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By Qingwei Meng, Victor Murinde and Ping Wang

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Centre for Global Finance
SOAS University of London
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WC1H 0XG

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Corporate investment, financing and payout decisions under financial constraints and uncertainty: Evidence from UK firms[1]

Qingwei Meng[a], Victor Murinde[b,2], Ping Wang[c]

[a]*Research Department, African Development Bank Group*
[b]*School of Finance and Management, SOAS University of London*
[c]*Birmingham Business School, University of Birmingham*

Abstract
We investigate interactions among corporate investment, financing, and payout decisions under uncertainty, using a panel of UK-listed firms. We model these corporate decisions within a simultaneous equations system where we treat each decision as endogenous, but allow for their contemporaneous interdependence, as implied by the flow-of-funds framework. We find that the effect of uncertainty on corporate investment is positive and significant, while those on debt financing and dividend payouts are significant and negative. Accordingly, firms facing greater uncertainty appear to increase investment, by resorting to internal finance and by cutting dividends rather than resort to external finance by issuing new debt. Further, we divide the entire sample into two groups, namely financially more constrained firms and less constrained firms, in order to explore the sensitivity of our results to financial constraints. We find that the simultaneity among the three corporate decisions is more pronounced for financially more constrained firms, but the effect of uncertainty is more significant for firms which are financially less constrained. It appears that financial constrains are the possible channel through which corporate decisions are jointed determined. Overall, our results offer new insight into the complex interdependence of corporate behaviour by UK-listed firms, under financial constraints and uncertainty.

Key words: Corporate investment; financing; payout decisions; uncertainty; UK-listed firms.

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[2] Corresponding author at: SOAS University of London, London WC1H 0XG, UK.
E-mail addresses: v.murinde@soas.ac.uk (V. Murinde), q.meng@afdb.org (Qingwei Meng), P.Wang1@bham.ac.uk (Ping Wang)

1. Introduction

Corporate investment, financing, and payout policies are known as the trilogy of corporate decisions (see, Wang, 2010). Although much effort has been devoted to investigating this key set of corporate decisions in literature, they were typically treated separately and hence there has been little analysis of the simultaneous determination among them. This is largely due to the great influence of the series of propositions formulated by Modigliani and Miller (1958) and Miller and Modigliani (1961) (MM hereafter) under the assumptions of perfect and complete capital markets[3]. They demonstrate that a firm's internal and external financings are perfect substitutes in a perfect market environment, and hence the firm's optimal investment spending should be solely determined by its real considerations and totally independent of its financing and payout decisions. In other words, MM's propositions suggest that there are no interdependencies among the set of corporate decisions within a perfect market environment.

However, another thread of literature initiated by Dhrymes and Kurz (1967) argues that, in the real world, the capital markets are sufficiently imperfect and incomplete so that the cost of external funds exceeds that of internal funds. Accordingly, the sources of funds are likely to be limited, and this in turn may hamper a firm's ability to invest efficiently. Under these circumstances, a firm has to consider its fund-raising ability in its fund-spending decisions, and rationally allocate the scarce funds between the competing uses, i.e. investment outlays and dividend payouts. Later studies that armed with further theoretical arguments, such as tax considerations, agency problems, and information asymmetry, also document how the corporate decisions may have significant influence on one another. Even though both strong intuitions and theoretical arguments suggest that corporate decisions are potentially interdependent, existing empirical literature that investigate firms' real and financial decisions overwhelmingly employs single equation techniques which permits no analysis of the interactions among corporate investment, financing, and dividend decisions. This study aims at overcoming this limitation of existing empirical literature by modelling corporate investment, financing and payout decisions within a context of simultaneous system, which may provide greater insight into the interrelationships that may exist among the set of corporate decisions.

In addition, the set of corporate decisions are potentially interdependent not only because they may affect one another directly, but also because they are likely to be affected by substantially overlapping or similar information. Recent literature that seeks to explore the determinants of corporate investment behaviour highlights the importance of uncertainty associated with firms' prospects. However, the importance of uncertainty in financing and payout decisions has received little attention. Given the fact that all corporate decisions are made on the basis of uncertain information, the degree of uncertainty should matter in both financing and payout decisions as well. Recent survey studies, such as Brounen et al. (2006) on capital structure and Brav et al. (2005) on dividend payout, also strongly suggest that

[3] The assumptions include the absence of transactions costs and taxes in the capital market and that all information is costlessly available to everyone.

uncertainty may also play a critical role in corporate financial decision making processes. Therefore, we consider uncertainty as a common factor that involves in each of the decisions modelled in our simultaneous system, to comprehensively investigate corporate behaviours under uncertainty.

This study contributes to the understanding of corporate behaviours in several ways. First, the comprehensive review of literature on the interactions between corporate policies explores several theoretical mechanisms through which firms' investment, financing, and payout decisions may be determined jointly. Second, the simultaneity analysis of corporate investment, financing, and payout policies, with reference to a panel of UK-listed firms, is helpful in understanding the interdependencies among the corporate decisions in the real world. Third, we empirically investigate the roles that uncertainty played in the set of corporate decision-making processes, which have been overlooked by the existing literature. Besides, we further explore the possible mechanism through which the set of corporate decisions are interdependent, by dividing the entire sample into subsamples. Taking all the innovations together, the whole study reveals new insight into the complex corporate behaviours under uncertain circumstances. The results may also shed some light for managers in deploying risk-reducing strategies in the face of vague prospects.

The remainder of this paper is organized as follows. Section 2 reviews the literature related to the simultaneity of and the uncertainty effect upon corporate investment, financing, and payout decisions. Section 3 discusses the sample, variables, and empirical models. Section 4 describes the estimation and testing procedures as well as the results for the empirical models. Concluding remarks are drawn in Section 5.

2. A review of selected literature

2.1. Corporate decisions and simultaneity

The influential propositions of MM demonstrate that, in a perfect market environment, a firm's investment decision is solely determined by its real (i.e. nonfinancial) considerations, and is completely unaffected by how the projects are financed. Accordingly, corporate investment decision should be totally independent of financial decisions within a firm. Therefore, under MM's perfect capital market assumptions, a firm's investment, financing, and payout policies should be treated as separate decisions[4]. As a consequence, each of the three aspects of the firm's behaviour has been studied intensively but separately over the last half-century, while the interactions among them are seldom explored systematically in the literature. Nonetheless, some studies have attempted to examine how various fractions in the real world may drive linkages among corporate investment, financing, and payout decisions. Several mechanisms through which the set of corporate decisions may affect one another have been explored, such as flow-of-funds approach, tax approach, agency approach, information approach, etc. It is worth noting that these hypothesized mechanisms are not

[4] MM (1985) argue that the problems involved in planning the optimal financial structure have no bearing on the basic decisions to invest.

mutually exclusive, but they may have very different implications for the interactions among the three main corporate decisions.

2.1.1. *Institutional facts*

The modern firm is a complex organization with a considerable degree of decentralization. The decisions made by one department have impacts on those made by the others. Hence, corporate decisions depend not only on the factors which are exogenous to the firm, but also on the factors which are endogenous to the firm. In the complex corporate decision-making process, the role of the top executives of a firm, e.g. the board of directors or the president, are not making decisions in the first instance, but receiving proposals, examining priorities, and making departmental decisions consistent with one another by simultaneously weighting the effects of one choice versus those of the others. Mueller (1967) stresses that, in formulating policy recommendations, one must be aware of the interactions of many of the firm's decisions, not only in order to avoid undesirable side effects which might stem from a given policy, but also to be certain that these interactions do not actually result in a negation of a policy's primary goal. Therefore, given the institutional facts of modern firms and the complexity of their decision-making process, it is reasonable to expect a joint determination of the main corporate decisions.

Because of the complexity of corporate behaviour, empirical models of corresponding complexity should be formulated in order to carry out valid empirical investigation. However, existing literature on corporate finance has overwhelmingly employed single equation techniques, which permits no analysis of interactions. To reveal deeper and more comprehensive insight into the complex corporate behaviour, especially the inherent linkages among the main corporate decisions, more sophisticated and more statistically correct techniques which explicitly allow for the simultaneity should be more plausible.

2.1.2. *Flow-of-funds approach*

The most intuitive and straightforward framework that set up the interconnectivity among the set of corporate decisions is the flow-of-funds approach proposed by Dhrymes and Kurz (1967). They take the view that a firm faces an outflow of funds represented mainly by its variable and fixed costs, taxes and dividend payments, as well as investment outlays. Meanwhile, it relies on an inflow of funds represented chiefly by its sales and the proceeds through various forms of external finance such as debt or stock issuance. Accordingly, Dhrymes and Kurz (1967) defines that the major problems of a firm are raising funds from profits, new debt, and equity and spending them on investment and dividends, where the overriding constraint is the flow-of-fund identity[5]. If the capital markets are less than perfect, firms are likely to have a marked reliance on internal funds and a strong aversion to use of the capital markets. Under such circumstances, the availability of funds may impose financial constraints on the firm's funds-spending decisions, so that the firm has to consider its financing ability in investment and payout decisions. Moreover, investment and dividend outlays are quite clearly competitive, which means the firm has to decide how to allocate the scarce funds between investment and dividends over certain period of time. Therefore, in a

[5] The sources of funds must equal uses of funds.

world where the capital markets are sufficiently imperfect, corporate investment, financing, and payout decisions are likely to be determined jointly. If the flow-of-funds conjecture about the interactions is empirically supported, then the coefficients of the jointly determined corporate decisions, i.e. the endogenous variables, should be significant in a simultaneous equations system, at least in several instances, where they serve as explanatory variables (see Dhrymes and Kurz, 1967).

Following up with the flow-of-funds framework, McCabe (1979) modifies Dhrymes and Kurz (1967)'s three-equation model by carefully specifying the exogenous variables and lag structures. The empirical evidence obtained from 112 US firms over eight years strongly suggests that corporate investment does not appear to be determined independently of financial variables. As expected, investment outlays and dividend payouts are significantly and negatively interrelated, while both of them are positively interrelated with the main sources of funds, i.e. current new debt and profit. Peterson and Benesh (1983) re-examines the empirical relationships among the same set of corporate decisions using alternative estimation techniques. They again conclude that the imperfections in capital markets are sufficient to invalidate MM's independence proposition, leading to joint determined investment, financing, and dividend decisions as predicted by the flow-of-funds approach. More recently, Gugler (2003) finds significantly negatively influence of dividends on capital investment, which also contradicts the premise of a perfect capital market. In contrast to the findings on US data, McDonald et al. (1975) empirically support MM's independence proposition and hence reject the Dhrymes and Kurz (1967)'s flow-of-funds conjecture using a sample of French firms.

In spite of the fact that the simple idea of flow-of-funds approach provides the guidance for the preliminary studies on the interdependencies among corporate decisions, the Dhrymes and Kurz (1967)'s three-equation model is criticized for the lack of coherent theory and hence fall short of resolving the issue regarding the directions of the interactions. Later studies that armed with further theoretical arguments address the issue more in depth.

2.1.3. ***Tax approach***

MM's assumption of a perfect market environment in their original proposition was criticized for failing to incorporate taxes in their theory. They then revised their original propositions in Modigliani and Miller (1963) by taking taxes into consideration. The revised version shows that, because interest payments were treated differently from dividends and capital gains for tax purposes, managers could increase the value of a firm by using debt financing. More specifically, if interest expense is tax deductible, then debt financing creates a tax shield which leads to an increase in existing shareholders wealth.

However, the tax-deductibility is not unique to debt financing. The depreciation resulting from investment made by firm provides an annual non-debt-related tax shields equal to the product of depreciation and the marginal tax rate. Myers (1974) argues that in valuing a project one must take into account its contribution to the tax shield value of the firm. From this point of view, taxes might offer a link between investment and financing decisions. DeAngelo and Masulis (1980) demonstrates that both investment and debt financing decisions give rise to tax shields, but if income does not always exceed all tax shields, some tax shields may not be deductible, and hence the plentiful non-debt tax shelter deductions reduce the need for debt. In other words, debt financing may be considerably more expensive if the investment which it finances creates enough depreciation-related tax shields to render the interest-related tax shields useless. Similarly, investment projects may be considerably less profitable if depreciation tax shelters cannot be used to their full advantage as a result of large deductions for interest payments (see Ravid, 1988). Given the substitutability of depreciation-related and interest-related tax shields, the innovative tax planning model reaches the conclusion that corporate investment and debt financing decisions should be determined simultaneously, so higher level of investment should be financed by less debt. A recent study by Graham and Tucker (2006) lends strong empirical support to the prediction of DeAngelo and Masulis (1980)'s model by showing that firms are significantly less likely to issue debt when their non-debt-related tax shields are large. They also acknowledge that it is difficult to unambiguously prove the direction of causality or order of sequential choice, because a firm might use less debt after having first established non-debt tax shields or it might resort to sheltering after discovering that it is unable to issue much debt for whatever reason. Cooper and Franks (1983) further take the issue of carry-forwards and carry-backs into considerations. They suggest that because operating tax losses resulting from the firm's choice of investment projects may affect the firm's effective tax rate in future periods, which will in turn affect the tax shield value of investment and debt. Thus current investment decision will interact with future investment and debt financing decisions.

The tax effect also has implication on dividend decisions. Dividends are taxed more heavily than capital gains, and this can create large burden of personal taxation to shareholders. For example, the dividend income in the UK is taxed at a basic rate of 32.5%, while capital gains are taxed at a much lower flat rate of 18%[6]. In order to save taxes, low dividend payout should be welcomed by any taxpaying investor, especially the investors in high-tax brackets. Moreover, taxes on dividends have to be paid immediately, while capital gains are not taxed until they are realized from the sale of shares. Under the tax code that favour capital gains, it ought to be rational for firms to try to minimize dividend payouts, and hence taxes, by holding and reinvesting their profits. Nevertheless, empirical evidence on dividends shows that taxes have been only a secondary consideration, which itself alone can neither justify the existence of dividends nor explain the corporate payout behaviour. Besides, it does not have any implication on the interactions between dividend and investment, and between dividend and financing.

In a nutshell, tax framework implies that tax planners of a firm should minimize dividend payout to avoid large burden of personal taxation, and then make investment and debt financing decisions simultaneously to make full use of both depreciation-related and interest-related tax shields. However, it must be emphasized that corporate decisions are, of course, not solely determined by tax considerations, and hence the tax approach can only provide a framework to analyze the relationships among the decisions in the particular way.

[6] Dividend income at or below the £37,400 basic rate tax limit will be taxed at 10%; dividend income above the £150,000 higher rate tax limit will be taxed at 42.5% (Source: HM Revenue and Customs website http://www.hmrc.gov.uk/taxon/uk.htm).

Besides, Adedeji (1998) points out that, since the imputation tax system in the UK does not encourage firms to use debt as much as classical tax system does in the US, the imputation tax system may weaken the interaction between investment and financing decisions, and strengthen the interaction between investment and payout decisions in the UK[7].

2.1.4. *Agency approach*

Alternatively, the set of corporate decisions might make sense in connection with one another through agency approach. In the context of modern corporations, managers, who perform as the agents of shareholders, have the duty to maximize shareholders' wealth. However, they may be tempted to maximize their personal wealth using their power, serving as imperfect agents. The conflicts of interest between managers and shareholders are likely to cause agency problems and to distort corporate behaviour. Jensen (1986) asserts that managers have incentive to cause their firms to grow beyond the optimal size so that increasing the resources under their control. Manager's incentive to build a larger empire rather than pay out its free cash flow may lead to a problem of overinvestment[8]. This problem is particularly severe in the firms with substantial free cash flow, and hence the internal control system and the market for corporate control are especially important in this context to ensure that managers are pursuing the shareholders' interests (see Jensen, 1986). In order to control the agency problem of overinvestment which could be proxied by investment ratio, it is advantageous to set up agency-cost control devices that give managers incentive to act as better agents. Agency literature suggests that both debt financing and dividend payout can be used as agency-cost control devices that motivate managers to disgorge free cash flow[9] rather than invest it at below the cost of capital.

