CORPORATE INVESTMENT, FINANCING AND PAYOUT DECISIONS:

EVIDENCE FROM UK-LISTED COMPANIES

by

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A thesis submitted to the

University of Birmingham

for the degree of

DOCTOR OF PHILOSOPHY

Department of Accounting and Finance

Birmingham Business School

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September 2012

ABSTRACT

The research reported in this doctoral thesis aims to contribute to the corporate finance literature by focusing on the interdependence of corporate investment, financing and payout decisions of UK-listed companies, within the period 1999–2008. The thesis consists of six chapters. After the introductory chapter, Chapter 2 critically reviews the existing theoretical and empirical literature on corporate investment, financing and payout policies, from which several promising research ideas are identified. Chapter 3 investigates the interactions among the three corporate decisions. One of the key findings is that the three corporate decisions are likely to be jointly determined in the presence of financial constraints. The results also suggest that the effect of uncertainty on corporate investment is significantly positive, but the effect on dividend payout is significantly negative. Chapter 4 explores the influence of managerial confidence and economic sentiment on the set of jointly determined corporate decisions. An important finding is that the state of confidence at aggregate levels has significantly positive effects on both real investment and debt financing decisions. Chapter 5 discriminates conceptually and evaluates empirically twenty alternative measures of corporate investment used in the existing literature. It is found that conclusions drawn from empirical analyses are likely to be sensitive to the choice of corporate investment measures, indicating that the measurement of corporate investment behaviour matters. The key findings of the thesis are summarised in the conclusion chapter, alongside some promising ideas for further research.

To my dear parents

for all of your love and support

ACKNOWLEDGEMENTS

This thesis has been made possible through the support and assistance of many individuals and organisations. I therefore wish to acknowledge the following in producing this thesis.

My greatest intellectual indebtedness is to Professor Victor Murinde and Dr. Ping Wang, my supervisor and co-supervisor, for their excellent guidance, valuable advice and continuous support throughout my PhD programme. They have provided me with helpful suggestions, not only for my research work, but also for my career development. My sincere gratitude also goes to Professor Christopher J. Green and Dr. Paul Cox, my external and internal examiners, for offering critical and constructive comments on the final draft of this thesis.

I wish to express my sincere gratitude to Birmingham Business School and the Graduate School of the University of Birmingham for providing me with valuable academic support during the course of my study, and for sponsoring me to present my research papers at the 18th Global Finance Conference in Bangkok, Thailand; the 18th Multinational Finance Conference in Rome, Italy; the 8th Applied Financial Economics Conference in Samos, Greece; the 19th Global Finance Conference in Chicago, USA; and the 19th Multinational Finance Conference in Krakow, Poland.

I would like to extend my gratitude to the discussants and participants at the Global Finance Conference 2011 and 2012, Multinational Finance Conference 2011 and 2012, Applied Financial Economics Conference 2011, Midlands Regional Doctoral Colloquium

2010 and 2011, ESRC seminar 2009 as well as research seminars held at the African Development Bank and Birmingham Business School for their valuable comments and constructive suggestions on the previous versions of the papers presented in this thesis. Special thanks to the Global Finance Association for awarding the paper entitled “Corporate investment, financing and payout decisions under financial constraints and uncertainty: evidence from UK panel data” the Best Paper Award; the College of Social Science of the University of Birmingham for awarding the above paper the Best Doctoral Research Paper Award; and the Midlands Doctoral Colloquium for awarding the paper entitled “The measurement of corporate investment matters: evidence from UK panel data” the Best Paper Award. The papers mentioned above are based on earlier versions of Chapters 3 and 5 presented in this thesis respectively.

I am grateful to the academic staff and my fellow PhD students in the Corporate Finance Research Group at Birmingham Business School who have also commented on my work, especially Professor Robert Cressy and Dr. Hisham Farag. Furthermore, I wish to thank all my colleagues and friends who helped me, motivated me, and made my stay in the UK enjoyable and unforgettable.

Finally, and most importantly, I am deeply indebted to my dear parents, Xianhua Meng and Yuzhen Shi, for their unconditional support with love and patience over the years. This study would not have reached its conclusion without their encouragement and inspiration.

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CHAPTER 1

INTRODUCTION

1.1 Background and motivation

Corporate investment, financing and payout choices are known as the trilogy of corporate decisions (see Wang, 2010), and are believed to have significant influence on corporate performance. They have attracted great attention in the existing literature (see, for example, Denis and Osobov, 2008; Almeida and Campello, 2007; Frank and Goyal, 2003; Baker *et al.*, 2002; among many others). Companies use internal and external funds to finance their investment projects, in an attempt to maximise their company value and thus shareholders' wealth. Internal funds are chiefly represented by retained earnings and non-cash expenses; and external funds mainly refer to the proceeds from issuing new debt and new equity. Managers, therefore, have to make both real (i.e. non-financial) and financial decisions. The real decisions are concerned with the optimal level of capital investment; while financial decisions are concerned with how to finance the desired investment, which involves the appraisal of two financial choices. One is dividend payout choice, i.e. how much internally generated funds should be paid out to shareholders as dividends which otherwise could be re-invested in the business. The other is external financing choice, i.e. how much external funds does a company need to raise from outside capital markets for its investment.

Although much effort has been devoted to investigating the corporate behaviour of companies, the three corporate decisions are typically discussed separately and routinely examined in isolation rather than altogether. Indeed, the seminal works by Modigliani and Miller (1958) and Miller and Modigliani (1961) posit separately the investment separation principle, capital structure irrelevance theorem and dividend irrelevance theorem (hereafter the Modigliani-Miller theorems). The Modigliani-Miller theorems demonstrate that internal and external funds for a company are perfect substitutes in a perfect market environment, and hence the company's optimal level of investment should be determined solely by its real considerations and totally independent of its financial decisions. Both capital structure and dividend payout choices, thus, should have no impact on company value, and be irrelevant to shareholders' wealth, suggesting no interdependencies among the set of corporate decisions within a perfect market environment. As a result, each of the three corporate decisions has been widely and intensively scrutinised in the existing corporate finance literature, but we know little about the interactions that may exist among them.

Prior research, however, has provided reasons and evidence that financial constraints in the real world, such as insufficient availability of internal funds and limited access to new external funds, may hamper companies' ability to invest efficiently (see, for example, Fazzari *et al.*, 1988; and Guariglia, 2008). It is true that in practice the corporate decisions are related through the accounting identity, in that sources of funds must equal uses of funds. So when a company adjusts any one policy, the other policies may also be affected. Therefore, companies should consider their investment decisions alongside their fund-raising choices.

Although no consensus has been reached, an important implication is that corporate investment, financing and payout decisions are likely to be interdependent upon one another and jointly determined by management. The single equation frameworks used by prior research without explicitly accounting for the interdependence among corporate decisions may be misspecified, which potentially leads to incomplete and biased results. A simultaneous equations framework, therefore, is likely to provide greater insight into the inter-relationships that may exist among the set of corporate decisions, improving our knowledge of corporate decision-making processes in the real world. It is worth highlighting that, by referring to the simultaneous determination of corporate decisions throughout the thesis, we are by no means arguing that corporate decisions are necessarily made at the same time, but rather that they are likely to be executed on simultaneously so that the outcomes can be observed via a simultaneous approach.

Recent literature that seeks to explore the determinants of corporate investment behaviour has highlighted the importance of uncertainty associated with companies' future prospects, even though the investment-uncertainty relationship remains theoretically ambiguous and empirically inconclusive (see, for example, Carruth *et al.*, 2000; Lensink and Murinde, 2006; and Baum *et al.*, 2008). However, the potential effects of uncertainty on corporate financing and payout decisions have received little attention. Given the fact that all corporate decisions are made on the basis of incomplete information and a company's future cash flows are likely to be uncertain, it is reasonable to argue that the degree of uncertainty matters in both corporate financing and payout decisions as well. If this is true, uncertainty may influence investment, not only on its own, but also through its effects on financing and payout choices. Prior research on corporate investment under uncertainty that ignore the roles played by financing and payout choices should be critically reviewed, since they may generate misleading results and lead to inappropriate inferences. It is, therefore, more plausible to model corporate investment, financing and payout decisions simultaneously, and to investigate the effect of uncertainty on the set of corporate decisions systematically.

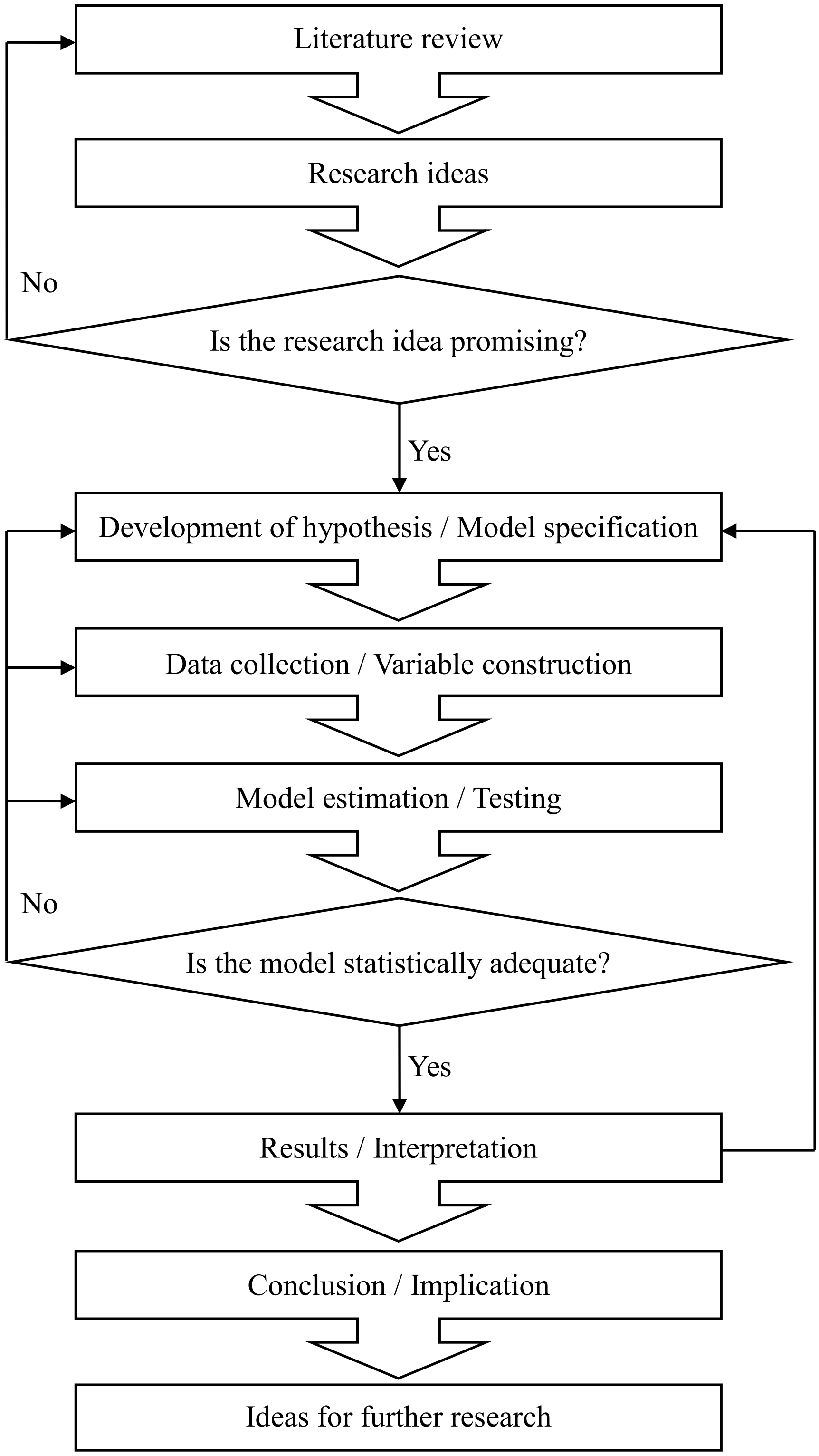
Moreover, recent developments suggest that behavioural finance plays an important role in explaining aspects of finance that traditional finance literature has failed to explain. Behavioural finance literature replaces the traditional assumption of broad rationality with a potentially more realistic assumption that agents' behaviours are less than fully rational. The assumption of less than full rationality finds strong support from a large body of psychological literature (see, for example, Gilovich *et al.*, 2002). The behavioural finance approach is now commonly used in asset pricing literature, in which investors are assumed to be less than fully rational. Corporate finance literature, however, rarely relaxes the assumption that managers are fully rational. Although the theoretical framework in this emerging area has not been firmly established and the empirical evidence is still relatively rare (see Baker *et al.*, 2006), it is plausible to hypothesise that the less than fully rational manager approach to behavioural corporate finance has the potential to explain a wide range of patterns in companies' investment, financing and payout choices. This thesis, therefore, also extends the existing corporate finance literature by incorporating the state of managerial confidence and economic sentiment into corporate behavioural models in an attempt to provide new insights into the influence of managers' psychological bias on aspects of corporate behaviour.

1.2 Data and methodology

The research methodology adopted by this study is described in Figure 1.1, using a simple flowchart. It starts with a comprehensive and critical review of the existing literature, which is not only helpful in understanding the relevant context of this study, but also useful for identifying the potential gaps in the previous studies from which a number of research ideas are proposed. The promising research ideas are used to develop testable hypotheses and to formulate empirical models.

The data used in this study are collected from different sources, which are mainly secondary and thus available electronically through financial and economic information providers. Specifically, accounting and financial data for the companies listed on the London Stock Exchange (LSE) within the period from 1999 to 2008 are retrieved from the Worldscope database via Thomson One Banker Analytics. Stock price data for the same batch of companies over the same period of time are collected from the DataStream database. The indicators for managerial confidence and economic sentiment are publicly available from the European Commission Economic Database. Worldscope is chosen as the principal data source since it is the most comprehensive web-based database covering accounting and financial information for companies from 130 exchanges, including the LSE listed companies.

Figure 1.1: Flowchart for the research methodology of this study



At the data collection stage, as many companies, years and items as possible are collected to form our dataset in order to prevent the need for extra data collection at later stages. The initial dataset has more than 30,000,000 data entries. There are, however, some variations among the sample sizes used in different empirical works presented in this thesis, depending on the objectives of the studies, the specifications of the models as well as the estimation techniques adopted. A detailed description of the sampling procedures employed to construct the final samples is given in each of the empirical chapters.

UK-listed companies are chosen as the sample for this thesis because it is argued that financial constraints on corporate investment are relatively more severe in the more market-oriented UK financial system than in the continental European financial system (see, for example, Bond *et al*., 2003; and Seitfert and Gonenc, 2008). Bond *et al.* (2003) indicate that, compared with the continental European financial market, the market-oriented financial system in the UK perform less well in channelling investment funds to companies with profitable investment opportunities because of the arm's-length relation between companies and suppliers of finance. The market-oriented financial system in the UK thus may give rise to financial constraints for the UK-listed companies. Moreover, Seifert and Gonenc (2008) point out that the ownership of the UK-listed companies is considerably dispersed as compared to companies in other markets. Because of the relatively widespread ownership of stock, investors in the UK face more severe problems of information asymmetry, which may also give rise to financial constraints. Therefore, the interactions among corporate investment, financing and payout decisions are likely to be more pronounced for the UK-listed companies which tend to be characterised by severe financial constraints. Besides, this study focus on the corporate decisions made by the UK-listed companies over the period 1999–2008 which allow us to sidestep the data breaks that characterise the period 2009–2012.

The dataset is organised as a panel which has both cross-company and time-series dimensions. The pooling of company-year observations provides a more informative dataset which enables us to tackle the complexity of corporate decision-making procedures by relaxing the assumptions that are implicitly made in pure cross-sectional or pure time-series analysis (see, for example, Baltagi, 2008; and Brooks, 2008). Therefore, the rich structure makes the panel dataset intuitively more preferable than pure cross-sectional and pure time-series data in the context of empirical corporate finance research.

The empirical models formulated in this thesis are estimated using a number of estimation techniques for panel data, including fixed effect, random effect, first-difference generalised method of moments (difference-GMM), system generalised method of moments (system-GMM), two-stage least squares (2SLS) and three-stage least squares (3SLS) estimations. The choice of estimation methods largely depends on the model specification, the sampling procedure and the results from statistical tests. Diagnostic tests and robustness checks are also carried out to statistically evaluate the estimation results. If a model is not statistically adequate, either the model will be reformulated or a different estimation technique will be used. The process of building a statistically adequate and robust model, therefore, is an iterative one, as illustrated in Figure 1.1. The empirical results obtained from estimating statistically adequate models are interpreted with reference to theoretical predictions.

Overall, the main research methodology adopted by this thesis is empirical. The thesis as a whole is structured following the steps described in Figure 1.1. Besides this, the empirical papers presented in Chapters 3, 4 and 5 are also structured in such a way as to ensure a good understanding of the existing literature, promising research ideas, solid theoretical frameworks, a sufficiently large dataset, appropriate econometric techniques, testing for robustness of empirical results, credible interpretations, and thus reliable findings and conclusions. A detailed methodology is provided in each of the empirical chapters.

1.3 Structure and scope of the thesis

The thesis consists of six chapters, including an introduction, a literature review chapter, three stand-alone empirical chapters and a conclusion. The remainder of the thesis is structured as follows.

Chapter 2 critically reviews the existing literature, both theoretical and empirical, on corporate investment, financing and payout policies. Corporate finance theories about the three key corporate decisions are briefly reviewed respectively, together with recent empirical evidence, in order to explore the current state of knowledge on aspects of corporate behaviour. More importantly, some prior studies attempt to examine how various frictions in the real world may drive linkages among corporate investment, financing and payout decisions. The mechanisms through which the set of corporate decisions may affect one another are explored in detail. Furthermore, since uncertainty has been identified as a key determinant of corporate investment, Chapter 2 comprehensively reviews literature on the effect of uncertainty on corporate investment decisions as well as its potential effects on corporate financing and payout decisions. In addition, following the recent argument that managers' psychological bias may explain a wide range of patterns in corporate behaviour that traditional corporate finance literature has failed to explain, Chapter 2 also reviews the small but growing strand of literature on behavioural corporate finance. Based on the literature reviewed in Chapter 2, several promising research ideas are proposed, aiming to fill the critical lacunae identified in the existing corporate finance literature.

Chapter 3 presents the first empirical work. It investigates the interactions among corporate investment, financing and payout decisions under financial constraints and uncertainty, using a large panel of UK-listed companies. We model these corporate decisions within a simultaneous equations system which explicitly allows for contemporaneous interdependence among them, as implied by the information asymmetry-based flow-of-funds framework for corporate behaviour. It is found that capital investment and dividend payout, as competing uses of funds, are negatively interrelated, but both are positively related to the net amount of new debt issued, which may imply joint determination of corporate decisions under financial constraints. We also offer the first attempt to examine simultaneously the effects of uncertainty on the three corporate decisions. The results show that the effect of uncertainty on corporate investment is significant and positive, while the effect on dividend payouts is significant and negative. Furthermore, the results suggest that financial constraints may intensify simultaneity among corporate decisions, and reduce managerial flexibility to respond to uncertainty.

Chapter 4 presents the second empirical work. It extends the work presented in Chapter 3 by taking into account the role of the state of confidence in the determination of corporate decisions. The relations between corporate decisions and the state of confidence are examined within the simultaneous equations system formulated in Chapter 3. It is found that the state of confidence at aggregate level, as proxied by UK or EU sector-specific managerial confidence indicators or overall economic sentiment indicators, has significantly positive effects on companies' real investment and debt financing decisions. The significant effects of the state of confidence on investment and financing decisions persist even after controlling for company idiosyncratic uncertainty and other company-specific fundamental characteristics. However, corporate payout decisions are mainly affected by company idiosyncratic uncertainty rather than confidence at sector level or sentiment at economy level. Besides, the results also show that, compared with the companies in the other sectors, UK-listed companies in the services sector behave more aggressively when the managerial confidence or economic sentiment is high. Specifically, they invest in capital stock more intensively, use debt financing more heavily, and cut dividends more decisively when their managers are confident. Chapter 4 contributes to the small but growing literature on behavioural corporate finance, providing evidence that managers' psychological bias plays an important role in the determination of corporate decisions.

Chapter 5 presents the third empirical work. The survey of corporate finance literature shows that use of corporate investment to capital stock ratio as a measure of corporate investment behaviour has been common practice in empirical analyses. Although the corporate investment measures used in the literature seem, at first sight, to be very similarly specified, they in fact vary in terms of the numerator and the denominator, i.e. how investment spending and capital stock are empirically measured. However, there is no literature that provides a comparison among the various versions of the corporate investment ratios, and thus we know little about how differently these corporate investment measures perform in empirical analyses. As a result, a claim has been implicitly made that the different measures of corporate investment can always yield equivalent results in corporate investment research. The purpose of Chapter 5, therefore, is to conceptually discriminate and statistically evaluate twenty alternative measures of corporate investment ratios which have been identified in the existing literature. Simple statistical and econometric procedures are utilised to test the sensitivity of the conclusions drawn from empirical analyses to choice of corporate investment measures. It is found that corporate investment measures with different specifications are not uniformly positively correlated with one another. Significantly negative correlations are also observed among the alternative measures, which appear surprising, since they are supposed to measure the investment behaviour of the same batch of companies over the same period of time. A simple regression of the Tobin's Q model clearly shows that the choice of corporate investment measures, to a considerable extent, influences the conclusions drawn from empirical analyses. Furthermore, the relative performances of the alternative corporate investment measures, in terms of volatility and information content, are empirically evaluated. Empirical results suggest that gross investment measures are less volatile around their respective trends and thus are more predictable compared with net investment measures, while cash based investment measures contain greater value relevant information than their accrual based counterparts. Accordingly, cash based gross investment measures, which contain relatively less noise and greater value relevant information, are recommended to researchers for future studies, if they have to make a mutually exclusive choice among the alternatives without any particular preference.

Chapter 6 concludes this thesis by recapping the research questions, summarising the key findings, highlighting the main contributions, discussing the broad implications and acknowledging the limitations. A number of promising ideas for future research are also proposed in Chapter 6.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Investment, financing and payout choices are the three important corporate decisions that have attracted much attention in the literature for more than half century (see, for example, Denis and Osobov, 2008; Almeida and Campello, 2007; Frank and Goyal, 2003; and Baker *et al.*, 2002). The seminal works by Modigliani and Miller (1958) and Miller and Modigliani (1961), i.e. the Modigliani-Miller theorems, show that, in a perfect market environment, internal and external funds are perfect substitutes for companies to finance their investment, and hence the optimal level of investment should be solely determined by the real considerations and totally independent of the financial decisions.[1]

Since the seminal works by Modigliani and Miller, researchers have tried to explain how real world complications alter perfect and efficient capital market conditions, and how market imperfections make corporate financing and payout choices relevant to investment decisions and company value. By relaxing Modigliani-Miller's assumptions and introducing

[1] The Modigliani-Miller theorems are generally considered as a cornerstone of modern corporate finance, so we shall not go into the details of the seminal works. Suffice it to say here that Modigliani-Miller's assumptions include the existence of risk class (i.e. each company belongs to a risk class), neutral taxes (i.e. all types of tax payer and all sources of income are taxed at the same rate), no capital market frictions (i.e. no transaction costs, no bankruptcy costs, no flotation costs and no asset trade restrictions), symmetrical access to credit markets (i.e. the same borrowing and lending rate for companies and investors); corporate financial policy contains no information (i.e. financial choices cannot be used to convey any signal about a company's value to investors), etc.

market imperfections, corporate finance research has intensively scrutinised each of the three corporate decisions. Although much effort has been devoted to investigating the corporate behaviour of companies, these three corporate decisions are typically discussed separately and routinely examined in isolation. For example, empirical investigations of corporate investment decisions commonly utilise a single equation framework in which a corporate investment measure is regressed on a set of exogenous explanatory variables, without explicitly accounting for the interdependence of various other policies, such as financing and payout choices. Similar approaches are also used to investigate corporate financing and payout decisions. In practice, however, corporate decision-making is a complex process, in which the decisions made by one department are likely to be affected by those made by others (Mueller, 1967). As argued by Fazzari *et al.* (1988), financial constraints, such as insufficient availability of internal finance and limited access to external finance, may hamper companies' ability to invest efficiently. Under such conditions, companies have to consider their fund-raising choices alongside investment decisions; that is, if any one policy is adjusted, other polices must also be adjusted accordingly (Gatchev *et al.*, 2010). However, our knowledge about the potential interactions among the corporate decisions is limited by the single equation framework currently used in the literature, which is unable to capture the simultaneous determination of corporate decisions and fails to provide a complete view of corporate behaviour. It should be borne in mind that the simultaneous determination corporate decision refers to the execution, or outcome, of the set of corporate decisions rather than the actual decision-making process.

Conventional literature on corporate finance has also been criticised for overlooking the effects of uncertainty on companies' real and financial behaviours. Recent studies that seek to explore the determinants of corporate investment have highlighted the importance of uncertainty associated with companies' prospects (see, for example, Baum *et al.*, 2008; Lensink and Murinde, 2006; and Carruth *et al.*, 2000). Several channels through which uncertainty may influence investment have been identified and examined. Nonetheless, the relationship between investment and uncertainty remains theoretically ambiguous and empirically inconclusive. Compared with corporate investment decisions, the importance of uncertainty in financing and payout decisions has received little attention, and consequently the influence of uncertainty on investment through its effects on financing and payout choices has also been largely ignored. The omission of relevant information in examining the effect of uncertainty on corporate investment is likely to generate misleading results and lead to inappropriate inferences, casting doubt on the conclusions drawn from the exiting literature on the investment-uncertainty relationship.

More recently, behaviour finance has begun to play an important role in explaining aspects of finance that traditional finance literature has failed to explain. Behavioural finance literature replaces the traditional assumption of broad rationality with a potentially more realistic behavioural assumption that agents' behaviours are less than fully rational, i.e. they may have behavioural biases (Baker *et al.*, 2006). Prior research in this area has mainly focused on the influence of investors' psychological bias, by adopting the less than fully rational investor approach to behavioural corporate finance. However, it is argued that managers' psychological bias may also have a substantial impact on corporate decisions (see, for example, Malmendier *et al*., 2011; Oliver and Mefteh, 2010; Hackbarth, 2008; and Heaton, 2002). In particular, managers' upward bias towards future company performance may generate overinvestment, underinvestment and pecking order financing behaviours through different mechanisms. Although the theoretical framework in this emerging area has not been firmly established and the empirical evidence is still relatively rare, the existing literature shows that the less than fully rational manager approach has the potential to explain a wide range of patterns in companies' investment, financing and payout choices which conventional corporate finance literature has failed to explain.

The remainder of this chapter proceeds as follows. Section 2.2 briefly reviews mainstream corporate finance theories on investment, financing and payout decisions respectively, alongside their empirical evidence. Section 2.3 explores the possible channels through which the three corporate decisions may be interdependent upon one another and thus jointly determined by management. Section 2.4 surveys both theoretical and empirical studies on the effects of uncertainty on investment decisions as well as on the financial decisions of companies. Section 2.5 focuses on the behavioural corporate finance literature and the relationships between managerial confidence and corporate decisions. Concluding remarks as well as promising research ideas are offered in Section 2.6.

2.2 Corporate decision theories

2.2.1 Corporate investment theories

Corporate investment decision is one of the fundamental decisions made by individual companies to risk their funds, in the hope of producing streams of revenue in the future. The best-known method of determining whether an investment should be undertaken is the standard net present value (NPV) rule. Its principle is fairly simple, that is, discount both expected future cash inflow and outflow of a project back to their present value at a specific discount rate, and then sum them up to obtain the NPV of the project. All projects with positive NPV would add value to shareholders' wealth and should be accepted, while all projects with negative NPV would damage company value and should be rejected.

The NPV rule, on the one hand, has been widely used throughout the business world. Graham and Harvey (2001) report that 74.9% of the Chief Financial Officers (CFOs) surveyed rely heavily on this technique for evaluating investment projects. One the other hand, it has long been acknowledged that the application of the NPV rule in capital investment practices is not without critique. As noted in Dixit and Pindyck (1994), discount rates set by companies to evaluate investment opportunities are typically three or four times the cost of capital. More recently, Ow-Yong and Murinde (2009) survey a sample of 159 UK non-financial companies listed on the London Stock Exchange. They find that a theory-practice gap still exists in terms of the non-usage of discounted cash flow techniques. Arnold and Hatzopoulos (2000) argue that the theory-practice gap in capital budgeting is partly due to the impractical assumptions underlying the NPV rule. As a result, the NPV rule provides little explanatory power for the observed corporate investment behaviour in practice. Given the importance of corporate investment decision in maximising shareholders' wealth, a number of more sophisticated investment theories, such as Tobin's *Q* theory, accelerator theory, financial constraints theory and real options theory, have been developed, aiming to fill the theory-practice gap.

2.2.1.1 Tobin's Q model

Tobin's *Q* is developed by Tobin (1969) as a ratio of the market value of reproducible real capital assets to the current replacement cost of those assets. Companies with Tobin's *Q* ratios greater than one should have an incentive to invest, since the market value of the asset being reproduced is greater than the current replacement cost of the asset. Conversely, companies with Tobin's *Q* ratios less than one should curtail investment. Accordingly, the standard Tobin's *Q* theory states that the marginal *Q*, which can be measured as the ratio of the capitalised value to the replacement cost of the marginal investment, summarises the effects of all the factors relevant to a company's investment decisions, and thus the company's corporate investment should be an increasing function of its marginal *Q* (see, for example, Blanchard and Fischer, 1989). In other words, Tobin's *Q* theory implies that all the information relevant to the expected future profitability affect corporate investment decisions through their effects on the marginal *Q*. High marginal *Q* values (if the marginal *Q* exceeds one) encourage companies to undertake new investments or expand current operations, while low marginal *Q* values (if the marginal *Q* falls below one) suggest companies reject investment opportunities and reduce existing investments. The optimal investment level is reached when the market value of the incremental unit of capital is equal to its replacement cost, i.e. when the marginal *Q* is equal to one.

Although some empirical studies find that Tobin's *Q* and investment rates are positively correlated (see, for example, Ascioglu *et al.*, 2008; Aggarwal and Zong, 2006; and Erickson and Whited, 2000), the empirical performance of Tobin's *Q* model of investment is far from satisfactory. This is largely attributable to a number of reasons. First, in the absence of a secondary market where the ownership of an investment can be traded, the capitalised value of investment is very difficult to observe, and thus the marginal *Q* is in fact unobservable. As a result, average *Q*, which is defined as the ratio of market value to the replacement value of capital stock, is typically used as a proxy for marginal *Q* in empirical studies (Erickson and Whited, 2000). As noted in Lensink and Murinde (2006), the measure of marginal *Q* is problematic, and different proxies for the marginal *Q* have been used in empirical literature. Thus, the disappointing empirical performance of Tobin's *Q* theory is primarily attributable to severe measurement errors. Second, it is argued that Tobin's *Q* does not carry all the information relevant to investment decisions, and some factors, such as capital market constraints, adjustment costs and uncertainty, may affect investment apart from Tobin's *Q*. For example, Ferderer (1993) finds that uncertainty has a larger impact on investment than does average *Q*, and that extending a standard Tobin's *Q* model of investment by including uncertainty measures improves the performance of the model significantly. In addition, Dixit and Pindyck (1994) point out that, in order to determine the value of Tobin's *Q*, the capitalised value of an investment has to be calculated as the expected present value of the stream of profit it would yield, and therefore the underlying principle of Tobin's *Q* theory is still the basic NPV model.

2.2.1.2 Accelerator model

The accelerator principle states that the stock of capital goods is supposed to be proportional to the level of production, and companies engage in capital investment in an attempt to close the gap between the desired stock of capital good and existing stock of capital goods left over from the past (see, for example, Lucas, 1967; and Chenery, 1952). According to this view, if the capital to output ratio is constant, a change in a company's output or sales requires a corresponding amount of investment to adjust its capital stock towards the desired level. The economic logic underlying the accelerator effect is that increased sales indicate that a company is likely to make more profits and greater use of existing capacity in the future, which would encourage companies to spend more funds on capital stock. The increased capital expenditure may lead to further growth of sales and profits, causing a multiplier effect. On the contrary, falling sales hurts a company's profit and use of capacity, which in turn discourages capital investment and worsens the company's prospects via the multiplier effect.

The relevance of the accelerator effect has been verified by a large number of empirical studies. For example, Lensink and Sterken (2000) find that corporate investment is highly sensitive to increase in sales for both small and large companies, which is consistent with the central prediction of the accelerator theory. Bo and Lensink (2005) investigate the investment-uncertainty relationship for a panel of Dutch non-financial companies based on a standard accelerator model. They find that, as expected, the estimated coefficient for the change in sales is highly significant with a positive sign. Furthermore, Lensink (2002) finds that, at an aggregate level, the accelerator type of effect, which is measured by the growth rate of real gross domestic product (GDP), also has important power in explaining the variation in the investment to GDP ratio for a group of 17 developed countries.

The dynamic relationship between capital stock and output has also been utilised to derive an error correction model (ECM), which is able to provide a flexible distinction between short-run and long-run influences of changes in a company's output on its investment behaviour (see, for example, Bloom *et al.*, 2007; and Bond *et al.*, 2003). The error correction behaviour is taken into account because the presence of adjustment costs makes it impossible for a company to adjust its capital stock to the desired level, which is considered as a function of output, immediately (see Guariglia, 2008). The error correction specification is widely used in empirical works on corporate investment. By examining the dynamic relationship between capital stock and real sales of a panel of manufacturing companies, Bond *et al.* (2003) find that capital stock and real sales series are indeed cointegrated, which shows empirical relevance of the long-run proportionality imposed in the error correction model. More importantly, they find that the error correction terms are correctly signed and statistically significant in all regressions being estimated, suggesting that a capital stock above its desired level is normally associated with lower future investment, and vice versa. Besides this, Guariglia (2008) and Bloom *et al.* (2007) also report qualitatively similar findings that, in the long run, UK companies adjust their capital stock towards the target level, which is proportional to real sales.

However, both the standard accelerator model and error correction model of investment have been criticised for overlooking the importance of financial variables and other factors related to investment decisions. Guariglia (2008) and Bond *et al.* (2003) investigate the role of financial variables play in corporate investment decisions using an error correction model of investment. They both provide robust findings that cash flow and profits terms appear to be highly significant in their investment models, indicating that the standard error correction model is potentially misspecified. Moreover, Bo and Lensink (2005), Lensink (2002) and Lensink and Sterken (2000) examine the effect of uncertainty on corporate investment behaviour based on an augmented accelerator model of investment. They all conclude that the standard accelerator model of investment is neither economically complete nor statistically adequate in the sense that it fails to capture the important roles played by other factors, such as financial constraints and uncertainty, in the determination of investment decisions.

2.2.1.3 Financial constraint model

Under the Modigliani-Miller theorems, a company's financial choices are irrelevant to its investment decisions and its value, since external funds provide a perfect substitute for internal funds within perfect capital markets. However, the irrelevance hypotheses fail to take account of the capital market imperfections, such as information asymmetry problems and the resulting financial constraints. To fill this gap, Myers and Majluf (1984) link corporate investment and capital market imperfections by offering an insight into the underinvestment problem in the presence of asymmetric information. They demonstrate that, when managers have superior information about a company's value, their efforts to raise external funds, especially new equity, to finance desired investment projects tend to be interpreted by outside investors as a signal that the company is overvalued. Consequently, outside investors will rationally lower their estimation of the company's value by raising their required rates of return. The increased cost of external financing in turn lowers projects' NPVs, which may force a company with insufficient internal funds to forgo some valuable investment opportunities, resulting in underinvestment. Similarly, Stiglitz and Weiss (1981) show that asymmetric information may also cause credit rationing in the loans market. Therefore, the costs of raising both new debt and new equity from external capital markets may differ substantially from the opportunity cost of internally generated funds, and corporate investment is likely to be financially constrained by the availability of internal finance and access to new external finance (Fazzari *et al.*, 1988).

Recognising the shortcomings of previous empirical models developed mainly under the assumption of perfect capital markets, an explosion of studies have focused on the role played by financial constraints in investment decisions (see, for example, Guariglia, 2008; Almeida and Campello, 2007; Kaplan and Zingales, 1997; and Fazzari *et al.*, 1988; among many others). Fazzari *et al.*'s (1988) pioneering paper investigates the effect of financial constraints on corporate investment using a wide range of empirical specifications, including the Tobin's *Q* and accelerator models. In each case, they find that the investment behaviour of low-dividend companies, which are more likely to be financially constrained, is more sensitive to fluctuations in cash flow, while the sensitivity of investment to cash flow is relatively low for high-dividend companies, which are less likely to face financial constraints. Their results, therefore, suggest that capital market imperfections lead to binding financial constraints on investment. However, Kaplan and Zingales (1997) find evidence that financially less constrained companies exhibit greater sensitivities than financially more constrained companies. They argue that higher sensitivities cannot be interpreted as evidence that companies are more financially constrained. Recently, Guariglia (2008) distinguishes the difference between internal and external financial constraints, and examines their effects on corporate investment, both separately and jointly. She finds that the sensitivity of investment to cash flow increases monotonically with the degree of external financial constraint, while the investment-cash flow relationship mimics a U-shaped curve if the sample is split on the basis of the degree of internal financial constraints faced by companies. Although the question of whether the sensitivity of investment to cash flow can be considered as an indicator of financial constraints has not been fully addressed, the broad consensus is that financial constraints affect investment decisions (Almeida and Campello, 2007).

Besides, Bond *et al.* (2003) empirically investigate the role of financial factors in investment decisions in Belgium, France, Germany and the UK. The cross-country comparison shows that cash flow and profits terms appear to be statistically more significant and economically more meaningful in the UK than in the three continental European countries. This finding is in line with the prediction that financial constraints on corporate investment are relatively more severe in market-oriented financial systems, such as the UK and the US, than in bank-based systems, such as Germany and Japan. Bond *et al.* (2003) indicate that the arm's-length relation between companies and supplier of finance in the market-oriented systems may exacerbate the problems of information asymmetry, and hamper efficiency in channelling investment funds to companies with valuable investment opportunities. Thus, the corporate investment of UK companies is likely to face more severe effects of financial constraints caused by a higher cost premium for the use of external finance. In addition, Seifert and Gonenc (2008) point out that the relatively widespread ownership of the UK-listed companies is also likely to cause more severe problems of information asymmetry and give rise to financial constraints.

2.2.1.4 Real options model

Conventional literature on corporate finance has also been criticised for overlooking the effects of uncertainty on corporate investment behaviour. To explain the failures and address the shortcomings of earlier models, recent studies that seek to explore the determinants of corporate investment have highlighted the importance of uncertainty associated with companies' prospects (see, for example, Baum *et al*., 2008; Lensink and Murinde, 2006; and Carruth *et al*., 2000). Among the several competing theoretical models (described in detail in Section 2.4.1), the real options approach to irreversible investments is generally accepted as the most promising direction to address the question regarding the investment-uncertainty relationship. It recognises on the option value to delay an investment decision in order to await the arrival of new information about market conditions, therefore provides a much richer dynamic framework for investigating corporate investment behaviour under uncertain circumstances (see Carruth *et al.*, 2000).

By exploiting an analogy with the theory of options in financial markets, Dixit and Pindyck (1994) derive a real options theory of investment. They demonstrate that, with irreversibility or partial irreversibility, an investment opportunity could be considered as a call option which can be exercised at any time before the option expires. The financial options literature indicates that the higher volatility of an underlying financial asset increases the option value, leading to a higher critical value for option exercise. Similarly, greater uncertainty associated with the outlook of an irreversible investment is likely to increase the value of the real option to invest, creating a larger wedge between the overall investment cost of a project and the standard present value of future cash flows. In order to make an optimal investment decision, the real option value should be accounted for as part of the full costs of the project. Given that an increase in uncertainty raises the trigger value of investment and hence discourages immediate investment, the real options theory, therefore, predicts a negative effect of uncertainty on corporate investment.

The prediction of the real options theory of investment is supported by a large body of empirical literature on the investment-uncertainty relationship. Guiso and Parigi (1999) investigate the effect of demand uncertainty on corporate investment decisions of a sample of Italian manufacturing companies. Their results show that uncertainty weakens the response of investment to demand, and slows down capital accumulation. Using a sample of US companies, Bond and Cummins (2004) find a significantly negative effect of uncertainty on capital accumulation, not only in the short run but also in the longer term. Furthermore, Bulan (2005) decomposes the total uncertainty faced by a company into its market, industry and company-specific components. She finds that empirical evidence from US companies lends strong support to the real options theory. Both company-specific and industry uncertainty components appear to increase the value of the option to delay, and depress investment. Although a number of studies also find a positive relationship between uncertainty and investment (see, for examples, Abdul-Haque and Wang, 2008; and Lensink and Sterken, 2000), the negative effect of uncertainty on investment still overwhelmingly dominates the empirical evidence.

Although the real options theory of investment seems to be a very promising direction for research on the investment-uncertainty relationship, it is criticised for overlooking the strategic interactions between peers under a competitive business environment. Mason and

Weeds (2010) highlight the effect of pre-emption and show that, when there is a strong and persistent advantage to be the first to invest, companies may forfeit the option value of delay to pre-empt their rivals in spite of the uncertain outcomes. Once strategic considerations are taken into account, the threat of being pre-empted will offset the value of the real option, and greater uncertainty can lead companies to take advantage of pre-emption by investing earlier. Mason and Weeds (2010), therefore, predict that an increase in uncertainty may increase corporate investment even if the projects are irreversible. The net effect of uncertainty on corporate investment behaviour must be determined empirically.

2.2.2 Corporate financing theories

The explanation of corporate financing behaviour is intensely debated in corporate finance. Modigliani and Miller (1958) provide the foundations for modern corporate financing theories. They prove that, in an efficient market with no taxes, transaction costs, bankruptcy costs and information asymmetry, the value of a company is not related to how the company is financed. In other words, internal funds and external funds are perfect substitutes for a company to finance its investment, and thus financing decisions are irrelevant to the company's value. Modigliani-Miller's irrelevance proposition has been generally accepted as correct. The focus of research on corporate financing decisions has shifted to questions about how real world complications alter the perfect capital market conditions, and whether market imperfections make a company's value depend on its corporate financing choices. The main competing theories of corporate financing decision-making include trade-off, pecking order, market timing and agency theories.

2.2.2.1 Trade-off model

By relaxing Modigliani-Miller's assumptions regarding the absence of tax and bankruptcy costs, the trade-off theory states that a company would seek an optimal debt-to-equity ratio to maximise its value by weighing the benefits and costs of taking on additional debts (see, for example, Myers, 1984). More precisely, a company's optimal debt ratio should be determined by a trade-off between benefits of interest tax shields and costs of financial distress or bankruptcy associated with additional debts. On the one hand, in the presence of corporate tax, interest on debt is typically a tax-deductible expense for tax-paying companies, which can be deducted from taxable income. Taking on debt can thus create a tax shield, giving rise to company value. However, on the other hand, taking on debt also increases the costs of financial distress and bankruptcy. At moderate debt levels, the probability of financial distress and bankruptcy is trivial, and hence the tax benefit of debt dominates. But, as debt level increases, the marginal benefit of further increases in debt declines, while the marginal cost associated with debt increases. Therefore, the theoretical optimal debt to equity ratio is achieved when the marginal benefit of future borrowing is exactly offset by its marginal cost.

The trade-off theory successfully explains industry differences in capital structure choice, and justifies moderate debt ratios observed in reality. Survey evidence offered by Graham and Harvey (2001) shows that 81% of the companies in their sample make their financing decisions by considering a target debt ratio or range. Frank and Goyal (2009) examine the relative importance of a long list of factors which, according to the different theories, are the determinants of capital structure decisions. Their empirical evidence obtained from publicly traded US companies over the period 1950–2003 seems reasonably consistent with the predictions of trade-off theory. Flannery and Rangan (2006) explicitly examine whether companies have long-run target debt ratios and, if so, how quickly they adjust towards the targets. By using a partial-adjustment model, Flannery and Rangan (2006) find that companies indeed have a target capital structure. Companies which are under-leveraged or over-leveraged adjust their debt ratios to offset about one third of the observed gap between the actual and target debt ratios each year. This targeting behaviour to some extent explains the observed corporate financing behaviour and lends empirical support to the prediction of trade-off theory.

However, as highlighted by Fama and French (2005), trade-off theory also has serious problems. There are many observed patterns in corporate financing decisions that cannot be explained by trade-off theory. In particular, the well-documented negative relation between leverage and profitability in reality is a contradictory to the central prediction of the trade-off theory (see, for example, Fama and French, 2002). In addition, the trade-off theory fails to explain the fact that companies with the same level of operating risk may have different capital structures.

2.2.2.2 Pecking order model

The pecking order theory of capital structure is developed by Myers and Majluf (1984) and

Myers (1984) by relaxing the assumption of no information asymmetry made by Modigliani and Miller (1958). It tries to explain corporate financing behaviour from a completely different prospective. The pecking order theory states that asymmetric information and signalling problems associated with external finance create a hierarchy of corporate financing choices, i.e. using up internal funds and safe debt first, then using up risky debt, and finally resorting to external equity. The driving force behind the pecking order theory of corporate financing decision, as argued by Myers and Majluf (1984), is that managers know more about the prospects, risks and value of their company than do outside investors. In the presence of information asymmetry, managers' efforts to issue risky securities tend to be interpreted by outside investors as a signal that the company is overvalued. Consequently, outside investors rationally discount the company's security price, leading to negative market reactions. In order to avoid adverse selection, managers prefer to finance all of the uses of funds with internally generated funds, which have a cost advantage and no information asymmetry problem. If internal funds are exhausted and external finance is required, managers raise external funds with debt, which is less likely to be affected by revelations of managers' superior information. Equity financing is only considered as a last resort and is rarely used. The strict pecking order theory, therefore, implies that debt issuance is chiefly driven by financing deficits.

By introducing the costs of financial distress into the adverse selection framework, Myers (1984) modifies the strict pecking order theory, and argues that companies may issue equity before it is absolutely necessary in order to build up financial slack which enables them to undertake investment opportunities in the future. Unlike trade-off theory, pecking order theory predicts that there is no optimal debt ratio. As noted by Shyam-Sunder and Myers (1999), a significant merit of pecking order theory is that it successfully explains the negative effect of profitability on financial leverage, which trade-off theory fails to explain.

Shyam-Sunder and Myers (1999) empirically test the predictions of the pecking order theory using a sample of US companies observed from 1971 to 1989. They refine the prediction of pecking order theory into a testable hypothesis that financing deficit should normally be matched dollar-by-dollar by a change in corporate debt. Their empirical evidence shows that the pecking order model provides stronger explanatory power for the observed time-series variation in debt ratios than does the trade-off model, especially for the mature companies in their sample. Shyam-Sunder and Myers (1999) conclude that pecking order theory is an excellent descriptor of corporate financing behaviour. Using a similar methodology, Frank and Goyal (2003) find that, although large companies exhibit some aspects of pecking order behaviour in the 1970s, the overall empirical evidence is not robust, lending little support to the prediction of the pecking order hypothesis. More surprisingly, Frank and Goyal (2003) find that net equity issues track the financing deficit even better than do net debt issues, which is contradictory to the predictions of pecking order theory. Frank and Goyal (2003) conclude that, over time, financing deficit becomes less important in explaining net debt issues, while equity becomes more important.

More recently, Leary and Roberts (2010) quantify the empirical relevance of the pecking order hypothesis using a large panel of companies over the period 1980 to 2005. Their simulation experiment results show that the pecking order can only accurately classify less than half of the observed debt and equity issuance decisions. However, by incorporating some factors suggested by trade-off theory, the classification ability of the model increases significantly. The expanded model is able to accurately classify more than 80% of the observed corporate financing decisions. This finding empirically supports the conjecture of Fama and French (2005) that both the take-off and pecking order theories have elements of truth, and therefore should be treated as complementary explanations of corporate financing decisions.

2.2.2.3 Market timing model

By relaxing the assumption of an efficient capital market made by Modigliani and Miller (1958), the market timing theory asserts that capital structure evolves as the cumulative outcome of managers' attempts to time the equity market (Baker and Wurgler, 2002). Baker and Wurgler (2002) offer two explanations for equity market timing behaviour. The first explanation is based on a dynamic version of Myers and Majluf's (1984) adverse selection problem. It is documented that the degree of information asymmetry and the resulting adverse selection costs vary across companies and over time, and are inversely related to the market-to-book ratio. Under this interpretation, market timing opportunities arise because of the changes in the degree of information asymmetry between rational managers and investors.

The second explanation is based on managers' perception of time-varying mispricing. Managers issue equity when they believe their shares are irrationally overvalued, and repurchase equity when they believe their shares are irrationally undervalued. Under this interpretation, market timing opportunities arise as long as managers believe that their company is irrationally mispriced. Both of the two explanations lead to the same conclusion that capital structure is the outcome of the accumulation of managers' attempts to time the equity market.

Survey evidence reported by Graham and Harvey (2001) shows that market timing appears to be an important consideration in making corporate financing decisions in practice. Two thirds of CFOs admit that they consider the amount by which their securities are mispriced as an important factor in making their decisions to issue new debt and equity. Baker and Wurgler (2002) also provide empirical investigation into the relationship between current capital structure and the historical path of the market-to-book ratio. Consistent with the prediction of the market timing theory, managers' perception of market timing opportunities, which is measured by the market-to-book ratio, have persistent effect that helps to explain the cross section of capital structure.

Alti (2006) examines the capital structure implication of market timing by focusing on initial public offerings (IPOs). It is found that market timing indeed plays an important role in making corporate financing decisions. Hot-market IPO companies issue substantially more equity, and thus lower their leverage ratios by more, than do their cold-market counterparts.

However, Alti (2006) further finds that market timing appears to have only a short-term impact on capital structure. The short-term deviations from the leverage target quickly reverse after going public, which is more consistent with the prediction of trade-off theory of capital structure. Alti (2006) cast doubt on the market timing theory by arguing that the commonly used measures of market timing, such as market-to-book ratio, are likely to be correlated with other determinants of financing decisions, and generate a spurious link between market timing and capital structure dynamics.

2.2.2.4 Agency cost model

By relaxing the assumption of no conflicts between principals and agents, agency theory suggests that debt serving obligations help to prevent overinvestment of free cash flow by self-serving managers, creating value in companies with agency problems (see, for example, Harvey *et al.*, 2004; and Jensen, 1986). Principal-agent problems mainly exist between outside shareholders and management, owning to the separation of ownership and control. In this agency setting, managers have an incentive to cause their companies to grow beyond the optimal size, so as to increase their compensation as well as the resources under their control. Jensen (1986) develops a "control hypothesis" for debt creation which predicts that debt reduces the agency costs of free cash flow by reducing the cash flow available for spending at the discretion of managers.[2] The control effect of debt, thus, is a potential determinant of

[2] Jensen (1986) defines free cash flow as the cash flow left over after a company has exhausted its positive NPV projects.

corporate financing decisions.

Harvey *et al.* (2004) test whether debt capital is able to reduce the impact of agency problems using a sample of emerging market companies which have potentially extreme managerial agency problems. They find evidence that debt mitigates the reduction in company value caused by the separation between management and ownership, and creates shareholder values for companies that face potentially high managerial agency costs. The incremental benefit of debt is particular meaningful for companies which are likely to have overinvestment problems; that is, have either high level of assets in place or limited growth opportunities in the future.

The agency perspective of debt is often embedded in the trade-off framework, in which the monitoring effect is considered alongside other benefits and costs of taking on additional debt (Frank and Goyal, 2009). In addition, Stulz (1990) points out that the use of debt, which requires management to pay out funds, reduces the overinvestment cost, but also exacerbates the underinvestment cost when cash flow is truly low. Meanwhile, an equity issue, which increases resources under management's control, can reduce the underinvestment cost, although it may worsen the overinvestment cost. Since the uses of debt and equity decrease one cost of agency problem and increase the other, there should be an optimal mix of debt and equity that minimises the overall costs of over- and underinvestment.

2.2.3 Dividend payout theories

Dividend policy is another important topic that remains unsolved in corporate finance, both theoretically and empirically. Theories on dividend policy differ in their assumptions and approaches, providing many reasons for paying and not paying dividends to shareholders. The debate which is often referred to as the dividend puzzle can be traced back to the dividend irrelevance theorem proposed by Miller and Modigliani (1961). Before the dividend irrelevance theorem, it is widely believed that increased dividends make shareholders better off because they reduce the uncertainty associated with future cash flows. The basic argument is that, in the presence of uncertainty and imperfect information, investors prefer the bird in the hand or current cash dividends, rather than the two in the bush or future capital gains (see, for example, Gordon, 1959). The bird in the hand theory argues that high dividend payout ratios reduce uncertainty associated with future cash flows and thus increase company value. However, Miller and Modigliani (1961) criticise the bird in the hand view by arguing that the risk of a company is determined by its real investment decisions, regardless of how the company distributes its earnings. Empirical evidence is also not in favour of the bird in the hand argument. Baker *et al.* (2002) survey managers of a sample of NASDAQ companies that consistently pay cash dividends to assess their views about dividend policy. As expected, most of the financial managers disagree with the bird in the hand explanation for paying dividends.

Based on their assumptions of perfect capital markets, Miller and Modigliani (1961) demonstrate that dividends and capital gains are perfect substitutes. Investors should be indifferent to dividend policies because they can always create homemade dividends by adjusting their portfolios in accordance with their preferences. Therefore, dividend policies should be irrelevant and unimportant in a perfect market environment. Again, by relaxing the assumptions of perfect capital markets, later studies focus on whether and how the real world complications and the resulting market imperfections make corporate payout decisions relevant to company value. A range of theoretical explanations as to the cause of the relevancy of corporate payout decisions have been developed and examined in the literature, including tax clienteles, signalling, catering, free cash flow and life cycle theories. However, empirical evidence suggests that no dividend model, either separately or jointly with other models, is supported invariably (see Frankfurter and Wood, 2002).

2.2.3.1 Tax clienteles model

Tax clientele theory explains corporate payout behaviour by focusing on the market imperfection caused by the differentials in tax treatment between dividend income and capital gains. First, dividends are typically taxed at a higher rate than capital gains. Second, dividends are taxed immediately, whereas capital gains are not taxed until they are actually realised from the sale of stocks. Given the tax advantages of capital gains over dividends, tax-paying investors are expected to prefer low dividend payout ratios which are associated with lower future tax liabilities. As a result, tax-paying investors are likely to pay a premium for low-payout companies, lowering low-payout companies' cost of equity. The tax effect hypothesis, therefore, suggests lower dividend payout ratios which lower the cost of capital and increase stock price (see, for example, Fankfurter and Wood, 2002).

Miller and Modigliani (1961) also admit that the imposition of a tax liability on dividends plays a role in making corporate payout decisions. But they argue that investors are likely to be attracted by different mixes of dividend income and capital gains, depending on their particular situations. For example, tax-exempt institutional investors and individual investors with low marginal tax rates may prefer dividend income, and tend to be attracted by high-payout companies, while investors with high marginal tax rates generally dislike dividend income, thus are likely to be attracted by low-payout companies. Meanwhile, companies also tend to attract certain types of investor by using their dividend choices. If the distribution of the company's payout ratios perfectly matches the distribution of the investors' preferences, no company can increase its value by changing its dividend strategy. Therefore, Miller and Modigliani (1961) claim that, owing to such a dividend clientele effect, a company's value should not be affected by its payout choice, and dividend policy remains irrelevant even in the presence of taxes.

The clientele effect has been supported by a number of empirical studies. Using actual portfolios and demographic data, Pettit (1977) finds significant empirical evidence for the existence of a dividend clientele effect, that is, portfolios' dividend yields are positively correlated with their investors' ages and negatively correlated with their investors' incomes. Similarly, a survey conducted by Lewellen *et al.* (1978) shows that stockholders in high marginal tax brackets buy securities with low-dividend yields and vice versa. Recently, Graham and Kumar (2006) provide direct evidence of dividend clienteles by studying the stock holdings and trading behaviour of more than 60,000 households. Their results show that, consistent with previous findings and the dividend clientele hypothesis, older and low-income individual investors prefer dividend-paying stocks and tend to buy stocks on the cum-dividends day or earlier in order to obtain the dividends. Lee *et al.* (2006) extend the examination of the existence of the dividend clientele effect to the Taiwan Stock Exchange, where capital gains tax is zero. They find that wealthy individuals who are subject to high rates of taxation on dividends tend to hold stocks with lower dividends by selling stocks that raise dividends and buying stocks that lower dividends, while institutions and less wealthy individuals who are in lower tax brackets behave in the opposite manner. All of these patterns are completely consistent with the tax-induced clientele effect.

2.2.3.2 Signalling model

The signalling model of dividends is characterised by information asymmetry between insiders and outsiders. It states that managers signal their private knowledge about the company's current and future prospects to the capital markets through their payout choices in an attempt to close the information gap (see, for example, Miller and Rock, 1985). According to the signalling hypothesis, managers have an incentive to use payout policy as a vehicle to communicate their private information to the outside investors about the real value of their company. Meanwhile, outside investors perceive dividend payouts as a reflection of managers' anticipations of the company's prospects. Under such conditions, outside investors tend to interpret increases in dividend payout as good news that the company has good future profitability, and thus react to the announcements positively. On the contrary, dividend cuts are likely to be considered as bad news that the company has poor future prospects, causing unfavourable market reactions. Therefore, mangers are reluctant to cut dividends in order to avoid the anticipated negative market reactions. They are also reluctant to increase dividends unless they are confident that they will be able to produce sufficient future cash flow to support their payouts at higher levels in the foreseeable future.

In the presence of information asymmetry, dividends are regarded as a credible signalling device because they are costly to companies in various ways. Miller and Rock (1985) argue that signalling costs may distort a company's investment behaviour. Therefore, only good quality companies can afford to signal their information through dividend payment, which cannot be mimicked by poor quality companies. The signalling hypothesis of dividends is also consistent with the early survey study by Lintner (1956), which shows that managers usually have a reasonably definitive target payout ratio in the long run, and slowly adjust the actual payout ratio towards the target over years.

The dividend signalling hypothesis has been extensively addressed by empirical studies by focusing on two main issues: the market reactions to dividend change announcements; and the predictive power of dividend changes for the future earnings. Bali (2003) documents significant drifts in stock returns following announcements of changes in cash dividends, which are consistent with the dividend signalling hypothesis. He reports that, on average, the positive abnormal return following dividend increases is 1.17 percent, which is smaller in magnitude than the negative abnormal return of –5.87 percent following dividend cuts. This shows that share prices follow the same direction as the dividend change announcements. Nissim and Ziv (2001) investigate the relation between dividend changes and future profitability, in an attempt to assess the information content of dividends. They find that dividend changes provide incremental information about the level of profitability in subsequent years beyond that provided by market and accounting data. However, Benartzi *et al.* (1997) find only limited support for the hypothesis that changes in dividends have information content about future earnings of the company. Their empirical results show that companies that increase dividends in year *t* have experienced significant earnings increases in years *t* and *t*–1, but show no subsequent unexpected earnings growth. Similarly, companies that cut dividends in year *t* have experienced a significant earnings drop in years *t* and *t*–1, and their earnings are likely to be improved significantly in the subsequent years. Although the predictive power of changes in dividends seems weak, it seems that there is a strong past and current link between earnings and dividend changes. Benartzi *et al.* (1997) conclude that Lintner's (1956) model of dividends remains the best description of corporate payout behaviour. Koch and Sun (2004) also find that changes in dividends cause investors to revise their expectations about the persistence of past earnings changes. Therefore, the market interprets changes in dividends as a signal about the persistence of past earnings changes.

2.2.3.3 Free cash flow model

Unlike the signalling model, in which managers have the incentive to signal their private information to the market by paying dividends, the free cash flow model of dividends is developed on the basis that managers may have an incentive not to pay dividends, and thus need to be forced to pay out free cash flow (see, for example, Easterbrook, 1984; and Jensen, 1986). By relaxing Modigliani-Miller's assumption of no conflicts of interest between managers and shareholders, the free cash flow hypothesis of dividend policy argues that managers as imperfect agents of shareholders may use free cash flow funds in a way that benefits themselves, at the expense of shareholders' interests. Under such an agency setting, paying more dividends may serve to align the interests of managers and shareholders, and mitigate the agency problems by reducing the discretionary funds available to managers and the resultant overinvestment problem (Jensen, 1986). The free cash flow model, therefore, also implies that corporate investment and payout decisions are likely to be interrelated, such that an increase in dividend payments may reduce investment in negative NPV or poor projects, especially when a company has a substantial surplus of cash.

In addition, Easterbrook (1984) offers another agency cost explanation of dividends. He hypothesises that dividend payments oblige managers to raise external funds, which in turn forces the companies to undergo management scrutiny by third parties including market regulators, financial intermediaries and potential investors. Capital market monitoring is expected to reduce the chances for managers to act in their own self-interest, as well as the agency costs associated with the separation of ownership and control. Therefore, dividend payments allow shareholders to monitor managers at lower cost, and simultaneously minimise collective action problems. However, Easterbrook (1984) also note that increasing dividend payments may force managers to take undesired actions such as taking on too much debt, leading to a potential conflict between shareholders and debtholders.

Rozeff (1982) addresses the free cash flow hypothesis of dividends empirically by focusing on two proxies for agency costs, namely, the percentage of common stock held by insiders and the number of shareholders. Using a large sample of US companies, he finds that companies tend to establish higher dividend payouts when insiders hold a lower fraction of common stock and when the ownership is more widespread, which is entirely consistent with the implications of the free cash flow hypothesis. It is also found that the benefits of dividends in reducing agency cost are more pronounced for companies with lower insider ownership and higher dispersion of ownership. Khan (2006) investigates the relationship between dividend payout and ownership structure for a panel of publicly traded UK companies. Consistent with previous findings, dividend payout is found to be negatively related with ownership concentration, indicating that dividend payments substitute for poor monitoring by a company's shareholders. In addition, La Porta *et al.* (2000) provide international evidence that dividends play a useful role in the agency context. Specifically, they find that, on average, companies operating in countries where minority shareholders have better legal protection pay higher dividends. In these countries, companies with good investment opportunities pay lower dividends than their counterparts with poor investment opportunities, indicating that well-protected shareholders are willing to wait for dividends when investment opportunities are attractive, and are able to force managers to disgorge cash when investment opportunities are unwanted. However, shareholders in countries where legal protection is poor tend to take whatever dividends they can get, regardless of investment opportunities.

2.2.3.4 Catering model

Baker and Wurgler (2004) propose a catering theory of dividends in an attempt to explain the payout puzzle from a new perspective. By relaxing Modigliani-Miller's assumption of market efficiency, Baker and Wurgler (2004) argue that the decisions to pay dividends are driven by prevailing investor demand for dividend payers. Essentially, they hypothesise that managers tend to rationally cater to investors' demand by initiating dividends when the investors put a premium on dividend payers, and by omitting dividends when the investors prefer nonpayers. Baker and Wurgler (2004) assert that the catering model of dividends is the most natural explanation of the discrete decision of whether to pay dividends. Li and Lie (2006) extend Baker and Wurgler's (2004) discrete decision model by including increases and decreases in existing dividends. The extended catering model predicts that both the probability and the magnitude of dividend changes are related to the dividend premium.

To test the dividend catering hypothesis, Baker and Wurgler (2004) relate dividend payment choices to several stock market-based proxies for dividend premiums. It is found that all four proxies for dividend premiums are significantly and positively related to the aggregate rate of dividend initiation, and two of them are significantly and negatively related to the rate of dividend omission. These results strongly suggest that dividends are highly related to share price and company value but in different directions at different times, and that managers cater to investors' demands by shifting their payout choices. Li and Lie (2006) also verify the empirical relevance of the extended dividend catering model. They find that the probability and the magnitude of dividend decreases are greater when the dividend premium is low, and the probability and magnitude of dividend increases are greater when the dividend premium is high. However, Denis and Osobov (2008) cast doubt on the catering hypothesis as a first-order explanation for dividend payment patterns around the world. They find little evidence of a systematic positive relation between dividend premium and the propensity to pay dividends outside the US market.

2.2.3.5 Life cycle model

More recently, DeAngelo and DeAngelo (2006) provide an alternative explanation for corporate payout behaviour by proposing a life cycle theory. The life cycle theory of dividends states that the dividend payout choices rely on the trade-off between retention and distribution which evolves over the life cycle stages of a company as profits accumulate and investment opportunities decline (see also DeAngelo *et al*., 2006; and Denis and Osobov, 2008). This theory predicts that companies optimally shift their payout choices over their life cycle stages in response to the evolution of the trade-off between retention and distribution. That is, companies in their early years face relatively abundant investment opportunities but have limited funds, so they pay fewer dividends and retain more profits to avoid the flotation and information costs of raising external funds. Companies in their later years tend to have sufficient funds but fewer attractive investment opportunities, so they have a stronger incentive to pay dividends to reduce agency costs associated with free cash flow. Therefore, as a company matures, the benefits of paying dividends overweight their costs, leading to a higher propensity to pay dividends.

DeAngelo *et al.* (2006) test the life cycle model by assessing the relation between a company's probability of paying dividends and its life cycle stage, which is proxied by the company's mix of earned and contributed capital. The idea is that companies with relatively low retained earnings as a proportion of total capital are likely to be in their capital infusion stage, whereas companies that cumulate relatively more retained earnings in their capital tend to be more mature. DeAngelo *et al.* (2006) find that a company's probability of paying dividends uniformly and significantly increases with the relative amount of earned equity in its capital. Their results provide direct evidence in favour of the life cycle model of dividends. The life cycle theory of dividends is further confirmed by Brockman and Unlu (2011) in an international setting. In addition, Denis and Osobov (2008) examine cross-sectional and time-series evidence on the propensity to pay dividends in a number of developed financial markets. Their international evidence on the determinants of dividend policy casts doubt on the signalling, clientele and catering explanations for dividends, but largely supports the agency cost-based life cycle theory.

2.3 Simultaneity of corporate decisions

As noted above, the Modigliani-Miller theorems provide the fundamental framework for modern corporate finance theories. The central lesson commonly drawn from the

Modigliani-Miller theorems is that, in a perfect market environment, a company's investment decision is solely determined by its real considerations, and is completely unaffected by how the projects are financed. As a consequence, corporate financing and payout choices have been automatically considered as by-products of investment decisions, and each of the three aspects of corporate behaviour has been studied intensively but separately. The interactions among the three corporate decisions, to a large extent, have been overlooked in the literature. Nonetheless, some studies have attempted to investigate how various market frictions in the real world may drive linkages among the three corporate decisions. Several mechanisms through which the set of corporate decisions may be interdependent upon one another have been identified. Arguably, the simultaneity of corporate decisions can be derived from five main sources, namely, institutional underpinnings of modern companies, flow-of-funds approach, tax approach, agency approach and information approach. It is worth noting that these hypothesised mechanisms are not mutually exclusive, but they may have very different implications for the interactions among the set of corporate decisions.

2.3.1 Institutional approach

The institutional underpinnings of modern companies suggest that a corporation is a complex organisation with a considerable degree of decentralisation (see, for example, Dhrymes and Kurz, 1967). Corporate decisions made by one department may have impacts on those made by the others, and vice versa. Given this institutional fact, corporate decisions depend not only on factors which are exogenous to the company, such as the economic environment, but also on factors which are endogenous to the company, such as decisions made by other departments. Thus, if any one of the decisions is adjusted, other decisions must also be adjusted accordingly. In such a context, the role of the top executives of a company, e.g. the board of directors or the president, are not making decisions in the first instance, but receiving proposals, examining priorities and making sure that the departmental decisions are executed consistently with one another by weighing the effects of one choice versus those of the others. Mueller (1967) emphasises that, in making corporate decisions, one must be aware of the inherent interactions among many of the company's decisions, not only in order to avoid undesirable side effects which may stem from a given decision, but also to be certain that these interactions do not actually result in the negation of a decision's primary goal. Therefore, given the institutional underpinnings of modern companies, it is reasonable to expect that the corporate decisions are likely to be executed on simultaneously so that the outcome can be observed via a simultaneous approach. It should be kept in mind that the simultaneity among the key corporate decisions does not require them to be actually made at the same time.

Mueller (1967) also points out that, due to 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 overwhelmingly employs single equation techniques, which permit no analysis of interactions among corporate decisions and fail to capture the complexity of corporate-making processes. To gain deeper and more comprehensive insight into the complex interdependence of corporate behaviour, in particular the inherent simultaneity among the key corporate decisions, more sophisticated and more statistically correct techniques which explicitly allow for the simultaneity should be more plausible.

2.3.2 Flow-of-funds framework for corporate behaviour[3]

The flow-of-funds approach is based on the argument that corporate investment, financing and payout decisions are interconnected within a flow-of-funds framework for corporate behaviour. This literature goes back to Dhrymes and Kurz (1967). It takes the view that a company faces an outflow of funds represented mainly by its variable and fixed costs, taxes and dividend payments, as well as investment outlays. Meanwhile, the company relies on an inflow of funds, represented chiefly by its sales and the proceeds of various forms of external finance such as debt or stock issuance. Accordingly, Dhrymes and Kurz (1967) define that the major problems of a company are raising funds from profits, new debt and equity, and spending it on investment and dividends, where the overriding constraint is the flow-of-funds identity, i.e. sources of funds must equal uses of funds. If the capital markets are sufficiently imperfect, companies are likely to have a marked reliance on internal funds and a strong aversion to resort to external capital markets. Under such circumstances, companies have to consider their fund-raising choices alongside their fund-spending decisions, and trade-off

[3] The flow-of-funds approach in this thesis refers to the framework set up by Dhrymes and Kurz (1967) to investigate the interactions between corporate investment and financial decisions. It is worth noting that there is another strand of flow-of-funds literature which studies issues concerning the financial sector and its relationships with the real economy (see, for example, Green and Murinde, 1998). Since it is beyond the scope of this thesis, we do not discuss it here.

between outlays for capital investment and dividend payouts. Therefore, in a world where the capital markets are sufficiently imperfect, corporate investment, financing and payout decisions are likely to be determined jointly, and must be investigated in the context of a simultaneous equations system (see also McCabe, 1979). If the flow-of-funds conjectures about the interactions are empirically relevant, the jointly determined corporate decisions, which are endogenous to a company, should be significantly interdependent upon one another (see Dhrymes and Kurz, 1967).

To empirically verify the predictions of the flow-of-funds approach, Dhrymes and Kurz (1967) set up a three-equation simultaneous system in which investment spending, new debt financing and dividend payouts are treated as endogenous variables, and each equation contains the other two endogenous variables as explanatory variables. They find that when the single equation methodology is adopted, the endogenous variables are generally significant in the equations where they serve as explanatory variables, but do not have the sign implied by the flow-of-funds approach. However, when the three corporate behavioural equations are put into a system and estimated simultaneously, the signs on the endogenous variables become consistent with the predictions of the flow-of-funds approach, and significant in most instances. Dhrymes and Kurz (1967), therefore, conclude that ignoring the interdependence of corporate decisions is likely to result in an incomplete and potentially misleading view of the complex corporate decision-making processes. Following up the flow-of-funds framework, McCabe (1979) modifies Dhrymes and Kurz's (1967) three-equation model by carefully specifying the exogenous variables and the lag structures. Using evidence obtained from US companies, he finds that corporate investment decision does not appear to be determined independently of financial choices. As implied by the flow-of-funds framework, investment outlays and dividend payouts are found to be significantly and negatively interrelated, while both are positively interrelated with the main sources of funds, i.e. current new debt and profits. In a similar vein, Peterson and Benesh (1983) re-examine the empirical relationships among the same set of corporate decisions. The results obtained using alternative estimation techniques provide additional evidence on the joint determination of corporate decisions. They conclude that the imperfections in capital markets are sufficient to invalidate the Modigliani-Miller's theorems, leading to a joint determination of corporate investment, financing and payout decisions as implied by the flow-of-funds approach. In contrast to the findings on US data, McDonald *et al.* (1975) find that empirical evidence from a sample of French companies in favour of Modigliani-Miller's independence proposition, that is, the dividend and investment decisions of individual companies are completely independent of each other. They reject Dhrymes and Kurz's (1967) flow-of-funds conjectures based on French data, and argue that the interactions among corporate decisions are likely to depend on the size of the capital markets.

Although the simple idea of the flow-of-funds approach seems to be intuitively appealing, Dhrymes and Kurz's (1967) three-equation model is criticised for its lack of coherent theoretical background, and it hence falls short of resolving the issue regarding the directions of the interactions (see, for example, Ravid, 1988). Later studies armed with further theoretical arguments, such as information asymmetry and agency problems, address the issue in more depth.

2.3.3 Information approach

The theoretical contributions in information economics provide another promising direction to justify the interdependencies among corporate investment, financing and payout decisions. The intuitive idea is that 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 evoking 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. In the presence of information asymmetry, managers have an incentive to use dividends as a signal to reveal some of their private information about the company’s current and future earnings to the outside investors (Miller and Rock, 1985). 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 expenditures cannot be soaked up freely by retained earnings, corporate investment is likely to be internally financially constrained. As a result, companies may be forced either to forego relatively low net present value investment projects or to raise more funds from outsiders to maintain their dividend payouts at the desired levels. Gugler (2003) finds empirical evidence of the competition for funds between dividends and investment in capital stock, and concludes that dividend payout choice should be regarded as a decision that significantly affects other corporate decisions, rather than as a mere residual, in the light of capital market failures.

The imperfect information not only impedes the ability of companies to raise funds from internal finance, but also limits their access to external finance. In the real world, the alternative sources of funds are no longer perfect substitutes, owing to the costs created by managers' superior information (Myers and Majluf, 1984). In the presence of information asymmetry, managers' efforts to issue risky securities tend to be rationally interpreted as a signal that the company is overvalued. Information asymmetry, therefore, justifies the pecking order behaviour of corporate financing. Specifically, managers prefer to finance all the uses of funds with internally generated cash flow if possible, which is not subject to the information problem and hence has a cost advantage. When the internal cash flow is exhausted and external finance is required, managers raise external funds with debt financing, which is less affected by revelations of managers' superior information. External equity financing is only considered as a last resort and is rarely used. If companies are not able to obtain as much internally generated cash flow and safe debt as they desire at a given cost in this context, their investment spending is likely to be externally financially constrained, resulting in high investment-cash flow sensitivities. A large body of literature finds support for this theoretical prediction (see, for example, Almeida and Campello, 2007).

Taken together, information asymmetry constrains companies' ability to raise internal finance via its effect on dividends, and limits their access to external finance via its effect on issuance 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 company by applying the vector autoregressive modelling technique to US industrial companies. Their causality test results strongly support the prediction of information approach that the causality flow between a company'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 dividends and borrowing decisions. They conclude that capital market imperfections caused by information asymmetry lead to the causality relations among a company's investment, financing and dividend decisions. More recently, Wang (2010) adopts more advanced techniques, including path analysis and directed acyclic graphs analysis, to explore the causal structure of the same set of corporate decisions. The empirical results obtained from high-tech companies listed in Taiwan and China further confirm that the investment, financing and dividend decisions made by companies can be effectively explained by the causal relationship among them in the presence of information asymmetry.

2.3.4 Tax approach

Modigliani-Miller's assumptions of a perfect market environment are criticised for failing to incorporate tax in their theory. Modigliani and Miller (1963) revise their original proposition by taking tax into consideration. The revised proposition states that, because interest payments are treated differently from dividends and capital gains for tax purposes, managers could be able to increase company value by using debt financing. More specifically, since interest expenses are tax deductible, debt financing creates a tax shield which leads to an increase in existing shareholders' wealth.

Tax deductibility, however, is not unique to debt financing. Depreciation allowances resulting from investments made by a company also provide an annual non-debt tax shield which is equal to the product of the 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 company. From this point of view, taxes might offer a link between corporate investment and financing decisions. DeAngelo and Masulis (1980) demonstrate that both investment and debt financing decisions give rise to tax shields. If a company's income does not always exceed all tax shields, some tax shields may not be deductible, and thus plentiful non-debt tax shields may reduce the need for debt financing. 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, thus higher level of investment should be financed by less debt, and vice versa.

