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Essays in Cash Holdings

Thesis submitted to the Graduate Program in Business Management at University of Brasília in partial fulfillment of the requirements for the degree of Ph.D in Business Management, area Finance.

Advisor: Dr. Herbert Kimura
Professor of Finance - University of Brasília

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Abstract

This thesis consists of three articles covering topics in corporate cash holdings. The first article proposes to map the current state of cash holdings through a systematic literature review that show links, core ideas, networks, methods, and findings that have built the research pathway for corporate cash holding strand. Basically, the saying “*once bitten, twice shy*” reflects how firms around the world have behaved over time regarding their cash-holding policy. We show that the upward trend on cash holdings remains across firms from both developed and developing countries. In a survey of 105 papers from 1997 to 2015, we identify papers published on cash-holding research that have used agency theory, trade-off theory, pecking order theory, and contemporary approaches to ground theoretical and empirical improvements to the cash holding literature. We then classified and coded each paper, and a research agenda and some recommendations that may advance the field are presented.

The second article attempts to answer an unexplored issue related to insider ownership, cash holdings and idiosyncratic risk. Cash is considered the most liquid of a firm’s assets enabling firms to finance growth opportunities, avoiding the high cost of raising external funds, and providing liquidity when firms need it the most. Although excess cash increases a firm’s ability to reach corporate goals, it does not ensure that managers will commit to a corporate strategy that protects shareholders and other investors. To mitigate potential misbehaviour, insider ownership should be increased to align managers with shareholders’ interests. However, if a significant proportion of manager’s personal wealth is linked to compensation packages based on equity shares, managers will be exposed to idiosyncratic risk. We investigate the relationship among corporate cash holdings, insider ownership, and idiosyncratic risk. Using a sample of US firms from 1992 to 2014, we find that idiosyncratic risk drives firm cash policies, and insider ownership is negatively related to corporate cash holdings. We do not find that the level of insider ownership affects the cash–idiosyncratic risk relationship.

The third article focuses on the real consequences on cash policy when firms face expected and unexpected shocks. In particular, it is explored how cash holdings and derivatives instruments interplay to manage corporate risk on exogenous shocks. We employ difference-in-differences methodology around two exogenous variation that produce expected and unexpected shocks on corn price volatilities in the American market. The paper provides evidence that the unexpected shock positively influences firms to holding cash. We further find that financially constrained firms also maintain higher cash balances than unconstrained firms after unexpected exogenous variation. The analysis also reveals that cash holdings and derivatives instruments perform a substitute role on firm’s risk management policy. The findings suggest that firms that used derivatives are less sensitive to exogenous shocks than firms that did not use these financial hedging instruments.

Keywords: Cash holdings, idiosyncratic risk, managerial ownership, financial constraints, derivatives.

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"Far better is it to dare mighty things, to win glorious triumphs, even though checkered by failure, than to rank with those poor spirits who neither enjoy nor suffer much, because they live in a gray twilight that knows not victory nor defeat". Theodore Roosevelt.

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1 Introduction

Why firms hold cash? What is the value of cash holdings? Is there an optimal amount of corporate cash holdings? How cash affects other corporate policies such as investment, financing and risk management? These questions have been extensively debated in corporate finance field over the last two decades. In fact, from funding daily operations through financing long-term investment to hedging risk, cash holdings play an important role at the firm's heart decisions. In this regard, understanding cash policy appears to be a relevant issue if we want to enhance and refine our knowledge on firm value, corporate investment and financing choices.

Three related facts have contributed to highlight the importance of cash holdings in corporate finance field. First, the dramatic increase of cash reserves by firms around the world in recent years. Second, the relevance of cash holdings among firms' financing choices. Third, the role of cash holdings have performed in risk management strategy. While the first strand has attempted to present the determinants of why firms hold cash, the second and third fields have studied how firms employ cash in corporate decisions and the real consequences of corporate choices.

The upward trend in cash holdings has been noticed either in the US or over the world. Among non-financial S&P500 firms, cash ratios increased from \$200 billion in 1996 to \$1,334 billion in 2012 (Almeida et al., 2014). The median cash to total asset ratios varied over the period 1989–2009 from 2.3% for New Zealand to 3.6% for Russia, 5.2% for Australia, 8% for Finland, 10.1% for Sweden, 13.7% for Singapore, and 16.6% for Hong Kong (Y. Chen et al., 2015).

Three main explanations have prevailed on the literature for the increase in firms' cash levels: precautionary motive, tax-based reasons, and agency incentives. The precautionary motive arises when firms are likely to face any constraints or uncertainty related to future economic or business condition. Under tax-based perspective, firms would hold cash overseas to avoid taxation costs associated with repatriation of foreign income (Fritz Foley et al., 2007) or/and to pay future tax claims on prior and current tax positions (Dyreg et al., 2008). Agency incentives aim for disciplining manager misbehavior regarding the efficient use of cash and aligning managers and shareholders interests to enhance firm value (Nikolov & Whited, 2014; Louis et al., 2012; Dittmar & Mahrt-Smith, 2007; Mikkelsen & Partch, 2003).

As a financing instrument, cash holdings can be used to undertake profitable investment opportunities (Ferreira & Vilela, 2004), to reduce the cost of accessing external financing (Almeida et al., 2004), to service debt during economic distress (Acharya et al., 2007), and/or as a resource to be utilized during difficult times (Campello et al., 2011). Although excess cash raises the firm's ability to support its financing and investment policies, it does not provide assurance that managers will commit to a corporate strategy that protects shareholders and other investors (Arnold, 2014). As a result, agency conflicts might arise and distort corporate cash policy.

In this regard, agency incentives through insider ownership is employed to minimise agency problems. However, using insider ownership as a monitoring tool may lead to other outcomes. First, the higher the level of insider ownership, the higher control the manager has over the company (Ozkan & Ozkan, 2004). It might encourage the manager to di-

vert resources for his/her own private benefit. Second, although compensating manager with firm's stakes might align shareholders and manager's interests, it also exposes the manager to the idiosyncratic risk when the executive is less diversified than stockholders (Holmström & Tirole, 1998). We then analyse in the third chapter whether the level of managerial ownership affects the relationship between cash and idiosyncratic risk.

As a risk management tool, cash might reduce cash flow volatility and consequently mitigate financial risks that could affect firm's future profits (Acharya et al., 2007). Nonetheless, holding cash is not costless, at least, due to the presence of transaction costs, such as taxes and flotation fees, imputing a value of reserving cash (Faulkender & Wang, 2006). Moreover, if cash is used to protect against future shortfall, it is expected firms might bypass interesting investment opportunities. In this regard, hedging via derivatives alleviates the effect of financial constraints by enhancing the corporate liquidity when firms need it the most. We therefore explore the relationship between cash holdings and derivatives on expected and unexpected shocks in the fourth chapter.

Addressing these points represent an important contribution for corporate finance literature. Then, the purpose of the three essays constituting this thesis attempts to contribute in three important directions. The first essay offers a broad literature review where it is possible to understand better the corporate motivations for holding cash as well the links, core ideas, methods, and findings that have built the research pathway for corporate cash holding strand. The second essay examines whether the agency incentive through insider ownership influences changes on corporate cash holdings when idiosyncratic risk is considered. The third essay analyses the effect of expected and unexpected exogenous shocks on corporate cash holdings and financial hedging policies.

This thesis is organized as follows. Chapter 2 describes a broad literature review involving cash holdings in different perspectives. Chapter 3 analyses the influence of insider ownership level on the relationship between idiosyncratic risk and cash holdings. Finally, Chapter 4 presents how firms manage their cash and hedging policies followed by expected and unexpected shocks.

2 Why once bitten, twice shy? Past, present and future on corporate cash holding research

Record levels of cash holdings have been maintained by U.S. corporations in recent years (Almeida et al., 2014; Harford et al., 2014; Bates et al., 2009). “*Once bitten, twice shy*”? Almeida et al. (2014) show that cash holdings among non-financial S&P500 firms increased from \$200 billion in 1996 to \$1,334 billion in 2012. Holding of cash is not just a feature for U.S. firms. Y. Chen et al. (2015) find that the median cash to total asset ratios varied over the period 1989–2009 from 2.3% for New Zealand to 3.6% for Russia, 5.2% for Australia, 8% for Finland, 10.1% for Sweden, 13.7% for Singapore, and 16.6% for Hong Kong. Focusing on two different times in a 20-year window for Compustat Global data, we observe this increasing trend for cash-holding ratios around the world, as shown in Figure 2.1.

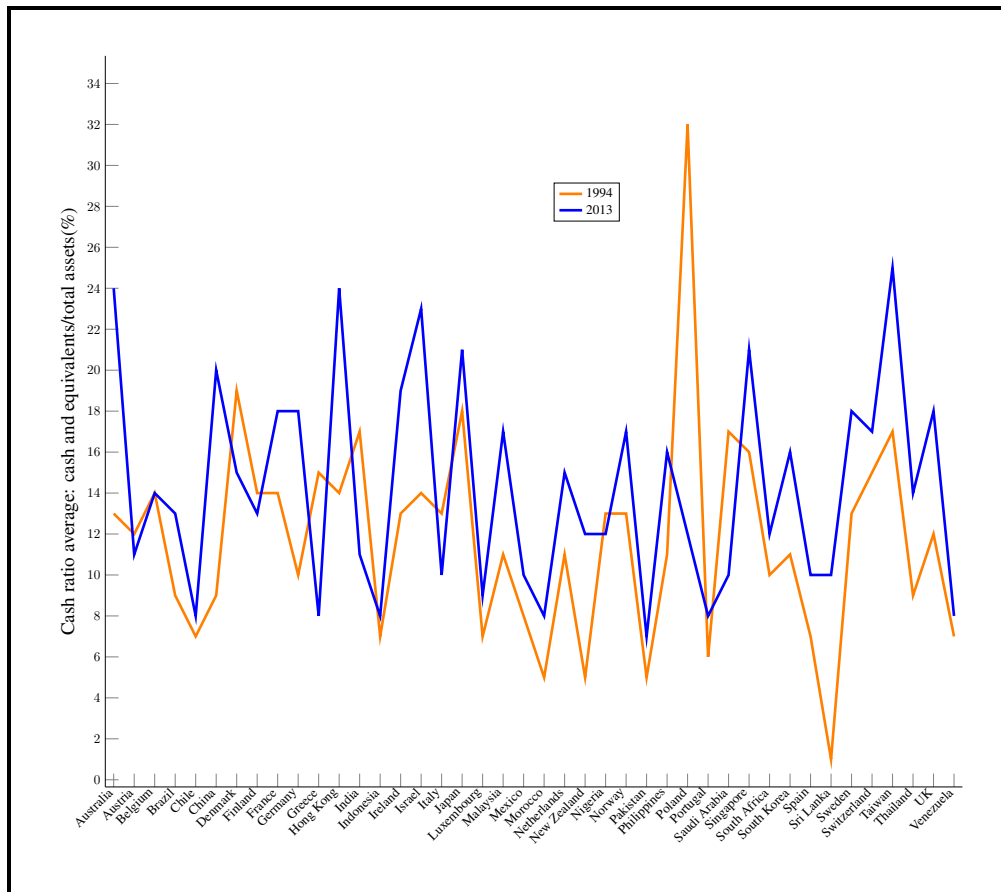


Figure 2.1: Cash ratio average (%) across the world in 1994 and 2013.

Several possible explanations for this upward trend in cash holdings have been explored in recent years. The relevance of cash holdings goes back at least as far as Keynes (1936), who ascribes corporate cash holdings for operational transactions and precautionary savings to future uncertainty. Supporting this view, Almeida et al. (2004) shed light on the role of the firm sensitivity of cash holdings to cash flows when a firm faces financial constraints. If a firm is financially constrained it may have to incorporate savings from incremental cash flows to protect its future. As a result, this firm might hold a

considerable portion of cash as a hedging tool during downturns. Likewise, cash holdings enable firms to attempt to take advantage of investment opportunities and/or reduce the cost of accessing external financing. Hence, the importance of cash for a firm depends on whether it will face a liquidity shortfall and have to use the cash to finance investments (Almeida et al., 2014; Acharya et al., 2007).

Determinants of cash holdings have been intensely debated in the finance literature in an effort to comprehend and forecast corporate cash-hoarding behaviour. Viewing cash holding from the perspective of its determinants might reveal why firms have held cash over time. Research topics have included firm-level factors such as size (Bigelli & Sánchez-Vidal, 2012; Colquitt et al., 1999), managerial compensation (Al-Najjar, 2015; Core et al., 2006), and leverage (Anderson & Carverhill, 2012; Ferreira & Vilela, 2004); the influence of sectors (Bates et al., 2009; Lamont, 1997), institutions, and structures such as banks (Francis et al., 2014; Kahle & Stulz, 2013), governance levels (Schauten et al., 2013; Kusnadi, 2011; Dittmar & Mahrt-Smith, 2007), unions (Klasa et al., 2009), and governments (D. Chen et al., 2014; Feng & Johansson, 2014); exogenous shocks (Davydova & Sokolov, 2014; Campello et al., 2011, 2010) and taxes (Fritz Foley et al., 2007); and national cultures around the world (Y. Chen et al., 2015; Ramírez & Tadesse, 2009).

Cash holdings have also been analysed as an antecedent factor that influences other corporate financial issues such as investment levels (Bao et al., 2012; Song & Lee, 2012; Özgür Arslan et al., 2006), acquisitions (Pinkowitz et al., 2013; Almeida, Campello, & Hackbarth, 2011; Harford, 1999), share repurchases (Rapp et al., 2014; Haw et al., 2011; E. Lee & Powell, 2011), payouts (Opler et al., 1999), R&D (J. R. Brown & Petersen, 2011; Dittmar et al., 2003), stocks and their expected returns (Fresard, 2011; N. Gao, 2011; A. G. Huang, 2009), and risk (Acharya et al., 2014; Palazzo, 2012). This wide research scope in terms of subjects, levels, and time has been grounded under classical and contemporaneous theoretical frameworks.

Given the relevance of the topic, we analyse nearly 190 papers related to cash holdings published from 1997 to 2015. Especially since the 2008 financial crisis, research on cash holdings significantly increased by more than 50% when compared to the period from 1997 to 2007, as shown in Figure 2.2. This evidence indicates considerable concern regarding cash holdings since 2008 among not only companies, industry and government levels but also academic financial researchers around the world.

Although research has pointed out the importance of cash among sources of corporate liquidity, the question of why and how firms have held cash remains to be answered (Almeida et al., 2014). Similarly, there is no consensus on the optimal level of corporate cash holdings (Riddick & Whited, 2009; Almeida et al., 2004), and their determinants and consequences remain ambiguous, particularly across countries (Y. Huang et al., 2013; Drobetz et al., 2010; Pinkowitz et al., 2006; Dittmar et al., 2003). Thus, understanding and mapping the debate on corporate cash holdings may support present and future research, and provide a better insight into the direction for such research and potential gaps. We therefore focus on three main questions:

1. What, where, when, and how have cash holdings been explored in the literature?
2. What contributions does the literature provide to the development of the finance field?
3. What are the main gaps to focus on for future research on cash holdings?

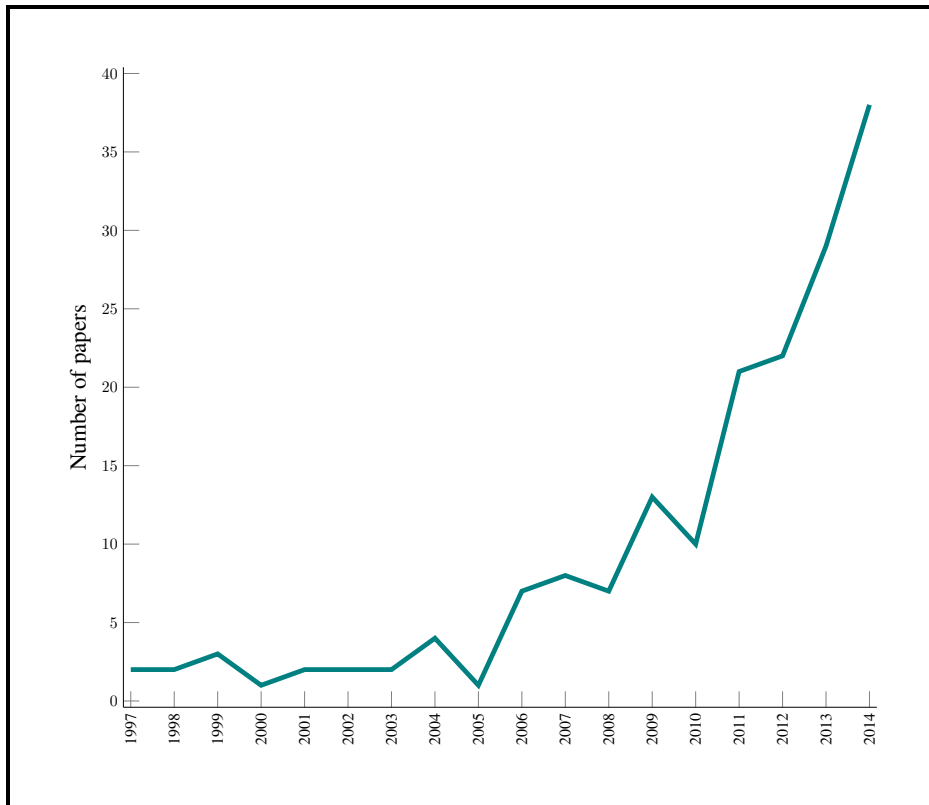


Figure 2.2: Papers published by year.