On the one hand, Easterbrook (1984) offers agency-cost explanations of dividends that the expected and continuing dividends compel firms to distribute more free cash flow in the hands of managers, and force firms to raise new funds in capital market more frequently in order to carry out their activities. Firms, that payout dividends and raising external funds simultaneously, subject themselves to the scrutiny of third parties[10] to attract needed capital. From this point of view, dividend payout provides an incentive for manages to reduce the costs associated with the agency problems. Meanwhile, Easterbrook (1984) also suggests the substitution among agency-cost control devices, such that when a non-dividend monitoring mechanism is in place, the use of costly dividend payout mechanism to induce capital market monitoring is less likely. Jensen (1986) further proposes a "control hypothesis" of debt and discusses the benefits of debt in monitoring managers and their companies. He argues that the use of debt can diminish the agency problem of overinvestment by committing the firm to fixed interest payments. By issuing debt, managers are bonding their promise to pay out

[7] According to Adedeji (1998), the imputation tax system in the UK encourages firms to pay dividend rather than reinvest their profits.
[8] Ravid (1988) argues that managers who by assumption are averse to paying dividend will prefer to invest even in negative NPV projects which will increase the size and importance of the organization.
[9] Jensen (1986) defines free cash flow as cash flow in excess of that required to fund all projects that have positive net present values when discounted at the relevant cost of capital.
[10] Easterbrook (1984) observes that when the firm issues new securities, its affairs will be reviewed by an investment banker or some similar intermediary acting as a monitor for the collective interest of shareholders, and by the purchasers of the new instruments. The same occurs when the firm issues new debt, including bonds, commercial paper, and syndicated bank loans.

future cash flows in a way that cannot be accomplished by simple dividend increases[11]. Thus, debt can be used as an effective substitute for dividends in reducing the agency costs of free cash flows. Stulz (1990) further proves that debt can reduce the managers' tendency to overinvest. The agency approach is successful in explaining why some firms raise new funds, often in the form of bank loans, simultaneously when they pay dividends. Although both floating new securities and issuing dividends incur costs, they reduce the shareholders' losses resulting from agency problems by setting up monitoring mechanisms. Moreover, because both of the agency-cost control devices are themselves costly, it would be expected to see substitution between them (see Easterbrook, 1984). The substitution between debt, dividends, and other agency-cost control devices is empirically verified by Jensen et al. (1992). Noronha et al. (1996) and Ding and Murinde (2010) also observe the simultaneity between capital structure and dividend decisions in an agency-cost framework, the latter obtains evidence from a panel of UK firms.

The implication is that the interactions among corporate investment, financing, and payout decisions might be driven by the agency-cost considerations, especially in large public firms where the ownership is considerably dispersed and the free cash flow is substantial. Firms with higher level of capital expenditures are likely to face more serious agency problem of overinvestment, thus are expected to be more closely monitored by using either more debt financing or higher dividend payout as monitoring mechanisms. Meanwhile, because of the substitution of debt financing and dividend payout for controlling agency costs, they are expected to be adversely related to each other. Within this framework, the investors may demand high dividend payouts or borrowing not because these are valuable in themselves, but because they encourage a more careful and value-oriented investment policy. Thus investors are willing to bear the relevant costs (e.g. tax burden and issuance costs) to realize the benefits of reduction in the costs associated with the agency problem of overinvestment, i.e. trade-off between agency cost and transaction cost. However, it should be noted that the monitoring rationale for debt and dividends is only a partial explanation of corporate financing and payout policies, and not all firms base their financial decisions on agency-cost considerations[12]. The effect of agency-cost considerations on corporate behaviours may not be as important for rapidly growing firms with large and highly profitable investment projects but no free cash flow[13].

2.1.5. *Information approach*

The theoretical contributions in information economics provide another promising approach for explaining the interdependencies among corporate investment, financing, and payout decisions. The general idea is that managers may have superior information regarding the

[11] Jensen (1986) points out that managers with substantial free cash flow can increase dividends or repurchase stock and thereby pay out current cash that would otherwise be invested in low-return projects or wasted. This leaves managers with control over the use of future free cash flows, but they can promise to pay out future cash flows by announcing a "permanent" increase in the dividend. Such promises are weak because dividends can be reduced in the future.
[12] According to Noronha et al. (1996), simultaneity between capital structure and dividend decisions is observed only for the subsample in which the monitoring rationale for dividends is found applicable.
[13] Jensen (1986) observes that such firms will have to go regularly to the financial markets to obtain capital. At these times the markets have an opportunity to evaluate the company, its management, and its proposed projects. Investment bankers and analysts play an important role in this monitoring, and the market's assessment is made evident by the price investors pay for the financial claims.

future prospects of the firm that outside investors do not have. The asymmetric information between insiders and outsiders may constrain corporate investment by reducing the elastic supply of internal funds as well as limiting the access to external funds, thus evoke the simultaneity among corporate investment, financing, and payout decisions.

Information asymmetry creates an imperfectly elastic supply of internal finance for capital expenditure by limiting the access to retained earnings. Miller and Rock (1985) demonstrate that, in the presence of information asymmetry, managers use dividends as signal to reveal some of their private information about firms' both current and future earnings to the outside investors. Given the information content of dividends, managers are reluctant to cut dividends in order to avoid the anticipated negative market reactions, meanwhile they are also reluctant to raise dividends unless they are confident that sufficient future cash will flow in to support their payouts at higher levels. The stickiness of dividends under information asymmetry, therefore, reduces the flexibility in raising funds for capital investment from internally generated cash flow. Since the variation in capital expenditure cannot be soaked up freely by retained earnings, corporate investment is likely to be internally financial constrained. As a result, firms may be forced either to forego relatively low net present value (NPV) investment projects or to raise more funds from outsiders to maintain their dividend payouts at desired levels.

Unfortunately, the imperfect information not only impedes the ability of firms to raise funds from internal finance, but it also limits the access to external finance. Myers and Majluf (1984) show that the alternative sources of funds are no longer perfect substitutes due to the costs created by managers' superior information. In the presence of information asymmetry, managers' efforts to issue risky securities tend to be rationally interpreted as a signal that the firm is overvalued. Hence, external finance is more costly than internal finance, and external equity is more costly than external debt. In other words, information asymmetry justifies the "pecking order" behaviour of corporate financing. Managers prefer to finance all the uses of funds with internally generated cash flow if possible, which is not subject to information problem and hence has cost advantage. When the internal cash flow is exhausted and external finance is required, managers raise external funds with safe debt, which is less affected by revelation of managers' superior information. Risky debt or equity is only considered as a last resort[14]. Therefore, if firms are not able to obtain as much safe debt as they desired at given cost, their investment spending is likely to be externally financial constrained, which means a decline in debt financing may result to capital rationing.

Taking together, information asymmetry constrains firms' ability in raising internal finance via its effect on dividends, and limits their access to external finance via its effect on issuances of securities. Therefore, corporate decisions are likely to be made systematically and simultaneously by managers with full recognition of competing needs for funds and alternative sources of funds. Mougoué and Mukherjee (1994) provide empirical justification of the interrelations among the three decisions of a firm by applying the vector autoregressive modelling technique to 100 US industrial firms. Their results of the causality test strongly

[14] Equity issues are comparatively rare among large established firms. Marsh (1982) shows that equity issue are particularly rare among large established firms in the UK.

support the prediction of information approach that the causality flow between a firm's investment decisions and dividend decisions is bidirectional and negative, while the causality flow is bidirectional and positive between investment and borrowing decisions and between dividend and borrowing decisions. They conclude that capital market imperfections caused by information asymmetry lead to the causality relations among a firm's investment, financing and dividend decisions. More recently, Wang (2010) adopts more advanced techniques, i.e. path analysis and directed acyclic graphs (DAG) analysis, to explore the causal structure of the same set of corporate decisions. The empirical results obtained from high-tech firms listed in Taiwan and China further confirm that the investment, financing, and dividend decisions made by the sample firms can be effectively explained by the causal relationship among them in the presence of information asymmetry.

[insert Table 1 about here]

An important implication of the theoretical literature surveyed above is that corporate investment, financing, and payout decisions are potentially linked in several important ways, thus should be better analyzed within a simultaneous model framework. If this is the case, then failure to take the simultaneity into account may result in serious simultaneity bias. A summary of selected previous studies on the simultaneity of corporate decisions is presented in Table 1. These findings provide us guidance in modelling corporate behaviours to avoid the danger of drawing spurious conclusions. However, none of the early studies are sufficiently comprehensive in the sense that they do not provide enough insight into the theoretical mechanism through which the set of corporate decisions may be bonded together and determined simultaneously. Beside, most of significant empirical studies that validate the joint determination of the corporate decisions are based on data from US firms, and the body of evidence on the other markets outside US is still relatively small. McDonald et al. (1975) point out that the interactions among the corporate decisions are likely to depend on the size of capital market. Thus, it still remains to be further investigated whether solid empirical evidence can be obtained to verify the possible interactions suggested by the theoretical arguments. Therefore, the issue is not yet satisfactorily resolved and the gaps in the existing literature motivate this study to present a theory-based empirical investigation of the simultaneous determination of corporate investment, financing, and payout decisions, with reference to the UK-listed firms.

2.2. Corporate decisions under uncertainty

2.2.1. *Corporate investment decisions and uncertainty*

Conventional literature on corporate finance has long been criticized for overlooking the effects of uncertainty on firms' real and financial behaviours. Recent studies that seek to explore the determinants of corporate investment have highlighted the importance of uncertainty associated with firms' prospects. Several channels through which uncertainty may influence investment has been identified and examined. Nonetheless, the investment-uncertainty relationship is still theoretically ambiguous and empirically inconsistent.

Under the assumption of competitive product markets and symmetric adjustment costs for capital, a line of literature demonstrates a positive correlation between investment and uncertainty. Hartman (1972)'s discrete-time model shows that, if the future input and output prices of a project are mean-preserving stochastic processes, then greater uncertainty about the distributions of these variables increases the expected present value of future profits associated with the project, and thus leads the competitive firms to increase their investment. Abel (1983) extends Hartman's discrete-time model to a continuous–time model and proves that Hartman's results continue to hold in this context. Hartman (1972)-Abel (1983) framework demonstrates that because some factors (say for example the labour input) can be optimally adjusted to price shock after the uncertainty has been dispelled, the marginal product of capital will be a convex function of these random variables (say the wage rate). Therefore, in their theoretical models, increased variations in the random variables raise the expected marginal product of capital by means of Jensen's inequality, resulting in a positive effect of uncertainty on investment. More intuitively, the idea behind these theoretical models is that uncertainty associated with a firm's prospects contains both downside and upside risks. If the firm can take appropriate strategies to deal with various possible situations in the future, it should reasonably put more weight on the favourable outcomes, which raises the attractiveness of the investment projects.

In contrast, another branch of literature, which emphasizes on the irreversibility and timing of investment, demonstrates a negative effect of uncertainty in a dynamic framework. McDonald and Siegel (1986) point out that most investments in reality can be delayed, but cannot be reversed. Under these circumstances, if the outlook of an irreversible investment project is unclear, the firm should choose to delay undertaking the project and wait for the arrival of new information. In the same vein, Dixit and Pindyck (1994) derive a real options theory of investment. They illustrate that greater uncertainty associated with the outlook of an irreversible investment is likely to increase the value of the real option to invest, rising the threshold for a project to be undertaken. Thus, in order to make an optimal investment decision, the real option value should be accounted for part of the full costs of the project. The real options theory, therefore, predicts a negative relationship between investment and uncertainty.

Recent theoretical innovations, however, tend to cast doubt on the assertion of the standard real options theory of investment. They argue that the real options approach only analyzes investment decisions in a single-agent context but overlook the strategic interactions between players under a competitive condition. In the real business world, investment usually takes place in a very competitive environment, so the strategic considerations of the competing firms should be taken into account when investigating investment-uncertainty relationship in a multi-player context. Caballero (1991) argues that the value of option to delay irreversible investment is insufficient to deter investment if the firm is operating in a perfectly competitive product market using a constant return to scale production technology, thus the effect of firm-specific uncertainty may still have a positive effect on investment as argued by Hartman (1972) and Abel (1983). More specifically, Mason and Weeds (2010) highlight two types of strategic interactions between investing agents need to be considered, i.e. pre-emption and externality. First, when there is a strong and persistent advantage to be the first to invest[15], firms may forfeit the option value of delay to pre-empt their rivals in spite of the certain outcomes. In these situations, the threat of being pre-empted will offset the value of wait due to the real option effect when firms evaluating their investment projects. Second, the value of an investment may also depend on the number of firms which have also invested. Externality may affect the value of investment negatively through a competitive effect, or positively through a complementary effect[16]. In both of the cases, the value and timing of a firm's investment is likely to be influenced by the investment decisions of its peers. Mason and Weeds (2010) prove that, under a very competitive condition, greater uncertainty can lead the leading companies to take the advantage of pre-emption by investing earlier. Therefore, by extending the real option analysis to include strategic interactions between players, Mason and Weeds (2010) conclude that an increase in uncertainty may increase corporate investment even if the projects are irreversible.

The theoretical ambiguity of investment-uncertainty relationship has subsequently stimulated a growing literature that attempt to address the question on empirical ground. Unfortunately, the empirical results regarding the investment-uncertainty relationship varies across studies both quantitatively and qualitatively. Abdul and Wang (2008) use data from Chinese companies to investigate the link between uncertainty and investment. Controlling for the short- and long-run investment dynamics, their results consistently show a positive and statistically significant effect of uncertainty on corporate investment. They conclude that higher risk perception leading to higher investment, and in turn stronger aspiration of reinvestment. Bloom et al. (2007) show that, with partial irreversibility, higher uncertainty increases real option values make firms more cautions when investing or disinvesting, resulting in a "cautionary effects" of uncertainty. Lensink and Murinde (2006) empirically verify an inverted-U hypothesis of investment under uncertainty, using a panel of UK firms. Their results suggest that the effect of uncertainty on investment is positive at low levels of uncertainty, but it becomes negative at high levels of uncertainty. Bulan (2005) decomposes the total uncertainty faced by a firm into its market, industry and firm-specific components. She finds that empirical evidence from US firms lend strong support to the real options theory. Both firm-specific and industry uncertainty components appear to increase the value of the option to delay, and depress investment.

2.2.2. *Corporate financial decisions and uncertainty*

Compared with investment decision, the importance of uncertainty in financing and dividend policies has received little attention. Indeed, all corporate decisions are made on the basis of uncertain information, and hence the degree of uncertainty should be carefully considered in the each of the decision-making processes for corporate policies. Several recent studies have indicated the potential role that uncertainty played in firms' financial decision-

[15] According to Mason and Weeds (2010), patent races are characterized by lasting first-mover advantage: the first to invent (or first to file) gains an exclusive right over the technology, which other firms must not infringe. System wars between incompatible technologies (e.g. Windows vs. Apple Mac, VHS vs. Betamax) are also instances where a first-mover advantage tends to persist; hence, one might expect to observe pre-emptive investment, and relatively little sensitivity to uncertainty.

[16] Mason and Weeds (2010) note that the interaction may have a positive effect, if there are complementarities between the agents' actions such as network externalities or demand expansion.

making processes. Frank and Goyal (2009) examine the relative importance of many factors in the capital structure decisions, and provide evidence suggests that uncertainty can to some extent explain firms' leverage. They argue that firms with greater uncertainty face higher expected cost of financial distress thus should use less debt. Brav et al. (2005) report the results of an international survey on payout policy. The feedback from financial executives indicates that perceived uncertainty of future performances is an important factor affecting dividend decisions. Uncertainty may have impact on the amount of dividend as well as the probability of paying dividend. These survey results on dividend policy and uncertainty is to some extent supported empirically by Chay and Suh (2009) who report a significant and negative impact of cash flow uncertainty on corporate payout policy. Chay and Suh (2009) argue that firms facing high cash-flow uncertainty tend to avoid paying high dividends because they are not confident of their ability to maintain high dividends. Therefore, managers' incentive to prevent financial trouble and adverse market reaction may lead to a negative effect of uncertainty on corporate payout policy.