A recent study by Graham and Tucker (2006) lends strong empirical support to the prediction of DeAngelo and Masulis's (1980) model by showing that companies are significantly less likely to issue debt when their non-debt 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 company 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 consideration. They argue that tax losses resulting from the company's choice of investment projects may affect the company's effective tax rate in future periods, which in turn affect the tax shield value of investment and debt. Therefore current investment decisions are also likely to interact with future investment and debt financing decisions.

Tax considerations also have implications for dividend decisions. Since dividend income is taxed more heavily than capital gains, paying higher dividends may create a 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%.[4] In order to reduce tax burden, low dividend payouts should be welcomed by any taxpaying investor, especially investors in high tax brackets. Moreover, taxes on dividends have to be paid immediately, while capital gains are not taxed until they are realised from the sale of shares. Under a tax code that favours capital gains, it is rational for companies to try to minimise dividend payouts, and hence taxes, by holding and reinvesting their profits. Nevertheless, it is well documented in dividend policy literature that taxes have been only a secondary consideration, which itself alone can neither justify the existence of dividends nor explain corporate payout behaviour (see, for example, Frankfurter and Wood, 2002). Besides, the tax approach does not have any implication on the interactions between dividends and investment decisions, and between dividends and financing decisions.

In a nutshell, the tax approach may imply that a company's tax planners should minimise dividend payout to avoid a large burden of personal taxation, and make investment and debt financing decisions simultaneously to take full advantages of both depreciation-related and interest-related tax shields. However, it must be emphasised that corporate decisions are, of course, not solely determined by tax considerations, and therefore the tax approach can only provide a framework to analyse the relationships among the

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

decisions in such a particular way. Besides, Adedeji (1998) points out that, since the imputation tax system in the UK does not encourage companies to use debt as much as the classical tax system does in the US, it may weaken the interaction between investment and financing decisions, and strengthen the interaction between investment and payout decisions in the UK.[5]

2.3.5 Agency approach

Alternatively, the set of corporate decisions may make sense in connection with one another through an agency approach. In the context of modern corporations, managers, who perform as the agents of shareholders, have the duty to maximise shareholders' wealth. However, they may be tempted to maximise 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 distort corporate behaviour. Jensen (1986) claims that managers have an incentive to make their companies to grow beyond the optimal size so as to increase the resources under their control. The managers' incentive to build a larger empire rather than pay out its free cash flow may distort corporate investment behaviour, leading to a problem of overinvestment. The overinvestment problem is likely to be more severe in companies with substantial free cash flow. Thus, the internal control system and the market for corporate

[5] Adedeji (1998) argues that the imputation tax system in the UK encourages companies to pay dividends rather than reinvest their profits. From 1973 to 1999, the UK operated an imputation system, with shareholders able to claim a tax credit reflecting advance corporate tax (ACT) paid by a company when distribution was made. A company could set off ACT against the company's annual corporate tax liability, subject to limitations. In 1999 ACT was abolished. Shareholders receiving a dividend are still entitled to a tax credit which offsets their tax liability, but the tax credit no longer necessarily represents tax paid by the company, and cannot be refunded to the shareholder.

control are particularly important for those companies to ensure that managers are pursuing the shareholders' interests (see Jensen, 1986). To control the agency problem of overinvestment, it is desirable to set up agency-cost control mechanisms that give managers an incentive to act as better agents. Literature on agency theory suggests that both debt financing and dividend payouts can be used as agency-cost control devices to motivate managers to disgorge free cash flow to shareholders rather than invest it in negative NPV projects (see, for example, Jensen, 1986).

Easterbrook (1984) offers an agency-cost explanation of dividends. That is, paying dividends compel companies to distribute more free cash flow in the hands of managers, and force companies to raise new funds in capital market more frequently. Companies that payout dividends and raise external funds simultaneously subject themselves to the scrutiny of third parties to attract the needed capital. From this point of view, dividend payout provides an incentive for managers to reduce the costs associated with the agency problems. Furthermore, Easterbrook (1984) indicates that, in the presence of alternative agency-cost control devices, such as when a non-dividend monitoring mechanism is in place, the use of costly dividend payout mechanisms to induce capital market monitoring is less likely. In this spirit, Jensen (1986) proposes a control hypothesis of debt by highlighting the benefits of taking on debt in monitoring managers and their companies. He argues that the use of debt can diminish the agency problem of overinvestment by committing a company to fixed interest payments in a way that cannot be accomplished by simple dividend increases. Therefore, debt can be used as an effective substitute for dividends in reducing the agency costs of free cash flows. The control hypothesis of debt is further confirmed by Stulz (1990), who proves that debt can indeed reduce the probability of overinvestment.

The agency approach is successful in explaining why some companies raise new funds, often in the form of bank loans, simultaneously with paying 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, one would expect to see substitution between them (see Easterbrook, 1984). The substitution among debt, dividends and other agency-cost control devices is empirically verified by Jensen *et al.* (1992). More recently, 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 obtaining evidence from a panel of UK companies.

One implication of the literature surveyed above is that the interactions among corporate investment, financing and payout decisions might be driven by agency-cost considerations, especially in large public companies where the ownership is considerably dispersed and the free cash flow is typically substantial. Companies with high levels of capital expenditures are more likely to face severe agency problems of overinvestment, thus should be more closely monitored by using either more debt financing or higher dividend payout as monitoring mechanisms. In such an agency setting, investors demand high levels of debt financing or dividend payouts not because these are valuable in themselves, but because they promote more careful and value-oriented investment decisions. In other words, investors are willing to bear certain relevant costs, such as tax burden and issuance costs, in order to realise the benefits of reduction in the costs associated with the agency problem of overinvestment. 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 companies base their financial decisions on agency-cost considerations (Noronha *et al.*, 1996). In particular, the effect of agency-cost considerations on corporate behaviours may not be as important for rapidly growing companies with large and profitable investment projects but insufficient free cash flow.

2.4 Corporate decisions under uncertainty

Conventional literature on corporate finance has long been criticised for overlooking the importance of uncertainty in determining aspects of corporate behaviour (see Knight, 1921). Along with the theoretical development relating to corporate investment behaviour and advances in econometric techniques, recent studies that seek to explore the determinants of corporate investment have highlighted the role of uncertainty associated with companies' prospects plays in determining corporate investment behaviour. However, the importance of uncertainty in financing and dividend decision-making processes has received little attention. Therefore, we know little about how uncertainty affects corporate financial choices, and whether uncertainty influences corporate investment decisions through its effects on financial choices.

2.4.1 Corporate investment decision and uncertainty

Conventional corporate finance literature has long been criticised for overlooking the effects of uncertainty on companies' real and financial behaviours. One stream of research in the literature that seeks to explore the determinants of corporate investment has recognised the importance of uncertainty associated with companies' prospects (see, for example, Baum *et al*., 2008; Bloom *et al*., 2007; Lensink and Murinde, 2006; and Carruth *et al*., 2000). The relationship between investment and uncertainty has been addressed in various ways in the literature, including the Hartman-Abel approach, financial constraints approach, real options approach, pre-emption approach, etc. However, the investment-uncertainty relationship remains theoretically ambiguous and empirically inconsistent.

2.4.1.1 Hartman-Abel approach

The Hartman-Abel framework of investment lays strong emphasis on the convexity of the marginal product of capital (see Hartman, 1972; and Abel, 1983). Under the assumption of competitive product markets and symmetric adjustment costs for capital, it suggests that uncertainty has a positive effect on corporate investment via Jensen's inequality. Specifically, Hartman's (1972) discrete-time model shows that, if the future input and output prices of a project are mean-preserving stochastic processes, greater uncertainty about the distributions of these variables increases the expected present value of future profits associated with the project. Since the higher marginal product of capital makes the projects more attractive, the quantity of current investment undertaken by a company is an increasing function of uncertainty.

Abel (1983) generalises Hartman's (1972) discrete-time model to a continuous–time model, and he proves that Hartman's results continue to hold. His analysis confirms that a company's marginal product of capital is a convex function of future price for its output, which implies that higher than expected output prices raise profits by more than lower than expected output prices reduce them. A wider range of the mean-preserving future output price, therefore, raises the expected level of future profits via Jensen's inequality. Accordingly, the convexity of profit function to the mean-preserving stochastic variables rationalises a positive effect of uncertainty on investment.

The intuitive idea in the Hartman-Abel framework is that uncertainty associated to an investment project contains both downside and upside risks, inducing not only dangers but also opportunities. If a company can take appropriate strategies to deal with various possible situations after a commitment has taken place, they can reasonably put more weight on the favourable outcomes, leading the company to undertake additional investment. However, it is also argued that the convex function relies heavily on the assumptions of perfect competition and constant return-to-scale production technology. If these assumptions are violated, the convexity of the relationship between profits and output prices may be weakened, or even reversed (see, for example, Caballero, 1991). In addition, the prediction of the Hartman-Abel framework is not favoured by empirical evidence. Using a panel of US companies, Leahy and Whited (1996) find no evidence that corporate investment increases with uncertainty through the convexity of the marginal product of capital.

2.4.1.2 Financial Constraints approach

Another strand of literature claims that the financial constraints caused by asymmetric information may induce a negative effect of uncertainty on investment. By taking bankruptcy cost into consideration, Greenwald and Stiglitz (1990) point out that the optimal level of a company's investment depends not only on the expected return to investment, but also on the level of uncertainty about future profitability. Higher levels of uncertainty about future profitability increase both the absolute and the incremental risk of bankruptcy. If a company cannot absorb the increased risk of bankruptcy by issuing new equity, the company may be forced to lower its investment spending. Therefore, profit uncertainty may force companies to rely on their internal finance, and impose a negative effect on corporate investment especially for financially distressed companies.

Based on Greenwald and Stiglitz's (1990) argument, Ghosal and Loungani (2000) use company size as a proxy for capital market access and examine the differential impact of profit uncertainty on investment in small and large businesses. Using US industry-level data, Ghosal and Loungani (2000) show that greater uncertainty significantly depresses investment in the full sample of industries, and the negative impact of uncertainty on investment is substantially larger in those industries which are dominated by small companies. They conclude that greater uncertainty may exacerbate the problem of information asymmetry between companies and the capital markets, and impose an adverse impact on investment by increasing the premium charged on external funds. Minton and Schrand (1999) also find evidence that cash flow volatility is positively associated with costs of external financing, which may force companies to forgo valuable investment opportunities and lower capital expenditures. Bo *et al.* (2003) empirically explore the relationships among uncertainty, capital market imperfections and corporate investment using a panel of Dutch company. They find evidence that companies that are confronted with higher levels of uncertainty suffer from more severe capital market constraints. Greater uncertainty, therefore, has an indirect negative effect on investment via its effect on financial constraints.

2.4.1.3 Real options approach

As briefly introduced in Section 2.2.1, the real options approach to investment emphasises the importance of the option value to delay an investment decision in order to await the arrival of new information about market conditions (see Carruth *et al.*, 2000). The value of waiting to invest is initially introduced by McDonald and Siegel (1986). They argue that, in reality, most investments can be delayed but cannot easily be reversed. Companies with investment opportunities have the right to choose to invest now or in the future. But once a company decides to commit an investment, the decision is irreversible, even if the market climate changes adversely. However, both the ability to delay investment and the irreversibility of capital investment are overlooked by the simple NPV model as well as the other investment models based on the NPV principle. These overlooked characteristics may have profound effects on corporate investment behaviour. According to the theoretical work by McDonald and Siegel (1986), if the outlook of an irreversible investment project is unclear, companies can choose to delay undertaking the project, waiting for the arrival of new information until the uncertainty decreases or until the expected payoff from the project increases enough to offset the uncertainty. To incorporate these dynamic considerations, an optimal real decision, therefore, should be made by comparing the value of immediate investment and the present values of delayed investment at all possible times in the future, and choosing the investment time point that yields the highest expected payoff (McDonald and Siegel, 1986).

By exploiting an analogy with theory of options in financial markets, Dixit and Pindyck (1994) extend the investment timing model, and derive a real options theory of investment. They show that, with irreversibility or partial irreversibility, an investment opportunity could be considered as a call option which can be exercised at any time before the option expires. Financial options literature, e.g. the Black-Scholes framework, indicates that higher volatility of underlying financial assets increases the option value, leading to a higher critical value for option exercise. Consistent with this intuition, greater uncertainty associated with the outlook of an irreversible investment is likely to increase the value of the real option to invest, creating a larger wedge between the standard present value of future cash flows and the overall investment cost of a project. Thus, in order to make an optimal investment decision, the real option value should account for part of the full costs of the project. Given that an increase in uncertainty raises the threshold for a project to be undertaken, the real options theory, therefore, clearly predicts a negative relationship between investment and uncertainty.

This theoretical development stimulates a growing empirical literature which examines uncertainty and threshold effects on corporate investment behaviour. For example, using a panel of US manufacturing industries, Ghosal and Loungani (1996) show that the impact of uncertainty on investment is significantly negative for highly competitive industries, whist that for less competitive industries is small and insignificant. Their finding is broadly consistent with the prediction of the real option model. Guiso and Parigi (1999) find that uncertainty weakens the response of investment to demand and slows down the capital accumulation of a sample of Italian manufacturing companies. Bond and Cummins (2004) report a significantly negative effect of uncertainty on the capital accumulation of a sample of US companies, both in the short run and in the longer term. Bulan (2005) shows that uncertainty, both company-specific and industry-wide, appears to increase the value of real options and depress investment in the US. Leahy and Whited (1996) also find evidence for a negative effect of uncertainty on the investment of a panel of US manufacturing companies. However, their results indicate that uncertainty influences corporate investment primarily through its effect on Tobin's *Q*.

Based on the standard real options model of investment, Abel *et al*. (1996) develop a more general model by allowing companies to disinvest, so that the irreversibility of investment is not complete, but limited. In this model, the ability to delay and abandon an investment yields two options. More specifically, when a company obtains an investment opportunity, the valuable real call option gives the company the right to invest within certain period of time. Likewise, once the company commits the investment, it automatically acquires a valuable real put option which enables it to resell the installed capital in the future. Since both the values of the call option and the put option depend on the volatility of future returns, greater uncertainty not only increases the value of the call option which encourages companies to wait to keep the call option alive, but also increases the value of the put option which encourages companies to invest to acquire the put option. Given that the effects of the two options act in opposite directions, Abel *et al*. (1996) conclude that the net effect of uncertainty on the incentive to invest remains ambiguous.

2.4.1.4 Pre-emption approach

Recent theoretical innovations, however, tend to cast doubt on the assertion of the standard real options theory of investment (see, for example, Grenadier, 2002; and Mason and Weeds, 2010). It is argued that the real options approach only analyses corporate investment decisions in a single-agent context, but overlooks the strategic interactions between peers under a competitive business environment (Mason and Weeds, 2010). In the real world, investment usually takes place in a very competitive business environment, so the strategic considerations should be taken into account when investigating the investment-uncertainty relationship in a multi-player context. Caballero (1991) demonstrates that if a company is operating in a perfectly competitive product market with constant return-to-scale production technology, the value of the option to delay irreversible investment is insufficient to deter the company's investment. Caballero (1991) therefore concludes that company-specific uncertainty may still have a positive effect on investment, as argued by Hartman (1972) and Abel (1983), even in the presence of asymmetric adjustment costs.

In addition, Grenadier (2002) points out that, in the real world, real option exercise strategies cannot be determined in isolation, but must be formulated as part of a strategic equilibrium, because the impact of competition on exercise strategies is dramatic. By including competitive interactions, Grenadier (2002) shows that a company is likely to choose its optimal investment strategy based on its belief about the analogous strategies of its competitors in the market. Competitive access to the investment opportunities, therefore, drastically erodes the value of the option to wait.

More recently, Mason and Weeds (2010) highlight that two types of strategic interaction between investing agents need to be considered, namely, pre-emption and externality. First, when there is a strong and persistent advantage to be the first to invest, companies may forfeit the option value of delay to pre-empt their rivals in spite of the uncertain outcomes.[6] Once the strategic considerations are taken into account, the threat of

[6] Mason and Weeds (2010) list several relevant situations. For example, patent races are characterised by lasting first-mover advantage. The first to invent (or first to file) gains an exclusive right over the technology, which other companies 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. Entry into industries with substantial economies of scale also tends to confer long-lasting benefits. Incumbents are difficult to displace and typically earn high returns. In these situations, one might expect to observe pre-emptive investment, and relatively little sensitivity to uncertainty.

being pre-empted will offset the value of real option. Second, the value of an investment may also depend on the number of companies which have also invested. Externality may affect the value of an investment negatively through a competitive effect, or positively through a complementary effect.[7] In both cases, the value and timing of a company's investment are likely to be influenced by the investment decisions of its peers. Mason and Weeds (2010) argue that, under a very competitive condition, greater uncertainty can lead companies to take the advantage of pre-emption by investing earlier. Therefore, by extending the real option analysis to include strategic interactions among peers, Mason and Weeds (2010) conclude that an increase in uncertainty may increase corporate investment, even if the projects are irreversible.

2.4.1.5 Nonlinear hypothesis

Although almost all the literature assumes that the relationship between investment and uncertainty is linear, a number of theoretical studies suggest that the relationship might not be monotonic, adding to the complexity of the problem.

Abel and Eberly (1999) distinguish between the short and long-run effects of uncertainty, and examine their effects on capital accumulation separately. In the short run, greater uncertainty raises the trigger value of irreversible investment, causing a "user-cost effect". In the long run, if a company encounters unfavourable conditions but fails to disinvest

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

the irreversible investments undertaken, the capital stock is likely to be higher than the optimal level, leading to a "hangover effect". Because these two effects have opposing implications for the expected long-run capital stock, Abel and Eberly (1999) conduct a numerical analysis to determine the overall effect of uncertainty on capital stock. The numerical results show that at low levels of uncertainty the hangover effect is relatively stronger, whereas the user-cost effect outweighs at high levels of uncertainty. Therefore the relationship between uncertainty and expected capital stock is represented by a proximately inverted-U shaped curve.

Instead of focusing on the level of expected long-run capital stock, Sarkar (2000) hypothesises a similar non-linear relationship between investment and uncertainty by emphasising the effect of increased volatility on the probability that an investment will take place within a specific time period. Again, two opposing effects of uncertainty on investment are identified. Apart from the negative effect of uncertainty on investment, which is in line with the standard real options theory, Sarkar (2000) also finds that increased volatility may raise the probability that a particular investment trigger will be hit, and in turn the likelihood of investment to be undertaken. The so called "hitting effect" may offset the effect of irreversibility and speed up investment. Again, the numerical results show that the net effect of uncertainty on the probability of investing mimics an inverted U-shaped curve. More precisely, the overall effect of uncertainty on investment is positive up to a certain threshold level of uncertainty, and turns out to be negative thereafter.

The empirical relevance of the inverted U-shaped relationship between investment and uncertainty has also been verified. Lensink and Murinde (2006) empirically verify an inverted U hypothesis of investment under uncertainty, using a panel of UK non-financial companies. The UK evidence suggests that the effect of uncertainty on investment is positive at low levels of uncertainty, but becomes negative at high levels of uncertainty. The inverted U effect of uncertainty on investment is similarly established for a panel of Dutch non-financial companies by Bo and Lensink (2005). Additionally, Lensink (2002) also provides evidence on the empirical relevance of the non-linear effect of uncertainty on investment at aggregate level for a set of developed economies.

2.4.2 Corporate financing decision and uncertainty

Although in the literature there is a plenty of evidence suggesting the effect of uncertainty on investment, the importance of uncertainty in companies' financial decision-making processes has received little attention. Given the fact that all corporate decisions are made on the basis of uncertain information, the degree of uncertainty should be carefully considered in each of the decision-making processes for corporate policies. Several recent studies have indicated the potential role that uncertainty plays in companies' financial decision-making processes.

Minton and Schrand (1999) hypothesise positive associations between cash flow uncertainty and costs of accessing external debt and equity finance. They argue that, all other things being equal, cash flow volatility increases the probability that a company's cash flow realisation in any given payment period will not be sufficient to cover its debt service requirements. Since the increased probability of default must be compensated by a higher risk premium, Minton and Schrand (1999) predict a negative effect of uncertainty on external debt financing. Turning to access to equity capital, Minton and Schrand (1999) claim that analysts are less likely to follow companies with volatile cash flow, and thus companies with higher levels of uncertainty are subject to greater information asymmetry. Greater information asymmetry in turn implies a higher cost of accessing equity capital. Taken together, Minton and Schrand's (1999) predictions imply a negative impact of uncertainty on companies' access to external finance through its effects on the costs of debt and equity capital. Minton and Schrand (1999) further show that their predictions with respect to the association between cash flow uncertainty and the cost of accessing debt and equity capital find strong empirical support from a panel of US companies.

Bo *et al.* (2003) argue that greater uncertainty leads to more risky projects. If debt holders are risk averse, greater uncertainty is likely to cause an increase of the risk premium, resulting in financial constraints. In addition, Bo *et al.* (2003) argue that uncertainty and financial constraints are interlinked, even if the debt holders are risk neutral. Due to the limited liability, shareholders of a company have an incentive to finance or partly finance projects with higher levels of risk using debt. Rational debt holders who anticipate such behaviour would charge a premium that reflects the expected costs they have to bear in the event of default (Bo *et al.*, 2003). Therefore, uncertainty increases the wedge between the costs of internal funds and external funds, leading to capital market constraints. Using a panel of Dutch companies, Bo *et al.* (2003) find empirical evidence that uncertainty and financial constraints are interlinked such that companies that are confronted with greater uncertainty suffer more from financial constraints.

Ghosal and Loungani (2000) also indicate that greater uncertainty exacerbates the information asymmetry between borrowers and lenders, and thus increases the premium charged on external funds, creating financing constraints for certain types of borrowing companies in the capital market. Therefore, they hypothesise that uncertainty may limit companies' access to capital markets and force companies to rely on their internally generated funds. A recent study by Baum *et al.* (2009) offers empirical evidence in support of this hypothesis maintaining that greater overall uncertainty associated with a company's prospects has a negative effect on its ability to borrow. In addition, Frank and Goyal (2009) examine the relative importance of many factors in capital structure decisions, and they provide empirical evidence that uncertainty can to some extent explain companies' leverage. They argue that companies with greater uncertainty face higher expected costs of financial distress, and thus should use less debt.

2.4.3 Corporate payout decision and uncertainty

Turning to the corporate payout choice, Minton and Schrand (1999) predict a negative association between dividend payout ratio and cash flow volatility. They argue that because negative market reactions to dividend cuts are normally larger in magnitude than positive reactions to dividend increases, companies with higher cash flow uncertainty may be forced to maintain lower dividends in order to avoid the cost associated with cutting dividends. The prediction of a negative association between dividend payout ratio and cash flow volatility is strongly supported by their empirical evidence from a panel of US companies. Furthermore, by including control for earnings volatility, Minton and Schrand (1999) find that both cash flow volatility and earnings volatility are negatively associated with dividend payout ratios.

Brav *et al.* (2005) report the results of an international survey on payout policy. Feedback from financial executives indicates that perceived uncertainty of future performances is an important factor affecting dividend decisions. Uncertainty may have an impact on the probability of paying dividends as well as the amount of dividend. These survey results on dividend policy and uncertainty are 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 using worldwide data. Chay and Suh (2009) argue that companies 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.

2.5 Corporate decisions and managerial confidence

2.5.1 Modern corporate finance versus behavioural corporate finance

As noted above, corporate investment, financing and payout choices are the main corporate decisions facing management and the controversial issues in modern corporate finance. A large body of literature has been devoted to investigating the primary determinants of this key set of corporate decisions. Under the traditional assumption of broad rationality, the prior research typically relies on company fundamental characteristics, such as cash flow, investment opportunity, company size, asset tangibility, ownership structure, life cycle stage, industry characteristics, etc., in explaining aspects of corporate behaviour, largely ignoring the importance of the state of managerial confidence and economic sentiment in corporate decision-making processes.

Recently, behaviour finance has begun to play an important role in attempting to explain aspects of finance that traditional finance literature has failed to explain. Behavioural finance literature replaces the traditional assumption of broad rationality with a potentially more realistic behavioural assumption that agents' behaviours are less than fully rational, i.e. they may have behavioural biases (see a survey by Baker *et al.*, 2006). The assumption of less than full rationality finds strong support from a large body of psychological literature (see, for example, Gilovich *et al.*, 2002). Behavioural approaches are now commonly used in asset pricing literature in which investors are assumed to be less than fully rational. However, corporate finance literature has rarely relaxed the assumption that managers are fully rational. A review of the existing literature in behavioural corporate finance offered by Baker *et al.* (2006) shows that two distinct approaches have been developed in this area, namely, the less than fully rational investor approach and less than fully rational manager approach.

The less than fully rational investor approach views investor behaviour as less than fully rational, which causes securities market mispricing, while managerial behaviour as rational response to market mispricing. In the less than fully rational investor framework, market mispricing influences corporate real and financial decisions through a catering channel, that is, if the market misprices a company's value according to the corporate decisions made by the company, managers may try to boost the short-run share prices of the company by catering to the current investor sentiment. In this spirit, Polk and Sapienza (2009) find evidence that corporate investment and market mispricing are positively correlated. Specifically, it is found that managers rationally cater to investor sentiment by investing in projects that are overpriced and by avoiding projects that are underpriced, in order to maximise the short-term stock prices of their companies. The catering idea has also been applied to corporate payout decisions by Baker and Wurgler (2004). They find that managers cater to investors by initiating dividends when the shares of payers are trading at a premium to those of nonpayers, and by omitting dividends when payers are at a discount or a negative dividend premium. Regarding corporate financing decisions, Graham and Harvey (2001) find that two thirds of CFOs in their survey consider the amount by which their securities is mispriced as an important factor in the decision to issue new debt and common stock. The market timing effect on capital structure is further developed and tested by Baker and Wurgler (2002). They find that current capital structure is strongly related to historical market values. They conclude that capital structure is the cumulative outcome of managers' attempts to time the equity market based on their perceptions of mispricing.

The less than fully rational manager approach to behavioural corporate finance assumes that managers have behavioural biases, while investor behaviour is fully rational. The less than fully rational manager assumption is supported by a large body of psychology literature demonstrating that individuals tend to systematically overestimate their intelligence quotient and skills relative to the average, i.e. the "better-than-average effect", and to consistently underestimate inherent risk, i.e. the "narrow confidence intervals" (see, for example, Gilovich *et al.*, 2002; Alicke *et al.*, 1995). Malmendier and Tate (2005) argue that top decision makers are more likely to exhibit overconfidence, both in terms of the "better-than-average effect" and in terms of the "narrow confidence intervals", for a number of reasons. First, top executives typically believe they have a great deal of control over their companies' performance (March and Shapira, 1987). Second, they are highly committed to their companies' good performance, which is closely related to their personal wealth, professional reputation and employability (Weinstein, 1980). Third, it is difficult to assess top executives' managerial skills relative to the average of others due to the abstract reference points involved (Alicke *et al.*, 1995).[8] It is well documented that all three factors, namely, the illusion of control, a high degree of commitment to good outcomes and abstract reference points, trigger managers' upward bias towards future company performance and downward

[8] Malmendier and Tate (2005) argue that assessing relative managerial skill is difficult due to other factors that influence overall company performance.

bias towards the associated risks (Malmendier and Tate, 2005). Therefore, thus far, the less than fully rational manger approach to behaviour corporate finance has mainly focused on the positive management illusions of optimism and overconfidence, and their resulting distortions of corporate decisions (see, for example, Heaton, 2002; Malmendier and Tate, 2005; Lin *et al.*, 2005).[9]

It is worth noting that the less than fully rational manager approach to behavioural corporate finance may share some predictions with the more established non-behavioural theories. However, Baker *et al.* (2006) highlight that the distortions in corporate decisions caused by less than fully rational managers' behavioural biases should be distinguished from those caused by rational managers' moral hazard behaviour. The less than fully rational manager approach to behavioural corporate finance is concerned with situations where the managers believe that they are loyal to shareholders and maximising company value, but are in fact deviating from their goal. Although the theoretical framework in this emerging area has not been firmly established and empirical evidence is still relatively rare, the existing literature indicates that the less than fully rational manager approach has the potential to explain a wide range of patterns in companies' investment, financing and payout choices. The remainder of this section, therefore, focuses on behavioural corporate finance literature that

[9] It is documented that managerial upward bias towards future company performance may be due to overconfidence or optimism (see, for example, Oliver and Mefteh, 2010; and Malmendier and Tate, 2005). According to psychology literature, overconfidence typically results from an overestimation of one's own abilities, such as intelligence quotient and managerial skills, while optimism typically results from an overestimation of exogenous events related to the probability of success, for example economic growth. Besides this, sentiment is also a term often used to describe confidence and optimism (Oliver and Mefteh, 2010). Therefore, the words sentiment, confidence and optimism have been used interchangeably in the literature, and we do not discriminate among them hereinafter in this thesis.

adopts the less than fully rational manager approach.

2.5.2 Corporate investment decision and managerial confidence

In his General Theory, Keynes (1936) links the notion of “sentiment” to the “state of long-term expectation” and the “state of confidence”. He points out that the level of confidence one has in the future of the economy, or a sector of it, plays an important role in the formation of one’s expectations of future profit levels, and hence in the determination of investment decisions. Accordingly, an intuitive and compelling channel through which sentiment and confidence could influence companies’ real investment decisions is that where the state of managerial sentiment and economic confidence is one of the major factors determining expected rates of return, upon which corporate investment decisions are made. Corporate investment, therefore, should be increase with managerial confidence or economic sentiment. However, as criticised by Keynes (1936), the state of confidence or sentiment, which receives the closest and most anxious attention in practice, has not been discussed carefully and analysed thoroughly by researchers in economics and finance.

The importance of confidence and sentiment, especially those of managers, in making corporate investment decisions has received little attention until recent years. The emerging literature in behavioural corporate finance recognises that managers’ psychological bias, particularly their positive illusions of optimism and overconfidence, may result in distortions in corporate investment decisions. More specifically, managerial optimism may result in overestimation of the expected returns to the investment projects, while managerial overconfidence may result in underestimation of the risk associated with projects. Thus, managerial upward bias towards future company performance leads naturally to unintended overinvestment and risk-taking behaviour which distorts corporate investment decisions (see Heaton, 2002). By adopting the behavioural approach in a simple corporate finance model, Heaton (2002) demonstrates that optimistic managers who systematically overvalue the company's investment opportunities may invest in projects whose net present values are in fact negative even if they are loyal to shareholders. Malmendier and Tate (2005) further confirm that managerial overconfidence indeed leads to distortions in corporate investment decisions made by a sample of large publicly traded UK companies. They argue that overconfident managers are likely to systematically overestimate the future returns to their investment projects, and thus overinvest relative to the optimal level. It is important to note that managerial overconfidence induced investment distortions are completely different from those caused by rational moral hazard behaviour under the agency view, such as overinvesting to build a large empire. To be more precise, unlike the traditional agency problems in which managers pursue their private benefits when there is a misalignment of interest between managers and shareholders (see Jensen and Meckling, 1976), managers who are less than fully rational under the behavioural approach still believe that they are actually maximising shareholders' wealth, even though they in fact overestimate the NPVs of investment projects and invest in negative NPV projects, deviating from their initial objectives (see Baker *et al.*, 2006).

Apart from its direct effect on investment, the state of confidence and sentiment may also influence investment decisions via its effects on corporate financing choices. It is documented that managerial overconfidence is also likely to cause managers to overvalue their companies, which in turn causes them to believe that the efficient capital market is undervaluing their company's risky securities (Heaton, 2002). As a result, overconfident managers view external funds, especially external equity, as unduly costly, leading to a preference for internal funds and risk-free debt. They may decline valuable investment opportunities that must be financed externally. From this point of view, managerial overconfidence may result in underinvestment, if companies do not have sufficient internal funds and risk-free debt for their desired investment projects. Therefore, Heaton (2002) establishes a framework which allows for managerial optimism induced trade-off between underinvestment and overinvestment, without invoking traditional theories of agency cost and information asymmetry.

Moreover, it is equally plausible to hypothesise that investor sentiment is heavily influenced by managerial confidence, and thus security prices might be inflated with managerial confidence and economic sentiment, allowing managers to infer lower required rates of return or cheaper external funds, which would prompt both external finance and investment. In this light, both investment and external financing should increase with sentiment. Ben-David *et al*. (2007) present empirical evidence that companies with overconfident CFOs invest in capital stock more intensively and use debt more aggressively.

2.5.3 Corporate financing decision and managerial confidence

Since the seminal work of Modigliani and Miller (1958), which proves the irrelevance of corporate financing decisions conditional on the assumptions of perfect capital market, a large number of theoretical and empirical analyses have been developed to investigate the determinants of corporate financing decisions caused by various market imperfections in the real world. The prior research in this area generally follows two competing theories, i.e. the trade-off theory and the pecking order theory, both of which assume a broad rationality. Recently, Baker and Wurgler (2002) propose a market timing theory of capital structure which drops the assumption of investor rationality, and allows for time-varying market mispricing. Rational managers, who incorporate mispricing caused by investor sentiment into their financing decisions, tend to issue equity when they believe its cost is irrationally low, and repurchase equity when they believe its cost is irrationally high. Therefore, capital structure can be considered as the cumulative outcome of managers' attempts to time the equity market based on their perceptions of mispricing. A recent study by Frank and Goyal (2009) reviews the existing literature on capital structure, and concludes that there is no universal theory which is able to fully explain corporate financing decisions, and there is no reason to expect one.

Traditional explanations for capital structure heavily rely on the rigorous assumption of managerial rationality, and none of them consider managers' psychological bias as an important determinant in corporate financing choice.[10] However, Heaton (2002) contends that managers tend to overvalue not only their investment opportunities, but also their company value. Because overconfident managers consistently overestimate the probability of good company performance versus the efficient capital market's outlook, they always perceive that the capital market is undervaluing their company. Therefore, it is possible to integrate managers' psychological bias into existing capital structure theories, and hypothesise managerial confidence and sentiment as an important determinant of corporate financing decisions alongside other company fundamental characteristics.

In the trade-off model of capital structure, managers seek an optimal level of financial leverage to maximise their company value by weighing the tax advantages of debt and the bankruptcy costs of debt. Hackbarth (2008) extends the traditional trade-off model by taking managerial traits into account. Under the assumption of the coexistence of fully rational investors and less than fully rational managers, the extended trade-off model suggests that managers with an upward bias towards future company performance tend to choose higher debt levels and issue new debt more often, resulting in actual choices of debt levels differing from the optimal ones. The distortions of debt levels are attributed to managers' less than fully rational perception of their company's growth and risk. On the one hand, optimistic managers tend to overestimate their company's growth rate of earnings, and thus believe their company

[10] To some extent, Baker and Wurgler (2002) can be considered an exception. They argue that market timing theory does not require that the market actually be inefficient, i.e. investors actually be less than fully rational. The marker timing explanation remains valid as long as managers believe that they can time the market if even they themselves are less than fully rational. Specifically, managers may be less than fully rational and they are not required to predict stock return successfully and perceive market mispricing correctly.

is more profitable than it actually is. On the other hand, overconfident managers tend to underestimate their company's riskiness of earnings, and thus believe their company is less risky than it actually is. Both the growth perception bias and the risk perception bias naturally lead managers to believe their company is less likely to experience financial distress, and in turn to choose higher than optimal debt levels. Hackbarth (2008) therefore predicts that overconfidence is associated with aggressive debt financing policies. On the empirical side, Oliver and Mefteh (2010) integrate managerial confidence into the trade-off model, and hypothesise that the more confident the managers are, the less likely they will be to expect the company to go into bankruptcy and the greater the extent to which they will use debt finance. Their prediction is strongly supported by the empirical evidence obtained from a sample of French companies, showing that managers act according to their expected psychological bias and prefer debt financing when they are confident.

According to the pecking order model, asymmetric information problems generate a hierarchy of financing policies with a preference for internal over external funds and for debt over equity. As a result, companies finance the use of funds first with internally generated cash flow, then with debt, and equity finance is only used under duress. Heaton (2002) models the financing decisions of less than fully rational managers, and shows that managerial overconfidence induces a misperception of the cost of risky external capital, leading to a hierarchy of financing similar to that predicted by conventional pecking order theory. It is argued that optimistic managers are prone to attach higher probabilities to good outcomes than an efficient capital market, thus they are likely to believe that the efficient capital market is undervaluing their company's risky securities.[11] For this reason, optimistic managers in an efficient market always perceive issuing a risky security, such as new equity, to be a negative net present value event which damages the interests of existing shareholders. Consequently, they believe there is never a good time to issue equity, and they never sell equity unless they have to. Likewise, optimistic managers believe that safer securities are less sensitive to probabilistic beliefs, and thus are less mispriced by the capital market.[12] Since internal funds and risk-free debt are insensitive to probabilistic beliefs, they are not subject to the problem of undervaluation from the optimistic manager's point of view. This induces a pecking order financing preference, in which optimistic managers attempt to minimise their overall cost of capital, without invoking asymmetric information. Heaton (2002) posits that optimistic managers strictly prefer internal funds and risk-free debt to any risky securities, and prefer risky debt to all equity financing. This pecking order of financing preference, therefore, is a testable prediction of the managerial optimism model.

Malmendier *et al*. (2011) hypothesise that overconfident managers raise risky external finance only if the overestimated investment returns are larger than the misperceived financing costs. If the misperceived cost of external finance exceeds the overestimated investment returns, overconfident managers are reluctant to access external capital market,

[11] The prices of risky securities reflect the capital market's probabilities of good versus bad states of the world (Heaton, 2002).

[12] Malmendier *et al.* (2011) assert that, in the case of equity financing, the difference in opinions between managers and investors about future cash flows matters for all states of the world. However, the difference in opinions matters only for default states in the case of risky debt financing.

and are likely to invest up to the limit of risk-free debt finance. The financing decisions of companies with less than full rational managers therefore depend, not only on their misperception of financing cost, but also on their overestimation of future returns.

Overall, the predictions about how the state of confidence and sentiment affect corporate debt financing decisions are unclear. A high level of managerial confidence may, on the one hand, lead to greater use of debt financing if the managers systematically overestimate future profitability and underestimate the probability of financial distress. On the other hand, a high level of managerial confidence may discourage the use of external finance if the overconfident managers believe that their risky securities are undervalued by the markets. The influence of managerial confidence and sentiment on corporate debt financing decision therefore needs to be addressed empirically. Ben-David *et al.* (2007) find empirical evidence from US data that companies with overconfident managers use debt more aggressively and maintain longer debt maturity. Malmendier *et al.* (2011) find that overconfident managers prefer to use internal funds and risk-free debt. Conditional on having to raise risky external capital, overconfident managers prefer debt to equity financing. Malmendier *et al.* (2011) also indicate that both the trade-off and pecking order theories are complementary to the managerial effect on capital structure, and hence it is not necessary to take a stand on their relative merits.

2.5.4 Corporate payout decision and managerial confidence

As discussed in Section 2.2.3, the models used to test dividend policy theories differ in their assumptions and approaches. Lintner's (1956) early study shows that managers usually have a reasonably definitive target payout ratio in the long run, and adjust the actual payout ratio slowly towards the target over years. Signalling model of dividends is characterised by information asymmetry and states that managers signal their private knowledge about the company's prospects to the capital markets through dividend policy. Tax clientele theory focuses on the market imperfection resulting from the differential taxation of dividends and capital gains to explain corporate payout behaviour. The catering theory posits that dividend payouts respond to investors' demand for dividends. Agency theory states that dividends are used by shareholders as a device to reduce free cash flow and the resultant overinvestment made by managers. More recently, a strand of literature highlights the importance of the company's financial life cycle stage in its dividend policy. However, the conventional wisdom on dividend policy, under the assumption of broad rationality, fails to capture the potential effect of managerial confidence on corporate payout behaviour.

Relaxing the assumption of broad rationality, it is plausible to argue that less than fully rational managers' upwards psychological bias may also have profound implications for corporate payout decisions. On the one hand, managerial optimism implies that managers are prone to overinvest since they misperceive projects as more profitable than they really are, resulting in higher financing needs. On the other hand, managerial overconfidence implies that managers also tend to overvalue their companies, and hence misperceive the cost of external financing as unduly costly, limiting their access to external sources of funds. To finance investment projects whose net present values are possibly overestimated, and at the same time to avoid external finance whose perceived costs are too high, managers are likely to retain internally generated cash flows that otherwise would have been paid out to shareholders as dividends, in an attempting to prevent losses from underinvestment (see Ben-David *et al.*, 2007). Since internal funds are perceived as more valuable due to managers' upward psychological bias, managerial confidence may lower the amount of dividends paid out as well as the propensity to pay out dividends. Ben-David *et al.* (2007) obtain empirical evidence from a panel of US companies showing that companies with overconfident CFOs pay out fewer dividends. The negative effect on payout policy is more significant for the long-term overconfidence measure compared with the short-term one, which is potentially due to the stickiness of dividend payments.

However, it is equally plausible to argue that, if managers are more optimistic and confident about future cash flow, they may view dividend payment as more sustainable, leading to high levels of dividend payouts (Baker *et al.*, 2006). In addition, DeAngelo *et al.* (1996) argue that because managers tend to be overly optimistic about company growth, they tend to send signals which are overly optimistic about future earnings. From this point of view, managerial overconfidence may cause a company's dividend to go up. Given that the conflicting arguments provide equally good reasons for both positive and negative effects of managerial confidence on dividend payouts, the related research questions are subjected to empirical testing.

2.6 Conclusion and promising research ideas

2.6.1 Conclusion

This chapter offers a comprehensive and critical review of the main theoretical and empirical literature on corporate investment, financing and payout decisions, starting from the Modigliani-Miller theorems. Specifically, the main theories surveyed in this chapter include Tobin's *Q*, accelerator, financial constraint and real options theories on corporate investment decisions; trade-off, pecking order, market timing and agency theories on corporate financing decisions; and bird in the hand, tax clienteles, signalling, catering, free cash flow and financial life cycle theories on corporate payout decisions. The conventional wisdom on the three aspects of corporate behaviour alongside selected recent empirical evidence are summarised in Appendices 2.A, 2.B and 2.C, respectively. Although these corporate finance puzzles which have captured the interest of researchers over the last six decades remain theoretically ambiguous and empirically inclusive, a number of conclusions can be drawn from the existing corporate finance literature reviewed in this chapter.

First, the literature review shows that, although much effort has been devoted to investigating this key set of corporate decisions in literature, corporate investment, financing and payout decisions have been typically treated separately, and hence there has been little analysis of the simultaneity among them. Previous studies, however, provide both reasons and evidence that corporate investment, financing and payout decisions are likely to be interdependent upon one another and jointly determined by management. Several mechanisms through which the set of corporate decisions may affect one another have been explored, such as the institutional approach, flow-of-funds approach, tax approach, agency approach, information approach, etc. One important implication is that corporate investment, financing and payout decisions are potentially linked in several important ways, thus should be better analysed within a simultaneous model framework. A summary of selected previous studies on the simultaneity of corporate decisions is presented in Appendix2.D. These studies 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. Besides, most of the significant empirical studies that investigate the joint determination of the corporate decisions are based on data from US companies, and the body of evidence on other markets outside the US is still rather small. McDonald *et al.* (1975) point out that the interactions among the corporate decisions are likely to depend on the size of the capital market. Thus, it still remains to be further investigated whether solid empirical evidence can be found to verify the possible interactions suggested by the theoretical arguments.

Second, the literature review also shows that uncertainty associated with a company's future prospects seems to be a critical factor in determining corporate investment behaviour, as highlighted by the real options theory of investment. However, the competing theories provide equally good reasons for both positive and negative relationships between investment and uncertainty, leaving the sign of the investment-uncertainty relationship remains unclear from a theoretical point of view. On the empirical side, a broad consensus in the existing literature is that the effect of uncertainty on investment is negative, although a number of studies also show that the investment-uncertainty relationship might be positive or non-linear. Prior research, however, has largely ignored the importance of uncertainty in financing and payout decisions as well as the potential influence of uncertainty on investment through its effects on the financial choices. Given the fact that all corporate decisions are jointly determined on the basis of uncertain information, the omission of relevant information in examining the effect of uncertainty on corporate investment may generate misleading results and lead to inappropriate inferences, which may bias our understanding of corporate behaviour under uncertain circumstances. Therefore, it is more plausible to model corporate, financing and payout decisions simultaneously, and to investigate the effect of uncertainty on aspects of corporate behaviour within a simultaneous equations system.

Third, an emerging body of literature on behavioural corporate finance reveals that managers' psychological bias may have a substantial impact on corporate decisions. In particular, managers' upward bias towards future company performance may generate overinvestment, underinvestment and pecking order financing behaviours through different mechanisms. Prior research in this area mainly focuses either on the influences of investor sentiment (see, for example, Polk and Sapienza, 2009), or on the impacts of managers' personality traits on corporate behaviour (see, for example, Malmendier *et al.*, 2011;

Hackbarth, 2008; and Malmendier and Tate, 2005). However, little has been done on the influences of the state of managerial confidence or economic sentiment at aggregate levels on aspects of corporate behaviour, despite it is often being argued this has some bearing on corporate decision-making. Although the theoretical framework in this emerging area has not been firmly established and the empirical evidence is still relatively rare, it is plausible to hypothesise that the less than fully rational manager approach to behavioural corporate finance has the potential to explain a wide range of patterns in corporate investment, financing and payout decisions.

2.6.2 Promising research ideas

One of the main objectives of the review of existing corporate finance literature is to identify some promising research ideas. In this section, we summarise four promising research ideas which are derived directly from the theoretical and empirical literature reviewed in this chapter.

The first promising research idea relates to the potential interactions that may exist among corporate investment, financing and payout decisions, as indicated in Gatchev *et al.* (2010), Wang (2010) and Dhrymes and Kurz (1967). Typically, corporate decisions are examined in isolation using a single equation framework, which fails to account for the interdependence among various policy choices. Such a methodology may produce coefficient estimates that suffer from omitted variables bias, and therefore provide incomplete view of corporate behaviour. To overcome the shortcomings of single equation techniques that are currently adopted in the existing literature, the proposed research idea is to empirically investigate the joint determinations of the three corporate decisions by modelling them within a simultaneous equations system which explicitly allows for the interactions among them. The simultaneous analysis is expected to improve our knowledge of the complex corporate decision-making processes by revealing new insights into the interdependences among the corporate decisions in practice.

The second promising research idea relates to the role played by uncertainty in corporate decision-making processes. Although uncertainty associated with a company's future prospects appears to be a critical factor in determining the company's investment in capital stock, the relationship between investment and uncertainty is still theoretically ambiguous and empirically inconsistent. The empirical evidence on the investment-uncertainty relationship seems sensitive to both the model specification and the uncertainty measurement. Moreover, the importance of uncertainty in companies' financing and payout policies has not been thoroughly evaluated in the empirical literature. Consequently, the effects of uncertainty on financial decisions as well as the influence of uncertainty on investment decisions through its effects on financial choices are largely overlooked. Therefore, a promising research idea is to fill these gaps in the literature by considering uncertainty as a common factor involved in each of the decisions modelled in the simultaneous equations system, in order to comprehensively investigate aspects of corporate behaviour under uncertainty.

The third promising research idea relates to the emerging body of literature on behavioural corporate finance which asserts that managers' psychological bias may have a substantial impact on corporate decisions. Although the theoretical framework in this emerging area has not been firmly established and the empirical evidence is relatively rare, it is plausible to hypothesise that the state of managerial confidence has the potential to explain a wide range of patterns in corporate investment, financing and payout decisions. A promising research idea, therefore, is to explore the role of managerial confidence and economic sentiment in explaining aspects of corporate behaviour by relaxing the conventional assumption that managers are fully rational. Again, the simultaneous equations system of corporate decisions provides a desirable platform for a systematic attempt to discover the effects of managerial confidence and economic sentiment on corporate behaviour.

The fourth promising research idea relates to the measurement of corporate investment in the empirical literature. Although the conflicting empirical evidence obtained from the tremendous amount of literature induces intense debates upon almost all aspects of corporate investment behaviour, the measure of corporate investment itself has received little attention. The literature review shows that the use of corporate investment to capital stock ratio as a measure of companies' investment behaviour has become common practice in applied studies. However, different measures of investment as well as various proxies for capital stock have been used to construct the corporate investment to capital stock ratio. At least twenty versions of corporate investment to capital stock ratio have been identified in the existing literature. To the best of our knowledge, there is no literature that provides comparison and evaluation among the various versions of corporate investment ratios which seem, at first sight, very similarly specified. Thus, we know little about how differently these investment ratios perform in empirical studies, and the extent to which the choice of measuring corporate investment influences their empirical results. A promising research idea is to fill this critical lacuna in the literature by conceptually discriminating and empirically evaluating the twenty most commonly used measures of corporate investment. Such analyses may improve our understanding of the financial information contained in different investment measures, and demonstrate whether the conflicting empirical evidence offered by the literature on corporate investment may be attributable to the differences in measuring corporate investment behaviour.

The remainder of the thesis attempts to implement these promising research ideas derived from the review of existing literature. Specifically, the first two research ideas, i.e. the simultaneity of corporate decisions and the effects of uncertainty on corporate decisions, are addressed in Chapter 3. A systematic attempt to explore the influences of managerial confidence on aspects of corporate behaviour is made in Chapter 4. The comparison and evaluation analyses of the various versions of corporate investment to capital stock ratio are carried out in Chapter 5. Chapter 6 concludes the study by proposing a number of promising ideas for future research which are drawn from both the existing literature reviewed and the findings presented in this thesis.

Appendix 2.A: Corporate investment theories and representative recent empirical evidence

Theory (Empirical work)	Main model / Variable / Estimation method / Data / Finding	
Tobin's Q theory (Hennessy *et al*., 2007)	Main model	$\frac{INV}{K}_{it} = f\left(Q_{it}, FC\ index_{it}, \frac{CF}{K}_{it}\right)$
	Variable	Investment (INV) = Capital expenditures on property, plant and equipment – Sales of property Capital stock (K) = Total property, plant and equipment Tobin's Q (Q) = Average Q as specified in Erickson and Whited (2000) Financial constraints index ($FC\ index$) adopted from Kaplan and Zingales (1997) or Whited and Wu (2006): KZ = –1.001909×Ratio of cash flow to book assets + 3.139193×Ratio of total long-term debt to book assets – 39.36780×Ratio of total dividends to book assets – 1.314759×Ratio of cash stock to book assets + 0.2826389×Ratio of market value of assets to book assets WW = –0.091×Ratio of cash flow to book assets – 0.062×Dividend payer dummy + 0.021×Ratio of total long-term debt to book assets – 0.044×Natural log of book assets + 0.102×Industry sales growth – 0.035×Own company sales growth Cash flow (CF) = Income before extraordinary items + Depreciation and amortisation
	Method	OLS and GMM
	Sample	46,118 US company-year observations over the period from 1968 to 2003, excluding regulated, financial and public service companies.
	Finding	The simple Q model of investment is easily rejected, because regressors other than Q enter significantly. The coefficient on either proxy for future collateral constraints is positive and significant, which indicates that a collateral channel is operative.
Accelerator theory (Guariglia, 2008)	Main model	$\frac{INV}{K}_{it} = f\left(\Delta \log S_{it}, \Delta \log S_{it-1}, (\log K_{t-2} - \log S_{t-2}), \frac{CF}{K}_{it}, \frac{INV}{K}_{it-1}\right)$
	Variable	Investment (INV) = Property, plant and equipment$_t$ – Property, plant and equipment$_{t-1}$ + Depreciation, depletion and amortisation$_t$ Capital stock (K) = Replacement value of capital stock calculated using the perpetual inventory formula Sales (S) = Real sales Cash flow (CF) = After tax profit + Depreciation Error correction term ($\log K_{t-2} - \log S_{t-2}$) = Difference between company's capital stock level and its desired level

Theory (Empirical work)	**Main model / Variable / Estimation method / Data / Finding**	
	Method	Difference-GMM
	Sample	124,590 annual observations on 24,184 UK companies, both quoted and unquoted, over the period from 1993 to 2003.
	Finding	The sales growth terms are both positive and statistically significant, and the error-correction term attracts a negative sign. The accelerator effect of sales on investment and the error-correction behaviour are confirmed. The coefficient associated with cash flow is positive and precisely determined, suggesting that a drop in cash flow is associated with a drop in investment.
Financial constraints model (Almeida and Campello, 2007)	Main model	$\frac{INV}{K}_{it} = f\left(Q_{it-1}, \frac{CF}{K}_{it}, TAN_{it}, \frac{CF}{K}_{it} \times TAN_{it}\right)$
	Variables	Investment (*INV*) = Capital expenditures Capital stock (*K*) = Total property, plant and equipment at the beginning of the period Investment opportunities (*Q*) = (Total assets + Annual close price × Common shares outstanding – Total common equity – Deferred taxes) / Total assets Cash flow (*CF*) = Earnings before extraordinary items + Depreciation Tangibility (*TAN*) = 0.715 × Total receivables + 0.547 × Total inventory + 0.535 × Total property, plant and equipment
	Method	OLS and GMM
	Sample	18,304 company-year observations from manufacturing companies over the period from 1985 to 2000.
	Finding	Pledgeable assets support more borrowing, which allows for further investment in pledgeable assets. The credit multiplier suggests that investment-cash flow sensitivities should increase with the tangibility of companies' assets (a proxy for pledgeability), but only if companies are financially constrained. The empirical results confirm that constrained companies' investment-cash flow sensitivities are increasing in asset tangibility, while unconstrained companies' sensitivities show little or no response to tangibility. The results strongly suggest that financing frictions affect investment decisions.
Real options theory (Bloom *et al*., 2007)	Main model	$\frac{INV_{it}}{K_{it-1}} = f\left(\Delta \log S_{it}, (\Delta \log S_{it})^2, \frac{CF_{it}}{K_{it-1}}, UNC_{it} \times (\Delta \log S_{it}), (\log S_{t-1} - \log K_{t-1}), UNC_{it}, \Delta UNC_{it}\right)$

Theory (Empirical work)	Main model / Variable / Estimation method / Data / Finding	
	Variable	Investment (*INV*) = Total new fixed assets – Sales of fixed assets Capital stock (*K*) = Replacement value of real capital stock constructed by applying a perpetual inventory procedure with a depreciation rate of 8% Sales (*S*) = Total sales, deflated by the aggregate GDP deflator Cash flow (*CF*) = Net profit + Depreciation Uncertainty (*UNC*) = Standard deviation of daily stock returns for company *i* in accounting year *t* Error correction term (log S_{t-1} – log K_{t-1}) = Difference between company's capital stock level and its desired level
	Method	System-GMM
	Sample	5,347 company-year observations from an unbalanced panel of 672 publicly traded UK manufacturing companies over the period from 1972 to 1991.
	Finding	It is found that with partial irreversibility higher uncertainty reduces the responsiveness of investment to demand shocks. Uncertainty increases real option values making companies more cautious when investing or disinvesting. The investment behaviour of large companies is consistent with a partial irreversibility model in which uncertainty dampens the short-run adjustment of investment to demand shocks.

Appendix 2.B: Capital structure theories and representative recent empirical evidence

Theory (Empirical work)	**Main model / Variable / Estimation method / Data / Finding**	
Trade-off theory (Flannery and Rangan, 2006)	Main model	$\frac{TD}{TD+ME}_{it} = f\left(\frac{EBIT}{TA}_{it-1}, MB_{it-1}, \frac{DEP}{TA}_{it-1}, SZ_{it-1}, TAN_{it-1}, RDD_{it-1}, \frac{RD}{TA}_{it-1}, IND_{it-1}, RATED_{it-1}, \frac{TD}{TD+ME}_{it-1}\right)$
	Variable	Total debt (*TD*) = Long-term debt + Short-term debt Market value of equity (*ME*) = Annual close price × Common shares outstanding Earnings before interest and taxes (*EBIT*) = Income before extraordinary items + Interest expense + Income taxes Total assets (*TA*) = Book value of total assets Market to book ratio of assets (*MB*) = (Long-term debt + Debt in current liabilities + Preferred stock + Annual close price × Common shares outstanding) / Book value of total assets Depreciation expense (*DEP*) = Depreciation and amortisation Company size (SZ) = Logarithm of total assets Fixed asset proportion of total assets (*TAN*) = Property, plant and equipment / Book value of total assets R&D dummy (*RDD*) = 1, if company did not report R&D expenses; and 0, otherwise Industry debt ratio (*IND*) = Median industry debt ratio calculated for each year based on industry groupings Rating dummy (*RATED*) = 1, if the company has a public debt rating; and 0, otherwise
	Method	Fama and MacBeth (1973) estimation and OLS
	Sample	111,106 company-year observations consisting of 12,919 non-financial and non-regulated companies over the period from 1965 to 2001.
	Finding	Target debt ratios depend on well-accepted company characteristics. Most of the lagged variables representing the target debt ratio carry significant coefficients with appropriate signs. Companies that are under- or over-leveraged by this measure soon adjust their debt ratios to offset the observed gap. Targeting behaviour is evident in both market-valued and book-valued leverage measures. Companies return relatively quickly to their target leverage ratios when they are shocked away from their targets.

Theory (Empirical work)	Main model / Variable / Estimation method / Data / Finding	
Pecking order theory (Frank and Goyal, 2003)	Main model	$NDF = f(DIV, INV, \Delta WC, CF)$ $\Delta\left(\frac{TD}{ME}\right)_{it} = f\left(\Delta TAN_{it}, \Delta MB_{it}, \Delta SZ_{it}, \Delta PRO_{it}, DEF_{it}\right)$
	Variable	Net debt issued (*NDF*) = Long-term debt issuance – Long-term debt reduction
		Dividends paid (*DIV*) = Cash dividend paid to shareholders Capital investments (*INV*) = Capital expenditures + Increase in investments + Acquisitions + Other uses of funds − Sale of property – Sale of investments Change in working capital (ΔWC) = Change in working capital + Change in cash and cash equivalents + Change in current debt Cash flow (*CF*) = Income before extraordinary items + Depreciation and amortisation Financing deficit (*DEF*) = $DIV + INV + \Delta WC - CF$ Tangibility (*TAN*) = Net fixed assets / Total assets Market-to-book ratio of assets (*MB*) = (Total assets + Annual close price × Common shares outstanding − Common equity) / Total assets Company size (*SZ*) = Natural logarithm of constant sales Profitability (*PRO*) = Operating income / Total assets
	Method	OLS
	Sample	A broad cross-section of publicly traded non-financial and non-regulated US companies over the period from 1971 to 1998.
	Finding	The pecking order theory is tested using disaggregated financing deficit. The coefficient on cash dividends, investment in fixed assets and investments in working capital are all significantly positive. But pecking order theory predicts a positive sign and a unit coefficient; after controlling for internal cash flows, the uses of funds should be matched dollar by dollar by increases in debt issues. Internal cash flow does lead to some reduction in debt issues, but the magnitude of the effect is small. While large companies exhibit some aspects of pecking order behaviour, the evidence is robust neither to the inclusion of conventional leverage factors, nor to the analysis of evidence from the 1990s. Financing deficit is less important in explaining net debt issues over time for companies of all sizes.

Theory (Empirical work)	Main model / Variable / Estimation method / Data / Finding	
	Main model	$\frac{TD}{TA}_{it} = f\left(EFWAMB_{it-1}, MB_{it-1}, TAN_{it-1}, PRO_{it-1}, SZ_{it-1}\right)$
	Variable	Total debt (*TD*) = Total liabilities – Deferred taxes Total assets (*TA*) = Book value of total assets; or Total assets − Common equity + Annual close price × Common shares outstanding;
Market timing theory (Mahajan and Tartaroglu, 2008)		External finance weighted average market-to-book ratio (*EFWAMB*) = $\sum_{s=1}^{t-1} \frac{e_s + d_s}{\sum_{r=1}^{t-1} e_r + d_r} \times MB_s$ where *e* is the net equity issues, and *d* is net debt issues (see also Baker and Wurgler, 2002) Market-to-book ratio of assets (*MB*) = (Total assets − Common equity + Annual close price × Common shares outstanding) / Total assets Tangibility (*TAN*) = Net property, plant and equipment / Total assets Profitability (*PRO*) = Earnings before interest, taxes, depreciation and amortisation / Total assets Company size (*SZ*) = Logarithm of net sales
	Method	Fama and MacBeth (1973) estimation
	Sample	Non-financial and non-regulated companies from Canada (3,150), France (3,194), Germany (2,359), Italy (900), UK (7,071), US (18,463) and Japan (7,602) over the period from 1994 to 2005.
	Finding	The equity market timing hypothesis suggests that capital structure is cumulative outcome of past equity market timing attempts. The results show that historical market-to-book ratio is inversely related to leverage in most industrialised countries. The results reveal that the effect of equity market timing on leverage is short lived and neutralised within at most five years of equity issuance. These findings contradict the market timing hypothesis which precludes companies from rebalancing their capital structure in response to temporary shocks such as equity market timing attempts.
Agency theory (Brailsford *et al*, 2002)	Main model	$\frac{TD}{ME}_{it} = f\left(OWN_{it}, OWN_{it}^2, SZ_{it}, IND_{it}, VOL_{it}, GRO_{it}, PRO_{it}, FCF_{it}, INTAN_{it}, NDTS_{it}, FDIV_{it}\right)$

Theory (Empirical work)	Main model / Variable / Estimation method / Data / Finding	
	Variable	Total debt (*TD*) = Book value of total debt Market value of equity (*ME*) = Annual close price × Common shares outstanding Managerial ownership (*OWN*) = Number of ordinary shares owned by all executive and non-executive directors / Number of ordinary shares outstanding Company size (*SZ*) = Natural logarithm of the book value of total assets Industry dummy (*IND*) = 1, if the company is in the industrial sector; and 0, otherwise Volatility (*VOL*) = Standard deviation of annual percentage change in operating income before interest, taxes and depreciation Growth (*GRO*) = Annual percentage change in total assets Profitability (*PRO*) = Operating income before interest and taxes / Total assets Free cash flow (*FCF*) = (Operating income before income tax + Depreciation and amortisation expenses − Total tax paid − Total dividend paid) / Total assets Intangibility (*INTAN*) = Intangible assets / Total assets Non-debt tax shield (*NDTS*) = Depreciation expense / Total assets Franked dividends (*DIV*) = Franked dividends paid / Total dividends paid
	Method	OLS
	Sample	49 large Australian companies over the period 1989 to 1995.
	Finding	The empirical results provide support for a non-linear relation between the level of managerial share ownership and leverage. Specifically, when the level of managerial share ownership is low, an increase in managerial share ownership has the effect of aligning management and shareholders' interests, and hence managers have less incentive to reduce the debt level, resulting in a higher level of debt. However, when corporate managers hold a significant proportion of a company's shares, the entrenchment effect sets in, resulting in higher managerial opportunism, and therefore a lower debt ratio. Besides, several of the control variables, including *IND*, *VOL*, *GRO* and *PRO* have statistically significant coefficients, and the signs on these coefficients are consistent with predictions. The results are consistent with the effects of convergence-of-interests and management entrenchment.

Appendix 2.C: Dividend policy theories and representative recent empirical evidence

Theory (Empirical work)	**Main model / Variable / Estimation method / Data / Finding**	
Bird in the hand (Baker *et al*., 2002)	Main model	Financial managers' opinions on the statement that "investors generally prefer cash dividends today to uncertain future price appreciation".
	Variable	Response = –2, if strongly disagree; –1, if disagree; 0, if no opinion; 1, if agree; or 2 if strongly agree with above statement
	Method	Survey of financial managers
	Sample	Financial managers of 188 NASDAQ companies surveyed in 1999.
	Finding	Consistent with previous evidence, no empirical support exists for the bird-in-the-hand explanation for why companies pay dividends. The evidence also shows that managers stress the importance of maintaining dividend continuity. Managers give the strongest support to a signalling explanation for paying dividends, and weak to little support for the tax-preference and agency cost explanations. The study provides evidence about how managers view dividend life cycles and residual dividend policy.
Tax clientele (Lee *et al*., 2006)	Main model	$\Delta OWN = f(\Delta DIV)$
	Variable	Change in ownership structure (ΔOWN) = First difference in the proportion of shares held by various investor groups (including wealthy individuals, medium-wealth individuals, and less-wealth individuals) from before the announcement of change in dividend until afterward Change in cash dividend per share (ΔDIV) = Announced change (first difference) in cash dividends per share
	Method	Cross-sectional regressions using OLS
	Sample	A panel of Taiwan companies over the period 1995 to1999.
	Finding	Strong evidence supports a clientele effect. Agents subject to high rates of taxation on dividends (wealthy individuals) tend to hold stocks with lower dividends and sell (buy) stock that raises (lowers) dividends. Agents in lower tax brackets (medium- and lower-wealth individuals) behave in the opposite manner. All of these patterns are completely consistent with the existence of dividend clientele.

<table>
<tr><th>Theory
(Empirical work)</th><th colspan="2">Main model / Variable / Estimation method / Data / Finding</th></tr>
<tr><td rowspan="5">Signalling theory
(Skinner and Soltes, 2009)</td><td>Main model</td><td>$\frac{EBI_{it+1}}{TA_{it-1}} = f(DIV_{it}, \frac{EBI_{it}}{TA_{it-1}}, \frac{EBI_{it-1}}{TA_{it-1}})$</td></tr>
<tr><td>Variable</td><td>Earnings before interest (EBI) = Income before extraordinary items + 0.6 × (Interest expense − Interest income)
Total assets (TA) = Book value of total assets
Dividend dummy (DIV) = 1, if the company pays dividends; 0, otherwise</td></tr>
<tr><td>Method</td><td>OLS with two-way robust standard errors (that is, clustered by company and year)</td></tr>
<tr><td>Sample</td><td>123,728 company-year observations on non-utility and non-financial US companies that trade on the NYSE, AMEX and NASDAQ over the period from 1974 to 2005.</td></tr>
<tr><td>Finding</td><td>The study posits and tests the idea that dividends allow investors to assess the underlying sustainability of the company's earnings quality. Consistent with the idea that the dividend payments provide information about the quality of reported earnings, the results show that the relation between current earnings and future earnings is stronger for companies that pay dividends than for those that do not. The study also finds that the magnitude of the dividend, measured in term of payout ratio terms, does not affect this relation.</td></tr>
<tr><td rowspan="2">Catering theory
(Ferris et al., 2009)</td><td>Main model</td><td>$DIV_{it} = f(DP_{it-1}, SZ_{it-1}, PRO_{it-1}, MB_{it-1}, GRO_{it-1}, \frac{RE}{TA}_{it-1}, DIV_{it-1})$</td></tr>
<tr><td>Variable</td><td>Dividend payment (DIV) = 1, if the company pays dividends; and 0, otherwise
Dividend premium (DP) = $\log(P/B)_{payer} - \log(P/B)_{nonpayer}$
where $\log(P/B)_{payer}$ is value-weighted average market-to-book ratios of payers
$\log(P/B)_{nonpayer}$ is value-weighted average market-to-book ratios of non-payers
Company size (SZ) = Percentile ranking of company's market capitalisation in a given year among all sample companies
Profitability (PRO) = Operating income / Book value of total assets
Market-to-book ratio (MB) = (Total assets − Common equity + Annual close price × Common shares outstanding) / Total assets
Growth (GRO) = Annual percentage change in total assets
Maturity (RE/TA) = Retained earnings / Book value of total assets</td></tr>
</table>

Theory (Empirical work)	**Main model / Variable / Estimation method / Data / Finding**	
	Method	Logistic regression with clustered standard errors
	Data	24,298 company-year observations drawn from a sample of 23 countries over the period from 1996 to 2004.
	Finding	Evidence of catering is found among companies incorporated in common law countries but not those in civil law nations. Catering persists even after controlling for the effect of the company's life cycle. Companies are more likely to pay dividends if they are large and profitable. The propensity to pay dividends is significantly negatively related with the market-to-book value of assets.
Agency theory (Khan, 2006)	Main model	$\frac{DIV}{S}_{it} = f\left(\frac{DIV}{S}_{it-1}, \frac{NI}{S}_{it}, \frac{LEV}{S}_{it}, \frac{OWN}{S}_{it}, \frac{OWN}{S}_{it-1}\right)$
	Variable	Gross dividends (*DIV*) = Ordinary dividends + Tax credit Sales (*S*) = Total sales Net income (*NI*) = Net profits after tax, minority interest and preference dividends Leverage (*LEV*) = Total loan capital / Net fixed assets = (Long-term loans + Short-term loans + Convertible loans + Leasing finance and hire purchase) / (Fixed assets – Accumulated depreciation) Ownership (*OWN*) = The relevant ownership variable
	Method	OLS and system-GMM
	Data	A panel of 3,030 company-year observations from 330 large quoted UK companies over the period from 1985 to 1997.
	Finding	The results indicate a negative relationship between dividends and ownership concentration. Ownership composition also matters, with a positive relationship observed for shareholding by insurance companies, and a negative one for individuals. The results are consistent with agency models in which dividends substitute for poor monitoring by a company's shareholders but can also be explained by the presence of powerful principals who are able to impose their preferred payout policy upon companies.

Theory (Empirical work)	**Main model / Variable / Estimation method / Data / Finding**	
Life cycle theory (Denis and Osobov, 2008)	Main model	$DIV_{it} = f\left(SZ_{it}, MB_{it}, GRO_{it}, PRO_{it}, \frac{RE}{TE}_{it}\right)$
	Variable	Dividend payment (*DIV*) = 1, if the company pays dividends; and 0, otherwise Company size (*SZ*) = Percent of companies in the benchmark population with smaller market capitalisation Market-to-book ratio (*MB*) = (Total assets – Common equity + Annual close price × Common shares outstanding) / Total assets Growth (*GRO*) = Annual percentage change in total assets Profitability (*PRO*) = (Net income + Interest expense + Deferred taxes) / Book value of total assets Earned-to-contributed equity mix (*RE/TE*) = Retained earnings / Total book equity
	Method	Logit regression using the Neway and West procedure
	Data	Company-year observations from US (30,131), Canada (3,589), UK (9,382), Germany (2,377), France (3,678) and Japan (12,747) over the period from1989 to 2002.
	Finding	The findings cast doubt on signalling, clientele and catering explanations for dividends, but support agency cost-based life cycle theories. Companies trade off the flotation cost savings against the agency costs of cash retention. As companies mature (as proxied by greater *RE/TE*), the expected cost of retention increase, perhaps due to greater free cash flow problems, and the propensity to pay dividends increases.

Appendix 2.D: Methodologies and findings of selected literature on simultaneity of corporate decisions

Empirical work	Dhrymes and Kurz (1967)	Fama (1974)	McDonald *et al.* (1975)	McCabe (1979)	Peterson and Benesh (1983)	Mougoué and Mukherjee (1994)	Noronha *et al.* (1996)	Ding and Murinde (2010)	Wang (2010)
Corporate decisions modelled	Investment; New debt; Dividend	Investment; Dividend	Investment; New debt; Dividend	Investment; New debt; Dividend	Investment; New debt; Dividend	Investment; New debt; Dividend	Capital structure; Dividend	Capital structure; Dividend	Investment; New debt; Dividend
Country	US	US	France	US	US	US	US	UK	China
Sample period	1951–1960	1946–1968	1962–1968	1966–1973	1975–1979	1978–1987	1986–1988	1997–2003	2000–2007
Number of companies	181	298	75	112	537–538	100	106	699	2710
Estimation techniques[a]	OLS; 2SLS; 3SLS	OLS; 2SLS	OLS; 2SLS	OLS; 2SLS	2SLS; 3SLS; SUR	VAR	3SLS	Pooled OLS	DAG; PA
Joint determination[b]	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

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

[b.] Findings with regard to whether the corporate decisions modelled in the system are jointly determined.

CHAPTER 3

CORPORATE DECISIONS, FINANCIAL CONSTRAINTS AND UNCERTAINTY

3.1 Introduction

Corporations face investment, financing and payout choices which are known as the trilogy of corporate decisions (Wang, 2010). Although much effort has been devoted to investigating this key set of corporate decisions in the literature, they have typically been treated separately, and hence there has been little analysis of the simultaneity among them. A review of the conventional wisdom on the three aspects of corporate behaviour is provided in Section 2.2, but nothing at all about the interactions that may exist among them.

Chapter 2 of this thesis provides a comprehensive review of relevant literature. Suffice it to point out here that prior research has provided reasons and evidence that financial constraints, such as limited availability of internal finance and access to new external finance, may hamper companies' ability to invest efficiently (see the literature reviewed in Section 2.3). According to this view, companies should consider their fund-raising choices alongside their fund-spending decisions. An important implication is that corporate investment, financing and payout decisions are likely to be interdependent upon one another and jointly determined by management. Nevertheless, previous studies that empirically investigate companies' real and financial decisions overwhelmingly employ single equation techniques, and thus permit no analysis of the contemporaneous interactions among these corporate decisions, leading to incomplete view of corporate behaviour (Gatchev *et al*., 2010). To overcome the shortcoming of single equation techniques, this chapter highlights the potential joint determination of corporate investment, financing and payout decisions by modelling them within a simultaneous system which explicitly allows for the interactions among them. The simultaneity analysis may reveal new insights into the inter-relationships that may exist among the set of corporate decisions, improving our knowledge of the complex corporate decision-making processes.

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 information. As discussed in Section 2.4, recent literature that seeks to explore the determinants of corporate investment behaviour has highlighted the importance of uncertainty associated with companies' prospects. However, the role that uncertainty plays in financing and payout decisions has received little attention. Due to the fact that all corporate decisions are made on the basis of uncertain information, it is plausible to argue that the degree of uncertainty matters in both financing and payout decisions as well. If this is true, uncertainty may not only influence corporate investment decisions directly on its own, but also indirectly through its effects on financing and payout choices. The omission of relevant information in modelling corporate decisions is likely to generate misleading results and lead to inappropriate inferences, which may bias our understanding of corporate behaviour.

Therefore, this chapter seeks to fill these gaps in the literature by considering uncertainty associated with a company's future prospects as a common factor that involved in each of the decisions modelled in our simultaneous system, in an attempt to comprehensively investigate corporate behaviour under uncertainty.

Based on a large panel of UK-listed companies within the period 1999–2008, this chapter empirically investigates the interactions among corporate investment, financing and payout decisions in the presence of financial constraints and uncertainty, contributing to the current knowledge of corporate behaviour in a number of ways. First, we develop a simultaneous equations system that explicitly accounts for the interactions among the three corporate decisions, with each of the decision variables being treated as endogenous and being subject to the constraint that sources must equal uses of funds, as implied by the flow-of-funds framework. The simultaneous equations analysis, therefore, overcomes the shortcomings of single equation techniques that are currently adopted in the existing literature, and provides new insights into the interdependences among corporate decisions in the real world. Second, we include the degree of uncertainty associated with a company's prospects as an explanatory variable in each of the decisions equations modelled in our simultaneous system. By including an uncertainty variable into the simultaneous system, we explicitly allow uncertainty to not only affect each of the corporate decisions directly on its own, but also indirectly through its effect on other corporate decisions. Such analyses can provide us better knowledge of corporate decision-making behaviour under uncertain circumstances.

Third, we explicitly explore the possible mechanisms through which the set of corporate decisions are determined simultaneously, by splitting the whole sample into two with financially more constrained and financially less constrained companies, based on a financial leverage index. We believe that our exclusive research design can shed light and provide a deeper understanding on corporate decision-making behaviour in the real world.

The remainder of this chapter is organised as follows. Section 3.2 reviews the empirical measures of uncertainty used in the existing literature. Section 3.3 develops a theoretical framework. Section 3.4 specifies the corporate behavioural equations. Section 3.5 discusses the sample, variables and preliminary analysis. Section 3.6 describes the estimation and testing procedures as well as the main results for the empirical models. Section 3.7 offers further evidence to check the robustness of our findings. Concluding remarks are drawn in Section 3.8.