To address these questions, we present a systematic literature review in which we analyse the content of articles related to cash holdings in the finance field. To this end, we have five specific objectives:

- Pinpointing the most relevant articles on cash holdings;
- Categorising the features of these articles;
- Providing a brief summary of the goal, contributions, and limitations of each article;
- Delineating evolution, links, and divergences among studies reported in the literature; and
- Designing an agenda and a framework for identifying major gaps in the current literature on cash holdings.

The remainder of the paper is organised as follows. Section 2.1 describes the research design. Section 2.2 provides a theoretical background on corporate cash holdings. Section 2.3 delineates the evolution of the literature on cash holdings, including the papers cited most often, scholar networks, and the research methods used. Section 2.4 identifies research gaps and suggests avenues for future research in the field. Section 2.5 presents concluding remarks.

2.1 Research design

Following Seuring (2013) and Furrer, Thomas, and Goussevskaia (2008), we use a content analysis approach from the field of exploratory network analysis (Nooy et al.,

2005) to reveal links, attributes, and core debates on cash holdings in the literature. This allows us to track the evolution of the research and to identify challenges and insights for future research in the field. Unlike the studies by Seuring (2013) and Furrer et al. (2008), we do not focus only on quantitative modelling or papers published in leading journals. We extend the scope of our investigation to most of the theoretical and empirical articles that have been published on cash holdings over time. We also fill a gap left by Almeida et al. (2014) by considering the liquidity literature on estimates of the value of cash and dynamics models of cash. Moreover, to the best of our knowledge this is the first survey on cash holdings.

We first identify all available papers on cash holdings using the keywords cash, cash ratio, cash holdings, corporate cash reserves, cash management, liquid assets, and corporate liquidity in different academic journal databases, including *Scopus*, *Wiley*, *Web of Science (WOS)*, *Academic Search Complete PLUS (Ebsco)*, *JSTOR*, *Taylor & Francis*, *Emerald* and *Springer*. This search reveals that 186 relevant papers were published in the period from 1997 to January 2015. From these, 105 papers published in journals with an impact factor of 1 or greater are selected to assess the evolution of and linkages among research topics related to corporate cash holdings. Then these papers are coded and analysed according to the ten categories shown in Table 2.1.

The main focus for each paper was identified from the keywords and aim. For the method category, conceptual/theoretical papers are those involving a literature review or design concepts associated with cash holdings, while survey papers are studies use survey instruments to gather primary data. The remainder of the classifications are self-explanatory.

In the statistical tool/data analysis category, standard econometric papers are considered to be those that use a univariate approach to explore only one dependent variable of interest. By contrast, multivariate analysis involves multiple dependent variables (Johnson & Wichern, 2007).

We then identify whether the variable related to cash holdings in the empirical model is a dependent variable, an independent variable, or used to construct other variables. We verify if the source of the variables used in the analysis is the balance sheet, market price data, macroeconomic data, exogenous sources, primary data, or other sources. The classification of exogenous variables follows that of the authors for studies that distinguish this type of variable.

Since cash holdings may vary across countries, sectors, firms, and time, we identify the analysis level, study context, and time period for all papers. Finally, we classify the theoretical perspective used by the authors and their findings. If the content of a paper does not fall within the previous subcategories, it is classified as other. If a paper is exclusively theoretical or does not match any previous criterion, it is classified as not applicable.

Table A.1 lists the data classification and categorisation for each paper. Then descriptive statistics for each category are estimated and evaluated concurrently with the paper content. Our analysis using Acharya et al. (2007)'s paper as an example (Table A.1).

In Table A.1, the main focus of Acharya et al. (2007) is classified as subcategory E (economic and financial constraints, market imperfections, exogenous shocks and risk); the method as quantitative (subcategory B); and the statistical tool/data analysis as mathematical modelling (subcategory A), a standard econometric model (subcategory B),

Table 2.1: Main categories of survey analysis.

Classification	Meaning	Cryptography
1	Main focus.	A - Corporate decisions, policies and strategies. B - Agency problems, ownership, governance, organizational forms, and compensation design. C - Culture, politic, government, unions, product market competition and relationships. D - Credit supply, internal and external capital market, financial markets. E - Economic and financial frictions, market imperfections, exogenous shocks and risk.
2	Method.	A - Conceptual/Theoretical. B - Quantitative (empirical and mathematical model). C - Qualitative. D - Quantitative/qualitative or qualitative/quantitative. E - Cases. F - Survey.
3	Statistical tool/data analysis.	A - Mathematical modeling. B - Standard econometric. C - Computational method. D - Multivariate analysis. E - Not applicable.
4	Position in analytical model.	A - Dependent variable. B - Independent variable. C - Used to construct other variable. D - Not applicable.
5	Variable source.	A - Balance sheet variables. B - Market price data. C - Macroeconomic variables. D - Exogenous variables. E - Primary data. F - Others. G - Not applicable.
6	Level analysis.	A - Country. B - Business group/Conglomerate. C - Sector/Industry. D - Firm. E - Others. F - Not applicable.
7	Study context.	A - World. B - USA/Canada. C - Europe. D - Asia/Oceania. E - Latin America. F - Africa. G - Not applicable.
8	Analysis period.	A - More than 10 years. B - Between 5 and 10 years. C - Between 3 and 5 years. D - Less than 3 years. E - Not applicable.
9	Theoretical perspective.	A - Trade-off theory. B - Pecking order theory. C - Agency-based theories. D - Others perspectives - contemporary trends. E - Not applicable.
10	Findings.	A - New perspectives. B - Consistent with previous literature. C - Previous model with different dataset/time period. D - Comparative study. E - Others. F - Not applicable.

and multivariate analysis (subcategory D). In this example, cash holdings are used to build other dependent variables (subcategory C) and the variable sources are the balance sheet (subcategory A) and market price data (subcategory B). Moreover, the study uses the firm level (subcategory D) for analysis and the USA (subcategory B) as its study context for a temporal window of more than 10 years (subcategory A). Theoretically, it is supported by trade-off (subcategory A) and other contemporary perspectives (subcategory D), and presents new findings (subcategory A) and reinforces previous studies (subcategory B) in cash holdings research.

After coding all the articles according to this example, we develop a summary that includes goals, primary conclusions, contributions, and limitations for each paper, as presented in Table B.1. The articles are arranged in alphabetic order according to the surname of the first author. It is important to highlight that all paper limitations have been pointed out by the authors themselves.

By combining these information, we develop the contents of Sections 2.2, 2.3 and 2.4. In Section 2.2, we describe the major theoretical frameworks and empirical trajectories used for cash holdings. Studies pertaining to the same perspective are grouped into a theory to provide an overall idea of cash holdings according to that viewpoint. For each theoretical perspective, descriptive results summarise the main characteristics and contributions, and the papers on cash holdings cited most often.

In Section 2.3, we trace the evolution of the literature on cash holdings in the 105 papers analysed. To do so, we build a chronological research pathway for the most influential papers and describe the contribution, core study, authors, journal, knowledge centre or university, and the absolute/relative number of citations since publication for each paper. Finally, Section 2.4 considers the gaps highlighted by the authors in the papers, and these gaps are checked against the main focus and theoretical perspective categories.

2.2 Background: from classic to contemporary literature on cash holdings

Several theoretical frameworks underpin the literature on corporate cash holdings. Agency theory, trade-off theory, and pecking-order theory have complemented different views on corporate cash-holding behaviour. Although a considerable stream of research has used these theories to support its hypothesis, new theoretical and empirical models have been presented in recent years. This section describes the main theoretical and empirical contributions in the literature on cash holdings, ranging from classical frameworks to contemporary studies.

2.2.1 Agency-based theories

Focusing on principal–agent relationships, the central idea in agency theory is to analyse contract relations that reflect efficient information and risk-shifting costs. As trade-offs arise from the separation of ownership and control, agency conflicts might occur when principals represented by agents differ in their interests and risk preferences, leading to problems such as moral hazards and adverse selection. These conflicts therefore require costly monitoring and incentives to control agent behaviour (Jensen & Meckling, 1976).

Presuming that monitoring mechanisms are imperfect and individuals have self-interest, the agency perspective suggests that managers are likely to appropriate firm

resources and extract rents by engaging in value-decreasing investments to satisfy their own preferences and gain discretionary power (Bao et al., 2012; Myers & Rajan, 1998; Jensen, 1986). In this sense, liquid assets such as cash can be turned into private benefits at a lower cost than for other assets, and thus represent a source for enhancing control by managers within firms (Baldenius, 2006; Myers & Rajan, 1998).

Agency theory as applied to cash holdings in the literature has mostly focused on agency conflicts that arise from ownership, corporate governance, and compensation design (73%). Indeed, agency problems are considered an important determinant of the value and level of corporate cash holdings (Dittmar et al., 2003).

Focusing on the importance of ownership features to corporate cash holdings by UK firms from 1984 to 1999, Ozkan and Ozkan (2004) supply evidence of the existence of a non-monotonic relationship between managerial ownership and cash holdings. According to the authors, corporate cash holdings first decrease as managerial ownership increases up to 24%, increase as managerial ownership increases to 64%, and then decrease again as managerial ownership increases further. Ozkan and Ozkan (2004) suggest that at lower levels of managerial ownership (by 24%) the interests of managers and shareholders are equalised, move from alignment to entrenchment (24–64%), and adjust again as managerial ownership further increases (>64%).

Colquitt et al. (1999) find that agency conflicts have an ambiguous effect on cash holdings by managers. If managers are risk-averse, exceeding the optimal level of cash would be appropriate to take advantage of investment opportunities. If managers have self-interest, holding excess cash provides them with discretionary power to target their own objectives at the expense of shareholders.

Yung and Nafar (2014), Ferreira and Vilela (2004) and Dittmar et al. (2003) provide empirical evidence that higher investor protection, better law enforcement, and more concentrated ownership are negatively related to the level of cash held by firms around the world. Results presented by Jain, Li, and Shao (2013) suggest that stronger internal corporate governance mechanisms, such as founder CEO governance, separation of CEO and Chairman positions, board domination by external directors, and greater institutional ownership, are positively associated with higher post-IPO cash holdings, especially in competitive product markets.

Pinkowitz et al. (2006) find that the value of cash holdings for minority shareholders in countries with higher investor protection is more worthwhile than for similar groups in countries with weaker governance. However, Pinkowitz et al. (2006) detect a weak relationship between cash holdings and firm value in countries that suffer from lower compared to stronger investor protection.

Analysing cash-holding behaviour in developing countries, Al-Najjar (2013) finds that distinct institutional frameworks that may differ in their influence on cash-holding behaviour. In this context, firms in weaker capital markets with lower investor protection systems have higher cash holdings.

Using a sample of public and private US firms over the period 1995–2011, H. Gao, Harford, and Li (2013) show that public firms hold more cash than private firms on average, because of agency conflicts. The authors further find that well-governed public firms with excess cash are likely to have a lower leverage level for disgorging cash to pay external debt. By contrast, poorly governed public firms with higher cash holdings spend their excess cash in investing in and acquiring different assets.

Using financial firm data from 39 countries over the period 1995–2004, Kusnadi

(2011) show that firms in countries with weaker legal investor protection reserve more cash than their peers. However, the authors do not find evidence that greater development of the financial system influences cash-holding behaviour by firms after controlling for legal investor protection. These results imply that the investor environment has a first-order effect in influencing international corporate policies on cash management.

Haw et al. (2011) demonstrate that a higher marginal value of cash is positively related to investor protection. Using annual firm observations from 33 countries over the period 1998–2004, the authors show that the marginal value of cash is lower in countries with weaker investor protection because firms distribute their excess cash via repurchases rather than dividends.

According to Y. Huang et al. (2013), stronger investor protection associated with straightforward accounting standards is positively correlated with corporate cash holdings. Nikolov and Whited (2014) show that firms with higher blockholder and institutional ownership ratios are likely to have a greater loss of shareholder value, higher cash holdings, and higher managerial perquisite consumption.

Kuan, Li, and Liu (2012) present that fewer excess control rights affect cash holdings negatively in cash-rich firms. Additionally, the authors find that family member serving as the CEO in low cash holding firms tend to hold more cash than an outsider CEO. In Kuan, Li, and Chu (2011), shareholders of family-controlled firms with higher board independence are likely to hold more cash for their operating strategy when compared to their non-family-controlled counterparts. Conversely, family-controlled firms with a higher pledge ratio tend to hold less cash because of greater agency conflicts arising from a higher director-ownership-in-pledge ratio.

In an analysis of small and medium-sized firms, Al-Najjar (2015) finds that governance mechanisms and insider ownership do not affect corporate cash-holding decisions. Rather, these factors are weakly related to cash holdings, while size and leverage are negatively associated with cash retention by small and medium-sized firms. However, Al-Najjar (2015) shows that CEO compensation has a significant positive effect on cash holdings.

Schauten et al. (2013) report that European firms with greater takeover defences are likely to hold a higher level of cash reserves, whereas other governance instruments, such as shareholder rights, disclosure, and board functioning, do not have a significant effect on the value of cash. Furthermore, Yun (2009) suggests that state-level changes in takeover protection lead poorly governed firms to switch from credit lines to cash holdings.

In the unique setting of a municipal context, Gore (2009) addresses the agency, precautionary, and transaction incentives that managers have for holding cash in US local government departments. Using data from the 1997–2003 Annual Survey of Governments by the Census Bureau, Gore (2009) demonstrates that larger governments with relatively lower variation in revenues, greater sources of revenues, and lower growth have less propensity to accumulate cash. By contrast, smaller governments with lower revenues and higher variation in revenues tend to accumulate cash for precautionary and operational reasons. Furthermore, the author provides evidence that agency conflicts between managers and citizens might arise in governments with excess cash since they have higher spending on administrative overheads, manager salaries, and compensation, and lower return to citizens in the form of tax reductions.

Under the agency view, compensation mechanisms can limit agency conflicts using outcome-based incentives or behaviour-based arrangements via reliable information sys-

tems. Jensen and Meckling (1976) find that limiting such potential problems might affect the cost and stockpiles of corporate cash holdings. The following findings shed light on the way that compensation incentives should be designed to minimise agency conflicts arising from policy decisions on corporate cash levels.

Core et al. (2006) explore the determinants and consequences of excess cash holdings (endowments) by not-for-profit organisations from 1992 to 2001. Supported by agency arguments, the authors find that not-for-profit firms maintain higher endowments associated with higher managerial compensation over time. Confirming the agency hypothesis, the authors show that these organisations do not have higher growth in program expenses or investments to justify their persistent excess cash holdings.

According to Tong (2010), managers who are risk-averse tend to hold more cash as a strategy to reduce firm risk. Using a measure of CEO risk incentives based on executive stock options for a sample of US firms from 1993 to 2000, the author finds that firms with higher CEO risk incentives have a lower level but higher value of cash holdings.

Y. Liu (2011) show that greater equity incentives, as measured by the sensitivity of equity compensation to stock price volatility, are associated with higher corporate cash holdings. By matching compensation and financial data from ExecuComp and Compustat over the period 1992–2006, the authors find that CEO compensation has a negative effect on the value of cash, while compensation incentives positively influence cash holdings by firms facing financial constraints.

Y. Liu, Mauer, and Zhang (2014) show that the impact of CEO debt compensation on cash holdings differs from the influence of CEO equity incentives on cash reserves. Using ExecuComp and Compustat data from 2006 to 2011, the authors find that CEO wealth, represented by inside debt, is positively related to cash holdings, and that an increase of one standard deviation in internal debt increases cash reserves by 3.7–6.2%. This suggests that inside debt promotes greater risk aversion, leading to higher cash holdings by firms as a signal of alignment between the interests of managers and bondholders.

Using the agency hypothesis and precautionary motives, Arnold (2014) explores the impact of managerial cash holdings on corporate financial policies and default risk. Under this arrangement, managers might target excess cash for self-preservation, particularly during recession periods. As managers receive compensation packages composed of a fixed wage and a variable payment (e.g. profit share, straight equity, or options), they might incorporate the impact of cash holdings on the default risk and the value of their fixed salary when deciding the firm's cash policy. By doing so, managers tend to hoard more cash to reduce the default risk and preserve their fixed income over an extended period of time. Hence, managers with higher risk-taking incentives target a higher level of excess cash, leading to lower cash valuations for shareholders (Arnold, 2014).

Tong (2011) reveals that firm diversification has a negative impact on the value of cash holdings and a positive relation with the cash reserve level. Using segment-level and firm-level data from 1998 to 2005 with credit rating as a proxy for financial constraints, the author finds significant differences in the value of cash holdings among firms. The marginal value of cash holdings is U\$ 0.92 for diversified firms, U\$ 1.08 for single-segment firms, U\$ 0.83 for unconstrained diversified firms, U\$ 0.93 for constrained diversified firms, and U\$ 0.49 for lower-governance diversified firms. By showing that diversified firms have a lower level of corporate governance, higher cash holdings, and a lower marginal value of cash, Tong (2011) provides evidence consistent with the agency perspective that shareholders place a lower value on cash holdings particularly because of the potential inefficiency of

spending cash.

In a related vein, Subramaniam, Tang, Yue, and Zhou (2011) observe that non-governance factors such as firm organisational structure, agency conflicts, and investment opportunities may affect corporate cash management and investment decisions by firms. Using Compustat data for US firms during 1988–2006, the authors find that diversified firms have held less cash than focused firms over time, after controlling for industry at the segment level. These findings indicate that diversified firms might have better access to internal capital markets, lower costs for conversion of assets into cash, better investment opportunities, and higher agency costs than non-core segments and focused firms.

