastic frontier of efficient *q*'s depends on corporate size, investment, turnover, operating margin and leverage. In addition, part of the error term of this model was modeled by insider and outsider ownership concentration. We call firms close to efficient frontier of optimal *q*'s, 'efficient firms'. This correction to Tobin's *q* may be important because firms with high *q* may significantly underperform their optimally achievable *q* whereas firms with low *q* may be close to their optimum.

In Panel A of Table 11, we show that investment in firms with low technical efficiency strongly depends on the available cash flow. The dependence of investment on cash is substantially reduced (by 40%) in firms with high technical efficiency or, in other words, in firms which optimally deploy their assets and achieve a Tobin's *q* close to their (hypothetically) highest achievable one. This finding is consistent with both Hypotheses 1e and 2d.

In order to disentangle the impact of the agency costs of free cash flow and of asymmetric information, we estimate the investment equation including both the efficiency and growth dummies.[16] We find that higher efficiency has a similar effect on the investment-cash flow sensitivity of both groups of firms (efficient firms' cash flow sensitivity of investment is reduced by 0.031 and by 0.061 for low-*q* and high-*q* firms, respectively; see Panel B).[17] This indicates that less efficient low-*q* firms suffer from higher agency cost of free cash flow, which is consistent with Hypothesis 1e. As the high growth firms (high efficient *q*) are unlikely to be affected by free cash flow problems, the analogous negative relationship between efficiency and investment-cash flow sensitivity indicates that these firms are affected by asymmetric information problems (Hypothesis 2d).

[Insert Table 11 about here]

Finally, we test Hypothesis 3 to verify whether liquidity constraints are the main reason for the observed investment-cash flow sensitivity in our sample. Cash flow sensitivity is expected to be more strongly positive in liquidity constrained firms. In Table 12, we classify firms that are not liquidity constrained as those firms which return free cash flow to the shareholders by repurchasing shares (Panel A) and by increasing the dividend payout (Panel B). We find that the cash flow sensitivity is reduced in firms expected not to suffer from liquidity constraints. The cash flow

[16] We proxy growth opportunities here with efficient *q* in order to avoid the problem of Tobin's *q* being a proxy for another explanatory variable, the firm's efficiency.

[17] Although the parameters of the two interaction term are not significantly different from zero when considered separately, they are *jointly* statistically significant at 1% (with $F = 9.45$).

sensitivity of firms that buy back their equity decreases by 0.004 for every 10% of repurchased equity value. Firms that increase dividends or keep them at the same level exhibit investment-cash flow sensitivity which is lower by 0.194, and 0.162, respectively, from the sensitivity of companies that reduce their level of cash disbursements. Finally, the sensitivity of firms that are classified as financially constrained (i.e. they reduce dividends/keep them at a constant level and do not repurchase equity) is higher by 0.047 than the measure calculated for their non-constrained counterparts (Panel C). These findings support Hypothesis 3, according to which liquidity constraints, and not other factors – such as cash flow being a proxy for investment opportunities – are the main reason for the observed investment-cash flow sensitivity.

[Insert Table 12 about here]

6. Conclusions

This paper has investigated the investment-cash flow sensitivity of a large sample of firms listed on the London Stock Exchange in the 1990s. In general, we find that investments are strongly cash flow sensitive. Are those suboptimal investment decisions the result of either the agency costs of free cash flow when managers with too much discretion overinvest or of asymmetric information when managers owning equity are underinvesting if the market (erroneously) demands too high a risk premium? We find evidence that a cash flow-dependent investment policy results mainly from agency problems. First, we document a significantly positive investment-cash flow sensitivity and show that this sensitivity depends on insider ownership in a non-monotonic way. For companies in which insiders own no or tiny share stakes, cash flow sensitivity is high. When insider control rises, cash flow sensitivity is reduced. This result holds both for firms with low and high growth opportunities (as proxied by Tobin's *q*). At moderate levels of insider ownership, cash flow sensitivity rises which may be explained by a high level of entrenchment which allows for the consumption of a high level of private benefits. For high insider ownership levels, that is, when management internalizes a large fraction of the changes in the firm's value resulting from their actions, the investment-cash flow sensitivity decreases. Comparable results are obtained when we analyze the impact of relative insider control, as measured by Shapley values which take into account the distribution of voting rights over both insiders and outside blockholders. Consistent with our previous evidence, the investment-cash flow sensitivity is much lower in firms with strong insiders' relative voting power.

Furthermore, we find that outside blockholders appear to have an impact on the investment policy. Different types of outside blockholders have different abilities and incentives to monitor management and influence the firm's investment decisions. Outside blockholders, such as financial institutions, the government, and industrial and commercial corporations (only at high control levels), reduce the cash flow sensitivity of investment via effective monitoring. The negative relationship between cash flow sensitivity and the ownership of financial institutions is consistent with the asymmetric information theory: institutions holding an equity block appear to reduce the informational asymmetry between the firm and capital markets.

We also find a negative relationship between the investment-cash flow sensitivity and corporate efficiency (as defined by the ratio of the firm's Tobin's q and to its optimally achievable (hypothetical) q). Lower efficiency in the subsample of low-q firms associated with a higher cash flow sensitivity of investment indicates that less efficient firms suffer from higher agency cost of free cash flow. An analogous relationship for high-q companies indicates that they may suffer from informational asymmetries.

Finally, we show the investment policy of companies that are expected not to be liquidity constrained – firms that repurchase equity, augment their dividend pay-out or keep it stable but positive – does not depend on the generated periodic cash flow. This result supports the view that liquidity constraints, and not other factors – such as cash flow being a proxy for investment opportunities – are the main reason for the observed cash flow sensitivity.

The results of this paper indicate that the agency costs of free cash flow appear to be the main source of the investment-cash flow sensitivity of the UK listed corporations in the post-Cadbury period. Therefore, from a policy perspective, it seems essential to pursue the further alignment of interests of managers and shareholders by stimulating effective shareholder monitoring and pay-for-performance schemes. Furthermore, our findings indicate that the current disclosure practices and transparency requirements – in principle – do not lead to severe informational asymmetries between firms and capital markets that would prevent corporations from pursuing value-maximizing investment policies. Finally, our results indicate promising avenues for future research. Firstly, one can attempt to incorporate managerial remuneration and turnover in the investment model to analyze to what extent the disciplining devices have already translated into efficient investment policies. Secondly, an interesting research opportunity is to analyze the changes in the cash flow sensitivity of investment in the aftermath of (voluntary) changes in corporate disclosure.

References

Abel, A. B., 1980, 'Empirical Investment Equations: An Integrative Framework', in: *On the State of Macroeconomics*, eds. K. Brunner and A. H. Meltzer, pp. 39-91.

Almeida, H., and M. Campello, 2002, 'Financial Constraints and Investment-Cash Flow Sensitivities: New Research Directions', *Working Paper*, New York University.

Almeida, H., and M. Campello, 2004, 'Financial Constraints, Asset Tangibility, and Corporate Investment', *Working Paper*, New York University.