3.2 Empirical proxies for uncertainty

The primary challenges of establishing the relations between uncertainty and corporate decisions are to identify the sources and to quantify the levels of uncertainty associated with companies' future prospects (Carruth *et al*., 2000). There is a considerable debate regarding how uncertainty should be captured empirically. To date, no consensus has been reached about the best practice of measuring uncertainty in empirical analyses. A number of broad approaches have been employed in the existing literature to construct proxy measures for uncertainty, but none of them appears without its particular problems and criticisms. This section, therefore, summarises the most commonly used empirical measures of uncertainty in the existing literature, which may provide us with guidance in formulating proxy measures for uncertainty.

3.2.1 Output volatility

Output volatility measures the variation in the expected revenue from an investment project. In the empirical literature, output volatility is typically defined as the variations in product price, product demand or total sales, which can be considered as consequences of demand-side shocks. According to the neoclassical investment model, a company's profit is a convex function with respect to the output price. Increased output volatility, therefore, raises the expected present value of future profit and encourages the company to undertake investment opportunities (see, for example, Hartman, 1972; and Abel, 1983).

Henley *et al*. (2003) measure industry-wide product price uncertainty using a moving standard deviation of the producer price index of the corresponding sector. However, the use of historical volatility has been widely criticised for being backward looking and failing to carry uncertainty information for future periods. In an attempt to devise a better proxy for uncertainty, Ghosal and Loungani (1996) assume that companies attempt to forecast their product prices using an autoregressive (AR) model. They argue that the unpredictable part of the stochastic process can be used to formulate a more reasonable measure that captures output price shocks. Accordingly, they calculate a rolling standard error of the forecasting residuals, and use it as the proxy for output price uncertainty. The major problem of using product price volatility to measure uncertainty is that the price indices are normally only available at aggregate levels, and thus are unlikely to carry uncertainty information specific to individual companies.

Guiso and Parigi (1999) employ product demand volatility to proxy for the output uncertainty. They draw information about managerial perception of future demand for their products from a survey conducted by the Bank of Italy. The conditional mean and variance derived from the survey data are used to measure the expected level of product demand and the expected degree of demand uncertainty, respectively. These measures, based on the managers' subjective certainty about their expectations, are expected to be more closely related to the investment decisions made by individual companies under different circumstances. In much the same vein, Calcagnini and Saltari (2001) also derive a proxy for uncertainty from business survey results regarding expected growth in demand, and use it to analyse the relationship between investment and demand uncertainty at aggregate level. However, due to the limited availability of survey data, the use of survey-based demand uncertainty proxies is relatively rare in the existing literature.

The most commonly used output uncertainty proxy is based on the volatility of companies' total sales. Because sales data can be easily obtained from a company's income statement, it enables empirical studies to more accurately explore the effect of a company's idiosyncratic output uncertainty on its investment decisions by using company-specific information. Lensink and Sterken (2000) measure companies' output uncertainty using the standard deviation of historical total sales. To account for the size effect, the standard deviation of total sales is scaled by its mean value to form the coefficient of variation of the underlying variable. The use of proxy for uncertainty at disaggregate level can effectively deal with the problems of heterogeneity across companies which may potentially bias the results from studies at aggregate levels (Carruth *et al*., 2000).

3.2.2 Input volatility

Input volatility measures uncertainty with respect to the prices of labour, raw materials and other on-going operating expenses that extend over time once a project is committed. Input volatility measures are expected to capture the supply-side uncertainty.

By assuming a fixed capital-labour ratio for a given level of technology, Huizinga (1993) considers the real wage as a proxy for the on-going operating expense. Accordingly, he constructs a bivariate autoregressive conditional heteroscedasticity (ARCH) model to estimate the conditional standard deviation of quarterly real wage, which is then used as a proxy for uncertainty associated with input costs in a model of aggregate investment. Besides this, Huizinga (1993) constructs another proxy for input uncertainty based on the volatility of material prices. It is found that aggregate investment appears to be negatively associated with both real wage and material price volatility. The results also indicate that any single volatility measure at aggregate levels is unlikely to adequately capture the various dimensions of uncertainty faced by a company. At disaggregate level, Lensink and Sterken (2000) use the volatility of employee costs as one of the proxies for uncertainty to investigation investment behaviour of companies under uncertain circumstances. However, due to the limited time period for company-level data, they simply measure uncertainty using the coefficient of variation of the underlying variable.

3.2.3 Profit volatility

Profit variables take both sales and costs into consideration, and thus the variation in profit counts for both input and output uncertainties. Therefore, profit volatility is typically regarded as a more general and more plausible proxy for uncertainty that carries information more relevant to an individual company's corporate decisions.

The standard deviation of the unpredictable component of profit has been widely used in empirical studies as a proxy for uncertainty. For example, Ghosal and Loungani (2000) set up a basic autoregressive forecasting equation for profit variable, and measure uncertainty using the standard deviation of the forecasting residuals. However, it is documented that the main concern about proxies for uncertainty derived from the forecasting residuals is that they are likely to be sensitive to the specification of the forecasting models (Carruth *et al.*, 2000). Therefore, it is important to carry out various specification tests to ensure that the forecasting model is correctly specified and statistically adequate.

Bond and Cummins (2004) develop a more innovative approach to measure uncertainty based on analysts' profits forecasts. They argue that more disagreement among different securities analysts is likely to be associated with greater underlying uncertainty about a company's future prospects. Accordingly, Bond and Cummins (2004) measure the dispersion across individual analysts' earnings per share forecasts for each company, and use it as a proxy for the company's profit uncertainty in their empirical investigation into the investment-uncertainty relationship. In addition, Bond and Cummins (2004) construct an alternative proxy for profit uncertainty using the variance of analyst forecast error, by arguing that large analyst forecast error is likely to reflect a high degree of uncertainty, and vice versa. The main advantage of Bond and Cummins' (2004) novel measures of uncertainty is that they carry information directly related to agents' expectation on companies' future profitability. However, the sample size is limited by the number of companies with sufficient analyst following.

3.2.4 Stock returns volatility

Stock returns volatility measures the variation of the changes in a company's share price. If the market is efficient, all information about a company's asset fundamentals and growth opportunities should be properly translated into its share price. Thus, the volatility of a company's stock returns is expected to summarise the volatilities of all aspects of the company's future prospects, capturing the overall uncertainty relevant to the company's investment decisions. This approach is adopted by most recent empirical studies to construct forward looking uncertainty measures, and the difference mainly lies in the statistics used to measure the volatility.

The standard deviation of stock returns is the most commonly used statistic to measure uncertainty. For example, Bond and Cummins (2004) and Lensink and Murinde (2006) simply quantify the degree of uncertainty faced by a company using the standard deviation of its daily stock returns observed over the period. A similar methodology is employed in Bulan (2005), where the standard deviation of daily stock returns is annualised to match the financial variables, which are only available on a yearly basis. However, there is a growing body of evidence suggests that the use of more sophisticated time series models can lead to better predictions of future volatility.

Since the stock market data are reported at a sufficient high frequency, it facilitates the application of the generalised autoregressive conditional heteroscedasticity (GARCH)-type modelling of volatility, which is able to generate more precise estimates of future uncertainty. To take the advantage of the high-frequency stock market information, Lensink and Murinde (2006) set up an autoregressive model to estimate the conditional mean of the stock returns, and simultaneously specify a GARCH model to estimate its conditional variance and thus conditional standard deviation. The average of the estimated conditional standard deviations over each period is then calculated for each company and used as a measure of the company's idiosyncratic uncertainty for the corresponding period. In order to account for the asymmetric component embedded in the volatility of stock returns, Bo and Lensink (2005) specify both threshold ARCH (TARCH) and exponential GARCH (EGARCH) models to derive volatility measures. These extended GARCH-type model allow for the asymmetric response of stock return volatility to positive and negative shocks. Specifically, negative shocks are allowed to have more impact on future volatility than positive shocks are the same magnitude.

Similar methodologies are also employed to measure aggregate uncertainty at industry and market levels, for example, the standard deviation of monthly stock market returns is used in Lensink (2002) as an uncertainty measure at aggregate level. Moreover, the use of aggregate stock market series also provides a channel to decompose a company's overall uncertainty into its market, industry and company-specific components. Bulan (2005) uses the volatility of daily stock returns as a proxy for the company's overall uncertainty. Similarly, the volatilities of daily returns on market index and industry index are considered as proxies for total market uncertainty and total industry uncertainty, respectively. A recent study by Baum *et al*. (2008) also utilises the intra-annual volatilities of daily stock returns and market index returns to distinguish between intrinsic and extrinsic uncertainty.

However, the use of stock returns volatility as proxy for uncertainty can be criticised from several aspects. The main concern with this approach is that share prices may be too noisy to provide useful information, because the volatility in stock market returns is likely to be driven not only by movements in company fundamentals but also by speculative bubbles. Besides, there is also a criticism that, although stock market returns may contain certain information about a company's cash flow uncertainty, they may reveal rather less about uncertainty associated with future economic shocks and policy changes, thus fail to capture the overall uncertainty associated with the company's future prospects (Carruth *et al*. 2000).

3.2.5 Macroeconomic volatility

Macroeconomic uncertainty is also considered by some empirical studies, especially those at aggregate levels. The volatilities of macroeconomic variables, such as GDP, interest rate, inflation rate and exchange rate, are expected to have influence on the corporate decisions of a large number of companies in an economy.

It is well documented that, since an economy faces more uncertainty in the distant future than in the near term, longer maturity of bonds entails greater uncertainty for investors. Under the assumption of risk aversion, the holders of long-term bonds, who are subject to greater risk, must be compensated by a risk premium. Therefore, the risk premium embedded in the term structure of interest rates facilitates the measuring of uncertainty associated with the macro economy. Accordingly, Ferderer (1993) uses the expected excess holding period return of long-term bonds over short-term bonds to estimate the risk premium. The implicit risk premium embedded in the term structure of interest rate is then used as a proxy for the uncertainty associated with interest rates and other macroeconomic variables.

Apart from the measure derived from the term structure of interest rate, macroeconomic volatility is also typically estimated based on the variations in GDP, inflation rate and exchange rate. For example, Price (1995) utilises a GARCH-in-mean (GARCH-M) estimate of conditional variance of GDP as a proxy for macroeconomic uncertainty. However, it is criticised that macroeconomic volatility measures are unlikely to adequately capture the various dimensions of uncertainty faced by corporate decision makers, and thus fail to capture all relevant uncertainty sources (Carruth *et al*., 2000).

As can be seen, there is no consensus about how uncertainty should be captured empirically. A number of broad approaches have been adopted in the existing literature to formulate proxy measures of uncertainty, ranging from output volatility to input volatility and from stock return volatility to macroeconomic volatility. Nevertheless, it is generally agreed that corporate decisions tend to be more sensitive to company idiosyncratic uncertainty than to macroeconomic uncertainty which affect all companies in general. Thus, uncertainty measures at disaggregate levels should be better able to capture all relevant uncertainty sources which may affect an individual company's decisions. Meanwhile, it is also widely believed that, compared with backward looking measures, forward looking measures reveal more information about both the range and the magnitude of uncertainty facing corporate decision makers (Carruth *et al*., 2000). Therefore, it is desirable to construct forward looking measures of uncertainty at company level to investigate aspects of corporate behaviour under uncertain circumstances.

3.3 An information asymmetry-based flow-of-funds framework for corporate behaviour

To justify the fundamental interactions among corporate investment, financing and payout decisions, we derive a model from a company's flow-of-funds identity, i.e. a company's uses of funds must equal its sources of funds. Based on stylised financial statements, a company's main sources and uses of funds identity can be expressed as follows,

$$\Delta FA + \Delta CA + DIV = \Delta LD + \Delta SD + \Delta EQU + PRO + DEP \quad (3.1)$$

where *FA* represents 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 companies raise funds from external debt (Δ*LD* and Δ*SD*), external equity (Δ*EQU*) as well as internally generated cash flow (*PRO* and *DEP*), and spend it on investment in assets (Δ*FA* and Δ*CA*) and dividend payout (*DIV*). The overriding constraint presented in Equation 3.1 is that the uses of funds must equal the sources of funds. If the capital markets are sufficiently imperfect, companies 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. The flow-of-funds identity specified in Equation 3.1 can also be reparameterised into the following form,

$$INV + \Delta CA + DIV = NDF + \Delta SD + \Delta EQU + PRO + DEP \quad (3.2)$$

where *INV* represents investment, i.e. the change in fixed assets over a period (Δ*FA*), *NDF* represents the net amount of new debt issued, i.e. the change in long-term debt outstanding (Δ*LD*). Among the various uses and sources of funds specified in Equation 3.2, the primary focus of our model is on capital investment (*INV*), long-term debt financing (*NDF*) and dividend payout (*DIV*) decisions. Internally generated cash flow (*CF*), which can be defined as the sum of net income (*PRO*) and non-cash expenses (*DEP*), is assumed to be determined by past investment and financing decisions.[13] Following the tradition of the corporate finance literature, we treat internally generated cash flow as exogenous or predetermined in our model. Moreover, it is argued that the changes in the elements contained in current assets (*CA*) and short-term debts (*SD*), such as inventories, accounts receivable, and accounts payable, are likely to be triggered by economic conditions, thus cannot be interpreted as the result of conscious decisions made by managers (see, for example, Kadapakkam *et al*., 1998). Accordingly, we treat the net changes in working capital (ΔWC, which is equivalent to $\Delta CA - \Delta SD$) as unintended residuals that balance the uses and sources of funds. Besides, in the presence of information asymmetry, 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 the stock market for fear of sending a negative signal to the markets. As a result, external equity financing is typically considered as a last resort and is rarely used. Given the fact that external equity finance is a less significant source of funds for listed companies after their initial public offerings, we drop ΔEQU from the flow-of-funds framework for simplicity.[14] Therefore, the reduced form flow-of-funds identity can be specified as follows,

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[13] It is believed that corporate decisions affect output (and profits) only with lags so that current corporate decisions affect only future output and hence profits, and that current output and current profits are not affected by current corporate decisions (see, for example, Dhrymes and Kurz, 1967; and McCabe, 1979).

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

$$INV + DIV + \Delta WC \approx NDF + CF \tag{3.3}$$

where *INV*, *NDF* and *DIV* are the three endogenous variables, representing investment outlays, net long-term debt financing and dividend payout respectively; *CF* represents cash flow, which is taken as exogenous; ΔWC represents the net change in working capital, which is considered as the residual to balance company's uses and sources of funds. Since the external equity financing variable (ΔEQU) is omitted in Equation 3.3, the reduced form flow-of-funds identity is no longer an equality (=) but an approximation ($\approx$). Given the arguments presented above, the number of endogenous variables in the simultaneous equations system reduces to three, namely, capital investment, long-term debt financing and dividend payout. Thus, the empirical framework comprises estimation of the following simultaneous equations system,

$$INV = f(NDF, DIV, CF, A) \tag{3.4}$$

$$NDF = f(INV, DIV, CF, B) \tag{3.5}$$

$$DIV = f(NDF, INV, CF, C) \tag{3.6}$$

where *A*, *B* and *C* are vectors of other exogenous variables which, according to existing literature, are the stylised determinants of corporate investment, financing and payout decisions, respectively. 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. It is worth mentioning that, although the net changes in working capital (ΔWC) is considered as the residual to balance company's uses and sources of funds, there is nevertheless a behavioural relation implied for working capital by Equations 3.4–3.6 through the adding-up restrictions implied by the reduced form flow-of-funds identity specified as Equation 3.3. The implication for working capital, however, is beyond the scope of this study.

We hypothesise that, in the presence of information asymmetry, both internal and external funds available for investment are likely to be constrained. To provide further insights into the potential interactions among the set of corporate decisions, in particular the influence of a company's financial decisions on its real decisions, we appeal to the superior knowledge that managers may possess about the company's fundamentals and prospects.

Miller and Rock (1985) hypothesise that, in the presence of information asymmetry, managers may use dividends as a signal to reveal some of their private information to the markets. The signalling effect of dividends is so well-known and widely accepted that mangers are not only reluctant to cut dividends in order to avoid the anticipated negative market reactions, but also 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. Due to the stickiness of dividends under such circumstances, raising funds for investment from internally generated cash flow becomes less flexible. As a consequence, the variation in investment expenditures cannot be soaked up freely by retained earnings. Therefore, the company may be forced to forego relatively low net present value 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 owing to the costs created by managers' superior information. Managers' efforts to issue risky securities tend to be interpreted as a signal that the company is overvalued. Myers and Majluf (1984) argue that, in the presence of information asymmetry, outsiders are likely to underprice risky securities, thereby external finance is more costly than internal finance, and external equity is more costly than external debt. Accordingly, managers prefer to finance all of the uses of funds with internally generated funds, which have a cost advantage and no information asymmetry problem. If 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 company's borrowing capacity at a given cost, a decline in new debt financing may inhibit the company's capital spending and may also cause capital rationing.

In a nutshell, asymmetric information not only constrains a company's access to internally generated funds via its effect on dividends, it also limits the company's ability in raising external funds. Therefore, corporate decisions are likely to be made simultaneously by managers with full recognition of competing needs for funds and alternative sources of funds.

The hypothesised relationships between each pair of the three endogenous variables are presented in Table 3.1. It is worth noting that the coefficient estimates for Equations 3.4– 3.6 throughout the thesis reflect conditional responses and this conditioning includes the simultaneously determined variables, i.e. *INV*, *NDF* and *DIV*. Also note that this thesis does not aim to disentangle all possible mechanisms through which corporate decisions are likely to be interdependent upon one another, as discussed in Section 2.3. Rather, we focus on the information asymmetry-based flow-of-funds framework of corporate behaviour. Other approaches may have very different implications for the interactions among the corporate decisions.

Table 3.1: Endogenous corporate decision variables and hypothesised interactions under the flow-of-funds framework for corporate behaviour[a]

Variable	Economic argument	Expected sign
NDF→INV	Decreases in new borrowing result to capital rationing and inhibits investment	+
DIV→INV	Increases in dividends reduce the pool of funds available to investment	–
INV→NDF	Increases in investment motivate a company to utilise its borrowing capacity	+
DIV→NDF	Increases in dividends limit the access to retained earnings and force a company to rely more heavily on debt for financing	+
INV→DIV	Decreases in investment spending enable a company to pay more dividends	–
NDF→DIV	Increases in debt financing allow a company to carry out planned dividend payout even when the profitability is low in the short run	+

Notes:

a. It is worth noting that the expected signs are hypothesised under the information asymmetry-based flow-of-funds framework. Other theoretical arguments of corporate behaviour may have very different implications for the interactions among corporate investment, financing, and dividend decisions.

3.4 Modelling corporate investment, financing and payout behaviour

3.4.1 Corporate investment equation

The investment equation specified in this thesis is based on a simple *Q* model, which is then extended by including the cash flow variable, used as a proxy for internal financial constraints, and debt financing and dividend payout variables that may potentially affect investment spending according to the flow-of-funds framework under information asymmetry. Besides, in order to empirically address the investment-uncertainty ambiguity, a proxy for uncertainty is included as well. Therefore, the investment equation is specified as follows,

$$\frac{INV}{K}_{it} = \alpha_0 + \alpha_1 \frac{NDF}{K}_{it} + \alpha_2 \frac{DIV}{K}_{it} + \alpha_3 \frac{CF}{K}_{it} + \alpha_4 Q_{it} + \alpha_5 \frac{INV}{K}_{it-1} + \alpha_6 UNC_{it-1} + \varepsilon_{it} \tag{3.7}$$

where *INV* represents the gross investment, *NDF* net new debt financing, *DIV* dividend payout, *CF* cash flow, *Q* the ratio of market to book value of total assets, *UNC* the measure of uncertainty, and ε an error term. A lagged investment variable is also included to capture the dynamic structure of the investment decision as implied by many empirical studies in this area (see, for example, Guariglia, 2008; and Lensink and Murinde, 2006). In addition, the corporate decisions are assumed to be made at the beginning of each year, and thus a lagged uncertainty variable is included to proxy for the perception of uncertainty when companies make corporate decisions at the beginning of each fiscal year for the year ahead, i.e. managers form their perceptions of uncertainty at the beginning of the year *t* (or end of year *t*–1) according to the information set available, and then decide how to finance and allocate their funds for the year *t*. The use of a lagged uncertainty variable, therefore, reduces the possibility of using more information in modelling corporate behaviour than managers actually have when they make their decisions (see, for example, Baum *et al.*, 2008).

All of the corporate decision and cash flow variables in Equation 3.7 are scaled by beginning-of-period capital stock (*K*), in order to control for company size and to reduce heteroscedasticity problems that may otherwise arise in the company-level data. We choose the beginning-of-period value as the deflator based on the assumption that all the key corporate decisions are made at the beginning of each fiscal year (see, for example, Bulan, 2005). Scaling by capital stock rather than total assets or sales is done because capital stock is relatively more stable over time and less likely to be distorted by economic conditions, thus the corporate policies can be better isolated (see, for example, Bond and Meghir, 1994).[15]

3.4.2 Debt financing equation

In the spirit of the literature on the financing hierarchy with asymmetric information, we specify the financing equation on the basis of pecking order theory (see, for example, Bharath *et al.*, 2009; Frank and Goyal, 2003; and Shyam-Sunder and Myers, 1999). Accordingly, the net amount of debt issued by a company is expected to be driven by the company's financing

[15] Bond and Meghir (1994) use investment to capital stock ratio, cash flow to capital stock ratio, debt to capital stock ratio and dividend payment to capital stock ratio to investigate the sensitivity of companies' investment spending to the availability of funds, using a panel of UK companies.

deficit, which can be reasonably captured by the linear combination of investment, dividend and cash flow variables according to its accounting definition (Shyam-Sunder and Myers, 1999).[16] It is well documented that pecking order theory is only partially successful in explaining companies' financing decisions, and its explanatory power can be significantly improved by including some factors suggested by other theories (see, for example, Leary and Roberts, 2010; and Bharath *et al*., 2009). Accordingly, we modify the strict pecking order model by controlling for stylised leverage factors such as company size and asset tangibility variables, which are used to proxy for companies' ability to access to external capital market and their collateral value, respectively. Uncertainty is also included because of its potential effect on financing decision. Therefore, the financing equation is specified as follows,

$$\frac{NDF}{K}_{it} = \beta_0 + \beta_1 \frac{INV}{K}_{it} + \beta_2 \frac{DIV}{K}_{it} + \beta_3 \frac{CF}{K}_{it} + \beta_4 TAN_{it} + \beta_5 SZ_{it} + \beta_6 UNC_{it-1} + \mu_{it} \tag{3.8}$$

where *TAN* is asset tangibility; *SZ* represents company size; and μ is an error term. Large companies tend to have a reputation of low default risk, with easy access to external capital markets. Tangible assets are easy for outsiders to value, mitigating the problem of information asymmetry and lowering the risk premium of borrowing. Thus, companies with both large

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16 Financing deficit (*DEF*) can be derived from a partially aggregated form of the flow of fund identify. More specifically, $DEF = DIV + INV - CF + \Delta WC$.

size and high level of tangible assets should be able to carry more debt. Besides, greater uncertainty is likely to exacerbate the degree of information asymmetry between insiders and outside capital markets, which in turn may generate a more significant cost disadvantage of external debt financing or even result in credit rationing. Companies, therefore, are likely to be required to pay a higher premium for new borrowing or be denied loans. Accordingly, we hypothesise a negative effect of uncertainty on the net amount of debt issued.

3.4.3 Dividend payout equation

The corporate payout equation is modelled on the basis of the signalling hypothesis of information asymmetry. Since the existing empirical evidence suggests that no single theory can fully explain the dividend puzzle (see Frankfurter and Wood, 2002), we utilise additional company characteristics variables, such as ownership structure and financial life cycle stage, to explain dividend payout behaviour. These factors are generally believed to be the primary determinants of dividend policy, according to the stylised facts.[17] Again, we include the proxy for uncertainty into the equation as well. The dividend model is specified as follows,

$$\frac{DIV}{K}_{it} = \gamma_0 + \gamma_1 \frac{INV}{K}_{it} + \gamma_2 \frac{NDF}{K}_{it} + \gamma_3 \frac{CF}{K}_{it} + \gamma_4 OWN_{it} + \gamma_5 \frac{RE}{TE}_{it} + \gamma_6 UNC_{it-1} + v_{it} \tag{3.9}$$

[17] Some studies also employ lagged dividend status as an explanatory variable (see, for example, Ferris *et al.*, 2009; and Khan, 2006). However, Fama and French (2001) argue that including a lagged dividend status is problematic because the resultant model seeks to explain a company's current dividend decision on the basis of the same decision made recently by the same company. Therefore, we ignore lagged dividend status in modelling corporate payout behaviour.

where *OWN* is insider ownership structure; *RE/TE* is a retained earnings-to-total equity ratio, a proxy for a company's financial life cycle stage; and ν is an error terms. Cash flow and retained earnings-to-total equity ratio are expected to have positive effects on dividend payout, whilst insider ownership is expected to have a negative effect. The relationship between uncertainty and dividend payout, however, is not so clear-cut. It is reasonable to argue that, with asymmetric information, managers adjust dividend payouts upward or downward only on a permanent change in their business environment. 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, uncertainty may dampen the response of dividend payout to cash flow. It is equally plausible to argue that a company's prospects are less predictable under 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.[18] We therefore expect the effect of uncertainty on corporate dividend payout to be neutral or negative.

3.5 Data and preliminary analysis

3.5.1 Data and measurement

The data are collected from the Worldscope database via Thomson One Banker Analytics. The

[18] Sant and Cowan (1994) assert that, if managers' confidence interval on the company's future performances no longer reassures them that they will be able to continue the current payout, they may cut or even omit dividends. Both decreased expected performance and increased variance of future performances may make managers' confidence interval less reassuring

initial sample includes all companies listed on the London Stock Exchange (LSE), including both active and inactive companies within the period 1999–2008. We then discard utilities (Standard Industrial Classification (SIC) code 4900–4949), and financial companies (SIC code 6000–6999). Companies that do not have complete records for the key data, such as capital investment committed, new debt issued and cash dividends paid, and those with less than five years of continuous observations are dropped from our sample. We also exclude company-year observations with negative cash flow from our sample. An unbalanced panel of company-level data is formed to avoid survivorship bias.[19] Stock prices are retrieved from DataStream for the same batch of companies over the same period of time.

To make full use of the data, a company-year observation is included in the sample for single equation analyses as long as it has records on the relevant variables in determining the corporate decision under investigation. For example, our single equation analysis for corporate investment behaviour utilises all the company-year observations which have records for *INV/K*, *NDF/K*, *DIV/K*, *CF/K*, *Q*, $(INV/K)_{-1}$ and *UNC*. However, for the simultaneous equations analyses, a company-year observation can be utilised only if it has complete records on all the relevant variables in determining the three corporate decisions. The number of company-year observations included in the final sample for our simultaneous equations analyses therefore reduces to 2,791.

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[19] The empirical investigation is based on an unbalanced panel of company-level data, which means that not only active but also dead and suspended listed companies on LSE are included in the sample.

Table 3.2: Description of main variables used in Chapter 3[a]

Gross investment (*INV*):

The sum of the changes in book value of net property, plant and equipment and depreciation expenses[b]

Net debt financing (*NDF*):

The change 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

Capital stock (*K*):

The book value of tangible fixed assets

Average *Q* (*Q*):

The ratio of the market value of equity plus the book value of debt to the book value of total assets

Company 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 (*UNC*1):

The difference between the highest and the lowest prices normalised by the mean over the period

Uncertainty measure 2 (*UNC*2):

The conventional standard deviation of daily stock market returns over the period

Uncertainty measure 3 (*UNC*3):

The average of conditional standard deviations of daily stock returns over the period

Financial leverage index (*FLI*):

The ratio of return on average assets to return on average equity

Notes:

a. The definition and measurement of the variables are based on the existing literature.

b. The data are collected from the Worldscope database via Thomson One Banker Analytics, except the daily share prices used to construct uncertainty measures 2 and 3, which were obtained from the DataStream database.

The definition of each variable used in this chapter is described in Table 3.2. As discussed in Section 3.2, constructing an appropriate proxy for uncertainty is the primary challenge faced by studies investigating the effects of uncertainty on corporate behaviour. We construct three proxies for uncertainty based on stock prices, under the assumption that all the information about a company's fundamentals and prospects will be properly transmitted into its share price.[20] The first proxy for uncertainty is share price volatility (*UNC*1), which is measured as the difference between the highest and the lowest prices normalised by the mean value for each year. The second proxy is the conventional standard deviation of daily stock market returns for each year (*UNC*2). Besides, the possible volatility clustering effect of stock market returns motivates us to derive a third measure of uncertainty (*UNC*3), which is estimated from a GARCH (1, 1) model specified as follows,

$$R_t = \phi_0 + \phi_1 R_{t-1} + \phi_2 R_{t-2} + u_t \tag{3.10}$$

$$\sigma_t^2 = \varphi_0 + \varphi_1 u_{t-1}^2 + \varphi_2 \sigma_{t-1}^2 \tag{3.11}$$

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 company by company over the entire sample period under

[20] The proxies for uncertainty based on stock market information are expected to be forward-looking indicators and able to capture the overall uncertainty associated with the changing aspects of a company's business environment. Share prices tend to fluctuate more when the prospects are less predictable.

investigation. To construct a proxy for uncertainty on yearly basis, we first take the square root of the estimated daily conditional variances to obtain the 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.

All the three proxies for uncertainty are derived from information on the volatility of individual companies' stock prices, and therefore are forward looking in nature. However, the main concern is that the high-frequency stock market data may reflect not only companies' fundamentals but also bubbles and fads, making this type of proxy for uncertainty too noisy (see, for example, Bond and Cummins, 2004; and Bloom *et al*., 2007). In particular, the use of daily stock returns may produce extremely noisy proxies for uncertainty. Thus, among the three alternatives, *UNC*1 is treated as the primary measure of uncertainty, because it is constructed as the normalised difference between yearly high and yearly low prices, and hence should be better able to match companies' annual financial data and to reduce the impact of high-frequency noise that may be present in the daily observations. *UNC*2 and *UNC*3 are used as supplementary measures of uncertainty.[21] Therefore, our empirical findings on the effects of uncertainty on corporate decisions are mainly drawn from the sign and significance level of the coefficient on *UNC*1 in the corresponding equations.

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[21] Lensink and Murinde (2006) also point out that the standard deviation of daily stock market returns and the average of daily conditional standard deviations of stock market returns do not measure annual volatility but the average daily volatility in the respective year. Another reason for using *UNC*1 as our primary measure of uncertainty is that the data on this variable, as well as the other accounting items, are collected from the Worldscope database, whereas the daily share prices used to compute *UNC*2 and *UNC*3 are collected from the DataStream database. Once the two datasets are merged, the number of observations declines significantly.

Table 3.3: Descriptive statistics for main variables used in Chapter 3[a]

Variable	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Obs.
***Panel A: Descriptive statistics of variables without winsorisation*[b]**								
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
*UNC*1	0.3122	0.2972	0.72	0.02	0.1046	0.7052	3	3423
*UNC*2	0.0293	0.0231	0.35	0.00	0.0234	3.3704	31	1907
*UNC*3	0.0299	0.0261	0.33	0.00	0.0198	3.1983	36	1799
***Panel B: Descriptive statistics of variables winsorised at the top and bottom 5th percentiles*[c]**								
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
*UNC*1	0.3123	0.2972	0.5591	0.1714	0.0992	0.6307	2.7302	3423
*UNC*2	0.0281	0.0231	0.0711	0.0054	0.0181	0.9267	2.9597	1907
*UNC*3	0.0291	0.0261	0.0634	0.0078	0.0159	0.6123	2.3965	1799

Notes:

a. The sample contains UK company-year data observed within the period 1999–2008.

b. Winsorisation is the transformation of extreme values in the statistical data.

c. The transformed data are identical to the original data except that, in this case, all data below the 5th percentile are set to the 5th percentile and all data above the 95th percentile are set to the 95th percentile.

Panel A of Table 3.3 presents the descriptive statistics for the main variables from our raw data. As is evident, extreme values appear in almost all the variables, especially those that are constructed as ratios. Baum *et al.* (2008) point out that the values of the investment-to-capital, cash flow-to-capital, debt-to-capital ratios and Tobin's *Q* outside the 5th and 95th percentile range should be judged implausible, and thus should be screened to reduce the potential impact of outliers upon the parameter estimates. Accordingly, we winsorise all the variables used in our analysis at the top and bottom 5th percentiles of their respective distributions. Specifically, the winsorisation transformation would set all observations below the 5th percentile equal to the 5th percentile, and observations above the 95th percentile equal to the 95th percentile. Such a transformation not only reduces the potential impact of outliers but also allows the full use of observations. Panel B reports the descriptive statistics after such a transformation is undertaken. It shows that the maximum values of *INV/K*, *NDF/K* and *DIV/K* reduce from 960.43, 243.45 and 48.00 to 2.35, 1.95 and 1.09, respectively. The standard deviations for each of these variables reduce from 16.61, 5.71 and 1.45 to 0.53, 0.53 and 0.27, respectively, and more importantly, their distributions are more close to normality after the transformation, as suggested by the skewness and kurtosis statistics. Since the winsorisation estimators are expected to be more robust, our empirical results presented hereafter are, therefore, obtained by using the winsorised variables.[22]

[22] It is believed that winsorisation is superior to the more standard transformations such as trimming. Winsorisation not only reduces the influences of outliers, but also allows us to make full use of the sample observations (see, for example, Chay and Suh, 2009).

Table 3.4: Correlation coefficient matrix of variables used in Chapter 3[a]

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[b] ***[c]	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] The sample contains UK company-year data observed for the period 1999–2008.

[b] For each cell, the reported figure is the pair-wise Pearson correlation coefficient between the corresponding variables.

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

The pair-wise correlation among the main variables is presented in Table 3.4. It shows that the three endogenous variables (namely, *INV/K*, *NDF/K* and *DIV/K*) are significantly correlated with one another, and that the predetermined cash flow variable (*CF/K*) is significantly correlated with all three endogenous variables. However, the correlation coefficients between endogenous variables are uniformly positive, which is not entirely consistent with the implications of flow-of-funds framework. It is also evident that the uncertainty proxy (*UNC*1) is significantly and positively correlated with corporate investment (*INV/K*), and weakly and negatively correlated with the new debt financing ratio (*NDF/K*) and dividend payout ratio (*DIV/K*). Finally, the correlations between the endogenous variables and other relevant exogenous variables are also informative. According to Table 3.4, *INV/K* is significantly and positively correlated with investment opportunities (*Q*); *NDF/K* is positively correlated with company size (*SZ*) but negatively correlated with asset tangibility (*TAN*); *DIV/K* is positively correlated with company's financial life cycle 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.

3.5.2 Preliminary diagnostic tests

Since the simultaneous determination of corporate investment, financing and payout decisions hypothesised in this thesis is based on the reduced form flow-of-funds identity alongside a number of associated assumptions, it is desirable to explicitly test the validity of these assumptions using our dataset before we proceed to the analysis of simultaneity among the set of corporate decisions.

3.5.2.1 Test for validity of the reduced form flow-of-funds identity

To derive the reduced form flow-of-funds identify, we assume that external equity financing is considered by managers as the last resort and thus rarely used in practice. Base on the assumption that external equity finance is a less significant source of funds for listed companies after their IPOs (see Shyam-Sunder and Myers, 1999; and Cleary *et al.*, 2007), we drop it from the flow-of-funds framework. To verify the assumption, we empirically test whether the reduced form flow-of-funds identity holds with respect to the UK-listed companies. Given the difficulties in measuring external equity financing in practice, we verify the validity of the reduced form identity and the associated assumption by testing the equality of the uses and sources of funds as specified in Equation 3.3. If the reduced form flow-of-funds identity is supported by our dataset, then external equity finance can 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, apart from external equity finance, for the UK-listed companies over the period under investigation are summarised in Table 3.5. The total uses and sources of funds are compared under a *t*-test framework. Both paired and unpaired mean-comparison tests are carried out to test for equality between the uses and sources of funds. According to the evidence obtained from the panel of UK-listed companies, the reduced form flow-of-funds identity is empirically supported in most of instances, suggesting that the sum of investment outlays, dividend payouts and change in working capital is approximately equal to the sum of external debt financing and internally generated cash flow. The uses and sources of funds identity is only rejected for years 2000 and 2007 under the paired *t*-test and for year 2007 under the unpaired *t*-test. The rejections of equality for in both cases are likely to be caused by the extreme economic environment under the dot-com crisis in 2000 and the global financial crisis starts in 2007, respectively. Overall, the reduced form flow-of-funds identity is verified by the pooled UK company-year observations over the entire period under investigation. We, therefore, can conclude that the reduced form flow-of-funds identity holds in the context of our investigation.

Another interesting result observed from Table 3.5 is that, compared with capital investment and dividends spending, the funds spent on working capital (ΔWC) is of minor significance for most of the years. The mean values for capital investment, dividend payout and spending on working capital made by UK-listed companies during the period from 1999 to 2008 are 74.28, 31.09 and 0.80 million pounds, respectively. The empirical evidence clearly shows that compared with capital investment and dividend outlays the funds spent on working capital (ΔWC) is of minor significance for UK-listed companies. In addition, the signs on the net spending on working capital are not consistent over the period under investigation, with 5 positive and 5 negative values observed during the ten-year observation window. This evidence empirically rationalises the view that net changes in working capital can be considered as residual to balancing the uses and sources of funds.

Table 3.5: Tests for equality of uses and sources of funds[a]

Year	Obs.[b]	*INV*	*DIV*	Δ*WK*	Total uses of funds	*NDF*	*CF*	Total sources of funds	Difference between uses and sources	Mean-comparison *t*-test (paired)[c]	Mean-comparison *t*-test (unpaired)[d]
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 millions.

[b.] The sample contains all the company-year observations in our dataset which have records for *INV*, *DIV*, Δ*WK*, *NDF* and *CF*. To check the robustness of the test results, we also carry out the same tests for the subsample of 2,791 company-year observations used for our simultaneous equations analyses, and qualitatively similar results are obtained.

[c.] 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.

[d.] 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.

Overall, the empirical evidence presented in Table 3.5 clearly demonstrates that the UK-listed companies raise funds mainly from internally generated cash flow and external debt finance, and spend it chiefly on capital investment and dividend payouts. Therefore, it is valid to derive the simultaneous equations system based on the reduced form flow-of-funds identity, which allows us to focus directly on the possible interactions among corporate investment, financing and payout decisions made by UK-listed companies.

3.5.2.2 Test for endogeneity of corporate decisions variables

Although the potential simultaneity that may exist among corporate investment, financing and payout decisions has been rationalised from a theoretical perspective, it is still important to test the hypothesis explicitly before proceeding to the simultaneous equations analysis of the set of corporate decisions. If the variables specified as endogenous can in fact be treated as exogenous, the coefficients estimated using simultaneous analyses are likely to be inefficient. To empirically justify the simultaneity of corporate decisions, we apply both the Hausman test for endogeneity and an enhanced test for endogeneity developed by Baum *et al.* (2007) to the corporate decision variables that are specified as endogenous in the simultaneous equations system. The enhanced test for endogeneity is equivalent to the Hausman test under conditional homoscedasticity. Unlike the Hausman test, the enhanced test for endogeneity provided by Baum *et al.* (2007) is robust to various violations of conditional homoscedasticity. Under the null hypothesis of the endogeneity test, the might-be-endogenous variables can actually be treated as exogenous, and the test statistic follows a *Chi*-squared distribution with degrees of freedom equal to the number of might-be-endogenous variables being tested. If the null hypothesis is rejected, the necessity of a simultaneous equations model can be statistically justified. The endogeneity test results are presented in Table 3.6.

Table 3.6: Endogeneity tests for corporate decision variables

	Investment Equation INV/K	Financing Equation NDF/K	Dividend Equation DIV/K
Regressors tested[a]	$(NDF/K)_t$; $(DIV/K)_t$	$(INV/K)_t$; $(DIV/K)_t$	$(INV/K)_t$; $(NDF/K)_t$
Instrumental variables used[b]	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;
Hausman test for endogeneity[c]	42.220***	15.950***	16.090***
(p-value)	(0.0000)	(0.0000)	(0.0000)
Enhanced test for endogeneity[d]	47.116***	12.931***	16.092***
(p-value)	(0.0000)	(0.0016)	(0.0003)

Notes:

a. The variables that are specified as endogenous in the regression.

b. The variables that are used as instruments for the specified endogenous variables being tested.

c. The Hausman test for endogeneity is formed by including the residuals of each right-hand side endogenous variable, as a function of the exogenous variables, in a regression of the original model. An F-test is then used to test a joint restriction that the coefficients on the residuals are all equal to zero. Under the null hypothesis that the specified endogenous regressors can be actually treated as exogenous, the test statistic follows an F distribution. The exact significant level (p-value) of the test statistics is reported in the parenthesis underneath.

d. The enhanced 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 the null hypothesis that the specified endogenous regressors can be actually treated as exogenous, the test statistic follows a *Chi*-squared distribution with degrees of freedom equal to the number of regressors tested. Under conditional homoscedasticity, this endogeneity test statistics is numerically equal to a Hausman test statistic. Unlike a Hausman test, the endogeneity test can report test statistics that are robust to various violations of conditional homoscedasticity (see Baum *et al.*, 2007). The exact significant level (p-value) of the test statistics is reported in the parenthesis underneath.

According to Table 3.6, the results of both tests suggest that the exogeneity of debt financing and dividend payout variables in the investment equation can be firmly rejected; again, that of investment and dividend payout variables in the debt financing equation can be firmly rejected; finally, that of investment and debt financing variables in the payout equation can be firmly rejected as well. An important implication is that it is inappropriate and invalid to treat these endogenous variables as exogenous, and thus a simultaneous equations model is necessary in practice. The existing literature in corporate finance that ignores the endogeneity of investment, financing and payout decisions is likely to generate misleading results and lead to inappropriate inferences, which may bias our understanding of corporate behaviour. Therefore, corporate investment, financing and payout decisions should be better considered as a joint decision-making procedure. A preferred strategy is to simultaneously estimate the corporate decision equations within a system which allows for the interactions among the set of corporate decisions.

3.5.2.3 Test for exogeneity of cash flow variable

To derive the simultaneous equations system, we also assume that internally generated cash flow is predetermined by past corporate real and financial decisions (Dhrymes and Kurz, 1967; and McCabe, 1979), and thus can be treated as exogenous to the system. It is, therefore, also desirable to test the validity of this assumption explicitly. For this reason, we also carry out endogeneity tests for the cash flow variable in investment, financing and payout equations, respectively. The test results are reported in Table 3.7.

Table 3.7: Endogeneity test for cash flow variable

	Investment Equation *INV/K*	Financing Equation *NDF/K*	Dividend Equation *DIV/K*
Regressors tested[a]	$(CF/K)_t$	$(CF/K)_t$	$(CF/K)_t$
Instrumental variables used[b]	$(INV/K)_{t-1,\ldots,t-3}$; $(NDF/K)_{t-1,\ldots,t-3}$; $(DIV/K)_{t-1,\ldots,t-3}$	$(INV/K)_{t-1,\ldots,t-3}$; $(NDF/K)_{t-1,\ldots,t-3}$; $(DIV/K)_{t-1,\ldots,t-3}$	$(INV/K)_{t-1,\ldots,t-3}$; $(NDF/K)_{t-1,\ldots,t-3}$; $(DIV/K)_{t-1,\ldots,t-3}$
Hausman test for endogeneity[c]	2.82*	2.10	5.27***
(*p*-value)	(0.0934)	(0.1475)	(0.0000)
Enhanced test for endogeneity[d]	1.124	0.057	1.872
(*p*-value)	(0.2890)	(0.8106)	(0.1713)

Notes:

[a.] The variables that are specified as endogenous in the regression.

[b.] The variables that are used as instruments for the specified endogenous variables being tested.

[c.] The Hausman test for endogeneity is formed by including the residuals of each right-hand side endogenous variables, as a function of the exogenous variables, in a regression of the original model. An *F*-test is then used to test a joint restriction that the coefficients on the residuals are all equal to zero. Under the null hypothesis that the specified endogenous regressors can be actually treated as exogenous, the test statistic follows an *F* distribution. The exact significant level (*p*-value) of the test statistics is reported in the parenthesis underneath.

[d.] The enhanced 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 the null hypothesis that the specified endogenous regressors can be actually treated as exogenous, the test statistic follows a *Chi*-squared distribution with degrees of freedom equal to the number of regressors tested. Under conditional homoscedasticity, this endogeneity test statistics is numerically equal to a Hausman test statistic. Unlike a Hausman test, the endogeneity test can report test statistics that are robust to various violations of conditional homoscedasticity (see Baum *et al.*, 2007).The exact significant level (*p*-value) of the test statistics is reported in the parenthesis underneath.

According to the Hausman test, the cash flow variable seems not to be strictly exogenous to corporate investment and payout decisions, while the exogeneity of cash flow variable with respect to the debt financing decision cannot be rejected. The Hausman test results suggest that current cash flow is not purely determined by previous corporate decisions, but also to some extent depend on concurrent decisions. However, the assumption of the exogeneity of the cash flow variable is empirically verified by the enhanced test for endogeneity developed by Baum *et al.* (2007). The null hypothesis that the cash flow variable can be treated as exogenous cannot be rejected throughout the tests regarding all the three equations. Accordingly, there should 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 simultaneity among corporate investment, financing and payout decisions. All in all, the preliminary tests presented in this section are reasonably satisfactory for us to move on to the joint determinations of corporate decisions as implied by the flow-of-funds framework for corporate behaviour.

3.6 Empirical results and implications for corporate behaviour

3.6.1 Single equation analyses

Although the purpose of the study is to investigate the simultaneity among corporate investment, financing and payout decisions, it is desirable to first apply the single equation estimation technique to the corporate behaviour equations separately. The single equation estimation results presented in this section are comparable to those provided by the previous studies which ignore the interdependence of the decision-making processes that we aim to investigate.

Given the endogeneity of the corporate decision variables and the dynamic structures of the corporate behaviour models, we estimate Equations 3.7, 3.8 and 3.9 separately using the system generalised methods of moments (system-GMM) estimators. This approach is an efficient extension of the first-difference generalised methods of moments (difference-GMM) estimators developed by Arellano and Bond (1991).[23] 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 used as instruments for the level equation (Aerllano and Bover, 1995; and Blundell and Bond, 1998).[24] The use of instruments in such a way is considered as a possible solution to the endogeneity problems as well as the weak instrument problems.

In the implementation of system-GMM estimators, we are also confronted with the choice of using one-step or two-step estimation. The one-step estimators assume homoscedastic errors, whereas the two-step estimators generate heteroscedasticity-consistent standard errors. Thus, the two-step estimators are expected to be asymptotically more efficient

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[23] Arellano and Bond's (1991) 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.
[24] The system-GMM estimator uses equations in first-differences, from which the company-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 company-specific effects. Blundell and Bond (1998) show that in autoregressive distributed lag models, the first-differences of the series can be uncorrelated with the company-specific effect provided that the series have stationary means.

than their one-step counterparts. However the reported standard errors in two-step estimation tend to be downward biased, it is important to use the finite-sample correction to the standard errors computed in two-step estimation (Roodman, 2009). We therefore resort to the two-step system-GMM estimators with finite-sample correction to estimate the structural equations for corporate behaviour. The two-step system-GMM estimation results are obtained using Stata 11 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. Year dummies also are included in all of the equations to account for the time effect that cannot be captured by the included regressors.[25] Tables 3.8–3.10 present the estimation and testing results corresponding to the corporate investment, borrowing and dividend equations, respectively.

3.6.1.1 Investment equation estimation results

Columns 2, 3 and 4 of Table 3.8 report the estimations and test results for three variants of the investment model specified as Equation 3.7. The three alternative proxies for uncertainty described in the previous section, namely, *UNC*1, *UNC*2 and *UNC*3, are used in the three

[25] To implement GMM estimations, it is assumed that errors are only correlated within individuals, not across them. Therefore, it is almost always desirable to include time dummies in order to remove universal time-related shocks from the errors (Roodman, 2009).

model variants, respectively. Given the drawback of constructing uncertainty measures using high-frequency stock return information, we treat the results obtained from model variant 1, in which *UNC*1 is used as the proxy for uncertainty, as our primary results.

Concentrating on the primary results presented in column 2, three features of these results are of particular interest. First, both the borrowing (*NDF/K*) and dividend (*DIV/K*) variables appear to be significant in the investment equation at the 1% and 5% significance level respectively. This result suggests that a company's financial decisions do have impacts on its real decisions in reality, so that Modigliani-Miller's independence proposition should be firmly rejected based on the evidence from UK-listed companies.

Second, the significantly positive relationship between investment and dividend found in the pair-wise correlation analysis (see Table 3.4) is reversed to be significantly negative when the full structural investment equation is estimated. The statistically significant and negative effect of dividend payouts on investment outlays lends strong empirical support to the flow-of-funds framework, in which investment outlays and dividend payouts are viewed as competing uses of limited funds and thus should not vary in the same direction. UK-listed companies seem to trade-off between investment and payout during the period under investigation. The significantly positive coefficients found for the cash flow variable (*CF/K*) and the debt financing variable (*NDF/K*) are also consistent with the predictions of the flow-of-funds framework that corporate investment choices are subject to the availability of internal funds as well as the access to external debt finance 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 companies are likely to be financially constrained, both internally and externally, and they therefore have to consider their financial choices alongside their investment decisions, with full recognition of competing needs for funds and alternative sources of funds.

Moreover, another result of particular interest is that the coefficient on the proxy for uncertainty (*UNC*1) appears to be significantly positive. The positive effect of uncertainty on corporate investment seems to favour the prediction of the Hartman-Abel 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 advantage of pre-emption in a competitive business environment, thus encouraging current investment spending. In other words, the option value of delay is likely to be offset by the threat of being pre-empted under a competitive situation. Thus, if managers take the strategic interactions between players into consideration, the overall benefits from delay may be insufficient to deter investment. In addition, if the advantage of pre-emption is sufficiently strong, greater uncertainty may lead to higher levels of capital expenditure even if the investment projects are irreversible, resulting in a positive impact of uncertainty on corporate investment.

Table 3.8: System-GMM estimation results for corporate investment equation with uncertainty[a]

Variable	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
NDF/K	0.2299***[e]	0.3752***	0.3650***
	(3.40)[f]	(4.96)	(4.82)
DIV/K	–0.3000**	–0.0629	–0.0295
	(2.33)	(–0.42)	(–0.17)
CF/K	0.2303**	0.1638***	0.1616***
	(8.60)	(5.12)	(4.84)
Q	–0.0018	0.0142	0.0151
	(–0.15)	(0.79)	(0.86)
$(INV/K)_{-1}$	0.1848***	0.2140***	0.2108***
	(3.43)	(2.81)	(2.72)
$UNC1_{-1}$	0.2566***		
	(2.93)		
$UNC2_{-1}$		0.2063	
		(0.36)	
$UNC3_{-1}$			1.1647
			(1.35)
Constant	0.1098***	0.1399***	0.1117***
	(2.71)	(2.89)	(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)	GMM instruments for levels: 67.80 (*d.f.* = 71; p = 0.586)	GMM instruments for levels: 67.18 (*d.f.* = 71; p = 0.607)

Variable	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
	for differences: 16.01 ($d.f.$ = 23; p = 0.855)	for differences: 28.95 ($d.f.$ = 23; p = 0.182)	for differences: 26.33 ($d.f.$ = 23; p = 0.286)
	Standard instruments for levels: 81.16 ($d.f.$ = 83; p = 0.537)	Standard instruments for levels: 89.27 ($d.f.$ = 83; p = 0.299)	Standard instruments for levels: 86.94 ($d.f.$ = 83; p = 0.362)
	for differences: 8.07 ($d.f.$ = 11; p = 0.386)	for differences: 7.48 ($d.f.$ = 11; p = 0.759)	for differences: 6.57 ($d.f.$ = 11; p = 0.833)
No. of companies	427	336	309
No. of observations[k]	2805	1435	1376
Instruments used	*Constant*; *Year dummies*; $(NDF/K)_{t-2,\dots,t-5}$; $(DIV/K)_{t-2,\dots,t-5}$; $(INV/K)_{t-3,\dots,t-5}$; $(CF/K)_t$; 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*; *Year dummies*; $(NDF/K)_{t-2,\dots,t-5}$; $(DIV/K)_{t-2,\dots,t-5}$; $(INV/K)_{t-3,\dots,t-5}$; $(CF/K)_t$; 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*; *Year dummies*; $(NDF/K)_{t-2,\dots,t-5}$; $(DIV/K)_{t-2,\dots,t-5}$; $(INV/K)_{t-3,\dots,t-5}$; $(CF/K)_t$; 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; $\Delta UNC3_{t-1}$
Year dummies[l]	Included	Included	Included
Industry dummies[m]	Not included	Not included	Not included
F-statistic for the equation[n]	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 UK company-year observations within the period 1999–2008. The investment equation is specified as Equation 3.7, and estimated by two-step system-GMM estimators using Stata 11.

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

[f] t-statistics are reported in parentheses.

[g.] The 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 the 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, in 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.] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.] The difference-in-Hansen test tests for whether subsets of instruments are valid. To be precise, it reports one test for each group of instruments.

[k.] 2,805 company-year observations are used to estimate model variant 1 in which all the relevant variables are computed using Worldscope data. The number of observation reduced to 1,435 for model variant 2, because *UNC*2 are derived from daily share returns which are collected from the DataStream database. The merge of the two datasets results in significant decrease in the number of observations. By excluding companies whose stock returns do not exhibit GARCH effect and thus *UNC*3 cannot be derived, the number of observations further reduces to 1,376 for model variant 3.

[l.] Year dummies are included in all of the equations to account for the time effect.

[m.] In alternative estimates industry dummies are also included to account for the inter-industry variations. Since they are jointly insignificant, we ignored them in the final set of estimates.

[n.] *F*-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Turning to the regression results of model variants 2 and 3 reported in Table 3.8, the coefficients of the endogenous explanatory variables remain qualitatively unchanged. But the dividend variables become statistically insignificant at the usual significance levels. Meanwhile, the supplementary uncertainty measures (i.e. *UNC*2 and *UNC*3) are also insignificant in their respective regressions. However, the estimated coefficients on all of the uncertainty proxies remain positive. The relatively disappointing explanatory powers of

*UNC*2 and *UNC*3 in the investment model are most likely attributable to the high-frequency noise contained in the daily stock 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 the *Q* variable is mainly due to its severe measurement problems. Thus, the poor performance of the *Q* variable in our regressions is not contradictory to the usual results from previous applied studies on corporate investment (see, for example, Lensink and Murinde, 2006). 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.

Besides, the results of diagnostic tests reported in Table 3.8 also suggest that the investment model performs reasonably well. Specifically, the results of Arellano-Bond test show that the first-differenced errors are autocorrelated at order 1, as expected. Meanwhile, the first-differenced errors are not autocorrelated at order 2, indicating that the model is well specified. In addition, the results of Hansen overidentifying restrictions test suggest that the instruments used in the system-GMM estimation are generally valid, both in the first-differenced and levels equations.

3.6.1.2 Financing equation estimation results

The results for the debt financing equation are presented in Table 3.9. Again, the only difference across the three model variants is that different uncertainty measures are used in their respective regressions. Looking first at the primary results reported in column 2, it is shown that both the investment (*INV/K*) and dividend (*DIV/K*) variables are significant determinants of external debt financing (*NDF/K*) as implied by the flow-of-funds framework. The positive signs of the coefficients on the endogenous explanatory variables suggest that the level of new debt issued by a company 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 companies are entirely in line with the hierarchy of raising funds as predicted by the pecking order hypotheses. This shows that, in the presence of information asymmetry, companies rely heavily on their internally generated funds, while the net amount of debt issued during a fiscal year is chiefly driven by their financing deficits.

Meanwhile, company size (*SZ*) is also proved to be an important determinant of new debt financing. Large companies are typically long-established, diversified, financially healthy companies with low default risks and good credit ratings, and hence are less likely to be constrained by access to external finance (see Guariglia, 2008). However, the coefficient on the asset tangibility variable (*TAN*) turns out to be significant but 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, which is supposed to increase a company's borrowing capacity.

Table 3.9: System-GMM estimation results for corporate financing equation with uncertainty[a]

Variable	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
INV/K	0.5426 ***[e]	0.5090***	0.5019***
	(5.07)[f]	(4.26)	(4.12)
DIV/K	0.4167**	–0.0083	–0.0355
	(2.29)	(–0.05)	(–0.18)
CF/K	–0.1184***	–0.0507	–0.0403
	(–3.08)	(1.50)	(–1.11)
TAN	–0.2075***	–0.2005**	–0.2082**
	(–2.90)	(–2.23)	(–2.28)
SZ	0.0336***	0.0400***	0.0397***
	(6.42)	(4.66)	(4.53)
$UNC1_{-1}$	–0.2357*		
	(–1.88)		
$UNC2_{-1}$		0.4830	
		(0.50)	
$UNC3_{-1}$			0.4784
			(0.46)
Constant	–0.0671	–0.1699*	–0.1685*
	(0.93)	(–1.96)	(–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)	GMM instruments for levels: 41.68 (*d.f.* = 50; p = 0.793)	GMM instruments for levels: 41.70 (*d.f.* = 50; p = 0.792)

Variable	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
	for differences: 12.59	for differences: 25.97	for differences: 24.09
	(*d.f.* = 16; *p* = 0.703)	(*d.f.* = 16; *p* = 0.054)	(*d.f.* = 16; *p* = 0.088)
	Standard instruments	Standard instruments	Standard instruments
	for levels: 53.28	for levels: 58.10	for levels: 56.05
	(*d.f.* = 54; *p* = 0.502)	(*d.f.* = 54; *p* = 0.327)	(*d.f.* = 54; *p* = 0.398)
	for differences: 10.70	for differences: 9.55	for differences: 9.74
	(*d.f.* = 12; *p* = 0.555)	(*d.f.* = 12; *p* = 0.656)	(*d.f.* = 12; *p* = 0.639)
No. of companies	427	336	309
No. of observations[k]	2814	1442	1382
Instruments used	*Constant*; *Year dummies*;	*Constant*; *Year dummies*;	*Constant*; *Year dummies*;
	$(INV/K)_{t-2,\ldots,t-5}$;	$(INV/K)_{t-2,\ldots,t-5}$;	$(INV/K)_{t-2,\ldots,t-5}$;
	$(DIV/K)_{t-2,\ldots,t-5}$;	$(DIV/K)_{t-2,\ldots,t-5}$;	$(DIV/K)_{t-2,\ldots,t-5}$;
	$(CF/K)_t$;	$(CF/K)_t$;	$(CF/K)_t$;
	TAN_t; SZ_t;	TAN_t; SZ_t;	TAN_t; SZ_t;
	$UNC1_{t-1;}$	$UNC2_{t-1;}$	$UNC3_{t-1;}$
	$\Delta(INV/K)_{t-1}$;	$\Delta(INV/K)_{t-1}$;	$\Delta(INV/K)_{t-1}$;
	$\Delta(DIV/K)_{t-1}$;	$\Delta(DIV/K)_{t-1}$;	$\Delta(DIV/K)_{t-1}$;
	$\Delta(CF/K)_t$;	$\Delta(CF/K)_t$;	$\Delta(CF/K)_t$;
	ΔTAN_t; ΔSZ_t;	ΔTAN_t; ΔSZ_t;	ΔTAN_t; ΔSZ_t;
	$\Delta UNC1_{t-1}$	$\Delta UNC2_{t-1}$	$\Delta UNC3_{t-1}$
Year dummies[l]	Included	Included	Included
Industry dummies[m]	Not included	Not included	Not included
F-statistic for the	10.66***	6.03***	5.29***
equation[n]	(*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 UK company-year observations within the period 1999–2008. The debt financing equation is specified as Equation 3.8, and estimated by two-step system-GMM estimators using Stata 11.

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

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

[g.] The 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 the 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, in 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.] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.] The difference-in-Hansen test tests for whether subsets of instruments are valid. To be precise, it reports one test for each group of instruments.

[k.] 2,814 company-year observations are used to estimate model variant 1 in which all the relevant variables are computed using Worldscope data. The number of observation reduced to 1,442 for model variant 2, because *UNC*2 are derived from daily share returns which are collected from the DataStream database. The merge of the two datasets results in significant decrease in the number of observations. By excluding companies whose stock returns do not exhibit GARCH effect and thus *UNC*3 cannot be derived, the number of observations further reduces to 1,382 for model variant 3.

[l.] Year dummies are included in all of the equations to account for the time effect.

[m.] In alternative estimates industry dummies are also included to account for the inter-industry variations. Since they are jointly insignificant, we ignored them in the final set of estimates.

[n.] *F*-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Finally, the effect of uncertainty on external debt financing is negative and significant at the 10% level according to the primary results. This is in line with our hypothesis that greater uncertainty may exacerbate the degree of information asymmetry which in turn exaggerates the cost disadvantage of debt or even results in credit rationing, reducing the availability of external financing.

The results for the other two model variants are also reported in Table 3.9. The results show that, among the set of potential determinants of companies' borrowing decisions, only the investment and company 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 the external debt financing decisions of UK-listed companies. The impacts of the dividend, cash flow and uncertainty variables turn into insignificant in model variants 2 and 3. The diminished explanatory power of the dividend variable may imply that companies are less likely to fund their desired dividend payouts by resorting to external finance.

Besides, the results of diagnostic tests suggest that the specification of the debt financing equation is reasonably well, and that the instruments used in the system-GMM estimation are generally valid.

3.6.1.3 Dividend equation estimation results

Turing to the dividend equation, the estimation results are presented in Table 3.10. Among the potential determinants, the 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 companies signal their private knowledge about the distributional support of the project cash flow to the market through their choice of dividends.

Table 3.10: System-GMM estimation results for corporate dividend equation with uncertainty[a]

Variable	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
INV/K	–0.0033	0.0116	0.0044
	(–0.09)[e]	(0.18)	(0.07)
NDF/K	0.0274	0.0269	0.0340
	(1.21)	(0.76)	(1.00)
CF/K	0.1355***[f]	0.1257***	0.1278***
	(12.20)	(8.65)	(8.22)
OWN	–0.0152	–0.0640	–0.0805*
	(–0.51)	(–1.46)	(–1.83)
RE/TE	0.0049**	0.0281	0.0290*
	(2.03)	(1.46)	(1.70)
$UNC1_{-1}$	–0.2655 ***		
	(–3.31)		
$UNC2_{-1}$		–0.0096	
		(–0.03)	
$UNC3_{-1}$			–0.1290
			(–0.23)
Constant	0.1586***	0.0831**	0.0982***
	(5.73)	(2.56)	(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)	GMM instruments for levels: 41.58 (*d.f.* = 50; p = 0.796)	GMM instruments for levels: 41.25 (*d.f.* = 50; p = 0.806)

Variable	Model variant 1[b]	Model variant 2[c]	Model variant 3[d]
	for differences: 20.22 ($d.f.$ = 16; p = 0.210)	for differences: 20.97 ($d.f.$ = 16; p = 0.180)	for differences: 18.76 ($d.f.$ = 16; p = 0.281)
	Standard instruments for levels: 44.21 ($d.f.$ = 54; p = 0.827)	Standard instruments for levels: 53.38 ($d.f.$ = 54; p = 0.498)	Standard instruments for levels: 50.91 ($d.f.$ = 54; p = 0.594)
	for differences:24.19 ($d.f.$ = 12; p = 0.019)	for differences: 9.17 ($d.f.$ = 12; p = 0.688)	for differences: 9.11 ($d.f.$ = 12; p = 0.694)
No. of companies	427	336	309
No. of observations	2800	1436	1377
Instruments used	*Constant*; *Year dummies*; $(GI/K)_{t-2,\ldots,t-5}$; $(NDF/K)_{t-2,\ldots,t-5}$; $(CF/K)_t$; 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*; *Year dummies*; $(GI/K)_{t-2,\ldots,t-5}$; $(NDF/K)_{t-2,\ldots,t-5}$; $(CF/K)_t$; 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*; *Year dummies*; $(GI/K)_{t-2,\ldots,t-5}$; $(NDF/K)_{t-2,\ldots,t-5}$; $(CF/K)_t$; OWN_t; RE/TE_t; $UNC3_{t-1}$; $\Delta(GI/K)_{t-1}$; $\Delta(BOR/K)_{t-1}$; $\Delta(CF/K)_t$; ΔOWN_t; $\Delta(RE/BE)_t$; $\Delta UNC3_{t-1}$
Year dummies[k]	Included	Included	Included
Industry dummies[l]	Not included	Not included	Not included
F-statistic for the equation[m]	27.70*** ($d.f.$ = 14, 426; p = 0.000)	13.51*** ($d.f.$ = 14, 335; p = 0.002)	16.28*** ($d.f.$ = 14, 308; p = 0.000)

Notes:

[a.] The sample contains UK company-year observations within the period 1999–2008. The dividend equation is specified as Equation 3.9, and estimated by two-step system-GMM estimators using Stata 11.

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

[g.] The 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 the 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, in 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.] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.] The difference-in-Hansen test tests for whether subsets of instruments are valid. To be precise, it reports one test for each group of instruments.

[k.] 2,800 company-year observations are used to estimate model variant 1 in which all the variables are computed using Worldscope data. The number of observation reduced to 1,436 for model variant 2, because *UNC*2 are derived from daily share returns which are collected from the DataStream database. The merge of the two datasets results in significant decrease in the number of observations. By excluding companies whose stock returns do not exhibit GARCH effect and thus *UNC*3 cannot be derived, the number of observations further reduces to 1,377 for model variant 3.

[l.] Year dummies are included in all of the equations to account for the time effect.

[m.] In alternative estimates, industry dummies are also included to account for the inter-industry variations. Since they are jointly insignificant, we ignored them in the final set of estimates.

[n.] *F*-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

The coefficients on the two endogenous explanatory variables (*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, in model variant 1 where the primary measure of uncertainty is used. Given the significant impact of dividends on investment decision and the insignificant impact of investment on dividend decisions, it seems that, if the availability of funds is not sufficient to allow independence between investment and dividend policies, UK-listed companies give dividends priority over investment. This leaves doubt as to whether dividend policy is independent of or interdependent with investment and financing choices.

As for the exogenous variables in the payout regression, insider ownership (*OWN*) does not seem to perform well as a determinant of dividend payouts, but the consistently negative coefficients associated with it to some extent indicate that insider holding of the common shares reduces the need for dividends as a monitoring mechanism and then reduces the dividend payout. Compared with insider ownership, the companies' financial life cycle stage variable (*RE/TE*) has a more significant impact on dividend decisions. The coefficients for *RE/TE* have the predicted positive sign everywhere, suggesting that companies in the mature life cycle stage tend to pay high dividends.

Again, the results of diagnostic test reported in Table 3.10 suggest that both the model and the instruments are generally well specified. However, the results of Arellona-Bond test indicate that the first-differenced errors obtained by estimating model variant 1 are likely to be autocorrelated at the 10% significance level.

3.6.2 Simultaneous equations analyses

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. All of the coefficients of the right-hand side endogenous variables bear the expected signs, and four out of six of them are statistically significant. To provide further evidence and more insights into the joint determination of the set of corporate decisions under uncertainty, we carry out simultaneous equations analyses.

Specifically, we estimate Equations 3.7 through 3.9 within a simultaneous equations system using both the three-stage least squares (3SLS) method and two-stage least squares (2SLS) method, which explicitly 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 three corporate behaviour equations, i.e. Equations 3.7, 3.8 and 3.9, suggests that the necessary condition, i.e. the order condition, for identification are satisfied, and thus the system can be identified.[26]

To apply the 2SLS to the system of structural equations, the reduced form equations are estimated by the ordinary least squares method to obtain the fitted values for the endogenous 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. 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 the 3SLS estimation technique, therefore, 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.

[26] Brooks (2008) explains the condition that could be examined to determine whether a given equation from a system is identified. Let G denote the number of structural equations in a simultaneous system. If the number of all endogenous and exogenous variables that are not presented in an equation is G–1, then the equation is just identified. If more than G–1 variables are not presented, then the equation is over-identified. If less than G–1 variables are not presented, then the equation is not identified.

Table 3.11: 3SLS estimation results for investment, financing and payout equations with uncertainty[a]

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)
$UNC1_{-1}$	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
Year dummies[g]	Included	Included	Included
Industry dummies[h]	Included	Included	Included
Chi^2-statistic for the equation[i]	2562.05*** (p = 0.000)	543.13*** (p = 0.000)	1259.90*** (p = 0.000)

Notes:

[a] The sample contains UK company-year observations within the period 1999–2008. The simultaneous structural form equations are specified as Equations 3.7 through 3.9, and estimated by 3SLS estimators using Stata 11.

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

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

[g.] Year dummies are included in all of the equations to account for the time effect.

[h.] Industry dummies are included in all of the equations to account for the inter-industry variations.

[i.] Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

The panel of UK company-year observations are pooled to gain degrees of freedom. Both year 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. Besides, given the relatively disappointing explanatory powers of *UNC*2 and *UNC*3 in the single equation analyses, our empirical findings with respect to the effects of uncertainty on corporate decisions are drawn from the sign and significance of the coefficients on *UNC*1 in the corresponding equations.[27]

The result from the 3SLS estimation to the system of equations is reported in Table 3.11. Looking first at the investment regression, it suggests that the coefficients of *NDF/K* and *CF/K* are significantly positive as expected, indicating that investments made by UK-listed companies are likely to be constrained by the availability of internal funds as well as access to external finance. More importantly, the significant and positive relationship between the

[27] 3SLS estimation results for corporate investment, financing and payout equations in which *UNC*2 and *UNC*3 are used as the proxy for uncertainty are presented in Appendices 3.D and 3.E respectively.

investment and dividend variables detected in the pair-wise correlation analysis is reversed to be significant and negative when the full structural investment equation is estimated within the simultaneous equations system. The negative coefficient of *DIV/K* is not only statistically significant but also economically meaningful, suggesting that managers of UK-listed companies have to trade-off between investment outlays and dividend payouts in order to allocate scarce funds rationally. Our results lend strong empirical support to the predictions of the flow-of-funds framework that companies have to consider their financing choices alongside their investment decisions.

Another result of particular interest is the significant and positive effect of uncertainty (*UNC*1) on investment, which is quite robust with respect to the methods of estimation.[28] The positive effect of uncertainty observed from the panel of UK-listed companies critically challenges the assertion of the established real options theory of investment, but empirically supports the argument of the recent theoretical innovation by Mason and Weeds (2010). In a competitive business environment, greater uncertainty may lead companies to invest earlier to take the advantage of pre-emption, thus the option value of delay investment under uncertainty is offset by the threat of being pre-empted by their rivals.[29] In fact, if the advantage of pre-emption is sufficiently strong, greater uncertainty can lead to a higher level of investment even if the projects are irreversible. Besides, the proxy for Tobin's *Q* is

[28] The system-GMM estimation results for the investment equation show that the coefficient on the proxy for uncertainty is positive and significant at a 1% significance level.

[29] Mason and Weeds (2010) show the possibility of pre-emption can have significant qualitative and quantitative effects on the relationship between uncertainty and investment.

insignificant, although with a positive sign.[30] The dynamic structure of corporate investment is statistically evident.

Turning to the financing regression, the coefficients on the endogenous variables, i.e. *INV/K* and *DIV/K*, are highly significant and uniformly positive, as predicted by the flow-of-funds framework. It appears that companies' external debt financing is driven not only by the demand from capital investment but also by that from dividend payouts. Moreover, internally generated cash flow (*CF/K*), as an alternative source of funds, has a significant and negative effect on the amount of new debt issued in the corresponding period, suggesting that companies with high levels of cash flow tend to borrow less. These results are entirely consistent with the predicted hierarchy of raising funds, suggesting that pecking-order behaviour is rather robust among UK-listed companies. Besides, the effect of company size (*SZ*) is highly significant, whilst the effect of asset tangibility (*TAN*) is also significant but with a wrong sign. However, the impact of uncertainty on external debt financing is relatively weak.

Moving to the payout regression, the highly significant coefficients on *INV/K* and *NDF/K* reported in the 3SLS results suggest the importance of investment and financing choices in the dividends decision-making process. Compared with the statistically insignificant coefficients on *INV/K* and *NDF/K* estimated using system-GMM estimators (see

[30] The low explanatory power of Tobin's *Q* in investment regression has long been observed in the literature (see, for example, Lensink and Murinde, 2006; Bulan, 2005; and Erickson and Whited, 2000).

Table 3.10), it seems that the importance of investment and financing choices in the payout decision-making process is underestimated by the single equation estimation techniques. Companies with more investment spending and/or less external debt financing tend to pay less cash dividends. Thus, the simultaneous analysis clearly shows that the dividend decision is neither totally residual nor totally independent but is taken with reference to investment and financing decisions. However, the cash flow variable (*CF/K*) is still the most important determinant of dividend policy, which implies that UK-listed companies may signal their anticipated cash flow to the market through their choices of dividend payment. Besides, the effect of uncertainty (*UNC*1) on dividend payouts turns out to be negative and highly significant, lending strong support to our hypothesis that companies facing greater uncertainty tend to pay less dividends. The results also show that the impact of uncertainty on UK-listed companies' payout decisions is statistically more significant and economically more meaningful than that of other factors which, according to the existing literature, are believed to be the primary determinants of dividend policy, such as insider ownership (*OWN*) and financial life cycle stage (*RE/TE*). This result implies that investment models that ignore the dividend payout-uncertainty relationship are likely to produce misleading estimates of the effect of uncertainty.

To sum up, our results seem to substantiate the claim that corporate investment, financing and payout decisions are indeed inextricably linked and jointly determined as implied by the flow-of-funds framework with financial constraints. In addition, companies 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 resorting 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. Our key findings are summarised in Appendix 3.A.

3.6.3 Long-run solution to the simultaneous equations system

It is useful to note that the coefficient estimates for the simultaneous equations system reported in Table 3.11 reflect conditional responses, and the conditioning includes the simultaneously determined corporate decision variables, namely, *INV/K*, *NDF/K* and *DIV/K*. Given some of the coefficient matrices for the endogenous variables seem to be non-positive, it cannot be assumed that the solved-out coefficients have the same sign as the conditional coefficients reported in Table 3.11. The objective of this section, therefore, is to obtain a long-run solution to the dynamic simultaneous equations system. To this end, we define *Y* as a 3×1 vector of endogenous corporate decision variables; *Z* as a $k\times1$ vector of exogenous variables ($k=7$, according to the specification of Equations 3.7–3.9), including cash flow, Tobin's *Q*, company size, asset tangibility, insider ownership and financial life cycle stage; *A* as a 3×1 vector of constants; *B* and *C* as 3×3 matrices of coefficients; and *D* as a $3\times k$ matrix of coefficients.[31] The estimated simultaneous equations system, therefore, can be

[31] Both the coefficient matrices *B* and *C* and the coefficient vector *D* include zeros depending on the model specification (see Equations 3.7–3.9).

written using matrix algebra as follows,

$$Y_t = A + BY_t + CY_{t-1} + DZ_t \quad (3.12)$$

We further define I as a 3×3 identity matrix. So that the solution for Y_t can be written as follows,

$$Y_t = (I - B)^{-1}(A + CY_{t-1} + DZ_t) \quad (3.13)$$

Therefore, any long-run static equilibrium solution to the dynamic system can be obtained by computing the coefficient matrices in the following equation,

$$Y = \left(I - (I - B)^{-1} C\right)^{-1} (I - B)^{-1} (A + DZ) \quad (3.14)$$

Time subscripts are removed from the variables because it is assumed that in the long run the variables attain some steady state values and are no longer changing, i.e. are in equilibrium.

Table 3.12 presents the long-run solution to the simultaneous equations system, which is computed based on the 3SLS estimates reported in Table 3.11. It is evident that the solved-out coefficients presented in Table 3.12 are consistent generally with the conditional coefficients reported in Table 3.12 in terms of their signs and sizes.