According to Louis et al. (2012), accounting conservatism might recognise previously inefficient investment decisions highlighted by financial reporting. The authors show that firms that adopt conservative accounting policies prevent managers from spending cash on value-decreasing projects to avoid decreases in firm value and to reduce agency costs.

By contrast, Mikkelsen and Partch (2003) show that persistent large cash holdings do not lead to poor operating performance and agency conflicts in cash-rich firms compared to their cash-poor counterparts. Using a sample of 89 publicly traded US firms that held more than 25% in cash holdings over the period 1986–1991, Mikkelsen and Partch (2003) show that firms with a higher cash holding ratio have greater operating performance, higher R&D spending, a higher market-to-book ratio, greater asset growth, and a lower leverage level than their peers matched by size and industry segment. These findings imply that a higher cash balance is the best cash level for these firms to support their corporate policies without devaluing firm performance.

The agency hypothesis has also been used to investigate the link between cash holdings and stock returns. Although cash stockpiles reflect high previous returns, excess of cash holdings do not ensure higher expected returns if they are not efficiently used. Under the agency perspective, if managers engage in wasteful capital spending, acquisitions, or excessive prerequisite consumption, this might be reflected in lower shareholder returns via stock prices (Mikkelsen & Partch, 2003).

As N. Gao (2011) points out, excess cash holdings leads to an adverse selection effect on stock prices in signalling an overvaluation for issuance financing. Similarly, Fresard (2011) suggests that corporate cash holdings are more sensitive to stock prices as the firm-specific return variation increases. According to Fresard (2011), this firm-specific return variation is not explained by market and industry movements and provides new information to investors that is not available to managers. Thus, it may positively influence cash-saving decisions via stock market learning.

Developing a stylised continuous-time model in which firms address internal agency costs and external financing costs simultaneously, Décamps, Mariotti, Rochet, and Vileneuve (2011) show that the marginal value of cash and the stock price are negatively correlated, while the marginal value of cash and the volatility of the stock price are positively related.

According to A. G. Huang (2009), expected returns are driven by investments in cash and physical capital. Specifically, the author shows that cash holdings increase future returns on physical capital and firm stocks. Showing that cash holdings and equity returns are positively associated, Palazzo (2012) also finds that a 0.10 increase in expected equity returns is associated on average with a 0.01 change in the cash-to-asset ratio.

Agency problems also impact on the interaction between cash holdings and acquisitions. A study by Harford (1999), which focuses on the impact of cash holdings on

acquisitions made by companies, indicates that cash-richer and larger firms tend to overpay for unattractive targets with high costs and low transactions benefits. As a result, their post-acquisition operating performance is worse than for other acquirers, suggesting that agency costs matter when managers decide to use cash holdings to boost firm size.

In the presence of agency conflicts, cash holdings cannot be collateralised given the transformation risk associated with agent misbehaviour. Consequently, firms with higher cash holdings have a lower ability to access external financing (Myers & Rajan, 1998).

Holmström and Tirole (1998) propose a moral hazard model to analyse the liquidity needs of a firm across periods. In the presence of a moral hazard, constrained firms cannot pledge eventual returns to outside investors. Rather, by choosing their investments, firms have to decide their liquidity needs before these materialise. If a constrained firm chooses its liquidity demand *ex ante*, it can borrow more than the investment amount and hold the excess in cash. However, holding excess cash under these conditions might be considered inefficient. Nevertheless, postponing corporate liquidity needs is not possible, as the market might be unable to provide an *ex ante* commitment to provide contingent financing at a later date. If liquidity needs are independent across firms, an intermediary not subject to uncertainty or moral hazard (e.g. a bank) can provide firms with credit lines to fund these liquidity needs when they are required (Holmström & Tirole, 1998).

The agency theory also emphasises payouts and repurchases as strategies for preventing managers from wasting cash flows and building firm size using cash holdings (Jensen, 1986; B. S. Lee & Suh, 2011). As noted by Kalcheva and Lins (2007), controlling managers tend to hold more cash and pay higher payouts in situations with weaker country-level external shareholder protection. As a consequence, higher cash reserves and weak investor protection also lead to lower levels of firm value. B. S. Lee and Suh (2011) use share repurchases as a flexible instrument for distributing excess cash and mitigating agency conflicts within firms.

The agency view of market competition and cash holdings suggests that higher rivalry enforces discipline on opportunistic managers, mitigating potential waste in the use of cash reserves (Alimov, 2014). Nonetheless, a stronger brand perception assured by consumer loyalty may reduce the discipline of the competition effect on managerial waste, and lead firms to hold more cash and less debt, intensifying agency conflicts (Larkin, 2013).

Consistent with the perspective that considers market competition as an important managerial disciplinary mechanism, Larkin (2013) shows that firms with a stronger brand perception have better corporate governance, despite hoarding less cash and using more debt. The author does not find any influence of the entrenchment index on the results, suggesting that managers may restrict the overuse of cash, taking a higher debt level and reducing cash holdings, as a strategy to boost their reputation among shareholders. Hoberg, Phillips, and Prabhala (2014) notes that competitive threats from product markets should act as a disciplinary factor in ensuring that firms conform to behaviour that protects shareholder welfare. Hence, payouts and other mechanisms are less necessary to monitor manager behaviour.

By contrast, Alimov (2014) does not identify a significant agency effect between cash holdings and managerial discipline under intense market competition. Using the Canada–United States Free Trade Agreement, the author finds that firms that experience substantial shocks in their competitive environment hold higher value of cash because of the predatory threats of their rivals.

Agency theory has been used as a theoretical basis for 37% of the cash-holding studies selected. Among these papers, 93% are empirical in context, involving various types of cooperative effort, management level, governance structure, and context (firms, sectors, and countries). Furthermore, 98% of the articles are quantitative, 59% explore a period of more than ten years, 66% analyse firms, 20% explore firms within countries, 53% are consider an American context, 47% use non-American settings (13% in Europe, 13% in Asia, and 21% across the world), and 71% were published after 2008.

Table 2.2 shows the ten papers based on agency theory that are cited most often. Indeed, these papers are classic references for cash-holding research, even for cases in which the study focus is another theoretical setting. Each of these papers has at least one of the following characteristics: an innovative proposal and/or new research method; a fundamental discovery; new findings; and published 11 years ago, on average. The two papers cited most often, Harford (1999) and Holmström and Tirole (1998) are references for cash-holding and liquidity research, as well as for acquisition and other finance studies.

Table 2.2: The 10 most cited papers on cash holdings literature related to agency theory.

Order	Paper	Citations - Scopus	Citations - ISI	Citations - Google
1	Harford (1999).	292	205	1229
2	Holmström and Tirole (1998).	245	229	1188
3	Dittmar and Mahrt-Smith (2007).	238	190	930
4	Harford, Mansi, and Maxwell (2008).	171	125	793
5	Dittmar et al. (2003).	164	132	796
6	Pinkowitz et al. (2006).	156	119	514
7	Ozkan and Ozkan (2004).	100	73	491
8	Kalcheva and Lins (2007).	87	63	384
9	Mikkelson and Partch (2003).	76	61	386
10	Ferreira and Vilela (2004).	44	44	290

Note: In absolute terms and considering 02/16/2015.

2.2.2 Trade-off theory

The trade-off perspective on cash holdings considers the optimal cash level for firms by assessing the marginal benefits and costs of holding cash in the presence of financial market constraints (C. S. Kim et al., 1998). Thus, determining the optimal amount of cash depends on the trade-off between the opportunity cost produced by the low return for holding cash and the benefit of minimising the need to access costly external financing when internal funds are insufficient to finance future investment opportunities (C. S. Kim et al., 1998).

In this sense, firms might reserve cash for transaction, precautionary, and/or speculative motives (Keynes, 1936). A transaction motive could be business operational needs, a precautionary motive may be unexpected contingencies arising from uncertainty faced by firms, and a speculative motive might be profitable future investment opportunities (Bates et al., 2009; Dittmar et al., 2003).

On one hand, corporate cash holdings benefit firms by reducing their dependence on costly external financing and supporting current investment opportunities (C. S. Kim et

al., 1998). On the other hand, holding cash and cash equivalents might directly generate two costs, the carrying cost associated with the lower return earned on cash relative to other investments with the same risk level, and the transaction cost related to fees charged on external financing (Dittmar et al., 2003).

While the carrying cost negatively impacts investment opportunities, transactions costs influence firms to hold more cash, particularly because of inability to access external funding and the marginal cost of cash shortfalls (Miller & Orr, 1966; Faulkender & Wang, 2006; Bates et al., 2009).

Opler et al. (1999) find that higher cash-holding levels increase the marginal tax rate of firms. Indeed, cash holdings can be a source of double taxation of gains because of taxation at the corporate level and again when generating income for shareholders.

Optimal models, precautionary savings, and a speculative motive have been widely applied to support theoretical insights into and empirical findings on cash holdings. C. S. Kim et al. (1998) develop a model of optimal cash holding based on a cost–benefit–trade-off between the cost of carrying cash and the benefit of taking future investment opportunities via internal funds. Specifically, the authors predict that the optimal investment in cash reserves is positively related to the cost of external financing, the uncertainty of expected cash flows, and the return on investment opportunities, and negatively associated with size, investment in physical assets, and financial distress. Using panel data for 915 industrial firms over the period 1975–1994, C. S. Kim et al. (1998) find that smaller firms, higher market-to-book ratios, higher cash flow volatility, and higher future investment opportunities lead to higher cash-holding levels.

Almeida et al. (2004) theoretically consider corporate demand for liquidity under imperfect capital markets. According to their model, firms are likely to choose the optimal cash level in line with the sensitivity of their cash holdings to cash flow. As a result, financially constrained firms tend to balance their profitability for current and future investments by saving cash from their cash inflow as a way to finance expected value-increasing projects. Nevertheless, it is expected that unconstrained firms have no systematic patterns regarding their cash policies.

Using a sample of American manufacturing firms between 1971 and 2000, Almeida et al. (2004) find that firms facing financial constraints, as measured by five different proxies, have a greater propensity to reserve cash from their cash flows, whereas unconstrained firms do not show any change in their cash policy behaviour.

Riddick and Whited (2009) propose a dynamic trade-off model in which the optimal cash policy relies on the cost of external finance and future financing needs. In this setting, firms hold a higher level of precautionary cash holdings when external financing is costly or income uncertainty is high. In contrast to the evidence of Almeida et al. (2004), Riddick and Whited (2009) find that corporate cash holdings and cash flows are negatively correlated after controlling for Tobin's Q . As positive productivity shocks arise, the negative sensitivity of cash holdings from cash flows and marginal product of capital both increase in absolute value in such firms. This model confirms the importance of income shocks and the cost of external finance in determining corporate cash behaviour.

Anderson and Carverhill (2012) show theoretically that firms have a negative marginal propensity to save cash at higher profitability, regardless of their investment projects. By contrast, at lower profitability the relationship between investment and cash holdings becomes highly path-dependent. In simulations of the model implications using empirical benchmarks for US industrial firms, Anderson and Carverhill (2012) show that firms with

a lower leverage level have higher cash holdings.

Han and Qiu (2007) present a two-period investment model based on the precautionary motive for cash holdings. The authors propose an intertemporal trade-off between current and future investments, with interactions among corporate cash holdings, cash flow uncertainty, and financial constraints. In this theoretical framework, financially constrained firms are sensitive to cash flow volatility, while unconstrained firms do not exhibit changes in cash holdings because their optimal future investment is independent of their optimal current investment. Han and Qiu (2007) estimate that higher cash flow volatility among publicly traded US firms during 1997–2002 has a positive impact on cash holdings and negative impact on current investments for financially constrained firms.

Using a dynamic framework comprising the costs of external financing, corporate and personal tax rates, and the liquidation value of capital, Gamba and Triantis (2008) examine the effects of financial flexibility on corporate policies regarding investment, financing, and cash retention. In a simulation considering several transaction and tax costs, the authors find that the marginal value of cash holdings is negatively related to liquidity, and positively correlated to investment opportunities and financial constraints.

Using a three-period model of a firm's corporate finance decisions, Palazzo (2012) outlines how cash flows and the systematic risk for cash holdings affect the optimal corporate cash policy. Assuming that investors are not risk-neutral and considering a stochastic discount factor, the author finds that the optimal cash-holding policy depends on the trade-off between the dividend distribution decision in the present and the cash reserve to prevent high costs of future external financing. As a consequence, from a precautionary savings view, riskier firms hold more cash as a buffer against expected cash flow shortfalls.

Bao et al. (2012) demonstrate that financially constrained firms facing profit shocks have lower capital expenditures and higher short-term debt, need to save money, and must give up investing in new projects. The authors find a non-linear relation between changes in cash holdings and cash flows, implying that firms might differ in their levels of cash holdings according to their cash flow. Bao et al. (2012) show that firms with negative cash flows have lower cash holdings, while those with positive cash flows maintain higher cash reserves.

In an analysis of cash-holding behaviour by American property-liability insurers from 1993 to 1995, Colquitt et al. (1999) find that smaller insurers with restrained access to external financing, greater short-term demand for cash, riskier cash flows, and greater future investment opportunities hold more cash to meet future needs in comparison to larger insurers. Consistent with a precautionary motive, these results confirm that firms might choose their cash balances on the basis of future cash needs, especially under unfavourable financial conditions.

Using a data sample for publicly traded US firms from 1972 to 2001, Faulkender and Wang (2006) show that the marginal value of cash has a significant negative relationship to cash levels and leverage, and is positively related to investment opportunity, financially constrained firms, and repurchase stock strategies. For a sample of non-financial publicly traded Turkish firms from 1998 to 2002, Özgür Arslan et al. (2006) find that smaller, financially constrained and younger firms reduce their sensitivity to investment expenditure by holding larger cash reserves.

Findings reported by Opler et al. (1999) and Ferreira and Vilela (2004) confirm that the number, size, and leverage of liquid asset substitutes negatively affect the level of cash holdings and investment opportunity, while cash flow positively affects cash re-

serves for American and European firms. For a sample of Italian private firms, (Bigelli & Sánchez-Vidal, 2012) find that cash holdings are significantly related to firms with smaller size, higher risk, and lower effective tax rates, confirming predictions from trade-off theory. However, when firms are analysed according to their diversification level under the precautionary savings view, diversified firms are characterised by both lower correlation between investment opportunity and cash flow, and higher correlation between investment opportunities and cash flow for lower cash holdings (Duchin, 2010).

In an analysis of firms that issue public bonds, Acharya, Davydenko, and Strebulaev (2012) show that firms with higher ratings, a higher credit spread, and smaller size have higher-than-average cash holdings and lower leverage levels for precautionary reasons. This finding contradicts the notion that firms with larger liquid asset reserves are safer than other firms. Bates et al. (2009) point out that stockpiling of cash by US firms might be driven by precautionary savings, especially for industries with higher idiosyncratic risk and firms that do not pay dividends.

Lins, Servaes, and Tufano (2010) report that the use of both credit lines and cash holdings by firms have both precautionary savings and transaction motives. Using data from a 2005 global survey of chief financial officers (CFOs), the authors find that credit lines are used as a hedge against future financial constraint, providing firms with fund investment opportunities in potential future good times, while cash holdings are used as insurance against operational and future cash flow shortfalls in unfavourable financial conditions.

In a study of the effect of credit supply on corporate cash policy after the 2009 subsidisation programme implemented by the Russian government, Davydova and Sokolov (2014) find that non-subsidised firms increased cash holdings by 6% relative to subsidised firms. Although the Russian government subsidised larger firms from smaller cities with lower employment opportunities, the authors report that the subsidy did not promote any corporate investment or employment changes in these firms, but increased corporate cash holdings for precautionary purposes, particularly for non-subsidised credit-constrained firms.

Trade-off theory has also supported relationships among firm value, investment, and cash holdings. Using a sample of US firms between 1985 and 2006, Denis and Sibilkov (2010) analyse the effect of financial constraints on the interaction between cash holdings and firm value. According to the authors, there is a stronger positive relationship between cash holdings and firm value for financially constrained firms than for their unconstrained peers.

Denis and Sibilkov (2010) report empirically two interesting findings on cash holdings for constrained firms. First, constrained firms hold more cash for precautionary savings. Second, these constrained firms display hierarchical cash-holding behaviour. Thus, firms with lower cash constraints that face high costs of external financing hold less cash than firms with higher cash constraints, particularly because the former produce lower cash flows than the latter. Denis and Sibilkov (2010) also show that constrained firms with higher hedging needs hold higher cash reserves to take advantage of future investment opportunities that they might otherwise not be able to do.

Focusing on time series differences, Song and Lee (2012) find a significant negative link between corporate cash holdings and investment. Therefore, firms tend to reduce their investment spending to increase their cash reserves. Song and Lee (2012) attribute this behaviour to a more conservative investment and liquidity policy, especially for pre-

cautionary motives, adopted by firms in Asia after the financial crisis period.

Wu, Rui, and Wu (2012) study how financial sector development affects the interaction between trade credit and cash holdings. Using a sample of Chinese listed firms from 1999 to 2009, the authors find that firms have to hold an additional U\$ 0.71 of cash for every U\$ 1 of credit payable and U\$ 1 of credit receivable substitutes but only U\$ 0.15 of cash. Firms in regions with higher levels of financial sector development and higher state ownership hold less cash to cover trade payables and have a higher substitute ratio of receivables for cash.

These findings suggest that firms that use trade credit must hold some additional cash for precautionary reasons to ensure timely payment of their obligations and avoid costs such as penalties, interest, and a low credit rating related to late payment, even within developed financial systems.