Alti, A., 2003, 'How Sensitive Is Investment to Cash Flow When Financing Is Frictionless?', *Journal of Finance* 58, pp. 707-722.

Altman, E. I., 1968, 'Financial Ratios Discriminant Analysis and the Prediction of Corporate Bankruptcy', *Journal of Finance* 23, pp. 589-609.

Battese, G. E., and T. J. Coelli, 1995, 'A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data', *Empirical Economics* 20, pp. 325-332.

Bernanke, B., and M. Gertler, 1989, 'Agency Costs, Net Worth and Business Fluctuations', *American Economic Review* 73, pp. 257-76.

Bond, S. and C. Meghir, 1994, 'Dynamic Investment Models and the Firm's Financial Policy', *Review of Economic Studies* 61, pp. 197-222.

Boyle, G. W., and G. A. Guthrie, 2003, 'Investment, Uncertainty, and Liquidity', *Journal of Finance* 58, pp. 2143-2166.

Burkart, M., 1995, 'Initial Shareholdings and Overbidding in Takeover Contests', *Journal of Finance* 50, pp. 1491-1515.

Burkart, M., D. Gromb, and F. Panunzi, 1997, 'Large Shareholders, Monitoring, and the Value of the Firm', *Quarterly Journal of Economics* 112, pp. 693-728.

Cadbury Committee, 1992, '*The Code of Best Practice*', Gee and Co. Ltd., London.

Carpenter, R. E., 1995, 'Finance Constraints of Free Cash Flow? A New Look at the Life Cycle Model of the Firm', *Empirica* 22, pp. 185-209.

Chung, K. and J.-K. Kim, 1999, 'Corporate Ownership and the Value of a Vote in an Emerging Market', *Journal of Corporate Finance* 5, pp. 35-54.

Cleary, S., 1999, 'The Relationship between Firm Investment and Financial Status', *Journal of Finance* 54, pp. 673-691.

Coelli, T., 1996, 'A Guide to FRONTIER 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation', *CEPA Working Paper* 96/07, University of New England.

Conyon, M., 1998, 'Directors' Pay and Turnover in UK Companies', *Oxford Bulletin of Economics and Statistics* 60, pp. 515-538.

Conyon, M., and K. Murphy, 2000, 'The Prince and the Pauper? CEO Pay in the US and the UK', *Economic Journal* 110, pp. 640-671.

Correia da Silva, L., M. Goergen and L. Renneboog, 2004, '*Dividend Policy and Corporate Governance*', Oxford: Oxford University Press.

Crespi, R. and L. Renneboog, 2002, 'Coalition Formation and Shareholder Monitoring in the UK', *CentER Discussion Paper*, Tilburg University.

Degryse, H., and A. de Jong, 2000, 'Investment Spending in the Netherlands: The Impact of Liquidity and Corporate Governance', *CentER Discussion Paper*, Tilburg University.

Dyck, A. and L. Zingales, 2004, 'Private Benefits of Control: An International Comparison, *Journal of Finance* 59, pp. 537-600.

Demsetz, H. , 1983, 'The Structure of Ownership and the Theory of the Firm', *Journal of Law and Economics* 56, pp. 375-393.

Demsetz, H. and K. Lehn, 1985, 'The Structure of Corporate Ownership: Causes and Consequences', *Journal of Political Economy* 93, pp. 1155-1177.

Fazzari, S. M., R. G. Hubbard, and B. C. Petersen, 1988, 'Financing Constraints and Corporate Investment', *Brookings Papers on Economic Activity* 1, pp. 141-195.

Fazzari, S. M., R. G. Hubbard, and B. C. Petersen, 2000, 'Investment-Cash Flow Sensitivities Are Useful: A Comment on Kaplan and Zingales', *Quarterly Journal of Economics* 115, pp. 695-705.

Fazzari, S. M., and B. C. Petersen, 1993, 'Working Capital and Fixed Investment: New Evidence on Financing Constraints', *RAND Journal of Economics* 24, pp. 328-342.

Felsenthal, D. and M. Machover, 1998, '*The Measurement of Voting Power*', Edward Elgar.

Franks, J., C. Mayer, and L. Renneboog, 2001, 'Who Disciplines the Management of Poorly Performing Companies?', *Journal of Financial Intermediation* 10, pp. 209-248.

Goergen, M. and L. Renneboog, 2001, 'Investment Policy, Internal Financing and Ownership Concentration in the UK', *Journal of Corporate Finance* 7, pp. 257-284.

Gomes, J., 2001, 'Financing Investment', *American Economic Review* 91, pp. 1263-1285.

Greene, W.H., 2002, '*Econometric Analysis*' (5th edition), Prentice Hall.

Greenwald, B., J. Stiglitz and A. Weiss, 1984, 'Informational Imperfections and Macroeconomic Fluctuations', *American Economic Review Papers and Proceedings* 74, pp. 194-199.

Grossman, S. J., and O. D. Hart, 1980, 'Takeover Bids, the Free Rider Problem and the Theory of the Corporation' *Bell Journal of Economics* 11, pp. 42-64.

Grossman, S. J., and O. D. Hart, 1982, 'Corporate Financial Structure and Managerial Incentives', in: *The Economics of Information and Uncertainty,* McCall, J.J. (ed.), University of Chicago Press.

Gugler, K., 2003, 'Corporate Governance and Investment', *International Journal of the Economics of Business*, 10, pp. 261-289.

Gugler, K., and B. B. Yurtoglu, 2003, 'Average Q, Marginal Q, and the Relation Between Ownership and Performance', *Economics Letters* 78, pp. 379-384.

Habib, M. A., and A. P. Ljungqvist, 2005, 'Firm Value and Managerial Incentives', *Journal of Business*, forthcoming.

Haid, A., and J. Weigand, 2001, 'R&D Investment, Liquidity Constraints, and Corporate Governance', *Jahrbücher für Nationalökonomie und Statistik*, 221, pp. 145-167.

Hadlock, C. J., 1998, 'Ownership, Liquidity and Investment', *RAND Journal of Economics* 29, pp. 487-508.

Hausman, J. A., 1978, 'Specification Tests in Econometrics', *Econometrica*, 46, pp. 1251-1271.

Holmström, B. and J. Tirole, 1993, 'Market Liquidity and Performance Monitoring', *Journal of Political Economy* 101, pp. 678-709.

Hoshi, T., A. Kashyap, and D. Scharfstein, 1991, 'Corporate Structure, Liquidity and Investment: Evidence from Japanese Industrial Groups', *Quarterly Journal of Economics* 20, pp. 33-60.

Hubbard, R. G., 1999, 'Capital-Market Imperfections and Investment', *Journal of Economic Literature* 36, pp. 193-225.

Jensen, M., 1986, 'Agency Costs of Free Cash Flow, Corporate Finance and Takeovers', *American Economic Review Papers and Proceedings* 76, pp. 323-329.