Table 3.12: Long-run solution to the simultaneous equations system[a]

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
CF/K	0.2370	0.0590	0.1322
Q	0.0187	0.0029	-0.0009
TAN	-0.0365	-0.3523	-0.1513
SZ	0.0034	0.0330	0.0142
OWN	-0.0226	0.0403	0.0604
RE/TE	-0.0095	0.0169	0.0254
$UNC1_{-1}$	0.5344	-0.1135	-0.3855
Constant	0.0788	0.1086	0.1020
No. of observations	2791	2791	2791
Year dummies[e]	Included	Included	Included
Industry dummies[f]	Included	Included	Included
Chi^2-statistic for the equation[g]	2562.05*** (p = 0.000)	543.13*** (p = 0.000)	1259.90*** (p = 0.000)

Notes:

a. The sample contains UK company-year observations within the period 1999–2008. The simultaneous structural form equations are specified as Equations 3.7 through 3.9, and estimated by 3SLS estimators using Stata 11. The long-run solution to the dynamic system is then obtained by computing the coefficient matrices following the methodology discussed in Section 3.7.1 (see Equations 3.12–3.14).

b. The estimated 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. The estimated financing 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. The estimated dividend 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. Year dummies are included in all of the estimated equations to account for the time effect.

[f.] Industry dummies are included in all of the estimated equations to account for the inter-industry variations.

[g.] Chi^2-statistic tests the null hypothesis that all of the estimated coefficients except the intercept coefficient are jointly zero.

However, the coefficient of the cash flow variables in the financing equation turns out to be positive, which suggests that, in the long run, internally generated cash flow may increase a company's borrowing capacity, allowing the company to take on more debt. The positive effect of cash flow on corporate debt finance lends support to the trade-off prediction that profitable companies face lower expected costs of financial distress and find interest tax shields more valuable, and thus tend to take on more debt. Moreover, the proxy for uncertainty in the financing equation becomes negative. This finding is more consistent with our prediction that greater uncertainty is likely to exacerbate the degree of information asymmetry between insiders and external capital markets, resulting in a more significant cost disadvantage of external debt financing. It also confirms that companies prefer to finance increased investment under uncertainty by resorting to internal funds rather than external funds.

In addition, the long-run solution to the simultaneous equations system presented in Table 3.12 provides some further insights into the determination of corporate decisions. First, it shows that Tobin's Q has a positive effect not only on corporate investment but also on debt financing, while its effect on dividend payouts is negative. These results are in line with the previous findings that companies are likely to use more debt and retain more cash flow to finance variable investment opportunities. Second, company size seems to have positive effect on all the three corporate decisions, indicating that larger companies are likely to have more investments, use more debt and distribute more dividends to their shareholders. Third, the coefficients on the proxy for financial life cycle stage show that, as a company matures, it tends to have fewer attractive investment opportunities, better access to external funds and thus a higher propensity to pay dividends. Besides, the coefficients on the assets tangibility variables are uniformly negative across all the three corporate behaviour equations, and the coefficients on the insider ownership variable are positive in both the financing and dividend equations but negative in the investment equation.

Overall, the long-run solution to the dynamic simultaneous equations system suggests that the solved-out coefficients have the same sign as the conditional coefficients reported in Table 3.11, except those on the cash flow and uncertainty variables in the financing equation. Nevertheless, since the coefficient estimates reported for the simultaneous equations system throughout the thesis reflect conditional responses, the empirical results presented here should be interpreted with cautions.

3.7 Robustness tests and further evidence

3.7.1 Robustness tests and results

In order to check the robustness of our main findings, we carry out further estimation and testing procedures. First, instead of using 3SLS estimators, we re-estimate the simultaneous equations system using 2SLS estimators. 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. Therefore, we apply the 2SLS estimation to the simultaneous equations system. As reported in Appendix 3.B, the 2SLS regression provides qualitatively similar results to those from the 3SLS estimation.

Second, we re-specify the simultaneous equations system by excluding the uncertainty variable. The 3SLS estimation results for the simultaneous equations system without uncertainty variable are reported in Appendix 3.C. As can be seen, all the endogenous explanatory variables are statistically significance with expected signs. Therefore, the simultaneity among corporate investment, financing and payout decisions remain hold, in the absence of the proxy for uncertainty associated with companies' future prospects.

Third, to determine the sensitivity of our findings to the choice of uncertainty measurement, we also estimate simultaneous equations systems in which the alternative measures of uncertainty, i.e. *UNC*2 and *UNC*3, are utilised. The 3SLS estimation results are presented in Appendices 3.D and 3.E, respectively. As expected, the alternative measures of uncertainty derived from daily stock returns are insignificant in their respective system variants. The disappointing explanatory power of the alternative measures of uncertainty is largely attributable to the high-frequency noise contained in the daily stock returns.

Overall, the robustness test results suggest that the corporate behavioural equations system performs reasonably well. The simultaneity among corporate decisions is robust with respect to different estimation techniques and model specifications. However, the results regarding the effect of uncertainty on corporate decisions are, to some extent, sensitive to how uncertainty is empirically captured.

3.7.2 Further evidence on the simultaneity of corporate decisions

Furthermore, in an attempt to explicitly explore the possible mechanism through which the set of corporate decisions are jointly determined, we split the whole sample into two subsamples based on the financial leverage index (*FLI*), which is defined as the ratio of return on average assets to return on average equity and used as a proxy for company's financial position.[32] It is believed that companies with a lower financial leverage index are highly indebted and hence more financially constrained, while companies with a higher financial leverage index are less indebted and hence less financially constrained. The median value of financial leverage index is used to divide the sample into two subsamples. Those with a lower financial leverage index are classified as financially more constrained companies, and those with a higher financial leverage index are financially less constrained companies.[33] Given the argument that the joint determination of corporate decisions is justified by the financial constrains caused by information asymmetry, the interactions among the set of corporate decisions are expected to be more pronounced for companies that are financially more constrained than for those that are financially less constrained. If this is the case, then the financial constraints may be

[32] The financial leverage index is collected directly from the 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 assets. Therefore, companies with a lower financial leverage index have higher financial leverage, while companies with a higher financial leverage index have lower financial leverage.

[33] Our sample split focuses on company-year observations rather than simply companies, and hence allows companies to transit between the two classes. See Guariglia (2008) for a similar approach.

viewed as the possible channel through which corporate investment, financing and payout decisions are jointly determined by management.

Panel A of Table 3.13 reports the 3SLS estimation results for the financially more constrained companies. As expected, companies which are financially more constrained exhibit much stronger simultaneity among the set of corporate decisions than the full sample results presented earlier. More specifically, the magnitude of the coefficient on dividend payout variable in investment equation increases considerably from –0.434 observed from the full sample results to –1.266 observed from the results for the financially more constrained group, suggesting that investment and dividends are extremely competitive in financially more constrained companies. This is also evident from the coefficient on the investment variable in the payout equation whose magnitude increases significantly from –0.118 to –0.223. Moreover, the magnitudes of the coefficients on external debt financing and internal cash flow variables in the investment regression increase from 0.259 and 0.208 to 0.533 and 0.405, respectively. These results are consistent with the well-documented phenomenon that the sensitivities of investment expenditures to internal cash flows and external debt finance are higher for financially more constrained companies. In addition, the effects of uncertainty on investment and payout decisions turn out to be insignificant, whilst the effect of uncertainty on debt financing becomes negative and marginally significant. It seems that financially more constrained companies act more defensively under uncertain circumstances, which may be due to the limited managerial flexibility caused by financial constraints.

Table 3.13: 3SLS estimation results for corporate behavioural equations with uncertainty using subsamples[a]

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
Panel A: Estimation results for the financially more constrained subsample			
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)
$UNC1_{-1}$	–0.1292	–0.3197	–0.0627
	(–0.89)	(–1.51)	(–0.52)
Constant	0.1255	1.1491	–0.0029
	(1.58)	(1.24)	(–0.04)
No. of observations	1395	1395	1395
Year dummies[g]	Included	Included	Included
Industry dummies[h]	Included	Included	Included
Chi^2-statistic for the equation[i]	1392.93*** (p = 0.000)	223.32*** (p = 0.000)	598.13*** (p = 0.000)

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
Panel B: Estimation results for the financially less constrained subsample			
INV/K		0.0844	–0.0955**
		(0.95)	(–2.08)
NDF/K	0.2653		0.4256***
	(1.33)		(2.72)
DIV/K	–0.2377	0.4215	
	(–1.01)	(0.99)	
CF/K	0.1438***	–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)
$UNC1_{-1}$	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
Year dummies[g]	Included	Included	Included
Industry dummies[h]	Included	Included	Included
Chi^2-statistic for the equation[i]	1311.30***	114.83***	791.16***
	(p = 0.000)	(p = 0.000)	(p = 0.000)
Panel C: Tests for the equality of coefficients obtained from the two subsample regressions			
Hausman test[j]	1463.41***	470.11***	44.19***
	(p = 0.000)	(p = 0.000)	(p = 0.007)

Notes:

[a.] Those with lower than median financial leverage index (0.43) are classified as financially more constrained, and those with higher than median financial leverage index are classified as financially less constrained. The simultaneous structural form equations are specified as Equations 3.7 through 3.9, and estimated by 3SLS estimators using Stata 11.

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

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

[g.] Year dummies are included in all of the equations to account for the time effect.

[h.] Industry dummies are included in all of the equations to account for the inter-industry variations.

[i.] Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

[j.] The Hausman test tests for the equality of the coefficients obtained using different subsamples. The null hypothesis is that difference in coefficients obtained from two subsample estimations is not systematic. The test statistic follows a *Chi*-squared distribution. The associated p-value is reported in parenthesis.

Panel B of Table 3.13 reports the 3SLS estimation for the companies that are financially less constrained. It shows that, although all the endogenous variables still bear the expected signs, their explanatory powers decline considerably, with 4 out 6 being statistically insignificant. Overall, the magnitude of the coefficients on the endogenous variables reduces significantly, suggesting that the simultaneity among the set of corporate decisions is relatively weak for financially less constrained companies. Corporate investment decisions of financially less constrained companies are likely to be independent of their debt financing and dividend payout decisions, and are less subject to internally generated cash flow as well. The proxy for Tobin's Q turns out to be positive and significant, which means that capital expenditure of financially less constrained companies depends 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 decisions remains negative and significant, which implies that if the available funds are not sufficient to allow independence between investment and dividend decisions, financially less constrained companies give investment expenditure priority over dividend payouts. Besides, it is worth noting that the effects of uncertainty on investment and payout decisions turns out to be statistically significant at the 5% and 1% levels, respectively. This shows that companies which are financially less constrained tend to act more aggressively under greater uncertainty, i.e. invest more and payout less. Presumably, they are more able and more willing to take the advantage of pre-emption in a competitive business environment by investing earlier, even if the prospects are not clear. Managers of financially less constrained companies have more flexibility to raise funds either externally by issuing debt or internally by cutting dividends.

In an attempt to formally test the difference in the results for the two subsamples, we carry out a Hausman test for each of the corporate behaviour equations. Under the null hypothesis, the coefficients estimated using financially more constrained companies are not systematically different from those estimated using financially less constrained companies. The test results reported in Panel C of Table 3.13 suggest that the null hypothesis of no substantial difference between the results reported in Panel A and those reported in Panel B should be resoundingly rejected with respect to all of the corporate behaviour equations. Therefore, financially more constrained companies indeed behave differently from those which are financially less constrained. The keys findings of this chapter are summarised in Appendix 3.A, alongside the findings from prior research.

3.8 Concluding remarks

In this chapter, we investigate the interactions among corporate investment, financing and payout decisions under financial constraints and uncertainty, using a large panel of UK-listed companies. The three main aspects of corporate behaviour are modelled within a simultaneous equations system where they are treated as endogenous.

On the whole, our results suggest that corporate investment, financing and payout decisions made by UK-listed companies are indeed inextricably linked and jointly determined as implied by the flow-of-funds framework, and the simultaneity among them is quite robust with respect to different methods of estimation. UK-listed companies are likely to be financially constrained by the availability of internal funds as well as by access to external finance. Therefore, managers have to consider their financing and payout choices alongside their investment decisions.

We also find that the effect of uncertainty on corporate investment is positive and significant, while that on dividend payouts is negative and also significant, suggesting that uncertainty stimulates investment in our sample not only on its own but also through its effect on dividend payout policy. Accordingly, companies facing greater uncertainty appear to invest more, and fund the increased investment spending by resorting to internal finance by cutting dividends rather than resorting to external finance by issuing new debts.

Furthermore, we divide the entire sample into financially more constrained and less constrained subsamples, in order to provide further insights into the simultaneity of corporate decisions. Comparing the magnitude and significance level of coefficients on the endogenous variables between the two subsample results, we find that the simultaneity among the corporate decisions is more pronounced for more constrained companies, whist that for less constrained companies is relatively weak. Accordingly, we argue that the substantial economic interactions among the set of corporate decisions observed from UK-listed companies are likely to be caused by financial constraints.

The subsample regressions also show that the effect of uncertainty is more significant for financially less constrained companies but insignificant for more constrained companies, suggesting that less constrained companies respond to uncertainty more aggressively than more constrained ones. Therefore, our results offer new insight that financial constraints intensify the simultaneity among corporate investment, financing and payout decisions, and reduce managerial flexibility in adjusting those corporate decisions in response to uncertainty.

Appendix 3.A: Key findings from Chapter 3 versus findings from prior research

Key findings from Chapter 3	**Findings from prior research**
Panel A: Key findings with respect to corporate investment behaviour	
New debt financing has a significantly positive effect on investment, suggesting that corporate investment is constrained by external debt financing ability.	Prior studies use debt ratios, such as debt to asset ratio and debt to equity ratio, to capture the financial constraint imposed by debt in the capital structure. Companies with higher debt ratios tend to invest less in imperfect capital markets (Ascioglu *et al.*, 2008; Baum *et al.*, 2008; Bulan, 2005; etc.).
Internally generated cash flow has a significantly positive effect on investment, indicating that investment is also constrained by the availability of internal cash flow.	Abroad consensus in the existing literature is that there is a significant positive relationship between investment levels and internal cash flow which is a proxy for a company's internal fund availability (Baum *et al.*, 2008; Almeida and Campello, 2007; Bloom *et al.*, 2007; Lensink and Murinde, 2006; Bulan, 2005; and Ghosal and Loungani, 2000).
Dividend payout has a significantly negative effect on investment, implying that investment and dividend payout are competing uses of funds under financial constraints, and companies have to trade-off between investment outlays and dividends payouts.	Dividend ratios are used in the existing literature as a proxy for financial constraints. The intuition is that financially constrained companies have significantly lower payout ratios, thus companies without or with low payout distribution are assigned to the financially constrained (Fazzari *et al.*, 1988; Almeida and Campello, 2007).
Tobin's Q as a proxy for investment opportunity is positive but insignificant in our investment equation. The insignificant Tobin's Q is not contradictory to the usual results from empirical studies on investment.	It is generally agreed that Tobin's Q is positively related to investment (Baum *et al.*, 2008; Almeida and Campello, 2007; and Bulan, 2005). But it is also well documented that Tobin's Q has severe measurement problems and thus often turns out to be insignificant in empirical models (Lensink and Murinde, 2006).
The lagged investment ratio as an explanatory variable is positive and highly significant in the investment equation, thus the dynamic structure of investment is statistically evident.	The lagged dependent variable is basically taken into account to allow for a possible dynamic structure in the dynamic variable. This may be caused by inertia of the dependent variable. In addition, a possible advantage of adding a lagged term is that it may remove serial correlation. The lagged investment ratio is significant in the investment equation estimated in Baum *et al.* (2008), but insignificant in Lensink and Murinde (2006) and Bo and Lensink (2005).

Key findings from Chapter 3	Findings from prior research
Uncertainty has a significant and positive effect on investment, which is robust with respect to the method of estimation and the measure of uncertainty. Our results suggest that uncertainty encourages companies to make investment. The positive effect of uncertainty on corporate investment is more pronounced for financially less constrained companies. (In alternative estimates, we also include a quadratic term of uncertainty in our investment equation, but it turns out to be insignificant.)	The broad consensus in existing empirical research is that the effect of uncertainty on investment is negative, as implied by the real option theory (Bloom *et al.*, 2007; and Carruth *et al.*, 2000). A number of studies also find a positive relationship between uncertainty and investment (Abdul-Haque and Wang, 2008; and Lensink and Sterken, 2000). Besides, Lensink and Murinde (2006) verify an inverted-U hypothesis of investment under uncertainty, using a panel of UK data.
Panel B: Key findings with respect to corporate financing behaviour	
Dividend payout variable is highly significant and positive in the financing equation, implying that external financing is not only driven by the demand from capital investment but also by that from dividend payout.	Baker and Wurgler (2002) use dividend variable as either a proxy for profitability or a proxy for investment opportunities, and find it generally has a positive effect on leverage ratio. Frank and Goyal (2003) find that dividend distributed to shareholders as a component of disaggregated deficit is a significant driver of new debt issued.
Internally generated cash flow as an alternative source of funds is negatively related to external debt financing, suggesting that companies with high level of cash flow tend to borrow less which is consistent with the prediction of pecking-order hypothesis.	Profitable companies face lower expected costs of financial distress and find interest tax shields more valuable. Trade-off predicts a positive relation between leverage and profitability. The pecking order theory argues that companies prefer internal finance over external funds, thus if investment and dividends are fixed, then more profitable companies will become less levered over time. Frank and Goyal (2009) find that companies that have more profits tend to have lower leverage.
Investment variable is highly significant and positive in our financing equation, suggesting that external financing is driven by the demand from capital investment.	Brailsford *et al.* (2002) take investment in total asset ratio as control for agency cost of debt and/or control for profitability, and they find growth in total assets has a negative effect on leverage. Frank and Goyal (2003) find that investment expenditure as a component of disaggregated deficit has a significantly positive effect on new debt issued.

Key findings from Chapter 3	Findings from prior research
Company size as a proxy for borrowing ability has a highly significant and positive effect on debt financing.	Large, more diversified, companies face lower default risk. In addition, older companies with better reputations in debt markets face lower debt-related agency costs. Thus, larger, more mature companies have relatively easier access to external finance, and thus carry more debt and higher leverage ratio (Frank and Goyal, 2009).
Asset tangibility, which is expected to mitigate information asymmetry and enhance borrowing capacity, turns out to be significantly negative which is count-intuitive.	Traditional capital structure models stress the collateral value of tangible assets and thus debt levels should be increased with more tangibility (Frank and Goyal, 2009). But Seifert and Gonenc (2008) find the coefficient on tangibility is negative for British companies.
Uncertainty variable is insignificant in our financing equation. But it becomes negative and marginally significant when the financially more constrained subsample is used to estimate the equations system, suggesting that uncertainty may further reduce a company's borrowing ability if the company is already financially constrained.	Baum *et al.* (2009) predict a negative relationship between uncertainty and optimal levels of borrowing. Their empirical results confirm that as uncertainty increases, companies decrease their level of short-term leverage. The effect is stronger for macroeconomic uncertainty than for idiosyncratic uncertainty.
Panel C: Key findings with respect to corporate payout behaviour	
Companies with more investment spending tend to pay less cash dividends. The results from dividend equation confirm the trade-off between investment and distribution. The importance of investment decisions in corporate payout choices is likely to be underestimated by single equation estimation techniques.	Companies with more investment have large cash requirements and thus may pay low dividends. If this is the case, the impact of investment on dividends is expected to be negative. Both Denis and Osobov (2008) and DeAngelo *et al*. (2006) find that growth in total assets is highly significant and negatively related to the probability of paying dividends, reflecting that companies with higher growth retain cash for investment.
Companies with less new external funds tend to payout less. Hence, dividend payouts are also likely to be constrained by the access to the external financing. The importance of debt financing decisions in corporate payout choices is also likely to be underestimated when single equation framework is adopted.	The leverage may help control agency costs, thus reducing the need to distribute cash to shareholders through dividends or repurchases. This view predicts a negative relationship between cash dividend and leverage. Alternatively, higher leverage might simply proxy for older, larger, more stable and more profitable companies that are better able to afford paying dividends. This view implies that

Key findings from Chapter 3	Findings from prior research
	a positive relationship between cash dividends and leverage should be observed. Eije and Megginson (2008) find that leverage is highly significant and negatively related to the probability to pay cash dividends.
Internally generated cash flow variable is the most significant determinant of dividend payout, suggesting that dividend policy signals current and future profitability.	Profitability is cited as one of the important predictors of dividends in prior studies (Chay and Suh, 2009; Denis and Osobov, 2008; and DeAngelo *et al.*, 2006).
Insider ownership has no significant effect on dividend payout policy.	Existing literature shows no apparent link exists between share ownership and payouts. Chay and Suh (2009) show that on average the coefficient on insider owner does not have the predicted sign or is not statistically significant.
Retained earnings to total equity ratio as a proxy for the financial life-cycle stage is positively related to dividend payout but statistically insignificant.	Life cycle stage theory of dividend predicts that the key determinant of the decision to pay dividends is the ratio of internally generated to total (earned plus contributed) common equity. Empirical evidence from Chay and Suh (2009), Denis and Osobov (2008) and DeAngelo *et al.* (2006) uniformly and strongly indicates that the probability a company pays dividends increases with the relative amount of earned equity in its capital structure.
The effect of uncertainty on dividend payouts is negative and highly significant, implying that companies facing greater uncertainty tend to pay fewer dividends. The negative effect of uncertainty on dividend payouts is more pronounced for financially less constrained companies.	Companies facing high cash flow uncertainty are likely to pay low dividends and keep earnings inside the company in anticipation of funding shortfalls. The impact of cash flow uncertainty on dividends is found to be negative (Chay and Suh, 2009).
Panel D: Key findings with respect to the simultaneity of corporate decisions	
Our results seem to substantiate the claim that corporate investment, financing and payout decisions are indeed inextricably linked and jointly determined as implied by the flow-of-funds framework with financial constraints. Specifically, it is found that capital investment and dividend payout, as competing uses of limited funds, are negatively interrelated, but both are positively related to the net amount of new debt issued.	Empirical evidence from US data suggests that imperfections in capital markets are sufficient to invalidate the Modigliani-Miller's theorems, leading to a joint determination of corporate investment, financing and payout decisions as implied by the flow-of-funds approach (Dhrymes and Kurz, 1967; McCabe, 1979; and Peterson and Benesh, 1983). In contrast to the findings on US data, McDonald *et al.* (1975) find that empirical evidence from a sample of French

Key findings from Chapter 3	Findings from prior research
	companies in favour of Modigliani-Miller's independence proposition, that is, the dividend and investment decisions of individual companies are completely independent of each other.
It is found that the simultaneity among the corporate decisions is more pronounced for more constrained companies, whist that for less constrained companies is relatively weak. Accordingly, our results suggest that the substantial economic interactions among the set of corporate decisions observed from UK-listed companies are likely to be caused by financial constraints.	To the best of our knowledge, no prior research has attempted to explicitly investigate the effect of financial constraints on the simultaneity among the set of corporate decisions.
Our results show that companies which are financially less constrained tend to act more aggressively under greater uncertainty, i.e. invest more and payout less, whereas financially more constrained companies tend to behave more defensively under uncertain circumstances. It seems that financial constraints reduce managerial flexibility in adjusting those corporate decisions in response to uncertainty.	To the best of our knowledge, no prior research has attempted to investigate the effect of uncertainty on the jointly determined corporate decisions within a simultaneous equations system.

Appendix 3.B: 2SLS estimation results for investment, financing and payout equations with uncertainty[a]

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)
$UNC1_{-1}$	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
Year dummies[g]	Included	Included	Included
Industry dummies[h]	Included	Included	Included
F-statistic for the equation[i]	105.67*** (p = 0.000)	10.97*** (p = 0.000)	52.22*** (p = 0.000)

Notes:

[a] The sample contains UK company-year observations within the period 1999–2008. The simultaneous structural form equations are specified as Equations 3.7 through 3.9, and estimated by 2SLS estimators using Stata 11.

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

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

[g] Year dummies are included in all of the equations to account for the time effect.

[h] Industry dummies are included in all of the equations to account for the inter-industry variations.

[i] *F*-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 3.C: 3SLS estimation results for investment, financing and payout equations without uncertainty[a]

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
INV/K		0.1722**	–0.1194***
		(2.53)	(–3.05)
NDF/K	0.2930***[e]		0.4281***
	(2.81)[f]		(5.31)
DIV/K	–0.6359***	0.4502*	
	(–3.61)	(1.71)	
CF/K	0.2359***	–0.0423	0.1321***
	(10.68)	(–1.05)	(13.06)
Q	0.0143		
	(1.47)		
$(INV/K)_{-1}$	0.3004***		
	(17.81)		
TAN		–0.2823***	
		(–3.39)	
SZ		0.0266***	
		(4.64)	
OWN			0.0256
			(0.99)
RE/TE			0.0376***
			(3.43)
Constant	0.1488***	0.0478	0.0107
	(3.45)	(0.66)	(0.32)
No. of observations	2791	2791	2791
Year dummies[g]	Included	Included	Included
Industry dummies[h]	Included	Included	Included
Chi^2-statistic for the equation[i]	2488.67*** (p = 0.000)	276.59*** (p = 0.000)	1259.81*** (p = 0.000)

Notes:

[a] The sample contains UK company-year observations within the period 1999–2008. The simultaneous structural form equations are specified as Equations 3.7 through 3.9 but without uncertainty variable (*UNC*), and estimated by 3SLS estimators using Stata 11.

b. Investment equation is specified as

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

c. Financing equation is specified as

$$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \mu \cdot$$

d. Dividend equation is specified as

$$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \nu \cdot$$

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

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

g. Year dummies are included in all of the equations to account for the time effect.

h. Industry dummies are included in all of the equations to account for the inter-industry variations.

i. Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 3.D: 3SLS estimation results for investment, financing and payout equations with alternative measure of uncertainty *UNC*2[a]

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
INV/K		0.0122	–0.0472
		(0.89)	(–1.04)
NDF/K	0.2583**[e]		0.3729***
	(2.03)[f]		(4.07)
DIV/K	–0.5060**	–0.6035	
	(–2.35)	(–1.38)	
CF/K	0.1903***	0.1004	0.1260***
	(6.93)	(1.62)	(11.31)
Q	0.0328**		
	(2.11)		
$(INV/K)_{-1}$	0.3578***		
	(16.44)		
TAN		–0.5992***	
		(–3.76)	
SZ		0.0468***	
		(4.64)	
OWN			0.0248
			(0.58)
RE/TE			0.0643***
			(3.62)
$UNC2_{-1}$	–0.7808	–0.2654	–0.3062
	(–1.27)	(–0.27)	(–0.64)
Constant	0.1526**	0.1624	0.0422
	(2.31)	(1.08)	(0.79)
No. of observations[g]	1429	1429	1429
Year dummies[h]	Included	Included	Included
Industry dummies[i]	Included	Included	Included
Chi^2-statistic for the equation[j]	1358.48*** (p = 0.000)	107.71*** (p = 0.000)	814.83*** (p = 0.000)

Notes:

[a] The sample contains UK company-year observations within the period 1999–2008. The simultaneous structural form equations are specified as Equations 3.7 through 3.9, and estimated by 3SLS estimators using Stata 11.

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

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

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

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

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

[g.] The number of observation reduced to 1,429 because the accounting items used to compute corporate decision variables and company characteristic variables are collected from the Worldscope database, whereas the daily stock returns used to derive *UNC*2 are collected from the DataStream database. The merge of datasets results in significant decrease in the number of observations.

[h.] Year dummies are included in all of the equations to account for the time effect.

[i.] Industry dummies are included in all of the equations to account for the inter-industry variations.

[j.] Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 3.E: 3SLS estimation results for investment, financing and payout equations with alternative measure of uncertainty *UNC3*[a]

Variable	Investment Equation[b] *INV/K*	Financing Equation[c] *NDF/K*	Dividend Equation[d] *DIV/K*
INV/K		–0.0436	–0.0156
		(–0.44)	(–0.35)
NDF/K	0.3123**[e]		0.3695***
	(2.52)[f]		(3.89)
DIV/K	–0.6287***	–0.7632	
	(–2.35)	(–1.54)	
CF/K	0.2021***	0.1366*	0.1190***
	(7.15)	(1.95)	(9.73)
Q	0.0351**		
	(2.35)		
$(INV/K)_{-1}$	0.3707***		
	(17.06)		
TAN		–0.6165***	
		(–3.60)	
SZ		0.0479***	
		(4.40)	
OWN			0.0013
			(0.03)
RE/TE			0.0720***
			(3.80)
$UNC3_{-1}$	–0.4487	00502	–0.7551
	(–0.63)	(0.04)	(–1.39)
Constant	0.1335**	0.1697	0.0298
	(1.97)	(1.07)	(0.55)
No. of observations	1371	1371	1371
Year dummies[g]	Included	Included	Included
Industry dummies[h]	Included	Included	Included
Chi^2-statistic for the equation[i]	1353.35*** (p = 0.000)	100.86*** (p = 0.000)	790.48*** (p = 0.000)

Notes:

[a.] The sample contains UK company-year observations within the period 1999–2008. The simultaneous structural form equations are specified as Equations 3.7 through 3.9, and estimated by 3SLS estimators using Stata 11.

[b.] Investment equation is specified as

$INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC3_{-1} + \varepsilon$.

[c.] Financing equation is specified as

$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC3_{-1} + \mu$.

[d.] Dividend equation is specified as

$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC3_{-1} + \nu$.

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

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

[g.] The number of observation reduced to 1,371 because the accounting items used to compute corporate decision variables and company characteristic variables are collected from the Worldscope database, whereas the daily stock returns used to derive *UNC*3 are collected from the DataStream database. The merge of datasets results in significant decrease in the number of observations. The number of observations further reduces by excluding companies whose stock returns do not exhibit GARCH effect and thus *UNC*3 cannot be derived,

[h.] Year dummies are included in all of the equations to account for the time effect.

[i.] Industry dummies are included in all of the equations to account for the inter-industry variations.

[j.] Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

CHAPTER 4

CORPORATE DECISIONS, MANAGERIAL CONFIDENCE AND ECONOMIC SENTIMENT

4.1 Introduction

Managerial confidence and economic sentiment are frequently cited and closely followed by practitioners, government bodies, financial institutions, research institutes and news media for both qualitative and quantitative analysis purposes. In his General Theory, Keynes (1936) links the notion of “sentiment” to the “state of long-term expectation” and the “state of confidence”. The level of confidence or sentiment reflects the prevailing attitude of economic agents towards anticipated economic and business developments. It is believed that they play key roles in the formation of companies’ expectations of future profit levels, and hence in the determination of their key corporate decisions. A high level of managerial confidence or economic sentiment creates favourable environment for a business to grow; conversely, a low confidence or sentiment level indicates a negative outlook for future business spending and capital investment. However, the concepts of managerial confidence and economic sentiment have not been embraced entirely into mainstream financial economics, which relies heavily on the rigid assumption of broad rationality in corporate decision-making processes. As researchers add more and more company fundamental characteristics in explaining corporate behaviour, these hard-to-define ideas such as managerial confidence and economic sentiment are largely ignored and excluded from their empirical models. It is noted that the major challenge for incorporating such ideas into economic models is to construct plausible proxies for the state of confidence and sentiment (see Malmendier and Tate, 2005).

This chapter represents one of the first studies to explicitly and systematically incorporate the state of managerial confidence and economic sentiment into the area of corporate finance. We employ a number of direct measures of agents' perceptions about current and expected business and economic conditions to explore their potential effects on corporate investment, financing and payout decisions. These direct measures of the state of economic sentiment and managerial confidence are drawn up from a series of qualitative economic surveys of managers in four main industry sectors as well as consumers across the European Union (EU) member states and candidate countries. The surveys are carried out by the Directorate-General for Economic and Financial Affairs (DG-ECFIN) of the European Commission (described in detail in Section 4.2). These novel measures of the state of confidence and sentiment are forward-looking in nature, and therefore are completely different from the *ex post* variables typically used in the previous literature.[34] The managerial confidence and economic sentiment indicators employed in this chapter are expected to represent managers' collective attitude towards the future prospects of the companies, the sectors and the economies at aggregate levels.

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[34] Previous studies typically assume rational expectations by using *ex post* variables such as GDP, industrial production or aggregate consumption as proxies for economic sentiment. The use of director measures of economic sentiment and managerial confidence obtained from the survey of agents' expectations about economic and business conditions should, to a considerable degree, eliminate noise that may exist in *ex post* variables.

We model corporate investment, financing and payout decisions endogenously within the simultaneous equations system set up in Chapter 3, with reference to a large panel of UK-listed companies observed within the period from 1999 to 2008. The simultaneous equations system allows for contemporaneous interdependence among the three corporate decisions, in attempting to overcome the shortcomings of the single equation techniques. Given their potential influences in the determination of these corporate decisions, we explicitly investigate the role of the state of confidence in each of the corporate decisions modelled in our system. The UK and EU managerial confidence indicators and economic sentiment indicators are used as the alternative proxies for the state of confidence separately and treated as a common exogenous factor in their respective system variants.

The empirical results presented in this chapter once again confirm the robustness of the joint determination of the three corporate decisions, as implied by the flow-of-funds framework for corporate behaviour. More importantly, it is found that both capital investment and debt financing variables are positively and significantly associated with the proxies for managerial confidence and economic sentiment, indicating that high levels of confidence and sentiment encourage companies to raise more funds through debt financing and to invest more intensively in their capital stock. The influence of confidence and sentiment on dividend payout policy is negative but rather weak. Our findings with regard to the influences of managerial confidence and economic sentiment on aspects of corporate behaviour persist even after controlling for company-level uncertainty and other fundamental characteristics.

Specifically, our empirical evidence shows that both the level of company idiosyncratic uncertainty and the state of aggregate confidence have significant and positive real effects on corporate investment decisions. Debt financing decisions are heavily influenced by the state of aggregate confidence but not by the level of company idiosyncratic uncertainty, whereas dividend payout decisions are mainly affected by company-specific uncertainty rather than the state of confidence at sector level or sentiment at economy level. Therefore, our results clearly show that the state of aggregate confidence and the level of company idiosyncratic uncertainty affect corporate behaviour independently through different channels. They both cause increases in corporate investment spending, but managers consider different financial choices in response to the increased demand for capital investment under different situations. In addition, it seems that UK-listed companies in the services sector behave more aggressively than others when the sector sentiment is high. Specifically, they invest in capital stock more intensively, use debt financing more heavily and cut dividends more decisively when their managers are confident about future performance.

This chapter reveals new findings related to several branches of the literature, contributing to the current knowledge of corporate behaviour in the following ways. First, to the best of our knowledge, this chapter offers the first attempt to explicitly and systematically examine the effects of managerial confidence and economic sentiment on corporate decisions within a simultaneous equations system. By relaxing the conventional assumption that managers are fully rational, our study provides insight into the influences of managers' psychological bias on aspects of corporate behaviour, adding to the small but growing literature on behavioural corporate finance. Second, our study highlights and discriminates the roles played by the degree of uncertainty and by the state of confidence, in the determination of corporate decisions. Our findings contribute to the literature by providing empirical evidence that they both influence corporate policies but independently through different mechanisms. Besides, we carry out a comparison across four main industry sectors, revealing additional insights into the influences of managerial confidence and economic sentiment on the behaviour of companies with different characteristics.

The remainder of this chapter is organised as follows. Section 4.2 describes the novel measures of sector-specific managerial confidence and economic sentiment used in this chapter. Section 4.3 specifies the empirical models. Section 4.4 discusses the sample, variables and preliminary analysis. Section 4.5 describes the estimation and testing procedures as well as the main results for the empirical models. Section 4.6 offers further evidence to check the robustness of our findings. Concluding remarks are drawn in Section 4.7.

4.2 Measures of managerial confidence and economic sentiment

The biggest challenge in incorporating the concepts of managerial confidence and economic sentiment into corporate behavioural modelling is to construct plausible measures of these hard-to-define ideas (see Malmendier and Tate, 2005). Previous studies under the assumption of rational expectations typically employ *ex post* variables such as gross domestic product (GDP), industrial production or aggregate consumption as proxies for economic sentiment.

Recent literature in behavioural corporate finance proposes more creative methods to proxy for managerial confidence. For example, Malmendier *et al.* (2011) and Malmendier and Tate (2005) exploit the overexposure of CEOs to the idiosyncratic risk of their companies, as reflected by their personal portfolio of their companies' options and stockholdings, to measure managerial confidence in the US. Ben-David *et al.* (2007) measure overconfidence based on CFOs' confidence intervals of their stock market predictions. Lin *et al.* (2005) construct a managerial confidence measure for Taiwanese companies based on CEOs' forecast errors in their companies' future earnings. Unfortunately, such data used to construct measures of managerial confidence at individual manager level are not publicly available in the UK.

Unlike prior studies, the confidence indicators employed in the present study are direct measures of managerial confidence and economic sentiment drawn from the Joint Harmonised EU Programme of Business and Consumer Surveys. The surveys are carried out by the European Commission Directorate-General for Economic and Financial Affairs (DG-ECFIN) across EU member states and candidate countries, aiming to obtain insights into the beliefs of economic agents, providing essential information for economic surveillance, short-term forecasting and economic research. Their results are often considered as early indicators for future economic developments (European Commission, 2007). The results of all surveys and the readings of all indicators are publicly available from the European Commission website.[35] The sample sizes for the Joint Harmonised EU Business and

[35] See the European Commission website via http://ec.europa.eu.

Consumer Surveys across countries can be found in Appendix 4.A. According to European Commission (2007), approximately 124,000 companies and almost 40,000 consumers are currently surveyed each month across the European Union, among which 3,800 companies and 2,000 consumers are surveyed in the UK. This chapter, therefore, focuses on managerial confidence and economic sentiment in the UK as well as their counterparts at EU level, using monthly data for the period from January 1999 to December 2008.

4.2.1 Sector-specific managerial confidence indicators

The general business and consumer surveys dataset is composed of five sets of sector-specific survey data, namely, industry (*INDU*), services (*SERV*), consumer (*CONS*), retail trade (*RETA*) and construction (*BUIL*).[36] For each sector, several questions are asked in each survey (see Appendix 4.B for the complete questionnaires). Nearly all of the survey questions are of a qualitative nature, trying to assess the recent trends in business situations and monitor the current status of the economy. Typically, the survey questions have similar answer schemes which are given according to a three- or five-option ordinal scale, from optimism to pessimism. More specifically, the three-option questions have alternative answers of "positive", "neutral" and "negative". The questionnaires are addressed to senior managers, such as Chairmen, CEOs or functional directors, of the sample companies in each of the sectors, as well as to consumers. Answers obtained from the surveys are aggregated and

[36] To be precise, industry (*INDU*) refers to manufacturing industry in the Joint Harmonised EU Programme of Business and Consumer Surveys (European Commission, 2007).

expressed in the form of a "balance" for each equation which is defined as the difference between the percentages of respondents giving positive and negative replies,

$$B = P - M \tag{4.1}$$

where P denotes the percentage of positive replies, E denotes the percentage of neutral replies, M denotes the percentage of negative replies, and therefore $P + E + M = 100\%$. B denotes aggregate balance which is the percentage of net positive or optimistic responses. In the case of questions with five options, i.e. "very positive" and "very negative" in addition to the three options mentioned above, the balances are defined as the weighted average of the responses as follows,

$$B = (PP + \frac{1}{2}P) - (\frac{1}{2}M + MM) \tag{4.2}$$

where PP denotes the percentage of very positive replies, MM denotes the percentage of very negative replies, and hence $PP + P + E + M + MM = 100\%$. According to above definitions, the balance values have a possible range between −100% and 100%. The balance value equals 100% (−100%) if all respondents choose the positive (negative) option in the case of three-option questions, or the most positive (negative) option in the case of five-option questions.

Based on the responses to a selection of survey questions, which are closely related to the reference variables they are supposed to track (e.g. industrial production), the sector-specific confidence indicators (*SCI*) are constructed for each of the five sectors. The questions selected to construct the confidence indicator for each sector mainly focus on the development of the business situation over the past few months, the current situation of the business, and the expectation of changes in business activities over the next few months. The sector-specific confidence indicators are defined as the arithmetic average of the balances (in percentage points) of the answers to the selected questions,[37]

$$SCI = \frac{\sum_{i=1}^{n} B_i}{n} \tag{4.3}$$

where *SCI* stands for a sector-specific confidence indicator, B_i denotes the balance of the answers to question *i* in the corresponding sector-specific survey, and *n* is the number of questions selected to build the confidence indicator. It is worth noting that the balances of the answers to some of the selected questions enter Equation 4.3 with inverted signs (see the notes attached to Appendix 4.B). The sector-specific confidence indicators for the industry, services, retail trade and construction sectors thus reflect the collective perceptions and confidence of the managers towards future business development at sector level. For each of

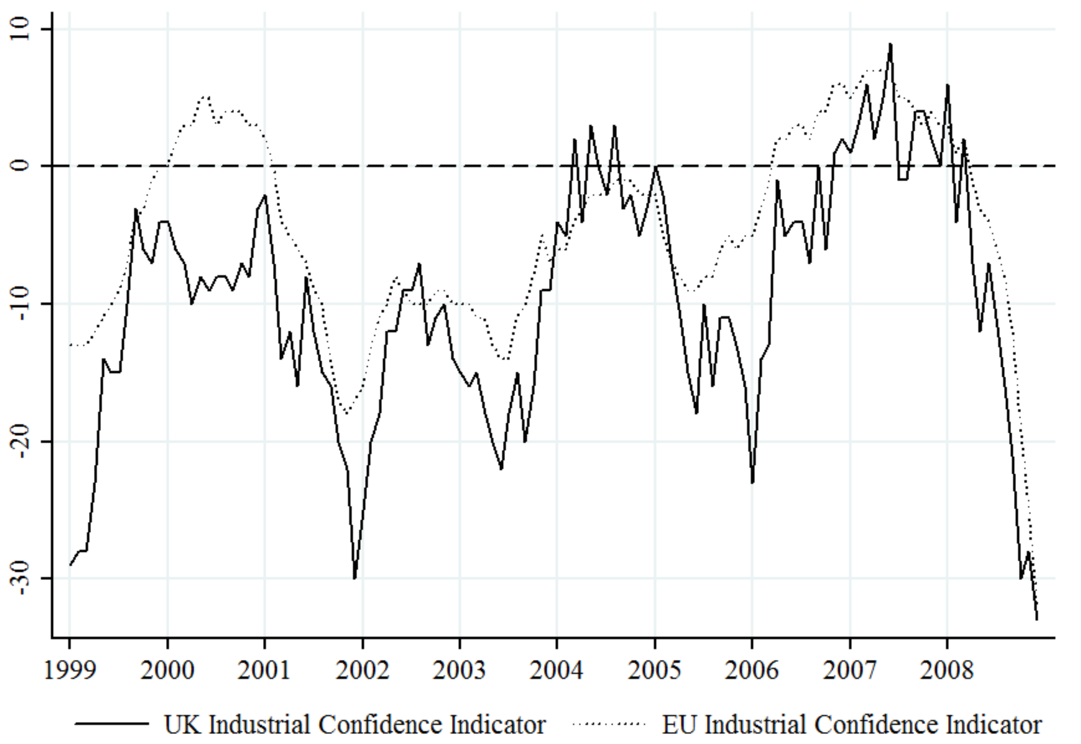
[37] The balance series from the selected questions are not standardised prior to their aggregation. The balance series used to calculate each confidence indicator are seasonally adjusted (European Commission, 2007).

the sectoral indices, positive values indicate a state of confidence above the average, whereas negative values indicate a below-average position.

The methodological approach used to construct the sector-specific confidence indicators, however, has a number of limitations. First, the use of the balances of positive and negative responses to compute confidence indicators is potentially problematic. A positive response (or a negative response, if the balance enters Equation 4.3 with an inverted sign) to some of the survey questions may not be necessarily attributable to higher levels of managerial confidence and sentiment, while a negative response (or a positive response, if the balance enters Equation 4.3 with an inverted sign) may not be always associated with a poor outlook for future businesses. The lack of inherent linkage between some of the survey questions and the state of managerial or consumer sentiment may lead the indicators to be biased proxies for sector-specific confidence. Second, taking simple arithmetic average across the balances of the answers to the survey questions to obtain the sector-specific confidence indicator may also result in possible ambiguities about the information contained in the sector-specific confidence indicators. These methodological limitations of the confidence indicators, therefore, should be kept in mind when we interpret our empirical results.

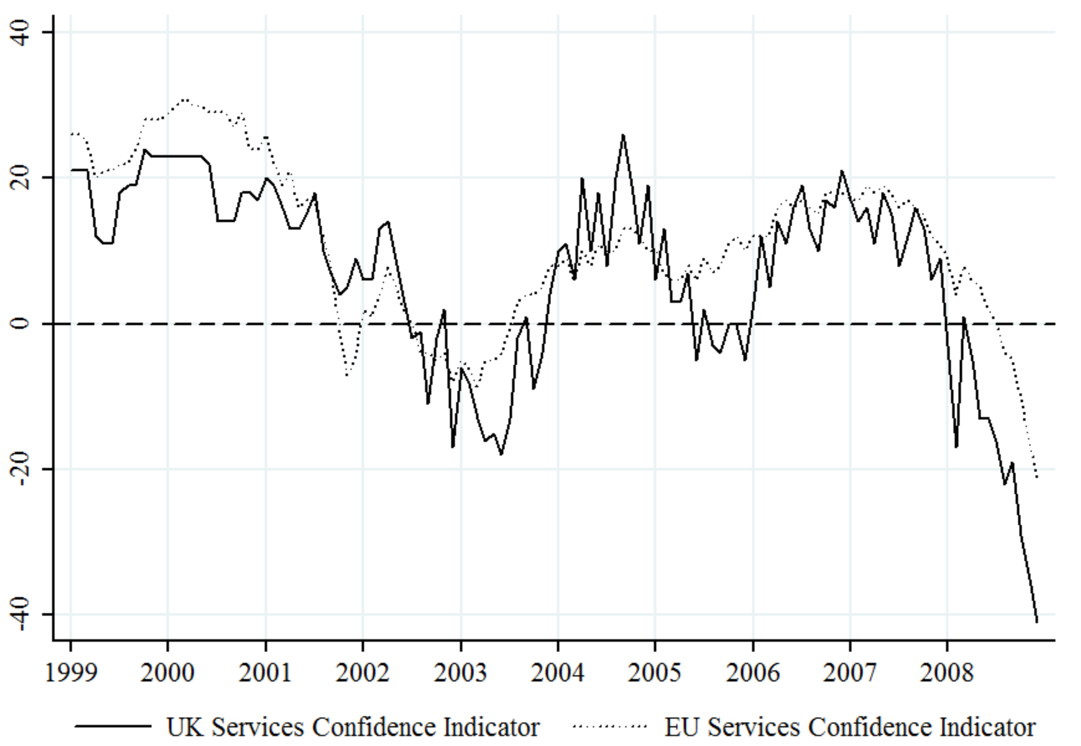
In order to provide a visual comparison between the evolutions of UK and EU sentiment at sector level, we plot the monthly UK and EU sector-specific confidence indicators for the five sectors over the period from January 1999 to December 2008 in Figures 4.1–4.5, respectively.

Figure 4.1: Time series plot of UK versus EU manufacturing sector confidence indicators[a]



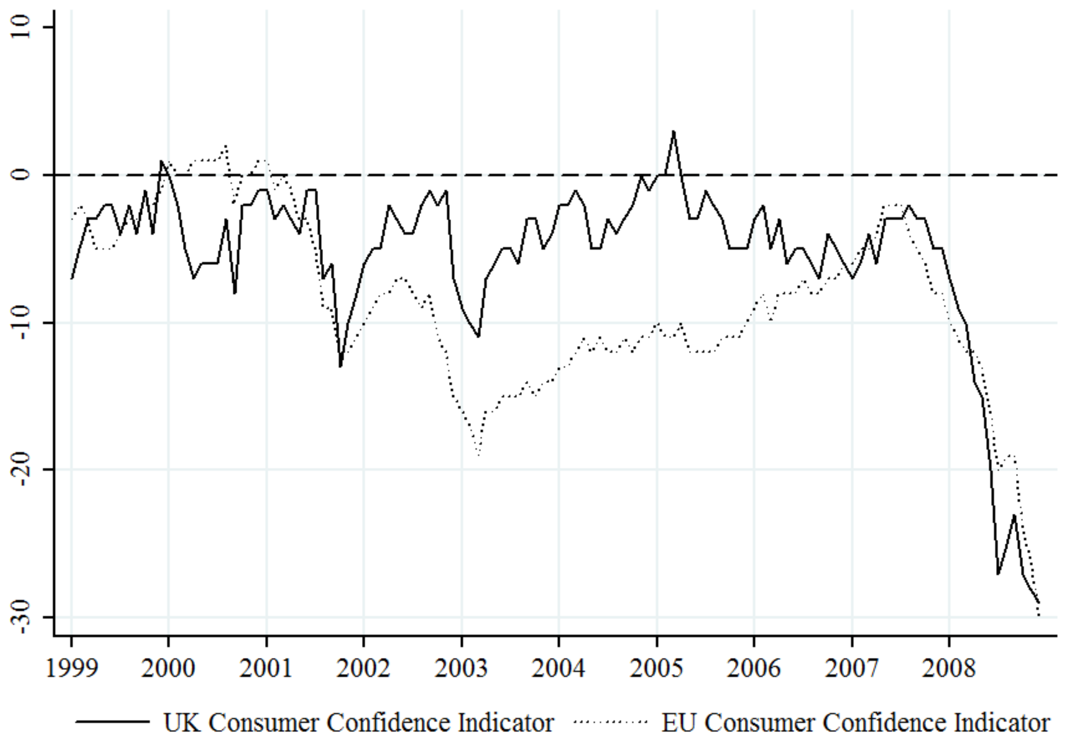
Note: [a.] The data are publicly available from the European Commission website via http://ec.europa.eu.

Figure 4.2: Time series plot of UK versus EU services sector confidence indicators[a]



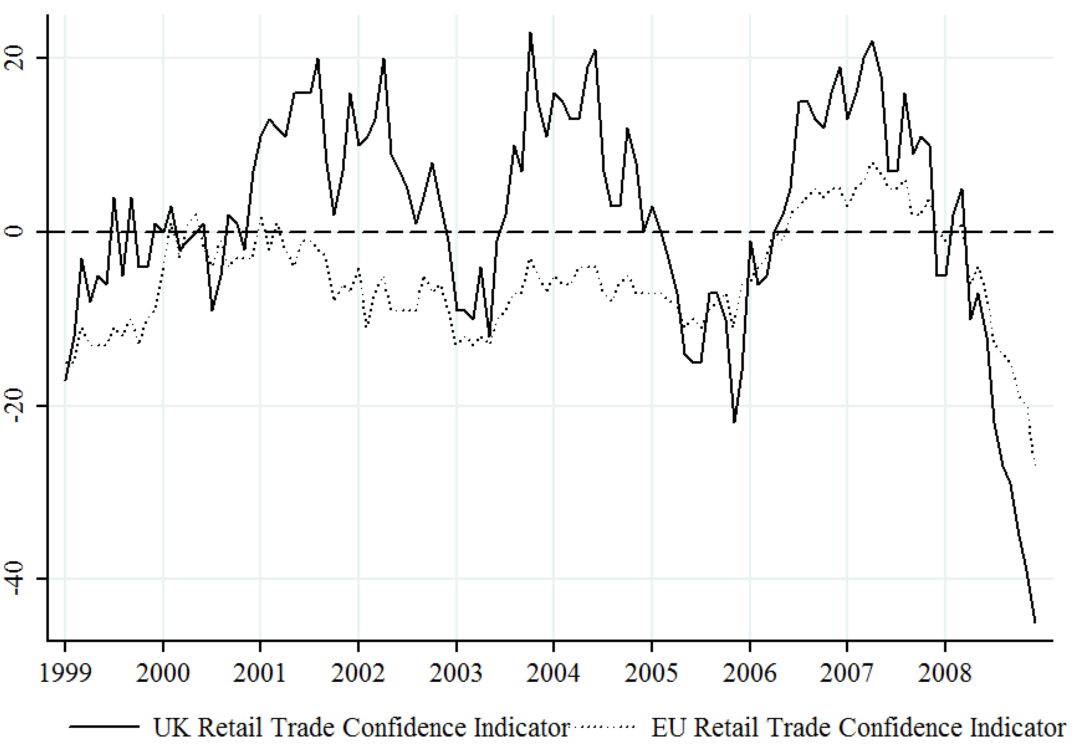
Note: [a.] The data are publicly available from the European Commission website via http://ec.europa.eu.

Figure 4.3: Time series plot of UK versus EU consumer confidence indicators[a]



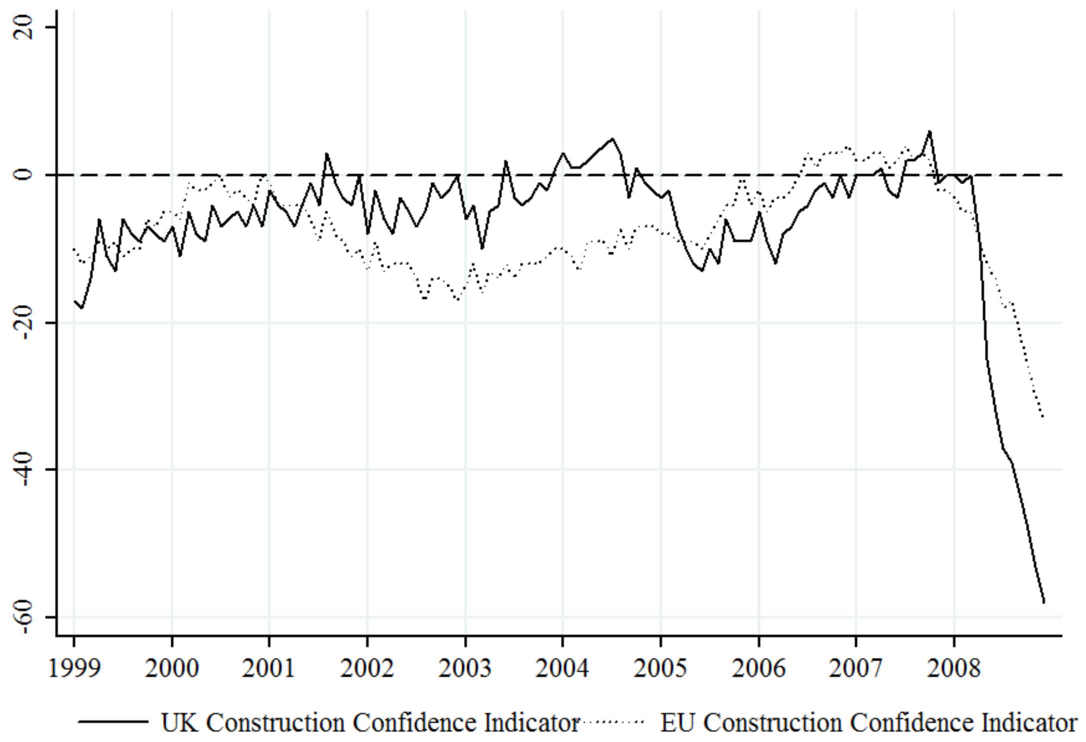
Note: [a.] The data are publicly available from the European Commission website via http://ec.europa.eu.

Figure 4.4: Time series plot of UK versus EU retail trade sector confidence indicators[a]



Note: [a.] The data are publicly available from the European Commission website via http://ec.europa.eu.

Figure 4.5: Time series plot of UK versus EU construction sector confidence indicators[a]



Note: [a.] The data are publicly available from the European Commission website via http://ec.europa.eu.

Figure 4.1 shows that managers in manufacturing industry view the growth in industrial production pessimistically most of the time within our observation window. The industrial confidence indicator takes positive values only in 2004 and 2007 for the UK, and takes positive values in 2000, 2006 and 2007 for the EU. The UK industrial confidence indicator is lower than its EU counterpart most of the time, and appears to be more volatile in our observation window. Figure 4.2 shows that managers in the services sector are relatively more optimistic about the development of their businesses. Both the UK and the EU service confidence indicators remain positive in most of our sample period. Again, the UK service confidence indicator is slightly more volatile, especially in the second half of our observation window. Consumers seem to be rather pessimistic about the financial conditions of their households as well as the economic situation in general, as shown in Figure 4.3. Compared with consumers in the EU as a whole, UK consumers are less pessimistic most of the time from 2002 to 2007. Figure 4.4 plots UK and EU retail trade sector confidence indicators over time. Managerial confidence in the retail trade sector in the UK outperforms that in the EU. However, the UK retail trade sector confidence indicator displays a rather large fluctuation, while the EU indicator is relatively stable over time. Figure 4.5 shows that the construction sector confidence indicators for the UK and the EU are less correlated with each other, other than being rather stable before 2008. There is no systematic pattern of one being consistently higher than the other. In all figures we can notice the magnitude of the downward shift in managerial confidence that characterises the last two years of the time series. The causes of the downwards shift may largely be attributed to the global financial crisis starts in late 2007.

4.2.2 Economic sentiment indicators

Based on the complete set of 15 balance series underlying the five sector-specific confidence indicators, the economic sentiment indicator (*ESI*) is formulated to synthesise the information contained in the individual surveys into a single variable, in an attempt to track the economy as a whole. Thus, this composite indicator can be considered as an aggregate indicator which summarises the information contained in the five sector-specific confidence indicators (European Commission, 2007). The economic sentiment indicator is defined as the weighted average of the standardised balance series, in which explicit weights are allocated to the five surveyed sectors, i.e. industry 40%, services 30%, consumers 20%, retail trade 5% and construction 5%.[38]

More specifically, the steps of the calculation of the economic sentiment indicator, according to European Commission (2007), can be summarised as follows. First, the balance series underlying the sector-specific confidence indicators are standardised,

$$Y_{jt} = \frac{B_{jt} - \overline{B}}{S_j} \tag{4.4}$$

where B_{jt} is the seasonally adjusted balance series j underlying the confidence indicators at time t, $\overline{B}_j$ is the arithmetic average of the balance series j, i.e. $\overline{B}_j = \sum_{t=11}^{T} B_{jt} / T$, and S_j is the sample standard deviation of the balance series j, i.e. $S_j = \sqrt{\sum_{t=1}^{T} (B_{jt} - \overline{B}_j)^2 / (T-1)}$.[39] Hence, Y_{jt} is the standardised balance series j. The available standardised balance series are then used to compute the weighted average Z_t as follows,

$$Z_t = \frac{\sum_j w_j \cdot Y_{jt}}{(\sum_j w_j)_t} \tag{4.5}$$

[38] The given weights are determined according to two criteria, namely, "representativeness" of the sector in question and tracking performance in relation to the reference variable. Corresponding to the broad scope of the Economic Sentiment Indicator, the obvious reference variable is GDP growth, tracking the movements of the economy as a whole. It is important to note that the weights are not directly applied to the five confidence indicators themselves but to their standardised individual component series (European Commission, 2007).

[39] The moments for standardisation are computed over a frozen sample to avoid monthly revisions of the index. Currently, the sample runs from January 1990 to December 2006, i.e. $T = 204$ (European Commission, 2007).

where w_j is the weight of standardised balance series j used to construct the economic sentiment indicator, which is computed as the sector weights mentioned above divided by the number of balance series making up the related sector-specific confidence indicator.[40] $(\sum_j w_j)_t$ is the sum of the weights of the available series at time t. Thus, Z_t can be viewed as the weighted average of standardised balance series, if all 15 components are available; otherwise, it is the weighted sum of the available balance series divided by the sum of the allocated weights of the available components. Then, the weighted average Z_t is standardised and scaled as follows,

$$ESI = (\frac{Z_t - \bar{Z}}{S_Z}) \times 10 + 100 \tag{4.6}$$

where $\bar{Z}$ and S_Z are the arithmetic average and the standard deviation of Z, which are computed as $\bar{Z} = \sum_{t=1}^{T} Z_t / T$ and $S_Z = \sqrt{\sum_{t=1}^{T} (Z_t - \bar{Z})^2 / (T-1)}$. The standardised Z_t is scaled to have a long-term mean of 100% and a standard deviation of 10%.[41] Finally, the aggregate *ESI* for the EU is calculated as a weighted average of the *ESI* of each member state. The weights utilised to calculate the *ESI* for the EU take into account the relative volume of each economy within the European Union, and are revised periodically.

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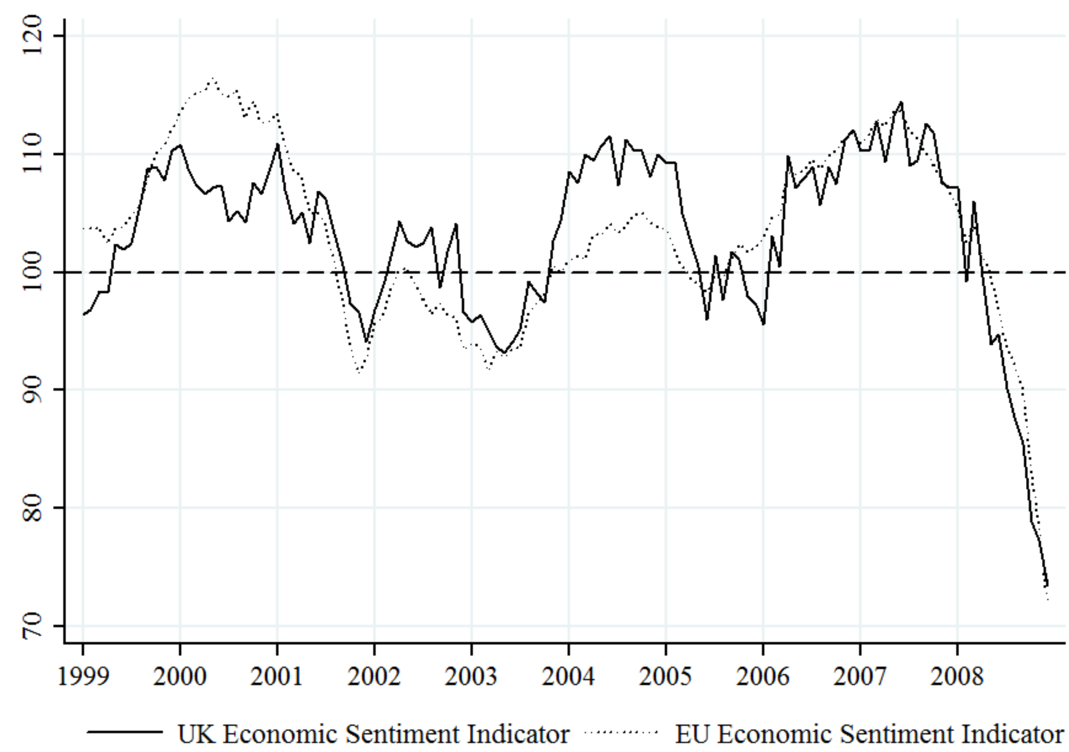
[40] For example, there are three balance series related to the service confidence indicator, thus each of the standardised balances receive a weight of 10%, adding up to the total services sector weight of 30%.
[41] According to European Commission (2007), the imposed standard deviation of 10 implies that in about 68% of the cases the economic sentiment indicator will be within the range of 90 to 110, assuming the indicator is normally distributed.

Figure 4.6: Time series plot of UK versus EU economic sentiment indicators[a]



Note: [a] The data are publicly available from the European Commission website via http://ec.europa.eu.

Therefore, for both *ESI* at country level and *ESI* at EU level, values greater than 100% indicate an above-average economic sentiment, whereas values below 100% indicate a below-average position (European Commission, 2007). We plot the economic sentiment indicators for both the UK and the EU from 1999 to 2008 in Figure 4.6. It shows that the two indicators trend together around the long-term mean of 100%, exhibiting similar periodic patterns of business cycle. But there is no systematic pattern of one economic sentiment indicator being consistently higher than the other. Both indicators show that the economic sentiment experiences the steepest drop in 2008, reaching their lowest readings in recent years. The collapse of economic sentiment is mainly attributable to the global financial crisis which starts in late 2007 and deteriorates in 2008.

Although the sector-specific managerial confidence indicators and the economic sentiment indicators are published at a monthly frequency, corporate decision variables and company characteristics variables are only available at an annual frequency. To empirically investigate the influence of managerial confidence and economic sentiment on corporate decisions, we have to convert the monthly-frequency indicators into their annual-frequency analogues. We therefore calculate the arithmetic averages of the monthly values over each calendar year as our proxies for managerial confidence and economic sentiment for the corresponding period. Given the argument that the key corporate decisions are likely to be made at the beginning of each fiscal year, the state of managerial confidence and economic sentiment in December tends to play a more important role than that in the other months of a year in making corporate decisions for the year ahead (Oliver and Mefteh, 2010). Therefore, we also consider the December figures as the relevant measures of managerial confidence and economic sentiment to check the robustness of our empirical results obtained using the arithmetic averages.[42]

Table 4.1 presents the descriptive statistics of the UK and the EU indicators at both monthly frequency and annual frequency observed over the period from January 1999 to December 2008

[42] Oliver and Mefteh (2010) take the December figure as the relevant measure of manager confidence to investigate the effect of confidence on the capital structure choices of a panel of French companies.

Table 4.1: Descriptive statistics for sector-specific confidence and economic sentiment indicators[a]

Indicator	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Obs.
Panel A: Monthly UK sector-specific confidence indicators[b]								
$INDU^{UK}$	–0.0956	–0.0900	0.0900	–0.3300	0.0886	–0.3941	2.7923	120
$SERV^{UK}$	0.0683	0.1050	0.2600	–0.4100	0.1340	–1.0897	3.9929	120
$CONS^{UK}$	–0.0545	–0.0400	0.0300	–0.2900	0.0585	–2.5028	9.5443	120
$RETA^{UK}$	0.0186	0.0300	0.2300	–0.4500	0.1280	–0.9824	4.4513	120
$BUIL^{UK}$	–0.0673	–0.0400	0.0600	–0.5800	0.1080	–2.8115	11.7169	120
ESI^{UK}	1.0310	1.0435	1.1450	0.7340	0.0736	–1.3400	5.6497	120
Panel B: Monthly EU sector-specific confidence indicators[b]								
$INDU^{EU}$	–0.0449	–0.0500	0.0700	–0.3200	0.0732	–0.5642	3.5507	120
$SERV^{EU}$	0.1120	0.1100	0.3100	–0.2100	0.1120	–0.2448	2.6031	120
$CONS^{EU}$	–0.0860	–0.0900	0.0200	–0.3000	0.0603	–0.4978	3.6683	120
$RETA^{EU}$	–0.0527	–0.0600	0.0800	–0.2700	0.0624	–0.1817	3.3173	120
$BUIL^{EU}$	–0.0741	–0.0800	0.0400	–0.3300	0.0675	–0.7095	4.5119	120
ESI^{EU}	1.0326	1.0370	1.1650	0.7210	0.0788	–0.7479	4.3837	120
Panel C: Annual UK sector-specific confidence indicators[c]								
$INDU^{UK}$	–0.0956	–0.1208	0.0283	–0.1608	0.0634	0.8073	2.4011	10
$SERV^{UK}$	0.0683	0.1267	0.1933	–0.1767	0.1224	–0.8743	2.5543	10
$CONS^{UK}$	–0.0545	–0.0408	–0.0200	–0.1950	0.0509	–2.3846	7.2379	10
$RETA^{UK}$	0.0186	0.0450	0.1233	–0.1867	0.1026	–0.7724	2.5210	10
$BUIL^{UK}$	–0.0673	–0.0454	0.0142	–0.2875	0.0858	–1.7929	5.5498	10
ESI^{UK}	1.0310	1.0303	1.1070	0.9111	0.0590	–0.6451	2.7991	10
Panel D: Annual EU sector-specific confidence indicators[c]								
$INDU^{EU}$	–0.0449	–0.0725	0.0525	–0.1042	0.0597	0.5786	1.7044	10
$SERV^{EU}$	0.1120	0.1108	0.2842	–0.0183	0.1038	0.2115	1.9728	10
$CONS^{EU}$	–0.0860	–0.0858	0.0050	–0.1767	0.0562	–0.0772	2.1293	10
$RETA^{EU}$	–0.0527	–0.0663	0.0442	–0.1208	0.0535	0.5069	2.0964	10
$BUIL^{EU}$	–0.0741	–0.0788	0.0167	–0.1608	0.0590	0.1515	1.8866	10
ESI^{EU}	1.0326	1.0292	1.1452	0.9332	0.0686	0.1297	1.9695	10

Notes:

[a.] Five sectors are covered by the Joint Harmonised EU Programme of Business and Consumer Surveys, namely, manufacturing industry (*INDU*), services (*SERV*), consumers (*CONS*), retail trade (*RETA*) and construction (*BUIL*). For each of the five surveyed sectors, confidence indicators are calculated as the arithmetic average of the balances of the answers to the selected questions, to reflect overall perceptions and expectations at the individual sector level in a one-dimensional index. The economic sentiment indicator (ESI) is formulated to synthesise the information contained in the individual surveys into a single variable (European Commission, 2007). The superscript (UK or EU) indicates the economy that the indicator tracks.

[b.] The five sector-specific surveys are currently conducted on a monthly basis, and the results are published every month.

[c.] To match the annual company-level variables, the monthly sector-specific confidence indicators and economic sentiment indicators are converted to their lower-frequency analogues by taking the arithmetic average of the monthly data over each year.

Table 4.1 shows that the average value of the UK (EU) sector-specific managerial confidence indicator over our sample period is –9.56% (–4.49%) for industrial companies, 6.83% (11.20%) for services companies, –5.45% (–8.60%) for consumers, 1.86% (–5.27%) for retailers, and –6.73% (–7.41%) for construction companies. Both the UK and EU economic sentiment indicators have an average value of 103% over the sample period, but the monthly EU indicator exhibits a slightly greater variation, ranging from 72.10% to 116.50% with a standard deviation of 7.88%.

A correlation coefficient matrix of the monthly UK and EU indicators is presented in Table 4.2. The message conveyed by the matrix confirms the visual comparisons offered by the figures above, and is consistent with our expectation that the UK and EU indicators are closely related with each other given the considerable degree of European economic integration. It should also be noted that the pair-wise correlations among all the indicators are uniformly positive and highly significant, indicating that managers in different sectors as well as consumers, to a great extent, share the same sentiment towards the prospects of the business and economic conditions.

Table 4.2: Correlation coefficient matrix of the UK and EU sector-specific confidence and economic sentiment indicators[a]

Indicator	$INDU^{UK}$	$SERV^{UK}$	$CONS^{UK}$	$RETA^{UK}$	$BUIL^{UK}$	ESI^{UK}	$INDU^{EU}$	$SERV^{EU}$	$CONS^{EU}$	$RETA^{EU}$	$BUIL^{EU}$	ESI^{EU}
$INDU^{UK}$	1.00											
$SERV^{UK}$	0.46[b] ***[c]	1.00										
$CONS^{UK}$	0.38 ***	0.67 ***	1.00									
$RETA^{UK}$	0.51 ***	0.57 ***	0.59 ***	1.00								
$BUIL^{UK}$	0.52 ***	0.55 ***	0.79 ***	0.80 ***	1.00							
ESI^{UK}	0.84 ***	0.82 ***	0.73 ***	0.71 ***	0.75 ***	1.00						
$INDU^{EU}$	0.84 ***	0.59 ***	0.37 ***	0.44 ***	0.47 ***	0.80 ***	1.00					
$SERV^{EU}$	0.41 ***	0.84 ***	0.50 ***	0.30 ***	0.31 ***	0.67 ***	0.67 ***	1.00				
$CONS^{EU}$	0.37 ***	0.83 ***	0.61 ***	0.43 ***	0.45 ***	0.68 ***	0.61 ***	0.90 ***	1.00			
$RETA^{EU}$	0.70 ***	0.52 ***	0.39 ***	0.71 ***	0.60 ***	0.73 ***	0.81 ***	0.48 ***	0.55 ***	1.00		
$BUIL^{EU}$	0.63 ***	0.67 ***	0.52 ***	0.53 ***	0.61 ***	0.76 ***	0.85 ***	0.71 ***	0.71 ***	0.83 ***	1.00	
ESI^{EU}	0.66 ***	0.83 ***	0.57 ***	0.49 ***	0.52 ***	0.84 ***	0.89 ***	0.92 ***	0.88 ***	0.74 ***	0.87 ***	1.00

Notes:

a. Monthly UK and EU sector-specific confidence and economic sentiment indicators over the period 1999–2008 are used to produce the correlation coefficient matrix.

b. For each cell, the reported figure is the pair-wise correlation coefficient between the corresponding indicators.

c. * significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level.

Although the managerial confidence indicators and the economic sentiment indicators drawn from the EU business and consumer surveys represent the combination of managerial confidence at aggregate levels, we can still use the term managerial overconfidence or optimism in this chapter, given the argument that the vast majority of managers provide responses which could be considered as overconfident on any reasonable scales (Ben-David *et al.*, 2007).[43] Oliver and Mefteh (2010) use the same set of indicators as proxies for managerial overconfidence to investigate the influence of managers' psychological bias on capital structure choice with reference to a panel of French companies.

4.3 Modelling corporate behavioural equations

4.3.1 Corporate behavioural equations with proxy for the state of confidence

This chapter incorporates managerial confidence and economic sentiment into corporate finance issues to investigate their impact on corporate investment, financing and payout decisions. To explicitly allow for the contemporaneous interactions among the key set of corporate decisions, we model companies' capital investment, debt financing and dividend payout behaviour endogenously within the simultaneous equations system set up in Chapter 3. Given the potential influences of managers' psychological bias on aspects of corporate behaviour, we treat the state of confidence as a common factor involved in each of the decisions modelled in our simultaneous system. Therefore, the simultaneous equations system

[43] This is a crude approximation of managerial overconfidence, however given the data this is the best we would do.

that models corporate behaviour with the state of confidence is specified as follows,

$$\left.\frac{INV}{K}\right._{it} = \alpha_0 + \alpha_1 \left.\frac{NDF}{K}\right._{it} + \alpha_2 \left.\frac{DIV}{K}\right._{it} + \alpha_3 \left.\frac{CF}{K}\right._{it} + \alpha_4 Q_{it} + \alpha_5 \left.\frac{INV}{K}\right._{it-1} + \alpha_6 CONF_{it-1} + \varepsilon_{it} \tag{4.7}$$

$$\left.\frac{NDF}{K}\right._{it} = \beta_0 + \beta_1 \left.\frac{INV}{K}\right._{it} + \beta_2 \left.\frac{DIV}{K}\right._{it} + \beta_3 \left.\frac{CF}{K}\right._{it} + \beta_4 TAN_{it} + \beta_5 SZ_{it} + \beta_6 CONF_{it-1} + \mu_{it} \tag{4.8}$$

$$\left.\frac{DIV}{K}\right._{it} = \gamma_0 + \gamma_1 \left.\frac{INV}{K}\right._{it} + \gamma_2 \left.\frac{NDF}{K}\right._{it} + \gamma_3 \left.\frac{CF}{K}\right._{it} + \gamma_4 OWN_{it} + \gamma_5 \left.\frac{RE}{TE}\right._{it} + \gamma_6 CONF_{it-1} + \nu_{it} \tag{4.9}$$

where *INV* represents gross investment, *NDF* net new debt financing, *DIV* dividend payout, *CF* cash flow, *Q* the ratio of market to book value of total assets, *TAN* asset tangibility, *SZ* company size, *OWN* ownership structure, *RE/TE* the ratio of retained earnings to total equity, and *CONF* the state of confidence, proxied either by the managerial confidence indicator or the economic sentiment indicator. ε, μ and ν are the error terms in their respective equations. A lagged investment variable is also included to capture the dynamic structure of the investment decision (see Guariglia, 2008; and Lensink and Murinde, 2006). In addition, the corporate decisions are assumed to be made at the beginning of each year, and thus a lagged confidence indicator is included to proxy for the managers' perceptions and expectations of future economic conditions when they make corporate decisions at the beginning of each fiscal year for the year ahead, i.e. managers form their perceptions and expectations at the beginning of the year t (or end of year t–1) according to the information set available, and then decide how to finance and allocate their funds for year t. All the corporate decision and cash flow variables are scaled by beginning-of-period capital stock (K), in order to control for company size and to reduce heteroscedasticity problems that may otherwise arise in the company-level data.