J. R. Brown and Petersen (2011) investigate the effect of cash holdings on intangible investments such as R&D under the precautionary motive. The authors find that younger and smaller firms with higher R&D intensity and facing financial constraints are likely to hold more cash to smooth their R&D project spending during downturns in comparison to larger and more mature firms.

Y. Chen et al. (2015) present a culture-based explanation from a precautionary perspective for corporate cash reserves in international context over the period 1989–2009 period. The authors find that national cultural features, such as individualism (e.g. American context, measured by the Hofstede individualism index) and uncertainty avoidance (measured by the Hofstede uncertainty avoidance index), influence the precautionary motive for holding cash. Firms in cultures with a higher individualism index or lower uncertainty avoidance index (interaction among cash flow volatility, R&D, and the Hofstede uncertainty avoidance index) are assumed to have lower business uncertainty and hold less cash than firms in collectivist cultures with higher uncertainty avoidance (Y. Chen et al., 2015).

The theoretical trade-off perspective supports 23% of the papers selected. Moreover, 95% of these papers are quantitative, 63% explore a period of more than ten years, 81% analyse firms, 71% focus on an American context, and 67% were published after 2008.

Table 2.3 lists the ten papers based on trade-off theory that have been cited most often. In general, these papers have common attributes that qualify them as standard references on cash holdings: an innovative proposal and/or new research method; a fundamental discovery; new findings; and publication 9 years ago, on average. It is important to highlight that some of these papers, such as Almeida et al. (2004), Gamba and Triantis (2008), and Riddick and Whited (2009), have also influenced other areas besides cash holdings, which partly explains the number of citations to date.

2.2.3 Pecking order theory

Pecking order theory posits the non-existence of an optimal cash level. As cash holdings are considered outcomes of corporate investment and financing decisions by firms, they can be replaced by debt. This view explains why firms might prefer (i) internal funds, independent of their cash level, taken from retained earnings; (ii) safe debt and risky debt for external financial resources, in that order; and finally (iii) debt with equity (Myers, 1984).

Table 2.3: The 10 most cited papers on cash holdings related to trade-off theory.

Order	Paper	Citations - Scopus	Citations - ISI	Citations - Google
1	Opler et al. (1999).	423	352	1940
2	Almeida et al. (2004).	333	284	1536
3	C. S. Kim et al. (1998).	193	134	783
4	Bates et al. (2009).	170	143	951
5	Faulkender and Wang (2006).	151	117	706
6	Gamba and Triantis (2008).	57	49	306
7	Riddick and Whited (2009).	51	43	259
8	Lins et al. (2010).	42	34	241
9	Han and Qiu (2007).	40	36	271
10	J. R. Brown and Petersen (2011).	27	26	147

Note: In absolute terms and considering 02/16/2015.

As Myers (1984) states, firms should first consider internal funds when pursuing valuable investment opportunities. In this setting, firms might use financial slack such as cash, liquid assets, or undrawn credit lines instead of issue equity. However, if a firm faces a deficit in internal funds, it will decrease cash reserves and probably raise debt. Thus, when valuable future investments arise and they exceed corporate cash balances, firms have to depend on external debt.

In this sense, firms with lower cash holdings might have higher leverage in the presence of higher investment opportunities (Ferreira & Vilela, 2004). Otherwise, as a firm becomes more profitable, external financing is unnecessary, implying a decrease in the corporate debt level and an increase in cash holdings according to the demand level for future investments (Opler et al., 1999).

In the pecking order approach, the increase in asymmetric information costs that arises when managers have to inform the market of real state of the firm might influence the choice between internal and external funds (Myers, 1984).

Dittmar et al. (2003) investigate the impact of asymmetric information on the ability to access capital markets for external financing for firms holding excess cash. When firms face a high degree of information asymmetry, the assets held and future growth opportunities are undervalued, increasing the costs of raising external capital and influencing firms to build up their financial slack via cash holdings.

Opler et al. (1999) provide evidence that firms facing a higher cost of raising funds and a higher asymmetric information level tend to hold more cash. Using data for US firms on the Compustat database from 1971 to 1994, the authors find that firms with less access to capital markets, stronger growth opportunities, higher business risk, and smaller size hold more cash than other firms.

Using data for international firms from the Worldscope database over the period 1995–2005, Drobetz et al. (2010) observe that higher information asymmetry, as measured by dispersion of analyst forecasts, has a positive influence on the market value of cash, increasing the firm value and decreasing the impact of adverse selection costs for external financing.

Ferreira and Vilela (2004) claim that firms with higher leverage have lower cash holdings for financing investments and paying debt. Using a sample of firms in EMU

countries from 1987 to 2000, the authors find that corporate cash holdings are positively related to investment sets and negatively associated with the leverage level.

D'Mello, Krishnaswami, and Larkin (2008) find that profitable investment opportunities might lead to deviation of the cash holding ratio from the optimal level. Focusing on 154 spin-off firms from 1996 to 2000, the authors show that spin-off firms with higher growth opportunities and higher asymmetric information are likely to hold more cash than their peers.

Although pecking order theory has played an important role in explaining capital structure decisions under informational asymmetry, few papers have used it to build arguments on cash holdings. Dittmar et al. (2003) suggest that pecking order arguments might confound the effect produced by other views such as trade-off and agency theories, especially for the relationship among cash holdings, leverage, and investment opportunities.

We find that agency-based perspectives and trade-off theory have been used in 37% and 24%, respectively, of the papers on cash holdings we selected, while pecking order theory has been used in 4% of these studies. Although the majority of the articles apply these classic theories, 34% involve new theoretical insights and empirical findings related to cash holdings, as shown in Figure 2.3. We explore these contemporary trends in the next section.

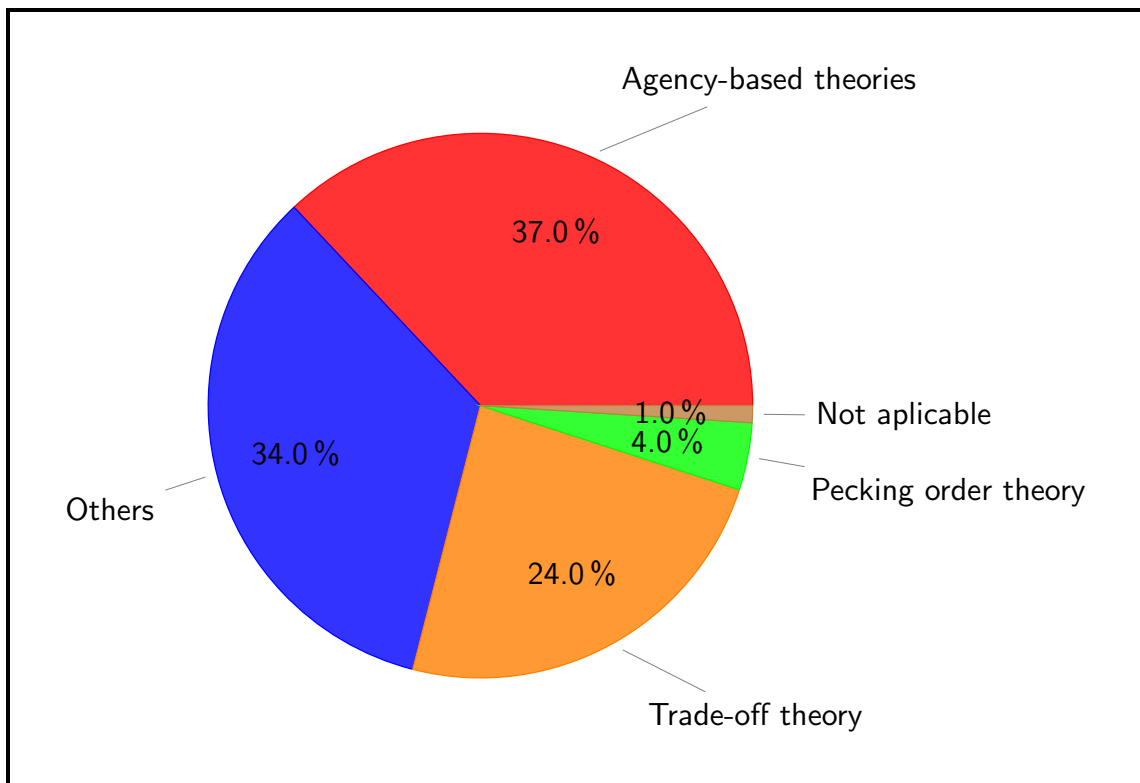


Figure 2.3: Theoretical perspectives used in the cash holding literature.

2.2.4 Contemporary trends

New avenues to explain trends in corporate cash holdings have also been explored in the literature. These contemporary approaches tend to analyse cash holdings in a

different manner to the papers already discussed, using perspectives that range from financial constraints to political participation.

Acharya et al. (2007) develop a theory of cash–debt substitutability considering an optimal corporate financial policy under financial constraints. The model predicts that firms might determine their cash and debt policies according to their hedging needs, as measured by the correlation between cash flows and investment opportunities. Financially constrained firms with higher hedging needs (lower correlation between cash flow and investment opportunities) tend to borrow more debt and hold cash into the future. By contrast, constrained firms with lower hedging needs (higher correlation between cash flow and investment opportunities) are likely to dispose of cash by paying for current debts to ensure resources will be available for future needs. From this perspective, cash is not seen as negative debt (Acharya et al., 2007).

The findings of Acharya et al. (2007) empirically support their prediction that constrained firms with profitable investment opportunities might behave differently to unconstrained firms regarding cash and debt arrangements. Using a sample of manufacturing firms from 1971 to 2001, the authors present evidence that constrained and unconstrained firms use excess cash from cash flows to reduce the amount of external debt when their hedging needs are low. Under these conditions, firms with higher investment opportunities may allocate their cash flow towards debt reductions to save or amplify their debt capacity. However, only constrained firms will prefer higher cash holdings to lower debt if their hedging needs are higher (Acharya et al., 2007).

Acharya et al. (2014) propose a theory of corporate liquidity to explain how cash flow, liquidity risk, credit lines, and cash holdings interact in the presence of future growth opportunities. The model predicts that firms with higher cash flow volatility are likely to experience higher liquidity risk. If these firms have a low ability to raise external funds, especially because of their low pledgeable income, they might choose to retain cash instead of using credit lines. Conversely, when firms have lower cash flow variance, higher pledgeable income, and higher future growth opportunities, they are likely to face lower liquidity risk, and hence they tend to use credit lines rather than holding cash.

Almeida, Campello, and Weisbach (2011) present a theoretical framework in which market imperfections affect corporate behaviour, leading to distortions of the real investment level, capital structure choices, and cash policy. Focusing on the optimality of corporate financial policies and considering potential costs of external finance in the future, the model predicts that firms have a propensity to allocate funds to safer and more liquid assets (e.g. cash) in the presence of financial constraints. On the flip side, by relaxing current and future financing constraints, the model foresees that firms might invest in riskier and more illiquid assets.

Hugonnier, Malamud, and Morellec (2014) also develop a dynamic model showing how capital supply constraints affect corporate cash holdings and investment policies. Relaxing the assumption of an infinitely elastic supply of capital and considering a scenario in which firms have finite growth opportunities, the model indicates that firms have to simultaneously make three interrelated decisions regarding their cash-holding policy, investment time, and financing funds. In this setting, Hugonnier et al. (2014) assume that firms facing capital supply constraints have less ability to raise external funds and tend to hold more cash to protect themselves against default risk. However, as cash is considered an asset with a lower return, firms might choose a target level for cash holdings that allows them to distribute dividends when the target is above the optimal level or to retain earnings and search for investors when cash holdings are below the target. As a

result, cash holdings are considered a hedging tool for preventing default and a financing instrument for providing internal funds for firms to finance their investment opportunities.

The model of Hugonnier et al. (2014) also predicts the target for cash holdings increases with cash flow volatility and decreases with asset tangibility and agency conflicts. However, it is not possible reach an optimal firm policy because investment and payout levels do not always increase with financial slack, and the choice between internal and external funds does not follow a financial hierarchy.

Focusing on the link between tax costs and cash holdings, Fritz Foley et al. (2007) show that multinational firms retain cash abroad. In an analysis of the effect of tax costs on cash held in distinct locations for a large sample of US firms for 1982–2004, the authors find that one standard deviation increase in the tax costs associated with repatriations leads to a 7.9% increase in the cash-holding ratio. This result confirms that firms with higher tax costs for repatriation of earnings hold more cash abroad.

Gamba and Triantis (2008) design a dynamical structural model of financial flexibility to assess the relationship among cash management, financing, and investment policies. Considering financial flexibility as the ability of a firm to raise financing when profitable investment opportunities arise, the authors find that different combinations of debt and cash might be created under uncertainty and taxes to provide optimal financial flexibility and maximise the firm value. Therefore, firms that save cash instead of distributing it to equity holders can boost their value by decreasing net debt to prevent default under low profitability. Indeed, building cash enables firms to increase costless net debt and to potentially prevent costly external financing costs for future investments during high profitability. In a simulation for a large cross-section of firms, Gamba and Triantis (2008) find that the marginal value of cash is negatively related to cash holdings, and positively correlated to investment opportunities and financial constraints.

The link between financial flexibility and corporate cash policies is also addressed by Rapp et al. (2014) and Hoberg et al. (2014). From a shareholder standpoint, Rapp et al. (2014) assess the value of financial flexibility for payout, capital structure, and cash policies using a single aggregated market-based measure with forward-looking weights based on the value-relevance of unexpected changes in cash holdings.

In an analysis of non-financial US firms for the period 1988–2010, Rapp et al. (2014) find that firms with greater financial flexibility have higher growth opportunities, lower reversibility of capital, lower profitability, and lower costs of external financing. Regarding corporate financial policies, Rapp et al. (2014) estimate that an increase of one standard deviation in financial flexibility decreases the dividend payout ratio by 7%, and leads to a decrease in leverage of 0.02 and an increase in cash holdings of 0.03. Moreover, financial flexibility decreases as the cost of cash holdings increases.

Hoberg et al. (2014) explore how cash holdings provide financial flexibility for firms facing product market threats. Using fluidity as a measure of product market threats, the authors find that firms with a greater change in their product markets tend to retain higher cash reserves, pay lower dividends, and repurchase fewer shares. The authors suggest that cash-rich firms have more flexibility in less stable markets and react more strongly to competitive threats as they arise.

Brisker, Çolak, and Peterson (2013) focus on changes in corporate cash-holding policies for firms listed on the S&P 500 index. Following the reverse trend for firms in the Compustat database, the authors provide evidence that industry-adjusted cash holdings decreased by nearly 32% in 2 years, implying firms listed on the S&P 500 have lower cash-

holding levels than their peers. Using matching estimators, Brisker et al. (2013) further confirm that firms hold, on average, U\$ 0.21 million more cash than their counterparts in the period immediately before index inclusion. However, after listing on the S&P 500, their cash reserves are U\$ 22.36 million less than for their matched peers. According to Brisker et al. (2013), the index inclusion effect might play a role in reducing idiosyncratic risk and reflecting better credibility for such firms in the external capital market. The authors find that changes in cash holdings and idiosyncratic risk are positively related, meaning that firms with lower idiosyncratic risk have lower cash retention. Addressing the effects of leverage and external financing costs on cash holdings, Brisker et al. (2013) observe that constrained firms increase their borrowing by 11.31% and reduce their credit spread by 1.58% after inclusion in the S&P 500. Thus, holding cash for precautionary or transaction cost reasons becomes less important as risk decreases and the ability to raise cheaper external funds increases in comparison to the time before index inclusion.

Brisker et al. (2013) also note that because S&P 500 firms are mature, they are likely to drain their internal growth opportunities and increase their outstanding opportunity sources. Confirming their hypotheses, firms with lower cash holdings have lower market-to-book ratios, net working capital, and R&D and capital expenditure after index inclusion. Although these firms tend to reduce investment opportunities, they increase their acquisition spending in the post-inclusion period.

Studying the impact of cash holdings on corporate investment decisions, Pinkowitz et al. (2013) investigate whether firms with higher cash stockpiles prefer to pay for acquisitions with their excess cash. Examining bids from 1984 to 2006, the authors find that firms may choose to finance their acquisitions with stock instead cash. They note that firms that hold more cash are 23% less likely to use cash to finance acquisitions than similar cash-poorer firms. After ruling out alternative explanations for the method of payment for acquisitions, such as agency theory, financial constraints, tax-related arguments, stock overvaluation, and capital structure, Pinkowitz et al. (2013) identify financial flexibility as a more suitable perspective to explain the trend whereby cash-rich firms acquire their targets using stocks.

In the study by Klasa et al. (2009), cash holdings are strategically managed for firms in collective bargaining agreements with labour unions. Using data for industry firms for the period 1983–2005, the authors find that cash holdings are negatively related to unionisation rates. When firms face powerful unions, they hold less cash to improve their bargaining position and avoid transfer of firm profits to meet unions demands. This negative relationship is more pronounced for stronger unions, more highly concentrated industries, and firms with greater financial constraint; conversely, it is weaker for dividend-paying firms and for firms with higher bond ratings.

C. Kim and Bettis (2014) use behavioural theory to highlight cash holdings as a strategic corporate asset. Cash holdings might be used for transaction and precautionary motives, as well as for defensive strategies. Indeed, this might provide advantages to deter competitors from building capacity ahead of demand, acquiring profitable targets, or investing in imminent technologies. Bearing in mind that cash holdings are considered a highly flexible form of credible threat to deter competitors, C. Kim and Bettis (2014) show that firms with higher cash holdings might create economic value through new investments and job creation, especially during times of greater financial uncertainty. Likewise, by reserving cash, firms may protect their strong competitive position by avoiding predation risk and bankruptcy.