Jensen, M., 2001, 'Value Maximization, Stakeholder Theory and the Corporate Objective Function', *European Financial Management* 7, pp. 297-317.

Jensen, M., and W. Meckling, 1976, 'Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure', *Journal of Financial Economics* 3, pp. 305-360.

Johnson, S., R. La Porta, F. Lopez-de-Silanes and A. Shleifer, 2000, 'Tunnelling', *American Economic Review* 90, pp. 22-27.

Kadapakkam, P., P. Kumar and L. Riddick, 1998, 'The Impact of Cash Flows and Firm Size on Investment: The International Evidence', *Journal of Banking and Finance* 22, pp. 293-320.

Kahn C., and A. Winton, 1998, 'Ownership Structure, Speculation, and Shareholder Intervention', *Journal of Finance* 53, pp. 99-129.

Kaplan, S. N., and L. Zingales, 1997, 'Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?', *Quarterly Journal of Economics* 20, pp. 169-215.

Kathuria, R. and D.C. Mueller, 1995, 'Investment and Cash Flow: Asymmetric Information or Managerial Discretion', *Empirica* 22, pp. 211-234.

Köke, J. and L. Renneboog, 2004, 'Do Corporate Control and Product Market Competition Lead to Stronger Productivity Growth? Evidence from Market-oriented and Blockholder-based Governance Regimes', *Journal of Law and Economics*, forthcoming.

Lai, J., and S. Sudarsanam, 1997, 'Corporate Restructuring in Response to Performance Decline: Impact of Ownership, Governance and Lenders', *European Finance Review* 1, pp. 197-233.

Lasfer, M., 1995, 'Agency Costs, Taxes and Debt: The UK Evidence, *European Financial Management* 1, pp. 265-285.

Lasfer, M., and M. Faccio, 1999, 'Managerial Ownership, Board Structure and Firm Value: The UK Evidence', *Working paper*, Cass Business School.

McConnell, J., and H. Servaes, 1990, 'Additional Evidence on Equity Ownership and Corporate Value', *Journal of Financial Economics* 27, pp. 595-612.

Modigliani, F., and M. H. Miller, 1958, 'The Cost of Capital, Corporation Finance and the Theory of Investment', *American Economic Review* 48, pp. 261-297.

Morck, R., A. Schleifer, and R. Vishny, 1988, 'Management Ownership and Market Valuation: An Empirical Analysis', *Journal of Financial Economics* 20, pp. 293-315.

Morgado, A., and J. Pindado, 2003, 'The Underinvestment and Overinvestment Hypotheses: an Analysis Using Panel Data', *European Financial Management* 9, pp. 163-177.

Moyen, N., 2004, 'Investment-Cash Flow Sensitivities: Constrained versus Unconstrained Firms', *Journal of Finance* 59, pp. 2061-2092.

Mudambi, R., and C. Nicosia, 1998, 'Ownership Structure and Firm Performance: Evidence from the UK Financial Services Industry', *Applied Financial Economics* 8, pp. 175-180.

Myers, S., 1977, 'Determinants of Corporate Borrowing', *Journal of Financial Economics* 5, pp. 147-175.

Myers, S., 1984, 'The Capital Structure Puzzle', *Journal of Finance* 39, pp. 575-592.

Myers, S., and N. Majluf, 1984, 'Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have', *Journal of Financial* Economics 13, pp. 187-221.

Pindado, J., and C. de la Torre, 2004, 'The Effect of Ownership Structure on Underinvestment and Overinvestment Processes', *EFMA 2004 Basel Meetings Paper*.

Renneboog, L. and G. Trojanowski, 2004, 'The Managerial Labour Market and the Governance Role of Shareholder Control Structures in the UK', *CentER Discussion Paper*, Tilburg University.

Shapley, L., 1953, 'A Value for *n*-Person Games', in: *Contributions to the Theory of Games* II (*Annals of Mathematics Studies* 28), Kuhn, H. and A. Tucker (eds.), Princeton University Press.

Shapley, L. and M. Shubik, 1954, 'A Method for Evaluating the Distribution of Power in a Committee System', *American Political Science Review* 48, pp. 787-792.

Shleifer, A., and R. W. Vishny, 1986, 'Large Shareholders and Corporate Control', *Journal of Political Economy* 94, pp. 461-488.

Shleifer, A., and R. W. Vishny, 1997, 'A Survey of Corporate Governance', *Journal of Finance* 52, pp. 737-783.

Short, H., and K. Keasey, 1999, 'Managerial Ownership and the Performance of Firms: Evidence from the UK', *Journal of Corporate Finance* 5, pp. 79-101.

Stiglitz, J., and A. Weiss, 1981, 'Credit Rationing in Markets with Imperfect Information', *American Economic Review* 71, pp. 393-410.

Stulz, R., 1990, 'Managerial Discretion and Optimal Financing Policies', *Journal of Financial Economics* 26, pp. 3-27.

Tobin, J., 1969, 'A General Equilibrium Approach to Monetary Theory', *Journal of Money, Credit and Banking* 1, pp. 15-29.

Vogt, S. C., 1994, 'The Cash Flow/Investment Relationship: Evidence from US Manufacturing Firms', *Financial Management* 23, pp. 3-20.

Table 1

Financial variables – descriptive statistics

Descriptive statistics for the sample of 985 UK firms over the entire sample period. I_t denotes investment in fixed assets (change in the net fixed assets plus depreciation). K_{t-1} denotes the beginning-of-the-year net fixed assets. CF_t denotes cash flow. $Sales_t$ (%) denotes (the percentage growth of) total revenues. $TOTASS_t$ denotes total assets. LEV_t is the ratio of book value of debt to market value of the firm (market value is estimated as total assets minus book value of equity plus market capitalization). $CURR_t$ is the ratio of current assets to current liabilities. COV_t is the ratio of earnings before interest and taxes to interest expense and tax corrected preferred dividend payments. MV_t/BV_t stands for the market-to-book value ratio (market value is estimated as total assets minus book value of equity plus market capitalization). Q^{eff}_t denotes the efficient Tobin's q (defined as $MV_t/BV_t * (EFF_t)^{-1}$, see Subsection 4.2.2). EFF_t is a technical efficiency parameter (see Subsection 4.2.2). $OperMar_t$ denotes the ratio of operating income before depreciation to revenues. $PAYOUT_t$ is the ratio of dividends to earnings before interest and taxes. DIV_t (%) denotes (the percentage growth of) dividends. B_BACK_t stands for the value of repurchased stock. D_INCR_t is the dummy corresponding to dividend increase. D_ZERO_t is the dummy corresponding to constant dividend. $BBACK_t$ denotes the value of repurchased stock. BB_EQ_t represents the ratio of market value of repurchased stock to book equity. BB_CAP_t is the ratio of market value of repurchased stock to market capitalization. $ISSUES_t$ denotes the value of equity issues. ISS_EQ_t is the ratio of market value of equity issues to book equity. ISS_CAP_t denotes the ratio of market value of equity issues to market capitalization.