According to the behavioural corporate finance literature, managerial overconfidence induces an underinvestment-overinvestment trade-off (see Heaton, 2002). If managers systematically overestimate future returns to their investment projects and thus overinvest, we expect the coefficient on the confidence variable in the investment equation to be positive. If managers consistently perceive their companies are undervalued by the capital market and thus are reluctant to access external finance, resulting in underinvestment, then we expect the coefficient on the confidence variable in Equation 4.7 to be negative. The overall effect of managerial confidence on corporate investment, therefore, is subject to empirical examination.

The prediction with respect to managerial confidence on corporate debt financing decision is also theoretically ambiguous. If managers have an upward bias towards future profitability and a downward bias towards the riskiness of future earnings, we expect the coefficient on the confidence variable in the debt financing equation to be positive. If managers consistently perceive their company as undervalued by the capital market, and external finance as unduly costly, we expect the coefficient on the confidence variable in Equation 4.8 to be negative. Thus, managers' psychological bias in relation to corporate debt financing decisions also needs to be addressed empirically.

Again, the relationship between the state of confidence and dividend payout is also not clear-cut. If managers are more confident about future cash flow and hence view dividend payout as more sustainable, we expect the coefficient on the confidence variable in the dividend payout equation to be positive. If managers overestimate both returns to investment and costs of external finance, and therefore view internally generated cash flows as more valuable, we expect managerial confidence in Equation 4.9 to have a negative effect on dividend payouts.

Equations 4.7 through 4.9 form a simultaneous equations system, in which corporate decisions are jointly determined by managers based on their confidence towards future company performance. We employ two proxies for the state of confidence (*CONF*), i.e. a sector-specific managerial confidence indicator (*SCI*) and economic sentiment indicator (*ESI*), as described in Section 4.3. Both indicators are measured at two levels, i.e. the UK country level (SCI^{UK} and ESI^{UK}) and the EU regional level (SCI^{EU} and ESI^{EU}). The candidate indicators are used as the confidence variable separately in their respective simultaneous equations system variants. Industry dummies are included in all of the equations to account for inter-industry variations that cannot be captured by the included regressors. We do not include year dummies in our equations because the variables employed to proxy for the state of confidence and sentiment in this chapter are all at aggregate levels, and their effects on corporate decisions may, to some extent, be captured by the year dummies.

4.3.2 Corporate behavioural equations with confidence and uncertainty variables

Recent literature in corporate finance has also recognised the importance of uncertainty associated with companies' prospects in the determination of corporate decisions (see the literature reviewed in Section 2.4). Chapter 3 of this thesis also pays great attention to the impacts of uncertainty at company level on jointly determined corporate investment, financing and payout choices. We construct our proxies for uncertainty based on stock price volatility, under the assumption that all the information about a company's fundamentals and prospects will be properly transmitted into its share price. Using a large panel of UK-listed companies within the period 1999–2008, we find that companies are likely to increase their investment outlays 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 resorting to external funds by issuing new debts. Overall, the findings of Chapter 3 strongly support the argument that managers do take uncertainty associated with their company's prospects into consideration when they make real and financial decisions.

An interesting related question is whether the state of managerial confidence and economic sentiment towards future business performance can be adequately reflected in the changes in share prices and empirically captured by our proxy for company-level uncertainty which is also forward looking in nature. To empirically address this research question, we also include our primary proxy for company-level uncertainty (*UNC*1) derived from the changes in share prices as an additional common exogenous determinant of corporate decisions into each of the behavioural equations modelled in our simultaneous equations system. Accordingly, the augmented equations system is specified as follows,

$$\frac{INV}{K}_{it} = \alpha_0 + \alpha_1 \frac{NDF}{K}_{it} + \alpha_2 \frac{DIV}{K}_{it} + \alpha_3 \frac{CF}{K}_{it} + \alpha_4 Q_{it} + \alpha_5 \frac{INV}{K}_{it-1} + \alpha_6 UNC1_{it-1} + \alpha_7 CONF_{it-1} + \varepsilon_{it} \tag{4.10}$$

$$\frac{NDF}{K}_{it} = \beta_0 + \beta_1 \frac{INV}{K}_{it} + \beta_2 \frac{DIV}{K}_{it} + \beta_3 \frac{CF}{K}_{it} + \beta_4 TAN_{it} + \beta_5 SZ_{it} + \beta_8 UNC1_{it-1} + \beta_7 CONF_{it-1} + \mu_{it} \tag{4.11}$$

$$\frac{DIV}{K}_{it} = \gamma_0 + \gamma_1 \frac{INV}{K}_{it} + \gamma_2 \frac{NDF}{K}_{it} + \gamma_3 \frac{CF}{K}_{it} + \gamma_4 OWN_{it} + \gamma_5 \frac{RE}{TE}_{it} + \gamma_6 UNC1_{it-1} + \gamma_7 CONF_{it-1} + \nu_{it} \tag{4.12}$$

Where *UNC*1 represents the primary proxy for uncertainty constructed in Chapter 3. Again, the uncertainty variable enters the system with a lag in an attempt to reduce the possibility of using more information in modelling corporate decisions than managers actually have when they make corporate decisions. If the state of managerial confidence and economic sentiment can be captured by the proxy for uncertainty, then the confidence variables will lose their explanatory powers for corporate decisions once the company-level uncertainty is incorporated in the system. On the other hand, if the confidence variables do indeed hold additional information useful in explaining corporate behaviour, their explanatory powers are expected to persist even after controlling for company-level uncertainty.

4.4 Data and preliminary analysis

Our data are collected from the Worldscope database via Thomson One Banker Analytics. The initial sample includes all companies listed on the London Stock Exchange (LSE), including both active and inactive companies, within the period 1999–2008. We then discard utilities (SIC code 4900–4949), and financial companies (SIC code 6000–6999). Companies that do not have complete records on all the relevant variables in determining corporate investment, financing and payout decisions as well as those with less than five years of continuous observations are dropped from our sample. We also exclude company-year observations with negative cash flow from our sample. The number of company-year observations included in the final sample for the simultaneous equations analyses therefore reduces to 2,791. The indicators for managerial confidence and economic sentiment at UK level and EU level are publicly available from the European Commission website. An unbalanced panel of company-level data, therefore, is formed to avoid survivorship bias and to make full use of the company-year observations. The measurement of each variable used in this chapter is described in Table 4.3.

Table 4.3: Description of main variables used in Chapter 4[a]

Gross investment (*INV*):

The sum of the changes in book value of net property, plant and equipment and depreciation expenses[b]

Net debt financing (*NDF*):

The change 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

Capital stock (*K*):

The book value of tangible fixed assets

Company 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 the balance sheet to the book value of total common equity

Uncertainty measure 1 (*UNC*1):

The difference between the highest and the lowest prices normalised by the mean over the period

UK industrial sector managerial confidence indicator ($INDU^{UK}$):

The arithmetic average of the balances of the answers given by 1,500 UK companies in the manufacturing sector to the survey questions on production expectations, order books and stocks of finished products[c]

UK services sector managerial confidence indicator ($SERV^{UK}$):

The arithmetic average of the balances of the answers given by 1,000 UK companies in the services sector to the survey questions on business climate and on recent and expected evolution of demand

UK consumer confidence indicator ($CONS^{UK}$):

The arithmetic average of the balances of the answers given by 2,000 UK consumers to the survey questions on the financial situation of households, the general economic situation, unemployment expectations and saving, all over the next months

UK retail trade sector managerial confidence indicator ($RETA^{UK}$):

The arithmetic average of the balances of the answers given by 500 UK companies in the retail trade sector to the survey questions on the present and future business situation, and on stocks

UK construction confidence indicator ($BUIL^{UK}$):

The arithmetic average of the balances of the answers given by 800 UK companies in the construction sector to the survey questions on order book and employment expectations

UK sector-specific managerial confidence indicator (SCI^{UK}):

The value of the industry-wide managerial confidence in the UK for a company, which is equal to $INDU^{UK}$ for companies in the manufacturing sector, $SERV^{UK}$ for companies in the services sector, $RETA^{UK}$ for companies in the retail trade sector and $BUIL^{UK}$ for companies in the construction sector

UK economic sentiment indicator (ESI^{UK}):

The indicator which is made up of 15 individual components of UK sector-specific confidence indicators to track cyclical movements in the UK economy as a whole

EU industrial sector managerial confidence indicator ($INDU^{EU}$):

The arithmetic average of the balances of the answers given by 38,250 EU companies in the manufacturing sector to the survey questions on production expectations, order books and stocks of finished products

EU services sector managerial confidence indicator ($SERV^{EU}$):

The arithmetic average of the balances of the answers given by 34,730 EU companies in the services sector to the survey questions on business climate and on recent and expected evolution of demand

EU consumer confidence indicator ($CONS^{EU}$):

The arithmetic average of the balances of the answers given by 39,900 EU consumers to the survey questions on the financial situation of households, the general economic situation, unemployment expectations and saving, all over the next months

EU retail trade sector managerial confidence indicator ($RETA^{EU}$):

The arithmetic average of the balances of the answers given by 31,780 EU companies in the retail trade sector to the survey questions on the present and future business situation, and on stocks

EU construction sector managerial confidence indicator ($RETA^{EU}$):

The arithmetic average of the balances of the answers given by 20,750 EU companies in the construction sector to the survey questions on order book and employment expectations

EU sector-specific managerial confidence indicator (SCI^{EU}):

The value of the industry-wide managerial confidence in the EU for a company, which is equal to $INDU^{EU}$ for companies in the manufacturing sector, $SERV^{EU}$ for companies in the services sector, $RETA^{EU}$ for companies in the retail trade sector and $BUIL^{EU}$ for companies in the construction sector

EU economic sentiment indicator (ESI^{EU}):

The indicator which is made up of 15 individual components of EU sector-specific confidence indicators to track cyclical movements in the EU economy as a whole

Notes:

[a.] The definition and measurement of the company characteristic variables are based on the existing literature.

[b.] The data are collected from the Worldscope database via Thomson One Banker Analytics.

[c.] The sector-specific confidence indicators and economic sentiment indicators are publicly available from the European Commission website.

The descriptive statistics for the main variables used in this chapter, both before and after winsorisation transformation, are presented in Table 4.4.

Table 4.4: Descriptive statistics for main variables used in Chapter 4[a]

Variable	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Obs.
Panel A: Descriptive statistics of variables without winsorisation[b]								
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
*UNC*1	0.3122	0.2972	0.72	0.02	0.1046	0.7052	3	3423
SCI^{UK}	–0.0217	–0.0325	0.19	–0.29	0.1124	0.2493	2	3423
SCI^{EU}	–0.0001	–0.0183	0.28	–0.16	0.0982	0.9457	3	3423
ESI^{UK}	1.0315	1.0288	1.11	0.91	0.0586	–0.6033	3	3423
ESI^{EU}	1.0295	1.0258	1.15	0.93	0.0642	0.1287	2	3423
Panel B: Descriptive statistics of variables winsorised at the top and bottom 5th percentiles[c]								
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
*UNC*1	0.3123	0.2972	0.5591	0.1714	0.0992	0.6307	2.7302	3423
SCI^{UK}	–0.0217	–0.0325	0.1933	–0.2875	0.1124	0.2493	1.9163	3423
SCI^{EU}	–0.0001	–0.0183	0.2842	–0.1608	0.0982	0.9457	3.3526	3423
ESI^{UK}	1.0315	1.0288	1.1070	0.9111	0.0586	–0.6033	2.5758	3423
ESI^{EU}	1.0295	1.0258	1.1452	0.9332	0.0642	0.1287	1.9270	3423

Notes:

[a] The sample contains UK company-year observations within the period 1999–2008.

[b] Winsorisation is the transformation of extreme values in the statistical data.

[c] The transformed data are identical to the original data except that, in this case, all data below the 5^{th} percentile are set to the 5^{th} percentile and all data above the 95^{th} percentile are set to the 95^{th} percentile. Variables at aggregate levels, i.e. SCI^{UK}, SCI^{EU}, ESI^{UK} and ESI^{EU}, are not winsorised.

Panel A in Table 4.4 presents the descriptive statistics for the main variables from our raw data. As is evident, extreme values appear in almost all the variables, especially those that are in the form of ratios. In order to cope with the potential impact of outliers upon our empirical tests, we winsorise all the company-level variables used in our analysis at both the top and bottom 5^{th} percentiles of their respective distributions. Panel B in Table 4.4 reports the descriptive statistics after such a transformation has been undertaken. Since the proxies for managerial confidence and economic sentiment are at aggregated levels, we do not winsorise them. Given the desired properties of the winsorisation estimators, our empirical results presented this chapter are based on the variables winsorised at both the top and bottom 5^{th} percentiles.

A pair-wise correlation among the main variables is presented in Table 4.5. It shows that the three endogenous variables, namely, *INV/K*, *NDF/K* and *DIV/K*, are significantly and positively correlated with one another, and that the predetermined cash flow variable *CF/K* is significantly correlated with all three endogenous variables. It is also evident that the managerial confidence and economic sentiment variables, namely, SCI^{UK}, SCI^{EU}, ESI^{UK} and ESI^{EU}, are significantly correlated with all three corporate decisions variables at the 1% significance level. The correlations between the confidence variables and corporate decisions variables are uniformly positive, indicating capital investment and debt financing as well as dividend payouts of UK-listed companies are likely to increase with the level of managerial confidence and economic sentiment.

Table 4.5: Correlation coefficient matrix of variables used in Chapter 4[a]

Variable	*INV/K*	*NDF/K*	*DIV/K*	*CF/K*	*Q*	*TAN*	*SZ*	*OWN*	*RE/TE*	*UNC*1	SCI^{UK}	SCI^{EU}	ESI^{UK}	ESI^{UK}
NDF/K	0.38[b] ***[c]	1.00												
DIV/K	0.34 ***	0.15 ***	1.00											
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						
RE/TE	–0.10 ***	–0.04 **	0.06 ***	–0.04 **	–0.03 *	0.09 ***	0.12 ***	–0.04 **	1.00					
*UNC*1	0.25 ***	0.00	0.05 **	0.25 ***	0.11 ***	–0.26 ***	–0.27 ***	0.14 ***	–0.28 ***	1.00				
SCI^{UK}	0.16 ***	0.09 ***	0.09 ***	0.11 ***	0.01	0.00	0.01	0.03 *	–0.04 *	0.06 ***	1.00			
SCI^{EU}	0.20 ***	0.11 ***	0.08 ***	0.13 ***	0.06 ***	–0.02	0.02	0.04 *	–0.09 ***	0.04 **	0.79 ***	1.00		
ESI^{UK}	0.09 ***	0.08 ***	0.08 ***	0.07 ***	–0.04 **	–0.06 ***	0.04 *	0.00	0.00	–0.02	0.53 ***	0.48 ***	1.00	
ESI^{EU}	0.07 ***	0.09 ***	0.05 ***	0.04 **	–0.04 **	–0.03 *	0.08 ***	–0.03	0.03 *	–0.12 ***	0.41 ***	0.58 ***	0.79 ***	1.00

Notes:

[a.] The sample contains UK company-year observations within the period 1999–2008.

[b.] For each cell, the reported figure is the pair-wise correlation coefficient between the corresponding variables.

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

The correlations between the endogenous variables and other relevant exogenous variables are also informative. According to Table 4.5, *INV/K* is significantly and positively correlated with *Q* and *UNC*1; *NDF/K* is positively correlated with *SZ* but negatively correlated with *TAN*; *DIV/K* is positively correlated with *RE/TE* and *UNC*1, but its correlation with *OWN* is rather weak. Besides, the proxy for company-level uncertainty *UNC*1 is positively correlated with the sector-specific managerial confidence indicators SCI^{UK} and SCI^{EU}, negatively correlated with the overall economic sentiment indicators ESI^{UK} and ESI^{EU}.

In addition, there is no evidence of near multicollinearity presented in the correlation coefficient matrix. Although the proxies for the state of managerial confidence and economic sentiment are highly correlated with one another (both the correlation coefficient between SCI^{UK} and SCI^{EU} and that between ESI^{UK} and ESI^{EU} are as high as 0.79), they do not cause the problem of multicollinearity since they do not enter the corporate behavioural equations at the same time. Instead, we include the alternative proxies for managerial confidence and economic sentiment into their respective system variants separately.

4.5 Empirical results and implications for corporate behaviour

To obtain our main empirical results, we apply the 3SLS estimation to all the simultaneous equations system variants that include one structural equation for each of the three policy choices specified in Section 4.3. The essential advantage of the 3SLS estimation technique is that it allows for not only simultaneity among the set of corporate decisions, but also for correlations among the error components. Therefore, 3SLS estimation is asymptotically more efficient than the limited information methods, such as 2SLS estimation.

We test the significance of the confidence variables within an individual equation as well as across all equations in the system using the Wald test.[44] The null hypothesis is that the confidence variable or the set of confidence variables does not help in explaining the variations in the corresponding corporate decision variable, and thus can be dropped from the equation. If the null hypothesis is rejected, it means that the managerial confidence or economic sentiment in fact plays a role in the determination of the corresponding corporate decision.[45]

The same test is also carried out to test the joint significance of a confidence variable in all corporate behavioural equations modelled in the system. The null hypothesis for the cross-equation test is that the coefficients on the confidence variable in all equations in which it appears are jointly equal to zero. In other words, under the null hypothesis, the confidence variable being tested does not contain useful information which can help in explaining any aspect of corporate behaviour, and hence should be excluded from the simultaneous equations system. If the composite hypothesis is rejected, the presence of the confidence variable in the system is justified, suggesting that modelling corporate behaviour without considering the state of managerial confidence or economic sentiment is economically incomplete and statistically inadequate.

[44] These test statistics are asymptotically distributed as *Chi*-squared.

[45] The Wald test result is identical to the corresponding z-statistic reported in the regression results, if there is only one coefficient under test.

4.5.1 Simultaneous analyses with proxy for the state of confidence

Table 4.6 reports the empirical results by applying the 3SLS estimation to Equations 4.7–4.9, where the managerial confidence indicators SCI^{UK} and SCI^{EU} are used as the proxy for the state of confidence in their respective system variants. The regression results for the investment, financing and payout equations, in which the UK managerial confidence indicator is used, are presented in columns 2, 4 and 6, respectively.

Looking first at the investment equation, it is evident that the coefficients on the two endogenous explanatory variables, i.e. *NDF/K* and *DIV/K*, are both significant at the 5% significance level. The significantly positive relationship between investment and dividend variables evidenced in the simple pair-wise correlation analysis is reversed to be significantly negative when the full structural investment equation is estimated within the simultaneous equations system, suggesting that they represent competing uses of limited funds. The coefficient on the cash flow variable *CF/K* is positive and highly significant as expected. The significantly positive effect of internally generated cash flow further confirms that UK-listed companies are financially constrained, and thus their investments display high sensitivity to the availability of internal funds. More importantly, the proxy for the UK managerial confidence SIC^{UK} in the investment equation turns out to be positive and highly significant at the 1% significance level, after controlling for the set of company fundamental variables which, according to the existing literature, are the primary determinants of corporate investment. It appears that UK-listed companies tend to invest more intensively in their capital stock when their managers are more confident, or possibly overconfident, about the future company performance. This is consistent with the theoretical predictions made by Heaton (2002) and empirical findings offered by Ben-David *et al.* (2007) that overconfident managers systematically overestimate the returns to their investment projects, and simultaneously underestimate the risks associated with those projects, resulting in unintended overinvestment and risk-taking behaviour. Besides, the proxy for investment opportunity *Q* is positively related to the investment variable, but not statistically significant at the conventional levels. The dynamic structure of corporate investment is statistically evident.

Turing to the financing regression reported in column 4 of Table 4.6, the coefficients on the endogenous variables *INV/K* and *DIV/K* are both positive and marginally significant, while the coefficient on the cash flow variable *CF/K* is negative and highly significant, as predicted by the flow-of-funds framework. These findings are in line with the hierarchy of raising funds as implied by the pecking-order theory. The coefficient on the UK managerial confidence indicator SIC^{UK} turns out to be positive and statistically significant at the 1% level. It shows that managerial confidence or overconfidence is an important factor in explaining corporate debt financing behaviour, even after controlling for the major conventional capital structure determinants. Managerial confidence is clearly associated with aggressive borrowing policies of the UK-listed companies, implying that managers tend to overestimate their companies' growth rate of earnings and underestimate the associated risks when they are more confident, and thus use debt financing more aggressively. Our finding is consistent with the prior studies on managerial overconfidence and corporate financial policies, for example Hackbarth (2008), Ben-David *et al.* (2007) and Malmendier *et al.* (2011). We do not find evidence that overconfident managers view external funds as unduly costly and are reluctant to raise funds externally. The results for the control variables are similar to those reported in Chapter 3 that the effect of company size *SZ* is highly significant as expected, whist the effect of asset tangibility *TAN* is also significant but with an unexpected sign.

Column 6 of Table 4.6 reports the estimation results for the dividend payout regression. The coefficients estimated for the endogenous variables *INV/K* and *NDF/K* as well as the predetermined cash flow variable *CF/K* have their expected signs and are highly significant at the 1% level, which further confirms the simultaneity among the key set of corporate decisions. The payout decisions of the UK-listed companies are neither totally residual nor entirely independent but are taken with reference to their investment and financing decisions. However, the effect of managerial confidence on corporate payout decisions is relatively weak. Although the coefficient on the managerial confidence variable SCI^{UK} is not significant at the usual significance levels, its negative sign implies that confident managers may have a stronger preference for internal funds and are more likely to retain internally generated cash flows in an attempt to finance their investment opportunities at a lower cost. Besides, the ownership structure and the financial life cycle stage variables (*OWN* and *RE/TE*) are both positively related to corporate payout decisions, and the highly significant coefficient on *RE/TE* is consistent with the predictions of the life cycle theory of dividend payout.

Table 4.6: 3SLS estimation results for corporate behavioural equations with sector-specific managerial confidence[a]

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
INV/K			0.1373*	0.1233*	–0.1114***	–0.1060***
			(1.88)	(1.65)	(–2.80)	(–2.65)
NDF/K	0.2601**[e]	0.2170**			0.4313***	0.4263***
	(2.50)[f]	(2.04)			(5.77)	(5.66)
DIV/K	–0.4605**	–0.3969**	0.3600	0.3671		
	(–2.56)	(–2.16)	(1.26)	(1.28)		
CF/K	0.2143***	0.2076***	–0.0251	–0.0242	0.1304***	0.1302***
	(9.68)	(9.20)	(–0.57)	(–0.55)	(12.98)	(12.90)
Q	0.0068	0.0052				
	(0.70)	(0.53)				
$(INV/K)_{-1}$	0.2993***	0.2991***				
	(17.99)	(18.05)				
TAN			–0.3268***	–0.3213***		
			(–3.54)	(–3.49)		
SZ			0.0284***	0.0288***		
			(4.86)	(4.89)		
OWN					0.0364	0.0395
					(1.39)	(1.49)
RE/TE					0.0394***	0.0383***
					(3.59)	(3.51)
SCI_{-1}^{UK}	0.3476***		0.3610***		–0. 0987	
	(4.33)		(3.22)		(–1.53)	
SCI_{-1}^{EU}		0.3876***		0.4056***		–0.1369**
		(4.33)		(3.44)		(–1.96)
Constant	0.1575***	0.1588***	–0.0181	–0.0191	0.0170	0.0156
	(4.97)	(4.99)	(–0.27)	(–0.29)	(0.62)	(0.57)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of *SCI* in the equation[i]	18.73*** (p = 0.000)	18.76*** (p = 0.000)	10.38*** (p = 0.001)	11.83*** (p = 0.001)	2.34 (p = 0.12)	3.83** (p = 0.050)
Wald test for the joint significance of *SCI* in the system[j]	28.29*** (p = 0.000)	29.05*** (p = 0.000)	28.29*** (p = 0.000)	29.05*** (p = 0.000)	28.29*** (p = 0.000)	29.05*** (p = 0.000)
Chi^2-statistic for the equation[k]	2535.86*** (p = 0.000)	2526.82*** (p = 0.000)	256.85*** (p = 0.000)	255.79*** (p = 0.000)	1278.87*** (p = 0.000)	1284.84*** (p = 0.000)

Notes:

a. The UK and EU sector-specific managerial confidence indicators (SCI^{UK} and SCI^{EU}) are used as a proxy for the state of confidence in their respective system variants. The sample contains UK company-year observations within the period 1999–2008. Equations 4.7 through 4.9 are estimated by 3SLS estimators using Stata 11.

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

c. Financing equation: $NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 SCI_{-1} + \mu$.

d. Dividend equation: $DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 SCI_{-1} + \nu$.

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

f. z-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either SCI^{UK} or SCI^{EU} in this case) is zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either SCI^{UK} or SCI^{EU} in this case) across all equations in the system are simultaneously equal to zero. The test report results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

k. Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Reported in columns 3, 5 and 7 of Table 4.6 are the estimation results for investment, financing and payout regressions of the system variant in which the managerial confidence indicator at EU level (SIC^{EU}) is used as the proxy for the state of confidence. As is evident, replacing the UK managerial confidence indicators with their EU counterparts does not cause significant changes in our results. However, the coefficient on the managerial confidence variable SIC^{EU} in the payout equation (see column 7) turns out to be negative and statistically significant. It seems that the dividend payout policies of the UK-listed companies are more likely to be influenced by the collective managerial confidence and sentiment at higher levels of aggregation. In accordance with the prediction of managerial psychological bias, overconfident managers misperceive the profitability of their investment opportunities as well as the value of their companies. Consequently, they tend to overinvest in projects whose net present values are possibly overestimated, resulting in higher financing needs. Meanwhile, they also try to avoid external financing which is possibly misperceived as unduly costly. Under such circumstances, overconfident managers view internal funds as more valuable and have a stronger preference for internal financing. Therefore, managers are likely to retain more internally generated cash flow when they are more confident, in order to prevent losses from underinvestment, and to keep their overall cost of capital as low as possible. Besides, the Wald test results reported at the bottom of Table 4.6 strongly suggest that our proxies for managerial confidence do indeed play an important role in the determination of the corporate decisions. Therefore, modelling corporate behaviour using company fundamental characteristics without considering the state of managerial confidence is incomplete.

An alternative measure of the state of confidence used in this chapter is the economic sentiment indicator (*ESI*). The UK economic sentiment indicator (ESI^{UK}) and the EU economic sentiment indicator (ESI^{EU}) are employed in their respective system variants, and the 3SLS estimation results are reported in Table 4.7. The regression results obtained by using the economic sentiment indicator as the proxy for the state of confidence are similar to those reported in Table 4.6 in the terms of the significance levels and the sizes of the coefficients for the confidence variable as well as the control variables. First, the coefficients on the endogenous explanatory variables are not only statistically significant but also economically meaningful, which lends strong empirical support to the prediction of the flow-of-funds framework that corporate investment, financing and payout decisions are simultaneously determined by the UK-listed companies. The UK economic sentiment indicator (ESI^{UK}) enters both the investment equation and the financing equation with a positive sign, and is statistically significant in both equations, indicating that UK-listed companies invest in capital stock more intensively and use debt more aggressively when the economic sentiment in the UK is high. The UK economic sentiment indicator enters the payout equation with a negative sign but its influence on dividend payout decisions of UK companies is rather weak. Compared with the UK economic sentiment indicator, its EU counterpart (ESI^{EU}) seems to be better able to explain the debt financing and dividend payout decisions of UK companies, while it provides less explanatory power for corporate investment decisions. The Wald test results exhibit high joint significance of the economic sentiment variables in their respective system variants. In summary, our results for both managerial confidence and economic sentiment are statistically significant, particularly in explaining the corporate investment and debt financing decisions of UK-listed companies.

Table 4.7: 3SLS estimation results for corporate behavioural equations with economic sentiment[a]

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
INV/K			0.1725**	0.1701**	–0.1220***	–0.1230***
			(2.51)	(2.47)	(–3.15)	(–3.13)
NDF/K	0.2838*** [e]	0.2948***			0.4224***	0.4342***
	(2.74) [f]	(2.82)			(5.48)	(5.48)
DIV/K	–0.6179***	–0.6194***	0.4446*	0.4369*		
	(–3.52)	(–3.53)	(1.64)	(1.60)		
CF/K	0.2341***	0.2342***	–0.0417	–0.0399	0.1333***	0.1326***
	(10.62)	(10.63)	(–1.00)	(–0.95)	(13.52)	(13.12)
Q	0.0109	0.0104				
	(1.14)	(1.09)				
$(INV/K)_{-1}$	0.3002***	0.2995***				
	(17.79)	(17.78)				
TAN			–0.2885***	–0.2882***		
			(–3.38)	(–3.37)		
SZ			0.0277***	0.0268***		
			(4.79)	(4.65)		
OWN					0.0295	0.0291
					(1.16)	(1.14)
RE/TE					0.0374***	0.0376***
					(3.48)	(3.44)
ESI_{-1}^{UK}	0.4179**		0.6388***		–0.1240	
	(2.29)		(2.70)		(–0.85)	
ESI_{-1}^{EU}		0.1835		0.5848***		–0.1743
		(1.29)		(3.32)		(–1.51)
Constant	–0.2766	–0.0310	–0.7035***	–0.6375***	0.1510	0.2016
	(–1.44)	(–0.21)	(–2.90)	(–3.51)	(1.00)	(1.70)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of *ESI* in the equation[i]	5.24** (p = 0.022)	1.67 (p = 0.197)	7.32*** (p = 0.007)	11.00*** (p = 0.001)	0.73 (p = 0.394)	2.29 (p = 0.130)
Wald test for the joint significance of *ESI* in the system[j]	12.22*** (p = 0.007)	12.48*** (p = 0.006)	12.22*** (p = 0.007)	12.48*** (p = 0.006)	12.22*** (p = 0.007)	12.48*** (p = 0.006)
Chi^2-statistic for the equation[k]	2458.31*** (p = 0.000)	2454.17*** (p = 0.000)	261.98*** (p = 0.000)	263.91*** (p = 0.000)	1291.99*** (p = 0.000)	1253.22*** (p = 0.000)

Notes:

a. The UK and EU economic sentiment indicators (ESI^{UK} and ESI^{EU}) are used as a proxy for the state of confidence in their respective system variants. The sample contains company-year observations within the period 1999–2008. Equations 4.7 through 4.9 are estimated by 3SLS estimators using Stata 11.

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

c. Financing equation: $NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 ESI_{-1} + \mu$.

d. Dividend equation: $DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 ESI_{-1} + \nu$.

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

f. z-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either ESI^{UK} or ESI^{EU} in this case) is zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either ESI^{UK} or ESI^{EU} in this case) across equations in the system are simultaneously equal to zero. The test report results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

k. Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

4.5.2 Simultaneous analyses with confidence and uncertainty variables

To address the research question that whether the state of confidence can be captured by the company's overall uncertainty, we add a proxy for company-level uncertainty into our simultaneous equations system as another common exogenous determinant of corporate decisions modelled in the system. Equations 4.10, 4.11 and 4.12 are estimated simultaneously using the 3SLS estimators. The results are presented in Tables 4.8 and 4.9 where different proxies for the state of confidence are used in their respective system variants. As is evident, our findings with regard to the influences of managerial confidence and economic sentiment on aspects of corporate behaviour persist even after controlling for company-level uncertainty (*UNC*1). This clearly shows that managerial confidence and economic sentiment at aggregate levels and the uncertainty at company level influence the corporate decisions of UK-listed companies independently through different channels. More specifically, both the state of aggregate confidence and the level of company idiosyncratic uncertainty have positive and significant effects on corporate investment decisions. Debt financing decisions are heavily influenced by the state of aggregate confidence but not by the level of company idiosyncratic uncertainty, while dividend payout decisions are mainly affected by company idiosyncratic uncertainty rather than the state of confidence at aggregate levels. The Wald test results report in Tables 4.8 and 4.9 suggest that the state of confidence remain statistically significant even in the presence of a proxy for overall uncertainty at company level.

According to our empirical results, corporate investment increases with both the state of confidence at aggregate levels and the degree of uncertainty at company level. However, managers of the UK-listed companies consider different financial choices in response to the increased financing needs caused by different factors. If the increased investment spending is due to high levels of managerial confidence or economic sentiment, companies tend to use external debt financing more aggressively, but they are unlikely to cut dividends in response to the increased financing needs. If the increased investment spending is caused by high levels of company idiosyncratic uncertainty, companies tend to resort to internal funds by cutting dividends rather than resorting to external funds by issuing new debts.

The different financial choices in response to the increased investment spending under different situations might be interpreted as follows. When managerial confidence or economic sentiment is high, managers are prone to attach higher probabilities to good outcomes, and believe that their company is more profitable and less risky than it actually is. Therefore, they are more confident of repaying debts in the future and maintaining dividend payout at desired levels. Under this circumstance, managers are likely to resort to external debt financing to finance the increased investment spending.

However, if the increased investment is due to high levels of uncertainty associated with the company's future prospects, managers are more cautious about possible future financial distress if the outcomes turn out to be unfavourable. Accordingly, managers prefer to retain the internally generated funds that otherwise would have been paid out to shareholders as dividends to finance the increased investment spending under uncertainty. Debt financing is used by managers with caution under uncertain circumstances, because higher levels of debt are likely to exacerbate the degree of uncertainty and further increase the premium charged on external funds.

Table 4.8: 3SLS estimation results for corporate behavioural equations with company-level uncertainty and sector-specific managerial confidence[a]

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
INV/K			0.1702**	0.1527**	–0.1152***	–0.1072**
			(2.45)	(2.14)	(–2.75)	(–2.55)
NDF/K	0.2280**[e]	0.1826*			0.4532***	0.4435 ***
	(2.22)[f]	(1.74)			(5.78)	(5.64)
DIV/K	–0.2510	–0.1893	0.6351**	0.6049**		
	(–1.41)	(–1.04)	(2.35)	(2.20)		
CF/K	0.1840***	0.1774***	–0.0665*	–0.0606**	0.1324***	0.1323***
	(8.16)	(7.70)	(–1.64)	(–1.46)	(12.82)	(12.83)
Q	0.0035	0.0016				
	(0.36)	(0.16)				
$(INV/K)_{-1}$	0.2985***	0.2977***				
	(18.32)	(18.32)				
TAN			–0.2784***	–0.2844***		
			(–2.98)	(–3.03)		
SZ			0.0224***	0.0233***		
			(4.21)	(4.32)		
OWN					0.0510**	0.0543**
					(1.97)	(2.06)
RE/TE					0.0182*	0.0176
					(1.65)	(1.61)
$UNC1_{-1}$	0.2920***	0.3163***	–0.0510	–0.0441	–0.2263***	–0.2372***
	(2.95)	(3.15)	(–0.32)	(–0.27)	(–3.10)	(–3.28)
SCI_{-1}^{UK}	0.3560***		0.3367***		–0.1057	
	(4.47)		(3.09)		(–1.60)	
SCI_{-1}^{EU}		0.4135***		0.3910***		–0.1559**
		(4.64)		(3.40)		(–2.19)
Constant	0.0633*	0.0575	–0.0100	–0.0088	0.0971***	0.0985***
	(1.47)	(1.33)	(–0.10)	(–0.09)	(2.71)	(2.77)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of *SCI* in the equation[i]	19.95*** (p = 0.000)	21.52*** (p = 0.000)	9.54*** (p = 0.002)	11.54*** (p = 0.001)	2.55 (p = 0.110)	4.79** (p = 0.029)
Wald test for the joint significance of *SCI* in the system[j]	28.68*** (p = 0.000)	31.46*** (p = 0.000)	28.68*** (p = 0.000)	31.46*** (p = 0.000)	28.68*** (p = 0.000)	31.46*** (p = 0.000)
Chi^2-statistic for the equation[k]	2584.23*** (p = 0.000)	2567.12*** (p = 0.000)	283.25*** (p = 0.000)	278.83*** (p = 0.000)	1248.61*** (p = 0.000)	1266.88*** (p = 0.000)

Notes:

a. The UK and EU sector-specific managerial confidence indicators (SCI^{UK} and SCI^{EU}) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies after controlling for the company-level uncertainty. The sample contains UK company-year observations within the period 1999–2008. Equations 4.10 through 4.12 are estimated by 3SLS estimators using Stata 11.

b. Investment equation is specified as
$INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC1_{-1} + \alpha_7 SCI_{-1} + \varepsilon$.

c. Financing equation is specified as
$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC1_{-1} + \beta_7 SCI_{-1} + \mu$.

d. Dividend equation is specified as
$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC1_{-1} + \gamma_7 SCI_{-1} + \nu$.

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

f. z-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either SCI^{UK} or SCI^{EU} in this case) is zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either SCI^{UK} or SCI^{EU} in this case) in all equations in the system are simultaneously equal to zero. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

k. Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Table 4.9: 3SLS estimation results for corporate behavioural equations with company-level uncertainty and economic sentiment[a]

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
INV/K			0.2010***	0.1946***	–0.1262***	–0.1245***
			(3.05)	(2.94)	(–3.09)	(–3.02)
NDF/K	0.2674***[e]	0.2661***			0.4430***	0.4500 ***
	(2.62)[f]	(2.58)			(5.48)	(5.48)
DIV/K	–0.4438***	–0.4328**	0.7219***	0.7142***		
	(–2.57)	(–2.51)	(2.83)	(2.78)		
CF/K	0.2082***	0.2072***	–0.0832**	–0.0810**	0.1356***	0.1350***
	(9.30)	(9.26)	(–2.16)	(–2.09)	(13.41)	(13.12)
Q	0.0086	0.0081				
	(0.89)	(0.84)				
$(INV/K)_{-1}$	0.2991***	0.2988***				
	(18.17)	(18.21)				
TAN			–0.0832***	–0.2412***		
			(–2.16)	(–2.78)		
SZ			0.0222***	0.0218***		
			(4.19)	(4.12)		
OWN					0.0431*	0.0433*
					(1.72)	(1.72)
RE/TE					0.0172	0.0173
					(1.60)	(1.59)
$UNC1_{-1}$	0.2346**	0.2516**	–0.0057	0.0307	–0.2276***	–0.2441***
	(2.36)	(2.51)	(–0.04)	(0.20)	(–3.14)	(–3.35)
ESI_{-1}^{UK}	0.4192**		0.5837**		–0.1602	
	(2.33)		(2.55)		(–1.08)	
ESI_{-1}^{EU}		0.2369*		0.5611***		–0.2338**
		(1.67)		(3.26)		(–2.01)
Constant	–0.3543*	–0.1680	–0.6537***	–0.6336***	0.2690*	0.3478***
	(–1.44)	(–1.08)	(–2.66)	(–3.15)	(1.76)	(2.86)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of *ESI* in the equation[i]	5.42** (p = 0.020)	2.79* (p = 0.095)	6.50** (p = 0.011)	10.61*** (p = 0.001)	1.16 (p = 0.281)	4.02** (p = 0.045)
Wald test for the joint significance of *ESI* in the system[j]	11.83*** (p = 0.008)	13.38*** (p = 0.004)	11.83*** (p = 0.008)	13.38*** (p = 0.004)	11.83*** (p = 0.008)	13.38*** (p = 0.004)
Chi^2-statistic for the equation[k]	2529.11*** (p = 0.000)	2526.38*** (p = 0.000)	289.60*** (p = 0.000)	290.54*** (p = 0.000)	1266.26*** (p = 0.000)	1241.63*** (p = 0.000)

Notes:

a. The UK and EU economic sentiment indicators (ESI^{UK} and ESI^{EU}) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies after controlling for the company-level uncertainty. The sample contains company-year observations within the period 1999–2008. Equations 4.10 through 4.12 are estimated by 3SLS estimators using Stata 11.

b. $INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC1_{-1} + \alpha_7 ESI_{-1} + \varepsilon$.

c. $NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC1_{-1} + \beta_7 ESI_{-1} + \mu$.

d. $DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC1_{-1} + \gamma_7 ESI_{-1} + \nu$.

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

f. z-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either ESI^{UK} or ESI^{EU} in this case) is zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either ESI^{UK} or ESI^{EU} in this case) in all equations in the system are simultaneously equal to zero. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

k. Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Overall, our findings strongly support the argument that jointly determined corporate real and financial decisions are indeed influenced by both company fundamental uncertainty and managerial confidence and sentiment. Managerial confidence and economic sentiment do provide additional information in explaining aspects of corporate behaviour over the fundamental factors, as indicated by the statistically significant Wald test results across all of the simultaneous equations system variants.

4.6 Robustness tests and further evidence

4.6.1 Robustness tests and results

To gauge the sensitivity of using the arithmetic average of monthly values over each year as proxies for managerial confidence and economic sentiment, we also follow Oliver and Mefteh's (2010) methodology by considering the December figures (SCI^{UKDEC}, SCI^{EUDEC}, ESI^{UKDEC} and ESI^{EUDEC}) as the relevant measures of managerial confidence and economic sentiment and re-estimating our simultaneous equations system. As can be seen from Appendices 4.C and 4.D, the results replicated using the December figures are largely consistent with those reported in Section 4.5 in terms of the signs and significance levels of the estimated coefficients in all of the corporate behavioural equations, except that the state of managerial confidence and economic sentiment in December is likely to have a more significant negative influence on corporate payout decisions than the arithmetic average values of managerial confidence and economic sentiment indicators over the year.

In addition, we also calculate series with the percentage changes in the economic sentiment indicators as alternative proxies for the state of confidence to re-estimate our systems. The 3SLS estimation results are reported in Appendices 4.E. Compared with the economic sentiment indicators in levels (see Table 4.7), the percentage changes in the economic sentiment indicators (ΔESI_{-1}^{EU}) have lower explanatory powers in both the debt financing and dividend payout equations, suggesting that corporate financial decisions are more likely to be influence by the level of economic sentiment rather than the changes in it. We do not attempt to calculate series with the percentage changes in the managerial confidence indicators. Unlike the economic sentiment indicators which are scaled to have a long-run mean of 100%, the value of managerial confidence indicators are close to zero with both positive and negative values. The percentage changes in such time series, thus, are likely to be extremely noisy and carry little information about changes in managerial confidence.

Furthermore, given the fact that 3SLS estimators are more likely to be vulnerable to specification errors as compared to the limited information methods, we also apply the 2SLS estimation to the simultaneous equations system variants as robustness check. The 2SLS estimation results are presented in Appendices 4.F and 4.G. The influences of the state of managerial confidence and economic sentiment indicated in the 2SLS estimation results seem to be more pronounced compared with those suggested by 3SLS estimation results reported in Tables 4.6 and 4.7. However, the simultaneity among the corporate decisions seems to be relatively weak when the 2SLS estimations are applied.

Overall, we conclude that our results for the relations between corporate decisions and the state of managerial confidence and economic sentiment are robust to different model specifications, variable measurements and estimation methods.

4.6.2 Further evidence on the influence of managerial confidence on corporate behaviour

To further explore the differential influence of managerial confidence on the corporate decisions of companies operating in different sectors, we re-specify our simultaneous equations system by interacting the sector-specific managerial confidence indicator with a set of sector dummies. Specifically, instead of estimating our simultaneous equations system on separate subsamples of companies, we interact the sector-specific managerial confidence variable in all of our specifications with a set of dummy variables indicating the sector to which a company belongs. This approach allows us not only to uncover the differential influence of managerial confidence on corporate behaviour of different categories of companies, but also to gain degrees of freedom for regression analyses. The interactive terms enter our simultaneous equations system as follows,

$$\begin{aligned}\frac{INV}{K}_{it} &= \alpha_0 + \alpha_1 \frac{NDF}{K}_{it} + \alpha_2 \frac{DIV}{K}_{it} + \alpha_3 \frac{CF}{K}_{it} + \alpha_4 Q_{it} + \alpha_5 \frac{INV}{K}_{it-1} \\ &+ \alpha_6 SCI_{t-1} \times DUMINDU_i + \alpha_7 SCI_{t-1} \times DUMSERV_i \\ &+ \alpha_8 SCI_{t-1} \times DUMRETA_i + \alpha_9 SCI_{t-1} \times DUMBUIL_i + \varepsilon_{it}\end{aligned} \tag{4.13}$$

$$\begin{aligned}\frac{NDF}{K}_{it} &= \beta_0 + \beta_1 \frac{INV}{K}_{it} + \beta_2 \frac{DIV}{K}_{it} + \beta_3 \frac{CF}{K}_{it} + \beta_4 TAN_{it} + \beta_5 SZ_{it} \\ &+ \beta_6 SCI_{t-1} \times DUMINDU_i + \beta_7 SCI_{t-1} \times DUMSERV_i \\ &+ \beta_8 SCI_{t-1} \times DUMRETA_i + \beta_9 SCI_{t-1} \times DUMBUIL_i + \mu_{it}\end{aligned} \tag{4.14}$$

$$\begin{aligned}\frac{DIV}{K}_{it} &= \gamma_0 + \gamma_1 \frac{INV}{K}_{it} + \gamma_2 \frac{NDF}{K}_{it} + \gamma_3 \frac{CF}{K}_{it} + \gamma_4 OWN_{it} + \gamma_5 \frac{RE}{TE}_{it} \\ &+ \gamma_6 SCI_{t-1} \times DUMINDU_i + \gamma_7 SCI_{t-1} \times DUMSERV_i \\ &+ \gamma_8 SCI_{t-1} \times DUMRETA_i + \gamma_9 SCI_{t-1} \times DUMBUIL_i + \nu_{it}\end{aligned} \tag{4.15}$$

where *DUMINDU*, *DUMSERV*, *DUMRETA* and *DUMBUIL* are the sector dummy variables represent manufacturing, services, retail trade and construction sectors, respectively. A sector dummy variable is set equal to 1 for companies operating in the sector; and 0, otherwise. The estimated coefficients for the interactive terms are expected to show the differences in the influence of managerial confidence on corporate decisions across the four sectors. In addition, we also augment the simultaneities equation system with interactive terms by including the proxy for company-level uncertainty ($UNC1$) as follows,

$$\begin{aligned}\frac{INV}{K}_{it} &= \alpha_0 + \alpha_1 \frac{NDF}{K}_{it} + \alpha_2 \frac{DIV}{K}_{it} + \alpha_3 \frac{CF}{K}_{it} + \alpha_4 Q_{it} + \alpha_5 \frac{INV}{K}_{it-1} + \alpha_6 UNC1_{it-1} \\ &+ \alpha_7 SCI_{t-1} \times DUMINDU_i + \alpha_8 SCI_{t-1} \times DUMSERV_i \\ &+ \alpha_9 SCI_{t-1} \times DUMRETA_i + \alpha_{10} SCI_{t-1} \times DUMBUIL_i + \varepsilon_{it}\end{aligned} \tag{4.16}$$

$$\begin{aligned}\frac{NDF}{K}_{it} &= \beta_0 + \beta_1 \frac{INV}{K}_{it} + \beta_2 \frac{DIV}{K}_{it} + \beta_3 \frac{CF}{K}_{it} + \beta_4 TAN_{it} + \beta_5 SZ_{it} + \beta_6 UNC1_{it-1} \\ &+ \beta_7 SCI_{t-1} \times DUMINDU_i + \beta_8 SCI_{t-1} \times DUMSERV_i \\ &+ \beta_9 SCI_{t-1} \times DUMRETA_i + \beta_{10} SCI_{t-1} \times DUMBUIL_i + \mu_{it}\end{aligned} \tag{4.17}$$

$$\begin{aligned}\frac{DIV}{K}_{it} &= \gamma_0 + \gamma_1 \frac{INV}{K}_{it} + \gamma_2 \frac{NDF}{K}_{it} + \gamma_3 \frac{CF}{K}_{it} + \gamma_4 OWN_{it} + \gamma_5 \frac{RE}{TE}_{it} + \gamma_6 UNC1_{it-1} \\ &+ \gamma_7 SCI_{t-1} \times DUMINDU_i + \gamma_8 SCI_{t-1} \times DUMSERV_i \\ &+ \gamma_9 SCI_{t-1} \times DUMRETA_i + \gamma_{10} SCI_{t-1} \times DUMBUIL_i + \nu_{it}\end{aligned} \tag{4.18}$$

Table 4.10 reports the estimation results for the system variants which are comprised of Equations 4.13–4.15. The results for the endogenous variables and the other control variables are similar to those reported in Section 4.5. Moreover, the results reported in Table 4.10 reveal more detailed evidence on how managerial confidence influences corporate decisions of companies in different sectors.

Specifically, the corporate investment decisions in all sectors are positively correlated with the shifts in sectoral managerial confidence. The positive effect of managerial confidence on corporate investment spending is particularly profound for the construction sector, as indicated by the large and highly significant coefficient estimated for the interactive terms for the construction sector. However, the influence of managerial confidence on manufacturing companies' investment behaviour is rather weak and not significant at the usual significance levels. As for debt financing decisions, services and manufacturing companies are likely to borrow more aggressively when the sectoral sentiment is high, while retail trade and construction companies' financing decisions are not evidently influenced by the level of managerial confidence and sentiment. Although the effect of managerial confidence on dividend payout policies of UK-listed companies is insignificant as a whole, the coefficients on the interactive terms reported in Table 4.10 indicate that companies in the services sector tend to retain more internally generated cash flow by cutting dividend payouts to finance their increased financing needs when their managers are confident about future company performance.

Table 4.10: 3SLS estimation results for corporate behavioural equations with sector-specific managerial confidence interacted with sector dummies[a]

	Investment Equation[b]		Financing Equation[c]		Dividend Equation[d]	
Variable	*INV/K*		*NDF/K*		*DIV/K*	
INV/K			0.1388*	0.1295*	–0.1169***	–0.1134***
			(1.82)	(1.68)	(–2.82)	(–2.76)
NDF/K	0.2703***[e]	0.2507**			0.4372***	0.4287***
	(2.59)[f]	(2.39)			(5.79)	(5.70)
DIV/K	–0.4459**	–0.4259**	0.3714	0.3592		
	(–2.45)	(–2.31)	(1.30)	(1.24)		
CF/K	0.2192***	0.2184***	–0.0293	–0.0250	0.1328***	0.1321***
	(9.82)	(9.71)	(–0.65)	(–0.55)	(12.61)	(12.52)
Q	0.0033	0.0015				
	(0.33)	(0.15)				
$(INV/K)_{-1}$	0.2910***	0.2904***				
	(17.55)	(17.69)				
TAN			–0.3251***	–0.3253***		
			(–3.51)	(–3.52)		
SZ			0.0279***	0.0285***		
			(4.75)	(4.82)		
OWN					0.0378	0.0396
					(1.44)	(1.50)
RE/TE					0.0382***	0.0382***
					(3.49)	(3.49)
$SCI_{-1}^{UK} \times DUMINDU$	0.2043		0.3409*		–0.0699	
	(1.53)		(1.77)		(–0.64)	
$SCI_{-1}^{UK} \times DUMSERV$	0.3249**		0.5049***		–0.2036*	
	(2.40)		(2.83)		(–1.93)	
$SCI_{-1}^{UK} \times DUMRETA$	0.4274**		0.0266		0.0871	
	(2.06)		(0.09)		(0.52)	
$SCI_{-1}^{UK} \times DUMBUIL$	3.1665***		–0.2444		0.4157	
	(5.53)		(–0.28)		(0.84)	
$SCI_{-1}^{EU} \times DUMINDU$		0.2836		0.4798*		–0.1013
		(1.58)		(1.90)		(–0.70)
$SCI_{-1}^{EU} \times DUMSERV$		0.2433**		0.4332***		–0.1906**
		(2.03)		(2.73)		(–2.09)
$SCI_{-1}^{EU} \times DUMRETA$		0.1852		0.1292		0.0332
		(0.68)		(0.34)		(0.15)

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
$SCI_{-1}^{EU} \times DUMBUIL$		2.4265***		0.1913		0.0979
		(6.62)		(0.34)		(0.31)
Constant	0.1525***	0.1590***	–0.0158	–0.0206	0.0170	0.0218
	(4.74)	(4.96)	(–0.24)	(–0.31)	(0.62)	(0.79)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included
Wald test for the significance of the set of confidence variables in the equation[i]	46.87*** (p = 0.000)	50.78*** (p = 0.000)	13.70*** (p = 0.008)	12.73** (p = 0.013)	5.70 (p = 0.223)	5.17 (p = 0.270)
Wald test for the joint significance of the set of confidence variables in the system[j]	61.36*** (p = 0.000)	64.56*** (p = 0.000)	61.36*** (p = 0.000)	64.56*** (p = 0.000)	61.36*** (p = 0.000)	64.56*** (p = 0.000)
Chi^2-statistic for the equation[k]	2596.19*** (p = 0.000)	2610.60*** (p = 0.000)	258.20*** (p = 0.000)	255.90*** (p = 0.000)	1263.16*** (p = 0.000)	1290.44*** (p = 0.000)

Notes:

[a.] The UK and EU sector-specific managerial confidence indicators (SCI^{UK} and SCI^{EU}) interacted with sector dummy variables (*DUMINDU*, *DUMSERV*, *DUMRETA* and *DUMBUIL*) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies. The sample contains UK company-year observations within the period 1999–2008. Equations 4.13 through 4.15 are estimated by 3SLS estimators using Stata 11.

[b.] Investment equation is specified as

$$INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 SCI_{-1} \times DUMINDU + \alpha_7 SCI_{-1} \times DUMSERV + \alpha_8 SCI_{-1} \times DUMRETA + \alpha_9 SCI_{-1} \times DUMBUIL + \varepsilon .$$

[c.] Financing equation is specified as

$$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 SCI_{-1} \times DUMINDU + \beta_7 SCI_{-1} \times DUMSERV + \beta_8 SCI_{-1} \times DUMRETA + \beta_9 SCI_{-1} \times DUMBUIL + \mu .$$

[d.] Dividend equation is specified as

$$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 SCI_{-1} \times DUMINDU + \gamma_7 SCI_{-1} \times DUMSERV + \gamma_8 SCI_{-1} \times DUMRETA + \gamma_9 SCI_{-1} \times DUMBUIL + \nu .$$

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

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

[g.] Industry dummies are included in all of the equations to account for the inter-industry variations.

[h.] Year dummies are not included.

[i.] We perform the Wald test to test the hypothesis that the coefficients on the set of interaction terms are zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated *z*-statistic is reported in parenthesis.

[j.] We perform the Wald test to test the joint hypotheses that the coefficients on the interaction terms in all equations in the system are simultaneously equal to zero. The test reports results using the Chi^2-statistic. The associated *z*-statistic is reported in parenthesis.

[k.] Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Taken together, it seems that company in the services sector act more aggressively when their managers are confident. Specifically, they tend to invest in capital stock more intensively, use debt financing more heavily and cut dividends more decisively when the sectoral sentiment is high. There are a number of possible explanations for these results found for the services sector. One reason for these results might be the basic characteristic of the companies in this sector. Unlike companies in the other sectors, companies in services sector offer the production of services using their knowledge and time. They typically do not have a large stock of capital goods and finished products, which leads naturally to a relatively low level of asset tangibility. Given the lack of pledgeable assets, companies in service sector are more likely to be externally financially constrained, and therefore they might be forced not only to resort to external funds by issuing new debt but also to resort to internal funds by cutting dividends, in an attempt to finance increased investments when the sectoral sentiment is high.

Table 4.11: 3SLS estimation results for corporate behavioural equations with company-level uncertainty and sector-specific managerial confidence interacted with sector dummies[a]

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
INV/K			0.1731**	0.1624**	–0.1209***	–0.1155***
			(2.40)	(2.21)	(–2.78)	(–2.68)
NDF/K	0.2383**[e]	0.2217**			0.4586***	0.4463***
	(2.30)[f]	(2.14)			(5.80)	(5.68)
DIV/K	–0.2479	–0.2397	0.6553**	0.6247**		
	(–1.38)	(–1.32)	(2.45)	(2.29)		
CF/K	0.1903***	0.1910***	–0.0725*	–0.0657	0.1351***	0.1345***
	(8.36)	(8.30)	(–1.75)	(–1.55)	(12.51)	(12.47)
Q	0.0001	–0.0015				
	(0.01)	(–0.15)				
$(INV/K)_{-1}$	0.2904***	0.2891***				
	(17.87)	(17.97)				
TAN			–0.2732***	–0.2801***		
			(–2.94)	(–2.99)		
SZ			0.0219***	0.0228***		
			(4.13)	(4.24)		
OWN					0.0516*	0.0533**
					(1.99)	(2.04)
RE/TE					0.0168	0.0173
					(1.53)	(1.57)
$UNC1_{-1}$	0.2853***	0.2858***	–0.0368	–0.0380	–0.2320***	–0.2361***
	(2.87)	(2.86)	(–0.23)	(–0.23)	(–3.15)	(–3.26)
$SCI_{-1}^{UK} \times DUMINDU$	0.1787		0.3110*		–0.0512	
	(1.34)		(1.64)		(–0.45)	
$SCI_{-1}^{UK} \times DUMSERV$	0.3755***		0.4935***		–0.2404**	
	(2.76)		(2.83)		(–2.23)	
$SCI_{-1}^{UK} \times DUMRETA$	0.4196**		–0.0166		0.0879	
	(2.04)		(–0.06)		(0.51)	
$SCI_{-1}^{UK} \times DUMBUIL$	3.0683***		–0.4023		0.4930	
	(5.39)		(–0.47)		(0.98)	
$SCI_{-1}^{EU} \times DUMINDU$		0.2814		0.4394*		–0.1056
		(1.58)		(1.79)		(–0.71)
$SCI_{-1}^{EU} \times DUMSERV$		0.2854**		0.4314***		–0.2160**
		(2.38)		(2.78)		(–2.33)

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
$SCI_{-1}^{EU} \times DUMRETA$		0.1690		0.1119		–0.0021
		(0.63)		(0.30)		(–0.01)
$SCI_{-1}^{EU} \times DUMBUIL$		2.3948***		0.0977		0.1190
		(6.59)		(0.18)		(0.37)
Constant	0.0588	0.0657	–0.0147	–0.0173	0.1023***	0.1050***
	(1.34)	(1.49)	(–0.14)	(–0.17)	(2.78)	(2.91)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included
Wald test for the significance of the set of confidence variables in the equation[i]	47.29*** (p = 0.000)	52.54*** (p = 0.000)	13.58*** (p = 0.009)	12.58** (p = 0.014)	6.97 (p = 0.138)	6.34 (p = 0.175)
Wald test for the joint significance of the set of confidence variables in the system[j]	61.82*** (p = 0.000)	65.68*** (p = 0.000)	61.82*** (p = 0.000)	65.68*** (p = 0.000)	61.82*** (p = 0.000)	65.68*** (p = 0.000)
Chi^2-statistic for the equation[k]	2641.63*** (p = 0.000)	2655.15*** (p = 0.000)	258.44*** (p = 0.000)	280.74*** (p = 0.000)	1235.68*** (p = 0.000)	1271.70*** (p = 0.000)

Notes:

[a.] The UK and EU sector-specific managerial confidence indicators (SCI^{UK} and SCI^{EU}) interacted with sector dummy variables (*DUMINDU*, *DUMSERV*, *DUMRETA* and *DUMBUIL*) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies after controlling for the company-level uncertainty. The sample contains UK company-year observations within the period 1999–2008. Equations 4.16 through 4.18 are estimated by 3SLS estimators using Stata 11.

[b.] Investment equation is specified as

$$INV/K = \alpha_0 + \alpha_1 NDF/K + \alpha_2 DIV/K + \alpha_3 CF/K + \alpha_4 Q + \alpha_5 INV/K_{-1} + \alpha_6 UNC1_{-1} + \alpha_7 SCI_{-1} \times DUMINDU + \alpha_8 SCI_{-1} \times DUMSERV + \alpha_9 SCI_{-1} \times DUMRETA + \alpha_{10} SCI_{-1} \times DUMBUIL + \varepsilon .$$

[c.] Financing equation is specified as

$$NDF/K = \beta_0 + \beta_1 INV/K + \beta_2 DIV/K + \beta_3 CF/K + \beta_4 TAN + \beta_5 SZ + \beta_6 UNC1_{-1} + \beta_7 SCI_{-1} \times DUMINDU + \beta_8 SCI_{-1} \times DUMSERV + \beta_9 SCI_{-1} \times DUMRETA + \beta_{10} SCI_{-1} \times DUMBUIL + \mu .$$

[d.] Dividend equation is specified as

$$DIV/K = \gamma_0 + \gamma_1 INV/K + \gamma_2 NDF/K + \gamma_3 CF/K + \gamma_4 OWN + \gamma_5 RE/TE + \gamma_6 UNC1_{-1} + \gamma_7 SCI_{-1} \times DUMINDU + \gamma_8 SCI_{-1} \times DUMSERV + \gamma_9 SCI_{-1} \times DUMRETA + \gamma_{10} SCI_{-1} \times DUMBUIL + \nu .$$

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

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

[g.] Industry dummies are included in all of the equations to account for the inter-industry variations.

[h.] Year dummies are not included.

[i.] We perform the Wald test to test the hypothesis that the coefficients on the set of interaction terms are zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated *z*-statistic is reported in parenthesis.

[j.] We perform the Wald test to test the joint hypotheses that the coefficients on the interaction terms in all equations in the system are simultaneously equal to zero. The test reports results using the Chi^2-statistic. The associated *z*-statistic is reported in parenthesis.

[k.] Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Table 4.10 also shows that replacing the UK sector-specific managerial confidence indicators with their EU counterparts does not cause a significant change in the results. In addition, our findings remain qualitatively unchanged even after augmenting the simultaneous equations system by controlling for company-level uncertainty. The estimation results for the augmented Equations 4.16–4.17 are reported in Table 4.11. The results further confirm that sectoral sentiment and company-specific uncertainty indeed influence corporate behaviour through different channels, and both of them play important roles in the corporate decision-making processes. Besides, the Wald test results reported in Tables 4.10 and 4.11 indicate that the interactive terms of the sector-specific managerial confidence indicator and sector dummies are jointly significant in all the specifications.

4.7 Concluding remarks

In this chapter, we offer the first systematic attempt to investigate the impacts of managerial confidence and economic sentiment at aggregate levels on jointly determined corporate investment, financing and payout decisions, using a large panel of UK-listed companies observed within the period from 1999 to 2008. The relations between corporate decisions and the state of sentiment and confidence are examined within a simultaneous equations system which allows for contemporaneous interdependence among the corporate decisions. Our empirical results confirm the joint determination of these corporate decisions, as implied by the flow-of-funds framework. More importantly, we find that the state of confidence at aggregate levels, as proxied by the UK or EU sector-specific managerial confidence indicators or economic sentiment indicators, has significantly positive effects on companies' real investment and debt financing decisions. The positive effects remain statistically significant even after controlling for company-specific uncertainty and other fundamental variables.

This chapter, therefore, provides empirical evidence shows that managerial psychological bias does indeed play an important role in the determination of corporate decisions, contributing to the small but growing literature on behavioural corporate finance. In addition, our results also provide empirical evidence that managers' psychological bias and companies' fundamental uncertainty influence corporate decisions independently through different channels. Both managerial confidence and fundamental uncertainty have a positive real effect on corporate investment decisions. However, managers consider different financial choices in response to the increased financing needs caused by different factors. To finance the increased investment spending caused by high managerial confidence and economic sentiment, companies tend to use external debt financing rather than cutting dividends paid to their shareholders. To finance the increased investment spending under high levels of uncertainty, companies prefer to resort to internal finance by cutting dividends rather than resorting to external finance by issuing new debts.

Besides, we find that companies in the services sector tend to behave more aggressively when their managers are confident, which might be attributable to the lack of pledgeable assets. Specifically, they invest in capital stock more intensively, use debt financing more heavily, and cut dividends more decisively when the sectoral sentiment is high.

Appendix 4.A: Sample sizes of the Joint Harmonised EU Business and Consumer Surveys[a]

Country	Industry	Services.	Consumer	Retail Trade	Construction	Total
Belgium	1,550	1,700	1,600	1,150	880	6,880
Bulgaria	1,290	970	1,000	1,100	610	4,970
Czech Republic	1,000	900	1,000	600	600	4,100
Denmark	500	500	1,500	300	750	3,550
Germany	3,600	2,650	2,000	810	1,400	10,460
Estonia	250	400	800	170	110	1,730
Ireland	1,100	650	1,300	640	500	4,190
Greece	1,700	900	1,500	480	440	5,020
Spain	2,300	700	2,000	540	380	5,920
France	4,000	4,500	3,300	3,750	3,000	18,550
Italy	4,100	2,000	2,000	1,000	500	9,600
Cyprus	480	610	1,000	440	230	2,760
Latvia	720	900	1,000	600	300	3,520
Lithuania	840	730	1,200	850	590	4,210
Luxembourg	110	N/A[b]	500	N/A	40	650
Hungary	1,500	1,500	1,500	1,500	1,500	7,500
Malta	640	N/A	1,000	N/A	N/A	1,640
Netherlands	1,700	1,600	1,500	400	600	5,800
Austria	810	1,150	1,500	5,800	220	9,480
Poland	3,500	5,500	1,000	5,000	5,000	20,000
Portugal	1,200	960	2,100	560	320	5,140
Romania	1,530	1,970	1,000	2,300	1,110	7,910
Slovenia	710	680	1,500	1,120	400	4,410
Slovakia	600	580	1,400	600	550	3,730
Finland	850	500	2,200	470	120	4,140
Sweden	980	1,180	1,500	1,100	160	4,920
United Kingdom	1,500	1,000	2,000	500	800	5,800
EU	38,250	34,730	39,900	31,780	20,750	166,580

Notes:

[a.] Five surveys are currently conducted on a monthly basis in the following areas: industry (manufacturing), services, consumer, retail trade and construction. The sample size for each survey across countries according to the heterogeneity of their economies, and is generally positively related to their respective population size (European Commission, 2007).

[b.] N/A stands for not available or not applicable.

Appendix 4.B: EU Programme of Business and Consumer Surveys

Panel A: The Joint Harmonised EU Industry Survey Questionnaire

Q1 How has your production developed over the past 3 months?
It has…
+ increased
= remained unchanged
– decreased

Q2 Do you consider your current overall order books to be…?*[a]
+ more than sufficient (above normal)
= sufficient (normal for the season)
– not sufficient (below normal)

Q3 Do you consider your current export order books to be…?
+ more than sufficient (above normal)
= sufficient (normal for the season)
– not sufficient (below normal)

Q4 Do you consider your current stock of finished products to be…?*[b]
+ too large (above normal)
= adequate (normal for the season)
– too small (below normal)

Q5 How do you expect your production to develop over the next 3 months?
It will…*
+ increase
= remain unchanged
– decrease

Q6 How do you expect your selling prices to change over the next 3 months?
They will…
+ increase
= remain unchanged
– decrease

Q7 How do you expect your firm's total employment to change over the next 3 months?
It will…
+ increase
= remain unchanged
– decrease

Panel B: The Joint Harmonised EU Services Survey Questionnaire

Q1 How has your business situation developed over the past 3 months?

It has…*

+ increased

= remained unchanged

– decreased

Q2 How has demand (turnover) for your company's services changed over the past 3months?

It has…*

+ increased

= remained unchanged

– decreased

Q3 How do you expect the demand (turnover) for your company's services to change over the next 3 months?

It will…*

+ increase

= remain unchanged

– decrease

Q4 How has your firm's total employment changed over the past 3 months?

It has…

+ increased

= remained unchanged

– decreased

Q5 How do you expect your firm's total employment to change over the next 3 months?

It will…

+ increase

= remain unchanged

– decrease

Q6 How do you expect the prices you charge to change over the next 3 months?

They will…

+ increase

= remain unchanged

– decrease

Panel C: The Joint Harmonised EU Retail Trade Survey Questionnaire

Q1 How has (have) your business activity (sales) developed over the past 3 months?
It has (They have)…*
+ improved (increased)
= remained unchanged
– deteriorated (decreased)

Q2 Do you consider the volume of stock you currently hold to be…?*[c]
+ too large (above normal)
= adequate (normal for the season)
– too small (below normal)

Q3 How do you expect your orders placed with suppliers to change over the next 3 months?
They will…
+ increase
= remain unchanged
– decrease

Q4 How do you expect your business activity (sales) to change over the next 3 months?
It (They) will…*
+ improve (increase)
= remain unchanged
– deteriorate (decrease)

Q5 How do you expect your firm's total employment to change over the next 3 months?
It will…
+ increase
= remain unchanged
– decrease

Q6 How do you expect the prices you charge to change over the next 3 months?
They will…
+ increase
= remain unchanged
– decrease

Panel D: The Joint Harmonised EU Construction Survey Questionnaire

Q1 How has your building activity developed over the past 3 months?
It has…
+ increased
= remained unchanged
– decreased

Q2 What main factors are currently limiting your building activity?
· none
· insufficient demand
· weather conditions
· shortage of labour force
· shortage of material and/or equipment
· financial constraints
· other factors

Q3 Do you consider your current overall order books to be…?*
+ more than sufficient (above normal)
= sufficient (normal for the season)
– not sufficient (below normal)

Q4 How do you expect your firm's total employment to change over the next 3 months?
It will…*
+ increase
= remain unchanged
– decrease

Q5 How do you expect the prices you charge to change over the next 3 months?
They will…
+ increase
= remain unchanged
– decrease

Panel E: The Joint Harmonised EU Consumer Survey Questionnaire

Q1 How has the financial situation of your household changed over the last 12 months?

It has…

+ + got a lot better

+ got a little better

= stayed the same

– got a little worse

– – got a lot worse

N don't know

Q2 How do you expect the financial position of your household to change over the next 12 months?

It will…*

+ + get a lot better

+ get a little better

= stay the same

– get a little worse

– – get a lot worse

N don't know

Q3 How do you think the general economic situation in the country has changed over the past 12 months?

It has…

+ + got a lot better

+ got a little better

= stayed the same

– got a little worse

– – got a lot worse

N don't know

Q4 How do you expect the general economic situation in this country to develop over the next 12 months?

It will…*

+ + get a lot better

+ get a little better

= stay the same

– get a little worse

– – get a lot worse

N don't know

Q5 How do you think that consumer prices have developed over the last 12 months?

They have…

+ + risen a lot
+ risen moderately
= risen slightly
– stayed about the same
– – fallen
N don't know

Q7 How do you expect the number of people unemployed in this country to change over the next 12 months?

The number will…*[d]

+ + increase sharply
+ increase slightly
= remain the same
– fall slightly
– – fall sharply
N don't know

Q8 In view of the general economic situation, do you think that now it is the right moment for people to make major purchases such as furniture, electrical/electronic devices, etc.?

+ + yes, it is the right moment now
= it is neither the right moment nor the wrong moment
– – no, it is not the right moment now
N don't know

Q9 Compared to the past 12 months, do you expect to spend more or less money on major purchases (furniture, electrical/electronic devices, etc.) over the next 12 months?

I will spend…

+ + much more
+ a little more
= about the same
– a little less
– – much less
N don't know

Q10 In view of the general economic situation, do you think that now is…?

+ + a very good moment to save
+ a fairly good moment to save
– not a good moment to save
– – a very bad moment to save
N don't know

Q11 Over the next 12 months, how likely is it that you save any money?*

+ + very likely
+ fairly likely
– not likely
– – not at all likely
N don't know

Q12 Which of these statement best describes the current financial situation of your household?

+ + we are saving a lot
+ we are saving a little
= we are just managing to make ends meet on our income
– we are having to draw on our savings
– – we are running into debt
N don't know

Notes:

[a.] * indicates questions chosen from the full set of questions in each individual survey to construct the corresponding sector-specific confidence indicator and the economic sentiment indicator.

[b.] The balance value of Q4 in Panel A is used to construct the managerial confidence indicator for manufacturing sector with an inverted sign.

[c.] The balance value of Q2 in Panel C is used to construct the managerial confidence indicator for retail trade sector with an inverted sign.

[d.] The balance value of Q7 in Panel E is used to construct the consumer confidence indicator with an inverted sign

Appendix 4.C: 3SLS estimation results for corporate behavioural equations with sector-specific managerial confidence at year end[a]

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
INV/K			0.1452**	0.1305*	–0.1141***	–0.1100***
			(2.02)	(1.78)	(–2.94)	(–2.84)
NDF/K	0.2702***[e]	0.2343**			0.4196***	0.4132***
	(2.60)[f]	(2.22)			(5.70)	(5.59)
DIV/K	–0.5178***	–0.4627**	0.3102	0.2985		
	(–2.86)	(–2.52)	(1.07)	(1.02)		
CF/K	0.2209***	0.2155***	–0.0206	–0.0176	0.1321***	0.1324***
	(9.89)	(9.50)	(–0.46)	(–0.39)	(13.56)	(13.60)
Q	0.0063	0.0048				
	(0.65)	(0.48)				
$(INV/K)_{-1}$	0.3004***	0.3010***				
	(17.95)	(18.05)				
TAN			–0.3336***	–0.3354***		
			(–3.61)	(–3.61)		
SZ			0.0295***	0.0301***		
			(4.97)	(5.04)		
OWN					0.0354	0.0387
					(1.36)	(1.47)
RE/TE					0.0403***	0.0396***
					(3.71)	(3.65)
SCI_{-1}^{UKDEC}	0.2324***		0.2572***		–0. 0880*	
	(3.49)		(2.90)		(–1.73)	
SCI_{-1}^{EUDEC}		0.2814***		0.3662***		–0.1300**
		(3.17)		(5.04)		(–2.18)
Constant	0.1599***	0.1609***	–0.0202	–0.0188	0.0177	0.0165
	(5.03)	(5.04)	(–0.31)	(–0.28)	(0.66)	(0.62)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of *SCI* in the equation[i]	12.15*** (p = 0.000)	10.06*** (p = 0.001)	8.41*** (p = 0.003)	10.55*** (p = 0.001)	3.00* (p = 0.083)	3.91** (p = 0.048)
Wald test for the joint significance of *SCI* in the system[j]	20.68*** (p = 0.000)	20.01*** (p = 0.000)	20.68*** (p = 0.000)	20.01*** (p = 0.000)	20.68*** (p = 0.000)	20.01*** (p = 0.000)
Chi^2-statistic for the equation[k]	2509.82*** (p = 0.000)	2497.57*** (p = 0.000)	251.02*** (p = 0.000)	250.80*** (p = 0.000)	1324.54*** (p = 0.000)	1336.59*** (p = 0.000)

Notes:

a. The UK and EU sector-specific managerial confidence indicators at year end (SCI^{UKDEC} and SCI^{EUDEC}) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies. The sample contains UK company-year observations within the period 1999–2008. Equations 4.7 through 4.9 are estimated by 3SLS estimators using Stata 11.

b. Investment equation is specified as

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

c. Financing equation is specified as

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

d. Dividend equation is specified as

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

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

f. z-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either SCI^{UKDEC} or SCI^{EUDEC} in this case) is zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either SCI^{UKDEC} or SCI^{EUDEC} in this case) in all equations in the system are simultaneously equal to zero. The test report results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

k. Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 4.D: 3SLS estimation results for corporate behavioural equations with economic sentiment at year end[a]

	Investment Equation[b]		Financing Equation[c]		Dividend Equation[d]	
Variable	*INV/K*		*NDF/K*		*DIV/K*	
INV/K			0.1652**	0.1593**	–0.1211***	–0.1198***
			(2.37)	(2.27)	(–3.18)	(–3.13)
NDF/K	0.2853***[e]	0.2914***			0.4105***	0.4134***
	(2.76)[f]	(2.80)			(5.51)	(5.45)
DIV/K	–0.6192***	–0.6224***	0.3234	0.2958		
	(–3.53)	(–3.55)	(1.12)	(1.02)		
CF/K	0.2345***	0.2351***	–0.0253	–0.0210	0.1341***	0.1339***
	(10.65)	(10.69)	(–0.58)	(–0.48)	(14.00)	(13.81)
Q	0.0087	0.0090				
	(0.91)	(0.94)				
$(INV/K)_{-1}$	0.3008***	0.3000***				
	(17.78)	(17.77)				
TAN			–0.3198***	–0.3244***		
			(–3.57)	(–3.59)		
SZ			0.0296***	0.0294***		
			(5.00)	(4.95)		
OWN					0.0315	0.0311
					(1.23)	(1.21)
RE/TE					0.0398***	0.0405***
					(3.71)	(3.73)
ESI_{-1}^{UKDEC}	0.2632**		0.3886**		–0.1083	
	(2.13)		(2.41)		(–1.15)	
ESI_{-1}^{EUDEC}		0.0566		0.4754***		–0.1547*
		(0.47)		(3.18)		(–1.68)
Constant	–0.1139	–0.0310	–0.4353	–0.5149***	0.1332	0.1791*
	(–0.87)	(–0.21)	(–2.52)	(–3.21)	(1.34)	(1.86)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of *ESI* in the equation[i]	4.53** (p = 0.033)	0.22 (p = 0.637)	5.82** (p = 0.016)	10.09*** (p = 0.001)	1.32 (p = 0.251)	2.81* (p = 0.093)
Wald test for the joint significance of *ESI* in the system[j]	10.13** (p = 0.018)	10.24** (p = 0.016)	10.13** (p = 0.018)	10.24** (p = 0.016)	10.13** (p = 0.018)	10.24** (p = 0.016)
Chi^2-statistic for the equation[k]	2462.19*** (p = 0.000)	2451.40*** (p = 0.000)	252.08*** (p = 0.000)	253.77*** (p = 0.000)	1347.60*** (p = 0.000)	1333.33*** (p = 0.000)

Notes:

a. The UK and EU economic sentiment indicators at year end (ESI^{UKDEC} and ESI^{EUDEC}) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies. The sample contains UK company-year observations within the period 1999–2008. Equations 4.7 through 4.9 are estimated by 3SLS estimators using Stata 11.