The brief review of literature shows that uncertainty associated with a firm's future prospects seems to be a critical factor in determining the firm's real as well as financial behaviours. However, there are a number of research gaps in the literature still remain unfilled. First, the measurement of uncertainty in empirical work is problematic and different measures are used in the literature. The measures used to proxy for uncertainty at firm level can be categorized into several broad approaches, including accounting-based performances volatility (see Ghosal and Loungani, 2000); survey-based forecasts dispersion (see Bond and Cummins, 2004), and market-based stock returns variation (see Lensink and Murinde, 2006). However, it is documented that none of these approaches is without its particular problems and criticisms (see Carruth et al., 2000). The ambiguous empirical evidence regarding the effects of uncertainty on corporate behaviour may partly due to the inability to measure uncertainty accurately. Second, the results of empirical studies on investment-uncertainty relationship seem sensitive to the model specifications. Omission of relevant information such as financing and dividend decisions in corporate investment equation is likely to generate misleading results and inappropriate inferences[17]. Third, the importance of uncertainty in firms' financing and dividend policy has not been thoroughly evaluated in empirical literature. Consequently, our knowledge of the role that uncertainty played in corporate financial decisions is limited. Finally, given the fact that all the corporate decisions are made on the basis of uncertain information, it seems more reasonable to consider corporate real decisions and financial decisions simultaneously. Drawing lessons from existing literature, this study constructs several alternative measurements of uncertainty and specifies structural models carefully within a simultaneous framework, in which investment, financing, and dividends are allowed to be jointly determined.

[17] According to Brooks (2008), the consequence of omitting important variables would be that the estimated coefficients on all the other variables will be biased and inconsistent unless the excluded variables are uncorrelated with all the included variables.

3. Empirical methodology

3.1. Theoretical framework

Following a number of analytical and empirical studies discussed in the previous section, this study postulates that, in the presence of information asymmetry and the resultant market imperfections, corporate investment, financing, and payout decisions should be viewed as part of a simultaneous and interdependent process. To justify the fundamental interactions among the three corporate decisions, we derive a model from the flow-of-funds identity for a firm. Based on stylized financial statements, a firm's basic sources and uses of funds identity can be expressed as follows:

$$\Delta FA + \Delta CA + DIV = \Delta LD + \Delta SD + \Delta EQU + PRO + DEP \qquad (1)$$

where, *FA* = fixed assets, *CA* = current assets, *DIV* = dividends paid to shareholders, *LD* = long-term debt, *SD* = short-term debt, *EQU* = common and preferred stock (exclusive of retained earnings), *PRO* = net income after tax, *DEP* = depreciation allowances, and Δ = the change in a variable from *t-1* to *t*. The flow-of-funds identity states that firms raise fund external debt (ΔLD and ΔSD), external equity (ΔEQU), as well as internally generated cash flow (*PRO* and *DEP*), and spend it on investment in assets (ΔFA and ΔCA) and dividend payout (*DIV*).

Under MM's assumption of perfect capital markets, the uses of funds are implicitly viewed as being taken solely, and the sources of funds are considered as perfect substitutes. If firms are able to finance as much funds as it desires to maintain the optimal level of spending, then external finance should be residually derived. In this context, firm's investment, financing, and payout decisions are made separately and can be analyzed independently. However, when the perfect markets assumption is relaxed, both internal and external finance are likely to be constrained. If the capital markets are sufficiently imperfect, firms have to consider the availability of internal and external funds alongside their investment and payout decisions, such that the set of corporate decisions may be determined jointly and should be viewed as a simultaneous and interdependent process. To provide a foundation for the capital market imperfections, which may cause substantial economic interactions among the set of corporate decisions, we appeal to the asymmetric information problems between firm insiders and the capital markets.

Among the various uses and sources of funds, the primary focus of the model is on capital investment (*INV*, i.e. ΔFA), long-term debt financing (*NDF*, i.e. ΔLD), and dividend payout (*DIV*) decisions. Internally generated cash flow, which is defined as the sum of net income plus non-cash expenses (*CF*, i.e. *PRO* + *DEP*), is assumed to be determined by past investment and financing decisions[18]. Therefore, following the tradition of literature on corporate finance, we treat internally generated cash flow as exogenous in the model. Besides, the most important elements contained in current assets (ΔCA) and short-term debts

[18] It is believed that investment affects output (and profits) only with lags so that current investment affects only future output, and hence profits, and that current output and hence current profits are not affected by current investment.

(ΔSD) are inventories, account receivables, and account payables. The changes in these elements are likely to be triggered by economic conditions, thus cannot be interpreted as the results of conscious decisions made by managers. Accordingly, we treat the net changes in working capital (ΔWC, i.e. ΔCA - ΔSD) as unintended residuals that balance the uses and sources of funds[19]. Moreover, in the presence of asymmetric information, external equity financing (ΔEQU) is rationally viewed by investors as bad news that the stock is overpriced, thus managers are extremely reluctant to issue new equity in stock market for the fear of sending a negative signal to the markets. As a result, external equity financing is typically considered as a last resort and a rarely used[20]. Given the fact that, compared with external debt finance, external equity finance is a less significant source of funds for listed firms after initial public offering, we eliminate ΔEQU as one of the endogenous variables from the flow-of-fund framework. Therefore, the reduced flow-of-funds identity can be specified as follows:

$$INV + DIV + \Delta WC = NDF + CF \tag{2}$$

where, *INV*, *NDF*, and *DIV* are the three endogenous variables, representing investment outlays, net long-term debt financing, and dividend payout respectively; *CF* is cash flow, which is taken as exogenous; ΔWC is net change in working capital, which is considered as the residual to balance firm's uses and sources of funds. Following the above arguments, the number of endogenous variables in the simultaneous equations system reduces to three, i.e. capital investment, long-term debt financing, and dividend payout. Thus, the empirical framework comprises estimation of the following simultaneous equations system:

$$INV = f(NDF, DIV, CF, A) \tag{3}$$

$$NDF = f(INV, DIV, CF, B) \tag{4}$$

$$DIV = f(NDF, INV, CF, C) \tag{5}$$

where, *A*, *B*, and *C* are vectors of other exogenous variables which, according to existing literature, are the primary determinants of corporate investment, borrowing, and payout decisions respectively. The structural models (Equations 3-5) employed in this study is an analogous to that of Dhrymes and Kurz (1967), McCabe (1979), and Peterson and Benesh (1983). The three endogenous variables are the dependent variables for the corresponding equations. Each equation contains the two remaining endogenous variables as explanatory variables, along with a predetermined cash flow variable and other exogenous determinants. According to the flow-of-funds approach initiated by Dhrymes and Kurz (1967), the

[19] Dhrymes and Kurz (1967) regard short-term investment as a predetermined variable and argue that: first, to the extent that a component of short-term investment is unintended inventory accumulation, we are clearly not committing a specification error; secondly, to the extent that the data for this series includes credit advanced to clients in the normal conduct of business (account receivable) this does not constitute a misspecification either; similarly for account payable; but to the extent that the series contains a component of intended inventory accumulation and short-term securities holdings for other than liquidity-transaction purpose, we are clearly committing a specification error.

[20] Shyam-Sunder and Myers (1999) show that, in the presence of asymmetric information, external equity financing is only used in extreme circumstances after initial public offering. Cleary et al. (2007) point out that debt finance is the most significant source of external finance in all countries: new equity finance accounts for only a very small proportion of total corporate sector financing.

hypothesized relationships between each pair of the three endogenous variables are presented in Table 2. It is worth noting that the expected signs are hypothesized under flow-of-funds framework, other theoretical arguments of corporate behaviours may have very different implications for the interactions among firm's investment, financing and dividend decisions.

[insert Table 2 about here]

In fact, MM propositions do not postulate complete independence between a firm's real decisions and its financial decisions. As long as the direction of causation is from the former to the latter, the MM theorems are not violated. Therefore, to investigate whether the capital markets are sufficiently imperfect to lead to joint determination of real and financial decisions, the focus of the empirical investigation is on the sign and statistical significance of the coefficients on the endogenous explanatory variables (i.e. *NDF* and *DIV*) in the investment equation. We hypothesize that, in the presence of information asymmetry, both internal and external funds available to investment are likely to be constrained. To justify the potential influence of a firm's financial decisions on its real decisions, we appeal to the superior knowledge that managers may possess about the firm's current earnings and future prospects.

On the one hand, Miller and Rock (1985) demonstrate that managers use dividends as signal to reveal some of their private information to the markets. The signalling effect of dividend is so well-known and widely accepted that mangers are reluctant to cut dividends in order to avoid the anticipated negative market reactions, and reluctant to increase dividends for fear they will not be able to maintain them at a higher level and have to cut them in the future. Therefore, given the stickiness of dividend under such circumstances, raising funds for investment from internally generated cash flow is less flexible, and hence the variation in investment expenditures cannot be soaked up freely by retained earnings. Consequently, the firm may be forced to forego relatively low NPV investment projects to maintain its dividend payout at a desired level.

On the other hand, Myers and Majluf (1984) demonstrate that the alternative sources of funds are no longer perfect substitutes due to the costs created by managers' superior information. In the presence of asymmetric information, managers' efforts to issue risky securities tend to be interpreted as a signal that the firm is overvalued. Hence, external financing is more costly than internal financing, and external equity is more costly than external debt. Accordingly, managers prefer to finance all the uses of funds with internally generated funds if possible, which have cost advantage and have no information asymmetry problem. When the internal funds are exhausted and external finance is required, managers raise external funds with debt, which is less likely to be affected by revelation of managers' superior information. Equity is only considered as a last resort. Therefore, if the level of debt is close to a firm's borrowing capacity at given cost, a decline in new debt financing may inhibit the firm's capital spending and may also cause capital rationing.

Taken together, asymmetric information not only constrains a firm's access to internally generated funds via its effect on dividends, it also limits the firm's ability in raising external funds by issuing new debt. Therefore, corporate decisions are likely to be made systematically and simultaneously by managers with full recognition of competing needs for funds and sources of funds. This study aims to establish whether the information asymmetry and the resultant market imperfections cause the interactions among corporate investment, financing, and payout decisions. The empirical equations for the corresponding corporate decisions in the simultaneous system are specified consistently according to the implication of information asymmetry.

3.2. Empirical equations

3.2.1. *Investment equation*

For the last several decades, corporate investment behaviour modelling has been dominated by neoclassical, accelerator, Tobin's *Q*, and financing constraints theories. The first two theories assume that a firm has its desired level of capital stock, which is determined by long-run real considerations. The neoclassical theory asserts that the desired capital stock of the firm is a function of its cost of capital, thus corporate investment can be specified as a function of changes in the cost of capital. On the other hand, the accelerator theory argues that desired capital stock is proportional to firm's output, and firms engage in capital investment in order to close the gap between desired capital stock and existing capital stock left over from the past. Thus, a firm's investment should be a function of changes in its output. Given corporate investment is likely to be determined by many other factors, Tobin's *Q* theory states that all aspects of information related to a firm's investment environment affect the firm's capital investment through their effects on marginal *Q*, which is the ratio of capitalized value to replacement value of the firm's marginal investment. In empirical work, however, it is observed that the measurement of *Q* itself is problematic and its empirical performance is often unsatisfactory. Financing constraints theories of investment emphasizes on the importance of internal finance in real investment spending, given its cost advantage over external finance in the presence of asymmetric information. It is now common practice to embed cash flow variable in corporate investment model. More recently, uncertainty has been identified as a critical determinant of corporate investment, even though the main competing theories leave even the sign of investment-uncertainty undetermined as discussed in the previous section.

A growing literature considers financial constraints on real investment decision as a result of the asymmetric information problem of external financing. Accordingly, the investment equation employed in this study is based on a simple *Q* model, extended by a cash flow variable as a proxy for internally financial constrains. The innovation is the inclusion of debt financing and dividend payout variables, which may also affect investment spending according to the flow-of-funds framework under information asymmetry. Besides, in order to address the investment-uncertainty ambiguity, a proxy for uncertainty is also included. Therefore, the investment equation is specified as follows:

$$\frac{INV}{K}_{it} = \alpha_0 + \alpha_1 \frac{NDF}{K}_{it} + \alpha_2 \frac{DIV}{K}_{it} + \alpha_3 \frac{CF}{K}_{it} + \alpha_4 Q_{it} + \alpha_5 \frac{INV}{K}_{it-1} + \alpha_6 UNC_{it-1} + \varepsilon_{it} \quad (6)$$

where, *INV* is gross investment, *NDF* is net new debt financing, *DIV* is dividend payout, *CF* is cash flow, *Q* is the ratio of market to book value of total assets, and *UNC* is uncertainty measurement. *INV*, *NDF*, *DIV*, *CF* are all scaled by beginning-of-period capital stock (*K*) to control for firm size and reduce heteroskedasticity problems that may otherwise arise in the firm-level data. We choose the beginning-of-period value as deflator based on the assumption that all the investment decisions are made at the start of each fiscal year. Following many empirical investment studies, we also introduce a dynamic structure into the investment model by including the lagged investment to capital ratio. The inclusion of the lagged dependent variable in the model allows for the inertia of corporate investment behaviour. Because our alternative measures of uncertainty constructed in this study are all derived from stock market-based information, themselves are forward-looking. We use lagged variable to proxy for the perception of uncertainty at the beginning of each period. By including a lag on the measurement of uncertainty, we reduce the risk of using more information than managers actually have when they make real and financial decisions at beginning of each fiscal year for the year ahead. We also include time dummies in all the equations[21].

3.2.2. *Financing equation*

The explanation of corporate financing decision is intensely debated in corporate finance. The most popular competing theories in the literature include trade-off, pecking order, market timing, and agency theories. In the trade-off model, managers seek an optimal leverage to maximize the firm value by weighting the benefits and costs of additional debts. The net amount of debt issued can be explained by the deviation of the current leverage from the target. On the contrary, the pecking order theory does not predict an optimal leverage. Based on the arguments in Myers and Majluf (1984), the asymmetric information problems generate a hierarchy of financing policies with a preference for internal over external funds and for debt over equity. Accordingly, firms finance the uses of funds first with internally generated cash flow, then with debt, and equity finance is only used under duress. Thus, pecking order theory implies that debt issuance is chiefly driven by financing deficit. Besides, the market timing theory asserts the leverage is the outcome of the accumulation of equity market timing financing decisions over time; and the agency theory links the leverage to the agency relationship between managers and shareholders.

In the spirit of literature on information asymmetry, this study specifies the financing equation on the basis of pecking order theory. Thus, the net amount of debt issued is expected to be driven by the financing deficit, which can be reasonably captured by the linear combination of investment, dividend, and cash flow according to its accounting definition[22]. In order to take a firm's borrowing ability into account, we also include firm size and asset

[21] To implement GMM, we assume that errors are only correlated within individuals, not across them. For this reason, it is almost always wise to include time dummies in order to remove universal time-related shocks from the errors (see Roodman, 2009).

[22] Financing deficit (*DEF*) can be derived from a partially aggregated form of the flow of fund identify ($DEF = DIV + INV - CF + \Delta WC$). (see Shyam-Sunder and Myers,1999)

tangibility variables to proxy for the firm's access to external capital markets and its collateral value respectively. Given its potential effect, we also include the measure of uncertainty. Therefore, the financing equation is specified as follows:

$$\frac{NDF}{K}_{it} = \beta_0 + \beta_1 \frac{INV}{K}_{it} + \beta_2 \frac{DIV}{K}_{it} + \beta_3 \frac{CF}{K}_{it} + \beta_4 TAN_{it} + \beta_5 SZ_{it} + \beta_6 UNC_{it-1} + \mu_{it} \quad (7)$$

where, *TAN* is asset tangibility, *SZ* is firm size. Larger firms tend to have better reputation lower default risk, and thus fewer difficulties in accessing external capital markets. Tangible assets are easier for outsider to value, so that are able to mitigate the problem of information asymmetry and lower the risk premium of borrowing. Therefore, firms with larger size and higher level of tangible assets should be able to carry more debt under information asymmetry. Besides, we posit that greater uncertainty may exacerbates the degree of information asymmetry between insiders and capital markets, which may in turn generate more significant cost disadvantage of external debt financing or even result in credit rationing. Under these circumstances, firms facing greater uncertainty are likely to be required to pay a higher premium for new borrowing or to be denied the applications for loans. Therefore, we hypothesize the negative effect of uncertainty on the net amount debt issued.