The effect of banking regulation on cash holdings is analysed by (Pinkowitz &

Williamson, 2001) and Francis et al. (2014). In their analysis of the determinants of cash holdings in Japanese compared to American and German firms, Pinkowitz and Williamson (2001) find that Japanese firms have a lower net working ratio and lower debt leverage than their US and German counterparts. However, Japanese firms hold higher cash reserve levels for greater durations compared to firms in the USA and Germany. After ruling out several factors that might influence differences among the three countries, the authors argue that banks induce Japanese firms to reserve high cash-holding levels to build up bank wealth. Before the introduction of regulation of the banking system in Japan, firms had to rely on banks to access external financing. In turn, these firms had to maintain higher cash holdings as a banking requirement instead of using it to pay down their debt. Thus, leverage and cash holdings were positively related. After regulation, the opposite relationship holds, whereby leverage and cash holdings are negatively correlated, confirming the bank power hypothesis.

Francis et al. (2014) find that banking deregulation is negatively associated with corporate cash holdings for American firms, especially among financially constrained companies with different hedging needs. As the authors point out, banking deregulation allows interstate and intrastate bank-branch acquisitions and consolidations, which eliminates less efficient banks, increasing bank competition, and reduces lending costs.

Using state deregulation and the Riegle-Neal Act as exogenous shocks for a sample of US firms for the period 1971–1997, Francis et al. (2014) observe that both financially constrained and unconstrained firms hoard lower cash holdings after banking deregulation. As access to external financing becomes easier and less costly, firms tend to have a lower marginal value of cash, although Francis et al. (2014) find that constrained firms with higher hedging needs are likely to hold more cash.

Exploring bank lending during the 2008 financial crisis, Kahle and Stulz (2013) show that cash holdings and capital expenditures for US firms were equally affected by a common shock, regardless of whether firms were leveraged, non-leveraged, or in a direct relationship with a bank. In an analysis of firm data for 2006–2009, the authors find that the effect of corporate cash-holding ratios among firms did not differ before and after the crisis. Non-leveraged firms experienced a 35% reduction in capital expenditures, while highly leveraged and bank-dependent firms decreased their capital expenditure by 30% and 37%, respectively. By contrast, cash-rich firms experienced no change in capital expenditure in the first year of the crisis, whereas their capital expenditure fell by 34% after the Lehman collapse (Kahle & Stulz, 2013).

May (2014) also analyses the impact of the Lehman collapse on corporate liquidity management. Using data for 73 non-financial, non-utility firms that had an active credit line with Lehman Brothers at the time of the bank's collapse, the authors find that firms with such a credit line lost 3% of their market value, on average, in the days around the collapse. These losses are more noticeable for firms with lower cash-holding ratios, firms with larger amounts of undrawn credit, financially constrained firms, and firms for which Lehman was their primary bank. In contrast to the findings of Kahle and Stulz (2013), May (2014) observe that following the Lehman collapse, these firms burned their cash reserves, lost their main access to a credit line, and decreased their investment level to a greater extent than firms not dependent on a bank.

Harford et al. (2014) focus on the mitigation of refinancing risk through corporate cash holdings with consideration of the interaction between cash policy and debt maturity decisions. The authors note that the nature of corporate debt changed from 1980 to 2008. Long-term debt remained constant, while short-term debt increased, leading to an increase

in refinancing risk for firms. In this scenario, firms tend to simultaneously reach decisions on maturity debt and cash-holding levels to mitigate their refinancing risk. Harford et al. (2014) provide empirical evidence that the average maturity of bonds and bank debt decreased from 10.9 to 5.6 years and the cash-holding ratio increased from 0.085 to 0.139 from 1980 to 2008. The authors show that a 1% increase in the fraction of total long-term debt due in the next 3 years leads to a 2.4% increase in corporate cash holdings. Moreover, the shortening of debt maturity explains why 31.8% of the increase in cash holdings is strongly significant even when credit market conditions become tight and the refinancing risk is higher.

Examining the impact of ambiguity on managerial investment and cash holding decisions, Neamtiu, Shroff, White, and Williams (2014) show that macroeconomic ambiguity is positively related to cash-holding ratios and negatively associated with investment levels. These findings suggest ambiguity-averse managers tend to shift resources from risky to riskless assets, investing less in capital expenditure and more in cash holdings as ambiguity expectations regarding future investment pay-offs arise.

Cash holdings have also been considered in other areas such as marketing, human resources, culture, innovation, public administration, and political issues. Following the line of market rivalry, D. Haushalter, Klasa, and Maxwell (2007) show that cash holdings, growth opportunities, and predation risk are interdependently determined when market competition is higher. They note that markets with higher industrial concentration reflect greater interdependence of investment opportunities among rival firms. According to D. Haushalter et al. (2007), in the presence of greater rivalry under downturn conditions, firms might hold more cash as a strategy to attempt to use investments opportunities to increase their market share and avoid predation risk. Studying S&P 500 manufacturing firms for 1993–1997, the authors find that higher interdependence regarding investment opportunities between firms and their rivals might lead to a 26.2% increase in cash-holding ratios.

Exploring the interplay between cash holdings and product market outcomes, Frésard and Salva (2010) show that cash holdings are positively related to market share growth. Using data for a sample of 105 four-digit industries, the author estimates that the performance of cash-rich firms is more than double that of financially fragile rivals in the product market. In this context, firms in more highly competitive and concentrated markets have higher cash reserves for future expansion of market share at the expense of their industry rivals. Frésard and Salva (2010) also find that the larger the interdependence of firm growth prospects among industry rivals, the greater is the effect of cash. Consistent with the results of D. Haushalter et al. (2007), cash holdings are seen as a strategic instrument providing firms with the financial strength to gain market share over their cash-poor rivals.

Itzkowitz (2013) demonstrates that the business relationship between buyers and suppliers may affect corporate cash-holding behaviour. Using 1979–2006 data for US manufacturing firms, the author finds that supply firms with major customers retain 30% more cash than firms that do not have major customers. Customer importance and cash holdings are positively correlated, suggesting that as the strength and concentration of buyer–supplier relationships increase, suppliers are likely to hold proportionately more cash. Itzkowitz (2013) shows that this relationship is strongly significant for businesses with idiosyncratic features or a high level of asset specificity. In these types of businesses, suppliers are required to commit to buyers not only regarding product sales but also for specialised services. Consequently, loss of a customer has a higher cost and affects future

cash flows, so firms with unique products tend to retain persistent high cash holdings for precautionary and commitment reasons.

Custódio and Metzger (2014) focus on the link between CEOs with a career background in finance and corporate financial policies. Exploring CEO–firm matching based on financial experience for the period 1993–2007, the authors find that firms with a CEO who is a financial expert have greater maturity, a lower investment level, lower asset volatility, lower asset growth, and lower cash holdings on average.

The effect of cultural factors on corporate cash holdings is examined by Ramírez and Tadesse (2009) and Y. Chen et al. (2015). In analysing firms from various countries, these studies show that national culture, represented by individualism and uncertainty avoidance, has a positive influence on corporate cash-holding behaviour. Both Ramírez and Tadesse (2009) and Y. Chen et al. (2015) find that firms in countries with greater uncertainty avoidance (risk aversion measure) have higher cash-holding levels. According to Ramírez and Tadesse (2009), an increase of one standard deviation in uncertainty avoidance leads to a 14% increase in the cash ratio of a domestic firm. Y. Chen et al. (2015) find that higher uncertainty avoidance results in a 6.45% increase in the cash-holding ratio. These findings suggest that managers in such firms tend to be less tolerant to higher volatility, especially when related to future cash flow, and holding more cash to compensate for this risk.

Levitas and McFadyen (2009) observe that cash-holding levels are positively influenced by R&D investment. The authors find that R&D-intensive firms face two challenges: a trade-off between funding of current projects or hoarding cash for future projects; and higher costs for access to external funds because of the knowledge asymmetry arising from an invention. To disentangle these issues, Levitas and McFadyen (2009) demonstrate that R&D-intensive firms might signal the attributes and value of their R&D program to capital markets to provide tangible outcomes, inform outsiders of their patent portfolio, and reduce knowledge asymmetries. In this setting, firms with higher-valued patents might send a positive signal to external markets to reduce the costs associated with raising external funds, and hence provide another liquidity source. As a consequence, these firms might raise cheaper external capital, produce cash flow from new R&D projects, and reduce their need to hold cash.

Qiu and Wan (2014) also consider the impact of R&D and product market competition on corporate cash holdings under financial constraints. Using a patent-weighted average for peer R&D stocks to measure the technology spillover effect, Qiu and Wan (2014) show that technology spillovers and market competition are positively related to corporate cash holdings. They find that a 1% increase in technology spillover leads to a 0.5% increase in cash reserves, and a 1% increase of market rivalry tends to increase the cash ratio by 0.36%. Moreover, the technology spillover effect is more pronounced for constrained than for unconstrained firms, as the former depend more heavily on cash holdings to take advantage of diffuse innovations.

D. Chen et al. (2014) explore the influence of government quality on corporate cash holdings. According to the authors, the quality of a government can affect corporate cash policy by avoiding firm exposure to expropriation risk and protecting property rights via law enforcement and regulations. Using data for a sample of Chinese firms from a 2006 World Bank survey, D. Chen et al. (2014) show that government quality, measured using four proxies (property rights protection, lightness of tax burden, government cleanliness, and aggregate government quality), is negatively related to corporate cash holdings. According to their results, a 1% increase in property rights protection leads to a 2% decrease

in the cash ratio for firms. The authors deduce that higher government quality mitigates financial constraints by creating a positive and strong investor environment that stimulates firms to invest more and hold less cash, and improve their access to bank and trade financing.

Studying the interaction between state ownership and cash holdings for Chinese firms during 2000–2012, Megginson, Ullah, and Wei (2014) find that state ownership and corporate cash holdings are negatively related. The authors ascribe this finding to the soft-budget constraint effect, which predicts that stated-owned firms in transition economies obtain preferential treatment when in financial trouble. Governments may support these firms through subsidies, tax concessions, or credit preferences in stated-owned banks. Megginson et al. (2014) show that the decrease in state ownership from a mean of 34.7% in 2000 to 4.3% in 2012 led to an increase in cash holdings from 18.7% in 2000 to 32.8% in 2012. Consistent with the soft-budget constraint theory, firms with higher state ownership hold lower cash reserves than non-state-owned firms, even during downturns.

Feng and Johansson (2014) analyse the effects of political participation on cash holdings for a sample of Chinese firms during 1999–2009. The authors show that firms controlled by entrepreneurs who participate in politics have significantly greater cash holdings than other privately controlled firms. In support of the political extraction hypothesis, Feng and Johansson (2014) note that firms with owners who are insider politicians have a higher probability of being included in higher political circles and a lower risk of political extraction of assets.

Figure 2.4 summarises our literature review on cash holdings, showing the papers analysed, their core topic in relation to cash holdings, and their timeline by category (A–E). Each category represents a set of topics according to the keywords and goal of papers. Each article is assigned to a core category, represented by different colours. Some papers (shown in green) are classified in more than one category because of interchangeable connections among themes. Among the articles, 27.6% of papers are in category A, 30.5% in category B, 8.6% in category C, 11.4% in category D, 15.2% in category E, and 6.7% in multiple categories.

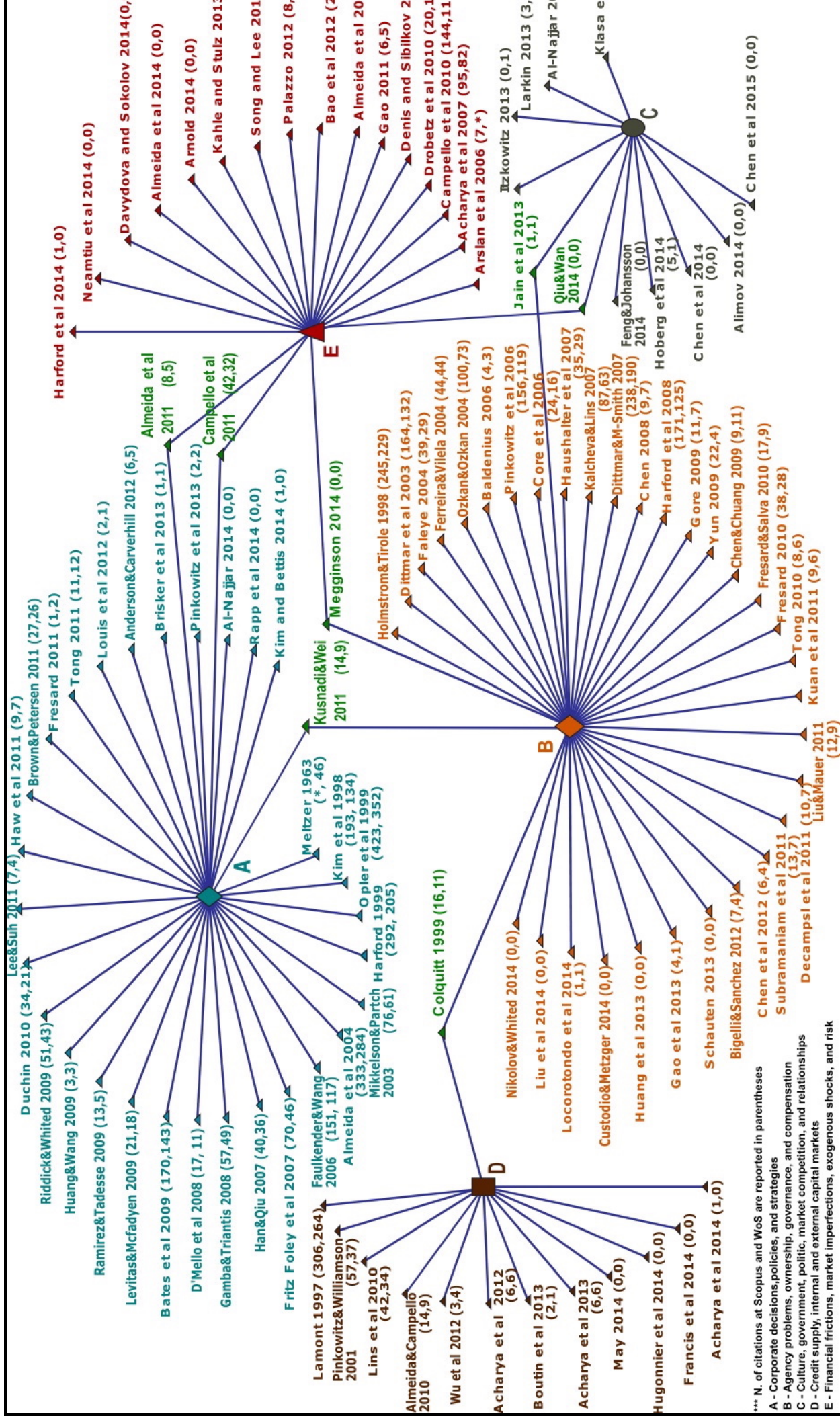


Figure 2.4: Main focus, papers and citation numbers over time.

There is a higher concentration of themes associated with categories A and B over the whole period, which reveals a trend for publications on topics such as corporate decisions, policies, and strategies, as well as those related to agency issues, ownership, governance, organisational forms, and compensation design. Topics related to diversification (organisation forms) and compensation design have been less studied in recent.

Although categories C, D, and E are less well represented between 1997 and 2010, academic contributions on these themes significantly increased from 2011 to 2014. Topics related to financial constraints, market imperfections, internal capital markets, credit lines, trade, market competition, banking, risk, and credit supply have received special attention among corporate finance scholars (Almeida et al., 2014; Foley & Manova, 2014). Papers in category C explore cash holdings in fields such as marketing, culture, public administration, innovation, and accounting. If we consider only papers published in 2013 and 2014, articles in category C exceed those in category A by 50%, category B by 25%, category D by 40%, and category E by 30%.

2.3 Pathway for the literature on cash holdings

The previous sections showed how cash-holding studies have been supported and developed. This analysis allows us to identify the focus areas and perspectives explored by scholars over time. Next, we describe the pathway for the literature on cash holdings in terms of research evolution, the period analysed (when?), the levels and countries investigated (where?), the papers cited most often (whom?), the main researchers and their networks (who?), and the main methods and variables used (how?).

2.3.1 Evolution of the literature: timeline, core studies, and keyword features

Interest in corporate cash holdings goes back at least as far as Keynes (1936), who identified the precautionary motive for holding of cash by firms. The literature on money demands has also contributed to the field, describing determinants of corporate cash holdings such as firm operating (or transactional) activities, interest rates, technological improvements, and opportunity costs (Mulligan, 1997; Miller & Orr, 1966; Meltzer, 1963). However, we did not find papers that used this approach with a finance focus. As described above, agency, trade-off and pecking order theories, based mainly on studies by Jensen and Meckling (1976); Jensen (1986) and Myers (1984), have been applied in a significant proportion of articles on cash holdings.

We also note growth in the literature since the mid-1990s, when cash holdings became an active topic in liquidity research. Figure 2.5 shows the main contributions to research on cash holdings over time. Each triangle represents the most important study in that period according to the absolute number of citations. Arrows indicate the direction of knowledge flow in a chronological citation path. It is important to note that this timeline does not present the influx among these papers. However, by following the focus of each paper, we can identify the ideas with a significant influence on other researchers in the field.