	Mean	Std. Dev.	Min	Max	25%	Median	75%	Skewness	Kurtosis
Number of Firms		985							
Number of firm-years		4416							
Panel A: Corporate investment, size and assets structure									
I_t	3399	10249	-11800	36945	-311	404	3459	2.026	7.281
K_{t-1}	68259	135466	917	549200	4781	13690	50258	2.731	9.437
I_t/K_{t-1}	0.097	0.246	-0.279	0.793	-0.040	0.044	0.175	1.246	4.598
CF_t/K_{t-1}	0.779	1.173	-0.612	4.477	0.140	0.420	0.951	1.905	6.302
$Sales_t$	393355	1805980	1	4.47E+07	24118	66276	197918	15.180	290.878
$Sales_t$ (%)	0.276	2.659	-1.000	109.965	-0.001	0.092	0.211	33.316	1276.463
$TOTASS_t$	324306	1544090	214	3.48E+07	18901	46918	148061	14.234	255.483
LEV_t	0.398	0.207	0.002	0.991	0.240	0.373	0.542	0.423	2.559
$CURR_t$	1.668	1.504	0.038	29.678	1.085	1.389	1.814	8.433	115.704
COV_t	16.5	33.4	-10.31	137.44	1.98	5.32	13.50	2.745	9.764
Panel B: Growth opportunities and operating performance									
MV_t/BV_t	1.872	1.841	0.363	46.652	1.091	1.451	2.033	9.669	170.014
Q^{eff}_t	3.610	6.675	0.385	196.488	1.213	1.672	2.678	8.696	162.171
EFF_t	0.846	0.259	0.100	1.000	0.871	0.940	0.986	-2.296	6.794
$OperMar_t$	0.068	0.101	-0.206	0.254	0.029	0.071	0.122	-0.743	4.279
ROE_t	0.117	0.238	-0.506	0.593	0.044	0.129	0.231	-0.655	4.244
Panel C: Dividend payout, buy-backs and rights issues									
$PAYOUT_t$	0.202	0.185	-0.121	0.626	0.055	0.198	0.302	0.445	2.832
DIV_t	9330.7	44108.6	0	774999	220	1034	3728	10.751	139.395
DIV_t (%)	0.473	8.155	-1	511.667	0	0.092	0.277	55.946	3421.503
D_INCR_t	0.701	0.496	0	1	0	1	1	-0.787	1.619
D_ZERO_t	0.162	0.309	0	1	0	0	0	2.388	6.705
Number of Buy-Backs		323							
$BBACK_t$	1035	17647	0	945000	0	0	0	35.534	1640.027
BB_EQ_t	0.007	0.057	0	0.804	0	0	0	11.458	147.598
BB_CAP_t	0.003	0.018	0	0.212	0	0	0	8.728	86.286
Number of Issues		3577							
$ISSUES_t$	2716	8123	0	42171	0	4	532	3.798	17.159
ISS_EQ_t	0.108	0.292	0	1.461	0	0	0.011	3.268	13.394
ISS_CAP_t	0.038	0.092	0	0.378	0	0.001	0.005	2.693	9.217

Table 2

Corporate investment levels over time

Descriptive statistics on the level of corporate investment, I_t, for the sample of 985 UK firms for period 1993-1998.

	1993	1994	1995	1996	1997	1998	All years
No Obs.	761	809	854	882	902	204	4416
Mean	2077	2717	5027	3255	3357	5067	3399
Std. Dev	9044	9130	11066	10454	10753	10999	10249
25%	-576	-225	-56	-372	-491	-121	-312
Median	74	425	960	345	337	1098	404
75%	1889	2673	4911	2256	3421	6413	3457
Skewness	2.355	2.213	1.921	1.994	1.852	1.660	2.026
Kurtosis	9.779	8.936	5.978	7.193	6.503	5.541	7.281

Table 3

Ownership of the largest shareholder and of all the blockholders

Ownership patterns in the sample companies calculated for the entire sample period. Panel A contains the data on the ownership of the single largest shareholder. Panel B describes the ownership by all shareholders whose stake is at least 5% of all shares outstanding. Panel C contains the statistics on Herfindahl index (HI) based on all blockholdings. HI is defined as $\Sigma^N(OWN_i)^2$, where OWN_i is the ownership of i-th blockholder, and i=1, 2,..., N.

	1992	1993	1994	1995	1996	1997	1998	All years
Panel A: Ownership stake of the largest shareholder								
Mean	0.212	0.216	0.214	0.212	0.206	0.205	0.207	0.210
Median	0.151	0.156	0.153	0.151	0.159	0.159	0.153	0.155
Std. Dev	0.162	0.159	0.155	0.153	0.144	0.142	0.146	0.151
Min	0.050	0.050	0.050	0.050	0.050	0.050	0.051	0.050
Max	0.898	0.898	0.899	0.899	0.899	0.899	0.899	0.899
Panel B: The accumulated ownership stakes of all blockholders								
Mean	0.404	0.394	0.388	0.388	0.379	0.377	0.391	0.394
Median	0.385	0.380	0.375	0.378	0.374	0.360	0.384	0.379
Std. Dev	0.206	0.202	0.200	0.190	0.182	0.188	0.186	0.199
Min	0.050	0.050	0.050	0.050	0.050	0.050	0.051	0.050
Max	0.988	0.993	0.978	0.938	0.985	0.985	0.899	0.993
Panel C: The Herfindahl index of all large ownership stakes								
Mean	0.092	0.091	0.089	0.087	0.081	0.080	0.084	0.086
Median	0.046	0.047	0.047	0.046	0.046	0.046	0.045	0.046
Std. Dev	0.120	0.117	0.110	0.110	0.100	0.099	0.101	0.108
Min	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Max	0.806	0.806	0.808	0.808	0.808	0.808	0.808	0.808

Table 4

Ownership and control by category of shareholder

Ownership patterns by category of owner calculated for the entire sample period. Panel A contains the data on the largest blockholdings. Panel B contains the ownership data categorized with respect to the identity of a shareholder. Panel C contains the data on the single largest blockholdings. Panel D shows Shapley values of given categories of blockholders. Panel E contains Shapley values of the single largest blockholdings. Herfindahl index is defined as $\Sigma^N(OWN_i)^2$, where OWN_i is the ownership of i-th blockholder, and i=1, 2,..., N. Shapley value is defined by Eq. (1).