3.2.3. *Dividend equation*

Dividend policy is also an important topic that remains unsolved in corporate finance, both theoretically and empirically. The models used to test dividend policy theories differ in their assumptions and approaches. Early study of Lintner (1956) shows that managers usually have reasonably definitive target payout ratio in the long run, and they adjust the actual payout ratio slowly towards the target over years. Signalling models of dividend characterizes the information asymmetry and states that managers signal their private knowledge about the firm's prospects to the capital markets through dividend policy. From this point of view, a firm's dividend payout should be proportional to its expected current and future cash flows. Tax clientele theory focus on the market imperfection results from the differential taxation of dividends and capital gains to explain corporate payout behaviour. Investors are expected to prefer capital gains over dividends, given the fact that dividends are typically taxed at a higher rate. In the same vein, Baker and Wurgler (2004) develop a catering theory of dividend which posits that dividend payouts are response to investors' demand for dividends. Another rationale for dividend policy is based on the principal-agent framework. According to this framework, dividends are used by shareholders as a device to reduce free cash flow and the resultant overinvestment made by managers. More recently, a line of literature pointed to the importance of firm's financial life-cycle stage in its dividend policy. Life-cycle theory argues that firms in the capital infusion stage are less able to afford to pay dividends, while mature firms with large cumulative profits are likely to pay high dividends (DeAngelo et al., 2006). Therefore, firm's dividend payouts are expected to increase over its financial life-cycle stages.

This study models corporate payout behaviour on the basis of signalling hypothesis which is characterized by information asymmetry. Because it is well known that there is no any single theory can fully explain the dividend puzzle, we also incorporate some other firm characteristics, such as ownership structure and financial lift-cycle stage, into the dividend model. These factors are generally believed as the primary determinants of dividend policy according to the stylized facts. Again, we include the proxy for uncertainty into the equation as well. Some studies also employ lagged dividend status as an explanatory variable. However, Fama and French (2001) argue that including a lagged dividend status is problematic because the resultant model seeks to explain a firm's current dividend decision on the basis of the same decision made recently by the same firm. Therefore, we ignore lagged dividend status and the dividend model to be estimated is specified as follows:

$$\frac{DIV}{K}_{it} = \gamma_0 + \gamma_1 \frac{INV}{K}_{it} + \gamma_2 \frac{NDF}{K}_{it} + \gamma_3 \frac{CF}{K}_{it} + \gamma_4 OWN_{it} + \gamma_5 \frac{RE}{TE}_{it} + \gamma_6 UNC_{it-1} + \nu_{it} \quad (8)$$

where, *OWN* is ownership structure, measured as insider holding of the common shares out of the total share of a firm, and *RE/TE* is retained earnings-to-total equity ratio, a proxy for a firm's financial life-circle stage. Cash flow and retained earnings-to-total equity ratios are expected to have positive effects on dividend payout, while insider ownership is expected to have a negative effect. The relationship between uncertainty and dividend payout, however, is not very clear-cut. It is possible to argue that, with asymmetric information, managers adjust dividend payouts upward or downward only a permanent change in their business environment has taken place. If the prospects are uncertain, managers may choose to wait for more information rather than adjust dividend policy immediately for fear of sending wrong information to the markets. If this argument is supported by empirical evidence, greater uncertainty should significantly damp the response of dividend payout to cash flow. It is equally plausible to argue that a firm's prospects are less predictable under greater uncertainty, so that managers' confidence in maintaining dividend payouts at certainty level will collapse. Thus, managers' perception of uncertainty may result in a cut in dividend payouts[23]. Therefore, we expect the effect of uncertainty on dividend payout to be neutral or negative.

3.3. Data set and measurement of variables

Our sample is constructed using Worldscope data collected via Thomson One Banker Analytics. The initial sample includes all (2482) firms listed on London Stock Exchange (LSE), both active and inactive, for which Worldscope provides financial information during the period 1999-2016. We discard 29 utilities (Standard Industrial Classification (SIC) code 4900-4949), and 743 financial firms (SIC code 6000-6999). Firms that do not have complete records on the key items, such as capital investment committed, new debt issued, and cash dividends paid are also dropped, as well as firms with less than 5 years of continuous observations. Given the fact that firms under such circumstances may behave very differently, we also exclude firm-year observations with negative cash flow, In order to avoid

[23] Sant and Cowan (1994) discusses that, if managers' confident interval on the firm's future performances no longer reassures that they will be able to continue the current payout, they may cut or even omit dividends. There are two reasons that may make managers' confidence interval less reassuring, i.e. decreased expected performance or increased variance of future performances, or both.

survivorship bias and make full use of the firm-year observations, the empirical investigation is based on an unbalanced panel of firm-level data, implying that not only active but also dead and suspended listed firms on LSE are included in the sample. Share price information is retrieved from DataStream for the same batch of firms over the same period of time. For these firms, we construct following variables on yearly basis as described in Table 3.

As mentioned in the previous section, the measure of uncertainty is another central issue of this study. A variety of measures of uncertainty has been derived in existing literature, ranging from input to output volatility, and from manager's perception to analysts' forecast, and etc. However, none of them appears without particular problems and criticisms. The arbitrariness in constructing uncertainty measurements may partly due to the lack of adequate knowledge of the source of uncertainty that influence firm's behaviour. Given the inability to underpin the specific source of uncertainty, this study derives general measures of uncertainty from stock market-based information. It is believed that if the market is efficient, all the information about a firm's asset fundamentals and growth opportunities will be properly transmitted into its share price. Thus, our measures of uncertainty are expected to be forward-looking indicators that capture the overall uncertainty associated with the changing aspects of a firm's environment, including input and output prices, wage rates, interest rates, exchange rates, taxes, technologies, and etc. We construct three measures of uncertainty at firm level. The first proxy for uncertainty is share price volatility (*UNC1*), which is measured as the difference between the highest and the lowest price normalized by the mean price for each year. The second proxy (*UNC2*) is the conventional standard deviation of daily stock market returns for each year. Besides, the possible volatility clustering effect of stock market returns provide us a motivation for deriving another uncertainty measure (*UNC3*) from estimating a GARCH (1, 1) model[24], which is specified as follows:

$$R_t = \phi_0 + \phi_1 R_{t-1} + \phi_2 R_{t-2} + u_t \tag{9}$$

$$\sigma_t^2 = \varphi_0 + \varphi_1 u_{t-1}^2 + \varphi_2 \sigma_{t-1}^2 \tag{10}$$

where, R_t denotes the stock market return at time t, and σ_t^2 denotes the conditional variance of the daily stock market return at time t. Both the conditional mean and conditional variance equations are estimated firm by firm over the entire sample period under investigation. To construct a proxy for uncertainty on yearly basis, we first take the square root of the estimated daily conditional variances to obtain daily conditional standard deviation, and then calculate the average of the daily conditional standard deviations of the stock market returns over each year as an uncertainty measure for the corresponding period.

[insert Table 3 about here]

The rationale for using uncertainty measures derived from stock market-based information is that the share prices tend to fluctuate more when the prospects are less predictable. However, the main concern is that the high frequent stock market data may

[24] We performed Engle's Lagrange multiplier test for ARCH effect on the stock price returns firm by firm and estimate the GARCH (1, 1) model only for the firms whose stock market returns display clustering effects.

reflect not only firms' fundamentals but also bubbles and fads. Many researchers point out that the major disadvantage of this type of measure is that it is too noisy (see for example Bond and Cummins, 2004; and Bloom et al., 2007). In particular, when the variables are derived from daily observations, extremely noisy proxies for uncertainty may be generated. Given this drawback, we treat *UNC1* as the primary measure of uncertainty in this study, in order to reduce the impact of high-frequency noise that may be present in the daily observations. *UNC2* and *UNC3* are treated as supplementary measures of uncertainty. Besides, it should be emphasized that *UNC2* and *UNC3* do not measure annual volatility but the average daily volatility in the respective year. *UNC1*, on the other hand, is constructed as the normalized difference between yearly high and yearly low prices, and hence should be better able to match firms' annual financial data. Therefore, our empirical findings on the effects of uncertainty on corporate investment, financing, and payout decisions are drawn from interpreting the sign and significance of the coefficients on *UNC1* in the corresponding equations.

[insert Table 4 about here]

The descriptive statistics of the main variables used in this analysis are presented in Table 4. As shown in the first panel, extreme values appear in almost all the variables, especially in the variables that take the form of ratio. In our raw data, some UK firm-year observations over the 1999-2016 period have gross investment-to-capital ratio (*INV/K*) as high as 96,043%; new debt financing-to-capital ratio (*NDF/K*) as high as 24,345%; and dividend-to-capital ratio (*DIV/K*) as high as 4,800%. In order to cope with the potential impact of outliers upon our empirical tests, we winsorize all the variables used in our analysis at the top and bottom 5 percentiles of their respective distributions. The second panel of Table 4 reports the descriptive statistics of the variables after the transformation. The maximum values of *INV/K*, *NDF/K*, and *DIV/K* now decline to 235.47%, 194.74%, and 108.88% respectively. Beside, standard deviations of the variables also decrease significantly (standard deviation of *INV/K* for example decrease to 0.53 from 16.61), and their distributions become much closer to normality after transformation (although the results of Skewness and Kurtosis test for normality still reject the hypotheses that the winsorized variables are normally distributed). It is believed that winsorization is superior to the more standard transformations such as trimming. Winsorization not only reduces the influences of outliers, but also allows us to make full use of the sample observations. Therefore, the winsorization estimators are expected to be more robust, and our empirical results presented hereafter are all obtained using the observations winsorized at the top and bottom 5 percentile.

4. Empirical results

4.1. Firm's uses and sources of funds identity

Since the potential interactions among corporate investment, financing, and payout decisions are justified within the flow-of-fund framework, the overriding constraint on all decisions is thus the sources and uses of funds identity. The flow-of-funds identity specified in preceding section states that a firm's sources of funds must equal its uses of funds, which can be expressed as follows

$$INV_t + DIV_t + \Delta WC_t = NDF_t + CF_t \tag{11}$$

with all stock variables measured at the end of period *t*, and flow variables measured over the period *t*. It is worth noting that Equation 11 is not an accounting identity because external equity issues or repurchases are assumed to be a last resort, and hence not included in the equation. Therefore, the validity of the reduced form identity as well as the validity of the assumption should be empirically verified before we proceed to the analysis of simultaneity. Given the difficulties in measuring external equity financing in practice, we verify the validity of the identity and the associated assumption by testing the equality of the uses and sources of funds as specified in equation 11 with respect to the panel of UK-listed firms. If the reduced form of flow-of-funds identity is supported by the observations in our sample, external equity finance can then be considered as a rarely used source of funds, and therefore can be dropped from the flow-of-funds framework.

The main uses and sources of funds, except external equity finance, for the UK-listed firms over the period under investigation are summarized in Table 5. The total uses and sources of funds are compared under *t*-test framework. Both paired and unpaired mean-comparison tests are employed to test for the equality between the uses and sources of funds. According to the evidence obtained from the panel of UK-listed firms, the reduced flow-of-funds identity is empirically supported in most of the cases, suggesting that the sum of investment outlays, dividend payouts, and change in working capital is roughly equal to the sum of external debt financing and internally generated cash flow. The uses and sources of funds identity is only rejected for 2000 and 2007 under paired *t*-test and for 2007 under unpaired *t*-test. The rejection of equality for 2000 and 2007 are likely to be caused by the extreme economic environment under the dot-com crisis and the global financial crisis respectively. Even so, the reduced flow-of-funds identity is still verified by the pooled UK firm-year observations over the entire period under investigation. Therefore, we can conclude that the reduced flow-of-funds holds in this context of our investigation.

Another result of interest from Table 5 is that, compared with investment and dividend, the funds spent on working capital (ΔWC) is of minor significance for most years. The overall average values for capital investment, dividend payout, and investment in working capital made by UK-listed firms during the period 1999-2016 are 74.28, 31.09, and 0.80 million pounds respectively. This finding would lead us to believe that investment in working capital is not a significant uses of firm's funds. Besides, the sign on the net change in working capital is not stable over time, in which 5 positive and 5 negative net changes are observed from the UK-listed firms over the span of 10 years. This evidence empirically rationalizes the view that the net changes in working capital are likely to be triggered by economic condition and not subject to management control. On a year-to-year basis, the net change in working capital acts a residual item to balance firm's uses and sources of funds.

[insert Table 5 about here]

Overall, the empirical evidence presented in Table 5 clearly demonstrates that the UK-listed firms raise funds mainly from internally generated cash flow and external debt finance, and spend them chiefly on capital investment and dividend distribution. Therefore, it is valid to derive the simultaneous equation system based on this reduced flow-of-funds identity, which allows us to focus directly on the possible interactions among corporate investment, financing, and payout decisions.

4.2. Correlation analysis

It is instructive to have a brief look at the pair-wise correlation among the main variables included in our study before proceed to the econometric analysis. The Pearson's correlation coefficient matrix is presented in Table 6.

[insert Table 6 about here]

The simple correlation coefficients show that the three endogenous variables (namely *INV/K*, *NDF/K*, and *DIV/K*) are significantly correlated with one another at 1% significance level. These results seem to reject MM's independence proposition and favour the simultaneous determination of the three main corporate decisions. However, the signs of pair-wise correlation coefficients between the endogenous variables are not entirely consistent with the predictions of the flow-of-fund framework under information asymmetry. According to the framework, corporate investment and dividend payout are competing uses of funds and should never move in the same direction. Thus, the significantly positive correlation between *INV/K* and *DIV/K* is difficult to be accepted within this framework at first glance. But following analysis shows that the relationship between investment and payout in a properly constructed simultaneous equation system is indeed contemporaneous and significantly negative. The pair-wise correlation coefficient between *INV/K* and *NDF/K* and that between *DIV/K* and *NDF/K* are both significantly positive as predicted by the flow-of-fund framework. Taken all together, the correlation coefficients between the three endogenous variables reported in Table 5 are qualitatively similar to the findings from the previous studies on US firms (see Dhrymes and Kurz, 1967; McCabe, 1979; and Peterson and Benesh, 1983).

The results in Table 6 suggest that the predetermined cash flow-to-capital ratio (*CF/K*) is significantly correlated with all three endogenous variables. The correlation coefficient between *CF/K* and *INV/K* is significantly positive with a value of 0.34. This finding is in line with the conventional wisdom about the effect of financial constraints on corporate investment behaviour, and also consistent with the empirical evidence reported in existing literature (see for example Lensink and Murinde, 2006). However, the correlation coefficient between *CF/K* and NDF/K is positive, which contradicts the prediction of pecking-order hypothesis of financing. Besides, the correlation between *CF/K* and *DIV/K* is positive as predicted by signally hypothesis of dividend, indicating that dividend payouts are in fact used by firms to convey information about their profitability to the outside world.

Table 6 also shows how the alternative measures of uncertainty are correlated with one another, as well as how they are correlated with corporate investment, debt financing, and dividend payout respectively. It is found that *UNC2* and *UNC3* are highly correlated with a correlation coefficient as high as 0.91, and they are similar in magnitude with mean values around 0.03. This is largely due to the fact that both of them are derived from standard deviation of daily stock market returns. Neither *UNC2* nor *UNC3* is highly correlated with our primary proxy for uncertainty (*UNC1*) even though the correlation coefficients are both positive. However, *UNC1* is supposed to be a less noisy and thus better indicator of uncertainty faced by firms. The correlation coefficients between the uncertainty measures and investment ratio are uniformly positive. In particularly, *INV/K* and *UNC1* are significantly correlated at 1% significance level. The correlation between uncertainty and new debt financing ratio (*NDF/K*) are weak and not consistent across different uncertainty measures. Dividend payout ratio (*DIV/K*) is negatively correlated with all three uncertainty measures, but the correlations are statistically insignificant at usual levels. Thus, the correlation analysis provides evidence that our primary uncertainty measure is significantly and positively correlated with corporate investment, while its correlations with new debt financing and dividend payout are negative but rather weak.

Finally, the correlations between the endogenous variables and other relevant exogenous variables are also informative. According to Table 6, *INV/K* is significantly and positively correlated with investment opportunities (*Q*); *NDF/K* is positively correlated with firm size (*SZ*) but negatively correlated asset tangibility (*TAN*); *DIV/K* is positively correlated with firm's financial life-circle stage (*RE/TE*) but its correlation with insider ownership (*OWN*) is rather weak. In addition, there is no evidence of near multicollinearity presented in the correlation coefficient matrix.

In summary, the simple correlation analysis shows that corporate investment, financing, payout decisions are pair-wise correlated. The correlations between each pair of the decisions are highly significant and uniformly positive. Meanwhile, it also provides evidence that investment is positively correlated with uncertainty, and dividend may be negatively correlated with uncertainty. It appears that firms that face high level of uncertainty tend to invest more and payout less, while the effect of uncertainty on financing policy is still ambiguous according to the simple correlation analysis.