Starting with Lamont (1997), cash holdings are seen as an important source of internal capital that enable firms to take advantage of investment opportunities. Assuming that corporate segments are financially dependent, the author shows that oil sector firms

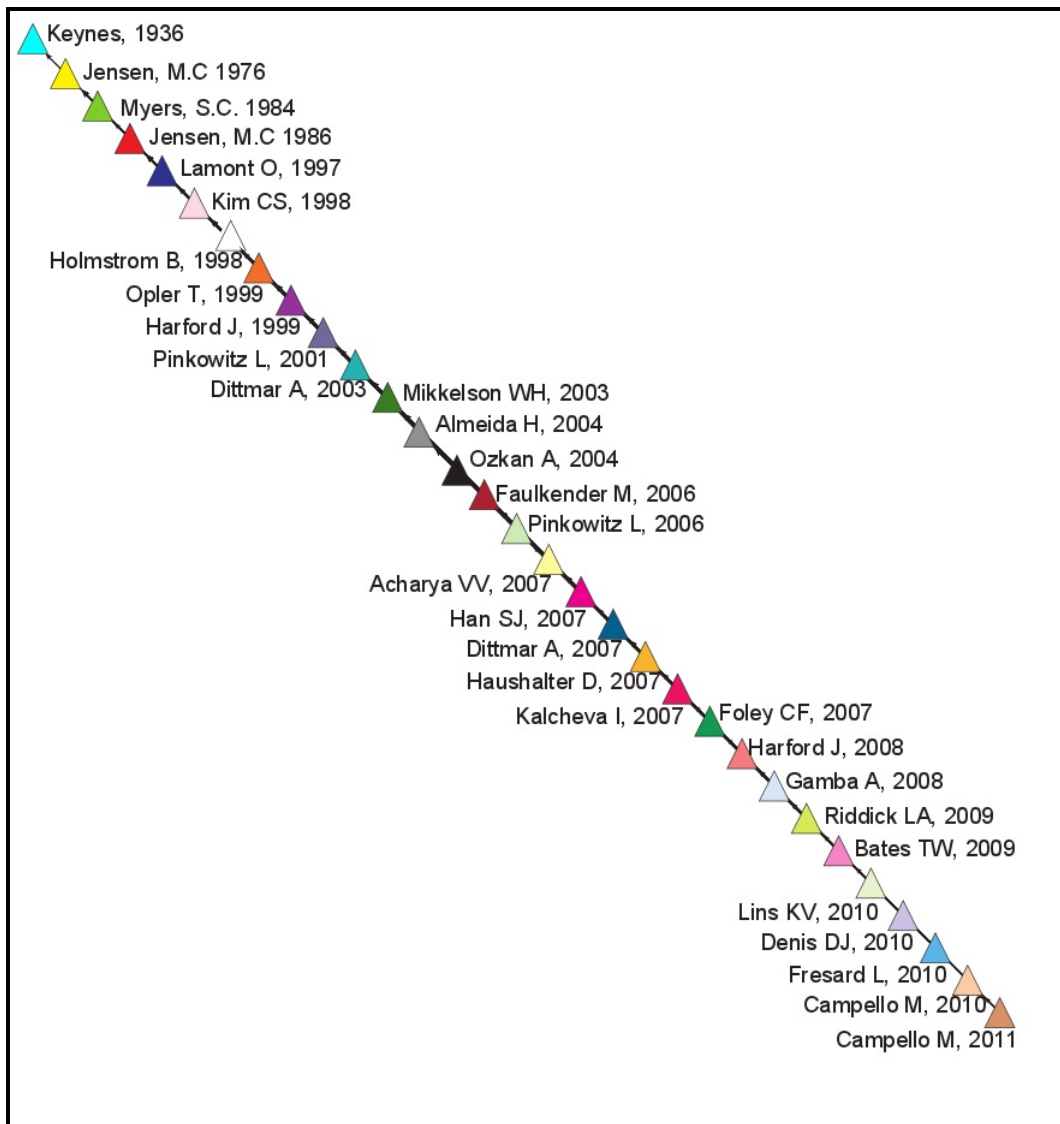


Figure 2.5: The evolution of cash holding literature.

exposed to business shocks tend to reduce investment as internal funds such as cash decrease. The relevance of cash holdings for internal markets and corporate investment is further studied by Almeida and Campello (2010); Subramaniam et al. (2011); Tong (2011); Boutin, Cestone, Fumagalli, Pica, and Serrano-Velarde (2013) and Locorotondo, Dewaelheyns, and Hulle (2014).

From the perspective of financing constraints, Almeida and Campello (2010) show that the choice between internal and external funds is interdependent on firm investment and profitability and the capacity to raise costless external financing. Focusing on firm diversification, Subramaniam et al. (2011) attribute the lower cash holdings among diversified firms to the availability of active internal capital markets and the current growth opportunities.

On the flip side, Tong (2011) finds that firm diversification has a negative impact on the value of cash from an efficient internal capital market view. The value of corporate cash holdings is 14.6% lower for diversified firms than for single-segment firms, independent of firm constraints.

Analysing business groups, Boutin et al. (2013) and Locorotondo et al. (2014) show

that affiliated firms might hold less cash because of their easy access to the internal capital market within the group. As these internal funds are a cheaper source compared to external capital, they also mean that affiliated firms have lower sensitivity to financial constraints and higher advantage on entry into new markets in comparison to non-affiliated firms.

Between 1998 and 1999, four influential papers (Holmström & Tirole, 1998; C. S. Kim et al., 1998; Opler et al., 1999; Harford, 1999) extended the scope of cash holding research and motivated a significant number of new theoretical and empirical insights.

Using a two-period agency framework, Holmström and Tirole (1998) shows that agency problems in firms could have a twofold effect: limiting the amount of external financing via banking lines and/or reducing the long-term commitments by outside investors. By introducing the effect of financial constraints on liquidity supply and presenting a credit line as an alternative source of liquidity, Holmström and Tirole (1998) inspired the models described by Almeida et al. (2004); Acharya et al. (2007); Lins et al. (2010); Almeida, Campello, and Hackbarth (2011); Acharya et al. (2012); Acharya, Almeida, and Campello (2013) and Acharya et al. (2014).

C. S. Kim et al. (1998) provide an optimal model of corporate liquidity using the trade-off among liquid asset holdings, investment opportunities, and future liquidity needs. Analysing the benefits and costs of holding cash, the authors establish that the optimal amount of liquidity is an increasing function of the cost of external financing, the variance of future cash flows, and the profitability of future investment opportunities. Thus, firms are likely to maintain higher cash holdings as cash flow uncertainties, lower profitability, and financial constraints arise in the future. The optimal trade-off model of (C. S. Kim et al., 1998) influenced work by Mikkelsen and Partch (2003); Faulkender and Wang (2006); Dittmar and Mahrt-Smith (2007); Harford et al. (2008); Gamba and Triantis (2008); Levitas and McFadyen (2009) and Frésard and Salva (2010).

The determinants and implications of cash holdings were first discussed by Opler et al. (1999). The authors systematically describe the impact on cash-holding behaviour of elements such as growth opportunities, cash flow volatility, size, credit rating, firm value, capital expenditure, acquisition spending, payouts, and access to capital markets. These findings provided a basis for the exploration of additional factors related to cash holdings. In fact, Opler et al. (1999) is the paper with the most citations in absolute terms, and their cash-holding measure is the proxy most often used for assessing cash holdings.

Following Opler et al. (1999), (Pinkowitz & Williamson, 2001; Ferreira & Vilela, 2004; Ozkan & Ozkan, 2004; Core et al., 2006; Pinkowitz et al., 2006; Kalcheva & Lins, 2007; Fritz Foley et al., 2007; J. R. Brown & Petersen, 2011; Kusnadi, 2011; Wu et al., 2012; H. Gao et al., 2013; Itzkowitz, 2013) and Al-Najjar (2015) extended determinant analysis by searching for different determinants and consequences associated with corporate cash holdings, including performance, ownership, governance, agency costs, R&D spending, asymmetric information, product market competition, managerial issues, taxes, dividends, and share repurchases. Identification of the determinants of persistent increases in cash holdings is also the central focus in studies by Mikkelsen and Partch (2003); Ferreira and Vilela (2004); Han and Qiu (2007); Bates et al. (2009) and C. Kim and Bettis (2014).

The work of Harford (1999) is central in highlighting the importance of links between cash holdings and acquisitions. Noting that cash-rich firms are likely to make unexpected acquisitions in bidding for unattractive and/or diversifying targets, the author finds that

the high costs and low transactions benefits related to value-decreasing acquisitions might lead to destruction of shareholder value. The interaction between cash holdings and acquisitions is further explored by Dittmar and Mahrt-Smith (2007); Harford et al. (2008); N. Gao (2011); Almeida, Campello, and Hackbarth (2011), and Pinkowitz et al. (2013).

Pinkowitz and Williamson (2001) study the role of banks in corporate cash-holding behaviour. However, it is only recently that research has again focused on the relationship between banks and corporate cash holdings, in particular for deregulation and consolidation banking (Francis et al., 2014), banking monitoring (Acharya et al., 2014), and firm borrowing and bank default (Kahle & Stulz, 2013; May, 2014).

Exploring ownership, performance and cash holdings, Mikkelsen and Partch (2003) show that there is no difference in operating performance and governance mechanisms between cash-rich firm and their cash-poor counterparts.

Influenced by Opler et al. (1999); Harford (1999), and Mikkelsen and Partch (2003), Dittmar et al. (2003) systematically explore the effect of international corporate governance on cash holdings in firms around world. Using agency-based theories to understand the relationship between corporate governance and cash holdings, Dittmar et al. (2003) provide insights for studies by Pinkowitz et al. (2006), Dittmar and Mahrt-Smith (2007), Harford et al. (2008), Y. R. Chen (2008), Y. R. Chen and Chuang (2009), Fresard (2010), Q. Chen, Chen, Schipper, Xu, and Xue (2012), and Schauten et al. (2013).

The novel association between financial constraints and the sensitivity of cash holdings to cash flow described by Almeida et al. (2004) influenced models proposed by Özgür Arslan et al. (2006); Acharya et al. (2007); Denis and Sibilkov (2010), and Almeida, Campello, and Weisbach (2011). Acharya et al. (2007) introduce the hedging need motive for cash holding by firms; Denis and Sibilkov (2010) and Acharya et al. (2014) address the same issue.

The 2008 global financial crisis highlighted the role of corporate cash holdings. Campello et al. (2010) note that the 2008 crisis affected capital supply, leading firms, particularly those with financial constraints, to reduce cash holdings, burn their reserves to maintain their operations, and postpone their investment plans. Focusing on how firms manage their liquidity when capital is scarce, Campello et al. (2011) reveal the effects of substitution by internal funds for external capital by firms during the 2008 crisis.

Figure 2.6 summarises the citation path among the studies cited most often. The figure shows the research pathway in chronological order and the most significant knowledge route among cash-holding studies. We can observe the strong influence of papers such as those by C. S. Kim et al. (1998); Opler et al. (1999); Harford (1999); Dittmar et al. (2003); Mikkelsen and Partch (2003), and Almeida et al. (2004) on the other articles. For example, the article by Opler et al. (1999) is cited by 71.4% (10/14) of these papers.

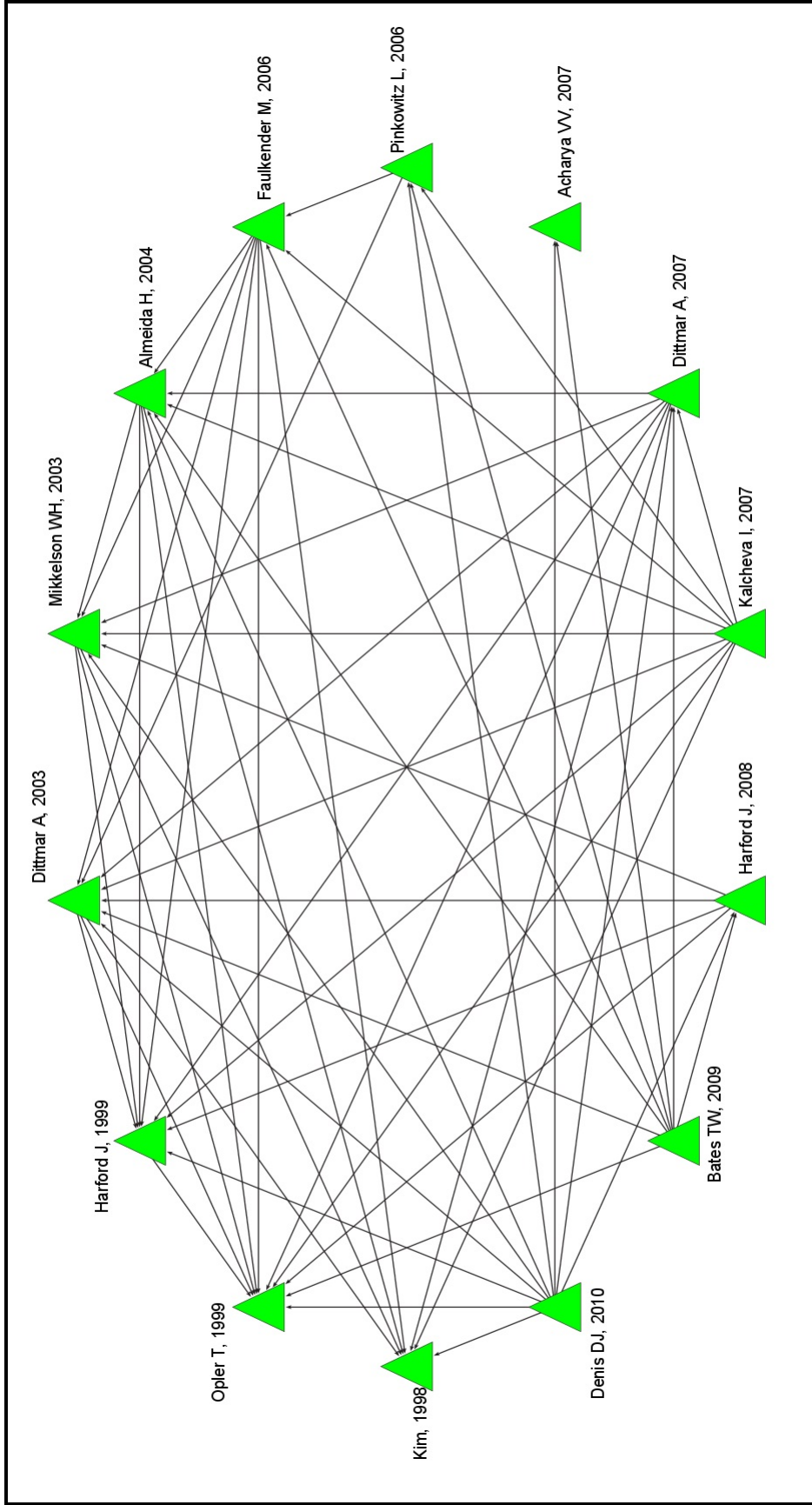


Figure 2.6: The citation path on cash holdings over time.

An analysis of keywords may also reveal the evolution of literature in a specific field, especially by showing increases in the use of some keywords over time (Furrer et al., 2008). Nearly 79% of 176 individual keywords retrieved from the articles were used only once, 12% were used twice, and 11% were used more than three times among the papers. Cash holdings is the most frequent keyword (47.6% of papers), followed by corporate governance (10.4%), cash (6.7%), capital structure (4.7%), and financial constraints (3.8%). Use of the keywords cash holdings, investment, liquidity, governance, financial constraints, acquisitions, firm value, and credit lines is also consistent and stable over time.

Other keywords such as determinants of cash, agency, trade-off, compensation, cash flow, repurchase, payout, and ownership have been used less, whereas keywords such as risk, product market competition, credit lines, trade credit, banking, and financial flexibility have been increasingly used in recent years. The overall mean is 2.84 keywords per paper. Considering the distribution over only the papers that used keywords, this average increases to 4.27 keywords per article.

It is natural to find cash holdings as the most cited keyword, as this is our core focus. It is surprising to note the low frequency of other keywords, especially for words directly connected to agency (e.g. agency costs 1.9%) and trade-off (e.g. precautionary savings 1.9%) theories, which were the basis for 60% of the papers. Thus, although the majority of articles used these theories to support their arguments, they do not use keywords related to the theories. By considering all possible keywords applied, such as agency costs, agency problems, agency theory, governance, asymmetric information, free cash flows, managerial control, managerial incentives, takeover, ownership, excess of cash, hedging needs, and precautionary motive, the total number of words associated with agency and trade-off perspectives increases to 40%, but this still does not match the proportion of papers that use agency and trade-off theories.

The absence of a keyword section in journals such as *Journal of Finance*, *Journal of Financial and Quantitative Analysis*, *Journal of Political Economy*, *Journal of Small Business Management*, *Quarterly Journal of Economics*, *Rand Journal of Economics*, *Review of Financial Studies*, and *Review of Finance* may partly explain this findings. Some 33% of the selected papers are published in these journals, of which 46% use agency-based theories or a trade-off model as their main theoretical approach. If we select only one keyword from these papers, the number of keywords related to these perspectives increases to 55%, confirming the findings for the theoretical perspective category.

2.3.2 Paper cited most often in cash-holding research

Citation in scientific papers is a useful and relatively cost-free instrument for measuring research performance and providing an indication of article acceptance and knowledge flow within the field (J. S. Liu et al., 2013). We consider both absolute and relative citation values. The absolute value is the number of citations a paper has received, regardless of the year in which it was published according to three different data sources: *Scopus*, *Web of Science*, and *Google*. To assess the relative citation value, namely the citation ratio, we measure the number of citations divided by the number of years since the paper was published. For both analyses, our cutoff is 10 citations per paper.