	Mean	Stand. Dev.	Min	Q25%	Median	Q75%	Max	Skewness	Kurtosis	Firmyears with data
Panel A: Aggregate statistics										
Sum of all stakes	0.394	0.199	0.050	0.239	0.379	0.539	0.995	0.284	2.407	5631
Largest share stake	0.210	0.151	0.050	0.110	0.155	0.257	0.899	1.679	5.537	5631
Sum of largest 3	0.349	0.179	0.050	0.224	0.321	0.458	0.929	0.631	2.997	5631
Herfindahl 3	0.083	0.108	0.003	0.021	0.041	0.093	0.808	2.626	11.252	5631
Sum of largest 5	0.388	0.194	0.050	0.239	0.376	0.526	0.991	0.296	2.491	5631
Herfindahl 5	0.086	0.108	0.003	0.023	0.045	0.098	0.808	2.597	11.170	5631
Panel B: Sum of all equity stakes by category of owner										
Institutions	0.203	0.167	0	0.066	0.177	0.305	0.954	0.886	3.692	5631
Banks	0.018	0.052	0	0	0	0	0.954	4.876	42.639	5631
Investment/ pension funds	0.159	0.156	0	0	0.126	0.246	0.899	1.274	4.932	5631
Insurance	0.025	0.047	0	0	0	0.052	0.358	2.219	8.563	5631
Real estate	0.001	0.017	0	0	0	0	0.520	18.091	428.553	5631
Corporations	0.044	0.118	0	0	0	0	0.929	3.526	16.738	5631
Individuals/ Families (no insiders)	0.025	0.068	0	0	0	0	0.698	3.864	22.022	5631
Government	0.0003	0.004	0	0	0	0	0.131	18.309	381.774	5631
Insiders	0.104	0.176	0	0	0	0.148	0.871	1.819	5.415	5631
CEO	0.051	0.127	0	0	0	0	0.871	3.130	13.258	5631
Chairman	0.075	0.148	0	0	0	0.092	0.870	2.341	8.141	5631
Exec. Dir. (ex CEO)	0.053	0.124	0	0	0	0	0.742	2.809	11.019	5631
Non-Exec. Dir.	0.005	0.030	0	0	0	0	0.513	9.081	105.270	5631
Panel C: Largest shareholding categorized by type of owner										
Institutions	0.158	0.110	0.050	0.100	0.131	0.173	0.899	2.975	14.408	3086
Banks	0.151	0.080	0.051	0.102	0.127	0.173	0.503	1.925	6.947	267
Investment/ pension funds	0.167	0.116	0.050	0.105	0.137	0.181	0.899	2.905	13.470	2504
Insurance	0.090	0.035	0.050	0.063	0.082	0.109	0.259	1.399	5.698	287
Real estate	0.191	0.112	0.069	0.146	0.154	0.189	0.520	1.817	6.116	28
Corporations	0.304	0.177	0.050	0.185	0.256	0.392	0.857	0.958	3.246	595
Individuals/ Families (no insiders)	0.169	0.112	0.050	0.089	0.134	0.239	0.698	1.666	6.747	236
Insiders	0.287	0.169	0.050	0.156	0.239	0.384	0.870	0.880	2.864	1464
CEO	0.306	0.179	0.050	0.160	0.262	0.426	0.870	0.793	2.670	710
Chairman	0.307	0.173	0.054	0.170	0.260	0.434	0.870	0.732	2.551	1133
Exec. Dir. (ex CEO)	0.271	0.158	0.054	0.151	0.224	0.341	0.742	0.929	2.942	754
Non-Exec. Dir.	0.185	0.101	0.055	0.121	0.156	0.239	0.502	1.280	4.574	93

Panel D: Shapley Values of each category of owner										
Institutions	0.566	0.435	0	0	0.667	1	1	-0.270	1.311	5631
Banks	0.049	0.172	0	0	0	0	1	4.376	22.840	5631
Investment/ pension funds	0.437	0.416	0	0	0.333	1	1	0.241	1.384	5631
Insurance	0.076	0.203	0	0	0	0	1	3.421	14.812	5631
Real estate	0.004	0.059	0	0	0	0	1	15.599	255.808	5631
Corporations	0.104	0.276	0	0	0	0	1	2.669	8.618	5631
Individuals/ Families (no insiders)	0.056	0.179	0	0	0	0	1	3.948	19.097	5631
Insiders	0.230	0.005	0	0	0	0	0.167	24.924	682.436	5631
CEO	0.232	0.370	0	0	0	0.333	1	1.287	3.010	5631
Chairman	0.112	0.275	0	0	0	0	1	2.560	8.226	5631
Exec. Dir. (ex CEO)	0.174	0.335	0	0	0	0.167	1	1.784	4.605	5631
Non-Exec. Dir.	0.120	0.282	0	0	0	0	1	2.377	7.321	5631
Panel E: Shapley Value of the largest shareholder, categorized according to type of shareholder										
Institutions	0.667	0.325	0.143	0.333	0.500	1	1	-0.052	1.174	3086
Banks	0.657	0.326	0.181	0.333	0.500	1	1	0.015	1.166	267
Investment/ pension funds	0.660	0.324	0.143	0.333	0.500	1	1	-0.008	1.184	2504
Insurance	0.734	0.328	0.162	0.333	1	1	1	-0.470	1.322	286
Real estate	0.762	0.326	0.300	0.333	1	1	1	-0.603	1.373	28
Corporations	0.831	0.269	0.200	0.500	1	1	1	-1.069	2.360	595
Individuals/ Families (no insiders)	0.680	0.324	0.200	0.333	0.600	1	1	-0.116	1.181	236
Insiders	0.731	0.310	0.143	0.400	1	1	1	-0.386	1.329	1464
CEO	0.746	0.309	0.162	0.400	1	1	1	-0.494	1.431	710
Chairman	0.767	0.297	0.162	0.500	1	1	1	-0.587	1.524	1133
Exec. Dir. (ex CEO)	0.717	0.311	0.143	0.333	1	1	1	-0.287	1.258	754
Non-Exec. Dir.	0.695	0.327	0.186	0.200	1	1	1	-0.264	1.306	157

Table 5

Technical efficiency – the stochastic frontier model

Specification of the stochastic efficient frontier model. The dependent variable in the main model (Panel A) is the market-to-book ratio, MV_t/BV_t. $LnSales_t$ is the natural logarithm of revenues. I_t/K_{t-1} represents the ratio of investment to the lagged capital stock. $K_{t-1}/Sales_t$ is the capital intensity. $OperMar_t$ is the operating margin, and LEV_t denotes the total leverage calculated on the basis of the market value of equity. Panel B shows the parameters of the inefficiency model. The dependent variable is v_t, which is a non-negative random component (distributed according to the truncated normal distribution $N(Z_t m, \sigma_v^2)$, where Z_t denotes the vector of variables affecting the inefficiency level and m is a vector of unknown parameters). INS_t is the insiders' share of stock. $Block_t$ denotes the other blockholders' share of stock. Panel C contains descriptive statistics of technical efficiency, EFF_t, defined as one minus ratio of v_t to MV_t/BV_t.