4.3. System-generalised method of moments analysis

We now apply single equation estimation technique to the empirical equations. Given the endogeneity problems and the dynamic structures of modelling corporate behaviour, we estimate the equations (6), (7), and (8) separately using the system-generalised methods of moments (GMM) estimators. This approach is an efficient extension of the first-difference GMM estimator developed by Arellano and Bond (1991)[25]. It combines an equation in differences of the variables with an equation in levels of variables to form a system, in which lagged levels are used as instruments for the differenced equation and lagged differences are

[25] Arellano and Bond (1991) first-difference GMM estimator can be subject to a large downward bias and very low precisions as a result of weak instruments in situations where the series are highly persistent and/or the relative variance of the fixed effects increases even for large N when T is small.

used as instruments for the level equation[26] (Aerllano and Bover, 1995, and Blundell and Bond, 1998). The use of instruments in this manner is considered as a possible solution to the endogeneity problems as well as the weak instrument problems. Two-step GMM estimations are obtained by using Stata 10 as implemented by Roodman (2009). Given the fact that the reliability of the system-GMM method depends crucially on the validity of instruments and serial correlation of the error terms, we check them with Hensen's *J* tests of over-identifying restrictions and Arellano-Bond's tests of serial correlation respectively. Table 7, 8, and 9 presents the estimation and testing results corresponding to investment, borrowing, and dividend equations.

4.3.1. ***Investment equation regression results***

Columns 2, 3, and 4 of Table 7 report the estimations and test results for three variants of the investment model specified as equation (6). The three alternative proxies for uncertainty described in the previous section, namely *UNC1*, *UNC2*, and *UNC3*, are used in the three variants respectively. Given the drawback of constructing uncertainty measures using high-frequency stock market information, we treat the results obtained by Model variant 1, i.e. column 2 of Table 7, as our primary results.

Concentrating on the primary results in column 2, three features of these results are of particular interest. First, both borrowing (*NDF/K*) and dividend (*DIV/K*) variables appear to be significant in the investment model at 1% and 5% significance level respectively. This result suggests that a firm's financial decisions do have impacts on its real decisions in practice, thus MM's independence proposition should be firmly rejected based on the evidence from UK-listed firms during the period 1999-2016. Second, the significantly positive relationship between investment and dividend detected in the pair-wise correlation analysis (see Table 6) is reversed to significantly negative when the full structural investment equation is estimated as expected. The statistically significant and negative effect of dividend payouts on investment outlays lend strong empirical support to the flow-of-fund framework, in which investment outlays and dividend payouts are considered as competing uses of limited funds and thus should not vary in the same direction. UK-listed firms seem to trade-off between investment and payout during the period under investigation. Second, the significantly positive coefficient found for the cash flow variable (*CF/K*) is also consistent with the prediction of flow-of-funds framework that corporate investment choices are subject to the availability of internal funds in an information asymmetry setting. An important implication of the first two features of our empirical findings from the investment regression is that UK-listed firms are likely to be financially constrained, and they have to consider their financing choices alongside their investment decisions. Moreover, another result of particular interest is that the coefficient on the proxy for uncertainty (*UNC1*) appears to be significantly positive. The positive effect of uncertainty on corporate investment seems to favour the

[26] The system GMM estimator uses equations in first-differences, from which the firm-specific effects are eliminated by the transformation, and for which endogenous variables lagged two or more periods will be valid instruments provided there is no serial correlation in the time-varying component of the error terms. These differenced equations are then combined with equations in levels, for which the instruments used must be orthogonal to the firm-specific effects. Blundell and Bond (1998) show that in autoregressive distributed lag models, first-differences of the series can be uncorrelated with the firm-specific effect provided that the series have stationary means.

prediction of Hartman (1972)-Abel (1983) framework as well as that of Mason and Weeds (2010). This result critically challenges the assertion of the established real option theory of investment, and empirically supports the argument of the recent theoretical innovation that greater uncertainty may lead companies to invest earlier to take the advantage of pre-emption in a competitive business environment, thus encourage current investment spending. In other words, the option value of delay is likely to be offset by the threat of being pre-empted under this situation. Thus, if managers take the strategic interactions between players into consideration, the overall benefits from delay may be insufficient to deter investment. In fact, if the advantage of pre-emption is sufficiently strong, greater uncertainty can lead to higher level of capital expenditure even if the investment projects are irreversible, resulting in a positive impact of uncertainty on corporate investment.

[insert Table 7 about here]

Turning to the regression results of model variants 2 and 3, the coefficients of the endogenous explanatory variables remain qualitatively unchanged. But dividend variables become statistically insignificant at the usual significance levels. Meanwhile, the supplementary uncertainty measures (i.e. *UNC2* and *UNC3*) are also insignificant in the respective variant. The relatively disappointing explanatory powers of *UNC2* and *UNC3* in the investment model are most likely attributable to the high-frequency noise contained in the daily stock-market return observations. Besides, the investment equation regression results also show that the coefficients on the proxy for Tobin's *Q* are insignificant and inconsistent across the model variants. It is well documented that the low explanatory power of *Q* variable is mainly due to its severe measurement problems. Thus, the poor performance of *Q* variable in our regressions is not contradictory to the usual results from previous applied studies on the similar topics. The coefficients on the lagged investment variable, in contrast, are consistently positive and highly significant in all variants, suggesting that corporate investment behaviour is indeed a dynamic process as expected.

4.3.2. ***Financing equation regression results***

The results for the borrowing equation are presented in Table 8. The only difference among the three variants is that different uncertainty measures are used in the respective regressions. Concentrating on the primary results reported in column 2, it is shown that both investment (*INV/K*) and dividend (*DIV/K*) variables are significant determinants of external debt financing (*NDF/K*) as predicted by the flow-of-fund framework. The positive signs of the coefficients on the endogenous explanatory variables suggest that the level of new debt issued by a firm depends primarily on the demand of its investment outlays and dividend payouts. Additionally, internally generated cash flow (*CF/K*) as an alternative source of funds has a significant and negative effect on borrowing. Thus, our empirical results obtained from the panel of UK-listed firms are entirely in line with the hierarchy of raising funds as predicted by pecking order hypotheses. It shows that, in the presence of information asymmetry, firms rely heavily on their internal funds, and the net amount of debt issued during a fiscal year is chiefly driven by their financing deficits. Meanwhile, firm size (*SZ*) is also proved to be an important determinant of new borrowing. Larger firms are typically long-established, diversified, financially healthy companies with low default risks and good credit ratings, and hence they are less likely to be constrained by access to external finance. However, the coefficient on the asset tangibility variable (*TAN*) turns out to be significantly negative. This finding is contrary to the intuition that tangible assets, such as property, plant, and equipment, can be easily valued by outsiders and used as collateral for loans, thus should increase firms borrowing capacity. Finally, the effect of uncertainty on external debt financing is negative and significant at 10% level according to the primary results. This is in line with our hypothesis that greater uncertainty may exaggerate the cost disadvantage of debt or even result in credit rationing, thus reduces the availability of external financing.

[insert Table 8 about here]

The results for the other two model variants are also reported in Table 8. The results show that, among the set of potential determinants of firms' borrowing decisions, only investment and firm size variables are uniformly and highly significant across all model variants. This indicates that investment demand and access to external finance are the most reliably important factors in external debt financing decisions of UK-listed firms. The impacts of dividend, cash flow, and uncertainty variables turn into insignificant in model variants 2 and 3. The declined explanatory power of dividend variable may imply that firms are less likely to fund their desired dividend payouts by resorting external finance.

4.3.3. *Dividend equation regression results*

Turing to the dividend equation, the empirical results are presented in Table 9. Among the potential determinants, cash flow variable (*CF/K*) has the greatest impact on dividend decisions. The coefficient on *CF/K* is consistently positive and highly significant throughout all model variants. Thus the signalling hypothesis of dividends under information asymmetry is empirically supported by our sample, which means that managers in UK-listed firms signal their private knowledge about the distributional support of the project cash flow to the market through the choice of dividends. The coefficients on the two endogenous explanatory variables (i.e. *INV/K* and *NDF/K*), however, are not statistically significant in the dividend regression even though both of them bear the expected signs as the flow-of-funds framework predicted. Given the significant impact of dividend on investment decision but insignificant impact of investment on dividend decisions, it seems that, if the availability of funds (both internal and external) is not sufficient to allow independence between investment and dividend policies, UK-listed firms give dividend priority over investment. This leaves doubt whether dividend policy is independent of or interdependent with investment and financing choices.

[insert Table 9 about here]

As for the exogenous variables in the payout regression, insider ownership (*OWN*) do not seem to fare well as determinant of dividend payouts, but the consistently negative coefficients associated with it to some extend indicate that insider holding of the common shares reduce the need for dividend as a monitoring mechanism and then reduce the dividend payout. Compared with insider ownership, firms' financial life-cycle stage (proxied by

RE/TE) variable has more significant impact on dividend decisions. The coefficients for *RE/TE* have predicted positive signs everywhere, suggesting that firms in mature life-cycle stage tend to pay high dividends. More importantly, the uncertainty measures have negative signs across all model variants with no exception. In particular, our primary measure of uncertainty (*UNC1*) is highly significant, and its impact on dividend payout is both statistically and economically stronger than the impacts of other established determinants of dividend policy, such as ownership structure and life-cycle stage. The regression results strongly support our hypothesis that firms with great uncertainty tend to pay low dividends.

4.4. Simultaneous equations analysis of corporate decisions

The system-GMM analysis reported above indicates that corporate investment, financing, and payout decisions are likely to be endogenous and sensitive to uncertainty in reality[27]. To provide further evidence and more insight into the joint determination of the set of corporate decisions under uncertainty, we also carry out simultaneous equations analysis. Specifically, we estimate equation 6 through 8 within a simultaneous equation system using both three-stage least squares (3SLS) method and two-stage least squares (2SLS) method, which allow for the interdependence of the set of corporate decisions, while controlling for effects that other factors may have on these decisions. The structure of the simultaneous equations 6, 7, and 8 shows that the necessary (order) conditions for identification are satisfied and the system can be estimated. The panel of UK firm-year observations are pooled to gain degree of freedom. Both time dummies and industry dummies are included in each equation to account for the time effect and inter-industry variations that cannot be captured by the included regressors.

Although the possibly simultaneity among corporate investment, financing, and payout decisions has been rationalized both analytically and empirically, it is still important to test the hypothesis explicitly before proceed to the simultaneous equation analysis of the set of corporate decisions. More specifically, we perform endogeneity test for the variables that are treated as endogenous in the simultaneous equations system. The null hypothesis of the endogeneity test is that might-be-endogenous variables can actually be treated as exogenous. If the null hypothesis is rejected, the necessity of a simultaneous equations model can be statistically justified. The test for endogeneity results are presented in Table 10.

[insert Table 10 about here]

According to Table 10, the exogeneity of debt financing and dividend payout variables in investment equation should be firmly rejected; again, that of investment and dividend payout variables in debt financing equation should be firmly rejected; finally, that of investment and debt financing variables in payout equation should be firmly rejected as well. An important implication is that it is inappropriate and invalid to treat these endogenous variables as exogenous to obtain the fixed effect, which is also know within, estimators using panel data. The existing literature on corporate finance that ignores the endogeneity of investment, financing, and payout decisions should be critically reviewed. Therefore,

[27] All coefficients of the right-hand side endogenous variables bear the expected signs, and four out of six of them are statistically significant according to our primary results obtained using system-GMM estimation.

corporate investment, financing, and payout decisions should be better considered as a joint decision-making procedure. A preferred strategy is to jointly estimate the corporate decision equations within a system which allows for the simultaneity among the set of corporate decisions.

[insert Table 11 about here]

To derive the simultaneous equations system, we also assume that internally generated cash flow is predetermined by past corporate real and financial decisions, and thus can be treated as exogenous in the system. It is also important to test the validity of this assumption explicitly. For this reason, we also carry out endogeneity test for the cash flow variable in investment, financing, and payout equations respectively, and present the test results in Table 11. The assumption of the exogeneity of cash flow variable is empirically verified. The null hypothesis that the cash flow variable can be treated as exogenous cannot be consistently rejected throughout the tests regarding all the three models. Accordingly, there will be no significant endogenous effect of cash flow variable on the estimates. The cash flow variable, therefore, can be validly taken as an exogenous variable in the simultaneous equations system, allowing us to focus directly on the issues of our interest, i.e. the simultaneity among corporate investment, financing and payout decisions.

4.4.1. ***3SLS estimation results for investment, financing, and payout equations system***

To conduct the simultaneous analysis, we first apply the 3SLS to the system of equations that includes one structural equation for each of the three policy choices. With the 3SLS procedure, the reduced-form equations of 6, 7, and 8 are estimated by ordinary least squares method to obtain the fitted values for the dependent variables in the first stage. The structural equations, in which the fitted values are used in place of the right-hand side endogenous variables, are then estimated in the second stage. The first two stages are identical to the 2SLS method. Additionally, the 3SLS method provides a third step in the estimation procedure that allows for non-zero covariances between the error terms across equations. The essential advantage of 3SLS estimation techniques is that it allows, not only for simultaneity among the set of corporate decisions, but also for correlations among the error components. Thus, it is believed that 3SLS estimators are asymptotically more efficient than 2SLS estimators. The 3SLS estimation results are provided in Table 12. In general, the 3SLS results substantiate the view that corporate investment, borrowing, and payout decisions are inextricably linked and jointly determined. The coefficients of the endogenous variables are all significant, at least at 5% significance level, where they serve as explanatory variables. The MM’s independence propositions are, therefore, rejected more clearly within the simultaneous equations system.

[insert Table 12 about here]

Looking now at the investment regression, it is apparent that the 3SLS results are qualitatively similar to results reported in the preceding system-GMM analysis. The coefficient of *DIV/K* is significantly negative and those of *NDF/K* and *CF/K* are significantly positive as expected. These indicate that investments made by UK-listed firms are likely to be constrained by the availability of internal funds as well as the access to external finance. As a result, managers have to trade-off between investment outlays and dividend payouts, allocating the scarce funds rationally. Both the sign and significant of the uncertainty measure (*UNC1*) remain unchanged, suggesting that the positive effect of uncertainty on investment is quite robust with respect to the method of estimation. Besides, the proxy for Tobin's *Q* remains insignificant, but its sign reversed to positive. The dynamic structure of corporate investment is still statistically evident.

Turning to the borrowing regression, both *INV/K* and *DIV/K* turn out to be highly significant and uniformly positive as expected. It appears that firms' external debt financing is driven not only by the demand from investment but also by that from dividend. Moreover, firms with more internally generated cash flow tend to borrow less. These results are entirely consistent with predicted hierarchy of raising funds, which shows that the pecking-order behaviour is rather robust among UK-listed firm. Besides, the firm size effect remains highly significant as expected. The effect of asset tangibility remains significant but anti-intuitive. The impact of uncertainty on external debt financing remains weak.

With respect to the payout regression, the highly significant coefficients on *INV/K* and *NDF/K* reported in the 3SLS results suggest that the importance of investment and financing choices in dividends decision-making process is likely to be underestimated by the single equation estimation techniques. Although is the cash flow variable (*CF/K*) is still the most important determinant, firm with more investment spending and/or less external financing tend to pay less cash dividends. Our simultaneous analysis clearly shows that dividend decision is neither totally residual nor totally independent but is taken with reference to investment and financing decisions. Besides, the negative effect of uncertainty (*UNC1*) on dividend payouts remains highly significant, but insider ownership (*OWN*) and financial life-cycle stage (*RE/TE*) variables lose their explanatory powers in the simultaneous equation system.

4.4.2. *2SLS estimation results for investment, financing, and payout equations system*

Even though the 3SLS method is asymptotically more efficient, it is also more vulnerable to specification errors as compared to limited information methods, such as 2SLS. Out of this consideration, we also apply the 2SLS estimation to the simultaneous equation system. The 2SLS estimation results for the investment, borrowing, as well as dividend equations are shown in Table 13.