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

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

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

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

f. z-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either ESI^{UKDEC} or ESI^{EUDEC} in this case) is zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either ESI^{UKDEC} or ESI^{EUDEC} in this case) in all equations in the system are simultaneously equal to zero. The test report results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

k. Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 4.E: 3SLS estimation results for corporate behavioural equations with changes in economic sentiment[a]

Variable	Investment Equation[b] INV/K		Financing Equation[c] NDF/K		Dividend Equation[d] DIV/K	
INV/K			0.1681** (2.31)	0.1660** (2.38)	–0.1208*** (–3.18)	–0.1205*** (–3.17)
NDF/K	0.2869***[e] (2.79)[f]	0.2869*** (2.79)			0.4118*** (5.57)	0.4090 *** (5.54)
DIV/K	–0.6147*** (–3.50)	–0.6177*** (–3.52)	0.3630 (1.28)	0.3409 (1.19)		
CF/K	0.2337*** (10.63)	0.2343*** (10.64)	–0.0302 (–0.70)	–0.0275 (–0.63)	0.1337*** (13.92)	0.1340 *** (13.99)
Q	0.0095 (1.00)	0.0091 (0.95)				
$(INV/K)_{-1}$	0.3012*** (17.82)	0.3007*** (17.78)				
TAN			–0.3126*** (–3.54)	–0.3170*** (–3.55)		
SZ			0.0293*** (4.98)	0.0297 *** (5.01)		
OWN					0.0312 (1.23)	0.0313 (1.23)
RE/TE					0.0390*** (3.66)	0.0395*** (3.69)
ΔESI_{-1}^{UK}	0.3347*** (2.77)		0.2608 (1.59)		–0.0433 (–0.47)	
ΔESI_{-1}^{EU}		0.1598 (1.29)		0.2577 (1.54)		–0.0505 (–0.53)
Constant	0.1560*** (4.89)	0.1589 *** (4.97)	–0.0366 (–0.57)	–0.0341 (–0.53)	0.0213 (0.81)	0.0209 (0.79)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of ΔESI in the equation[i]	7.67*** (p = 0.006)	1.67 (p = 0.197)	2.51 (p = 0.113)	2.37 (p = 0.124)	0.22 (p = 0.642)	0.28 (p = 0.595)
Wald test for the joint significance of ΔESI in the system[j]	9.96** (p = 0.019)	3.88 (p = 0.274)	9.96** (p = 0.019)	3.88 (p = 0.274)	9.96** (p = 0.019)	3.88 (p = 0.274)
Chi^2-statistic for the equation[k]	2467.16*** (p = 0.000)	2452.43*** (p = 0.000)	250.22*** (p = 0.000)	247.81*** (p = 0.000)	1343.41*** (p = 0.000)	1352.24*** (p = 0.000)

Notes:

a. The percentage changes in the UK and EU economic sentiment indicators (ΔESI^{UK} and ΔESI^{EU}) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies. The sample contains UK company-year observations within the period 1999–2008. Equations 4.7 through 4.9 are estimated by 3SLS estimators using Stata 11.

b. Investment equation is specified as

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

c. Financing equation is specified as

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

d. Dividend equation is specified as

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

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

f. z-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either ΔESI^{UK} or ΔESI^{EU} in this case) is zero in the corresponding equation. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either ΔESI^{UK} or ΔESI^{EU} in this case) in all equations in the system are simultaneously equal to zero. The test reports results using the Chi^2-statistic. The associated z-statistic is reported in parenthesis.

k. Chi^2-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 4.F: 2SLS estimation results for corporate behavioural equations with sector-specific managerial confidence[a]

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
INV/K			0.0503	0.0369	–0.1081***	–0.1045***
			(1.54)	(1.48)	(–2.80)	(–2.56)
NDF/K	0.2413**[e]	0.2111**			0.4743***	0.4718***
	(2.31)[f]	(1.98)			(6.14)	(6.06)
DIV/K	–0.3812**	–0.3536*	0.1231	0.1225		
	(–2.10)	(–1.91)	(1.26)	(1.24)		
CF/K	0.2036***	0.2011***	–0.0291	–0.0313	0.1265***	0.1266***
	(9.12)	(8.85)	(–0.55)	(–0.58)	(12.43)	(12.39)
Q	0.0129	0.0109				
	(1.32)	(1.09)				
$(INV/K)_{-1}$	0.3010***	0.2997***				
	(18.02)	(18.00)				
TAN			–0.4628***	–0.4573***		
			(–4.40)	(–3.72)		
SZ			0.0423***	0.0423***		
			(6.75)	(6.72)		
OWN					0.0834**	0.0857***
					(2.55)	(2.61)
RE/TE					0.0505***	0.0487***
					(3.88)	(3.77)
SCI_{-1}^{UK}	0.3531***		0.4323***		–0. 1181*	
	(4.38)		(3.77)		(–1.82)	
SCI_{-1}^{EU}		0.3890***		0.4056***		–0.1592**
		(4.33)		(3.44)		(–2.25)
Constant	0.1461***	0.1588***	0.0263	0.0271	–0.0035	–0.0039
	(4.59)	(4.33)	(0.36)	(0.37)	(–0.13)	(–0.14)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of *SCI* in the equation[i]	19.18*** (p = 0.000)	18.75*** (p = 0.000)	14.23*** (p = 0.000)	13.84*** (p = 0.000)	3.30* (p = 0.069)	5.08** (p = 0.024)
Wald test for the joint significance of *SCI* in the system[j]	12.24*** (p = 0.000)	12.56*** (p = 0.000)	12.24*** (p = 0.000)	12.56*** (p = 0.000)	12.24*** (p = 0.000)	12.56*** (p = 0.000)
F-statistic for the equation[k]	157.23*** (p = 0.000)	156.75*** (p = 0.000)	14.83*** (p = 0.000)	14.75*** (p = 0.000)	79.73*** (p = 0.000)	80.12*** (p = 0.000)

Notes:

a. The UK and EU sector-specific managerial confidence indicators (SCI^{UK} and SCI^{EU}) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies. The sample contains UK company-year observations within the period 1999–2008. Equations 4.7 through 4.9 are estimated by 2SLS estimators using Stata 11.

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

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

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

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

f. t-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either SCI^{UK} or SCI^{EU} in this case) is zero in the corresponding equation. The test reports results using the F-statistic. The associated p-value is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either SCI^{UK} or SCI^{EU} in this case) in all equations in the system are simultaneously equal to zero. The test report results using the F-statistic. The associated p-value is reported in parenthesis.

k. F-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 4.G: 2SLS estimation results for corporate behavioural equations with economic sentiment[a]

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
INV/K			0.0846	0.0806	–0.1187***	–0.1181***
			(1.19)	(1.13)	(–2.99)	(–2.93)
NDF/K	0.2497**[e]	0.2600**			0.4718***	0.4837***
	(2.39)[f]	(2.47)			(5.89)	(5.87)
DIV/K	–0.4916***	–0.4928***	0.0983	0.0912		
	(–2.76)	(–2.76)	(1.28)	(1.19)		
CF/K	0.2175***	0.2176***	–0.0147	–0.0117	0.1289***	0.1279***
	(9.74)	(9.74)	(–1.35)	(–1.63)	(12.90)	(12.48)
Q	0.0181*	0.0176*				
	(1.85)	(1.81)				
$(INV/K)_{-1}$	0.3041***	0.3035***				
	(17.93)	(17.92)				
TAN			–0.4031***	–0.4086***		
			(–4.07)	(–4.10)		
SZ			0.0422***	0.0403***		
			(6.83)	(6.68)		
OWN					0.0826**	0.0831**
					(2.52)	(2.51)
RE/TE					0.0501***	0.0516***
					(3.85)	(3.87)
ESI_{-1}^{UK}	0.4331**		0.8491***		–0.1716	
	(2.37)		(3.54)		(–1.17)	
ESI_{-1}^{EU}		0.2001		0.7119***		–0.2145*
		(1.40)		(3.99)		(–1.84)
Constant	–0.3068	–0.0627	–0.8885***	–0.7320***	0.1771	0.2183
	(–1.59)	(–0.42)	(–3.64)	(–4.00)	(1.17)	(1.83)
No. of observations	2791	2791	2791	2791	2791	2791
Industry dummies[g]	Included	Included	Included	Included	Included	Included
Year dummies[h]	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included

Variable	Investment Equation[b] *INV/K*		Financing Equation[c] *NDF/K*		Dividend Equation[d] *DIV/K*	
Wald test for the significance of *ESI* in the equation[i]	5.60** (p = 0.018)	1.97 (p = 0.161)	12.56*** (p = 0.000)	15.89*** (p = 0.000)	1.37 (p = 0.243)	3.39* (p = 0.066)
Wald test for the joint significance of *ESI* in the system[j]	6.51*** (p = 0.000)	7.08*** (p = 0.000)	6.51*** (p = 0.000)	7.08*** (p = 0.000)	6.51*** (p = 0.000)	7.08*** (p = 0.000)
F-statistic for the equation[k]	152.32*** (p = 0.000)	152.05*** (p = 0.000)	14.94*** (p = 0.000)	15.10*** (p = 0.000)	80.55*** (p = 0.000)	78.15*** (p = 0.000)

Notes:

a. The changes in the UK and EU economic sentiment indicators (ESI^{UK} and ESI^{EU}) are used as a proxy for the state of confidence in their respective system variants to investigate their impacts on corporate decisions of UK-listed companies. The sample contains UK company-year observations within the period 1999–2008. Equations 4.7 through 4.9 are estimated by 2SLS estimators using Stata 11.

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

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

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

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

f. t-statistics for the coefficients on the explanatory variables are reported in parentheses.

g. Industry dummies are included in all of the equations to account for the inter-industry variations.

h. Year dummies are not included.

i. We perform the Wald test to test the hypothesis that the coefficient on the confidence variable (either ESI^{UK} or ESI^{EU} in this case) is zero in the corresponding equation. The test reports results using the F-statistic. The associated p-value is reported in parenthesis.

j. We perform the Wald test to test the joint hypotheses that the coefficients on the confidence variable (either ESI^{UK} or ESI^{EU} in this case) in all equations in the system are simultaneously equal to zero. The test reports results using the F-statistic. The associated p-value is reported in parenthesis.

k. F-statistic tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

CHAPTER 5

THE MEASUREMENT OF CORPORATE INVESTMENT BEHAVIOUR MATTERS

5.1 Introduction

Corporate investment behaviour is one of the most widely and intensively investigated areas in corporate finance. As can be seen in Chapter 2, with theoretical developments relating to corporate investment behaviour has come a large body of literature devoted to empirically investigating the relations between capital investment decision and relevant company-level characteristics, such as the investment opportunity set, financial constraints, uncertainty, managerial confidence, etc. Although the empirical models used to examine corporate investment behaviour differ in their objectives and approaches, the use of a ratio of corporate investment to capital stock as the empirical measure of the conceptual variable of corporate investment behaviour has become a common practice in the literature.

The ratios of corporate investment to capital stock used in the literature, which seem at first sight to be very similarly specified, are in fact different both on the numerator and the denominator. Specifically, corporate investment spending has been empirically measured using a wide range of methods, either based on a cash flow statement or a balance sheet, either on a gross or net basis, and either with or without considering disinvestment. Meanwhile, capital stock has also been proxied in a number of different ways, either using tangible fixed assets or total assets, either based on book value or replacement value, either with or without taking a time lag. The combinations of different measures of corporate investment spending alongside various proxies for capital stock generate numerous ways in which the ratio of corporate investment to capital stock can be specified, making the measurement of corporate investment behaviour even more problematic.

At least twenty different versions of corporate investment to capital stock ratio calculations have been identified in the existing literature. However, no attempt has been made to provide a comparison among various corporate investment measures. One claim which has been implicitly made is that different measures of corporate investment behaviour will always yield the same, or at least qualitatively similar, results in empirical analyses. As a consequence, we know little about how differently these corporate investment measures perform in empirical analyses, and the extent to which the choice of corporate investment measures may influence the conclusions drawn from the analyses. Therefore, the purpose of this chapter is to fill the gap by conceptually discriminating and empirically evaluating twenty alternative measures of corporate investment behaviour which are currently used in the literature.

Using data from a balanced panel of 432 UK-listed companies over the period 1999–2008, this chapter discriminates conceptually and evaluates empirically twenty alternative measures of corporate investment behaviour, contributing to the existing literature in a number of ways. First, this chapter calls attention to the potential misuse of numerous corporate investment measures in applied corporate finance research. The question of whether the measurement of corporate investment behaviour matters, which has never been raised, is empirically addressed in this chapter. Second, this chapter highlights the distinctions between accrual based and cash flow based corporate investment measures as well as between gross and net corporate investment measures from an accounting perspective, providing insight into the fundamental differences among the similarly specified alternatives. Third, using a large panel of UK-listed companies, this chapter empirically evaluates the performance of the alternative investment measures in terms of their volatility and information content. The evaluation results are of great interest to corporate finance researchers as well as other users of financial statements. Furthermore, based on the evaluation results, we suggest a set of best performing measures of corporate investment behaviour, which are less noisy and more informative, for researchers to utilise. Taking all the innovations together, this chapter may shed some light and provide some guidance for measuring corporate investment behaviour in empirical analyses.

The remainder of this chapter is organised as follows. Section 5.2 highlights and explains the differences among various corporate investment measures utilised in the existing empirical literature. Section 5.3 develops a number of testable hypotheses. Section 5.4 describes the sample selection, corporate investment measures, and preliminary analysis. Section 5.5 offers an illustrative example to determine the extent to which the choice of corporate investment measures influences the conclusions drawn from empirical analyses.

Sections 5.6 and 5.7 assess the volatility around the trends and the information content of the corporate investment measures, respectively. Concluding remarks are drawn in Section 5.8.

5.2 Empirical measures of corporate investment behaviour

Although the relevant literature has been reviewed in Chapter 2, it is useful to highlight the key aspects of the literature that illustrate the numerous corporate investment measures that are in vogue in empirical works. As can be seen in Chapter 2, corporate investment decisions play an important role in maintaining and increasing the scope of a company's operations, and have been the focus of a large amount of academic research. Existing literature in corporate finance mainly focuses on the effect of relevant company characteristics, such as investment opportunity set (see Carpenter and Guariglia, 2008), internal financial constraints (see Guariglia, 2008; Cummins *et al.*, 2006; and Barran and Peeters, 1998), external financial constraints (see Guariglia, 2008; and Aggarwal and Zong, 2006), information asymmetry (see Ascioglu *et al.*, 2008), managerial optimism (see Ben-David *et al*., 2007; and Malmendier and Tate, 2005), and uncertainty (see Baum *et al.*, 2008; and Lensink and Murinde, 2006), on corporate investment behaviour. Conflicting empirical evidence obtained from the tremendous amount of literature induces intense debates upon almost all aspects of corporate investment behaviour. For example, Fazzari *et al.* (1988) and Ascioglu *et al.* (2008), among many others, find a higher sensitivity of corporate investment to cash flow for companies that are more likely to be financially constrained, whereas Kaplan and Zingales (1997), Cleary (1999) and some others find the opposite. Abdul-Haque and Wang (2008) and Lensink and

Sterken (2000) find a positive effect of company-specific uncertainty on corporate investment, whereas Bloom *et al.* (2007), Xie (2009) and many others find the opposite. Some innovative models, therefore, have been developed in an attempt to reconcile the conflicting findings from theoretical points of view (see, for example, Cleary *et al.*, 2007; and Sarkar, 2000).

However, to the best of our knowledge, no attention has been directed to the measurement of corporate investment behaviour in the existing literature. The equation of whether the measurement of corporate investment behaviour matters has never been raised. One claim which has been implicitly made is that the different measures of corporate investment behaviour are equivalent to one another, and can be used interchangeably. Thus we know little about how differently the measures of corporate investment perform in applied studies, and the extent to which the choice for measuring corporate investment influences the results of empirical analyses. Although corporate investment is customarily measured by the ratio of corporate investment to capital stock, the seemingly similarly specified investment ratios actually vary both on the numerator and on the denominator. Therefore, it is reasonable to posit that the conflicting conclusions drawn from the existing literature on corporate investment may partly be attributable to the differences in measuring companies' investment behaviour.

Twenty different versions of corporate investment to capital stock ratio specifications, ranging from simply constructed measures based on reported accounting items to relatively complex measures which involve estimating the replacement value of capital stock, have been identified in the recent empirical works published in highly cited academic journals.[46] Different measures of capital investment spending alongside various proxies for capital stock are used in the specification of these investment ratios. As pointed out by Adam and Goyal (2008), the lack of understanding of measurements is a crucial problem in empirical corporate finance research. Likewise, the potential misuse of corporate investment measures in the applied corporate finance literature may also be largely due to a lack of understanding of the financial information provided by relevant accounting items. Therefore, the starting point for conceptually discriminating various measures of corporate investment should be their respective accounting definitions.

5.2.1 Cash based versus accrual based corporate investment measures

Corporate investment refers to the amount of investment made by a company to its capital stock during certain period of time. The measurement of corporate investment relies heavily on the relevant accounting information reported in a company's financial statements. More specifically, a measure of corporate investment can either be taken directly from a cash flow statement or be derived indirectly from a balance sheet. Given the fact that different accounting principles are involved in the preparation of cash flow statements and balance sheets, corporate investment measures can be classified into two broad categories, namely, cash based and accrual based measures.

[46] The studies, from which different corporate investment to capital stock ratios are identified, are all published in journals listed in the Association of Business School's (ABS) Academic Journal Quality Guide. Most of them are published in journals that are rated as 4*, 4, or 3 by ABS. A list of cited studies can be found in Table 5.1.

5.2.1.1 Cash based corporate investment measures

The most commonly used measures of corporate investment in the existing literature are based on capital expenditures (*CAPX*) which is a reported item on a company's cash flow statement under the investing subsection (see, for example, Grundy and Li, 2010; Bakke and Whited, 2010; Denis and Sibilkov, 2010; Adam, 2009; Hovakimian and Titman, 2006; etc.). Since cash flow statements are prepared using the cash basis accounting method, the measures of corporate investment based on the cash flow statement item of capital expenditures can be classified as cash based measures.

A cash flow statement is concerned with inflows and outflows of cash and cash equivalent of a company, without considering transactions that do not directly affect cash receipts and payments. The capital expenditures item reported on a cash flow statement represents the funds used by a company to acquire fixed assets and those associated with the acquisitions over the reporting period. Under cash basis accounting, capital expenditures are recognised immediately at historical costs when cash is paid out either to buy fixed assets or to add to the value of an existing fixed asset. Therefore, the capital expenditures item showing up on a company's cash flow statement can be adopted directly as a measure of the amount of funds spent by a company on its capital stock over the reporting period. It is worth noting that, according to International Accounting Standard (IAS) 7, the funds used to acquire fixed assets associated with acquisitions are not included in capital expenditures.

The main advantage of using the reported capital expenditures to measure corporate investment is that the cash based figures are less subject to distortions from differing accounting practices, and thus are able to more objectively reflect a company's investing activities (Dechow, 1994). However, a fundamental drawback of cash based investment measures is that cash flows have timing and mismatching problems which may cause them to be noisy (Dechow, 1994). Specifically, capital expenditures under cash basis accounting are recognised when cash is paid out to purchase a fixed asset, regardless of whether the fixed asset is in place. To mitigate the timing and mismatching problems of cash based figures, the accrual basis accounting method has been implemented to alter the timing of cash flow recognition, aiming to more closely reflect business activities.

5.2.1.2 Accrual based corporate investment measures

Instead of using cash based measures, a body of literature derives measures of corporate investment from a company's balance sheet, using the book value of tangible fixed assets (see, for example, Engel and Middendorf, 2009; Guariglia, 2008; Gan, 2007; and Lensink and Murinde, 2006).[47] Tangible fixed assets are also referred to as property, plant and equipment which can be found on a company's balance sheet under the non-current assets section. The difference in the carrying amount of tangible fixed assets (*NPPE*) between the end and beginning of a period, therefore, reflects net additions to the availability of a company's capital assets. Since balance sheets are prepared under accrual basis accounting, corporate

[47] In most cases, only tangible assets are referred to as fixed.

investment measures derived from the balance sheet item of property, plant and equipment can be classified as accrual based measures.

Accrual basis accounting is a method that measures the financial position and performance of a company by recognising economic events regardless of when cash transactions occur. Because it is supposed to provide a more accurate picture of a company's current financial conditions by reducing noise from timing mismatches between when cash is paid out and when an asset is recognised, accrual basis accounting has been generally accepted as the standard accounting practice for most businesses. Under accrual basis accounting, a capital asset is recognised as a historical cost when it is incurred, and reflected as an addition to tangible fixed assets on the balance sheet.[48] Since accrual basis accounting mitigates the timing and matching problems of cash flows, accrual based corporate investment measures should be able to more closely reflect net additions to the availability of a company's capital assets.

However, the implementation of accrual basis accounting creates a new set of problems. Previous studies question the reliability and relevance of accrual basis accounting figures because of the accrual components (see, for example, Wilson, 1986). It is argued that management typically have some discretion over the recognition of accruals, and this discretion might be used by management to opportunistically manipulate the reported accounting figures, including the carrying amount of tangible fixed assets. The managerial

[48] The historical cost of a tangible fixed asset is subject to revaluations and writedowns.

manipulation of accruals, therefore, may reduce the credibility and relevance of accrual based investment measures. In addition, the accrual based investment measures are likely to be distorted by asset revaluations and writedowns. Both revaluations and writedowns of fixed assets are different from planned depreciation in the sense that they aim to bring the fair market value of the capital goods into the books. However, it is found that, in practice, the most important determinant of writedown decisions is changes in senior management (Strong and Meyer, 1987). Thus, the accrual based measures of corporate investment derived from balance sheet are more vulnerable to managers' opportunistic manipulation. The question of whether the net effect of accruals is to improve or reduce the ability of investment measures to reflect business investment behaviour must be addressed empirically.

The use of accrual based measures of corporate investment is mainly driven by a number of considerations. First, cash based measures of capital expenditures are not always readily available. Some studies utilise the first difference of tangible fixed assets as a proxy for corporate investment spending simply because no any independent estimate of corporate investment, such as reported capital expenditures, is available to the public in the market being investigated (see, for example, Garcia-Marco and Ocana, 1999). Second, some theoretical considerations may lead naturally to the use of balance sheet-based measures of corporate investment. For example, the accelerator model of corporate investment asserts that a company's capital stock should be proportional to its level of production, and companies engage in capital investment in an attempt to close the gap between the desired level of capital stock and the existing level of capital stock left over from the previous period. Accordingly, empirical investment equations formulated based on the accelerator model typically specify the change in capital stock of a company as a function of the change in the company's output over the same period. The first difference transformation of tangible fixed assets, therefore, can be utilised as an ideal approximation of the change in capital stock and employed in the accelerator model of investment as the dependent variable (see, for example, Engel and Middendorf, 2009; Bo and Lensink, 2005). In addition, a strand of literature based on the flow-of-funds framework for corporate behaviour also tends to measure corporate investment using balance sheet items (see, for example, Mougoué and Mukherjee, 1994; Fama, 1974; and Dhrymes and Kurz, 1967). This is because the budget constraint that overrides the flow-of-funds framework for corporate behaviour is essentially derived from the accounting identity that change in assets must equal the sum of changes in liability and equity.

A few studies also consider using the changes in total assets as a proxy for capital investment (see, for example, Adedeji, 1998). However, it is generally believed that the changes in total assets that arise from changes in its elements of current assets, such as accounts receivable and inventories, are likely to be triggered by economic conditions, and thus cannot be interpreted as the results of corporate investment decisions made by management (see, for example, Kadapakkam *et al*., 1998). By contrast the changes in tangible fixed assets, which focus on investment in property, plant and equipment, should be better able to reflect the conscious investment decisions taken by management.

To sum up, cash basis accounting is fundamentally different from accrual basis accounting (see Salmi *et al.*, 1990). Since different accounting principles are involved in the preparation of the accounting items used to empirically measure a company's investment spending, accrual based measures of corporate investment may contain information about a company's investing activities which is not present in their cash based counterparts, and vice versa. Therefore, it is meaningful to investigate whether cash based and accrual based measures of corporate investment behaviour perform similarly in empirical analyses.

5.2.2 Gross versus net corporate investment measures

In accounting, a capital expenditure is required to be capitalised and recorded as a tangible fixed asset on a company's balance sheet. According to the basic matching principle of accounting, the tangible fixed asset is then required to be depreciated over its useful life, allocating its cost as a depreciation expense to the periods in which the asset is expected to be used. Therefore, both cash based and accrual based measures of corporate investment behaviour can be adjusted to be either gross investment measures (see, for example, Grundy and Li, 2010; Carpenter and Guariglia, 2008; Guariglia, 2008; and Lensink and Murinde, 2006) or net investment measures (see, for example, Denis and Sibilkov, 2010; Wang *et al.*, 2009; Firth *et al.*, 2008; and Rousseau and Kim, 2008), by adding or netting depreciation, depletion and amortisation expense (*DDA*) recognised in the corresponding period.

According to Standard Accounting Statement (SAS) 3 and IAS 16, the value of a tangible fixed asset is required to be carried at its net book value, which is essentially the difference between the historical cost of the asset and its associated accumulated depreciation.[49] Thus, by definition, the carrying amount of tangible fixed assets reported on a balance sheet has already taken depreciated capital goods into account. The accrual based corporate investment measures, which are simply calculated as the first difference of the carrying amount of tangible fixed assets, therefore represent net additions to the availability of a company's capital goods, and can be classified as net investment measures. Accrual based gross investment measures can be obtained by adding depreciation expense charged over the period back to the change in the carrying amount of tangible fixed assets. Gross investment measures, thus, are concerned with the overall investment in capital stock made by a company over a period. The use of the change in carrying amount of tangible fixed assets to measure net corporate investment is observed in Chow *et al.* (2010), Wang *et al.* (2009), Rousseau and Kim (2008), Mueller and Peev (2007), etc.; while the use of the sum of the change in the carrying amount of tangible fixed assets and depreciation expenses to measure gross corporate investment is adopted by Engel and Middendorf (2009), Guariglia (2008), Bo (2007), Lensink and Murinde (2006), etc.

Turing to cash based corporate investment measures, the reported capital expenditures item on the cash flow statement represents the funds spent by a company both to acquire new

[49] The net book value of tangible fixed assets is considered the best way of consciously presenting the true and fair value of capital assets to the owner of the business and other users of the financial statements.

fixed capital assets and to maintain or upgrade existing tangible fixed assets, without considering the non-cash expenses such as depreciation. Thus, the reported capital expenditures can be used directly to construct cash based gross investment measures. This type of gross corporate investment measure is utilised by a large number of applied studies (see, for example, Grundy and Li, 2010; Bakke and Whited, 2010; Brown and Petersen, 2009; Carpenter and Guariglia, 2008; Ratti *et al*., 2008; Cummins *et al*., 2006; etc.). Cash based net investment measures can be easily obtained by subtracting depreciation expense charged for the reporting period from the amount of total spending on capital goods over the same period. The use of cash based net investment measures can be found in Denis and Sibilkov (2010), Firth *et al.* (2008), Cleary (1999), etc.

Besides, some studies, such as Kang *et al.*(2010), Bloom *et al.* (2007), Hennessy *et al.*(2007) and Lin *et al.* (2005), define corporate investment as the net spending on fixed assets (*NSFA*), in an attempt to construct a relatively more accurate measure which captures both capital investment and disinvestment, using cash based accounting figures. Accordingly, they compute the difference between capital expenditures (*CAPX*) and revenue from sales of property, plant and equipment (*SPPE*), both of which can be found on the cash flow statement under the investing activities subsection, as a measure of net spending on fixed assets. The net spending on fixed assets takes proceeds from the sale of fixed assets into account, and thus could take both positive and negative signs.

5.2.3 Book versus replacement values of capital stock

To account for heteroscedasticity across companies, capital investment spending is typically normalised by a proxy for capital stock to construct a ratio of corporate investment to capital stock. The book value of net tangible fixed assets (*K*) and book value of total assets (*TA*) on the balance sheet are often chosen as proxies for capital stock to normalise the investment measures. The use of book value of net tangible fixed assets to scale capital investment is adopted by the majority of applied studies, such as Chow *et al.* (2010), Grundy and Li (2010), Engel and Middendorf (2009), Ratti *et al.* (2008), Hennessy *et al.* (2007), etc. Bond and Meghir (1994) argue that book value of net tangible fixed assets is preferred because it is relatively more stable over time and less likely to be distorted by economic conditions. The use of book value of total assets can be observed in Bakke and Whited (2010), Denis and Sibilkov (2010), Kang *et al.* (2010), Wang *et al.* (2009), etc. Brown and Petersen (2009) argue that the book value of total assets is chosen because they wish to maintain a common scale factor for all regressors, including research and development expenditures. Therefore, the choice between book value of tangible fixed assets and that of total assets as a proxy for capital stock is largely determined by the model specification.

Given the fact that the books record the historical costs of capital goods, which may deviate from their fair market values, it is also common to derive a replacement value of capital stock (*Kr*) from the book value of tangible fixed assets (see, for example, Guariglia, 2008; Baum *et al*., 2008; Bloom *et al*., 2007; Cummins *et al*., 2006; etc.). Replacement value of capital stock is preferred by some researchers because it represents the actual cost to replace the current productive capacity of a company at the present time. Replacement value, however, is difficult to estimate in the absence of active markets for used capital goods (Perfect and Wiles, 1994). In practice, replacement value of capital stock is conventionally estimated using a standard perpetual inventory method initially proposed by Salinger and Summers (1983). Under the standard perpetual inventory method, the book value of tangible fixed assets is treated as the historical value of the capital stock. The replacement value and historical value are assumed to be the same in the first year of data, which is then adjusted for each following period in accordance with the corresponding price deflator of non-residential investment goods (see Appendix 5.A for a detailed explanation of the perpetual inventory method). Because the price level for capital goods normally increases over time, the replacement value of capital stock estimated using the perpetual inventory method is typically greater than the corresponding book value. However, owing to the assumptions necessary to implement the estimation, the standard perpetual inventory procedure may lead to negative replacement value of capital stock in certain instances, which is intuitively undesirable.

5.2.4 Contemporaneous versus lagged proxies for capital stock

Researchers also face a choice between contemporaneous or lagged deflator when they construct a ratio of corporate investment to capital stock. Some studies choose to use a contemporaneous proxy for capital stock as the deflator of corporate investment in an attempt to make full use of their company-year observations and maximise sample size for their analyses (see, for example, Bakke and Whited, 2010; Ratti *et al.*, 2008; Firth *et al.*, 2008; and Lensink and Murinde, 2006); while others argue that all of the investment decisions are made at the beginning of each fiscal year, and thus it is more appropriate to use the beginning-of-period value of capital stock to deflate corporate investment, especially for companies with substantial growth over the sample period. In addition, the use of lagged proxy for capital stock can effectively reduce the possibility of using more information in modelling corporate investment behaviour than managers actually have when they make their decisions. However, if a lagged proxy for capital stock is chosen to construct corporate investment measures, the first year observation for each company has to be sacrificed, leading to relatively lower degrees of freedom for regression analyses. The use of corporate investment to lagged capital stock ratios can be found in Grundy and Li (2010), Chow *et al.* (2010), Denis and Sibilkov (2010), Kang *et al.* (2010), etc.

5.2.5 Conclusion

The review of relevant literature shows that, although the use of corporate investment to capital stock ratio to measure companies' investment behaviour has become common practice in applied studies, there is no consensus about how the ratio should be empirically specified. The combinations of different measures of capital investment spending alongside various proxies for capital stock generate a large number of ways in which the ratio of corporate investment to capital stock can be specified. More importantly, given the fact that different accounting principles are involved in the preparation of relevant accounting items used to measure corporate investment behaviour, corporate investment to capital stock ratios with different specifications are likely to carry different information about a company's investing activities. The implicit assumption that different corporate investment ratios will always yield equivalent results in empirical analyses may not be valid. Therefore, it is necessary to compare and contrast these alternative measures of corporate investment behaviour, which are potentially misused in the existing empirical literature. However, to the best of our knowledge, the question of whether the measurement of corporate investment behaviour matters has never been raised, and thus we know little about how differently these alternative measures perform in applied analyses, and the extent to which the choice of corporate investment measures influence the conclusions drawn from empirical analyses. Therefore, we seek to fill this important gap by discriminating and evaluating twenty different corporate investment measures used in the existing literature, in an attempt to provide some guidance for measuring companies' investment behaviour.

The twenty corporate investment measures alongside their respective definitions and representative recent studies are summarised in Table 5.1, where *GINV* and *NINV* represent accrual based measures of gross and net additions to tangible fixed assets, respectively; *GCAPX* and *NCAPX* represent cash based measures of gross and net capital expenditures, respectively; *NSFA* represents cash based measure of net spending on fixed assets; *K* and *TA* represent book values of net tangible fixed assets and total assets, respectively; and *Kr* represents replacement value of tangible fixed assets.

Table 5.1: Corporate investment measures and representative recent studies

No.	Corporate investment measure	Definition[a]	Representative recent studies
1.	The ratio of gross additions to fixed assets ($GINV_t$) to fixed assets (K_t)	$\frac{GINV_t}{K_t} = \frac{NPPE_t - NPPE_{t-1} + DDA_t}{NPPE_t}$	Lensink and Murinde (2006); Bo and Sterken (2002); Barran and Peeters (1998)
2.	The ratio of gross additions to fixed assets ($GINV_t$) to lagged fixed assets (K_{t-1})	$\frac{GINV_t}{K_{t-1}} = \frac{NPPE_t - NPPE_{t-1} + DDA_t}{NPPE_{t-1}}$	Engel and Middendorf (2009); Bo and Lensink (2005); Koo and Maeng (2005); Pawlina and Renneboog (2005)
3.	The ratio of gross additions to fixed assets ($GINV_t$) to replacement value of fixed assets (Kr_t)	$\frac{GINV_t}{Kr_t} = \frac{NPPE_t - NPPE_{t-1} + DDA_t}{RNPPE_t}$	Garcia-Marco and Ocana (1999)
4.	The ratio of gross additions to fixed assets ($GINV_t$) to lagged replacement value of fixed assets (Kr_{t-1})	$\frac{GINV_t}{Kr_{t-1}} = \frac{NPPE_t - NPPE_{t-1} + DDA_t}{RPPE_{t-1}}$	Guariglia (2008); Gan (2007)
5.	The ratio of gross additions to fixed assets ($GINV_t$) to total assets (TA_t)	$\frac{GINV_t}{TA_t} = \frac{NPPE_t - NPPE_{t-1} + DDA_t}{TA_t}$	Bo (2007)
6.	The ratio of net additions to fixed assets ($NINV_t$) to fixed assets (K_t)	$\frac{NINV_t}{K_t} = \frac{NPPE_t - NPPE_{t-1}}{NPPE_t}$	Kato *et al.* (2002); Lensink and Sterken (2000)
7.	The ratio of net additions to fixed assets ($NINV_t$) to lagged fixed assets (K_{t-1})	$\frac{NINV_t}{K_{t-1}} = \frac{NPPE_t - NPPE_{t-1}}{NPPE_{t-1}}$	Chow *et al.* (2010); Rousseau and Kim (2008); Mueller and Peev (2007); Kadapakkam *et al.* (1998)
8.	The ratio of net additions to fixed assets ($NINV_t$) to lagged total assets (TA_{t-1})	$\frac{NINV_t}{TA_{t-1}} = \frac{NPPE_t - NPPE_{t-1}}{TA_{t-1}}$	Wang *et al.* (2009); Abdul-Haque and Wang (2008)
9.	The ratio of gross capital expenditures ($GCAPX_t$) to fixed assets (K_t)	$\frac{GCAPX_t}{K_t} = \frac{CAPX_t}{NPPE_t}$	Ratti *et al.* (2008)
10.	The ratio of gross capital expenditures ($GCAPX_t$) to lagged fixed assets (K_{t-1})	$\frac{GCAPX_t}{K_{t-1}} = \frac{CAPX_t}{NPPE_{t-1}}$	Grundy and Li (2010); Adam (2009); Hilary and Hui (2009); Hovakimian (2009); Hovakimian and Hovakimian (2009); Polk and Sapienza (2009); Xie (2009); Agca and Mozumdar (2008); Ascioglu *et al.* (2008); Chava and Roberts (2008); Almeida and Campello (2007); Cleary (2006); Hovakimian and Titman (2006); Kaplan and Zingales (1997)

No.	Corporate investment measure	Definition[a]	Representative Reference studies
11.	The ratio of gross capital expenditures ($GCAPX_t$) to replacement value of fixed assets (Kr_t)	$\frac{GCAPX_t}{Kr_t} = \frac{CAPX_t}{RNPPE_t}$	Cummins *et al.* (2006); Bond and Cummins (2004); Henley *et al.* (2003); Leahy and Whited (1996)
12.	The ratio of gross capital expenditure ($GCAPX_t$) to lagged replacement value of fixed assets (Kr_{t-1})	$\frac{GCAPX_t}{Kr_{t-1}} = \frac{CAPX_t}{RNPPE_{t-1}}$	Carpenter and Guariglia (2008); Baum *et al.* (2008); Bulan (2005); Bond *et al.* (2003); Fazzari *et al.* (1988)
13.	The ratio of gross capital expenditures ($GCAPX_t$) to total assets (TA_t)	$\frac{GCAPX_t}{TA_t} = \frac{CAPX_t}{TA_t}$	Bakke and Whited (2010); Duchin *et al.* (2010); Lin and Smith (2007); Ahn and Denis (2004)
14.	The ratio of gross capital expenditures ($GCAPX_t$) to lagged total assets (TA_{t-1})	$\frac{GCAPX_t}{TA_{t-1}} = \frac{CAPX_t}{TA_{t-1}}$	Brown and Petersen (2009); Ovtchinnikov and McConnell (2009); Chemmanur *et al.* (2009); Wei and Zhang (2008); Chen *et al.* (2007); Alderson and Betker (2006); Alderson *et al.* (2006)
15.	The ratio of net capital expenditures ($NCAPX_t$) to lagged fixed assets (K_{t-1})	$\frac{NCAPX_t}{K_{t-1}} = \frac{CAPX_t - DAA_t}{NPPE_{t-1}}$	Aivazian *et al.* (2005); Cleary (1999); Lang *et al.* (1996)
16.	The ratio of net capital expenditures ($NCAPX_t$) to total assets (TA_t)	$\frac{NCAPX_t}{TA_t} = \frac{CAPX_t - DAA_t}{TA_t}$	Firth *et al.* (2008)
17.	The ratio of net capital expenditures ($NCAPX_t$) to lagged total assets (TA_{t-1})	$\frac{NCAPX_t}{TA_{t-1}} = \frac{CAPX_t - DAA_t}{TA_{t-1}}$	Denis and Sibilkov (2010)
18.	The ratio of net spending on fixed assets ($NSFA_t$) to fixed assets (K_t)	$\frac{NSFA_t}{K_t} = \frac{CAPX_t - SPPE_t}{NPPE_t}$	Hennessy *et al.* (2007)
19.	The ratio of net spending on fixed assets ($NSFA_t$) to lagged replacement value of fixed assets (Kr_{t-1})	$\frac{NSFA_t}{Kr_{t-1}} = \frac{CAPX_t - SPPE_t}{RNPPE_{t-1}}$	Bloom *et al.* (2007)
20.	The ratio of net spending on fixed assets ($NSFA_t$) to lagged total assets (TA_{t-1})	$\frac{NSFA_t}{TA_{t-1}} = \frac{CAPX_t - SPPE_t}{TA_{t-1}}$	Kang *et al.* (2010); Lin *et al.* (2005)

Note:

[a] All items used to define and compute the corporate investment measures refer to annual data items from the Worldscope database via Thomson One Banker Analytics. *GINV* and *NINV* represent accrual based measures of gross and net additions to tangible fixed assets, respectively. *GCAPX* and *NCAPX* represent cash based measures of gross and net capital expenditures, respectively. *NSFA* represents cash based measure of net spending on fixed assets. *K* and *TA* represent book values of net tangible fixed assets and total assets, respectively. *Kr* represents replacement value of tangible fixed assets. *NPPE* represents net property, plant and equipment, which equals to gross property, plant and equipment (*GPPE*) less accumulated depreciation, depletion and amortisation. *RNPPE* represents the replacement value of tangible fixed assets, calculated using the standard perpetual inventory method. *DDA* represents depreciation, depletion and amortisation expense. *CAPX* represents the funds used to acquire fixed assets other than those associated with acquisitions. *SPPE* represents sales of property, plant and equipment, which is the amount a company received from the disposal of fixed assets. Items with subscript t are measured at the end of the fiscal year, while the items with subscript $t-1$ are beginning-of-period values, i.e. lagged values.

5.3 Development of hypotheses

Based on the review of the measurement of corporate investment behaviour in the existing literature, a number of testable hypotheses are formulated in this section. The hypotheses formulated here can be summarised in three research questions, i.e. whether the different measures of corporate investment can always yield equivalent results in empirical analyses, which measures are relatively less noisy and thus more predictable, and which measures have greater information content.

5.3.1 Hypotheses regarding whether the measurement of investment matters

The review of literature shows that numerous versions of corporate investment to capital stock ratio have been widely used in the empirical studies to capture corporate investment behaviour. The claim is implicitly made that various corporate investment measures will always yield equivalent empirical results. In other words, it is assumed that these corporate investment measures can be used interchangeably without altering the conclusions drawn from empirical analyses. However, we argue that, because different accounting principles are involved in the calculation of relevant accounting figures, accrual based measures of corporate investment may contain information about a company's investment activities which is not present in their cash based counterparts, and vice versa. Meanwhile, gross investment measures and net investment measures are also likely to provide different information about companies' future productive capacity. Thus, the first hypothesis (Hypothesis 1) is formulated as follows:

> H_N: Conclusions drawn from empirical analyses are not sensitive to the choice of corporate investment measures;
>
> H_A: Conclusions drawn from empirical analyses are sensitive to the choice of corporate investment measures.[50]

Hypothesis 1 can be tested by examining the pair-wise correlation coefficients among the alternative corporate investment measures. The correlation coefficients can quantify the amount of overlapping information contained in the alternatives. The correlation coefficient analysis results are presented in Section 5.4. In addition, to better illustrate the extent to which the choice of corporate investment measures may affect conclusions drawn from empirical analyses, a conventional Tobin's *Q* model is repeatedly estimated in Section 5.5 using

[50] H_N and H_A represent the null hypothesis and alternative hypothesis, respectively.

different measures of corporate investment as the dependent variable in their respective regressions. The differences in the estimation results across regressions are expected to show whether the measurement of corporate investment behaviour matters in empirical analyses.

5.3.2 Hypotheses regarding the volatility of investment measures

As discussed in Section 5.2, there is a potential timing difference in recognising capital investment between accrual basis and cash basis accounting methods. Specifically, capital investment is recognised when it is incurred under accrual basis accounting, whereas it is recognised when cash is paid under cash basis accounting. Thus, cash based corporate investment measures are subject to timing and mismatching problems which may cause them to be noisy and unpredictable. By contrast, accrual based corporate investment to capital stock ratios, which are supposed to mitigate the timing and mismatching problems of cash based accounting figures, can be considered as smoothed measures of corporate investment behaviour. Accordingly, the second hypothesis (Hypothesis 2) is formulated as follows:

> H_N: Cash based corporate investment measures are as noisy as their accrual based counterparts;
>
> H_A: Cash based corporate investment measures are noisier than their accrual based counterparts.

In addition, gross corporate investment measures are likely to behave differently from net corporate investment measures, since the former focus on the overall investment in capital stock made by a company over certain period, whereas the latter further take depreciated capital goods into consideration by subtracting depreciation expense charged for the same period from the overall spending on capital stock. Because net corporate investment measures are jointly determined by gross investment spending and depreciation expense, they are expected to exhibit greater volatility than gross corporate investment measures. Therefore, it is reasonable to expect that gross corporate investment measures are relatively less noisy and more predictable than net corporate investment measures, especially when the managers have an incentive to opportunistically manipulate depreciation figures. Accordingly, the third hypothesis (Hypothesis 3) can be formulated as follows:

H_N: Net corporate investment measures are as noisy as their corresponding gross corporate investment measures;

H_A: Net corporate investment measures are noisier than their corresponding gross corporate investment measures.

Hypotheses 2 and 3 regarding the volatility (or predictability) of the corporate investment measures are empirically tested in Section 5.6 using trend analysis.

5.3.3 Hypotheses regarding the information content of investment measures

Although the cash based measures are expected to contain more noise than their accrual based counterparts, the proponents of cash flow basis accounting believe that cash flow measures are less subject to distortions from differing accounting practices and managers opportunistic manipulation, and thus impart such additional information that is not contained in the accrual based measures (see, for example, Salmi *et al.*, 1990). Therefore, the fourth hypothesis (Hypothesis 4) is developed as follows:

> H_N: Cash based corporate investment measures are as informative as their accrual based counterparts;
>
> H_A: Cash based corporate investment measures are more informative than their accrual based counterparts.

Meanwhile, it is also believed that net corporate investment measures contain more information about a company's future prospects than do gross corporate investment measures. It is argued that gross investment includes both new investments and replacement investments. New investments are undertaken to increase the scope of a company's operations, while replacement investments are made to maintain a company's current operations. Since new investments in additional operating capacity are expected to have a more significant effect on the company's future earnings, net corporate investment measures are likely to provide more forward-looking information about company value and thus shareholders' wealth. Accordingly, the fifth hypothesis (Hypothesis 5) can be formulated as follows:

> H_N: Net corporate investment measures are as informative as their corresponding gross corporate investment measures;
>
> H_A: Net corporate investment measures are more informative than their corresponding gross corporate investment measures.

Hypotheses 4 and 5 regarding the information content of the corporate investment measures are tested in Section 5.7. Given the argument that changes in a company's corporate investment yield information about changes in the company's future earnings that is not captured by unexpected earnings (see, for example, Kerstein and Kim, 1995; and Park and Pincus, 2003), we focus on the value relevant information content provided by the alternative corporate investment measures.

5.4 Data and preliminary analysis

5.4.1 Data and measurement

The data are collected from the Worldscope database via Thomson One Banker Analytics. The initial sample includes all companies listed on the London Stock Exchange (LSE), during the period 1999–2008. We then discard utilities (SIC code 4900–4949), and financial companies (SIC code 6000–6999), as these two industries are highly regulated. Companies that do not have complete records of key data, such as net property, plant and equipment (*NPPE*), gross property, plant and equipment (*GPPE*), total assets (*TA*), depreciation, depletion and amortisation (*DDA*), capital expenditure (*CAPX*), and sales of property, plant and equipment (*SPPE*), are dropped from our sample. A strongly balanced panel of company-level data over the period from 1999 to 2008 is formed with 4,320 company-year observations. The balanced panel dataset is preferred because it eliminates the potential effect of missing values on our empirical results, allowing us to focus on our research question of whether the measurement of corporate investment matters. The twenty alternative measures of corporate investment identified in the existing literature (see Table 5.1 for detailed definitions) are calculated using the data from the panel of UK-listed companies over the period 1999–2008.

5.4.2 Summary statistics

The summary statistics of the alternative measures of corporate investment are presented in Table 5.2. In addition to the conventional statistics, we also calculated the coefficient of variation (CV) for each of the corporate investment measures. The coefficient of variation is defined as the ratio of the standard deviation to the absolute mean of the underlying variable. Thus, it is a dimensionless statistic which can be used to compare volatility among variables with widely different means. As is evident in Panel A, extreme values appear in almost all the corporate investment to capital stock ratios, indicating that the observed corporate investment measures are severely distorted by outliers which may have a significant effect upon the results of our empirical tests. In order to reduce the potential impact of outliers, the observed corporate investment measures are winsorised at both the top and bottom 5^{th} percentiles. Specifically, for all of the investment ratios, the extreme values, which are defined as the top and bottom 5 percent of the sample observations, are assigned to the cut-off values. This approach not only reduces the potential impact of outliers but also allows the full use of observations. Given the argument that winsorisation estimators are expected to be more plausible and robust than those of the standard transformations such as trimming (Baum *et al*, 2008; and Chay and Suh, 2009), the empirical results presented in this chapter are obtained based on the observations that are winsorised at both the top and bottom 5^{th} percentiles.

Table 5.2: Summary statistics for corporate investment measures examined in Chapter 5[a]

Variable[b]	Mean	Median	Max.	Min.	S.D.	C.V.	Skewness	Kurtosis
Panel A: Descriptive statistics of investment measures without winsorisation[c]								
1. $GINV_t/K_t$	0.20	0.22	15.02	–210.88	3.57	17.99	–49.14	2842.71
2. $GINV_t/K_{t-1}$	2.36	0.22	4621.51	–0.97	78.22	33.11	52.09	2923.71
3. $GINV_t/Kr_t$	0.19	0.17	43.16	–38.47	1.04	5.49	3.54	1127.96
4. $GINV_t/Kr_{t-1}$	0.72	0.17	1278.57	–41.75	20.58	28.49	57.50	3486.23
5. $GINV_t/TA_t$	0.05	0.04	1.50	–3.58	0.15	3.15	–8.65	162.58
6. $NINV_t/K_t$	–0.18	0.02	1.00	–220.38	3.96	22.28	–44.47	2308.70
7. $NINV_t/K_{t-1}$	1.89	0.02	4238.52	–1.00	72.94	38.60	50.77	2777.33
8. $NINV_t/TA_{t-1}$	0.03	0.00	10.59	–0.89	0.26	9.33	26.58	983.59
9. $GCAPX_t/K_t$	0.27	0.19	103.48	0.00	1.61	6.03	61.82	3961.42
10. $GCAPX_t/K_{t-1}$	0.61	0.19	994.33	0.00	15.46	25.22	61.88	3960.67
11. $GCAPX_t/Kr_t$	–0.28	0.15	37.78	–260.01	12.51	44.66	–20.02	412.82
12. $GCAPX_t/Kr_{t-1}$	–0.63	0.16	540.36	–1752.39	35.50	56.78	–33.47	1512.95
13. $GCAPX_t/TA_t$	0.06	0.04	26.97	0.00	0.41	7.01	63.89	4159.26
14. $GCAPX_t/TA_{t-1}$	0.07	0.04	28.33	0.00	0.45	6.47	59.11	3703.13
15. $NCAPX_t/K_{t-1}$	0.14	0.00	611.34	–19.99	9.77	69.69	57.58	3553.84
16. $NCAPX_t/TA_t$	0.01	0.00	26.93	–1.30	0.41	34.74	63.77	4149.42
17. $NCAPX_t/TA_{t-1}$	0.02	0.00	28.29	–0.59	0.45	24.65	59.56	3741.21
18. $NSFA_t/K_t$	–0.17	0.13	80.95	–224.13	5.67	33.96	–28.50	1003.78
19. $NSFA_t/Kr_{t-1}$	–0.35	0.15	3181.49	–2163.73	67.34	194.04	14.84	1462.69
20. $NSFA_t/TA_{t-1}$	0.04	0.03	22.17	–2.06	0.37	10.15	50.51	2979.98
Panel B: Descriptive statistics of investment measures winsorised at the 5th percentiles[d]								
1. $GINV_t/K_t$	0.28	0.22	0.89	–0.21	0.28	1.03	0.64	2.91
2. $GINV_t/K_{t-1}$	0.37	0.22	1.61	–0.16	0.45	1.21	1.55	4.77
3. $GINV_t/Kr_t$	0.21	0.17	0.74	–0.18	0.23	1.06	0.71	3.12
4. $GINV_t/Kr_{t-1}$	0.28	0.17	1.26	–0.15	0.34	1.23	1.54	4.94
5. $GINV_t/TA_t$	0.06	0.04	0.22	–0.05	0.06	1.11	0.89	3.83
6. $NINV_t/K_t$	0.01	0.02	0.47	–0.52	0.23	20.74	–0.37	3.34
7. $NINV_t/K_{t-1}$	0.07	0.02	0.88	–0.35	0.28	3.88	1.21	4.63
8. $NINV_t/TA_{t-1}$	0.02	0.00	0.23	–0.09	0.07	3.73	1.39	5.24
9. $GCAPX_t/K_t$	0.23	0.19	0.61	0.04	0.15	0.68	1.03	3.31
10. $GCAPX_t/K_{t-1}$	0.25	0.19	0.82	0.03	0.20	0.82	1.45	4.46
11. $GCAPX_t/Kr_t$	0.21	0.15	0.67	0.01	0.18	0.87	1.23	3.71
12. $GCAPX_t/Kr_{t-1}$	0.24	0.16	0.92	0.01	0.24	1.01	1.59	4.81
13. $GCAPX_t/TA_t$	0.05	0.04	0.18	0.00	0.04	0.87	1.43	4.67
14. $GCAPX_t/TA_{t-1}$	0.06	0.04	0.22	0.00	0.05	0.93	1.64	5.36

Variable[b]	Mean	Median	Max.	Min.	S.D.	C.V.	Skewness	Kurtosis
15. $NCAPX_t/K_{t-1}$	–0.01	0.00	0.44	–0.39	0.19	16.46	–0.01	3.52
16. $NCAPX_t/TA_t$	0.01	0.00	0.12	–0.04	0.04	5.66	1.22	4.46
17. $NCAPX_t/TA_{t-1}$	0.01	0.00	0.14	–0.04	0.04	4.70	1.45	5.03
18. $NSFA_t/K_t$	0.13	0.13	0.53	–0.36	0.21	1.61	–0.43	3.53
19. $NSFA_t/Kr_{t-1}$	0.23	0.15	1.38	–0.57	0.45	1.93	0.82	4.01
20. $NSFA_t/TA_{t-1}$	0.04	0.03	0.19	–0.07	0.06	1.57	0.78	4.08

Notes:

[a.] The sample contains 4,320 UK company-year observations over the period 1999–2008.

[b.] See detailed definitions of the corporate investment measures in Table 5.1.

[c.] Winsorisation is the transformation of extreme values in the statistical data.

[d.] The transformed data are identical to the original data except that, in this case, all data below the 5th percentile are set to the 5th percentile and data above the 95th percentile are set to the 95th percentile.

The summary statistics for the winsorised corporate investment measures are presented in Panel B of Table 5.2. After getting rid of the most extreme observations on both sides of their respective distributions, the standard deviations as well as the coefficients of variations for all the corporate investment measures reduce significantly. More importantly, the distributions of the corporate investment measures are much closer to normality after winsorisation, although the results of skewness and kurtosis test for normality can still reject the hypotheses that the winsorised measures are normally distributed. After controlling for the effect of outliers, a number of patterns can be observed from the descriptive statistics.

First, accrual based corporate investment measures are systematically higher than their cash based counterparts. For example, the mean values of $GINV_t/K_{t-1}$ and $GCAPX_t/K_{t-1}$ are 0.37 and 0.25 respectively, and those of $NINV_t/K_{t-1}$ and $NCAPX_t/K_{t-1}$ are 0.07 and –0.01 respectively. Although there is a timing difference in recognising capital investment under different accounting methods, the timing difference cannot adequately justify the large gap between the mean values of accrual based and cash based investment measures. The differences between accrual based and cash based investment measures are largely due to asset revaluations as well as assets associated with acquisitions, which are reflected in the carrying amount of tangible fixed assets on balance sheet but cannot be captured by capital expenditures on cash flow statement. In addition, the coefficients of variation suggest that, on average, cash flow based investment measures are less volatile that their accrual based counterparts. For example, the coefficients of variation of $GINV_t/K_t$ and $GCAPX_t/K_t$ are 1.03 and 0.68 respectively, and those of $GINV_t/Kr_t$ and $GCAPX_t/Kr_t$ are 1.06 and 0.87 respectively. It is worth noting that the extremely high levels of volatility of $NINV_t/K_t$, $NCAPX_t/K_{t\text{–}1}$ and $NCAPX_t/TA_t$, as suggested by their respective coefficients of variation, are likely to be caused by their low mean values, which are close to zero. It is acknowledged that, when the mean value is close to zero, the coefficient of variation is highly sensitive to small changes in the mean, limiting its usefulness.

Second, it is evident that the mean values of gross corporate investment measures are systematically higher than those of their corresponding net corporate investment measures. For example, the mean value of $GINV_t/K_t$ is 0.28, while that of $NINV_t/K_t$ is 0.01; the mean values of $GCAPX_t/K_{t\text{–}1}$ and $NCAPX_t/K_{t\text{–}1}$ are 0.25 and –0.01, respectively. The difference in the mean values of gross and net investment measures is directly related to their respective definitions. Deducting depreciation expense from overall investment creates a large wedge between the mean values of gross investment measures and those of net investment measures. Meanwhile, as expected, gross investment measures are less volatile than net investment measures, as indicated by the coefficients of variation. However, the higher values of the coefficient of variation for the net investment measures may also be attributable to their lower mean values.

Third, the use of lagged proxies of capital stock to scale investment spending inflates the values of corporate investment measures significantly. After lagging the proxy for capital stock by one period, the mean of gross investment to fixed assets ratio ($GINV/K$) increases from 0.28 to 0.37 and the mean of gross investment to replacement value of fixed assets ratio ($GINV/K_r$) increases from 0.21 to 0.28. Meanwhile, the volatilities of the corporate investment measures are also likely to be inflated by lagging the proxy for capital stock. For example, the coefficients of variation of $GINV_t/K_t$ and $GINV_t/K_{t-1}$ are 1.03 and 1.21 respectively, and those of $GINV_t/K_r$ and $GINV_t/K_{r-1}$ are 1.06 and 1.23 respectively.

In addition, the choice of the proxies for capital stock influences the mean values of the corporate investment measures substantially. In general, corporate investment measures scaled by the replacement value of fixed assets are lower than those scaled by the book value of fixed assets, implying that changes in price level have a substantial impact on the value of capital goods, while the corporate investment measures scaled by book value of total assets typically have the lowest means values among the alternatives.

The observed differences in the mean values of the corporate investment measures are formally tested using mean-comparison tests. The results of the pair-wise t tests on the equality of means are reported in Appendix 5.B. The null hypothesis that the means of the corresponding corporate investment measures are equal can be firmly rejected in almost all instances. In addition, the annual mean value of each corporate investment measure is plotted over time in Appendix 5.C, providing a visual comparison among the alternative measures of corporate investment.

5.4.3 Correlation coefficient analysis

To gauge the extent of correlation among the twenty measures of corporate investment, we compute correlation coefficients between each pair of them. A number of distinct patterns can be observed from the Pearson correlation coefficients presented in Table 5.3.

First, the correlation coefficients reveal a considerable degree of association between each pair of corporate investment measures with only five exceptions. Most of the correlation coefficients are significantly positive at the 1% significance level, suggesting that, although the corporate investment measures are specified differently, they do provide similar information about a company's investing activities. However, it is also found that the correlation coefficients among the corporate investment measures are not uniformly positively. Seven pairs of corporate investment measures are found to be negatively correlated with each other, which appears surprising given that all the measures are supposed to depict the investment behaviour of the same batch of companies over the same period of time. Specifically, the correlation coefficient matrix shows that $GINV_t /K_t$ is negatively correlated with $GCAPX_t /TA_t$, $NCAPX_t /K_{t–1}$, $NCAPX_t /TA_t$ and $NCAPX_t /TA_{t–1}$, while $NCAPX_t /K_{t–1}$ is negatively correlated with $GINV_t /K_{t–1}$, $GINV_t /Kr_t$ and $GINV_t /Kr_{t–1}$. The negative correlation coefficients vary between –0.03 and –0.31. Four of them are statistically significant at the 1% significance level, and the others are also marginally significant. The strongest negative correlation is observed between $GINV_t /K_t$ and $NCAPX_t /K_{t–1}$. The correlation coefficient of –0.31 suggests that the negative assocation between the two corporate investment measures is not only statistically significant but also economically significant. If these two significantly and negatively correlated corporate investment measures are used to investigate the same research question, they are likely to yield qualitatively dissimilar results. Since the negative correlations are only observed between accrual based and cash based corporate investment measures, it is plausible to argue that the differences among alternative measures are primarily attributable to the different accounting principles involved in the preparation of relevant accounting figures.

Second, a significant definitional correlation effect can be observed from the correlation coefficient matrix. In other words, corporate investment measures which are similarly specified are likely to be highly correlated with each other. For example, the highest correlation coefficients are observed between $GINV_t /K_t$ and $GINV_t /K_{t–1}$, $GINV_t /Kr_t$ and $GINV_t /Kr_{t–1}$, $NINV_t /K_t$ and $NINV_t /K_{t–1}$, $GCAPX_t /K_t$ and $GCAPX_t /K_{t–1}$, $GCAPX_t /Kr_t$ and

$GCAPX_t\ /Kr_{t-1}$, $GCAPX_t\ /TA_t$ and $GCAPX_t\ /TA_{t-1}$, and $NCAPX_t\ /TA_t$ and $NCAPX_t\ /TA_{t-1}$, ranging from 0.85 to 0.96. These significant associations also suggest that lagging the proxy for capital stock by one period does not create many changes in the behaviour of corporate investment measures. Therefore, the empirical results of corporate investment research are unlikely to be affected by different assumptions regarding the specific time point at which the investment decisions are made. Moreover, the correlation coefficients between $GINV_t/K_t$ and $GINV_t/Kr_t$, $GINV_t/K_{t-1}$ and $GINV_t/Kr_{t-1}$, $GCAPX_t/K_t$ and $GCAPX_t/Kr_t$, and $GCAPX_t/K_{t-1}$ and $GCAPX_t/Kr_{t-1}$ are 0.81, 0.81, 0.62 and 0.72, respectively, suggesting that the choice between using book value or replacement value of capital stock to deflate corporate investment is also unlikely to have significant influence upon the results of empirical analyses.

Third, the weakest pair-wise correlations are found between corporate investment measures which are constructed in completely different ways. The correlation coefficient between $GINV_t/K_{t-1}$ and $GCAPX_t/TA_t$, for example, is as low as 0.005 and is not significantly different from zero. The independence of the two corporate investment measures is likely to be caused by the differences in measuring both investment spending and capital stock, which leads to less overlapping information being conveyed by the two variables. Overall, the correlation coefficients represented in Table 5.3 suggest that the conflicting results observed in the existing literature may, at least partially, be attributable to the choice of corporate investment measures.

Table 5.3: Pearson correlation coefficients of alternative corporate investment measures[a]

Variable[b]	1. $\frac{GINV_t}{K_t}$	2. $\frac{GINV_t}{K_{t-1}}$	3. $\frac{GINV_t}{Kr_t}$	4. $\frac{GINV_t}{Kr_{t-1}}$	5. $\frac{GINV_t}{TA_t}$	6. $\frac{NINV_t}{K_t}$	7. $\frac{NINV_t}{K_{t-1}}$	8. $\frac{NINV_t}{TA_{t-1}}$	9. $\frac{GCAPX_t}{K_t}$	10. $\frac{GCAPX_t}{K_{t-1}}$	11. $\frac{GCAPX_t}{Kr_t}$	12. $\frac{GCAPX_t}{Kr_{t-1}}$	13. $\frac{GCAPX_t}{TA_t}$	14. $\frac{GCAPX_t}{TA_{t-1}}$	15. $\frac{NCAPX_t}{K_{t-1}}$	16. $\frac{NCAPX_t}{TA_t}$	17. $\frac{NCAPX_t}{TA_{t-1}}$	18. $\frac{NSFA_t}{K_t}$	19. $\frac{NSFA_t}{Kr_{t-1}}$
2. $\frac{GINV_t}{K_{t-1}}$	0.859[c] (0.0000)[d]																		
3. $\frac{GINV_t}{Kr_t}$	0.814 (0.0000)	0.715 (0.0000)																	
4. $\frac{GINV_t}{Kr_{t-1}}$	0.746 (0.0000)	0.806 (0.0000)	0.909 (0.0000)																
5. $\frac{GINV_t}{TA_t}$	0.512 (0.0000)	0.429 (0.0000)	0.567 (0.0000)	0.492 (0.0000)															
6. $\frac{NINV_t}{K_t}$	0.619 (0.0000)	0.564 (0.0000)	0.667 (0.0000)	0.600 (0.0000)	0.673 (0.0000)														
7. $\frac{NINV_t}{K_{t-1}}$	0.608 (0.0000)	0.758 (0.0000)	0.660 (0.0000)	0.744 (0.0000)	0.599 (0.0000)	0.848 (0.0000)													
8. $\frac{NINV_t}{TA_{t-1}}$	0.445 (0.0000)	0.478 (0.0000)	0.542 (0.0000)	0.558 (0.0000)	0.844 (0.0000)	0.699 (0.0000)	0.751 (0.0000)												
9. $\frac{GCAPX_t}{K_t}$	0.465 (0.0000)	0.493 (0.0000)	0.399 (0.0000)	0.416 (0.0000)	0.115 (0.0000)	0.115 (0.0000)	0.277 (0.0000)	0.112 (0.0000)											
10. $\frac{GCAPX_t}{K_{t-1}}$	0.636 (0.0000)	0.721 (0.0000)	0.604 (0.0000)	0.657 (0.0000)	0.341 (0.0000)	0.494 (0.0000)	0.665 (0.0000)	0.390 (0.0000)	0.846 (0.0000)										
11. $\frac{GCAPX_t}{Kr_t}$	0.563 (0.0000)	0.547 (0.0000)	0.732 (0.0000)	0.701 (0.0000)	0.311 (0.0000)	0.348 (0.0000)	0.423 (0.0000)	0.291 (0.0000)	0.625 (0.0000)	0.672 (0.0000)									

Variable[b]	1. $\frac{GINV_t}{K_t}$	2. $\frac{GINV_t}{K_{t-1}}$	3. $\frac{GINV_t}{Kr_t}$	4. $\frac{GINV_t}{Kr_{t-1}}$	5. $\frac{GINV_t}{TA_t}$	6. $\frac{NINV_t}{K_t}$	7. $\frac{NINV_t}{K_{t-1}}$	8. $\frac{NINV_t}{TA_{t-1}}$	9. $\frac{GCAPX_t}{K_t}$	10. $\frac{GCAPX_t}{K_{t-1}}$	11. $\frac{GCAPX_t}{Kr_t}$	12. $\frac{GCAPX_t}{Kr_{t-1}}$	13. $\frac{GCAPX_t}{TA_t}$	14. $\frac{GCAPX_t}{TA_{t-1}}$	15. $\frac{NCAPX_t}{K_{t-1}}$	16. $\frac{NCAPX_t}{TA_t}$	17. $\frac{NCAPX_t}{TA_{t-1}}$	18. $\frac{NSFA_t}{K_t}$	19. $\frac{NSFA_t}{Kr_{t-1}}$
12. $\frac{GCAPX_t}{Kr_{t-1}}$	0.538	0.575	0.701	0.722	0.325	0.383	0.492	0.339	0.619	0.715	0.959								
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)								
13. $\frac{GCAPX_t}{TA_t}$	–0.025	0.005	0.100	0.105	0.535	0.227	0.224	0.394	0.290	0.322	0.238	0.273							
	(0.1071)	(0.7344)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)							
14. $\frac{GCAPX_t}{TA_{t-1}}$	0.107	0.154	0.246	0.268	0.624	0.362	0.393	0.582	0.320	0.434	0.324	0.370	0.922						
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)						
15. $\frac{NCAPX_t}{K_{t-1}}$	–0.308	–0.186	–0.050	–0.025	0.209	0.306	0.325	0.344	0.151	0.288	0.060	0.135	0.535	0.559					
	(0.0000)	(0.0000)	(0.0009)	(0.1056)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)					
16. $\frac{NCAPX_t}{TA_t}$	–0.052	0.012	0.096	0.118	0.410	0.337	0.350	0.515	0.271	0.360	0.192	0.251	0.797	0.796	0.707				
	(0.0006)	(0.4262)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
17. $\frac{NCAPX_t}{TA_{t-1}}$	–0.024	0.054	0.129	0.163	0.444	0.342	0.384	0.574	0.285	0.395	0.220	0.288	0.783	0.847	0.723	0.964			
	(0.1139)	(0.0004)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
18. $\frac{NSFA_t}{K_t}$	0.471	0.365	0.450	0.364	0.366	0.468	0.368	0.282	0.387	0.480	0.386	0.374	0.245	0.285	0.143	0.210	0.211		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
19. $\frac{NSFA_t}{Kr_{t-1}}$	0.285	0.289	0.391	0.384	0.224	0.280	0.299	0.232	0.291	0.377	0.485	0.508	0.153	0.214	0.141	0.153	0.178	0.413	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
20. $\frac{NSFA_t}{TA_{t-1}}$	0.262	0.217	0.349	0.303	0.635	0.469	0.410	0.559	0.255	0.401	0.317	0.342	0.694	0.771	0.414	0.609	0.646	0.686	0.350
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes:

[a] The sample contains 4,320 UK company-year observations over the period 1999–2008.

[b] See detailed definitions of the corporate investment measures in Table 5.1.

[c] For each cell, the reported figure is the pair-wise Pearson correlation coefficient between the corresponding corporate investment measures.

[d] Figures in parentheses underneath denote *p*-values, reporting the significance level of each correlation coefficient.

Given the fact that the winsorised corporate investment measures are still skewed and leptokurtotic, a nonparametric method, i.e. Spearman's rank correlation, is also employed to check the robustness of the association between each pair of corporate investment measures. Spearman's rank correlation assesses how well the relationship between a pair of corporate investment measures can be described as a monotonic function. More specifically, this method converts the values of the corporate investment measures into ranks, and evaluate whether the orders ranked by different corporate investment measures are monotonically related. Increasing positive values imply increasing agreement between the rankings according to different corporate investment measures. Spearman's rank correlation coefficients are presented in Appendix 5.D. The associations among the corporate investment measures observed from Table 5.3 are confirmed by the results of the nonparametric method, except that the negative pair-wise correlations reduce to four and become less significant when the assumption of normality are relaxed.

5.5 A simple regression of Tobin's *Q* model of investment

Although our preliminary analysis reveals that most of the corporate investment measures are positively correlated with one another, this does not necessarily imply that they will behave similarly in empirical analyses. More importantly, negative pair-wise associations are also found between some corporate investment measures. These negatively associated corporate investment measures are likely to yield qualitatively dissimilar results in empirical analyses. Therefore, the principal purpose of this section is to illustrate the extent to which the choice of corporate investment measures affects the conclusions drawn from empirical analyses.

5.5.1 Empirical procedures

To illustrate the potential impact of the choice of corporate investment measures on the results of empirical analyses, a simple Tobin's *Q* model of investment is estimated in this section with reference to a balanced panel of UK-listed companies. Specifically, all the corporate investment measures listed in Table 5.1 are used as the dependent variable and regressed on the same proxy for Tobin's *Q* in their respective regressions. The extent to which the choice of corporate investment measures may affect conclusions drawn from empirical studies can be determined by examining the differences in the estimation results across regressions in which different corporate investment measures are used as the dependent variable. The simple Tobin's *Q* model of corporate investment is specified as follows,

$$INV_{it} = \alpha_0 + \alpha_1 Q_{it} + \alpha_2 INV_{it-1} + \varepsilon_{it} \tag{5.1}$$

where *INV* represents corporate investment measure, *Q* represents a proxy for Tobin's *Q* which is measured as the market-to-book value of total assets, and ε represents the error term. According to the standard *Q* theory, all of the information relevant to the future prospects affects investment decisions through Tobin's *Q*. Thus, the coefficient on the proxy for Tobin's *Q* is expected to be positive in all the regressions. A lagged corporate investment measure is also included to capture the dynamic structure of companies' investment behaviour.

Moreover, we control for time effects by adding year dummies. Equation 5.1 is estimated repeatedly for different corporate investment measures, using system-GMM estimators.

5.5.2 Empirical results

The system-GMM estimation results for the simple Tobin's *Q* model of corporate investment are reported in Table 5.4. As expected, distinct conclusions with respect to the association between Tobin's *Q* and companies' investment behaviour can be drawn when different corporate investment measures are employed as the dependent variable.

More specifically, as shown in column 3 of Table 5.4, the coefficient on Tobin's *Q* turns out to be positive in 14 regressions, indicating that higher *Q* values encourage companies to undertake more investment projects. However, the estimation results for the remaining 6 regressions indicate the opposite that the Tobin's *Q* affects corporate investment adversely. When $GINV_t/K_{t-1}$, $GCAPX_t/K_t$, $GCAPX_t/K_{t-1}$, $GCAPX_t/Kr_{t-1}$, $NSFA_t/K_t$ and $NSFA_t/Kr_{t-1}$ are regressed on the proxy for Tobin's *Q*, the estimation results suggest that the positive association between corporate investment and Tobin's *Q* is statistically significant, whereas, when $GINV_t/TA_t$ and $NINV_t/TA_{t-1}$ are regressed on the same proxy for Tobin's *Q*, the association between corporate investment and Tobin's *Q* is also statistically significant but negative. Therefore, it is shown that no consensus can be reached about either the sign or the significance level of the relation between corporate investment behaviour and Tobin's *Q* across regressions where different measures of corporate investment are employed.