Panel A: Stochastic frontier model				
	Coefficient	Std. Error	t-statistic	P>|t|
$lnSales_t$	0.432	0.894	0.483	0.629
$(lnSales_t)^2$	-0.217	0.448	-0.484	0.628
I_t/K_{t-1}	0.004	0.002	1.777	0.076
$K_{t-1}/Sales_t$	-0.032	0.009	-3.759	0.000
$OperMar_t$	-0.694	0.082	-8.513	0.000
LEV_t	-0.352	0.108	-3.248	0.001
Const.	0.503	0.173	2.909	0.004
Panel B: Inefficiency model				
INS_t	0.108	0.061	1.774	0.076
$(INS_t)^2$	-0.672	0.760	0.884	0.377
$Block_t$	0.153	0.108	1.415	0.157
$(Block_t)^2$	-0.116	0.560	-0.207	0.836
Const.	-0.324	0.043	-7.451	0.000
LR test of the one-side error (χ^2) :	42.59			

Panel C: Technical efficiency – descriptive statistics

	Mean	Std. Dev.	Min	Max	25%	Median	75%	Skewness	Kurtosis
EFF_t	0.846	0.259	0.100	1.000	0.871	0.940	0.986	-2.296	6.794

Table 6

Investment model with managerial and outside block ownership

The investment model based on a fixed effects estimation. The dependent variable is the ratio of investment to the lagged capital stock, I_t/K_{t-1}. Panel A shows results for all firms in the dataset (3445 firm-years). Panel B shows the estimation results with interaction terms including dummies related to insider ownership and outside block ownership. MV_{t-1}/BV_{t-1} stands for beginning-of-the-period market-to-book ratio. CF_t/K_{t-1} stands for cash flow divided by beginning-of-the-period capital stock. D_INS_t is a dummy variable which equals 1 if insider ownership exceeds median level. D_Block_t is a dummy variable which equals 1 if outside blockholders' ownership is above median.

Panel A: Investment model for all firm-years

	Coefficient	Std. Error	t-statistic	P>|t|
CF_t/K_{t-1}	0.109	0.004	28.66	0.000
MV_{t-1}/BV_{t-1}	0.001	0.019	0.05	0.964
Const.	0.049	0.040	1.25	0.212
R^2- within	0.257		F(2,2508)	433.90
R^2- between	0.275		Number of obs.	3445
R^2- overall	0.265		Numb. of groups	935

Panel B: Sample with interaction dummies associated with high concentration of managerial ownership and high ownership concentration of other blockholders

	Coefficient	Std. Error	t-statistic	P>|t|
CF_t/K_{t-1}	0.096	0.010	10.04	0.000
MV_{t-1}/BV_{t-1}	0.002	0.015	0.12	0.904
$CF_t/K_{t-1}*D\_INS_t$	-0.035	0.010	-3.40	0.001
$CF_t/K_{t-1}*D\_Block_t$	-0.048	0.011	-4.39	0.000
$CF_t/K_{t-1}*D\_INS_t*D\_Block_t$	0.053	0.015	3.36	0.001
Const.	0.097	0.031	3.21	0.001
R^2- within	0.134		F(5,2382)	73.95
R^2- between	0.054		Number of obs.	3312
R^2- overall	0.112		Numb. of groups	935

Table 7

The non-monotonic relation between ownership and cash flow

Random effects specification of the basic investment model with interaction terms involving cash flow and the level of insider ownership. The dependent variable is the ratio of investment to the lagged capital stock, I_t/K_{t-1}. MV_{t-1}/BV_{t-1} stands for beginning-of-the-period market-to-book ratio. CF_t/K_{t-1} stands for cash flow divided by capital stock. INS_t is the percentage stake of ownership held by insiders, and $Block_t$ is the stake of ownership held by other blockholders. $INS16_t$ is the fraction of insider ownership, INS_t, lower than 16% ($INS16_t$ = min[0.16; INS_t]), $INS1622_t$ is the fraction of insider ownership between 16% and 22% ($INS1622_t$ = max[0;min[INS_t-0.16; 0]]), $INS22_t$ is the fraction of insider ownership higher than 22% ($INS22_t$ = max[INS_t-0.22; 0]). D_Block_t is a dummy variable which equals 1 if outside blockholders' ownership is above median.

	Coefficient	Std. Error	t-statistic	P>|t|
Panel A: The non-monotonic relation between cash flow sensitivity and insider control				
CF_t/K_{t-1}	0.086	0.009	9.31	0.000
MV_{t-1}/BV_{t-1}	0.011	0.011	0.97	0.330
$CF_t/K_{t-1}*INS_t$	-0.183	0.106	-1.73	0.084
$CF_t/K_{t-1}*(INS_t)^2$	-0.016	0.488	-0.03	0.974
$CF_t/K_{t-1}*(INS_t)^3$	0.259	0.624	0.42	0.678
$CF_t/K_{t-1}*Block_t$	-0.064	0.056	-1.13	0.257
$CF_t/K_{t-1}*(Block_t)^2$	0.031	0.094	0.33	0.741
Const.	0.099	0.037	2.67	0.008
R^2- within	0.140		$\chi^2(7)$	471.13
R^2- between	0.064		Number of obs.	3312
R^2- overall	0.121		Numb. of groups	925
Panel B: Cash flow sensitivity and insider control at various ownership thresholds				
CF_t/K_{t-1}	0.088	0.006	13.98	0.000
MV_{t-1}/BV_{t-1}	0.012	0.012	1.03	0.303
$CF_t/K_{t-1}*INS16_t$	-0.522	0.101	-5.16	0.000
$CF_t/K_{t-1}*INS1622_t$	0.811	0.346	2.35	0.019
$CF_t/K_{t-1}*INS22_t$	-0.249	0.091	-2.73	0.006
$CF_t/K_{t-1}*Block_t$	-0.065	0.022	-2.93	0.003
Const.	0.100	0.037	2.71	0.006
R^2- within	0.144		$\chi^2(6)$	487.92
R^2- between	0.067		Number of obs.	3312
R^2- overall	0.124		Numb. of groups	925
Panel C: The impact of outsider blockholdings on sensitivity-insider ownership relationship				
CF_t/K_{t-1}	0.101	0.006	18.14	0.000
MV_{t-1}/BV_{t-1}	0.005	0.012	0.41	0.681
$CF_t/K_{t-1}*INS16_t$	-0.767	0.125	-6.12	0.000
$CF_t/K_{t-1}*INS1622_t$	0.516	0.427	1.21	0.227
$CF_t/K_{t-1}*INS22_t$	-0.099	0.108	-0.92	0.359
$CF_t/K_{t-1}*INS16_t$ $*D\_Block_t$	0.535	0.207	2.59	0.010
$CF_t/K_{t-1}*INS1622_t$ $*D\_Block_t$	1.529	0.822	1.86	0.063
$CF_t/K_{t-1}*INS22_t$ $*D\_Block_t$	-0.940	0.461	-2.04	0.041
$CF_t/K_{t-1}*D\_Block_t$	-0.048	0.007	-6.66	0.000
Const.	0.109	0.037	2.97	0.003
R^2- within	0.156		$\chi^2(9)$	536.36
R^2- between	0.073		Number of obs.	3312
R^2- overall	0.133		Numb. of groups	925