[Table 13 about here]

Generally, the 2SLS regression and the 3SLS regression provide qualitatively similar results. The coefficient of dividend variable (*DIV/K*) in investment equation and that of investment variable (*INV/K*) in dividend equation are again significant and negative, while the new debt financing variable (*NDF/K*) has significant and positive effect in both investment and dividend equations. The 2SLS results for the other regressors in these two equations also reveal no important changes in the estimated coefficients, relative to the 3SLS findings reported in Table 12, except that insider ownership (*OWN*) and financial life-cycle stage variables (*RE/TE*) regain their explanatory powers (although *OWN* takes an unexpected sign). For the borrowing equation, the investment variable (*INV/K*) remains significant and positive, but the dividend variable (*DIV/K*) turns into insignificant with a negative coefficient. The sign of the coefficient on the cash flow variables (*CF/K*) is also reversed. Meanwhile, it seems that uncertainty (*UNC1*) plays a much more important role according to the 2SLS estimation. The coefficient on *UNC1* turns out to be negative and significant at 1% significance level, implying that firms with greater uncertainty tend to resort less to external finance.

Taken all the results from the preceding analyses together, the results suggest that corporate investment, financing, and payout decisions are indeed inextricably linked and jointly determined as predicted by the flow-of-funds framework under information asymmetry. In addition, firms are likely to increase their investment spending in the face of greater uncertainty. To finance the increased investment under uncertainty, they tend to resort to internal funds by cutting dividends rather than resort to external funds by issuing new debts. These results clearly support the argument that managers do take uncertainty into consideration when they make real and financial decisions.

4.5. Robustness check

In order to determine the robustness of our findings in the simultaneous equations analysis of corporate decisions, we split our sample by financial leverage index[28], which is defined as ratio of return on average assets to return on average equity. The financial leverage index is used as a proxy for firm's financial position. It is believed that firms with lower financial leverage index are highly indebted and hence financially more constrained, while firms with higher financial leverage index are less indebted and hence financially less constrained. Given the fact that the joint determination of corporate investment, financing, and payout decisions are justified by the financial constrains in the presence of information asymmetry, the interactions among the set of corporate decisions are expected to be more significant for financial more constrained firms than that of financial less constrained firms. Therefore, we choose the financial leverage index as the proxy for financial constrains faced by firms. The firm-year observations with lower financial leverage index than the median value are classified as financially more constrained which contains 1395 firm-year observations, and the firm-year observations with higher financial leverage index than the median value are classified as financially less constrained which contains 1396 firm-year observations. We expect the evidence of interactions among corporate investment, financing, and payout decisions found in the simultaneous equation analysis to be more pronounced for firms which are subject to severer financial constrains. If this is the case, it can be argued that financial constrains are the possible channel through which corporate investment, financing, and payout decisions are jointly determined by management. To make provide further insight in this direction, we estimate the simultaneous equations system specified as equation 6 to 8 using the two subsamples separately as a robustness check of the results presented in Tables

[28] Financial leverage index is collected directly from Worldscope database via Thomson One Banker Analytics. It is defined as the ratio of return on average assets to return on average equity, which is equivalent to the ratio of average equity to average asset. Therefore, firms with lower financial leverage index have higher financial leverage, while firms with higher financial leverage index have lower financial leverage.

12 and 13. The simultaneous equations analysis results obtained using the two subsamples are presented in Tables 14 and 15 respectively.

[insert Table 14 about here]

Table 14 reports the 3SLS estimation results of corporate investment, financing, and payout equations for the financially more constrained firm-year observations. As we expected, the financially more constrained firm-year observations shows much stronger simultaneity among the set of corporate decisions than entire sample observations. Compared with the results presented in Table 12, the financial variables, i.e. *NDF/K*, *DIV/K*, and *CF/K*, become much more significant both economically and statistically. In particular, the coefficient on dividend payout variable in investment equation declines dramatically from -0.434 to -1.266, suggesting that investment and dividend are extremely competitive in financially more constrained firms. This is also confirmed by the coefficient on the investment variable in payout equation, which declines from -0.118 to -0.223. Meanwhile, the effects of external debt financing and internal cash flow are also doubled in terms of magnitude, with the coefficients on them increase from 0.259 and 0.208 to 0.533 and 0.405 respectively. These results clearly show that firms in this subsample are financially more constrained, not only externally but also internally. Whilst the endogenous variables gain their explanatory powers, the exogenous variables generally become less significant compared with the result for entire sample observations that presented in Table 12. Besides, the significant effects of uncertainty on investment and payout decisions observed from whole sample turns out to be insignificant. However, the effect of uncertainty on debt financing becomes negative and marginally significant. It seems that financially more constrained firms act more defensively under uncertain circumstances, which may due to the limited managerial flexibility caused by the financial constrains.

The 3SLS estimation results reported in Table 15 are obtained from the subsample which is formed by the financially less constrained observations. Although all the endogenous variables still bear the expected signs, their explanatory powers decay considerably, and 4 out 6 of them become statistically insignificant. Meanwhile, the magnitude of the coefficients on the endogenous variables reduces systematically, suggesting that the simultaneity among the set of corporate decisions is relatively weak. Corporate investment decision of financially less constrained firms is likely to be independent of their debt financing and dividend payout decisions, and less subject to internally generated cash flow. The proxy for Tobin's *Q* turns out to be positive and significant, which means that capital expenditure of financially less constrained firms depend relatively more on the real considerations and less on the financial considerations, leading to more efficient investment decisions. However, the effect of investment on payout decision remains negative and significant, which implies that if the available funds are not sufficient to allow independence between investment and dividend decisions, UK-listed firms give investment priority over dividend. Besides, it is worth noting that the effects of uncertainty on investment and dividend decisions turns out to be significant at 5% and 1% significance level respectively. It shows that firms which are financially less constrained tend to act more aggressively under greater uncertainty. They are more able and more willing to take the advantage of pre-emption in a competitive business environment by investing earlier even the prospects are not clear. Managers of the financially less constrained firms are more flexible to raise funds either externally by issuing debt or internally by cutting dividend.

[insert Table 15 about here]

The sharp contrasts between the evidence obtained from financially more constrained firm-year observations and that from financially less constrained firm-year observations strongly suggest that the greater the financial constrains, the greater the tendency towards a joint determination of corporate decisions, and vice versa. Therefore, the subsample estimation results provide indirect evidence that the interactions among corporate investment, financing, and payout decisions are caused by financial constrains in the presence of information asymmetry. Meanwhile, financially less constrained firms seem to be more aggressive than financially more constrained firms. They tend to invest earlier under greater uncertainty to take the advantage of pre-emption in the competitive business environment, and fund-raising is likely to be more flexible for them.

5. Concluding remarks

In this paper, we empirically investigate the interactions among corporate investment, financing, and payout decisions under uncertain circumstances using a panel of UK-listed firms. We model the set of corporate behaviours in a simultaneous equations system which is then estimated by using system-GMM, 2SLS, and 3SLS methods. On the whole, our regression outcomes strongly suggest that the three corporate decisions are actually interdependent, and thus MM's independence propositions should be rejected in the real world with a high level of confidence. More specifically, investment outlays and dividend payouts as competing needs for limited funds are significantly and negatively interrelated with each other, while both of them are significantly and positively related with the amount of new debt issued during the corresponding period. These empirical results on UK data are entirely consistent with the predictions of the flow-of-fund framework with information asymmetry, implying that UK-listed firms are likely to be financially constrained by the availability of internal funds as well as the access to external finance. Therefore, the managers have to consider their financing choices alongside with their investment and payout decisions.

Our study also calls for attention to the role of uncertainty played in the corporate decision-making processes. It is shown that the effect of uncertainty on corporate investment is significantly positive. The positive influence of uncertainty on investment critically challenges the established real option theory of investment which predicts a negative investment-uncertainty relationship given the option value of delay. In fact, the evidence from the panel of UK-listed firm lends strong support to the recent theoretical argument that the advantage of pre-emption may lead firms to invest earlier within a competitive business environment. Moreover, corporate financing and payout decisions appear to be influenced by uncertainty as well. Our results show that uncertainty influences both new debt financing and cash dividend payout significantly and negatively. Taken together, firms facing greater uncertainty are likely to investment more, and in order to finance the increased investment under uncertainty, they tend to resort to internal funds by cutting dividends rather than resort to external funds by issuing new debts. Therefore, corporate investment, financing, and payout decisions appears to be made systematically and simultaneously with full recognition of the competing uses and the limited sources of funds, as well as the uncertainty associated with future prospects.

To determine the robustness of our empirical findings, we further split the entire sample into two subsamples according the financial leverage index, and estimate the simultaneous equations system using the two subsamples separately. A much stronger simultaneity among corporate investment, financing, and payout decisions is observed from the financially more constrained subsample, while the simultaneity is relatively week for the financially less constrained subsample. This indirectly implies that one possible channel through which corporate investment, financing, and payout decisions might be jointly determined is financial constrains. Beside, uncertainty has stronger effect on the set of corporate decisions made by financially less constrained firms, suggesting that financially less constrained firms act more aggressively under uncertainty by cutting dividend payout and investing earlier to take the advantage of pre-emption.

In addition, we tested the flow-of-funds identity that underpins the simultaneous equations system, and found that the identity holds. Also, we performed endogeneity tests on the variables that are treated as endogenous in the study (i.e. investment ratio, debt financing ratio, and divide payout ratio) under the null hypothesis that the variable can be treated as exogenous; the test results uniformly rejected the null, suggesting the simultaneous equation system is required. Further, we performed the same endogeneity tests on the cash flow variable that is taken as exogenous in the system, the null hypothesis cannot be rejected, which means it is valid to treat the cash flow as exogenous in the system as I did. Also, we split further the entire sample into two subsamples according to a financial leverage index, in order to determine the robustness of the findings as well as to explore the possible channel through which the three main corporate decisions are interdependent. The results show that the simultaneity among the set of corporate decisions is much more significant for the firms which are financially more constrained, while the simultaneity is relatively less significant for the firms that are financially less constrained, suggesting that the financial constrains may provide the mechanism through which the corporate decisions are jointly determined. 5. Besides, the effects of uncertainty on corporate decisions are more significant for financially less constrained firms, but less significant for financially more constrained firms, suggesting that firms which are less constrained are able to and willing to react to uncertainty aggressively, i.e. cutting dividend payout and increasing investment, while financially more constrained firms are acting defensively under uncertainty.

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Table 1: Methodology and findings of selected literature on simultaneity of corporate decisions

	Dhrymes and Kurz (1967)	McDonald et al. (1975)	McCabe (1979)	Peterson and Benesh (1983)	Mougoue and Mukherjee (1994)	Wang (2010)
Decisions Modelled	Investment New Debt Dividend	Investment New Debt Dividend	Investment New Debt Dividend	Investment New Debt Dividend	Investment New Debt Dividend	Investment New Debt Dividend
Country	US	France	US	US	US	China
Years Analyzed	1951-1960	1962-1968	1966-1973	1975-1979	1978-1987	2000-2007
Number of Firms	181	75	112	537-538	100	2710
Estimation Techniques[a]	OLS, 2SLS, 3SLS	OLS, 2SLS	OLS, 2SLS	2SLS, 3SLS, SUR	VAR	DAG, PA
Joint Determination	Yes	No	Yes	Yes	Yes	Yes

Notes:

[a.] OLS = ordinary least squares; 2SLS = two-stage least squares; 3SLS = three-stage least squares; SUR = seemingly unrelated regressions; VAR = vector autoregressive model; PA =path analysis; DAG = directed acyclic graph model

Table 2: Endogenous variables and hypothesized relationships under flow-of-funds framework

Variable	Economic argument	Expected sign
NDF→INV	Decreased new borrowing results to capital rationing and inhibits investment	+
DIV→INV	Increased dividends reduce the pool of funds available to investment	–
INV→NDF	Increased investment motivates the firm to utilize its borrowing capacity	+
DIV→NDF	Increased dividends limit the access to retained earnings and causes the firm rely more heavily on debt for financing	+
INV→DIV	Decreased investment enables the firm to pay more dividends	–
NDF→DIV	Increased debt financing allows the firm to carry out planned dividend payout even when the profitability is low in the short run	+

Table 3: Description of main variables used in this study

Gross investment (*INV*)	
	The sum of the changes in book value of net property, plant and equipment and depreciation expenses;
Net new debt financing (*NDF*)	
	The differences in the book value of long-term debt;
Dividends (*DIV*)	
	The reported total dividends paid on common stock, including extra and special dividends;
Cash flow (CF)	
	The sum of net income and depreciation expenses;
Average *Q* (*Q*)	
	The ratio of the market value of equity plus the book value of debt to the book value of total assets;
Firm size (*SZ*)	
	The natural logarithm of the book value of total assets;
Asset tangibility (*TAN*)	
	The ratio of the book value of net property, plant and equipment to the book value of total assets;
Ownership structure (*OWN*)	
	The percentage of common share outstanding that is held by insiders;
Retained earnings-to-total equity ratio (*RE/TE*)	
	The ratio of the book value of retained earnings in balance sheet to the book value of total common equity;
Uncertainty measure 1 (*UNC1*)	
	The difference between the highest and the lowest price normalized by the mean over the period;
Uncertainty measure 2 (*UNC2*)	
	The conventional standard deviation of daily stock market returns over the period;
Uncertainty measure 3 (*UNC3*)	
	The average of conditional standard deviations of daily stock returns over the period

Table 4: Descriptive statistics of variables used in the study

Variable	Mean	Median	Max.	Min.	Std. dev.	Skewness	kurtosis	Obs.
Panel A: Descriptive statistics of variables as observed								
INV/K	0.8180	0.2388	960.43	-0.96	16.6124	56.8067	3279	3398
NDF/K	0.3435	0.0000	243.45	-67.54	5.7114	27.8121	1083	3401
DIV/K	0.3250	0.1020	48.00	0.00	1.4514	19.7664	521	3399
CF/K	1.4156	0.4651	155.20	0.00	5.4895	15.4013	320	3398
Q	2.1415	1.3779	143.71	0.02	5.2062	17.0323	383	3410
TAN	0.2951	0.2470	0.95	0.00	0.2305	0.8798	3	3407
SZ	5.5161	5.3538	12.05	-0.03	2.0197	0.2745	3	3411
OWN	0.2447	0.2023	0.99	0.00	0.2093	0.8046	3	3393
RE/TE	0.3081	0.5478	71.29	-437.33	8.2261	-44.0193	2358	3407
UNC1	0.3122	0.2972	0.72	0.02	0.1046	0.7052	3	3423
UNC2	0.0293	0.0231	0.35	0.00	0.0234	3.3704	31	1907
UNC3	0.0299	0.0261	0.33	0.00	0.0198	3.1983	36	1799
Panel B: Descriptive statistics of variables winsorized at the top and bottom 5 percentiles[a]								
INV/K	0.4130	0.2388	2.3547	-0.0723	0.5313	2.3133	8.2628	3398
NDF/K	0.1347	0.0000	1.9474	-0.6391	0.5292	2.0772	7.6866	3401
DIV/K	0.2036	0.1020	1.0888	0.0000	0.2717	2.1325	6.9118	3399
CF/K	0.9722	0.4651	6.1150	0.0733	1.3625	2.5842	9.2465	3398
Q	1.6939	1.3779	4.5970	0.7125	0.9760	1.5863	4.9233	3410
TAN	0.2920	0.2470	0.7871	0.0172	0.2222	0.7621	2.6143	3407
SZ	5.4855	5.3538	8.9878	1.9947	1.8750	0.1343	2.2278	3411
OWN	0.2410	0.2023	0.6713	0.0011	0.1999	0.6096	2.3451	3393
RE/TE	0.4208	0.5478	0.9724	-1.2778	0.4996	-1.7403	6.1775	3407
UNC1	0.3123	0.2972	0.5591	0.1714	0.0992	0.6307	2.7302	3423
UNC2	0.0281	0.0231	0.0711	0.0054	0.0181	0.9267	2.9597	1907
UNC3	0.0291	0.0261	0.0634	0.0078	0.0159	0.6123	2.3965	1799

Note:

[a.] Winsorization is the transformation of statistics by transforming extreme values in the statistical data. The transformed data is identical to the original one except that, in this case, all data below the 5 percentile are set to the 5 percentile and data above the 95 percentile are set to the 95 percentile.