Table 5.4: System-GMM estimation results for Tobin's *Q* model of corporate investment[a]

Investment measure[b]	*Constant*	Tobin's *Q*	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]
1. $GINV_t/K_t$	0.1099***[c]	0.0023	0.7872***	–6.11***	2.84***	29.24*	14.54***
	(2.90)[d]	(0.62)	(5.84)	(*p*=0.000)	(*p*=0.000)	(*p*=0.062)	(*p*=0.000)
2. $GINV_t/K_{t-1}$	0.3471***	0.0117*	0.3330*	–3.54***	0.54	23.62	11.82***
	(4.26)	(1.90)	(1.94)	(*p*=0.000)	(*p*=0.590)	(*p*=0.211)	(*p*=0.000)
3. $GINV_t/Kr_t$	0.1232***	0.0020	0.5829***	–6.31***	2.79***	24.66	12.81***
	(5.25)	(0.80)	(5.49)	(*p*=0.000)	(*p*=0.005)	(*p*=0.172)	(*p*=0.000)
4. $GINV_t/Kr_{t-1}$	0.1946***	0.0055	0.3716***	–6.02***	1.12	26.22**	9.87***
	(6.41)	(1.07)	(3.93)	(*p*=0.000)	(*p*=0.262)	(*p*=0.124)	(*p*=0.000)
5. $GINV_t/TA_t$	0.0487***	–0.0011*	0.2595**	–4.07***	0.50	28.98*	6.68***
	(6.26)	(–1.82)	(1.96)	(*p*=0.000)	(*p*=0.615)	(*p*=0.066)	(*p*=0.000)
6. $NINV_t/K_t$	0.0670***	–0.0047	0.2775*	–3.63***	0.80	19.57	11.35***
	(4.42)	(–1.21)	(1.74)	(*p*=0.000)	(*p*=0.422)	(*p*=0.421)	(*p*=0.000)
7. $NINV_t/K_{t-1}$	0.1463***	–0.0018	0.1150	–3.13***	–0.28	14.26	12.24***
	(5.07)	(–0.46)	(0.74)	(*p*=0.000)	(*p*=0.782)	(*p*=0.769)	(*p*=0.000)
8. $NINV_t/TA_{t-1}$	0.0320***	–0.0013*	0.0741	–3.50***	–0.99	26.01	10.93***
	(6.73)	(–1.82)	(0.63)	(*p*=0.000)	(*p*=0.322)	(*p*=0.130)	(*p*=0.000)
9. $GCAPX_t/K_t$	0.1535***	0.0075***	0.3059***	–4.99***	–0.55	28.56*	9.06***
	(7.14)	(4.29)	(3.32)	(*p*=0.000)	(*p*=0.580)	(*p*=0.073)	(*p*=0.000)
10. $GCAPX_t/K_{t-1}$	0.2028***	0.0077***	0.2675***	–5.28***	–1.21	24.17	10.41***
	(8.67)	(3.02)	(3.43)	(*p*=0.000)	(*p*=0.226)	(*p*=0.190)	(*p*=0.000)

Investment measure[b]	*Constant*	Tobin's Q	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	F-statistic[h]
11. $GCAPX_t/Kr_t$	0.1314***	0.0029	0.3602***	–5.22***	–0.99	24.98	12.98***
	(8.16)	(1.46)	(4.78)	(p = 0.000)	(p=0.324)	(p=0.161)	(p=0.000)
12. $GCAPX_t/Kr_{t-1}$	0.1500***	0.0065**	0.3070***	–4.84***	–0.88	26.21	14.52***
	(7.37)	(2.29)	(3.89)	(p=0.000)	(p=0.378)	(p=0.124)	(p=0.000)
13. $GCAPX_t/TA_t$	0.0198***	0.0002	0.5204***	–5.75***	–1.04	22.59	22.05***
	(4.92)	(0.55)	(6.32)	(p=0.000)	(p=0.299)	(p=0.256)	(p=0.000)
14. $GCAPX_t/TA_{t-1}$	0.0289***	0.0002	0.4227***	–5.79***	–0.88	20.41	28.38***
	(7.30)	(0.51)	(6.19)	(p=0.000)	(p=0.381)	(p=0.370)	(p=0.000)
15. $NCAPX_t/K_{t-1}$	–0.0139	–0.0001	0.4844***	–4.78***	–0.67	28.98*	10.81***
	(–1.24)	(–0.04)	(4.22)	(p=0.000)	(p=0.503)	(p=0.066)	(p=0.000)
16. $NCAPX_t/TA_t$	0.0041***	–0.0001	0.3732***	–5.76***	–1.77*	16.32	17.37***
	(2.43)	(–0.25)	(6.09)	(p=0.000)	(p=0.077)	(p=0.636)	(p=0.000)
17. $NCAPX_t/TA_{t-1}$	0.0051**	0.0000	0.3844***	–5.41***	–1.66*	18.35	12.83***
	(2.54)	(0.04)	(5.72)	(p=0.000)	(p=0.097)	(p=0.499)	(p=0.000)
18. $NSFA_t/K_t$	0.0787***	0.0065**	0.3990**	–4.15***	1.43	23.83	2.81***
	(3.54)	(2.56)	(2.49)	(p=0.000)	(p=0.154)	(p=0.203)	(p=0.002)
19. $NSFA_t/Kr_{t-1}$	0.2479***	0.0181**	–0.1447	–3.15***	–0.77	15.94	2.80***
	(3.31)	(2.22)	(–0.43)	(p=0.002)	(p=0.422)	(p=0.661)	(p=0.002)
20. $NSFA_t/TA_{t-1}$	0.0214***	0.0008	0.3892***	–5.55***	0.75	18.00	8.11***
	(5.20)	(1.41)	(4.21)	(p=0.000)	(p=0.451)	(p=0.522)	(p=0.000)

Notes:

[a] The sample contains 4,320 UK company-year observations for the period 1999–2008. The simple Tobin's Q model of corporate investment is estimated by two-step system-GMM estimators using Stata 11. The first year observation for each company is lost because the dynamic structure of the model.

[b] Different corporate investment measures are used as the dependent variable (*INV*) in their respective regressions. The simple Tobin's *Q* model is specified as $INV_{it} = \alpha_0 + \alpha_1 Q_{it} + \alpha_2 INV_{it-1} + \varepsilon_{it}$.

We also control for time effects by adding a set of year dummy variables. The instruments used for the regression include *Constant*, *Year dummies*, Q_t, $INV_{t-3 \ldots t-5}$, Δ*Year dummies*, ΔQ_t, and ΔINV_{t-2}.

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

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

[e] The 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.

[f] To check for AR(1) in levels, look for AR(2) in differences, in 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.

[g] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.

[h] *F*-statistic for the regression which tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Although it is well known that Tobin's Q has severe measurement problems (see, for example, Erickson and Whited, 2000), the distinct empirical results obtained by regressing different corporate investment measures on the same proxy Tobin's Q clearly illustrate that the choice of corporate investment measures, to a considerable extent, influences the conclusions drawn from empirical analyses.

In spite of the inconsistent results obtained regarding the association between corporate investment and Tobin's Q, the estimation results reported in Table 5.4 exhibit a number of features which are of particular interest. First, both accrual based and cash based gross corporate investment measures, apart from $GINV_t/TA_t$, seem to be positively influenced by the proxy of Tobin's Q. Second, the association between Tobin's Q and net corporate investment appears to be negative, with only one exception, i.e. $NCAPX_t/TA_{t-1}$. However, the association between Tobin's Q and net corporate investment is rather weak and is not significant at the usual significance levels. Moreover, the cash based measures of net spending on fixed assets, namely, $NSFA_t/K_t$, $NSFA_t/Kr_{t-1}$ and $NSFA_t/TA_{t-1}$, are uniformly and positively related to the proxy for Tobin's Q. Accordingly, the differences in estimation results across regression suggest that Tobin's Q performs better in explaining variations in gross corporate investment than those in net corporate investment. Besides, it is also shown that corporate investment behaviour is likely to be a dynamic process as indicated by the positive and significant coefficients found for the lagged corporate investment variables in most of the regressions.

After estimating the Tobin's *Q* model using two-step system-GMM estimators, we carry out a number of conventional diagnostic tests. We test both first-order and second-order serial correlation of the first-differenced errors using Arellona-Bond tests. In addition, we test the validity of the instruments used in both the levels and the differenced equations using the Hansen overidentifying restrictions test. The diagnostic test results reported in Table 5.4 suggest that the Tobin's *Q* model of corporate investment is well specified and the instruments used to implement the system-GMM estimation are generally valid. Therefore, it is satisfactory for us to estimate Equation 5.1 using system-GMM estimators.

5.5.3 Robustness tests and results

To check the robustness of the system-GMM estimation results, we first re-estimate Equation 5.1 using an alternative econometric method for dynamic panel data, i.e. the difference-GMM estimators developed by Arellano and Bond (1991). The difference-GMM estimation results presented in Appendix 5.E confirm that the conclusions drawn from the simple regression of the Tobin's *Q* model is indeed sensitive to the choice of corporate investment measures. The sensitivity of empirical results to the choice of corporate investment measures is, therefore, robust with respect to different estimation techniques.

Second, we re-specify the standard Tobin's *Q* model by excluding the lagged corporate investment measure from Equation 5.1. The system-GMM estimation results for the re-specified Tobin's *Q* model of corporate investment are presented in Appendix 5.F. Again, the results presented in Appendix 5.F are similar to those reported in Table 5.4 in terms of the signs and the significance levels of the coefficients on the proxy for Tobin's *Q*. However, the results of Arellona-Bond test for second-order serial correlation of the first-differenced errors reported in Appendix 5.F are statistically significant with only two exceptions, suggesting that without considering the dynamic structure of corporate investment, the Tobin's *Q* model is potentially misspecified.

Furthermore, given the fact that the empirical measure of Tobin's *Q* is also subject to considerable measurement error, we also construct an alternative proxy for Tobin's *Q* using market-to-book value of common equity. Equation 5.1 is then re-estimated with the alternative proxy for Tobin's *Q*. The system-GMM estimation results are reported in Appendix 5.G. The results show that our findings are also robust with respect to alternative proxies for Tobin's *Q*.

5.5.4 Conclusion

Overall, an important lesson to be learned from this illustrative example is that that various corporate investment measures behave rather differently in empirical analyses. As a consequence, the results of empirical analyses exhibit high sensitivity to the choice of corporate investment measures. More precisely, distinct conclusions with respect to companies' investment behaviour are likely to be drawn when different measures of corporate investment are used in analyses. Therefore, Hypothesis 1 that the choice of corporate investment measures has no significant impact on the conclusions drawn from empirical analyses should be firmly rejected based on our evidence. In addition, it is also plausible to argue that the inconsistent empirical findings from the existing literature on corporate investment may, at least partially, be attributable to the differences in measuring corporate investment behaviour. Therefore, the measurement of corporate investment behaviour does indeed matter.

5.6 Trend analysis

The empirical evidence obtained from the preliminary analysis and the illustrative example clearly shows that various corporate investment measures tend to behave differently and yield qualitatively dissimilar results in empirical analyses. Therefore, it is desirable to evaluate the relative performance of the corporate investment measures from different perspectives. This section assesses the predictability of the alternative measures by examining their volatilities around their respective underlying trends. Corporate investment measures that contain low levels of noise are expected to be less volatile around their respective trends and thus are relatively more predictable, whereas those containing higher levels of noise are expected to exhibit high volatility, making them less predictable.

5.6.1 Empirical procedures

To carry out the trend analysis, we simply regress the various corporate investment measures on an artificial time trend variable in separate regressions. To capture the possible nonlinear trend of corporate investment behaviour, we also add a quadratic term of the time trend variable to the regression. In addition, a lagged corporate investment measure is also included to capture the dynamic structure of companies' investment behaviour. We do not attempt to estimate the "best" investment equation by controlling other explanatory variables, because the most commonly used explanatory variables in investment equations, such as Tobin's Q and cash flow, are also subject to considerable measurement errors. In order to allow us to focus directly on the empirical performance of the corporate investment measures, we estimate a trend regression model which is specified as follows,

$$INV_{it} = \alpha_0 + \alpha_1 T_t + \alpha_2 T_t^2 + \alpha_3 INV_{it-1} + \varepsilon_{it} \tag{5.2}$$

where INV represents corporate investment measure, T represents a time trend, T^2 represents the quadratic term of the time trend variable, and ε represents the error term. The time trend variables T and T^2, alongside the autoregressive term INV_{-1}, are expected to capture the trend underlying corporate investment behaviour, leaving the random noise in the error term ε.

Based on the residuals obtained from the trend regressions, a number of statistics can be calculated to quantify the volatility of each corporate investment measure around its underlying trend, which can then be used to evaluate the level of noise contained in the corporate investment measure. More specifically, for each corporate investment measure, its volatility around the underlying trend is measured by the corresponding root mean square error which can be computed as follows,

$$\mathrm{RMSE} = \sqrt{\frac{\sum (INV_{it} - I\hat{N}V_{it})^2}{N}} \tag{5.3}$$

where RMSE represents the root mean square error, INV and $I\hat{N}V$ represent the observed and fitted value of corporate investment measures respectively and N represents the total sample size. According to its definition, the RMSE aggregates the individual residuals into a single measure of volatility around the underlying trend for each of the corporate investment measures. For unbiased estimators, the RMSE can be considered as the standard error of the residuals from the trend regression. Like the standard error, the RMSE is on the same scale as the observed variable, and thus it cannot be used to compare the volatilities across various corporate investment measures with different scales. Hyndman and Koehler (2006) point out that the RMSE of a regression must be understood in the context of the mean of the observed variable. Accordingly, we further calculate the coefficient of variation of the root mean square error for each of the corporate investment measures by scaling the RMSE with the corresponding absolute mean of the corporate investment measures. The coefficient of variation of the root mean square error is a similar concept to the coefficient of variation, and is defined as follows,

$$\mathrm{CV(RMSE)} = \frac{\mathrm{RMSE}}{\left| I\bar{N}V \right|} \tag{5.4}$$

where CV(RMSE) represents the coefficient of variation of the root mean square error, and $\overline{INV}$ represents the mean of the observed corporate investment measure. Thus, the CV(RMSE) is a dimensionless statistic which can be used to compare the volatilities of various corporate investment measures around their respective trends. It is worth noting that, like the coefficient of variation, the usefulness of the coefficient of variation of the root mean squared error is limited when the mean value of the observed variable is close to zero.

5.6.2 Empirical results

Table 5.5 presents the system-GMM estimation results of the trend regression specified as Equation 5.2 for each of the corporate investment measures. As is evident, the time trend variables are highly significant in their linear as well as quadratic forms in almost all regressions. Estimated coefficients for the linear time trend term are uniformly negative, whereas those for the quadratic term are consistently positive, indicating that corporate investment behaviour trends around a U-shaped curve over the period 1999–2008. In addition, the autoregressive term turns out to be positive in all of the regressions, and statistically significant in most cases, suggesting the existence of a dynamic structure in corporate investment behaviour. Moreover, the results of the diagnostic tests for the trend regressions also suggest that the model specification is reasonably well and the instruments used are generally valid. Therefore, the residuals from the estimated trend regressions can be satisfactorily used to assess the level of noise contained in the corporate investment measures.

Table 5.5: System-GMM estimation results for the trend regression of corporate investment measures[a]

Investment measure[b]	*Constant*	*T*	T^2	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]
1. $GINV_t/K_t$	0.1759***[c]	–0.0460***	0.0044***	0.6739***	–5.42***	1.47	21.03	28.34***
	(3.50)[d]	(–5.08)	(6.05)	(4.56)	(*p*=0.000)	(*p*=0.142)	(*p*=0.335)	(=0.000)
2. $GINV_t/K_{t-1}$	0.5533***	–0.1140***	0.0101***	0.2203	–3.41***	0.11	17.41	24.52***
	(5.67)	(–5.94)	(6.64)	(1.39)	(*p*=0.000)	(*p*=0.911)	(*p*=0.562)	(*p*=0.000)
3. $GINV_t/Kr_t$	0.1855***	–0.0423***	0.0037***	0.5623***	–6.25***	2.66	20.29	32.54***
	(4.70)	(–5.53)	(6.35)	(5.15)	(*p*=0.000)	(*p*=0.008)	(*p*=0.377)	(*p*=0.000)
4. $GINV_t/Kr_{t-1}$	0.4160***	–0.0887***	0.0071***	0.2793***	–5.69***	0.68	20.75*	22.19***
	(7.27)	(–6.36)	(6.76)	(2.99)	(*p*=0.000)	(*p*=0.499)	(*p*=0.088)	(*p*=0.000)
5. $GINV_t/TA_t$	0.0702***	–0.0113***	0.0009***	0.1947	–3.51***	0.14	27.06	11.85***
	(5.33)	(–4.71)	(5.03)	(1.33)	(*p*=0.000)	(*p*=0.889)	(*p*=0.103)	(*p*=0.000)
6. $NINV_t/K_t$	0.1400***	–0.0644***	0.0056***	0.2837*	–3.83***	–0.86	17.76	26.32***
	(3.78)	(–4.79)	(5.50)	(1.89)	(*p*=0.000)	(*p*=0.391)	(*p*=0.539)	(*p*=0.000)
7. $NINV_t/K_{t-1}$	0.3416***	–0.1126***	0.0094***	0.0635	–3.15***	–0.54	15.63	31.96***
	(5.69)	(–6.05)	(6.55)	(0.44)	(*p*=0.002)	(*p*=0.587)	(*p*=0.682)	(*p*=0.000)
8. $NINV_t/TA_{t-1}$	0.0710***	–0.0232***	0.0019***	0.0320	–3.19***	–1.19	20.69	28.19***
	(5.89)	(–6.35)	(6.87)	(0.26)	(*p*=0.001)	(*p*=0.234)	(*p*=0.354)	(*p*=0.000)
9. $GCAPX_t/K_t$	0.1880***	–0.0125***	0.0012***	0.2581***	–4.56***	–0.89	24.29	8.64***
	(6.19)	(–2.61)	(3.04)	(2.69)	(*p*=0.000)	(*p*=0.375)	(*p*=0.186)	(*p*=0.000)
10. $GCAPX_t/K_{t-1}$	0.2932***	–0.0443***	0.0039***	0.2087***	–4.87***	–2.48**	19.45	20.32***
	(7.58)	(–5.12)	(5.69)	(2.63)	(*p*=0.000)	(*p*=0.013)	(*p*=0.428)	(*p*=0.000)

Investment measure[b]	*Constant*	*T*	T^2	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]
11. $GCAPX_t/Kr_t$	0.2133***	–0.0244***	0.0018***	0.2840***	–4.76***	–1.34	20.67	27.68***
	(8.52)	(–5.78)	(5.60)	(3.67)	(*p*=0.000)	(*p*=0.179)	(*p*=0.355)	(*p*=0.000)
12. $GCAPX_t/Kr_{t-1}$	0.3006***	–0.0417***	0.0030***	0.2108**	–4.33***	–1.36	29.36*	21.13***
	(7.67)	(–5.20)	(4.99)	(2.51)	(*p*=0.000)	(*p*=0.174)	(*p*=0.061)	(*p*=0.000)
13. $GCAPX_t/TA_t$	0.0268***	–0.0019	0.0001	0.5274***	–5.50***	–0.99	24.51	60.94***
	(2.98)	(–1.20)	(1.15)	(5.92)	(*p*=0.000)	(*p*=0.321)	(*p*=0.177)	(*p*=0.000)
14. $GCAPX_t/TA_{t-1}$	0.0535***	–0.0079***	0.0006***	0.3853***	–5.13***	–1.00	27.02	69.82***
	(5.01)	(–3.63)	(3.76)	(4.79)	(*p*=0.000)	(*p*=0.318)	(*p*=0.104)	(*p*=0.000)
15. $NCAPX_t/K_{t-1}$	0.0077	–0.0092	0.0008	0.4946***	–4.75***	–0.63	39.97***	27.80***
	(0.25)	(–0.87)	(1.01)	(4.24)	(*p*=0.000)	(*p*=0.527)	(*p*=0.003)	(*p*=0.000)
16. $NCAPX_t/TA_t$	0.0117**	–0.0046***	0.0004***	0.3892***	–5.83***	–2.71***	19.30	47.76***
	(2.58)	(–3.18)	(3.66)	(6.50)	(*p*=0.000)	(*p*=0.000)	(*p*=0.438)	(*p*=0.000)
17. $NCAPX_t/TA_{t-1}$	0.0123**	–0.0044***	0.0004***	0.3899***	–5.40***	–1.59	21.33	33.97***
	(2.28)	(–2.64)	(3.08)	(5.73)	(*p*=0.000)	(*p*=0.111)	(*p*=0.319)	(*p*=0.000)
18. $NSFA_t/K_t$	0.0685*	–0.0083	0.0009	0.4433**	–3.79***	1.50	22.92	3.43***
	(1.69)	(–0.83)	(1.18)	(2.33)	(*p*=0.000)	(*p*=0.134)	(*p*=0.241)	(*p*=0.017)
19. $NSFA_t/Kr_{t-1}$	0.3772***	–0.0659***	0.0052***	0.0286	–1.40	–0.38	16.77	2.90***
	(2.91)	(–2.61)	(2.71)	(0.08)	(*p*=0.163)	(*p*=0.705)	(*p*=0.605)	(*p*=0.035)
20. $NSFA_t/TA_{t-1}$	0 .0352***	–0.0065**	0.0005**	0 .3885***	–5.10***	0.74	16.60	20.95***
	(3.16)	(–2.35)	(2.56)	(3.68)	(*p*=0.000)	(*p*=0.457)	(*p*=0.671)	(*p*=0.000)

Notes:

[a.] The sample contains 4,320 UK company-year observations for the period 1999–2008. The trend regressions are estimated by two-step system-GMM estimators using Stata 11. The first year observation for each company is lost because the dynamic structure of the model.

[b.] Different corporate investment measures are used as the dependent variable in their respective time trend regressions. The time trend regression is specified as $INV_{it} = \alpha_0 + \alpha_1 T_t + \alpha_2 T_t^2 + \alpha_3 INV_{it-1} + \varepsilon_{it}$.

The instruments used for the regression include *Constant*, *T*, T^2, $INV_{t-3\ldots t-5}$, ΔT, ΔT^2, and ΔINV_{t-2}.

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

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

[e.] The 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.

[f.] To check for AR(1) in levels, look for AR(2) in differences, in 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.

[g.] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.

[h.] *F*-statistic for the regression which tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Based on the residuals obtained by estimating the trend regression as specified in Equation 5.2, the RMSE, absolute mean and CV(RMSE) for each of the corporate investment measures are calculated and reported in Table 5.6. In addition, according to their respective CV(RMSE)s, the corporate investment measures are ranked from lowest volatility to highest volatility. Several features of these results are of particular interest.

First, corporate investment measures in the highest ranked (lowest volatility) group are without exception gross investment measures, and those in the lowest ranked (highest volatility) group are all net investment measures. This finding suggests that the gross corporate investment measures are systematically less volatile around their respective trends than the net corporate investment measures. Our results indicate that if depreciated capital goods are taken into account, corporate investment behaviour becomes more volatile and thus less predictable. The excess volatility of the net corporate investment measures over the gross investment measures is directly attributable to the depreciation component which is potentially subject to managers' opportunistic manipulation. Our empirical evidence, therefore, lends strong support to the prediction that net corporate investment measures, which are jointly determined by gross investment and depreciation expense, are noisier than gross corporate investment measures, and thus Hypothesis 3 should be firmly rejected. However, the high CV(RMSE) values for the net corporate investment measures may also be attributable to their low mean values, and therefore the results should be interpreted with caution.

Table 5.6: Coefficients of variation of the root mean square error of the corporate investment measures[a]

INV measure	RMSE[b]	Absolute mean of *INV*	CV(RMSE)[c]	Rank[d]
1. $GINV_t/K_t$	0.3011	0.2772	1.0862	7
2. $GINV_t/K_{t-1}$	0.5881	0.3683	1.5968	11
3. $GINV_t/Kr_t$	0.2278	0.2144	1.0625	6
4. $GINV_t/Kr_{t-1}$	0.4033	0.2773	1.4544	10
5. $GINV_t/TA_t$	0.0682	0.0560	1.2179	9
6. $NINV_t/K_t$	0.2977	0.0113	26.3451	20
7. $NINV_t/K_{t-1}$	0.3571	0.0722	4.9460	17
8. $NINV_t/TA_{t-1}$	0.0828	0.0186	4.4516	15
9. $GCAPX_t/K_t$	0.1465	0.2281	0.6423	1
10. $GCAPX_t/K_{t-1}$	0.2248	0.2506	0.8970	5
11. $GCAPX_t/Kr_t$	0.1619	0.2076	0.7799	3
12. $GCAPX_t/Kr_{t-1}$	0.2662	0.2375	1.1208	8
13. $GCAPX_t/TA_t$	0.0341	0.0501	0.6806	2
14. $GCAPX_t/TA_{t-1}$	0.0453	0.0566	0.8004	4
15. $NCAPX_t/K_{t-1}$	0.2113	0.0114	18.5351	19
16. $NCAPX_t/TA_t$	0.0337	0.0065	5.1846	18
17. $NCAPX_t/TA_{t-1}$	0.0405	0.0090	4.5000	16
18. $NSFA_t/K_t$	0.3099	0.1293	2.3968	13
19. $NSFA_t/Kr_{t-1}$	0.6921	0.2347	2.9489	14
20. $NSFA_t/TA_{t-1}$	0.0614	0.0365	1.6822	12

Notes:

[a] The sample contains 4,320 UK company-year observations for the period 1999–2008. The residuals are obtained by estimating the trend regressions specified as Equation 5.2 using two-step system-GMM estimators.

[b] The root mean square error, which is defined as the square root of the mean square error (see Equation 5.3).

[c] The coefficient of variation of the root mean square error, which is defined as the ratio of the root mean square error to the absolute mean of the observed values (see Equation 5.4).

[d] The corporate investment measures are ranked based on their coefficients of variation of the root mean square error, from lowest volatility to highest volatility around their respective trends.

Second, the statistics reported in Table 5.6 show that cash based corporate investment measures do not exhibit higher levels of volatility around their respective trends than do their accrual based counterparts. Although accrual based accounting figures are typically considered as smoothed measures of cash flow based accounting figures since they are supposed to mitigate the timing and mismatching problems of cash flows, we do not find empirical evidence that accrual based corporate investment measures are systematically less noisy than cash based measures. Surprisingly, for gross corporate investment measures, cash based measures appear to be systematically less volatile around their respective trends than accrual based measures, as indicated by the CV(RMSE)s. This is largely due to the fact that accrual based measures of corporate investment, according to accounting standards, take asset revaluations and writedowns as well as disinvestments into account, which introduce additional fluctuations into these measures. On the other hand, cash based measures focus on the amount of funds spent by a company on its fixed assets and are not affected by the amount of disinvestment, and therefore behave relatively stable over time. According to our results, we do not find any empirical evidence that cash based corporate investment measures are nosier than their accrual based counterparts, and thus Hypothesis 2 cannot be rejected.

Third, the results presented in Table 5.6 also show that the cash based measures of net spending on fixed assets (i.e. $NSFA_t / K_t$, $NSFA_t / Kr_{t-1}$ and $NSFA_t / TA_{t-1}$), which take into account the revenue from the sales of fixed assets, are more volatile than gross corporate investment measures due to the additional volatilities brought in by disinvesting activities. However, they are less volatile than the net corporate investment measures, indicating that depreciation which may opportunistically manipulated by management is the most volatile and unpredictable component in measuring corporate investment behaviour, although it has been conventionally considered as a process of smoothly allocating the cost of a tangible fixed asset over its useful life.

5.6.3 Robustness tests and results

To assess the robustness of our trend analysis results, we also carry out further estimation and testing procedures to gauge the sensitivity of our results with respect to the measurement of volatility, estimation techniques and model specifications.

First, instead of using the RMSE, we calculate the mean absolute error (MAE) to measure the volatilities of the corporate investment measures around their respective trends. Hyndman and Koehler (2006) highlight an attractive additional property of the MAE that it is less sensitive to outliers compared to the RMSE. As shown in Appendix 5.H, the results based on the MAE are consistent with those based on the RMSE reported in Table 5.6. Although the orders of corporate investment measures ranked by different statistics are slightly different, our conclusions drawn from the trend analysis remain hold.

Second, we re-estimate the trend regression model specified as Equation 5.2 using difference-GMM estimators. The difference-GMM estimation results reported in Appendix 5.I are similar to those obtained from system-GMM estimation in terms of the signs and significant levels of the estimated coefficients. As can be seen from Appendix 5.J, the ranking of the corporate investment measures based on the difference-GMM estimation residuals are also generally consistent with our earlier evidence presented in Table 5.6.

Third, we examine how robust the results of trend analysis are with respect to the specification of the lag structure of the corporate investment measure in the regressions. In addition to the lagged dependent variable (INV_{-1}), we also include a corporate investment measure which is lagged twice (INV_{-2}) as an additional explanatory variable. The coefficients estimated for the additional lagged dependent variable are statistically insignificant in most of the regressions. Meanwhile, the inclusion of the additional lagged dependent variable also suppresses the explanatory power of other explanatory variables. However, the ranking of the corporate investment measures produced under this alternative specification of lag structure is largely consistent with our main results reported in Table 5.6. It is also found that corporate investment measures lagged beyond two periods have little explanatory power in all of the regressions.

Besides, we also estimate a trend regression in which the time trend is included only as a linear term rather than as linear and quadratic terms. We find that the linear time trend term becomes statistically insignificant when the quadratic term is ignored, which suggests that the underlying trend of corporate investment behaviour over the period under investigation is indeed nonlinear.

5.6.4 Conclusion

In summary, the trend analysis of the corporate investment measures shows that the investment behaviour of UK-listed companies follows a U-shaped trend over the period

1999–2008. It is found that the gross investment measures are systematically less volatile around their respective trends, and thus are less noisy than the net investment measures. The excess volatility of net investment measures is largely due to the noise contained in depreciation expense which is subject to opportunistic manipulation by management. However, our empirical results do not show any evidence that cash based measures contain higher levels of noise than do their accrual based counterparts. In fact, it is suggested that cash based gross investment measures exhibit the lowest volatilities around their respective trends among the alternatives. The trend analysis results presented in this section are robust with respect to the measurement of volatility, model specification and estimation techniques.

5.7 Information content analysis

We turn now to the information content of the corporate investment measures. Information content analysis has been used extensively in accounting studies to address different research questions (see Biddle *et al.*, 1995). However, few previous studies have applied information content comparisons in the field of corporate investment. Two exceptions are Park and Pincus (2003) and Kerstein and Kim (1995), who explicitly examine the incremental information about a company's future earnings provided by capital expenditures which is not captured by current earnings. To the best of our knowledge, no attempt has been made to provide a comparison of the information content of the alternative corporate investment measures. To fill the gap, this section examines whether the alternative corporation investment measures yield value relevant information which is incremental to that of current earnings; and if they do, which measures have the greatest value relevant incremental information content.

5.7.1 Incremental and relative information content

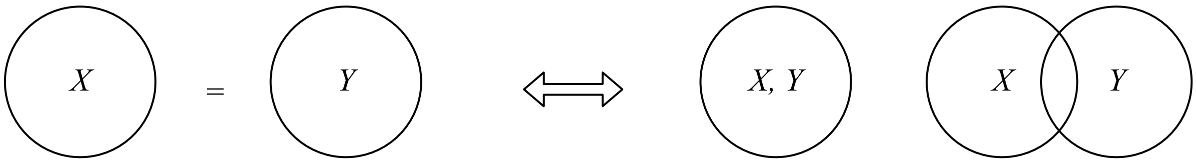
There are two types of information content analysis, namely, relative information content analysis and incremental information content analysis. Adam and Goyal (2008) indicate that incremental comparison is useful in determining whether one variable provides information beyond that provided by another, while relative comparison is useful in determining which variable has the greatest information content among the alternatives.[51]

The logical relations between the relative and incremental information content comparisons of two variables (say *X* and *Y*, for example) can be illustrated by the Venn diagrams presented in Figure 5.1, which adopted from Biddle *et al.* (1995). The areas covered by the circles, as defined by Biddle *et al.* (1995), represent the proportion of variation in a dependent variable explained by predictor variables *X* and *Y*, i.e. the relative information content of the two predictor variables with respect to the dependent variable. The left hand column of Figure 5.1 portrays three possible relationships between the relative information contents of *X* and *Y*, while the right hand column portrays the corresponding possible relationships between *X* and *Y* in terms of their incremental information content with respect to each other.

[51] Biddle *et al.* (1995) also point out that relative information content analysis applies when making mutually exclusive choices among alternatives, or when rankings by information content are desired.

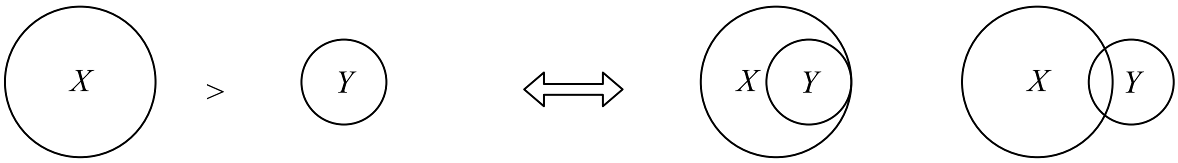
Figure 5.1: Logical relation between incremental and relative information content of two variables[a]

Panel A: X and Y have equal relative information content[b]



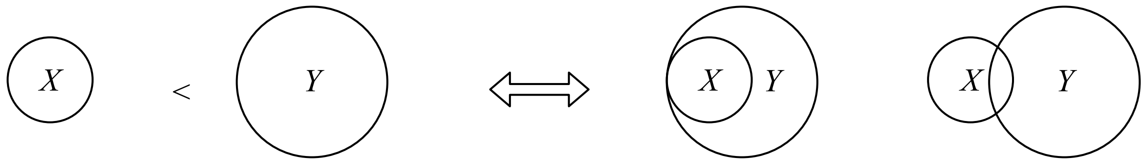
X and *Y* have equal relative information content	Neither *X* or *Y* is incremental	Both *X* and *Y* are incremental

Panel B: X has larger relative information content than Y



X has larger relative information content than *Y*	Only *X* is incremental	Both *X* and *Y* are incremental

Panel C: X has smaller relative information content than Y



X has smaller relative information content than *Y*	Only *Y* is incremental	Both *X* and *Y* are incremental

Notes:

[a.] Adopted from Biddle *et al.* (1995), Figure 1 on page 4.

[b.] Areas covered by circles represent variation in a dependent variable explained by predictor variables *X* and *Y*.

Variables *X* and *Y* depicted in Panel A of Figure 5.1 have equal relative information content as indicated by the equal size of the two circles (i.e. *X* = *Y*). If the information content provided by the two variables is exactly the same, then the two circles coincide and neither *X* or *Y* is incremental with respect to each other (i.e. $X \cup Y = X = Y$). But if they provide different sets of information related to the dependent variable, both of them are incremental. This is because the information content of *X* and *Y* together is greater than that of one variable alone (i.e. $X \cup Y > X$ and $X \cup Y > Y$). The intersection of the two circles (i.e. $X \cap Y$) represents the overlapping information contained in both *X* and *Y*, which can be quantified by the correlation between *X* and *Y*. The area in *Y* but not in *X* represents the incremental information content provided by *Y* beyond that provided by *X*, and vice versa.

In Panel B of Figure 5.1, the size of the circle for *X* is larger than that for *Y*, indicating that variable *X* has greater relative information content than *Y* (i.e. $X > Y$). There are also two possible incremental information content outcomes. If *Y* is a subset of *X* (i.e. $Y \subset X$), then the information content provided by *Y* is already included in *X* and therefore only *X* is incremental. However, as long as *Y* is not entirely included in *X*, then both variables *X* and *Y* are incremental. In this case, although *Y* has smaller relative information content, it also provides additional information content beyond that provided by *X*, contributing to the information content of the union of the two variables. Similarly, Panel C of Figure 5.1 portrays the relationship between relative and incremental information content under the condition that *X* has smaller relative information content than *Y*.

To sum up, the relationships between relative and incremental information are not a one-to-one correspondence. Each relative information content condition can be matched to at least two incremental outcome conditions as shown in each of the panels of Figure 5.1. The relative information content of a variable is determined by its explanatory power for the variability of the dependent variable, which can be visualised by the size of a circle in Figure 5.1, while the variable's incremental information content with respect to another variable is determined by the additional explanatory power it provides, as reflected by the position of the circle relative to another circle.

5.7.2 Empirical procedures

In the context of corporate finance, it is generally believed that changes in corporate investment yield information about the changes in a company's future prospects that is not captured by the company's unexpected current earnings (see Park and Pincus, 2003; and Kerstein and Kim, 1995). It is argued that, if the capital market is strong form efficient, corporate investment decisions would not be value relevant, because the information based on which investment decisions are made should be fully available to the capital market and appropriately reflected in the security prices. However, in the real world, where information asymmetry exists, managers know more than outsiders about a company's future prospects, and they may use their private information to make corporate investment decisions. Under such circumstances, unexpected changes in corporate investment would signal managers' private information, such as the availability of valuable investment opportunities to the company and the growth opportunities of the industry, to the capital market. Therefore, Kerstein and Kim (1995) predict that, because managers may respond to the private information about their company's future prospects through their investment decisions, unexpected corporate investments are expected to be reflected in the company's stock returns in a forward-looking capital market, providing value relevant information beyond that provided by the company's current earnings.

To formally assess the information content of the alternative corporate investment measures, we adopt the regression-based methodology developed by Biddle *et al.* (1995). Specifically, we first examine whether corporate investment measures provide value relevant information content beyond that of current earnings by regressing market adjusted return on unexpected current earnings and unexpected corporate investment. More specifically, we estimate the regression model specified as follows,

$$MAR_{it} = \beta_0 + \beta_1 UEPS_{it} + \beta_2 UINV_{it} + e_{it} \tag{5.5}$$

where MAR_{it} denotes market adjusted return for company i over year t, which is calculated as the sum of capital gains and dividend incomes per share deflated by the share price at the beginning of the period, and then adjusted to the stock market return over the same period; $UEPS_{it}$ denotes unexpected earnings per share of company i's common stock in year t scaled by the beginning of the period share price; and $UINV_{it}$ denotes unexpected change in the measure of investment ratio for company i in year t. Following the previous studies of Park and Pincus (2003) and Kerstein and Kim (1995), we assume that both earnings per share and corporate investment follow a random walk process, so that the entire change in these two variables from one period to the next is considered as unexpected change.

The model specified in Equation 5.5 first tests whether changes in corporate investment provide information about company's future earnings growth opportunities in the presence of current earnings surprises, by examining the sign and significance level of the coefficient estimated for *UINV* (Kerstein and Kim, 1995). If the measures of corporate investment do indeed provide incremental value relevant information after controlling for the unexpected changes in earnings per share, the coefficient estimated for the changes incorporate investment variable is expected to be positive and statistically significant.

If unexpected corporate investment is incremental with respect to unexpected current earnings, our primary focus will be shifted to the comparison of the relative information content of the alternative corporate investment measures. The corporate investment measures that have greater relative information content are expected to be statistically more significant in their respective regressions. The significance level of the unexpected corporate investment variable in the regression model can be tested using the Wald test. Under the Wald test, the null hypothesis that unexpected corporate investment is not informative should be rejected more resoundingly if the corporate investment measure being tested has greater information content on a relative scale. Therefore, the information content of the corporate investment measures can be ranked based on their respective Wald test results.

5.7.3 Empirical results

The system-GMM estimation results for the regression of market adjusted returns on unexpected earnings and unexpected corporate investment, as specified in Equation 5.5, are reported in Table 5.7. As expected, the coefficients estimated for *UEPS* are highly significant in all regressions, indicating that unexpected current earnings have significant explanatory power for the market adjusted returns. More importantly, it is found that changes in corporate investment measures have the predicted positive sign everywhere and are statistically significant in 19 out of 20 regressions. The significantly positive coefficients found for *UINV* clearly show that unexpected corporate investment does indeed provide value relevant information which is incremental to that provided by current earnings. We, therefore, conclude that unexpected current earnings and unexpected corporate investment are incremental with respect to each other, and market adjusted returns are sensitive to both of them. The results presented in Table 5.7 are highly consistent with the theoretical argument as well as the empirical evidence provided by previous studies (see, for example, Park and Pincus, 2003; and Kerstein and Kim, 1995). Besides, results of the Arellona-Bond test for serial correlations and the Hansen test for overidentifying restrictions reported in Table 5.7 suggest that the model used to assess the information content of corporate investment measures is well specified, and the instruments used to implement the system-GMM estimation are generally valid.

Table 5.7: System-GMM estimation results for the regression of stock returns on unexpected earnings and unexpected corporate investment[a]

Investment measure[b]	*Constant*	*UEPS*	*UINV*	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]	Wald test[i]	Rank[j]
1. $GINV_t/K_t$	0.0498***[c]	0.7802***	0.0985**	–11.92***	–1.52	66.64	22.90	4.71**	17
	(2.76)[d]	(7.19)	(2.17)	(0.000)	(0.128)	(0.230)	(*p*=0.000)	(*p*=0.031)	
2. $GINV_t/K_{t-1}$	0.0493***	0.777***	0.0614**	–11.88***	–1.52	66.31	22.97	6.66**	15
	(2.70)	(7.34)	(2.58)	(0.000)	(0.127)	(0.239)	(*p*=0.000)	(*p*=0.010)	
3. $GINV_t/Kr_t$	0.0446**	0.7506***	0.1494**	–11.97***	–1.58	66.93	22.20	6.10**	16
	(2.48)	(7.08)	(2.47)	(0.000)	(0.114)	(0.223)	(*p*=0.000)	(*p*=0.014)	
4. $GINV_t/Kr_{t-1}$	0.0419**	0.7459***	0.0966***	–11.94***	–1.52	62.66	21.70	8.70***	14
	(2.25)	(6.98)	(2.95)	(0.000)	(0.128)	(0.347)	(*p*=0.000)	(*p*=0.003)	
5. $GINV_t/TA_t$	0.0490***	0.7544***	0.2277	–11.87***	–1.61	49.11	23.32	1.39	20
	(2.72)	(7.00)	(1.18)	(0.000)	(0.107)	(0.817)	(*p*=0.000)	(*p*=0.239)	
6. $NINV_t/K_t$	0.0482**	0.7524***	0.1520***	–11.97***	–1.63	70.55	23.01	10.50***	12
	(2.56)	(6.69)	(3.24)	(0.000)	(0.103)	(0.144)	(*p*=0.000)	(*p*=0.001)	
7. $NINV_t/K_{t-1}$	0.0535***	0.7573***	0.1427***	–11.98***	–1.61	65.51	25.22	14.82***	7
	(2.90)	(6.89)	(3.85)	(0.000)	(0.107)	(0.261)	(*p*=0.000)	(*p*=0.000)	
8. $NINV_t/TA_{t-1}$	0.0528***	0.7500***	0.5329***	–11.91***	–1.60	58.60	24.46	11.16***	10
	(2.98)	(6.96)	(3.34)	(0.000)	(0.110)	(0.490)	(*p*=0.000)	(*p*=0.001)	
9. $GCAPX_t/K_t$	0.0557***	0.6836***	0.3982***	–11.78***	–1.57	83.16**	19.73	13.54***	9
	(2.85)	(6.28)	(3.68)	(0.000)	(0.116)	(0.021)	(*p*=0.000)	(*p*=0.000)	
10. $GCAPX_t/K_{t-1}$	0.0457**	0.7354***	0.3294***	–11.02***	–1.61	70.10	23.77	25.70***	1
	(2.37)	(6.94)	(5.07)	(0.000)	(0.1074)	(0.152)	(*p*=0.000)	(*p*=0.000)	

Investment measure[b]	*Constant*	*UEPS*	*UINV*	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]	Wald test[i]	Rank[j]
11. $GCAPX_t/Kr_t$	0.0453** (2.30)	0.6593*** (6.13)	0.5068*** (4.32)	–11.82*** (0.000)	–1.66* (0.097)	77.64* (0.052)	21.50 (p=0.000)	18.66*** (p=0.000)	3
12. $GCAPX_t/Kr_{t-1}$	0.0508** (2.57)	0.6676*** (6.44)	0.2734*** (4.15)	–11.86*** (0.000)	–1.66* (0.096)	75.61* (0.071)	20.40 (p=0.000)	17.22*** (p=0.000)	5
13. $GCAPX_t/TA_t$	0.0551*** (3.04)	0.7063*** (6.67)	0.9042** (2.13)	–11.89 *** (0.000)	–1.53 (0.126)	54.30 (0.649)	20.69 (p=0.000)	4.54** (p=0.034)	18
14. $GCAPX_t/TA_{t-1}$	0.0504*** (2.67)	0.6946*** (6.61)	1.5800*** (4.13)	–11.98*** (0.000)	–1.40 (0.162)	55.37 (0.610)	22.12 (p=0.000)	17.06*** (p=0.000)	6
15. $NCAPX_t/K_{t-1}$	0.0435** (2.36)	0.7019*** (6.68)	0.2825*** (4.38)	–11.82*** (0.000)	–1.56 (0.119)	71.17 (0.133)	23.36 (p=0.000)	19.18*** (p=0.000)	2
16. $NCAPX_t/TA_t$	0.0429*** (2.40)	0.7006*** (6.85)	1.6433*** (3.83)	–11.93*** (0.000)	–1.52 (0.129)	66.37 (0.237)	24.57 (p=0.000)	14.67*** (p=0.000)	8
17. $NCAPX_t/TA_{t-1}$	0.0501*** (2.76)	0.7118*** (6.93)	1.5575*** (4.24)	–11.94*** (0.000)	–1.47 (0.142)	63.82 (0.310)	24.86 (p=0.000)	17.98*** (p=0.000)	4
18. $NSFA_t/K_t$	0.0399** (2.14)	0.7595*** (6.96)	0.1580*** (3.29)	–11.87*** (0.000)	–1.44 (0.150)	70.51 (0.145)	21.06 (p=0.000)	10.82*** (p=0.001)	11
19. $NSFA_t/Kr_{t-1}$	0.0580*** (3.11)	0.6776*** (6.12)	0.0385* (1.88)	–11.82*** (0.000)	–1.66 (0.097)	67.16 (0.217)	16.93 (p=0.000)	3.53** (p=0.061)	19
20. $NSFA_t/TA_{t-1}$	0.0341* (1.80)	0.7364*** (6.86)	0.8043*** (3.21)	–11.95*** (0.000)	–1.34 (0.180)	63.01 (0.336)	20.87 (p=0.000)	10.30*** (p=0.001)	13

Notes:

[a.] The sample 4,320 contains UK company-year observations for the period 1999–2008. The model specified as Equation 5.5 is estimated by two-step system-GMM estimators using Stata 11.

[b] Unexpected change in corporate investment measures are used as an explanatory variable in their respective regressions. The regression is specified as

$$MAR_{it} = \beta_0 + \beta_1 UEPS_{it} + \beta_2 UINV_{it} + e_{it}$$

We also control for time effects by adding a set of year dummy variables. The instruments used for the regression include *Constant*, *Year dummies*, $UEPS_{t-1\ldots,t-3}$, $UINV_{t-1\ldots,t-3}$, Δ*Year dummies*, $\Delta UEPS_t$ and $\Delta UINV_t$.

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

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

[e] The 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.

[f] To check for AR(1) in levels, look for AR(2) in differences, in 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.

[g] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.

[h] *F*-statistic for the regression which tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

[i] We perform Wald test to test the null hypothesis that the coefficient on *UINV* is equal to zero. The test reports results using the *F*-statistic. The associated *p*-value is reported in parenthesis.

[j] The corporate investment measures are ranked based on their respective Wald test results from the highest informative to lowest informative.

We now focus on the relative information content of the alternative corporate investment measures. The Wald test is carried out to test the significance of the unexpected corporate investment variable in each regression. The Wald test results are reported in Table 5.7. In addition, the alternative corporate investment measures are ranked from the most informative to the least informative based on their respective Wald test results. It is found that cash based corporate investment measures are systematically more informative compared to their accrual based counterparts. This finding lends strong support to the prediction that investors are more concerned with cash flow based measures, which are less subject to distortions from differing accounting practices. The accrual based corporate investment measures, which are more likely to be distorted by the choices of discretionary accounting policies and by managers' opportunistic manipulations, are thus less relevant to company value. Therefore, our empirical evidence rejects Hypothesis 4 that cash based and accrual based corporate investment measures are equally informative, in favour of the alternative hypothesis that cash based measures are relatively more informative.

Besides, the results presented in Table 5.7 do not show any systematic difference between the gross and net corporate investment measures in terms of their value relevant information content. However, for the accrual based measures, net corporate investment measures seem to be slightly more informative than gross corporate investment measures. Overall, we do not find significant evidence that net corporate investment measures are more informative than gross corporate investment measures. Therefore, Hypothesis 5 that net corporate investment measures are as informative as their corresponding gross corporate investment measures cannot be rejected based on our empirical evidence.

5.7.4 Robustness tests and results

To ensure the robustness of the results regarding the information content of the corporate investment measures presented in this section, we carry out further estimation and testing procedures. First, we re-estimate Equation 5.5 using fixed effect estimators to determine the robustness of the results of the regression analysis with respect to changes in estimation techniques. The fixed effect estimation is implemented because the model specified in Equation 5.5 does not have a dynamic structure, and thus the econometric techniques for dynamic panel data are not required. However, we also confronted with the choice of using fixed effect or random effect estimators. As reported in Appendix 5.K, the results of Hausman test are highly significant everywhere, indicating that the fixed effect estimation should be more appropriate. The fixed effect estimation results presented in Appendix 5.K are largely consistent with our main results discussed earlier in terms of the sign and significance level of the estimated coefficients as well as the order of the corporate investment measures ranked on the basis of the Wald test results.

Second, instead of assuming a random walk process, we assume that corporate investment behaviour follows an underlying trend as modelled by Equation 5.2. Accordingly, we use the residuals obtained from estimating Equation 5.2 as an alternative measure of unexpected corporate investment. The results of information content analysis based on the alternative measures of unexpected corporate investment are presented in Appendix 5.L. Although there are some differences in the ranking of the corporate investment measures, they do not alter the conclusions drawn from our main results.

In addition to the information content analysis, we also carry out a factor analysis in an attempt to form a most informative single variable by extracting a common factor from the twenty corporate investment measures. However, it is found that the common factor extracted from the corporate investment measures does not outperform the individual measures in the highest ranked group in terms of value relevant information content.

5.7.5 Conclusion

To sum up, the information content analysis shows that corporate investment indeed provides value relevant information which is incremental to that provided by current earnings. More importantly, it is found that cash based corporate investment measures are systematically more informative than their accrual based counterparts, suggesting that investors are more concerned with cash flow based measures which are less likely to be distorted by the choices of discretionary accounting policies and by managers' opportunistic manipulations in practice. However, our results do not show a systematic difference between gross and net corporate investment measures in terms of their value relevant information content. The conclusions drawn from our information content analysis are robust with respect to various estimation techniques and alternative construction of variables.

Table 5.8: Volatility-information content matrix for corporate investment measures[a]

	Low-volatility[b]	High-volatility
High-information content[c]	$GCAPX_t/K_t$;	$NCAPX_t/K_{t-1}$;
	$GCAPX_t/K_{t-1}$;	$NCAPX_t/TA_t$;
	$GCAPX_t/Kr_t$;	$NCAPX_t/TA_{t-1}$;
	$GCAPX_t/Kr_{t-1}$;	$NINV_t/K_{t-1}$;
	$GCAPX_t/TA_{t-1}$;	$NINV_t/TA_{t-1}$;
Low-information content	$GCAPX_t/TA_t$;	$GINV_t/K_{t-1}$;
	$GINV_t/K_t$;	$NINV_t/K_t$;
	$GINV_t/Kr_t$;	$NSFA_t/K_t$;
	$GINV_t/Kr_{t-1}$;	$NSFA_t/Kr_{t-1}$;
	$GINV_t/TA_t$;	$NSFA_t/TA_{t-1}$;

Notes:

[a.] The volatility-information content matrix for corporate investment measures is constructed based on the results of trend analysis and information content analysis presented in Sections 5.6 and 5.7.

[b.] Corporate investment measures whose volatility around its underlying trend is lower than the median are defined as low-volatility measures; and the opposite as high-volatility measures.

[c.] Corporate investment measures whose information content is greater than the median are defined as high-information content measures; and the opposite as low-information content measures.

The empirical findings drawn from the information content analysis alongside those drawn from the trend analysis can be summarised in Table 5.8. Specifically, we define the corporate investment measures whose volatility around the trend is lower than the median as low-volatility measures, and the opposite as high-volatility measures. Similarly, we define the corporate investment measures whose information content is greater than the median as high-information content measures, and the opposite as low-information content measures. The corporate investment measures are then grouped based on their volatilities and value relevant information contents.

The volatility-information content matrix clearly shows that cash based gross corporate investment measures, except $GCAPX_t / TA_t$, contain less noise and provide greater value relevant information, and thus are the best performing measures among the alternatives. Both cash based and accrual based net corporate investment measures, excluding $NINV_t / K_t$, are also rather informative, but they exhibit relatively high levels of volatility around their respective underlying trends, which makes them noisy and less predictable. In contrast, accrual based gross corporate investment measures, with the exception of $GINV_t / K_{t-1}$, are found to be less volatile and thus more predictable. However, they are relatively less relevant to company value, and hence less useful in explaining variations in company value. Besides, cash based net spending on fixed assets measures are without exception characterised by high volatility and low information content, therefore are less attractive compared to the alternatives.

5.8 Concluding remarks

The use of corporate investment to capital stock ratio as a measure of corporate investment behaviour has been common practice in empirical analyses. Although the corporate investment measures are similarly constructed, they in fact vary both in terms of the numerator and the denominator. However, no attempt has been made to provide a comparison among various corporate investment measures. One claim which has been implicitly made is that different measures of corporate investment behaviour will always yield the same, or at least qualitatively similar, results in empirical analyses. As a consequence, we know little about how differently these corporate investment measures perform in empirical analyses, and the extent to which the choice of corporate investment measures may influence the conclusions drawn from empirical analyses. This chapter, therefore, aims to fill these gaps by offering the first attempt to discriminate conceptually and evaluate empirically twenty different corporate investment measures which are currently used in the literature.

We first discriminate various corporate investment measures from an accounting perspective. Given the fact that different accounting principles as well as different elements are involved in the preparation of relevant accounting items used to construct the corporate investment measures, corporate investment to capital stock ratios with different specifications are likely to carry different sets of information about a company's investing activities. Due to a lack of understanding of the financial information provided by the relevant accounting items, corporate investment measures are potentially misused in empirical analyses of corporate investment behaviour. The conflicting conclusions drawn from the existing literature on corporate investment, therefore, may also be attributable to the differences in measuring companies' investment behaviour.

Based on a balanced panel of UK-listed companies over the period 1999–2008, it is found that the corporate investment measures with different specifications are not uniformly positively correlated with one another. Significantly negative correlations are also observed among the alternatives, which appear surprising since they are supposed to measure the investment behaviour of the same batch of companies over the same period of time. Therefore, we argue that the choice of corporate investment measures is likely to have a profound impact on the conclusions drawn from the empirical analyses of corporate investment behaviour. Our argument is empirically supported by the results obtained from estimating a simple Tobin's Q model. As expected, distinct conclusions with respect to the association between Tobin's Q and companies' investment behaviour can be drawn when different corporate investment measures are employed as the dependent variable, indicating that the measurement of corporate investment behaviour does indeed matter in empirical analyses.

To evaluate the empirical performance of the alternative corporate investment measures, we carry out both trend analysis and information content analysis. The trend analysis results suggest that the gross investment measures are systematically less volatile around their respective trends, and thus are less noisy compared to the net investment measures. The excess volatility of net investment measures is largely due to the noise contained in the depreciation component which is potentially subject to managerial manipulation. Meanwhile, the information content analysis results show that cash based corporate investment measures are systematically more informative than their accrual based counterparts, suggesting that investors are more concerned with cash flow based measures which are less likely to be distorted by the choices of discretionary accounting policies and by managers' opportunistic manipulations as compared to the accrual based measures.

According to the results from both analyses, we conclude that cash based gross corporate investment to capital stock ratios are the best performing measures of corporate investments behaviour among the alternatives, as they contain relatively less noise and greater value relevant information. Researchers in the area of corporate finance, therefore, are suggested to utilise cash based gross corporate investment measures for their future empirical analyses if they have to make mutually exclusive choices among the alternatives without any particular preference. Overall, this chapter may shed some light and provide some guidance for measuring corporate investment behaviour.

Appendix 5.A: Perpetual inventory method for estimating the replacement value of capital stock

Replacement value of capital stock (*Kr*) used in this chapter is calculated on the basis on the standard perpetual inventory formula developed by Salinger and Summers (1983). Specifically, we treat book value of net property, plant and equipment (*NPPE*) as historic value of capital stock, and assume that replacement value and historic value are the same in the first year of data for each company. We then apply the perpetual inventory formula as follows:

$$L_{it} = \frac{GPPE_{it-1} + INV_{it}}{DDA_{it}} \tag{5A.1}$$

$$Kr_{it} = (INV_{it} + \frac{p_t}{p_{t-1}} Kr_{it-1}) \times (1 - 2 / L_i) \tag{5A.2}$$

where L_{it} represents the useful life of company *i*'s capital goods in year *t*; $GPPE_{t-1}$ represents book value of gross property, plant and equipment at the beginning of year *t*; INV_t represents corporate investment in year *t*; DDA_t represents accounting depreciation, depletion and amortization in year *t*; *Kr* represents the replacement value of capital stock; and p_t represents the price of investment goods, which is proxied by the implicit deflator for gross fixed capital formation obtained from UK Office for National Statistics (ONS). Since L_{it} fluctuates from year to year, we use L_i which is an average of L_{it} over time as a proxy for the useful life of company *i*'s capital goods. The amount of the capital stock depreciated each year is calculated based on the assumption that economic depreciation is double declining balance (this may result in negative replacement value of capital stock). See Salinger and Summer (1983) for the other assumptions necessary to use this method of calculation.

Appendix 5.B: Mean-comparison test results for alternative corporate investment measures[a]

Variable[b]	1. $\frac{GINV_t}{K_t}$	2. $\frac{GINV_t}{K_{t-1}}$	3. $\frac{GINV_t}{Kr_t}$	4. $\frac{GINV_t}{Kr_{t-1}}$	5. $\frac{GINV_t}{TA_t}$	6. $\frac{NINV_t}{K_t}$	7. $\frac{NINV_t}{K_{t-1}}$	8. $\frac{NINV_t}{TA_{t-1}}$	9. $\frac{GCAPX_t}{K_t}$	10. $\frac{GCAPX_t}{K_{t-1}}$	11. $\frac{GCAPX_t}{Kr_t}$	12. $\frac{GCAPX_t}{Kr_{t-1}}$	13. $\frac{GCAPX_t}{TA_t}$	14. $\frac{GCAPX_t}{TA_{t-1}}$	15. $\frac{NCAPX_t}{K_{t-1}}$	16. $\frac{NCAPX_t}{TA_t}$	17. $\frac{NCAPX_t}{TA_{t-1}}$	18. $\frac{NSFA_t}{K_t}$	19. $\frac{NSFA_t}{Kr_{t-1}}$
2. $\frac{GINV_t}{K_{t-1}}$	–0.091[c] (0.0000)[d]																		
3. $\frac{GINV_t}{Kr_t}$	0.063 (0.0000)	0.154 (0.0000)																	
4. $\frac{GINV_t}{Kr_{t-1}}$	0.000 (0.9662)	0.091 (0.0000)	–0.063 (0.0000)																
5. $\frac{GINV_t}{TA_t}$	0.221 (0.0000)	0.312 (0.0000)	0.158 (0.0000)	0.221 (0.0000)															
6. $\frac{NINV_t}{K_t}$	0.266 (0.0000)	0.357 (0.0000)	0.203 (0.0000)	0.266 (0.0000)	0.045 (0.0000)														
7. $\frac{NINV_t}{K_{t-1}}$	0.205 (0.0000)	0.296 (0.0000)	0.142 (0.0000)	0.205 (0.0000)	–0.162 (0.0000)	–0.061 (0.0000)													
8. $\frac{NINV_t}{TA_{t-1}}$	0.259 (0.0000)	0.350 (0.0000)	0.196 (0.0000)	0.259 (0.0000)	0.037 (0.0000)	–0.007 (0.0000)	0.054 (0.0000)												
9. $\frac{GCAPX_t}{K_t}$	0.049 (0.0000)	0.140 (0.0000)	–0.014 (0.0000)	0.049 (0.0000)	–0.172 (0.0000)	–0.217 (0.0000)	–0.156 (0.0000)	–0.210 (0.0000)											
10. $\frac{GCAPX_t}{K_{t-1}}$	0.027 (0.0000)	0.118 (0.0000)	–0.036 (0.0000)	0.027 (0.0000)	–0.195 (0.0000)	–0.239 (0.0000)	–0.178 (0.0000)	–0.232 (0.0000)	–0.022 (0.0000)										
11. $\frac{GCAPX_t}{Kr_t}$	0.070 (0.0000)	0.161 (0.0000)	0.007 (0.0029)	0.070 (0.0000)	–0.152 (0.0000)	–0.196 (0.0000)	–0.135 (0.0000)	–0.189 (0.0000)	0.020 (0.0000)	0.043 (0.0000)									

Variable[b]	1. $\frac{GINV_t}{K_t}$	2. $\frac{GINV_t}{K_{t-1}}$	3. $\frac{GINV_t}{Kr_t}$	4. $\frac{GINV_t}{Kr_{t-1}}$	5. $\frac{GINV_t}{TA_t}$	6. $\frac{NINV_t}{K_t}$	7. $\frac{NINV_t}{K_{t-1}}$	8. $\frac{NINV_t}{TA_{t-1}}$	9. $\frac{GCAPX_t}{K_t}$	10. $\frac{GCAPX_t}{K_{t-1}}$	11. $\frac{GCAPX_t}{Kr_t}$	12. $\frac{GCAPX_t}{Kr_{t-1}}$	13. $\frac{GCAPX_t}{TA_t}$	14. $\frac{GCAPX_t}{TA_{t-1}}$	15. $\frac{NCAPX_t}{K_{t-1}}$	16. $\frac{NCAPX_t}{TA_t}$	17. $\frac{NCAPX_t}{TA_{t-1}}$	18. $\frac{NSFA_t}{K_t}$	19. $\frac{NSFA_t}{Kr_{t-1}}$
12. $\frac{GCAPX_t}{Kr_{t-1}}$	0.040	0.131	–0.023	0.049	–0.182	–0.226	–0.165	–0.219	–0.009	0.013	–0.030								
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0007)	(0.0000)	(0.0000)								
13. $\frac{GCAPX_t}{TA_t}$	0.227	0.318	0.164	0.227	0.006	–0.039	0.022	–0.032	0.178	0.200	0.158	0.187							
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)							
14. $\frac{GCAPX_t}{TA_{t-1}}$	0.221	0.321	0.158	0.221	–0.001	–0.045	0.016	–0.038	0.172	0.194	0.151	0.181	–0.006						
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.4100)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)						
15. $\frac{NCAPX_t}{K_{t-1}}$	0.289	0.380	0.226	0.289	0.067	0.226	0.084	0.030	0.240	0.262	0.219	0.249	0.062	0.068					
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)					
16. $\frac{NCAPX_t}{TA_t}$	0.271	0.362	0.208	0.271	0.050	0.005	0.066	0.012	0.222	0.244	0201.	0.231	0.044	0.050	–0.018				
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.1550)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
17. $\frac{NCAPX_t}{TA_{t-1}}$	0.268	0.360	0.205	0.268	0.047	0.002	0.063	0.010	0.219	0.242	0.199	0.229	0.041	0.048	–0.020	–0.003			
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.4980)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
18. $\frac{NSFA_t}{K_t}$	0.148	0.239	0.085	0.148	–0.073	–0.118	–0.057	–0.111	0.099	0.121	0.078	0.108	–0.079	–0.073	–0.141	–0.123	–0.120		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
19. $\frac{NSFA_t}{Kr_{t-1}}$	0.043	0.134	–0.020	0.043	–0.179	–0.223	–0.162	–0.216	–0.007	0.016	–0.027	0.003	–0.185	–0.178	–0.246	–0.228	–0.226	–0.105	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.3035)	(0.0094)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
20. $\frac{NSFA_t}{TA_{t-1}}$	0.241	0.332	0.178	0.241	0.019	–0.025	0.036	–0.018	0.192	0.214	0.171	0.201	0.014	0.020	–0.048	–0.030	–0.028	0.093	0.198
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes:

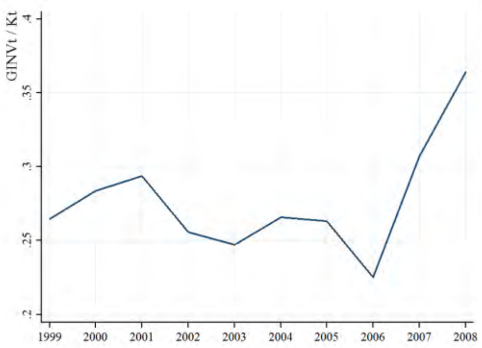
[a] The sample contains 4,320 UK company-year observations over the period 1999–2008.

[b] See detailed definitions of the corporate investment measures in Table 5.1.

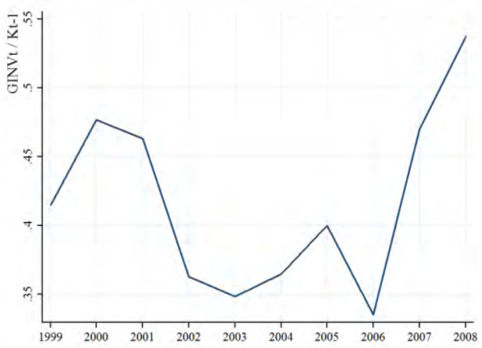
[c] For each cell, the reported figure is the pair-wise difference in the means between the corresponding investment measures.

[d] Figures in parentheses underneath denote *p*-values, reporting the significance level of the difference in the means between the corresponding investment measures.

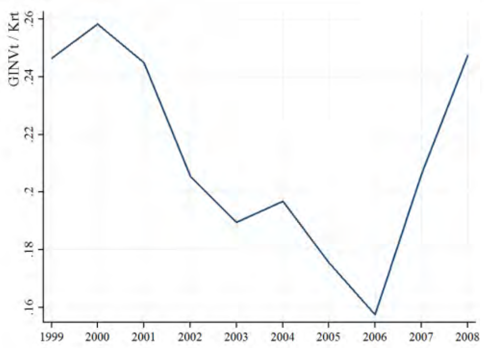
Appendix 5.C: Time series plot of annual mean values of corporate investment measures[a]



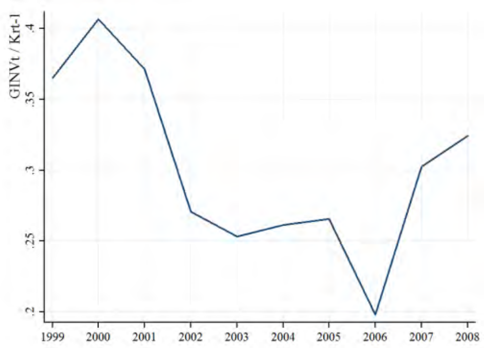
1. $GINV_t / K_t$[b]



2. $GINV_t / K_{t-1}$

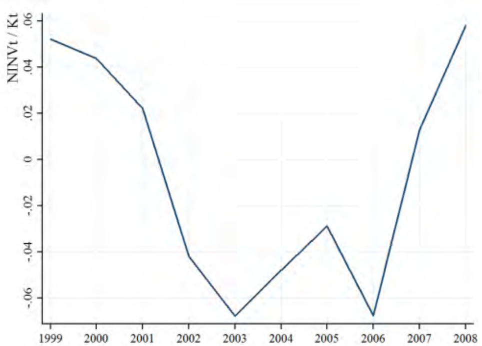


3. $GINV_t / Kr_t$

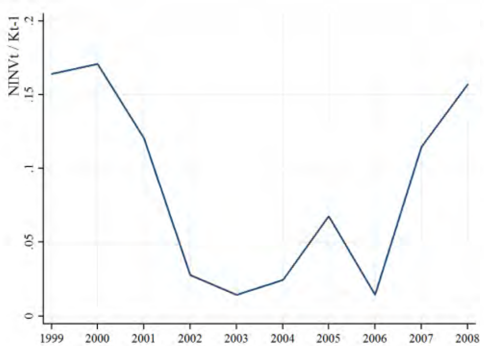


4. $GINV_t / Kr_{t-1}$

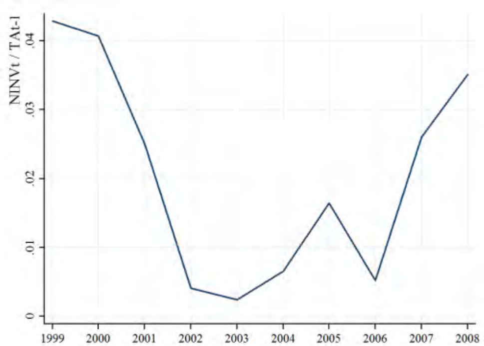
5. $GINV_t / TA_t$



6. $NINV_t / K_t$

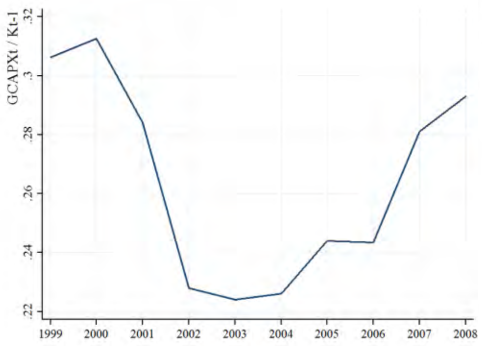


7. $NINV_t / K_{t-1}$



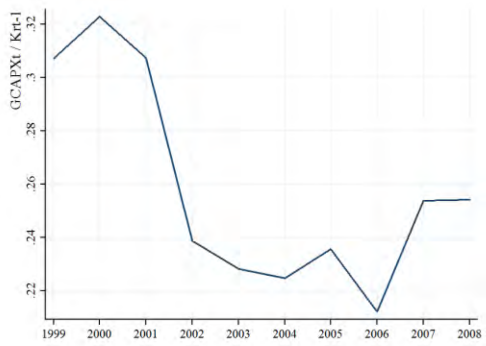
8. $NINV_t / TA_{t-1}$

9. $GCAPX_t / K_t$

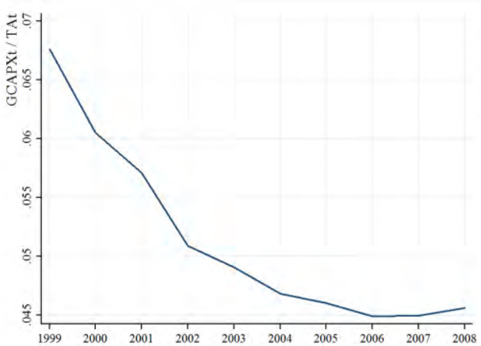


10. $GCAPX_t / K_{t-1}$

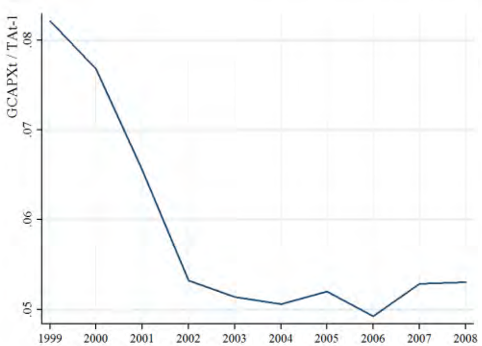
11. $GCAPX_t / Kr_t$



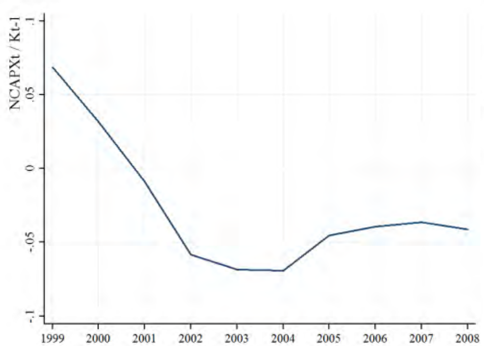
12. $GCAPX_t / Kr_{t-1}$



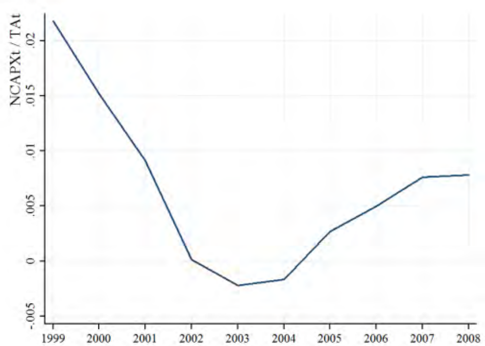
13. $GCAPX_t / TA_t$



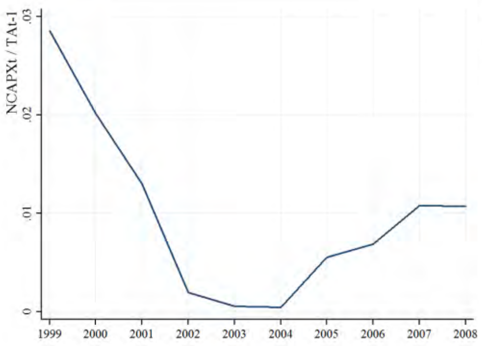
14. $GCAPX_t / TA_{t-1}$



15. $NCAPX_t / K_{t-1}$

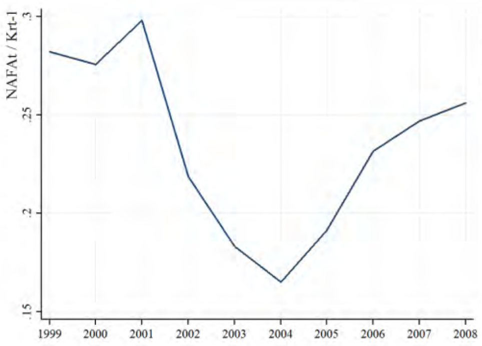


16. $NCAPX_t / TA_t$

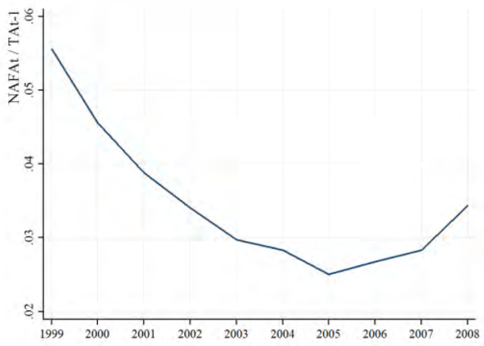


17. $NCAPX_t / TA_{t-1}$

18. $NSFA_t / K_t$



19. $NSFA_t / Kr_{t-1}$



20. $NSFA_t / TA_{t-1}$

Notes:

[a.] The sample contains 4,320 UK company-year observations over the period 1999–2008.

[b.] See detailed definitions of the corporate investment measures in Table 5.1.