Table 8

Investment model with cash flow and piece-wise block ownership

Fixed effects specification of the basic investment model with interaction terms involving cash flow and level of control held by different types of shareholder. The dependent variable is the ratio of investment to the lagged capital stock, I_t/K_{t-1}. MV_{t-1}/BV_{t-1} stands for beginning-of-the-period market-to-book ratio. CF_t/K_{t-1} stands for cash flow divided by capital stock. $INS16_t$ is the fraction of insider ownership, INS_t, lower than 16% ($INS16_t$ = min[0.16; INS_t]), $INS1622_t$ is the fraction of insider ownership between 16% and 22% ($INS1622_t$ = max[0;min[INS_t-0.16; 0]]), $INS22_t$ is the fraction of insider ownership higher than 22% ($INS22_t$ = max[INS_t-0.22; 0]). FL_t is the fraction of ownership by financial institutions, F_t, lower than 25% (FL_t = min[0.25; F_t]), FH_t is the fraction of ownership by financial institutions higher than 25% (FH_t = max[F_t-0.25; 0]). The remaining variables are defined analogously, with *I* referring to industrial and commercial companies, *NE* to non-executive directors, *O* to other individuals, and *G* to the government.

	Coefficient	Std. Error	t-statistic	P>|t|
CF_t/K_{t-1}	0.088	0.008	11.43	0.000
MV_{t-1}/BV_{t-1}	0.013	0.015	0.84	0.401
$CF_t/K_{t-1}*INS16_t$	-0.713	0.129	-5.52	0.000
$CF_t/K_{t-1}*INS1622_t$	1.030	0.400	2.57	0.010
$CF_t/K_{t-1}*INS22_t$	-0.209	0.101	-2.02	0.038
$CF_t/K_{t-1}*FL_t$	-0.090	0.051	-1.79	0.010
$CF_t/K_{t-1}*FH_t$	-0.059	0.056	-1.05	0.296
$CF_t/K_{t-1}*IL_t$	0.909	0.118	7.72	0.000
$CF_t/K_{t-1}*IH_t$	-0.915	0.170	-5.38	0.000
$CF_t/K_{t-1}*NEL_t$	0.355	0.214	1.66	0.097
$CF_t/K_{t-1}*NEH_t$	0.101	0.502	0.20	0.840
$CF_t/K_{t-1}*OL_t$	-0.309	0.198	-1.57	0.118
$CF_t/K_{t-1}*OH_t$	2.633	1.027	2.56	0.010
$CF_t/K_{t-1}*GL_t$	-62.041	7.705	-8.05	0.000
Const.	0.066	0.031	2.13	0.034
R^2- within	0.186		F(14, 2373)	38.75
R^2- between	0.052		Number of obs.	3312
R^2- overall	0.128		Number of groups	925

Table 9
Investment model with insider ownership and growth opportunities

Fixed effects specification of the investment model. The dependent variable is the ratio of investment to the lagged capital stock, $I_t/K_{t\text{-}1}$. The model is estimated with interaction dummies related to insider ownership and growth opportunities. $MV_{t\text{-}1}/BV_{t\text{-}1}$ stands for beginning-of-the-period market-to-book ratio. $CF_t/K_{t\text{-}1}$ stands for cash flow divided by capital stock. D_INS_t is a dummy variable which equals 1 if insider ownership exceeds median level. $D\_Q_{t\text{-}1}$ is a dummy variable which equals 1 if the beginning-of-the-period market-to-book ratio is above median.

	Coefficient	Std. Error	t-statistic	P>|t|
$CF_t/K_{t\text{-}1}$	0.031	0.006	4.90	0.000
$MV_{t\text{-}1}/BV_{t\text{-}1}$	-0.010	0.015	-0.67	0.505
$CF_t/K_{t\text{-}1}*D\_INS_t$	-0.010	0.012	-0.79	0.428
$CF_t/K_{t\text{-}1}*D\_Q_{t\text{-}1}$	0.066	0.009	6.99	0.000
$CF_t/K_{t\text{-}1}$ $*D\_INS_t*D\_Q_{t\text{-}1}$	-0.017	0.015	-1.12	0.261
Const.	0.112	0.030	3.72	0.000
R^2- within	0.150		F(5, 2382)	84.22
R^2- between	0.057		Number of obs.	3312
R^2- overall	0.122		Numb. of groups	925

Table 10

Investment model with managerial SVs, liquidity constraints and growth opportunities

Investment model with proxies for differing managerial Shapley values (SVs) for the entire sample (random effects specification), differing degree of liquidity constraints and differing degree of growth opportunities (both fixed effects specification). The dependent variable, I_t/K_{t-1}, is the ratio of investment to the lagged capital stock. MV_{t-1}/BV_{t-1} stands for beginning-of-the-period market-to-book ratio. CF_t/K_{t-1} stands for cash flow divided by capital stock. $D\_0<SV<1_t$ is a dummy variable which equals 1 if managerial Shapley value is between 0 and 1. $D\_SV=1_t$ is a dummy variable which equals 1 if managerial Shapley value is 1. D_Q_{t-1} is a dummy variable which equals 1 if the beginning-of-the-period market-to-book ratio is above median. D_CONSTR_t is a dummy variable which equals 1 if a firm is financially constrained, i.e. it reduces the dividend/keeps it at the constant level AND does not buy back its shares.

	Coefficient	Std. Error	t-statistic	P>|t|
Panel A: All sample firms				
CF_t/K_{t-1}	0.070	0.003	20.79	0.000
MV_{t-1}/BV_{t-1}	0.015	0.011	1.35	0.179
$CF_t/K_{t-1}*D\_0<SV<1_t$	-0.046	0.016	-2.94	0.003
$CF_t/K_{t-1}*D\_SV=1_t$	-0.043	0.007	-6.63	0.000
Const.	0.090	0.037	2.44	0.015
R^2- within	0.140		$\chi^2(4)$	477.13
R^2- between	0.069		Number of obs.	3312
R^2- overall	0.124		Numb. of groups	925
Panel B: Constrained vs. non-constrained firms				
CF_t/K_{t-1}	0.036	0.005	7.59	0.000
MV_{t-1}/BV_{t-1}	0.014	0.015	0.92	0.346
$CF_t/K_{t-1}*D\_0<SV<1_t$	-0.010	0.015	-0.66	0.509
$CF_t/K_{t-1}*D\_SV=1_t$	-0.017	0.011	-1.56	0.119
$CF_t/K_{t-1}*D\_CONSTR_{t-1}$	0.099	0.008	12.53	0.000
$CF_t/K_{t-1}*D\_0<SV<1_t$ $*D\_CONSTR_{t-1}$	-0.037	0.080	-0.46	0.645
$CF_t/K_{t-1}*D\_SV=1_t$ $*D\_CONSTR_{t-1}$	-0.094	0.014	-6.66	0.000
Const.	0.073	0.030	2.43	0.015
R^2- within	0.178		F(7,2207)	68.26
R^2- between	0.036		Number of obs.	3108
R^2- overall	0.116		Numb. of groups	894
Panel C: Firms with high *q* vs. firms with low *q*				
CF_t/K_{t-1}	0.034	0.006	5.66	0.000
MV_{t-1}/BV_{t-1}	-0.012	0.015	-0.83	0.408
$CF_t/K_{t-1}*D\_0<SV<1_t$	-0.002	0.052	-0.04	0.971
$CF_t/K_{t-1}*D\_SV=1_t$	-0.029	0.013	-2.21	0.027
$CF_t/K_{t-1}*D\_Q_{t-1}$	0.071	0.008	9.11	0.000
$CF_t/K_{t-1}*D\_0<SV<1_t$ $*D\_Q_{t-1}$	-0.080	0.055	-1.46	0.146
$CF_t/K_{t-1}*D\_SV=1_t$ $*D\_Q_{t-1}$	-0.045	0.015	-2.91	0.004
Const.	0.112	0.030	3.76	0.000
R^2- within	0.180		F(7,2380)	74.76
R^2- between	0.071		Number of obs.	3312
R^2- overall	0.146		Numb. of groups	925