Table 5: Firm's uses and sources of funds identity verification

Year	Obs.	*INV* [a]	*DIV* [a]	*ΔWK* [a]	Total uses of funds [a]	*NDF* [a]	*CF* [a]	Total sources of funds [a]	Difference between uses and sources [a]	Mean-comparison *t*-test (paired)[b]	Mean-comparison *t*-test (unpaired)[c]
1999	601	76.59	39.05	8.04	123.67	25.22	94.72	119.94	3.74	0.3190 (*p*=0.75)	0.1037 (*p*=0.92)
2000	636	54.97	26.15	0.10	81.23	25.86	89.29	115.15	-33.92	-3.8363 (*p*=0.00)	-0.9922 (*p*=0.32)
2001	729	98.79	37.82	-4.88	131.73	30.63	95.92	126.55	5.18	0.1756 (*p*=0.86)	0.0983 (*p*=0.92)
2002	821	84.32	30.53	-6.31	108.54	6.84	64.99	71.82	36.72	1.6205 (*p*=0.11)	0.8933 (*p*=0.37)
2003	947	62.43	26.08	7.90	96.41	9.03	83.23	92.25	4.16	0.3038 (*p*=0.76)	0.1124 (*p*=0.91)
2004	1064	55.39	25.87	22.67	103.94	-0.221	95.68	95.47	8.47	0.6072 (*p*=0.54)	0.2376 (*p*=0.81)
2005	1062	74.36	30.05	8.39	112.81	3.39	113.5	116.98	-4.17	-0.3682 (*p*=0.71)	-0.0956 (*p*=0.92)
2006	1064	40.80	37.89	-3.52	75.17	7.77	98.87	106.64	-31.47	-1.4195 (*p*=0.16)	-0.8515 (*p*=0.39)
2007	1034	32.09	18.15	-7.93	42.31	10.63	62.08	72.71	-30.40	-5.3224 (*p*=0.00)	-2.5870 (*p*=0.01)
2008	990	170.51	42.61	-17.72	195.41	77.87	142.86	220.73	-25.32	-1.1906 (*p*=0.23)	-0.3628 (*p*=0.72)
Total	8948	74.28	31.09	0.80	106.17	18.75	94.89	113.64	-7.47	-1.3483 (*p*=0.18)	-0.5486 (*p*=0.58)

Notes:

[a] The values are translated into British Pound Sterling and scaled into million.

[b] This column presents the results of *t* tests on the equality of uses and sources of funds, assuming paired data. The exact significant level (p-value) of each t statistic is reported in parentheses underneath.

[c] This column presents the results of *t* tests on the equality of uses and sources of funds, assuming unpaired data. The exact significant level (p-value) of each t statistic is reported in parentheses underneath.

Table 6: Correlation coefficient matrix of variables used in the study

Variable	$\frac{INV}{K}$	$\frac{NDF}{K}$	$\frac{DIV}{K}$	$\frac{CF}{K}$	Q	TAN	SZ	OWN	$\frac{RE}{TE}$	$UNC1$	$UNC2$	$UNC3$
$\frac{INV}{K}$	1.00											
$\frac{NDF}{K}$	0.38 ***[a]	1.00										
$\frac{DIV}{K}$	0.34 ***	0.15 ***	1.00									
$\frac{CF}{K}$	0.57 ***	0.18 ***	0.67 ***	1.00								
Q	0.13 ***	0.03	0.20 ***	0.19 ***	1.00							
TAN	-0.33 ***	-0.15 ***	-0.50 ***	-0.53 ***	-0.16 ***	1.00						
SZ	-0.08 ***	0.10 ***	-0.02	-0.12 ***	0.02	0.14 ***	1.00					
OWN	0.02	-0.07 ***	0.00	0.02	-0.05 ***	-0.04 **	-0.48 ***	1.00				
$\frac{RE}{TE}$	-0.10 ***	-0.04 **	0.06 ***	-0.04 **	-0.03 *	0.09 ***	0.12 ***	-0.04 **	1.00			
$UNC1$	0.22 ***	-0.02	-0.01	0.21 ***	0.10 ***	-0.24 ***	-0.28 ***	0.15 ***	-0.29 ***	1.00		
$UNC2$	0.01	0.03	-0.03	-0.01	-0.16 ***	0.02	-0.08 ***	0.02	0.00	0.03	1.00	
$UNC3$	0.01	0.03	-0.03	0.00	-0.14 ***	0.01	-0.10 ***	0.04	-0.01	0.05 *	0.91 ***	1.00

Notes:

[a.] * significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level.

Table 7: System-GMM estimation of corporate investment equation for UK firms[a]

	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
NDF/K	0.2299***[e] (3.40)[f]	0.3752*** (4.96)	0.3650*** (4.82)
DIV/K	-0.3000** (2.33)	-0.0629 (-0.42)	-0.0295 (-0.17)
CF/K	0.2303** (8.60)	0.1638*** (5.12)	0.1616*** (4.84)
Q	-0.0018 (-0.15)	0.0142 (0.79)	0.0151 (0.86)
$(INV/K)_{-1}$	0.1848*** (3.43)	0.2140*** (2.81)	0.2108*** (2.72)
$UNC1_{-1}$	0.2566*** (2.93)		
$UNC2_{-1}$		0.2063 (0.36)	
$UNC3_{-1}$			1.1647 (1.35)
Constant	0.1098*** (2.71)	0.1399*** (2.89)	0.1117*** (1.98)
Arellano-Bond test for AR(1) in first differenced errors[g]	-5.71*** (p = 0.000)	-4.50*** (p = 0.000)	-4.39*** (p = 0.000)
Arellano-Bond test for AR(2) in first differenced errors[h]	-1.06 (p = 0.289)	-1.04 (p = 0.300)	-1.12 (p = 0.263)
Hansen test of over-identifying restrictions[i]	89.23 $d.f.$ = 94 (p = 0.620)	96.75 $d.f.$ = 94 (p = 0.402)	93.51 $d.f.$ = 94 (p = 0.495)
Difference-in-Hansen test of exogeneity of instrument subsets[j]	GMM instruments for levels: 73.22 ($d.f.$=71; p=0.405) for differences: 16.01 ($d.f.$=23; p=0.855) Standard instruments for levels: 81.16 ($d.f.$=83; p=0.537) for differences: 8.07 ($d.f.$=11; p=0.386)	GMM instruments for levels: 67.80 ($d.f.$=71; p=0.586) for differences: 28.95 ($d.f.$=23; p=0.182) Standard instruments for levels: 89.27 ($d.f.$=83; p=0.299) for differences: 7.48 ($d.f.$=11; p=0.759)	GMM instruments for levels: 67.18 ($d.f.$=71; p=0.607) for differences: 26.33 ($d.f.$=23; p=0.286) Standard instruments for levels: 86.94 ($d.f.$=83; p=0.362) for differences: 6.57 ($d.f.$=11; p=0.833)
No. of firms	427	336	309
No. of observations	2805	1435	1376
Instruments used	*Constant*; *TD*; $(NDF/K)_{t-2,\ldots,t-5}$; $(DIV/K)_{t-2,\ldots,t-5}$; $(INV/K)_{t-3,\ldots,t-5}$; $(CF/K)_t$; Q_t; $UNC1_{t-1}$; $\Delta(NDF/K)_{t-1}$; $\Delta(DIV/K)_{t-1}$; $\Delta(INV/K)_{t-2}$; $\Delta(CF/K)_t$; ΔQ_t; $\Delta UNC1_{t-1}$	*Constant*; *TD*; $(NDF/K)_{t-2,\ldots,t-5}$; $(DIV/K)_{t-2,\ldots,t-5}$; $(INV/K)_{t-3,\ldots,t-5}$; $(CF/K)_t$; Q_t; $UNC2_{t-1}$; $\Delta(NDF/K)_{t-1}$; $\Delta(DIV/K)_{t-1}$; $\Delta(INV/K)_{t-2}$; $\Delta(CF/K)_t$; ΔQ_t; $\Delta UNC2_{t-1}$	*Constant*; *TD*; $(NDF/K)_{t-2,\ldots,t-5}$; $(DIV/K)_{t-2,\ldots,t-5}$; $(INV/K)_{t-3,\ldots,t-5}$; $(CF/K)_t$; Q_t; $UNC3_{t-1}$; $\Delta(NDF/K)_{t-1}$; $\Delta(DIV/K)_{t-1}$; $\Delta(INV/K)_{t-2}$; $\Delta(CF/K)_t$; ΔQ_t; $\Delta UNC3_{t-1}$
Time dummies	Included	Included	Included

F-statistic	34.04*** (*d.f.*=14, 426; *p*=0.000)	16.02*** (*d.f.*=14, 335; *p*=0.000)	17.13*** (*d.f.*=14, 308; *p*=0.000)

Notes:

[a.] The sample contains firm-year observation of the period 1999-2016. The investment equation estimated is specified as equation (6), and estimated by System-GMM using Stata 10.

[b.] Variant 1 is specified as $INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC1_{-1} + \varepsilon$.

[c.] Variant 2 is specified as $INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC2_{-1} + \varepsilon$.

[d.] Variant 3 is specified as $INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC3_{-1} + \varepsilon$.

[e.] * significant at 10%; ** significant at 5%; and ***significant at 1%.

[f.] *t*-statistics are reported in parentheses.

[g.] Arellona-Bond test tests for serial correlation in the first-differenced errors in order to purge the unobserved and perfectly autocorrelated individual effects. Autocorrelation at order 1 is expected in first differences, because $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ should correlate with $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$, since they share the ε_{it-1} term.

[h.] To check for AR(1) in levels, look for AR(2) in differences, on the idea that this will detect the relationship between the ε_{it-1} in $\Delta\varepsilon_{it}$ and the ε_{it-2} in $\Delta\varepsilon_{it-2}$. Autocorrelation indicates that lags of the dependent variable (and any other variables used as instruments that are not strictly exogenous), are in fact endogenous, thus bad instruments. Therefore, rejecting the null hypothesis of no serial correlation in the first-differenced errors at an order greater than one implies model misspecification.

[i.] Hansen overidentifying restrictions test tests for whether the instruments, as a group, appear exogenous. Under two-step robust GMM estimation, the Sargan statistic is not robust to heteroskedasticity or autocorrelation, but Hensen *J*-statistic, which is the minimized value of the two-step GMM criterion function, is robust. The joint null hypothesis is that the instruments are valid instruments, i.e. uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. A statistically significant test statistic always indicates that the instruments may not be valid. However, the *J*-test has its own problem: it can be greatly weakened by instrument proliferation.

[j.] Difference-in-Hansen test tests for whether subsets of instruments are valid. To be precise, it reports one test for each group of instruments.

Table 8: System-GMM estimation of corporate financing equation for UK firms[a]

	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
INV/K	0.5426 ***[e] (5.07)[f]	0.5090*** (4.26)	0.5019*** (4.12)
DIV/K	0.4167** (2.29)	-0.0083 (-0.05)	-0.0355 (-0.18)
CF/K	-0.1184*** (-3.08)	-0.0507 (1.50)	-0.0403 (-1.11)
TAN	-0.2075*** (-2.90)	-0.2005** (-2.23)	-0.2082** (-2.28)
SZ	0.0336*** (6.42)	0.0400*** (4.66)	0.0397*** (4.53)
$UNC1_{-1}$	-0.2357* (-1.88)		
$UNC2_{-1}$		0.4830 (0.50)	
$UNC3_{-1}$			0.4784 (0.46)
Constant	-0.0671 (0.93)	-0.1699* (-1.96)	-0.1685* (-1.90)
Arellano-Bond test for AR(1) in first differenced errors[g]	-7.92*** (*p* = 0.000)	-5.23*** (*p* = 0.000)	-5.17*** (*p* = 0.000)
Arellano-Bond test for AR(2) in first differenced errors[h]	0.09 (*p* = 0.925)	0.53 (*p* = 0.599)	0.49 (*p* = 0.627)
Hansen test of over-identifying restrictions[i]	63.98 *d.f.* = 66 (*p* = 0.548)	67.65 *d.f.* = 66 (*p* = 0.421)	65.79 *d.f.* = 66 (*p* = 0.484)
Difference-in-Hansen test of exogeneity of instrument subsets[j]	GMM instruments for levels: 51.39 (*d.f.*=50; *p*=0.419) for differences: 12.59 (*d.f.*=16; *p*=0.703) Standard instruments for levels: 53.28 (*d.f.*=54; *p*=0.502) for differences: 10.70 (*d.f.*=12; *p*=0.555)	GMM instruments for levels: 41.68 (*d.f.*=50; *p*=0.793) for differences: 25.97 (*d.f.*=16; *p*=0.054) Standard instruments for levels: 58.10 (*d.f.*=54; *p*=0.327) for differences: 9.55 (*d.f.*=12; *p*=0.656)	GMM instruments for levels: 41.70 (*d.f.*=50; *p*=0.792) for differences: 24.09 (*d.f.*=16; *p*=0.088) Standard instruments for levels: 56.05 (*d.f.*=54; *p*=0.398) for differences: 9.74 (*d.f.*=12; *p*=0.639)
No. of firms	427	336	309
No. of observations	2814	1442	1382
Instruments used	*Constant*; *TD*; $(INV/K)_{t-2,\ldots,t-5}$; $(DIV/K)_{t-2,\ldots,t-5}$; $(CF/K)_t$; TAN_t; SZ_t; $UNC1_{t-1}$; $\Delta(INV/K)_{t-1}$; $\Delta(DIV/K)_{t-1}$; $\Delta(CF/K)_t$; ΔTAN_t; ΔSZ_t;	*Constant*; *TD*; $(INV/K)_{t-2,\ldots,t-5}$; $(DIV/K)_{t-2,\ldots,t-5}$; $(CF/K)_t$; TAN_t; SZ_t; $UNC2_{t-1}$; $\Delta(INV/K)_{t-1}$; $\Delta(DIV/K)_{t-1}$; $\Delta(CF/K)_t$; ΔTAN_t; ΔSZ_t;	*Constant*; *TD*; $(INV/K)_{t-2,\ldots,t-5}$; $(DIV/K)_{t-2,\ldots,t-5}$; $(CF/K)_t$; TAN_t; SZ_t; $UNC3_{t-1}$; $\Delta(INV/K)_{t-1}$; $\Delta(DIV/K)_{t-1}$; $\Delta(CF/K)_t$; ΔTAN_t; ΔSZ_t;

	$\Delta UNC1_{t-1}$	$\Delta UNC2_{t-1}$	$\Delta UNC3_{t-1}$
Time dummies	Included	Included	Included
F-statistic	10.66***	6.03***	5.29***
	(*d.f.*=14, 426; *p*=0.000)	(*d.f.*=14, 335; *p*=0.000)	(*d.f.*=14, 308; *p*=0.000)

Notes:

[a.] The sample contains firm-year observation of the period 1999-2016. The debt financing equation estimated is specified as equation (7), and estimated by System-GMM using Stata 10.

[b.] Variant 1 is specified as $NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC1_{-1} + \mu$.

[c.] Variant 2 is specified as $NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC2_{-1} + \mu$.

[d.] Variant 3 is specified as $NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC3_{-1} + \mu$.

[e.] * significant at 10%; ** significant at 5%; and ***significant at 1%.

[f.] *t*-statistics are reported in parentheses.

[g.] Arellona-Bond test tests for serial correlation in the first-differenced errors in order to purge the unobserved and perfectly autocorrelated individual effects. Autocorrelation at order 1 is expected in first differences, because $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ should correlate with $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$, since they share the ε_{it-1} term.

[h.] To check for AR(1) in levels, look for AR(2) in differences, on the idea that this will detect the relationship between the ε_{it-1} in $\Delta\varepsilon_{it}$ and the ε_{it-2} in $\Delta\varepsilon_{it-2}$. Autocorrelation indicates that lags of the dependent variable (and any other variables used as instruments that are not strictly exogenous), are in fact endogenous, thus bad instruments. Therefore, rejecting the null hypothesis of no serial correlation in the first-differenced errors at an order greater than one implies model misspecification.

[i.] Hansen overidentifying restrictions test tests for whether the instruments, as a group, appear exogenous. Under two-step robust GMM estimation, the Sargan statistic is not robust to heteroskedasticity or autocorrelation, but Hensen *J*-statistic, which is the minimized value of the two-step GMM criterion function, is robust. The joint null hypothesis is that the instruments are valid instruments, i.e. uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. A statistically significant test statistic always indicates that the instruments may not be valid. However, the *J*-test has its own problem: it can be greatly weakened by instrument proliferation.

[j.] Difference-in-Hansen test tests for whether subsets of instruments are valid. To be precise, it reports one test for each group of instruments.