Table C.1 presents data for the papers cited most often, including the year of publication, journal name, impact factor, absolute citation value, and the author affiliation(s) (university, college, or research centre). We set 10 citations in all databases over time as the cutoff.

Selection of papers cited at least 10 times reduces our sample from 105 to 39 articles. Their general features are:

- They were published 9 years ago, on average;
- 61.5% were published in journals with an impact factor greater than 3.5;
- 66.7% of the research was conducted exclusively in American universities, and 15.38% jointly in American, UK, and Canadian Universities;
- 53.8% present new findings to the field; and
- 100% are quantitative.

Among these papers, 43.6% of the studies were concentrated in one UK and four US universities. The main knowledge centres are the University of Arizona (10.25%), the University of Illinois (10.25%), Georgetown University (7.7%), the London Business School (7.7%), and Ohio State University (7.7%).

The 20 papers cited most often are written by 2.5 authors on average and cited at least 40 times; 75% were published 11 years ago in journals with an impact factor greater than 3.5. Moreover, 90% of the research was carried out in US universities, 70% used a US context, 45% is related to category A (corporate decisions, strategies and policies), and 35% to category B (agency problems, ownership, governance, organisational forms, and compensation design). Finally, 50% of the papers produced new findings, and 100% applied a quantitative analysis method.

As more recently published papers have less potential to have a large number of citations, we also compared citation ratios for the papers. Using *Scopus* and *Web of Science* as data sources, we ranked the papers as shown in Table 2.4. According to Furrer et al. (2008), the citation ratio better reflects the real influence of an article in the field. Selection of papers cited at least 10 times/year reduces our sample to 14. Nonetheless, the features among them remain similar.

Table 2.4: Paper statistics: year, journal, knowledge center and citation ratio.

No [†]	Paper	Year	Journal	IF (SCR) [‡]	Knowledge Center	Citation Ratio (Scopus)	Citation Ratio (WoS)
1	Almeida et al. (2004).	2004	The Journal of Finance.	6,033	New York University, University of Illinois.	30,27	25,82
2	Bates et al. (2009).	2009	The Journal of Finance.	6,033	Arizona State University, University of Georgia and The Ohio State University.	28,33	23,83
3	Dittmar and Mahrt-Smith (2007).	2007	Journal of Financial Economics.	3,769	University of Michigan and University of Toronto.	29,75	23,75
4	Campello et al. (2010).	2010	Journal of Financial Economics.	3,769	University of Illinois and Duke University.	28,80	22,40
5	Opler et al. (1999).	1999	Journal of Financial Economics.	3,769	The Ohio State University and Georgetown University.	26,44	22,00
6	Harford et al. (2008).	2008	Journal of Financial Economics.	3,769	University of Washington, Virginia Tech, and University of Arizona.	24,43	17,86
7	Lamont (1997).	1997	The Journal of Finance.	6,033	University of Chicago.	17,00	14,67
8	Holmström and Tirole (1998).	1998	Journal of Political Economy.	3,617	Massachusetts Institute of Technology.	14,41	13,47
9	Pinkowitz et al. (2006).	2006	The Journal of Finance.	6,033	Georgetown University and Ohio University.	17,33	13,22
10	Faulkender and Wang (2006).	2006	The Journal of Finance.	6,033	Washington University.	16,78	13,00
11	Harford (1999).	1999	The Journal of Finance.	6,033	University of Oregon.	18,25	12,81
12	Dittmar et al. (2003).	2003	The Journal of Financial and Quantitative Analysis.	1,877	Indiana University, University of Toronto, and London Business School.	13,67	11,00
13	Denis and Sibilkov (2010).	2010	Review of Financial Studies.	3,532	Purdue University and University of Wisconsin.	14,20	10,60
14	Acharya et al. (2007).	2007	Journal Financial Intermediation.	1,625	London Business School, New York University, and University of Illinois.	11,88	10,25

† Order.

‡ Impact factor.

2.3.3 Scholar networks on cash holdings

Many scholars have contributed to the literature on cash holdings. We assess a total of 245 researchers as authors and co-authors. Acknowledging the influence and contribution of a researcher encourages the improvement of knowledge within the field. One way to recognise good work is to identify the core areas that authors choose to research. To this end, we select individuals who authored at least three papers on cash holdings. Figure 2.7 presents these authors and their core research areas related to cash holdings. It is evident that these authors have researched more than four topics related to cash holdings, confirming their important role in the development of knowledge in this area.

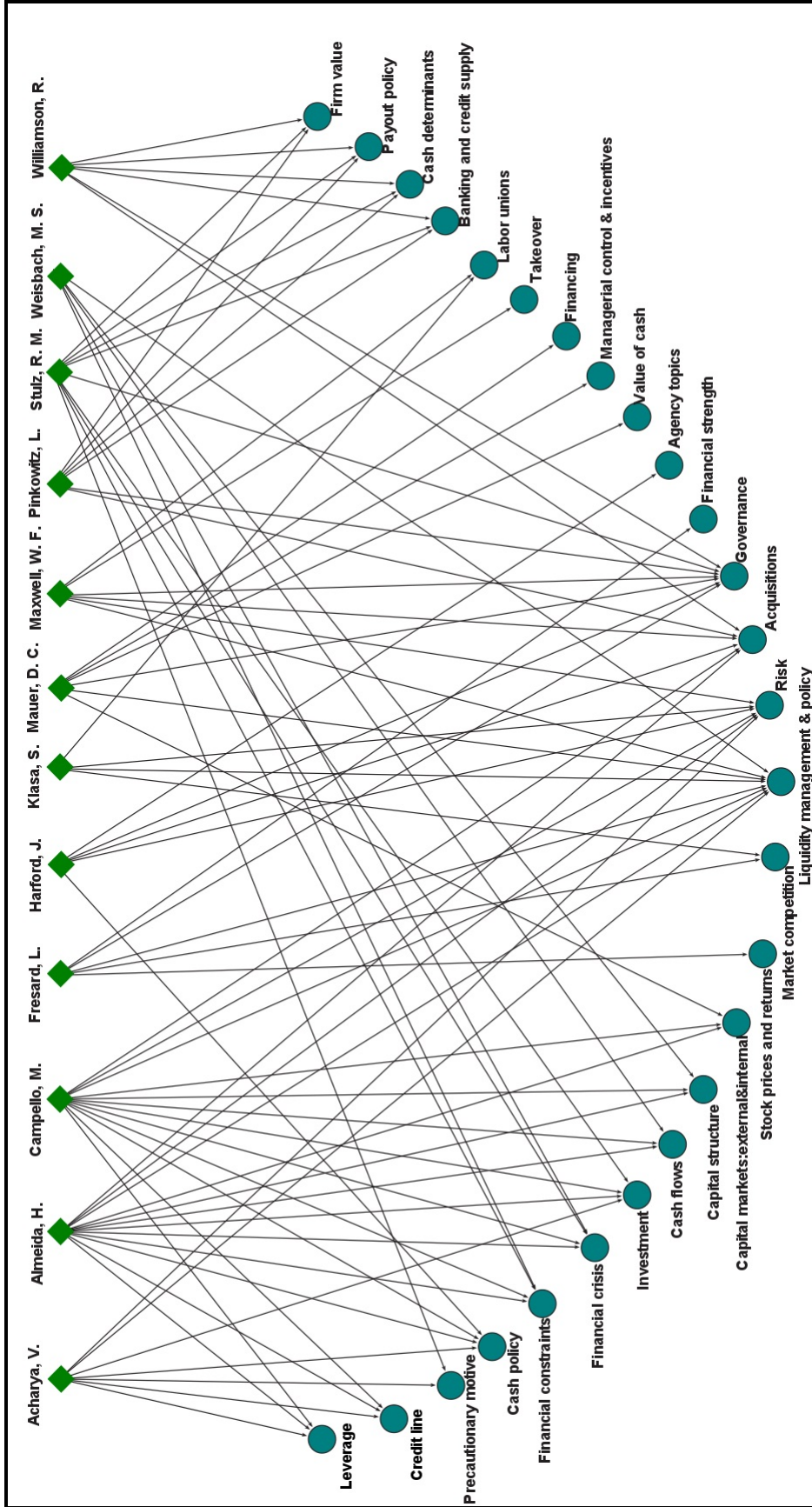


Figure 2.7: Authors and their core areas on cash holdings.

Cross-referencing authors and co-authors of the selected papers reveals networks among them. Our analysis also reveals the strength and direction of these relationships, as shown in Figure 2.8. A researcher can be just an author (yellow triangle), just a co-author (grey triangle), an author of one paper and co-author of another paper (green triangle), and a single author (blue triangle).

We can distinguish 12 networks with more than four researchers (shaded area in grey), 16 with three researchers, 22 with two researchers, and 23 with single scholars. The arrows indicate the direction of the authorship, and more than one arrow indicates the strength among researchers. The strongest relationships are among H. Almeida, V. Acharya, M. Campello, and M.S. Weisbach, and between L. Pinkowitz and R. Williamson. This means that these authors published at least three papers together.

2.3.4 Research methods in the literature on cash holdings

Cash holdings have been used in empirical models as the dependent variable (39%), an independent or explanatory variable (20%), and to build other related variables (31%). As cash holdings are not readily available from financial statements, the literature has used different proxies for measuring this variable. Table 2.5 lists the concepts used most often in the literature on cash holdings.

Table 2.5: The concepts of cash holdings employed by the papers.

Definition	Paper
Logarithm of the cash-to-net assets ratio.	Y. Chen et al. (2015); D. Chen et al. (2014); Francis et al. (2014); Locorotondo et al. (2014); Y. Huang et al. (2013); Song and Lee (2012); Harford et al. (2008); Fritz Foley et al. (2007); Dittmar et al. (2003); Opler et al. (1999).
Logarithm of cash and marketable securities over total assets ratio.	Qiu and Wan (2014); H. Gao et al. (2013); Fresard (2010).
Logarithm of the cash and cash equivalents to sales ratio.	Harford et al. (2008).
Logarithm of one plus the ratio of cash to net assets.	Itzkowitz (2013).
Ratio of cash plus marketable securities to the book value of total assets.	Francis et al. (2014); Qiu and Wan (2014); H. Gao et al. (2013); Bigelli and Sánchez-Vidal (2012); Subramaniam et al. (2011); Kalcheva and Lins (2007); C. S. Kim et al. (1998).
Ratio of cash plus marketable securities to the net total assets (net assets=book assets minus cash).	Y. Liu et al. (2014); Locorotondo et al. (2014); Song and Lee (2012); Y. Liu (2011); D'Mello et al. (2008); Opler et al. (1999).
Ratio of total cash and marketable securities to monthly operating and interest expenditures.	Gore (2009).
Ratio of cash and short-term investments to total assets.	Harford et al. (2014); Nikolov and Whited (2014); Larkin (2013); Duchin (2010); Fresard and Salva (2010); Fritz Foley et al. (2007); Pinkowitz and Williamson (2001); Colquitt et al. (1999).
Ratio of cash and short-term investments to net assets.	Ramírez and Tadesse (2009); D. Haushalter et al. (2007).
Ratio of cash and cash equivalents to total assets.	Y. Chen et al. (2015); Al-Najjar (2015); Feng and Johansson (2014); Neamtiu et al. (2014); Al-Najjar (2013); Bigelli and Sánchez-Vidal (2012); Y. R. Chen and Chuang (2009); Y. R. Chen (2008); Han and Qiu (2007); Kalcheva and Lins (2007); Özgür Arslan et al. (2006); Ozkan and Ozkan (2004).
Ratio of cash and cash equivalents to net assets.	Y. Chen et al. (2015); Feng and Johansson (2014); Schauten et al. (2013); Wu et al. (2012); Kuan et al. (2011); Harford et al. (2008); Ferreira and Vilela (2004); Opler et al. (1999).
Ratio of cash and cash equivalents to sales.	Y. Chen et al. (2015); Al-Najjar (2015); Y. Huang et al. (2013); Larkin (2013); Dittmar et al. (2003).
Ratio of cash to noncash assets.	Q. Chen et al. (2012); Yun (2009).
Ratio of cash plus cash equivalents to noncash assets (net assets).	Meggison et al. (2014).
Ratio of pure cash to total assets (cash, cheques and bank deposits divided by total assets).	Feng and Johansson (2014); Bigelli and Sánchez-Vidal (2012); Pinkowitz and Williamson (2001).
Ratio of cash and cash equivalents to the market value of equity at the beginning of the fiscal year.	Haw et al. (2011).

Bates et al. (2009) point out that the ratio of cash and cash equivalents to total assets is the most traditional measure among papers. As reported by the authors, the cash-to-net assets ratio and its logarithm might produce outliers for firms with a high asset concentration in cash or with assets of less than US\$ 100 million. Although the authors choose one of these measures, they also use an alternative measure of cash holdings as a basic check for robustness.

There are two reasons for using cash holdings as an independent variable: (1) when investigating the effect of cash holdings on other financial factors, such as investments, acquisitions, stock returns, firm value, financing, and governance; and (2) when analysing the relationship between two parameters influenced by cash holdings. In the latter case, cash holdings are used as a control variable.

Cash holdings are also used to build other related variables, such as the sensitivity of cash flow to cash (Almeida et al., 2004; Acharya et al., 2007; Bao et al., 2012; Brisker et al., 2013), the variation of cash holdings (Kahle & Stulz, 2013; Kusnadi, 2011; Riddick & Whited, 2009; Opler et al., 1999), excess cash (Schauten et al., 2013), unexpected changes in market values (Rapp et al., 2014; Tong, 2011), the marginal value of cash holdings (Tong, 2010), industry-adjusted cash holdings, and imputed cash holdings (Subramaniam et al., 2011).

The literature has presented different determinants of and distinct relationships involving cash holdings. We identify 31 different variables revealed as determining factors for cash holdings. Firm-specific factors such as size, age, net working capital, growth opportunities, profitability, cash flow, leverage, investment opportunities, capital expenditure, asset liquidity, risk, and R&D have been extensively explored as control variables. Exogenous factors, such as investor protection systems, government quality, external capital markets, financial shocks, financial constraints, credit ratings, inflation, and corruption have also been identified as influential factors for corporate cash retention behaviour.

The following are some examples of predictions from papers in which cash holdings are used as a dependent variable:

- Larger firms have lower cash holdings;
- Younger firms have larger cash holdings;
- Firms with higher levels of uncertainty and risk typically have higher levels of cash reserves;
- Firms with higher industry volatility are likely to retain more cash;
- Firms financially constrained are likely to have higher cash holdings;
- Firms with higher effective tax rates hold lower cash balances;
- Firms with higher growth opportunities should have higher cash holdings;
- Higher financing deficits are associated with lower cash holdings;
- Firms with higher leverage have lower cash reserves;
- Firms that pay dividends have higher cash balances;
- Firms with higher payouts have lower cash reserves;

- Firms with shorter cash-conversion cycles have lower cash balances;
- Firms with higher net working capital might have lower cash reserves;
- Firms with higher investment opportunities have higher cash-holding levels;
- Firms with higher cash holdings have lower investment levels;
- Firms with a higher level of managerial ownership might have higher cash balances;
- Cash-rich firms have lower acquisitions levels;
- Firms with an independent board are likely to hold more cash;
- Firms with higher CEO compensation firms have lower cash holdings; and
- Firms with higher shareholder rights have lower cash holdings.

Tables D.1 and E.1 summarise our findings for the principal relationships between cash holdings (dependent variable) and several independent variables among the papers. In the majority of these articles, cash holdings are positively related to the market-to-book ratio, cash flows, investment opportunities, age, managerial ownership, sales growth, profitability, R&D, industry volatility, board independence, state-owned firms, financial constraints, and cash flow volatility. By contrast, cash holdings are negatively associated with size, net working capital, leverage, credit spread, investment level, capital expenditure, acquisitions, liquidity, taxes, bond rating, inflation, government quality, and corruption.

All the papers we analyse are quantitative, and 14.3% use both theoretical and empirical approaches to develop a model and then test the predictions empirically. Some 78.1% use an empirical model and 7.6% apply mathematical modelling.

The empirical papers use the following data analysis tools:

- Three-equation SURE;
- 2SLS regression;
- 3SLS regressions
- Cross-sectional regression;
- Differences-in-differences;
- Fama-McBeth regression;
- Fixed effect regression;
- Instrumental variables estimation;
- Generalised method of moments (GMM);
- GMM 4;
- GMM 5;
- Industry-adjusted regression;

- Full-information maximum likelihood (FIML);
- Event study with CAR;
- Logit regression;
- Multinomial logistic regression;
- Ordinary least squares (OLS) regression;
- Poisson regression;
- Probit regression;
- Propensity score-matching;
- System of seemingly unrelated regression (SUR);
- Weighted least squares (WLS);
- Time-series regression;
- The Abadie-Imbens matching estimator; and
- Tobit regression.

In general, the papers present a main empirical analysis with one specification model. OLS regressions are the most frequent traditional econometric instrument, used by 30.5% of the papers, followed by differences-in-differences (7.6%) and GMM models (6.7%). Some econometric tools such as differences-in-differences, Poisson regression, and The Abadie-Imbens matching estimator have only been used since 2012.

2.4 Gaps and future research on cash holdings

Combining the main focus and theoretical perspective categories reveals 33 unique combinations, as shown by Figure 2.9. This highlights the applicability of cash holdings research to other finance topics, and its connections to other fields such as behavioural theory, marketing, public administration, corruption, human resources, culture, and innovation.