Table 11

Investment model with technical efficiency

Fixed effects specification of the investment model with the interaction terms involving technical efficiency. The dependent variable is the ratio of investment to the lagged capital stock, $I_t/K_{t\text{-}1}$. $MV_{t\text{-}1}/BV_{t\text{-}1}$ stands for beginning-of-the-period market-to-book ratio. $CF_t/K_{t\text{-}1}$ stands for cash flow divided by capital stock. $D\_EFF_{t\text{-}1}$ is a dummy variable which equals 1 if beginning-of-the-period technical efficiency (cf. subsection 4.4.2) is above median. $D\_Q^{eff}_{t\text{-}1}$ is a dummy variable which equals 1 if the beginning-of-the-period efficient q is above median.

Panel A: Investment model with technical efficiency				
	Coefficient	Std. Error	t-statistic	P>|t|
$CF_t/K_{t\text{-}1}$	0.119	0.004	28.99	0.000
$MV_{t\text{-}1}/BV_{t\text{-}1}$	0.010	0.020	0.52	0.606
$CF_t/K_{t\text{-}1}*D\_EFF_{t\text{-}1}$	-0.047	0.008	5.96	0.000
Const.	0.045	0.039	1.14	0.255
R^2- within	0.267		F(3,2507)	305.06
R^2- between	0.259		Number of obs.	3445
R^2- overall	0.270		Number of firms	935
Panel B: Investment model with technical efficiency and efficient *q*				
$CF_t/K_{t\text{-}1}$	0.175	0.027	6.46	0.000
$MV_{t\text{-}1}/BV_{t\text{-}1}$	0.019	0.020	0.99	0.322
$CF_t/K_{t\text{-}1}*D\_Q^{eff}_{t\text{-}1}$	-0.056	0.027	-2.08	0.037
$CF_t/K_{t\text{-}1}*D\_EFF_{t\text{-}1}$	-0.031	0.032	-0.97	0.330
$CF_t/K_{t\text{-}1}*D\_EFF_{t\text{-}1}*D\_Q^{eff}_{t\text{-}1}$	-0.030	0.033	-0.89	0.372
Const.	0.019	0.040	0.46	0.643
R^2- within	0.274		F(5,2505)	188.93
R^2- between	0.254		Number of obs.	3445
R^2- overall	0.271		Number of firms	935

Table 12

Investment model for firms buying back equity and increasing dividends

Fixed effects specification of the basic investment model with the interaction term involving cash flow and technical efficiency. The dependent variable is the ratio of investment to the lagged capital stock, I_t/K_{t-1}. MV_{t-1}/BV_{t-1} stands for beginning-of-the-period market-to-book ratio. CF_t/K_{t-1} stands for cash flow divided by capital stock. BB_EQ_t is the ratio of the value of repurchased stock to equity capital. D_INCR_t is a dummy variable indicating that the firm increases its dividends. D_ZERO_t is a dummy variable indicating that the firm does not change its dividends. The firms with financing constraints of Panel C, refrain both from buying back shares and from increasing their dividends. D_CONSTR_t is a dummy variable which equals 1 if a firm is financially constrained, i.e. it reduces the dividend/keeps it at the constant level AND does not buy back its shares.

Panel A: Investment model with firms buying back shares				
	Coefficient	Std. Error	t-statistic	P>|t|
CF_t/K_{t-1}	0.111	0.004	28.81	0.000
MV_{t-1}/BV_{t-1}	-0.001	0.020	-0.03	0.973
$CF_t/K_{t-1}*BB\_EQ_{t-1}$	-0.044	0.016	-2.71	0.007
Const.	0.053	0.040	1.31	0.189
R^2- within	0.259		F(3,2507)	292.43
R^2- between	0.276		Number of obs.	3445
R^2- overall	0.267		Numb. of groups	935
Panel B: Investment model with firms increasing dividend payout				
CF_t/K_{t-1}	0.227	0.005	44.41	0.000
MV_{t-1}/BV_{t-1}	-0.003	0.017	0.19	0.850
$CF_t/K_{t-1}*D\_INCR_{t-1}$	-0.194	0.007	-27.49	0.000
$CF_t/K_{t-1}*D\_ZERO_{t-1}$	-0.162	0.007	-22.35	0.000
Const.	0.085	0.034	2.45	0.015
R^2- within	0.453		F(4,2506)	519.48
R^2- between	0.336		Number of obs.	3445
R^2- overall	0.418		Numb. of groups	935
Panel C: Investment model with financing constraints				
CF_t/K_{t-1}	0.031	0.005	6.36	0.000
MV_{t-1}/BV_{t-1}	0.006	0.018	0.31	0.757
$CF_t/K_{t-1}*CONSTR_{t-1}$	0.047	0.007	6.46	0.000
Const.	0.093	0.036	2.59	0.010
R^2- within	0.090		F(3.2316)	76.25
R^2- between	0.072		Number of obs.	3223
R^2- overall	0.082		Numb. of groups	904

about ECGI

The European Corporate Governance Institute has been established to improve *corporate governance through fostering independent scientific research and related activities.*

The ECGI will produce and disseminate high quality research while remaining close to the concerns and interests of corporate, financial and public policy makers. It will draw on the expertise of scholars from numerous countries and bring together a critical mass of expertise and interest to bear on this important subject.

The views expressed in this working paper are those of the authors, not those of the ECGI or its members.

Financial assistance for the services of the editorial assistant of these series is provided by the European Commission through its RTN Programme on Understanding Financial Architecture: Legal and Political Frameworks and Economic Efficiency (Contract no. HPRN-CT-2000-00064).

Electronic Access to the Working Paper Series

The full set of ECGI working papers can be accessed through the Institute's Web-site (www.ecgi.org/wp) or SSRN:

Finance Paper Series	http://www.ssrn.com/link/ECGI-Fin.html
Law Paper Series	http://www.ssrn.com/link/ECGI-Law.html