Table 9: System-GMM estimation of corporate dividend equation for UK firms[a]

	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
INV/K	-0.0033 (-0.09)[e]	0.0116 (0.18)	0.0044 (0.07)
NDF/K	0.0274 (1.21)	0.0269 (0.76)	0.0340 (1.00)
CF/K	0.1355***[f] (12.20)	0.1257*** (8.65)	0.1278*** (8.22)
OWN	-0.0152 (-0.51)	-0.0640 (-1.46)	-0.0805* (-1.83)
RE/TE	0.0049** (2.03)	0.0281 (1.46)	0.0290* (1.70)
$UNC1_{-1}$	-0.2655 *** (-3.31)		
$UNC2_{-1}$		-0.0096 (-0.03)	
$UNC3_{-1}$			-0.1290 (-0.23)
Constant	0.1586*** (5.73)	0.0831** (2.56)	0.0982*** (2.78)
Arellano-Bond test for AR(1) in first differenced errors[g]	-3.01*** (p = 0.003)	-2.18*** (p = 0.000)	-2.65*** (p = 0.008)
Arellano-Bond test for AR(2) in first differenced errors[h]	-1.69* (p = 0.091)	-1.52 (p = 0.128)	-1.54 (p = 0.123)
Hansen test of over-identifying restrictions[i]	68.40 *d.f.* = 66 (p = 0.396)	62.55 *d.f.* = 66 (p = 0.598)	60.01 *d.f.* = 66 (p = 0.684)
Difference-in-Hansen test of exogeneity of instrument subsets[j]	GMM instruments for levels: 48.18 (*d.f.*=50; p=0.547) for differences: 20.22 (*d.f.*=16; p=0.210) Standard instruments for levels: 44.21 (*d.f.*=54; p=0.827) for differences: 24.19 (*d.f.*=12; p=0.019)	GMM instruments for levels: 41.58 (*d.f.*=50; p=0.796) for differences: 20.97 (*d.f.*=16; p=0.180) Standard instruments for levels: 53.38 (*d.f.*=54; p=0.498) for differences: 9.17 (*d.f.*=12; p=0.688)	GMM instruments for levels: 41.25 (*d.f.*=50; p=0.806) for differences: 18.76 (*d.f.*=16; p=0.281) Standard instruments for levels: 50.91 (*d.f.*=54; p=0.594) for differences: 9.11 (*d.f.*=12; p=0.694)
No. of firms	427	336	309
No. of observations	2800	1436	1377
Instruments used	*Constant*; *TD*; $(GI/K)_{t-2,..., t-5}$; $(NDF/K)_{t-2,..., t-5}$; $(CF/K)_t$; OWN_t; RE/TE_t; $UNC1_{t-1}$; $\Delta(GI/K)_{t-1}$; $\Delta(BOR/K)_{t-1}$; $\Delta(CF/K)_t$; ΔOWN_t; $\Delta(RE/BE)_t$; $\Delta UNC1_{t-1}$	*Constant*; *TD*; $(GI/K)_{t-2,..., t-5}$; $(NDF/K)_{t-2,..., t-5}$; $(CF/K)_t$; OWN_t; RE/TE_t; $UNC2_{t-1}$; $\Delta(GI/K)_{t-1}$; $\Delta(BOR/K)_{t-1}$; $\Delta(CF/K)_t$; ΔOWN_t; $\Delta(RE/BE)_t$; $\Delta UNC2_{t-1}$	*Constant*; *TD*; $(GI/K)_{t-2,..., t-5}$; $(NDF/K)_{t-2,..., t-5}$; $(CF/K)_t$; OWN_t; RE/TE_t; $UNC3_{t-1}$; $\Delta(GI/K)_{t-1}$; $\Delta(BOR/K)_{t-1}$; $\Delta(CF/K)_t$; ΔOWN_t; $\Delta(RE/BE)_t$; $\Delta UNC3_{t-1}$

Time dummies	Included	Included	Included
F-statistic	27.70***	13.51***	16.28***
	(*d.f.*=14, 426; *p*=0.000)	(*d.f.*=14, 335; *p*=0.002)	(*d.f.*=14, 308; *p*=0.000)

Notes:

[a.] The sample contains firm-year observation of the period 1999-2016. The dividend equation estimated is specified as equation (8), and estimated by System-GMM using Stata 10.

[b.] Variant 1 is specified as $DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC1_{-1} + \nu$.

[c.] Variant 2 is specified as $DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC2_{-1} + \nu$.

[d.] Variant 3 is specified as $DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC3_{-1} + \nu$.

[e.] *t*-statistics are reported in parentheses.

[f.] * significant at 10%; ** significant at 5%; and ***significant at 1%.

[g.] Arellona-Bond test tests for serial correlation in the first-differenced errors in order to purge the unobserved and perfectly autocorrelated individual effects. Autocorrelation at order 1 is expected in first differences, because $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ should correlate with $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$, since they share the ε_{it-1} term.

[h.] To check for AR(1) in levels, look for AR(2) in differences, on the idea that this will detect the relationship between the ε_{it-1} in $\Delta\varepsilon_{it}$ and the ε_{it-2} in $\Delta\varepsilon_{it-2}$. Autocorrelation indicates that lags of the dependent variable (and any other variables used as instruments that are not strictly exogenous), are in fact endogenous, thus bad instruments. Therefore, rejecting the null hypothesis of no serial correlation in the first-differenced errors at an order greater than one implies model misspecification.

[i.] Hansen overidentifying restrictions test tests for whether the instruments, as a group, appear exogenous. Under two-step robust GMM estimation, the Sargan statistic is not robust to heteroskedasticity or autocorrelation, but Hensen *J*-statistic, which is the minimized value of the two-step GMM criterion function, is robust. The joint null hypothesis is that the instruments are valid instruments, i.e. uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. A statistically significant test statistic always indicates that the instruments may not be valid. However, the *J*-test has its own problem: it can be greatly weakened by instrument proliferation.

[j.] Difference-in-Hansen test tests for whether subsets of instruments are valid. To be precise, it reports one test for each group of instruments.

Table 10: Endogeneity test of endogenous variables[a]

	Investment Equation *INV/K*	Financing Equation *NDF/K*	Dividend Equation *DIV/K*
Regressors tested[b]	$(NDF/K)_t$ and $(DIV/K)_t$	$(INV/K)_t$ and $(DIV/K)_t$	$(INV/K)_t$ and $(NDF/K)_t$
Instrumental variables used[c]	TAN_t; SZ_t; OWN_t; $(RE/TE)_t$;	Q_t; $(INV/K)_{t-1}$; OWN_t; $(RE/TE)_t$;	Q_t; $(INV/K)_{t-1}$; TAN_t; SZ_t;
Endogeneity test[d]	47.116	12.931	16.092
(p-value)[e]	(0.0000)	(0.0016)	(0.0003)

Notes:

[a.] The endogeneity test is defined as the difference of two Sargan-Hansen statistics: one for the equation with the smaller set of instruments, where the suspect regressors are treated as endogenous, and one for the equation with larger set of instruments, where the suspect regressors are treated as exogenous. Under conditional homoscedasticity, this endogeneity test statistics is numerically equal to a Hausman test statistic. Unlike Hausman test, the endogeneity test can report test statistics that are robust to various violations of conditional homoscedasticity.

[b.] The variables that are suspected to be endogenous in the regression.

[c.] The variables that are used as instruments for the regressors tested.

[d.] Under the null hypothesis that the specified endogenous regressors can be actually treated as exogenous, the test statistic is distributed as *Chi*-squared with degrees of freedom equal to the number of regressors tested.

[e.] The exact significant level (p-value) of test statistics is reported in the parenthesis underneath.

Table 11: Endogeneity test of cash flow variable[a]

	Investment Equation *INV/K*	Financing Equation *NDF/K*	Dividend Equation *DIV/K*
Regressors tested[b]	$(CF/K)_t$	$(CF/K)_t$	$(CF/K)_t$
Instrumental variables used[c]	$(CF/K)_{t-2}$; $(CF/K)_{t-3}$; $(CF/K)_{t-4}$	$(CF/K)_{t-2}$; $(CF/K)_{t-3}$; $(CF/K)_{t-4}$	$(CF/K)_{t-2}$; $(CF/K)_{t-3}$; $(CF/K)_{t-4}$
Endogeneity test[d]	1.124	0.057	1.872
(p-value)[e]	(0.2890)	(0.8106)	(0.1713)

Notes:

a. The endogeneity test is defined as the difference of two Sargan-Hansen statistics: one for the equation with the smaller set of instruments, where the suspect regressors are treated as endogenous, and one for the equation with larger set of instruments, where the suspect regressors are treated as exogenous. Under conditional homoscedasticity, this endogeneity test statistics is numerically equal to a Hausman test statistic. Unlike Hausman test, the endogeneity test can report test statistics that are robust to various violations of conditional homoscedasticity.

b. The variables that are suspected to be endogenous in the regression.

c. The variables that are used as instruments for the regressors tested.

d. Under the null hypothesis that the specified endogenous regressors can be actually treated as exogenous, the test statistic is distributed as *Chi*-squared with degrees of freedom equal to the number of regressors tested.

e. The exact significant level (p-value) of test statistics is reported in the parenthesis underneath.

Table 12: Simultaneous estimation of corporate investment, financing, and payout equations for UK firms[a], using 3SLS method

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
INV/K		0.1931***	-0.1177***
		(2.94)	(-2.87)
NDF/K	0.2588** [e]		0.4415***
	(2.52) [f]		(5.30)
DIV/K	-0.4340**	0.7383***	
	(-2.49)	(3.00)	
CF/K	0.2079***	-0.0843**	0.1340***
	(9.23)	(-2.27)	(13.07)
Q	0.0119		
	(1.19)		
$(INV/K)_{-1}$	0.3003***		
	(18.39)		
TAN		-0.2336***	
		(-2.79)	
SZ		0.0219***	
		(4.14)	
OWN			0.0400
			(1.57)
RE/TE			0.0168
			(1.54)
$UNC1_{-1}$[g]	0.2360**	0.0679	-0.2725***
	(2.59)	(0.43)	(-3.72)
Constant	0.0713	0.0181	0.0633
	(1.49)	(0.19)	(1.50)
No. of observations	2791	2791	2791
Time dummies	Included	Included	Included
Industry dummies	Included	Included	Included
Chi^2-statistic	2562.05	543.13	1259.90
	(p = 0.000)	(p = 0.000)	(p = 0.000)

Notes:

a. The sample contains firm-year observation of the period 1999-2016. The simultaneous structural form equations are specified as equation (6) through (8), and estimated by 3SLS using Stata 10.

b. Investment equation is specified as
$$INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC1_{-1} + \varepsilon \cdot$$

c. Borrowing equation is specified as
$$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC1_{-1} + \mu \cdot$$

d. Payout equation is specified as
$$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC1_{-1} + \nu \cdot$$

e. * significant at 10%; ** significant at 5%; and ***significant at 1%.

f. *z*-statistics are reported in parentheses.

g. *UNC1* is used as the primary proxy for the uncertainty faced by a firm in the 3SLS estimation.

Table 13: Simultaneous estimation of corporate investment, financing, and payout equations for UK firms[a], using 2SLS method

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
INV/K		0.1268*	-0.1118***
		(1.89)	(-2.66)
NDF/K	0.2296** [e]		0.4938***
	(2.22) [f]		(5.69)
DIV/K	-0.3299*	-0.5028	
	(-1.88)	(-1.56)	
CF/K	0.1944***	0.0968**	0.1288***
	(8.55)	(2.06)	(12.36)
Q	0.0149		
	(1.47)		
$(INV/K)_{-1}$	0.3031***		
	(18.39)		
TAN		-0.3972***	
		(-3.82)	
SZ		0.0363***	
		(6.30)	
OWN			0.0970***
			(2.86)
RE/TE			0.0410***
			(2.90)
$UNC1_{-1}$[d]	0.2724***	-0.4070***	-0.2472***
	(2.59)	(-2.19)	(-3.33)
Constant	0.0543	0.2007*	0.0590
	(1.13)	(1.74)	(1.43)
No. of observations	2791	2791	2791
Time dummies	Included	Included	Included
Industry dummies	Included	Included	Included
F-statistic	105.67	10.97	52.22
	(p = 0.000)	(p = 0.000)	(p = 0.000)

Notes:

a. The sample contains firm-year observation of the period 1999-2016. The simultaneous structural form equations are specified as equation (6) through (8), and estimated by 2SLS using Stata 10.

b. Investment equation is specified as
$INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC1_{-1} + \varepsilon$.

c. Borrowing equation is specified as
$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC1_{-1} + \mu$.

d. Payout equation is specified as
$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC1_{-1} + \nu$.

e. * significant at 10%; ** significant at 5%; and ***significant at 1%.

f. *t*-statistics are reported in parentheses.

g. *UNC1* is used as the primary proxy for the uncertainty faced by a firm in the 2SLS estimation.

Table 14: Simultaneous estimation of corporate investment, financing, and payout equations for financially constrained firms[a], using 3SLS method

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
INV/K		0.3559***	-0.2231***
		(2.71)	(-2.99)
NDF/K	0.5326*** [e]		0.4375***
	(3.38) [f]		(4.26)
DIV/K	-1.2660***	0.8727***	
	(-4.50)	(2.66)	
CF/K	0.4051***	-0.1396*	0.1785***
	(11.29)	(-1.95)	(7.55)
Q	-0.0152		
	(-0.95)		
$(INV/K)_{-1}$	0.1852***		
	(8.64)		
TAN		-0.2345**	
		(-2.34)	
SZ		0.0204**	
		(2.31)	
OWN			0.0319
			(0.99)
RE/TE			0.0086
			(1.54)
$UNC1_{-1}$[g]	-0.1292	-0.3197	-0.0627
	(-0.89)	(-1.51)	(-0.52)
Constant	0.1255	0.1491	-0.0030
	(1.58)	(1.24)	(-0.04)
No. of observations	1395	1395	1395
Time dummies	Included	Included	Included
Industry dummies	Included	Included	Included
Chi^2-statistic	1392.93	223.32 (p = 0.000)	598.13
	(p = 0.000)		(p = 0.000)

Notes:

[a] The sample contains firm-year observation of the period 1999-2016. The simultaneous structural form equations are specified as equation (5) through (7), and estimated by 3SLS using Stata 10.

[b] Investment equation is specified as

$$INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC1_{-1} + \varepsilon \cdot$$

[c] Borrowing equation is specified as

$$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC1_{-1} + \mu \cdot$$

[d] Payout equation is specified as

$$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC1_{-1} + \nu \cdot$$

[e] * significant at 10%; ** significant at 5%; and ***significant at 1%.

[f] *z*-statistics are reported in parentheses.

[g] *UNC1* is used as the primary proxy for the uncertainty faced by a firm in the 3SLS estimation.

Table 15: Simultaneous estimation of corporate investment, financing, and payout equations for financially less constrained firms[a], using 3SLS method

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
INV/K		0.0844	-0.0955**
		(0.95)	(-2.08)
NDF/K	0.2653		0.4256***
	(1.33) [f]		(2.72)
DIV/K	-0.2377	0.4215	
	(-1.01)	(0.99)	
CF/K	0.1438*** [e]	-0.0296	0.1232***
	(4.84)	(-0.51)	(10.17)
Q	0.0273*		
	(1.95)		
$(INV/K)_{-1}$	0.3495***		
	(13.94)		
TAN		-0.2505*	
		(-1.66)	
SZ		0.0176**	
		(2.32)	
OWN			0.0068
			(0.17)
RE/TE			0.0373*
			(1.65)
$UNC1_{-1}$[g]	0.4256**	0.2573	-0.4240***
	(2.53)	(1.02)	(-4.55)
Constant	0.0325	-0.0184	0.1361**
	(0.45)	(-0.11)	(2.49)
No. of observations	1396	1396	1396
Time dummies	Included	Included	Included
Industry dummies	Included	Included	Included
Chi^2-statistic	1311.30	114.83	791.16
	(p = 0.000)	(p = 0.000)	(p = 0.000)

Notes:

a. The sample contains firm-year observation of the period 1999-2016. The simultaneous structural form equations are specified as equation (5) through (7), and estimated by 3SLS using Stata 10.

b. Investment equation is specified as
$INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC1_{-1} + \varepsilon$.

c. Borrowing equation is specified as
$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC1_{-1} + \mu$.

d. Payout equation is specified as
$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC1_{-1} + \nu$.

e. * significant at 10%; ** significant at 5%; and ***significant at 1%.

f. *z*-statistics are reported in parentheses.

g. *UNC1* is used as the primary proxy for the uncertainty faced by a firm in the 3SLS estimation.