Appendix 5.D: Spearman's rank correlation coefficients of alternative corporate investment measures[a]

Variable[b]	1. $\frac{GINV_t}{K_t}$	2. $\frac{GINV_t}{K_{t-1}}$	3. $\frac{GINV_t}{Kr_t}$	4. $\frac{GINV_t}{Kr_{t-1}}$	5. $\frac{GINV_t}{TA_t}$	6. $\frac{NINV_t}{K_t}$	7. $\frac{NINV_t}{K_{t-1}}$	8. $\frac{NINV_t}{TA_{t-1}}$	9. $\frac{GCAPX_t}{K_t}$	10. $\frac{GCAPX_t}{K_{t-1}}$	11. $\frac{GCAPX_t}{Kr_t}$	12. $\frac{GCAPX_t}{Kr_{t-1}}$	13. $\frac{GCAPX_t}{TA_t}$	14. $\frac{GCAPX_t}{TA_{t-1}}$	15. $\frac{NCAPX_t}{K_{t-1}}$	16. $\frac{NCAPX_t}{TA_t}$	17. $\frac{NCAPX_t}{TA_{t-1}}$	18. $\frac{NSFA_t}{K_t}$	19. $\frac{NSFA_t}{Kr_{t-1}}$
2. $\frac{GINV_t}{K_{t-1}}$	0.989[c] (0.0000)[d]																		
3. $\frac{GINV_t}{Kr_t}$	0.887 (0.0000)	0.901 (0.0000)																	
4. $\frac{GINV_t}{Kr_{t-1}}$	0.883 (0.0000)	0.905 (0.0000)	0.990 (0.0000)																
5. $\frac{GINV_t}{TA_t}$	0.565 (0.0000)	0.618 (0.0000)	0.633 (0.0000)	0.663 (0.0000)															
6. $\frac{NINV_t}{K_t}$	0.635 (0.0000)	0.721 (0.0000)	0.693 (0.0000)	0.734 (0.0000)	0.698 (0.0000)														
7. $\frac{NINV_t}{K_{t-1}}$	0.635 (0.0000)	0.721 (0.0000)	0.693 (0.0000)	0.734 (0.0000)	0.698 (0.0000)	1.000 (0.0000)													
8. $\frac{NINV_t}{TA_{t-1}}$	0.593 (0.0000)	0.673 (0.0000)	0.660 (0.0000)	0.702 (0.0000)	0.785 (0.0000)	0.920 (0.0000)	0.920 (0.0000)												
9. $\frac{GCAPX_t}{K_t}$	0.553 (0.0000)	0.538 (0.0000)	0.482 (0.0000)	0.462 (0.0000)	0.164 (0.0000)	0.251 (0.0000)	0.251 (0.0000)	0.210 (0.0000)											
10. $\frac{GCAPX_t}{K_{t-1}}$	0.723 (0.0000)	0.734 (0.0000)	0.674 (0.0000)	0.669 (0.0000)	0.381 (0.0000)	0.540 (0.0000)	0.540 (0.0000)	0.476 (0.0000)	0.908 (0.0000)										
11. $\frac{GCAPX_t}{Kr_t}$	0.579 (0.0000)	0.586 (0.0000)	0.733 (0.0000)	0.714 (0.0000)	0.397 (0.0000)	0.428 (0.0000)	0.429 (0.0000)	0.398 (0.0000)	0.646 (0.0000)	0.722 (0.0000)									

Variable[b]	1. $\frac{GINV_t}{K_t}$	2. $\frac{GINV_t}{K_{t-1}}$	3. $\frac{GINV_t}{Kr_t}$	4. $\frac{GINV_t}{Kr_{t-1}}$	5. $\frac{GINV_t}{TA_t}$	6. $\frac{NINV_t}{K_t}$	7. $\frac{NINV_t}{K_{t-1}}$	8. $\frac{NINV_t}{TA_{t-1}}$	9. $\frac{GCAPX_t}{K_t}$	10. $\frac{GCAPX_t}{K_{t-1}}$	11. $\frac{GCAPX_t}{Kr_t}$	12. $\frac{GCAPX_t}{Kr_{t-1}}$	13. $\frac{GCAPX_t}{TA_t}$	14. $\frac{GCAPX_t}{TA_{t-1}}$	15. $\frac{NCAPX_t}{K_{t-1}}$	16. $\frac{NCAPX_t}{TA_t}$	17. $\frac{NCAPX_t}{TA_{t-1}}$	18. $\frac{NSFA_t}{K_t}$	19. $\frac{NSFA_t}{Kr_{t-1}}$
12. $\frac{GCAPX_t}{Kr_{t-1}}$	0.569	0.583	0.722	0.711	0.419	0.465	0.465	0.433	0.644	0.731	0.993								
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)								
13. $\frac{GCAPX_t}{TA_t}$	–0.028	0.025	0.115	0.138	0.561	0.291	0.291	0.345	0.275	0.320	0.326	0.363							
	(0.0677)	(0.1016)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)							
14. $\frac{GCAPX_t}{TA_{t-1}}$	0.100	0.161	0.248	0.275	0.635	0.436	0.436	0.484	0.298	0.407	0.401	0.441	0.951						
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)						
15. $\frac{NCAPX_t}{K_{t-1}}$	–0.051	0.036	0.090	0.124	0.295	0.472	0.472	0.482	0.262	0.353	0.240	0.291	0.641	0.666					
	(0.0007)	(0.0188)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)					
16. $\frac{NCAPX_t}{TA_t}$	–0.009	0.068	0.112	0.144	0.314	0.471	0.471	0.538	0.286	0.377	0.254	0.303	0.645	0.674	0.919				
	(0.5428)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
17. $\frac{NCAPX_t}{TA_{t-1}}$	–0.021	0.056	0.100	0.133	0.307	0.455	0.455	0.527	0.284	0.369	0.247	0.297	0.645	0.669	0.931	0.991			
	(0.1692)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
18. $\frac{NSFA_t}{K_t}$	0.587	0.586	0.548	0.541	0.360	0.416	0.416	0.375	0.688	0.732	0.552	0.554	0.278	0.332	0.245	0.263	0.258		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
19. $\frac{NSFA_t}{Kr_{t-1}}$	0.420	0.436	0.524	0.522	0.355	0.399	0.399	0.382	0.401	0.485	0.606	0.612	0.251	0.313	0.241	0.240	0.240	0.605	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
20. $\frac{NSFA_t}{TA_{t-1}}$	0.256	0.304	0.363	0.386	0.659	0.496	0.496	0.545	0.273	0.408	0.386	0.415	0.723	0.783	0.517	0.532	0.529	0.658	0.526
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes:

[a.] The sample contains 4,320 UK company-year observations over the period 1999–2008.

[b.] See detailed definitions of the corporate investment measures in Table 5.1.

[c.] For each cell, the reported figure is the pair-wise Spearman's rank correlation coefficient between the corresponding corporate investment measures.

[d.] Figures in parentheses underneath denote *p*-values, reporting the significance level of each correlation coefficient.

Appendix 5.E: Difference-GMM estimation results for Tobin's Q model of corporate investment[a]

Investment measure[b]	*Constant*	Tobin's Q	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Sargan test[g]	Wald test[h]
1. $GINV_t/K_t$	0.2861***[c]	0.0013	0.2152***	–10.59***	1.56	32.75	170.31***
	(15.55)[d]	(0.25)	(7.39)	(p=0.000)	(p=0.119)	(p=0.577)	(p=0.000)
2. $GINV_t/K_{t-1}$	0.4199***	0.0048	0.1631***	–9.16***	–0.43	49.61*	143.53***
	(13.01)	(0.55)	(5.80)	(p=0.000)	(p= 0.664)	(p=0.052)	(p=0.000)
3. $GINV_t/Kr_t$	0.2077***	0.0004	0.1899***	–11.03***	1.58	45.17	177.33***
	(12.39)	(0.12)	(7.85)	(p=0.000)	(p=0.113)	(p=0.116)	(p=0.000)
4. $GINV_t/Kr_{t-1}$	0.2467***	0.0038	0.1787***	–8.72***	0.07	52.60**	196.53***
	(13.17)	(0.64)	(7.82)	(p=0.000)	(p=0.942)	(p=0.028)	(p=0.000)
5. $GINV_t/TA_t$	0.0518***	0.0006	0.1760***	–10.09***	0.15	44.02	114.96***
	(11.13)	(0.66)	(6.30)	(p=0.000)	(p=0.881)	(p=0.141)	(p=0.000)
6. $NINV_t/K_t$	0.0586***	–0.0024	0.1776***	–11.20***	0.84	27.90	152.92***
	(3.72)	(–0.40)	(7.47)	(p=0.000)	(p=0.398)	(p=0.797)	(p=0.000)
7. $NINV_t/K_{t-1}$	0.1517***	–0.0049	0.1461***	–10.48***	–0.33	37.00	163.44***
	(6.14)	(–0.77)	(6.52)	(p=0.000)	(p=0.739)	(p=0.376)	(p=0.000)
8. $NINV_t/TA_{t-1}$	0.0297***	–0.0017*	0.1888***	–9.49***	–0.58	51.12**	176.93***
	(5.93)	(–1.69)	(7.67)	(p=0.000)	(p=0.556)	(p=0.038)	(p=0.000)
9. $GCAPX_t/K_t$	0.1383***	0.0069***	0.3094***	–9.33***	–0.71	41.83	188.87***
	(12.92)	(2.72)	(11.01)	(p=0.000)	(p=0.473)	(p=0.198)	(p=0.000)
10. $GCAPX_t/K_{t-1}$	0.1779***	0.0097***	0.2599***	–8.95***	–1.68*	38.47	236.99***
	(12.24)	(2.56)	(10.91)	(p=0.000)	(p=0.093)	(p=0.315)	(p=0.000)

Investment measure[b]	*Constant*	Tobin's *Q*	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Sargan test[g]	Wald test[h]
11. $GCAPX_t/Kr_t$	0.1236***	0.0057***	0.4035***	–8.16***	–0.88	42.56	294.61***
	(10.85)	(3.31)	(12.77)	(*p*=0.000)	(*p*=0.378)	(*p*=0.177)	(*p*=0.000)
12. $GCAPX_t/Kr_{t-1}$	0.1406***	0.0072**	0.3182***	–7.29***	–0.95	46.17*	294.21***
	(11.28)	(2.18)	(13.35)	(*p*=0.000)	(*p*=0.337)	(*p*=0.0981)	(*p*=0.000)
13. $GCAPX_t/TA_t$	0.0298***	0.0006	0.4114***	–8.39***	–1.47	41.81	364.69***
	(12.54)	(1.30)	(14.71)	(*p*=0.000)	(*p*=0.139)	(*p*= 0.198)	(*p*=0.000)
14. $GCAPX_t/TA_{t-1}$	0.0372***	0.0005	0.4033***	–8.07	–0.99	47.56*	460.11***
	(11.08)	(0.97)	(15.71)	(*p*=0.000)	(*p*=0.318)	(*p*=0.076)	(*p*=0.000)
15. $NCAPX_t/K_{t-1}$	0.0048	0.0051	0.3719***	–9.22***	–1.28	41.69	358.55***
	(0.38)	(1.53)	(12.63)	(*p*=0.000)	(*p*=0.197)	(*p*=0.202)	(*p*=0.000)
16. $NCAPX_t/TA_t$	0.0020	0.0009*	0.4342***	–9.11***	–1.74*	33.87	409.08***
	(1.10)	(1.86)	(16.28)	(*p*=0.000)	(*p*=0.081)	(*p*=0.522)	(*p*=0.000)
17. $NCAPX_t/TA_{t-1}$	0.0037***	0.0004	0.4096***	–8.30***	–1.70*	34.31	352.26***
	(1.53)	(0.80)	(14.87)	(*p*=0.000)	(*p*= 0.087)	(*p*=0.501)	(*p*=0.000)
18. $NSFA_t/K_t$	0.0599**	0.0162***	0.0982***	–9.06***	0.17	37.32	45.73***
	(2.56)	(2.87)	(4.33)	(*p*=0.000)	(*p*=0.861)	(*p*=0.362)	(*p*=0.000)
19. $NSFA_t/Kr_{t-1}$	0.2050***	0.0141	0.0904***	–8.74***	–0.80	31.74	39.47***
	(5.87)	(1.32)	(3.64)	(*p*=0.000)	(*p*=0.421)	(*p*=0.626)	(*p*=0.000)
20. $NSFA_t/TA_{t-1}$	0.0282***	0.0008	0.2383***	–10.18***	0.08	44.26	102.75***
	(6.44)	(0.84)	(8.66)	(*p*=0.000)	(*p*=0.931)	(*p*=0.135)	(*p*=0.000)

Notes:

[a.] The sample contains 4,320 UK company-year observations for the period 1999–2008. The simple Tobin's *Q* model of corporate investment is estimated by difference-GMM estimators using Stata 11. The first year observation for each company is lost because the dynamic structure of the model.

[b] Different corporate investment measures are used as the dependent variable (*INV*) in their respective regressions. The Tobin's *Q* model is specified as $INV_{it} = \alpha_0 + \alpha_1 Q_{it} + \alpha_2 INV_{it-1} + \varepsilon_{it}$

We also control for time effects by adding a set of year dummy variables. The instruments used for the regression include *Constant*, Δ*Year dummies*, ΔQ_t, and $INV_{t-2\ldots}$.

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

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

[e] The 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.

[f] To check for AR(1) in levels, look for AR(2) in differences, in 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.

[g] The Sargan overidentifying restrictions test tests for whether the instruments, as a group, appear exogenous. 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. Under the null hypothesis of instrument validity, the Sargan test has an asymptotic *Chi*-squared distribution.

[h] The Wald test tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 5.F: System-GMM estimation results for Tobin's *Q* model of corporate investment without dynamic structure[a]

Investment measure[b]	*Constant*	Tobin's *Q*	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]
1. $GINV_t/K_t$	0.2230***[c]	0.0103	–10.05***	–1.76*	29.09	6.47***
	(7.00)[d]	(0.86)	(p=0.000)	(p=0.079)	(p=0.142)	(p=0.000)
2. $GINV_t/K_{t-1}$	0.3010***[c]	0.0301***	–8.53***	–2.80*	23.21	5.47***
	(3.37)[d]	(2.95)	(p=0.000)	(p=0.075)	(p=0.395)	(p=0.000)
3. $GINV_t/Kr_t$	0.1831***	0.0188***	–9.72***	–1.52	25.61	7.96***
	(9.11)	(2.75)	(p=0.000)	(p=0.128)	(p=0.269)	(p=0.000)
4. $GINV_t/Kr_{t-1}$	0.2379***	0.0375***	–8.55***	–2.14**	17.78	10.64***
	(7.41)	(3.93)	(p=0.000)	(p=0.032)	(p=0.719)	(p=0.000)
5. $GINV_t/TA_t$	0.0674***	–0.0004	–9.57***	–2.47**	21.06	6.25***
	(11.54)	(–0.24)	(p=0.000)	(p=0.013)	(p=0.517)	(p=0.000)
6. $NINV_t/K_t$	0.0577***	–0.0027	–10.61***	–2.12**	25.21	6.45***
	(2.21)	(–0.31)	(p=0.000)	(p=0.034)	(p=0.287)	(p=0.000)
7. $NINV_t/K_{t-1}$	0.1405***	–0.0036	–9.81***	–2.46**	30.25	8.14***
	(4.13)	(–0.31)	(p=0.000)	(p=0.014)	(p=0.112)	(p=0.000)
8. $NINV_t/TA_{t-1}$	0.0359***	–0.0015	–9.08***	–3.02***	31.03*	9.98***
	(5.22)	(–0.78)	(p=0.000)	(p=0.003)	(p=0.096)	(p=0.000)
9. $GCAPX_t/K_t$	0.1999***	0.0133**	–8.56***	–4.48***	27.35	4.26***
	(13.90)	(2.59)	(p=0.000)	(p=0.000)	(p=0.1982)	(p=0.000)
10. $GCAPX_t/K_{t-1}$	0.2359***	0.0211**	–8.18***	–5.46***	23.78	6.37***
	(10.26)	(2.44)	(p=0.000)	(p=0.000)	(p=0.3589)	(p=0.000)

Investment measure[b]	*Constant*	Tobin's Q	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	F-statistic[h]
11. $GCAPX_t/Kr_t$	0.2076***	0.0124**	–6.62***	–5.04***	35.96**	7.27***
	(13.00)	(2.10)	(p=0.000)	(p=0.000)	(p=0.031)	(p=0.000)
12. $GCAPX_t/Kr_{t-1}$	0.2466***	0.0175**	–6.64***	–4.79***	34.45**	8.53***
	(10.30)	(1.99)	(p=0.000)	(p=0.000)	(p=0.044)	(p=0.000)
13. $GCAPX_t/TA_t$	0.0640***	0.0006	–7.07***	–4.49***	27.02	9.66***
	(17.66)	(0.73)	(p=0.000)	(p=0.000)	(p=0.210)	(p=0.000)
14. $GCAPX_t/TA_{t-1}$	0.0768***	0.0014**	–6.31***	–4.08***	31.06*	10.88***
	(19.01)	(1.99)	(p=0.000)	(p=0.000)	(p=0.095)	(p=0.000)
15. $NCAPX_t/K_{t-1}$	0.0561***	0.0079	–7.91***	–4.98***	35.49**	9.11***
	(2.47)	(0.98)	(p=0.000)	(p=0.000)	(p=0.034)	(p=0.000)
16. $NCAPX_t/TA_t$	0.0203***	–0.0001	–6.80***	–5.84***	43.52***	9.89***
	(6.77)	(–0.03)	(p=0.000)	(p=0.000)	(p=0.004)	(p=0.000)
17. $NCAPX_t/TA_{t-1}$	0.0241***	0.0006	–6.47***	–4.91***	50.59	9.27***
	(6.47)	(0.74)	(p=0.000)	(p=0.000)	(p=0.001)	(p=0.000)
18. $NSFA_t/K_t$	0.1033***	0.0118	–9.07***	–0.85	32.96*	1.70*
	(4.50)	(1.49)	(p=0.000)	(p=0.397)	(p=0.062)	(p=0.079)
19. $NSFA_t/Kr_{t-1}$	0.1773***	0.0323**	–8.60***	–1.75*	32.23*	1.57
	(3.62)	(1.96)	(p=0.000)	(p=0.081)	(p=0.073)	(p=0.112)
20. $NSFA_t/TA_{t-1}$	0.0486***	0.0017	–9.43***	–2.61***	27.96	4.67***
	(9.91)	(1.57)	(p=0.000)	(p=0.009)	(p=0.177)	(p=0.000)

Notes:

[a] The sample contains 4,320 UK company-year observations for the period 1999–2008. The re-specified Tobin's Q model of corporate investment is estimated by two-step system-GMM estimators using Stata 11.

[b] Different corporate investment measures are used as the dependent variable (*INV*) in their respective regressions. The Tobin's *Q* model is re-specified as $INV_{it} = \alpha_0 + \alpha_1 Q_{it} + \varepsilon_{it}$.

We also control for time effects by adding a set of year dummy variables. The instruments used for the regression include *Constant*, *Year dummies*, Q_{t-2}, Q_{t-3}, Δ*Year dummies*, and ΔQ_t.

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

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

[e] The 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.

[f] To check for AR(1) in levels, look for AR(2) in differences, in 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.

[g] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.

[h] *F*-statistic for the regression which tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 5.G: System-GMM estimation results for Tobin's *Q* model of corporate investment with alternative measure of *Q*[a]

Investment measure[b]	*Constant*	Tobin's *Q*	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]
1. $GINV_t/K_t$	0.1326***[c]	0.0179***	0.6883***	–5.20***	1.78*	23.90	11.85***
	(3.37)[d]	(2.95)	(5.17)	(*p*=0.000)	(*p*=0.075)	(*p*=0.200)	(*p*=0.000)
2. $GINV_t/K_{t-1}$	0.3820***	0.0296**	0.1756	–2.11**	–0.09	25.07	7.69***
	(3.74)	(1.99)	(0.68)	(*p*=0.035)	(*p*=0.926)	(*p*=0.158)	(*p*=0.000)
3. $GINV_t/Kr_t$	0.1422***	0.0124**	0.5019***	–5.09***	1.42	16.00	12.20***
	(5.47)	(2.47)	(4.26)	(*p*=0.000)	(*p*=0.154)	(*p*=0.657)	(*p*=0.000)
4. $GINV_t/Kr_{t-1}$	0.2572***	0.0194*	0.1492	–2.45**	–0.43	26.61	8.38***
	(4.62)	(1.82)	(0.71)	(*p*=0.014)	(*p*=0.666)	(*p*=0.114)	(*p*=0.000)
5. $GINV_t/TA_t$	0.0613***	0.0032*	0.0313	–2.24**	–0.97	17.87	5.56***
	(6.60)	(1.79)	(0.18)	(*p*=0.025)	(*p*=0.330)	(*p*=0.531)	(*p*=0.000)
6. $NINV_t/K_t$	0.0737***	–0.0057	0.3258**	–4.09***	1.01	26.32	6.52***
	(4.43)	(–0.84)	(2.39)	(*p*=0.000)	(*p*=0.311)	(*p*=0.121)	(*p*=0.000)
7. $NINV_t/K_{t-1}$	0.1643***	–0.0051	–0.0272	–2.04***	–0.80	19.41	7.94***
	(5.38)	(–0.57)	(–0.13)	(*p*=0.042)	(*p*=0.422)	(*p*=0.431)	(*p*=0.000)
8. $NINV_t/TA_{t-1}$	0.0316***	–0.0009	0.0671	–2.66***	–0.84	17.61	6.67***
	(6.24)	(–0.52)	(0.42)	(*p*=0.008)	(*p*=0.398)	(*p*=0.549)	(*p*=0.000)
9. $GCAPX_t/K_t$	0.1296***	0.0147***	0.3263**	–3.63***	–1.45	29.99*	6.12***
	(4.41)	(3.52)	(2.29)	(*p*=0.000)	(*p*=0.148)	(*p*=0.052)	(*p*=0.000)
10. $GCAPX_t/K_{t-1}$	0.1839***	0.0213***	0.2491**	–3.53***	1.32	26.15	7.18***
	(6.11)	(3.65)	(2.05)	(*p*=0.000)	(*p*=0.187)	(*p*=0.126)	(*p*=0.000)

Investment measure[b]	*Constant*	Tobin's *Q*	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]
11. $GCAPX_t/Kr_t$	0.1084***	0.0132***	0.4227***	–3.96***	–1.55	23.43	8.50***
	(5.04)	(2.89)	(3.78)	(*p*=0.000)	(*p*=0.120)	(*p*=0.219)	(*p*=0.000)
12. $GCAPX_t/Kr_{t-1}$	0.1369***	0.0180**	0.3257**	–3.39***	–1.61	32.34**	9.22***
	(5.26)	(2.33)	(2.49)	(*p*=0.001)	(*p*=0.108)	(*p*=0.029)	(*p*=0.000)
13. $GCAPX_t/TA_t$	0.0223***	0.0025**	0.3996***	–3.50***	–1.22	22.91	10.55***
	(3.72)	(2.28)	(3.01)	(*p*=0.000)	(*p*=0.221)	(*p*=0.241)	(*p*=0.000)
14. $GCAPX_t/TA_{t-1}$	0.0253***	0.0017	0.4855***	–3.66***	–0.60	18.46	15.92***
	(3.54)	(1.42)	(3.53)	(*p*=0.000)	(*p*=0.550)	(*p*=0.492)	(*p*=0.000)
15. $NCAPX_t/K_{t-1}$	–0.0229*	0.0078	0.2721**	–3.62***	–1.53	26.14	4.91***
	(–1.96)	(1.45)	(2.21)	(*p*=0.000)	(*p*=0.126)	(*p*=0.126)	(*p*=0.000)
16. $NCAPX_t/TA_t$	0.0022	–0.0005	0.3698***	–4.56***	–1.84*	21.62	10.24***
	(1.25)	(–0.56)	(4.75)	(*p*=0.000)	(*p*=0.065)	(*p*=0.304)	(*p*=0.000)
17. $NCAPX_t/TA_{t-1}$	0.0041**	–0.0003	0.3121***	–4.01***	–1.31	23.86	7.64***
	(1.82)	(–0.33)	(3.71)	(*p*=0.000)	(*p*=0.191)	(*p*=0.201)	(*p*=0.000)
18. $NSFA_t/K_t$	0.0752***	0.0244	0.2055***	–2.81***	0.12	25.32	1.84*
	(3.28)	(3.53)	(1.17)	(*p*=0.005)	(*p*=0.907)	(*p*=0.150)	(*p*=0.054)
19. $NSFA_t/Kr_{t-1}$	0.2958***	0.0606***	–0.4652*	–2.19**	–0.47	16.00	1.88**
	(4.24)	(3.10)	(–1.80)	(*p*=0.028)	(*p*=0.638)	(*p*=0.657)	(*p*=0.047)
20. $NSFA_t/TA_{t-1}$	0.0216***	0.0054***	0.2802*	–3.10***	–0.40	14.91	3.68***
	(3.39)	(3.36)	(1.67)	(*p*=0.002)	(*p*=0.688)	(*p*=0.728)	(*p*=0.000)

Notes:

[a] The sample contains 4,320 UK company-year observations for the period 1999–2008. The simple Tobin's Q model of corporate investment is estimated by two-step system-GMM estimators using Stata 11. Tobin's Q is measured as the market-to-book value of common equity. The first year observation for each company is lost because the dynamic structure of the model.

[b] Different corporate investment measures are used as the dependent variable (*INV*) in their respective regressions. The Tobin's Q model is specified as $INV_{it} = \alpha_0 + \alpha_1 Q_{it} + \alpha_2 INV_{it-1} + \varepsilon_{it}$.

We also control for time effects by adding a set of year dummy variables. The instruments used for the regression include *Constant*, *Year dummies*, Q_t, $INV_{t\text{-}3\ldots\,t\text{-}5}$, Δ*Year dummies*, ΔQ_t and $\Delta INV_{t\text{-}2}$.

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

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

[e] The 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.

[f] To check for AR(1) in levels, look for AR(2) in differences, in 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.

[g] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.

[h] *F*-statistic for the regression which tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 5.H: Rankings of the corporate investment measures based on an alternative measure of volatility[a]

INV measure	MAE[b]	Absolute mean of *INV*	Scaled MAE[c]	Rank[d]
1. $GINV_t/K_t$	0.2021	0.2772	0.7290	8
2. $GINV_t/K_{t-1}$	0.3564	0.3683	0.8538	11
3. $GINV_t/Kr_t$	0.1537	0.2144	0.7221	7
4. $GINV_t/Kr_{t-1}$	0.2429	0.2773	0.8049	9
5. $GINV_t/TA_t$	0.0457	0.0560	0.8389	10
6. $NINV_t/K_t$	0.1917	0.0113	29.9578	20
7. $NINV_t/K_{t-1}$	0.2212	0.0722	2.5221	16
8. $NINV_t/TA_{t-1}$	0.0501	0.0186	2.4432	15
9. $GCAPX_t/K_t$	0.1066	0.2281	0.4577	2
10. $GCAPX_t/K_{t-1}$	0.1461	0.2506	0.5529	5
11. $GCAPX_t/Kr_t$	0.1148	0.2076	0.5299	4
12. $GCAPX_t/Kr_{t-1}$	0.1650	0.2375	0.6382	6
13. $GCAPX_t/TA_t$	0.0220	0.0501	0.4281	1
14. $GCAPX_t/TA_{t-1}$	0.0289	0.0566	0.4916	3
15. $NCAPX_t/K_{t-1}$	0.1309	0.0114	4.9210	19
16. $NCAPX_t/TA_t$	0.0221	0.0065	3.3924	18
17. $NCAPX_t/TA_{t-1}$	0.0251	0.0090	2.5392	17
18. $NSFA_t/K_t$	0.1807	0.1293	1.7645	14
19. $NSFA_t/Kr_{t-1}$	0.4081	0.2347	1.7372	13
20. $NSFA_t/TA_{t-1}$	0.0389	0.0365	1.1212	12

Notes:

[a.] The sample contains 4,320 UK company-year observations for the period 1999–2008. The errors are obtained from estimating the time trend regressions specified as Equation 5.2 using two-step system-GMM estimators.

[b.] The mean absolute error is defined as the square root of the mean square error which can be calculated as follows,

$$\text{MAE}=\frac{\sum_{i=1}^{n}\left|INV_{it}-\hat{INV}_{it}\right|}{N}$$

where $\hat{INV}_{it}$ denotes the estimated value of INV_{it} obtained from estimating the trend regression, and N denotes the total sample size.

[c.] The scaled mean absolute error is defined as the ratio of the mean absolute error to the mean of the absolute mean of the observed values

[d.] The corporate investment measures are ranked based on their respective scaled mean absolute errors, from lowest volatility to highest volatility around their respective trends.

Appendix 5.I: Difference-GMM estimation results for the trend regression of corporate investment measures[a]

Investment measure[b]	*Constant*	*T*	T^2	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Sargan test[g]	Wald test[h]
1. $GINV_t/K_t$	0.3208***[c]	–0.0550***	0.0052***	0.1970***	–10.49***	1.30	38.34	130.36***
	(11.61)[d]	(–6.24)	(7.46)	(6.92)	(p=0.000)	(p=0.193)	(p=0.320)	(p=0.000)
2. $GINV_t/K_{t-1}$	0.5447***	–0.1213***	0.0108***	0.1781***	–9.27***	–0.18	39.65	108.88***
	(10.14)	(–6.87)	(7.61)	(6.51)	(p=0.000)	(p=0.849)	(p=0.270)	(p=0.000)
3. $GINV_t/Kr_t$	0.3005***	–0.0546***	0.0045***	0.1909***	–11.07***	1.48	45.13	142.08***
	(12.38)	(–7.42)	(8.05)	(8.02)	(p=0.000)	(p=0.137)	(p=0.117)	(p=0.000)
4. $GINV_t/Kr_{t-1}$	0.4108***	–0.0842***	0.0066***	0.1889***	–9.03***	0.20	54.90**	117.16***
	(10.64)	(–6.99)	(7.29)	(8.36)	(p=0.000)	(p=0.838)	(p=0.017)	(p=0.000)
5. $GINV_t/TA_t$	0.0709***	–0.0118***	0.0010***	0.1931***	–10.20***	0.29	41.02	86.99***
	(10.55)	(–5.70)	(6.06)	(6.94)	(p=0.000)	(p=0.769)	(p=0.2234)	(p=0.000)
6. $NINV_t/K_t$	0.1571***	–0.0692***	0.0059***	0.1758***	–11.24***	0.79	29.00	112.02***
	(5.20)	(–6.48)	(6.97)	(7.35)	(p=0.000)	(p= 0.426)	(p=0.752)	(p=0.000)
7. $NINV_t/K_{t-1}$	0.2874***	–0.0992***	0.0084***	0.1424***	–10.33***	–0.26	39.32	108.77***
	(7.96)	(–7.96)	(8.48)	(6.40)	(p=0.000)	(p=0.794)	(p=0.282)	(p=0.000)
8. $NINV_t/TA_{t-1}$	0.0525***	–0.0182***	0.0015***	0.1893***	–9.51***	–0.51	41.16	121.26***
	(6.44)	(–6.65)	(7.32)	(7.64)	(p=0.000)	(p=0.607)	(p=0.219)	(p=0.000)
9. $GCAPX_t/K_t$	0.1707***	–0.0114***	0.0011***	0.3092***	–9.16***	–0.84	44.79	130.34***
	(12.50)	(–2.91)	(3.46)	(10.61)	(p=0.000)	(p=0.395)	(p=0.124)	(p=0.000)
10. $GCAPX_t/K_{t-1}$	0.2527***	–0.0382***	0.0034***	0.2751***	–8.83***	–1.67*	42.56	180.54***
	(11.68)	(–5.55)	(6.13)	(11.21)	(p=0.000)	(p=0.094)	(p=0.177)	(p=0.000)

Investment measure[b]	*Constant*	*T*	T^2	INV_{-1}	Test for AR(1)[e]	Test for AR(2)[f]	Sargan test[g]	Wald test[h]
11. $GCAPX_t/Kr_t$	0.1736***	–0.0201***	0.0015***	0.3933***	–8.11***	–1.01	45.08	251.80***
	(11.44)	(–5.59)	(5.41)	(12.98)	(p=0.000)	(p=0.308)	(p=0.118)	(p=0.000)
12. $GCAPX_t/Kr_{t-1}$	0.2446***	–0.0362***	0.0027***	0.3166***	–7.19***	–0.96	45.96	225.21***
	(11.40)	(–5.80)	(5.68)	(13.38)	(p=0.000)	(p=0.335)	(p=0.101)	(p=0.000)
13. $GCAPX_t/TA_t$	0.0385***	–0.0040***	0.0003***	0.4102***	–8.40***	–1.46	43.79	281.40***
	(11.54)	(–4.05)	(3.29)	(14.32)	(p=0.000)	(p=0.142)	(p=0.146)	(p=0.000)
14. $GCAPX_t/TA_{t-1}$	0.0522***	–0.0080***	0.0005***	0.3934***	–8.00***	–1.08	43.77	379.46***
	(11.26)	(–6.12)	(5.62)	(14.57)	(p=0.000)	(p=0.278)	(p=0.146)	(p=0.000)
15. $NCAPX_t/K_{t-1}$	0.0509***	–0.0231***	0.0015***	0.3780***	–9.15***	–1.28	46.98*	247.84***
	(2.44)	(–3.19)	(2.74)	(12.76)	(p=0.000)	(p=0.199)	(p=0.08)	(p=0.000)
16. $NCAPX_t/TA_t$	0.0094***	–0.0032***	0.0002***	0.4319***	–9.12***	–1.78*	37.13	311.97***
	(3.15)	(–3.18)	(3.14)	(16.50)	(p=0.000)	(p=0.075)	(p=0.370)	(p=0.000)
17. $NCAPX_t/TA_{t-1}$	0.0121***	–0.0042***	0.0003***	0.4085***	–8.23***	–1.68*	35.91	260.95***
	(3.29)	(–3.47)	(3.59)	(14.75)	(p=0.000)	(p=0.092)	(p=0.425)	(p=0.000)
18. $NSFA_t/K_t$	0.1409***	–0.0193**	0.0017**	0.1032***	–9.11***	0.22	41.16	23.61***
	(4.96)	(–1.98)	(2.22)	(4.36)	(p=0.000)	(p=0.822)	(p=0.218)	(p=0.000)
19. $NSFA_t/Kr_{t-1}$	0.3331***	–0.0511**	0.0040**	0.0932***	–8.68***	–0.90	33.15	18.61***
	(5.14)	(–2.22)	(2.19)	(3.84)	(p=0.000)	(p=0.364)	(p=0.557)	(p=0.000)
20. $NSFA_t/TA_{t-1}$	0.0447***	–0.0075***	0.0005***	0.2344***	–10.20***	0.09	43.56	90.71***
	(7.08)	(–3.56)	(3.45)	(8.61)	(p=0.000)	(p= 0.928)	(p=0.151)	(p=0.000)

Notes:

[a] The sample contains 4,320 UK company-year observations of the period 1999–2008. The trend regressions are estimated by difference-GMM estimators using Stata 11. The first year observation for each company is lost because the dynamic structure of the model.

[b] Different corporate investment measures are used as the dependent variable (*INV*) in their respective trend regressions. The trend regression is specified as $INV_{it} = \alpha_0 + \alpha_1 T_t + \alpha_2 T_t^2 + \alpha_3 INV_{it-1} + \varepsilon_{it}$

The instruments used for the regression include *Constant*, ΔT, ΔT^2_t and $INV_{t\text{-}2\ldots}$.

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

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

[e] 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.

[f] 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.

[g] The Sargan overidentifying restrictions test tests for whether the instruments, as a group, appear exogenous. 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. Under the null hypothesis of instrument validity, the Sargan test has an asymptotic *Chi*-squared distribution.

[h] The Wald test tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

Appendix 5.J: Coefficients of variation of the root mean square error based on difference-GMM estimation results[a]

Investment measure	RMSE[b]	Absolute mean of *INV*	CV(RMSE)[c]	Rank[d]
1. $GINV_t/K_t$	0.3253	0.2772	1.1737	8
2. $GINV_t/K_{t-1}$	0.5964	0.4174	1.4290	11
3. $GINV_t/Kr_t$	0.2465	0.2129	1.1581	7
4. $GINV_t/Kr_{t-1}$	0.4132	0.3018	1.3690	10
5. $GINV_t/TA_t$	0.0682	0.0545	1.2518	9
6. $NINV_t/K_t$	0.2971	0.0064	46.2709	20
7. $NINV_t/K_{t-1}$	0.3555	0.0877	4.0535	16
8. $NINV_t/TA_{t-1}$	0.0804	0.0205	3.9309	15
9. $GCAPX_t/K_t$	0.1432	0.2329	0.6149	1
10. $GCAPX_t/K_{t-1}$	0.2204	0.2642	0.8342	5
11. $GCAPX_t/Kr_t$	0.1482	0.2166	0.6842	2
12. $GCAPX_t/Kr_{t-1}$	0.2504	0.2585	0.9686	6
13. $GCAPX_t/TA_t$	0.0357	0.0514	0.6945	3
14. $GCAPX_t/TA_{t-1}$	0.0451	0.0587	0.7690	4
15. $NCAPX_t/K_{t-1}$	0.2186	0.0266	8.2144	19
16. $NCAPX_t/TA_t$	0.0333	0.0065	5.0905	18
17. $NCAPX_t/TA_{t-1}$	0.0403	0.0099	4.0894	17
18. $NSFA_t/K_t$	0.3103	0.1024	3.0315	14
19. $NSFA_t/Kr_{t-1}$	0.6848	0.2349	2.9156	13
20. $NSFA_t/TA_{t-1}$	0.0631	0.0347	1.8197	12

Note:

[a.] The sample contains 4,320 UK company-year observations of the period 1999–2008. The residuals are obtained by estimating the trend regressions specified as Equation 5.2 using difference-GMM estimators.

[b.] The root mean square error, which is defined as the square root of the mean square error (see Equation 5.3). The coefficient of variation of the root mean square error, which is defined as the ratio of the root mean square error to the absolute mean of the observed values (see Equation 5.4).

[c.] The corporate investment measures are ranked based on their respective coefficients of variation of the root mean square error, from lowest volatility to highest volatility around their respective trends.

Appendix 5.K: Fixed effect estimation results for the regressions of stock returns on unexpected earnings and unexpected corporate investment[a]

Investment measure[b]	*Constant*	*UEPS*	*UINV*	Hausman	*F*-statistic[e]	Wald test[f]	Rank[g]
1. $GINV_t/K_t$	0.3178***[c] (8.40) [d]	0.7489*** (8.08)	0.0796* (1.93)	13.54*** (*p*=0.001)	23.41 (*p*=0.000)	3.7249 (*p*=0.054)	18
2. $GINV_t/K_{t-1}$	0.3176*** (8.42)	0.7558*** (8.18)	0.0613*** (2.61)	13.08*** (*p*=0.001)	24.21 (*p*=0.000)	6.8121 (*p*=0.009)	14
3. $GINV_t/Kr_t$	0.3175*** (8.44)	0.7534*** (8.14)	0.1383** (2.57)	19.09*** (*p*=0.000)	23.42 (*p*=0.000)	6.6049 (*p*=0.011)	16
4. $GINV_t/Kr_{t-1}$	0.3174*** (8.45)	0.7563*** (8.18)	0.0809** (2.59)	15.70*** (*p*=0.000)	23.32 (*p*=0.000)	6.7081 (*p*=0.010)	15
5. $GINV_t/TA_t$	0.3178*** (8.39)	0.7489*** (8.12)	0.1460 (0.88)	25.57*** (*p*=0.000)	22.51 (*p*=0.000)	0.7744 (*p*=0.379)	20
6. $NINV_t/K_t$	0.3181*** (8.46)	0.7526*** (8.16)	0.1270*** (3.21)	59.91*** (*p*=0.000)	24.65 (*p*=0.000)	10.3041 (*p*=0.001)	11
7. $NINV_t/K_{t-1}$	0.3179*** (8.49)	0.7603*** (8.28)	0.1396*** (3.98)	41.96*** (*p*=0.000)	26.01 (*p*=0.000)	15.8404 (*p*=0.000)	5
8. $NINV_t/TA_{t-1}$	0.3182*** (8.45)	0.7512*** (8.20)	0.4911*** (3.38)	30.85*** (*p*=0.000)	24.73 (*p*=0.000)	11.4244 (*p*=0.001)	10
9. $GCAPX_t/K_t$	0.3180*** (8.45)	0.7545*** (8.21)	0.3140*** (3.18)	15.48*** (*p*=0.000)	21.97 (*p*=0.000)	10.1124 (*p*=0.001)	12
10. $GCAPX_t/K_{t-1}$	0.3182*** (8.52)	0.7554*** (8.19)	0.2536*** (4.42)	14.08*** (*p*=0.000)	24.41 (*p*=0.000)	19.5364 (*p*=0.000)	3
11. $GCAPX_t/Kr_t$	0.3176*** (8.49)	0.7565*** (8.22)	0.3955*** (3.72)	12.58*** (*p*=0.002)	24.65 (*p*=0.000)	13.8384 (*p*=0.000)	8
12. $GCAPX_t/Kr_{t-1}$	0.3177*** (8.51)	0.7568*** (8.26)	0.2221*** (3.86)	11.54*** (*p*=0.003)	25.16 (*p*=0.000)	14.8996 (*p*=0.000)	6
13. $GCAPX_t/TA_t$	0.3177*** (8.39)	0.7524*** (8.13)	0.3557 (0.99)	11.11*** (*p*=0.004)	21.93 (*p*=0.000)	0.9801 (*p*=0.323)	19
14. $GCAPX_t/TA_{t-1}$	0.3198*** (8.55)	0.7481*** (8.16)	1.3857*** (4.54)	7.49*** (*p*=0.024)	24.84 (*p*=0.000)	20.6116 (*p*=0.000)	2
15. $NCAPX_t/K_{t-1}$	0.3188*** (8.55)	0.7458*** (8.20)	0.2789*** (4.83)	6.53*** (*p*=0.038)	24.25 (*p*=0.000)	23.3289 (*p*=0.000)	1
16. $NCAPX_t/TA_t$	0.3180*** (8.43)	0.7495*** (8.16)	1.2760*** (3.65)	11.12*** (*p*=0.004)	24.14 (*p*=0.000)	13.3225 (*p*=0.000)	9

Investment measure[b]	*Constant*	*UEPS*	*UINV*	Hausman	*F*-statistic[e]	Wald test[f]	Rank[g]
17. $NCAPX_t/TA_{t-1}$	0.3187***	0.7489***	1.2075***	10.71***	23.92	14.8996	7
	(8.48)	(8.18)	(3.86)	(p=0.005)	(p=0.000)	(p=0.000)	
18. $NSFA_t/K_t$	0.3179***	0.7662***	0.0940***	19.95***	21.82	7.5076	13
	(8.43)	(8.20)	(2.74)	(p=0.000)	(p=0.000)	(p=0.006)	
19. $NSFA_t/Kr_{t-1}$	0.3178***	0.7511***	0.0393**	14.87***	22.11	5.7121	17
	(8.45)	(8.17)	(2.39)	(p=0.000)	(p=0.000)	(p=0.017)	
20. $NSFA_t/TA_{t-1}$	0.3187***	0.7710***	0.7384***	11.24***	23.03	16.8921	4
	(8.49)	(8.33)	(4.11)	(p=0.004)	(p=0.000)	(p=0.000)	

Note:

[a.] The sample contains 4,320 UK company-year observations of the period 1999–2008. The model specified in Equation 5.5 is estimated by fixed effect estimators using Stata 11.

[b.] Unexpected change in corporate investment measures are used as an explanatory variable in their respective regressions. The regression is specified as

$$MAR_{it} = \beta_0 + \beta_1 UEPS_{it} + \beta_2 UINV_{it} + e_{it}$$

We also control for time effects by adding a set of year dummy variables.

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

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

[e.] The Hausman test is implemented to test for whether the individual effect is correlated with regressors. The test compares the coefficients obtained from both fixed effect and random effect estimators. Under the null hypothesis that individual effects are random, the fixed effect and random effect estimates should be similar because both are consistent. Under the alternative hypothesis, the fixed effect and random effect estimators diverge due to the inconsistence of random effects estimators, and thus the fixed effect estimator should be used. The test statistic asymptotically follows the *Chi*-squared distribution.

[f.] We perform Wald test to test the null hypothesis that the coefficient on *UINV* is equal to zero. The test reports results using the *F*-statistic. The associated *p*-value is reported in parenthesis.

[g.] The corporate investment measures are ranked based on their respective Wald test results, from the most informative to the lowest informative.

Appendix 5.L: System-GMM estimation results for the regressions of stock returns on unexpected earnings and alternative measure of unexpected corporate investment[a]

Investment measure[b]	*Constant*	*UEPS*	*UINV*	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]	Wald test[i]	Rank[j]
1. $GINV_t/K_t$	0.0452***	0.7561***	0.0451	–11.90***	–1.56	54.52	21.10***	2.53	17
	(2.50)	(6.91)	(1.59)	(*p*=0.000)	(*p*=0.118)	(*p*=0.641)	(*p*=0.000)	(*p*=0.112)	
2. $GINV_t/K_{t-1}$	0.0454***	0.7542***	0.0375***	–11.86***	–1.53	56.50	20.08***	7.62***	14
	(2.51)	(6.76)	(2.76)	(*p*=0.000)	(*p*=0.126)	(*p*=0.568)	(*p*=0.000)	(*p*=0.006)	
3. $GINV_t/Kr_t$	0.0465**	0.7598***	0.0850**	–11.92***	–1.47	51.14	22.71***	4.93**	15
	(2.59)	(7.14)	(2.22)	(*p*=0.000)	(*p*=0.141)	(*p*=0.756)	(*p*=0.000)	(*p*=0.027)	
4. $GINV_t/Kr_{t-1}$	0.0422**	0.7725***	0.0710***	–11.92***	–1.42	47.48	22.62***	15.29***	8
	(2.35)	(7.15)	(3.91)	(*p*=0.000)	(*p*=0.155)	(*p*=0.859)	(*p*=0.000)	(*p*=0.000)	
5. $GINV_t/TA_t$	0.0531***	0.7320***	0.0713	–11.85***	–1.71*	52.93	21.76***	0.30	20
	(2.88)	(6.60)	(0.55)	(*p*=0.000)	(*p*=0.087)	(*p*=0.697)	(*p*=0.000)	(*p*=0.584)	
6. $NINV_t/K_t$	0.0456***	0.7208***	0.0544**	–11.93***	–1.66*	62.59	22.10***	3.96**	16
	(2.45)	(6.40)	(1.99)	(*p*=0.000)	(*p*=0.096)	(*p*=0.350)	(*p*=0.000)	(*p*=0.047)	
7. $NINV_t/K_{t-1}$	0.0446***	0.7229***	0.0686***	–11.94***	–1.59	60.49	22.43***	11.97***	9
	(2.46)	(6.43)	(3.46)	(*p*=0.000)	(*p*=0.111)	(*p*=0.421)	(*p*=0.000)	(*p*=0.001)	
8. $NINV_t/TA_{t-1}$	0.0463***	0.7270***	0.2807***	–11.89***	–1.63	50.93	22.68***	8.47***	13
	(2.57)	(6.50)	(2.91)	(*p*=0.000)	(*p*=0.103)	(*p*=0.763)	(*p*=0.000)	(*p*=0.004)	
9. $GCAPX_t/K_t$	0.0504***	0.6967***	0.2937***	–11.80***	–1.48	66.89	22.01***	16.97***	4
	(2.68)	(6.48)	(4.12)	(*p*=0.000)	(*p*=0.138)	(*p*=0.224)	(*p*=0.000)	(*p*=0.000)	
10. $GCAPX_t/K_{t-1}$	0.0400**	0.7242***	0.2044***	–11.99***	–1.45	70.32	24.01***	23.04***	1
	(2.09)	(6.55)	(4.80)	(*p*=0.000)	(*p*=0.147)	(*p*=0.148)	(*p*=0.000)	(*p*=0.000)	

Investment measure[b]	*Constant*	*UEPS*	*UINV*	Test for AR(1)[e]	Test for AR(2)[f]	Hansen test[g]	*F*-statistic[h]	Wald test[i]	Rank[j]
11. $GCAPX_t/Kr_t$	0.0363*	0.7002***	0.3186***	–11.83***	–1.56	72.22	23.78***	17.14***	3
	(1.85)	(6.59)	(4.14)	(*p*=0.000)	(*p*=0.118)	(*p*=0.115)	(*p*=0.000)	(*p*=0.000)	
12. $GCAPX_t/Kr_{t-1}$	0.0481**	0.7003***	0.1648***	–11.89***	–1.52	70.26	21.48***	16.08***	5
	(2.46)	(6.80)	(4.01)	(*p*=0.000)	(*p*=0.128)	(*p*=0.149)	(*p*=0.000)	(*p*=0.000)	
13. $GCAPX_t/TA_t$	0.0547***	0.7411***	0.8594***	–11.88***	–1.56	54.70	21.60***	8.58***	12
	(3.09)	(6.93)	(2.93)	(*p*=0.000)	(*p*=0.118)	(*p*=0.634)	(*p*=0.000)	(*p*=0.004)	
14. $GCAPX_t/TA_{t-1}$	0.0444**	0.7162***	1.1106***	–11.97***	–1.31	64.51	22.82***	20.88***	2
	(2.41)	(6.82)	(4.57)	(*p*=0.000)	(*p*=0.190)	(*p*=0.290)	(*p*=0.000)	(*p*=0.000)	
15. $NCAPX_t/K_{t-1}$	0.0327***	0.7098***	0.1604***	–11.80***	–1.60	66.32	23.35***	16.08***	6
	(1.75)	(6.64)	(4.01)	(*p*=0.000)	(*p*=0.109)	(*p*=0.239)	(*p*=0.000)	(*p*=0.000)	
16. $NCAPX_t/TA_t$	0.0365**	0.7251***	0.9310***	–11.93***	–1.55	62.83	21.76***	10.43***	11
	(2.05)	(6.90)	(3.23)	(*p*=0.000)	(*p*=0.121)	(*p*=0.342)	(*p*=0.000)	(*p*=0.001)	
17. $NCAPX_t/TA_{t-1}$	0.0393***	0.7203***	0.9200***	–11.93***	–1.47	60.06	22.26***	15.60***	7
	(2.20)	(6.95)	(3.95)	(*p*=0.000)	(*p*=0.141)	(*p*=0.437)	(*p*=0.000)	(*p*=0.000)	
18. $NSFA_t/K_t$	0.0336***	0.7375***	0.0331	–11.85***	–1.62	57.35	21.79***	1.35	19
	(1.87)	(7.12)	(1.16)	(*p*=0.000)	(*p*=0.105)	(*p*=0.536)	(*p*=0.000)	(*p*=0.246)	
19. $NSFA_t/Kr_{t-1}$	0.0498***	0.6741***	0.0167	–11.83***	–1.74*	59.45	18.35***	2.34	18
	(2.62)	(6.28)	(1.53)	(*p*=0.000)	(*p*=0.081)	(*p*=0.459)	(*p*=0.000)	(*p*=0.127)	
20. $NSFA_t/TA_{t-1}$	0.0288***	0.7216***	0.5006***	–11.90***	–1.43	68.60	21.37***	11.83***	10
	(1.53)	(6.67)	(3.44)	(*p*=0.000)	(*p*=0.152)	(*p*=0.1839)	(*p*=0.000)	(*p*=0.001)	

Note:

[a] The sample contains 4,320 UK company-year observations for the period 1999–2008. The model specified in Equation 5.5 is estimated by two-step system-GMM estimators using Stata 11.

[b.] The alternative measures of unexpected change in corporate investment are used as an explanatory variable in their respective regressions. The model is specified as

$MAR_{it} = \beta_0 + \beta_1 UEPS_{it} + \beta_2 UINV_{it} + e_{it}$

We also control for time effects by adding a set of year dummy variables. The instruments used for the regression include *Constant*, *Year dummies*, $UEPS_{t\text{-}1\ldots,t\text{-}3}$, $UINV_{t\text{-}1\ldots,t\text{-}3}$, Δ*Year dummies*, $\Delta UEPS_t$ and $\Delta UINV_t$.

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

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

[e.] The 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.

[f.] To check for AR(1) in levels, look for AR(2) in differences, in 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.

[g.] The 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 heteroscedasticity or autocorrelation, but the Hensen *J*-statistic, which is the minimised 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.

[h.] *F*-statistic for the regression which tests the null hypothesis that all of the coefficients except the intercept coefficient are jointly zero.

[i.] We perform Wald test to test the null hypothesis that the coefficient on *UINV* is equal to zero. The test reports results using the *F*-statistic. The associated *p*-value is reported in parenthesis.

[j.] The corporate investment measures are ranked based on their respective Wald test results from the highest informative to lowest informative.

CHAPTER 6

CONCLUSION

6.1 Summary

This thesis empirically investigates the interdependence of corporate investment, financing and payout decisions in the presence of financial constraints, with reference to a large panel of UK-listed companies observed within the period from 1999 to 2008, in an attempt to improve our current knowledge of the simultaneity of the execution of corporate decisions. It also represents one of the first studies to explicitly and systematically examine the influence of uncertainty and managerial confidence on the set of jointly determined corporate decisions within a simultaneous equations system. The simultaneous equations framework explicitly allows uncertainty and managerial confidence to not only affect each of the corporate decisions directly on their own, but also indirectly through their effect on other decisions. Such analyses reveal new insights into the role played by companies' fundamental uncertainty and by managers' psychological bias in determining aspects of corporate behaviour. In addition, this thesis offers, for the first time, a comparison and evaluation of the alternative measures of corporate investment that are currently utilised in applied corporate finance studies. It, therefore, sheds some light and provides some guidance for measuring corporate investment behaviour.

This chapter concludes the thesis by briefly recapping the research questions, summarising the key findings, highlighting the main contributions, discussing the broad implications, acknowledging the limitations, as well as offering some promising ideas for further research.

6.2 Key empirical findings and conclusions

6.2.1 Simultaneous determination of corporate decisions

The comprehensive review of existing literature shows that, although much effort has been devoted to investigating this key set of corporate decisions, corporate investment, financing and payout decisions have typically been treated separately and examined in isolation rather than altogether, and hence there has been little analysis of the simultaneity among them. Prior research, however, has provided both reasons and evidence that corporate investment, financing and payout decisions are likely to be interdependent upon one another and jointly determined by management. Several mechanisms through which the set of corporate decisions may be related to one another have been explored, such as the institutional approach, flow-of-funds approach, tax approach, agency approach, information approach, etc. An important implication is that corporate investment, financing and payout decisions are potentially linked in several important ways, thus should be better analysed within a simultaneous model framework. However, previous studies on the simultaneous determination of corporate decisions are not sufficiently comprehensive, in the sense that they neither provide enough insight into the theoretical mechanism through which the set of corporate decisions are likely to be simultaneously determined, nor offer solid empirical evidence which can verify the potential interactions suggested by the theoretical arguments. Nonetheless, previous studies provide us with guidance in modelling corporate behaviours to avoid the danger of drawing spurious conclusions.

To fill this gap in the existing literature, Chapter 3 investigates the interactions among corporate investment, financing and payout decisions in the presence of financial constraints, with reference to the UK-listed companies. The three main aspects of corporate behaviour are modelled within a simultaneous equations system where they are treated as endogenous. On the whole, our results suggest that corporate investment, financing and payout decisions are indeed inextricably linked and jointly determined by UK-listed companies, as implied by the information asymmetry-based flow-of-funds framework for corporate behaviour. It is found that capital investment and dividend payout, as competing uses of limited funds, are negatively interrelated, and both are positively interrelated to internally generated cash flow and the net amount of new debt issued. These results suggest that UK-listed companies are likely to be financially constrained not only by the availability of internal funds but also by the access to external finance, and therefore managers have to consider their financing and payout choices alongside with their investment decisions.

Furthermore, we divide the entire sample into financially more constrained and less constrained subsamples and analyse them separately, in an attempt to gain deeper insights into the mechanisms through which the set of corporate decisions interrelated with one another. By comparing the magnitude and significance of coefficients on the endogenous variables across the two subsamples results, we find that simultaneity among the three corporate decisions is more pronounced for financially more constrained companies, whist that for less constrained companies is relatively weak. Our empirical results indicate that the substantial economic interactions among the set of corporate decisions observed from UK-listed companies are likely to be attributable to financial constraints.

6.2.2 Corporate decisions under uncertainty

The review of literature also shows that uncertainty associated with a company's future prospects seems to be a critical factor in determining corporate investment behaviour, as highlighted by the real options theory of investment. A broad consensus in existing empirical research is that the effect of uncertainty on investment is negative, although a number of studies also suggest that relationship between uncertainty and investment might be positive or non-linear. However, prior research has largely ignored the importance of uncertainty in financial decisions as well as the potential influence of uncertainty on investment through its effects on financing and payout choices. Given the fact that all corporate decisions are determined on the basis of uncertain information, the omission of relevant information in examining the effect of uncertainty on corporate investment is likely to generate misleading results and lead to inappropriate inferences. Therefore, it is more plausible to model corporate, financing and payout decisions simultaneously, and to investigate the effect of uncertainty on aspects of corporate behaviour within the simultaneous equations system.

In order to comprehensively investigate corporate behaviour under uncertainty, Chapter 3 offers the first systematic attempt to uncover the influences of uncertainty on aspects of corporate behaviour. By examining the effects of uncertainty on corporate decisions within the simultaneous equations system, this thesis offers new insight into the role uncertainty plays, not only as one of the key determinants of real investment decisions, but also as a key factor affecting corporate financial decisions which has been overlooked by the existing literature. We find that the effect of uncertainty on corporate investment is positive and significant, while that of uncertainty on dividend payouts is negative and also significant, suggesting that uncertainty stimulates investment in capital stock, not only on its own but also through its effect on dividend payout policy. Accordingly, companies facing greater uncertainty appear to invest more, and fund the increased investment by resorting to internal finance by cutting dividends rather than resorting to external finance by issuing new debts.

In addition, we find that the effect of uncertainty is more significant for financially less constrained companies but insignificant for more constrained ones, suggesting that less constrained companies respond to uncertainty more aggressively than more constrained ones. Therefore, our results offer new insights that financial constraints not only intensify the simultaneity among corporate investment, financing and payout decisions, but also reduce managerial flexibility in adjusting those corporate decisions to respond to uncertainty.

6.2.3 Corporate decisions and the state of confidence

Recently, an emerging body of literature on behavioural corporate finance uncover that managers' psychological bias may have substantial impact on corporate decisions. In particular, managers' upwards bias towards future company performance may generate overinvestment, underinvestment and pecking order financing behaviours through different channels. Prior research in this area mainly focuses either on the influences of investor sentiment (e.g. Polk and Sapienza, 2009), or on the impacts of managers' personality traits on corporate behaviour (e.g. Malmendier *et al.*, 2011; Hackbarth, 2008; and Malmendier and Tate, 2005). However, little research has been undertaken on the influences of the state of managerial confidence or economic sentiment at aggregate levels on aspects of corporate behaviour, despite it often being argued that this has some bearing on corporate decision-making processes. Although the theoretical framework in this emerging area has not been firmly established and the empirical evidence is still relatively rare, it is plausible to hypothesise that the less than fully rational manager approach to behavioural corporate finance has the potential to explain a wide range of patterns in corporate investment, financing and payout decisions.

By relaxing the conventional assumption that managers are fully rational, Chapter 4 offers the first attempt to investigate the impacts of managerial confidence and economic sentiment at aggregate levels on the jointly determined corporate investment, financing and payout decisions, using data from the panel of UK-listed companies observed within the period from 1999 to 2008. The relations between corporate decisions and the state of sentiment and confidence are examined within a simultaneous equations system which allows for contemporaneous interdependence among the corporate decisions. The empirical results show that the state of confidence at aggregate levels, as proxied by the UK or EU managerial confidence indicators or economic sentiment indicators, has significantly positive effects on companies' real investment and debt financing decisions. The positive effects remain statistically significant even after controlling for company idiosyncratic uncertainty and other fundamental variables. These findings show that managerial psychological bias plays an important role in the determination of corporate decisions, adding new evidence to the small but growing literature on behavioural corporate finance.

In addition, the results presented in Chapter 4 also provide empirical evidence that managers' psychological bias and companies' fundamental uncertainty influence corporate decisions independently through different channels. Both managerial confidence and fundamental uncertainty have positive real effects on corporate investment decisions. However, managers consider different financial choices in response to the increased financing needs caused by different factors. To finance the increased investment spending caused by high managerial confidence and economic sentiment, companies tend to use external debt financing rather than cutting dividends paid to their shareholders. To financing the increased investment spending under a high level of uncertainty, companies prefer to resort to internal finance by cutting dividends rather than resorting to external finance by issuing new debts. Moreover, we find that companies in the services sector behave more aggressively compared to others when their managers are confident. Specifically, they invest in capital stock more intensively, use debt financing more heavily, and cut dividends more decisively when the sentiment is high.

6.2.4 Measurement of corporate investment behaviour

The review of corporate finance literature also shows that the use of the corporate investment to capital stock ratio as a measure of corporate investment behaviour has been common practice in applied studies. Although the corporate investment ratios used in the existing literature are similarly specified and interpreted in the same way, they in fact vary both on the numerator and the denominator. At least twenty different constructions of corporate investment to capital stock ratio have been identified in the existing literature. However, no attempt has been made to provide a comparison among various corporate investment measures. One claim which has been implicitly made is that different measures of corporate investment behaviour will always yield the same, or at least qualitatively similar, results in empirical analyses. As a consequence, we know little about how differently these corporate investment measures perform in empirical analyses, and the extent to which the choice of corporate investment measures may influence the conclusions drawn from empirical analyses.

Chapter 5, therefore, aims to fill this important gap in the literature by discriminating conceptually and evaluating empirical twenty different measures of corporate investment that are currently used in applied studies. The various corporate investment measures are first discriminated from an accounting perspective. Given the fact that different accounting principles as well as different elements are involved in the construction of the alternative corporate investment measures, they are likely to carry different sets of information about a company's investing activities. Information about a company's future prospects contained in one corporate investment measure may not necessarily present in others, and vice versa. Due to a lack of understanding of the financial information provided by the relevant accounting items, corporate investment measures are potentially misused in empirical analyses. The conflicting conclusions drawn from the empirical literature on corporate investment, therefore, may also be attributable to the differences in measuring companies' investment behaviour.

With a balanced panel of UK-listed companies over the period 1999–2008, we empirically demonstrate that the alternative corporate investment measures are not uniformly positively correlated with one another. Significantly negative correlations are also observed among the alternatives, which appear surprising, since they are supposed to measure the investment behaviour of the same batch of companies over the same period of time. Therefore, there is no reason to expect the different measures of corporate investment ratio to yield equivalent results in empirical analyses. Accordingly, we posit that the conclusions drawn from empirical analyses are likely to be sensitive to the choice of corporate investment measures. This prediction is empirically verified by repeatedly estimating a simple Tobin's Q model of investment, which indicates that the measurement of corporate investment behaviour does indeed matter in empirical analyses.

To assess the empirical performance of the alternative corporate investment measures, we carry out both trend analysis and information content analysis. The empirical results suggest that gross investment measures are systematically less noisy compared to the net investment measures, while cash based corporate investment measures are systematically more informative than their accrual based counterparts. Accordingly, we conclude that cash based gross corporate investment to capital stock ratios are the best performing measures of corporate investments behaviour among the alternatives, as they contain relatively less noise and greater value relevant information. Researchers in the area of corporate finance, therefore, are suggested to utilise cash based gross corporate investment measures for their future empirical analyses if they have to make mutually exclusive choices among the alternatives without any particular preference.

6.3 Main contributions to the existing literature

This thesis aims to fill the critical lacunae identified in the existing corporate finance literature, by investigating corporate investment, financing and payout decisions simultaneously, with reference to a large panel of UK-listed companies. Based on an implicit flow-of-funds framework for corporate behaviour, we develop a simultaneous equations system that explicitly accounts for the interdependence among the three corporate decisions, with each of the decisions being treated as endogenous. Furthermore, the simultaneous equations system is also used as a platform for undertaking empirical investigations into the influences of fundamental uncertainty and sentimental bias on the set of jointly determined corporate decisions. Conducting such a study makes a number of important contributions to the existing literature, which we believe, would enhance our understanding of the complex corporate decision-making process in the real world.

Specifically, the main contributions of this thesis are fivefold. First, unlike previous studies that focus only on one aspect of corporate behaviour, we treat corporate investment, financing and payout decisions endogenously, and model them simultaneously within a system as implied by an implicit flow-of-funds framework for corporate behaviour. By utilising recent econometric methods for simultaneity analysis, this research overcomes the shortcomings of single equation techniques currently adopted in the existing literature, and provides new insight into the interdependences among the corporate decisions in practice. The interactions among the corporate decisions are empirically verified in Chapter 3 and further confirmed in Chapter 4 based on the evidence obtained from UK-listed companies, contributing to the current knowledge of the complex interdependence of corporate behaviour under financial constraints.

Second, we explicitly explore the possible channel through which the set of corporate decisions are interdependent upon one another, in order for us to fully facilitate the corporate decision-making process. By splitting the entire sample into two subsamples with financially more constrained and less constrained companies respectively, we find that the simultaneity among the three corporate decisions is more pronounced for financially more constrained companies, whist that for financially less constrained companies is relatively weak. This indicates that the substantial economic interactions among the set of corporate decisions observed from UK-listed companies are likely to be caused by financial constraints. The findings offered in Chapter 3 are helpful in explaining the joint determination of corporate decisions in practice.

Third, this thesis offers the first systematic attempt to uncover the influences of uncertainty on aspects of corporate behaviour. By examining the effects of uncertainty on corporate decisions within the simultaneous equations system, this thesis offers new insight into the role uncertainty plays, not only as one of the key determinants of real investment decisions, but also as a key factor affecting corporate financial decisions which has been overlooked by the existing literature. In addition, we find that financially less constrained companies tend to behave differently under uncertainty from financially more constrained ones. This thesis, therefore, extends the existing literature on corporate behaviour under uncertain circumstances. This is again achieved in Chapter 3.

Fourth, this thesis represents one of the first studies to explicitly and systematically investigate the influences of the state of confidence at aggregate levels on the set of jointly determined corporate decisions. By relaxing the conventional assumption of broad rationality, the study highlights the importance of managers' psychological bias, as proxied by managerial confidence and economic sentiment indicators, in the determination of the corporate decisions. The findings with regard to the influence of the state of confidence on aspects of corporate behaviour persist even after controlling for company-level uncertainty and other company fundamental characteristics, indicating that the state of confidence and the level of fundamental uncertainty affect corporate behaviour independently through different channels. The research work presented in Chapter 4 adds empirical evidence to the small but growing strand of literature on behavioural corporate finance.

Finally, the comprehensive review of literature shows that the use of corporate investment to capital stock ratio as a measure of corporate investment behaviour in empirical analyses has become a common practice. However, to the best of our knowledge, there has been no literature that provides a comparison among the various versions of corporate investment ratio which seem at first sight very similarly constructed. An attempt is made in this thesis to conceptually discriminate and statistically compare twenty alternative measures of corporate investment which have been identified in the existing literature. The evaluation results presented in Chapter 5 not only provide some guidance for measuring corporate investment behaviour in future empirical analyses, but also to some extent explain the inconsistent evidence and conflicting conclusions in the existing empirical literature on corporate investment.

6.4 Practical implications of the findings

The findings and conclusions presented in this thesis not only contribute to the existing academic literature, but also have broader practical implications, especially for corporate managers, public policy makers and investors.

6.4.1 Implications for corporate managers

Since our investigation focuses particularly on the simultaneity as well as determinants of corporate investment, financing and payout decisions of UK-listed companies, we first consider the practical implications for corporate managers.

First, the interactions among corporate investment, financing and payout decisions evidenced in this study have distinct implications for companies and their managements. In making key corporate decisions, managers must be aware of the inherent interactions which exist among them, in order to avoid undesirable side effects which may stem from a given decision. Thus, managers should consider the key corporate decisions simultaneously, or if the decisions are taken piece meal due consideration must be paid to the influence of the other factors. Particularly, in the presence of financial constraints, companies have to consider their fund-raising choices alongside their fund-spending decisions, in an attempt to prevent losses from underinvestment and at the same time to keep their overall cost of capital as low as possible, such that shareholders' wealth can be maximized.

Second, the empirical evidence on the relationship between investment and uncertainty uncovered in this study also has profound implications for corporate decision makers. Our results indicate that, in a competitive business environment, uncertainty associated with future prospects tends to increase not only the value of real option but also the advantage of pre-emption. In such a multi-player context, selectivity, value and timing of a company's investments are likely to be influenced by the similar investment decisions made by its peers. Managers therefore need to consider the strategic interactions among the peers in making corporate investment decisions. If there a strong and persistent advantage to be the first to invest, companies might be better off by investing earlier to pre-empt their rivals in spite of the uncertain outcomes.

Third, it is found that managers are likely to be overconfident in making corporate decisions, and their upward psychological bias towards their companies' future performance may result in distortions in corporate decisions. Although the less than fully rational managerial behaviour is fundamentally different from the rational moral hazard behaviour in the sense that managers believe that they are maximising their company's value, managers' upward psychological bias are likely to result in unintended overinvestment problems and simultaneously make their companies over indebted, which may damage shareholders' wealth. These unintended distortions in corporate behaviour caused by managerial overconfidence cannot even be mitigated by using conventional incentives such as stock- or option-based compensation, as indicated in earlier work by Malmendier *et al.* (2011). Therefore, in order to better serve shareholders' interests, innovative contracting practices and organizational designs are needed to constrain managers' upward psychological bias.

6.4.2 Implications for public policy makers

Although this study focuses primarily on aspects of corporate behaviour, the empirical findings and conclusions drawn from this thesis may also have some implications for public policy makers.

First, our empirical results suggest that the corporate investments of UK-listed companies are likely to be financially constrained not only by the insufficient availability of internal funds but also by the limited access to external funds. It is evident that financially less constrained companies are able to invest more efficiently by putting more weight on their real considerations in making corporate investment decisions, whereas the investments of financially more constrained companies are highly sensitive to their financial choices. Previous studies, such as Bond *et al.* (2003), indicate that, compared with the continental European financial system, the market-oriented financial system in the UK perform less well in channelling investment funds to companies with profitable investment opportunities because of the information asymmetry results from the arm's-length relation between companies and suppliers of finance. Therefore, an important implication for public policy makers is that, by mitigating the degree of information asymmetry, which seems to be severe in the UK financial system, a more accommodative environment for business activities, in terms of corporate investment and financing, can be created.

Second, it is found that managerial confidence and economic sentiment play a key role in the formation of companies' expectations of future returns and risks, and thus in the determination of corporate decisions. High levels of confidence and sentiment encourage companies to take on more debt, which in turn enables them to invest more in capital assets. Therefore, the extent to which a policy stimulus contributes to an improvement in managerial confidence and economic sentiment is likely to be highly important. This implication is particularly relevant for the public policy makers who are trying to stimulate corporate investment spending amid the on-going global financial crisis. In addition, certain level of uncertainty may also encourage companies to investment earlier in a competitive market environment, because the threat of being pre-empted may offset the value of the real option.

Third, our simultaneous analyses show that corporate investment spending and dividend payout are competing uses of limited funds, and the negative relationship between the two variables may also have some implications for policy makers. It has long been argued that, in comparison to the classical system, the imputation tax system in the UK encourages companies to pay dividends rather than retain their profits (see, for example, Adedeje, 1998). Such a tax system therefore may exert a negative influence on corporate investment spending in the long run. Given this negative interaction between corporate investment and dividend payout decisions, government might be able to encourage corporate sector's investment spending by adjusting its tax policy on dividends.

6.4.3 Implications for investors

In addition to the implications for corporate managers and public policy makers, the empirical evidence presented in this thesis also has implications for investors in general.

The simultaneous analysis clearly shows that a company's dividend decision is neither totally residual nor completely independent, but is taken with reference to its investment and financing decisions. In practice, investors seem to have strong preferences for high dividend payout ratios as they consider it as a sign that directors are alive to their shareholders.

However, investors may have not thought through the interactions that exist between dividend payout and corporate investment, and between dividend payout and debt financing. If fact, the size of dividend paid to shareholders directly affect both capital investment and debt financing decisions made by a company. If investors constantly put a high premium on dividend payers, companies might be forced either to forego relatively low net present value investment projects or to raise more external funds through a catering channel, resulting in either underinvestment losses or flotation costs. Therefore, an important implication for investors is that high levels of dividend payouts are not always in the best interest of shareholders. Shareholders should consider dividends paid by a company in the contest of the company's investment opportunities and financing abilities.

6.5 Limitations of the research

It is worth noting that there are several limitations of the research reported in this thesis. First, the research relies mainly on the empirical research methodology, as illustrated by Figure 1.1, to test theoretical predictions. The findings and conclusions of this thesis are largely drawn from the accumulation of evidence collected from the dataset. Hence, the first main limitation of this thesis is that the validity of the conclusions may, to some extent, be sensitive to the selection of the sample, the measurement of variables, the specification of models, the choice of estimation techniques and the interpretation of results. Given the fact that a large amount of financial and accounting information is used to produce the empirical evidence, the results presented in this thesis may also be subject to the managerial manipulation of the reported accounting data.

Second, this thesis does not attempt to develop theoretical models and proofs on corporate finance issues. By using statistical hypothesis testing methods, we can only find empirical evidence to support or reject the theoretical predictions implied by the existing corporate finance theories, rather than prove them. Thus, theoretical issues in corporate finance are not explicitly addressed in this thesis.

Third, although this thesis tries to systematically and simultaneously investigate the key corporate decisions within a framework as a whole, some important issues relating to corporate finance, such as corporate governance, initial public offering and seasoned equity offering, are not addressed here, owning to the lack of availability of relevant data. In particular, external equity financing is dropped from the flow-of-funds framework for simplicity, and thus the importance of financing through stock issuance is overlooked.

Besides this, since the thesis is produced by combining four stand-alone research papers, presented in Chapters 2, 3, 4 and 5, there is some limited amount of overlap among the chapters, in particular the duplication of literature review material. However, it is also necessary to review briefly the relevant previous studies in the empirical chapters to maintain their stand-alone status. We, therefore, allow for a limited amount of overlap among chapters, but the amount of overlap has been minimised where possible.

Despite the above shortcomings, this research reveals new insights into the complex corporate decision-making processes. Some of the limitations of the research are expected to be addressed in the future research.

6.6 Promising ideas for further research

Finally, a number of promising ideas for future research can be drawn from the existing literature reviewed and the empirical findings presented in this study. We conclude this thesis by proposing a number of promising research ideas for the further extensions of this study.

This study investigates a key set of corporate decisions within a simultaneous equations system, as implied by the flow-of-funds framework. However, we do not consider external equity finance as a significant source of external finance, given the argument that it is rarely used after initial public offerings (see, for example, Cleary *et al.*, 2007; and Shyam-Sunder and Myers, 1999). Following the "fairly standard assumption", external equity financing thus has been dropped from the system for simplicity in this study. However, some other studies, such as Frank and Goyal (2003), claim that net equity issues on average exceed net debt issues in the US, and that net equity issues may track financing deficit more closely than do net debt issues. Therefore, further research may incorporate external equity financing into the simultaneous equations system, in order to explore the interactions between the external equity financing decision and other corporate decisions modelled in the system.

Apart from the flow-of-funds framework for corporate behaviour, a number other approaches, such as tax approach and agency approach, may also be adopted to establish linkages among corporate investment, financing and payout decisions. These hypothesised mechanisms are not mutually exclusive, but they may have very different implications for the interactions among the set of corporate decisions. Further research may specify simultaneous equations systems for the set of corporate decisions in accordance with the alternative mechanisms, to further improve our understanding of the complex corporate decision-making process in the real world.

Contrary to the broad consensus in the existing literature that uncertainty hampers corporate investment because of the increased value of the real "call option" to invest under uncertain circumstances (see, for example, Bloom *et al.*, 2007 and Carruth *et al.*, 2000), this study finds a significant but positive effect of uncertainty on the corporate investment of the UK-listed companies. This finding provides empirical support for the recent argument by Mason and Weeds (2010) that greater uncertainty can lead companies to take the advantage of pre-emption by investing earlier under a competitive business environment. However, the mechanism through which uncertainty stimulates corporate investment is not explicitly explored in this study, and thus needs to be addressed in future research. One possible solution is to classify the sample companies into monopolies and competitive companies according to their market structures (see, for example, Lensink and Murinde, 2006), and re-estimate the simultaneous equations system using subsamples. If Mason and Weeds' (2010) argument holds, we expect the positive effect of uncertainty on investment to be more significant for a competitive company than for a monopolistic company.

The construction of an appropriate proxy for uncertainty remains as the primary challenge faced by studies considering the effects of uncertainty on corporate 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 of the information about a company's asset fundamentals and growth opportunities will be properly transmitted into its share price. Thus, our measures of uncertainty are expected to capture the overall uncertainty associated with the changing aspects of a company's environment. However, Carruth *et al*. (2000) argue that a test of the investment-uncertainty relationship should distinguish between the effects of industry-wide and company-specific shocks. The main concern is that irreversibility and strategic considerations act in opposite directions, thus the two effects may cancel each other out and lead to an inconclusive result. Therefore, another promising research idea is to decompose a company's total uncertainty into its market, industry and company-specific components, and explore the effect of uncertainty at different levels on aspects of the corporate behaviour of UK-listed companies.

Similarly, the principal challenge of incorporating the concepts of confidence into corporate behavioural modelling is to construct plausible measures of the hard-to-define idea (see Malmendier and Tate, 2005). In this study, we employ managerial confidence and economic sentiment indicators as proxies for the state of confidence at aggregate levels. However, recent literature in behavioural corporate finance has proposed a number of creative methods to proxy managerial confidence at company level. For example, Malmendier *et al.* (2011) and Malmendier and Tate (2005) exploit the overexposure of CEOs to the idiosyncratic risk of their companies, as reflected by their personal portfolio of their companies' options and stockholdings, to measure managerial confidence in the US. Ben-David *et al.* (2007) measure overconfidence based on CFOs' confidence intervals of their stock market predictions. Lin *et al.* (2005) construct managerial confidence measures for Taiwanese companies based on CEOs' forecast errors in their companies' future earnings. Unfortunately, such data that can be used to construct measures of managerial confidence at manager level is not readily available in the UK market. However, it is possible for further study to construct more direct measures of managerial confidence using survey instruments. Survey responses from corporate decision makers are expected to be better able to capture managerial confidence or overconfidence.

It is clear that future research into corporate investment, financing and payout decisions is required, and much more remains to be done. With the development of theoretical frameworks and the accumulation of empirical evidence, our knowledge about aspects of corporate behaviour will be continually improved in the future.

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