Categories related to the main focus are denoted focus and those related to the theoretical perspective are denoted theoretical. Combining these two categories identifies strong links among focus category B (agency problems, ownership, governance, organisational forms, and compensation design) and theoretical category C (agency-based theories), focus category A (corporate decisions, policies, and strategies), and theoretical category D (other perspectives). These interactions account for 35% of the papers analysed and also provide other unique combinations that have not been explored so far. Among the focus and theoretical groups, we do not find any relation between focus category B and theoretical category B (pecking order theory), between focus category C (culture, politics, government, unions, product market competition, and relationships) and theoretical category C (agency-based theories), or between focus category D and theoretical category C. In addition, we do not detect interrelations among the focus categories (e.g. focus A with focus C, focus A with focus D, focus C with focus D, or focus D with focus E).

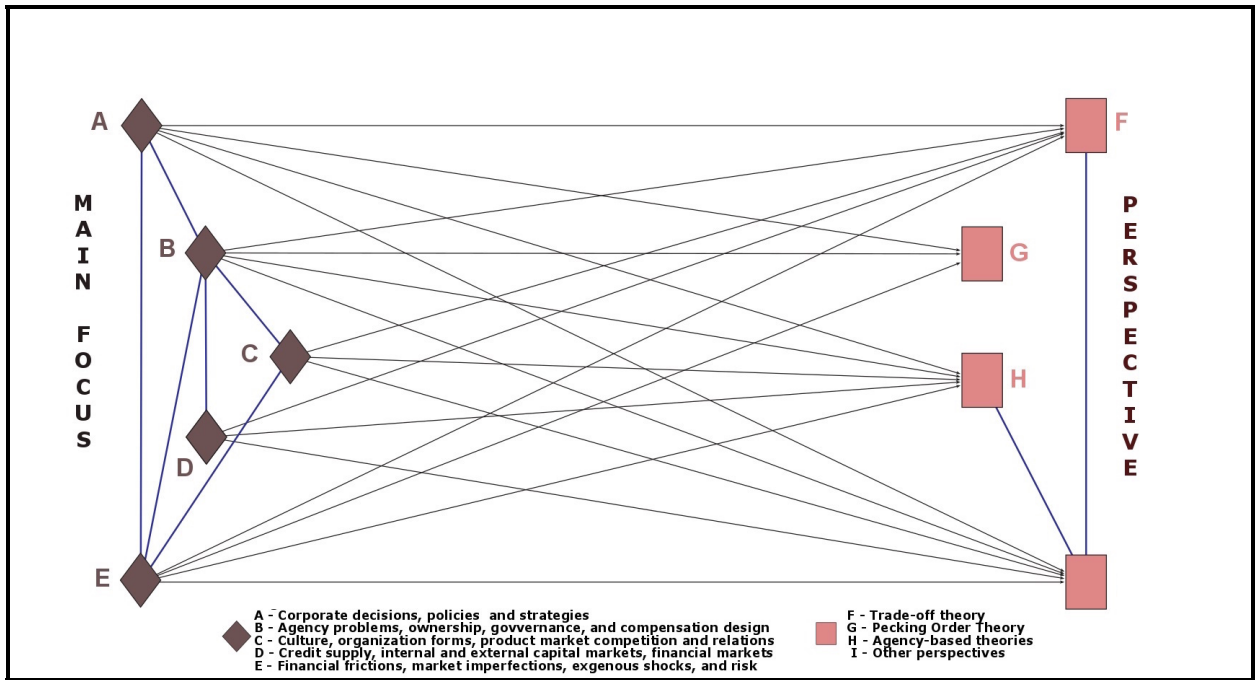


Figure 2.9: Theoretical perspective and main focus matchings.

The analysis levels differed among the papers: 47.6% use a firm-level approach, 16.2% use firms within segments, 11.43% use firms across countries, and 4.76% use business groups in their study. Another interesting finding is that 94.3% of the papers use publicly listed firms, 1.9% use cross-listed companies (those listed on a different exchange to their original stock exchange), 1.9% use private firms (non-listed), 0.9% explore small and medium-sized firms, and 0.9% study family-controlled firms.

Publicly listed firms have to disclose financial reports periodically, which provides a rich and large data set, especially in developed countries, and allows wide research into such firms. By contrast, the lack of data availability for private, small, and medium-sized firms is a natural barrier to their investigation.

Splitting the papers according to the organisation structure studied reveals a potential research avenue. Among the 105 papers, 2.85% study diversified firms, 1.9% stated-owned companies, 0.9% IPO firms, 0.9% vertically integrated firms, 0.9% venture capital, 0.9% property-liability insurers, and 0.9% spin-offs. None of the papers explore private equity buyouts or hedge fund activism. These issues have been considered hot topics for future research in corporate finance (Davis et al., 2014; Brav et al., 2011).

The US context is explored by 62% of the papers, with 8.6% focusing on Europe, 8.6% on Asia, 0.9% on BRICS, and 11.4% on a world framework. None of the papers study Latin America or Africa as the main target. In general, Latin American and African countries are studied jointly with other countries around the world using firm samples from the Compustat Global or Worldscope database.

Combining these observations with gaps pointed out by the authors, we identify some potential topics for future research. Only one paper considered small and medium-sized firms. According to US Census Bureau data (Bureau, 2012), there were 28,443,856 small and medium-sized firms in 2012; they borrowed \$ 1,830.5 billion in 2011 and contributed 46% of private non-agricultural GDP in 2008, playing an important role in the US economy. Given this relevance, an increase in the number of studies exploring this

setting are expected as more data become available.

As pointed out by Al-Najjar (2013), important internal corporate governance factors such as board characteristics, audit features, and CEO characteristics have been explored for developed countries, but require further analysis in emerging countries. As countries differ in their financial and governance structures, firm cash holdings might differ in behaviour by country as well.

Al-Najjar (2015) suggests that investigation of corporate governance and cash holdings in small and medium-sized firms around the world is a way to compare the development of governance mechanisms and their effects on corporate cash holdings by such firms. C. Kim and Bettis (2014) also recommend research into the dynamics of cash holdings and their strategic deployment among firms of different relative size across industries.

According to Fritz Foley et al. (2007), financially constrained firms with higher domestic leverage and lower investment grade show less propensity to defer taxes related to repatriation by hoarding cash overseas. However, the tests used by Fritz Foley et al. (2007) do not provide enough evidence that these tax burdens reduce domestic cash balances, offering a worthwhile avenue to explore in future research.

Despite providing an interesting dynamic model, Gamba and Triantis (2008) conclude that their theoretical framework is still inaccurate in matching previous empirical findings on corporate financial policy. To solve this issue, the authors suggest new theoretical extensions, such as “relaxing the restriction on debt risk, examining both managerial and debt-related agency problems, allowing for a richer set of investment opportunities, and underlying stochastic variables”.

Innovation issues are only examined by two papers in our survey. Levitas and McFadyen (2009) recommend new research to examine the relationship between cash-holding behaviour and innovation for alliances among industries under different levels of financial uncertainty.

Credit lines and banking topics have been proposed by scholars in the literature on cash holdings. However, the relationship among cash holdings, bank lending, and firm borrowing has not been fully elucidated. Francis et al. (2014) propose that future research should provide an understanding of how the risk incentive mechanisms of consolidated banks can affect the risk-taking behaviour of corporate borrowers.

Issues involved in firm bankruptcy and fraud have not been discussed from a cash-holding perspective. Marcel and Cowen (2013) show that financial fraud tends to be associated with weaker governance instruments. Governance has been an active topic in cash holdings research, but a bridge connecting financial fraud, governance, and cash-holding behaviour is lacking.

Finally, Almeida et al. (2014) suggest the investigation of cash holdings in a real sense by including not only traditional measures of cash and cash equivalents but also those named by firms as cash investments. Almeida et al. (2014) state that this approach may allow researchers to estimate the magnitude of risks to which a firm’s cash holdings are exposed, particularly during downturns.

2.5 Concluding remarks

The saying “*once bitten, twice shy*” reflects how firms around the world have behaved over time regarding their cash-holding policy. This trend remains across firms from both

developed and developing countries. In a survey of 105 papers from 1997 to 2015, we identify papers published on cash-holding research, and identify links, core ideas, methods, and findings that have built the research pathway for this field.

Different standpoints have been used to explain trends for corporate cash holdings. We analyse studies that use agency theory, trade-off theory, pecking order theory, and contemporary approaches. We list the papers cited most often and the knowledge centres from which they come, as well as their contributions to the literature. Moreover, we identify the main networks established among authors and co-authors, and the strongest relationships among these scholars according to co-authorship of papers.

We also describe the concepts used to define cash holdings, the main independent variables, and the relationships established with these independent variables for cash holdings as the dependent variable. We discuss the major data analysis tools used in the literature, pointing out that differences-in-differences, Poisson regression, and the Abadie-Imbens matching estimator have only been used as instruments since 2012.

Comprehending how firms manage their cash holdings has become increasingly relevant to corporate finance research and practice. Moreover, understanding the antecedents of why firms hold such excess cash and their consequences could be important in shedding light on the influence of several factors on corporate cash-holding management. Studies that consider interdependence among corporate financial policies could represent a challenge in the field.

Although much has been studied, taxes, organisational structure, fraud, bank lending, and firm bankruptcy are topics that have been explored by few scholars. Emerging topics such as risk, shocks, financial constraint, credit lines, and banking issues are also fruitful areas for future research.

Even though other liquidity instruments such as credit lines, derivatives, and working capital have been explored in recent years, the majority of the literature recognises the importance of cash holdings to corporate liquidity management, so this topic continues to be a relevant research issue in the finance field.

3 A bird in the hand is not worth two in the bush: insider ownership, idiosyncratic risk, and cash holdings

Cash is central to a firm's liquidity management, enabling firms to finance investments and other liabilities and to avoid the high costs of raising external funds (Harford et al., 2014; Almeida et al., 2014). Therefore, cash holdings are the most common, quick way for firms to ensure liquidity. Comprehending how firms manage their cash holdings has become increasingly relevant to corporate finance research and practice. Moreover, understanding the antecedents of excess cash holding by firms and the consequences could elucidate the influence of several factors on corporate cash-holding management (Almeida et al., 2014).

Because cash is considered the most liquid of a firm's assets, it can be quickly transformed, held, or applied elsewhere carrying a high transformation risk (Myers & Rajan, 1998). For instance, cash holdings could induce managers to turn excess cash into perks or excessive salaries (La Porta et al., 2002). Although excess cash raises the firm's ability to raise external financing and undertake investment opportunities, it does not provide assurance that managers will commit to a corporate strategy that protects shareholders and other investors (Arnold, 2014). To mitigate potential misbehaviour, insider ownership should be increased to align managers with shareholders' interests (Al-Najjar, 2015; Nikolov & Whited, 2014; Jensen, 1986; Jensen & Meckling, 1976).

On the one hand, the greater the level of managerial ownership, the more direct control the manager has over the firm, and external shareholders may find it more difficult to monitor manager's actions or estimate the true value of the manager's corporate decisions (Ozkan & Ozkan, 2004). Therefore, greater managerial ownership may increase the likelihood that managers will pursue private interests at the expense of shareholders by potentially diverting resources, such as outright stealing, excessive salaries, perquisite consumption, and/or transfer pricing (La Porta et al., 2002). Hence, under the entrenchment agency hypothesis, a positive relation between managerial ownership and cash holdings is expected (Al-Najjar, 2015; Y. R. Chen, 2008).

On the other hand, if managerial ownership acts as a monitoring tool within companies, it could inhibit discretionary behaviour avoiding conflicts of interest between shareholders and managers in cases where executives own more company shares. Thus, compensating managers with firm's stakes might discourage them to pursue their own interests, and using available resources such as cash could maximise shareholder value (Al-Najjar, 2015; Ozkan & Ozkan, 2004). As a result, executives in publicly traded firms worldwide hold substantial ownership in their companies (Panousi & Papanikolaou, 2012). In this regard, studies based on the interest-alignment hypothesis have found a negative relation between insider ownership and corporate cash holdings (Y. R. Chen & Chuang, 2009; Ozkan & Ozkan, 2004).

Although compensation schemes may seem to have desirable incentive/motivational properties, they may also discourage the manager from bearing risk that could be better carried by diversified stockholders (Holmström & Tirole, 1998). If a significant proportion of a manager's personal wealth is linked to compensation packages based on equity shares, the manager tends to exhibit risk averse behaviour, whereas the principal may tend to exhibit risk neutral behaviour (Zajac & Westphal, 1994). Therefore, while the principal

only bears systematic risk, the manager bears both systematic and idiosyncratic risks (Tong, 2010).

If idiosyncratic risk cannot be fully diversified for reasons such as transaction costs (Malkiel & Xu, 1997; Merton, 1987), low liquidity stocks (Merton, 1987), restrictions imposed on companies when the investor holds a strategic position within the firm (Acharya & Bisin, 2009; G. Brown & Kapadia, 2007; Campbell et al., 2001), or even prohibition because of issues associated with insider trading (Leland, 1992), the level of insider ownership may positively affect corporate cash holdings. Additionally, when the risk taking preferences are different, it is costly and difficult for the outside shareholders to convince the manager to bear idiosyncratic risk. Thus, studies related to the risk agency hypothesis suggest that risk averse managers may retain more liquid assets to minimise firm risk and protect their own wealth at the expense of shareholder value (Arnold, 2014; Tong, 2010).

The questions that arise from this context are: Does corporate exposure to idiosyncratic risk drive firm's cash policies? Does insider ownership affect the level of corporate cash holdings? If firms maintain more cash reserves because of idiosyncratic risk, does the level of insider ownership change the cash holding–idiosyncratic risk relationship?

Cash holdings, managerial ownership, and idiosyncratic risk have been explored by the finance literature in recent years. G. Brown and Kapadia (2007) identify that idiosyncratic risk is greater for firms in more recent IPO listing cohorts, and Bates et al. (2009) find that firms that have recently gone public hold more cash. Additionally, Bates et al. (2009) and Harford et al. (2008) present idiosyncratic risk, measured by cash flow volatility, as an important determinant that substantially impacts corporate cash holdings. According to these authors, when firms have unhedgeable risks, they hold more cash. Corroborating this perspective, Palazzo (2012) and Opler et al. (1999) show that changes in cash holdings are positively related to firm-level risk measured by cash flow volatility.

The influence of managerial ownership on cash holdings is debated in Nikolov and Whited (2014) and Ozkan and Ozkan (2004). Using a dynamic model, Nikolov and Whited (2014) estimate that when a manager retains a unit of cash today, the manager decreases her utility of cash within the firm tomorrow. As manager utility of cash is scaled down by the manager's ownership fraction, with a low level of ownership, the manager tends to accumulate cash above the optimal cash holding.

Ozkan and Ozkan (2004) provide evidence of the existence of a non-monotonic relationship between managerial ownership and cash holdings from a sample of UK firms for the period from 1984 to 1999. According to the authors, a non-monotonic relationship could be observed because cash holdings do not always increase, decrease, or remain constant as insider ownership increases. Ozkan and Ozkan (2004) suggest that with lower and higher levels of managerial ownership, by 24% and over 64%, respectively, the interests of managers and shareholders are equalised resulting in lower cash retention. However, when executives own between 24% and 64% of a firm's stakes, they tend to maintain greater cash balances to pursue their own interest within firms.

The relation of managerial ownership and idiosyncratic risk is approached in Glover and Levine (2014) and Panousi and Papanikolaou (2012). Glover and Levine (2014) discussed theoretically that components of stock and option compensation combined with firm volatility may motivate managers to over or underinvest. Panousi and Papanikolaou (2012) show that a single standard deviation increase in idiosyncratic risk in firms with poor-diversified managers reduces investment by 8% of the existing capital stock

compared to 2% for firms with a more diversified shareholder base.

Despite the interest in designing and testing the relationship among insider ownership, idiosyncratic risk, and investment in Glover and Levine (2014) and Panousi and Papanikolaou (2012), there has been no empirical analysis on the effects of the level of insider ownership on cash holdings when idiosyncratic risk is considered. We argue that managerial shareholdings facing unhedgeable risk induce a stronger, positive relationship between idiosyncratic volatility and cash holdings. To our knowledge, this hypothesis has not yet been explored by the finance literature.

Therefore, the contributions of our study are threefold. First, our findings extend the growing literature on the determinants of corporate cash holdings by exploring the effect of idiosyncratic risk from the volatility of common stock returns on cash holdings rather than from cash flow volatility. Employing a different proxy from Bates et al. (2009) may reflect better variations on the asset fundamentals and firm future prospects and capture the impact on firm-level decisions (Bulan, 2005).

Second, we support additional arguments for both asset pricing and corporate finance research by providing evidence that idiosyncratic risk can be a priced risk factor explaining in part the variation in cash holdings and, consequently, the effect on corporate cash decisions (Fu, 2009; Goyal & Santa-Clara, 2003; Xu & Malkiel, 2003).

Lastly, we supplement the literature on ownership, corporate policies, and agency theory by investigating the effect of the extent of insider ownership on the relationship between corporate cash holdings and idiosyncratic risk. Although the research regarding ownership and cash holdings under agency perspective has been intensively explored (Al-Najjar, 2015; Y. Liu et al., 2014; Ameer, 2012; Tong, 2010; Y. Liu, 2011; Core et al., 2006; Jensen & Meckling, 1976), we found no papers that analysed empirically the relationship among cash holdings, idiosyncratic risk, and the level of insider ownership. We address an unexplored subject in the finance field that may improve the understanding of whether and how cash holding–idiosyncratic risk sensitivity can be associated with the level of manager shareholding.

Following the theoretical insights of Nikolov and Whited (2014) and Panousi and Papanikolaou (2012), we test whether and how the level of insider ownership influences the relation between corporate cash holdings and idiosyncratic risk.

We develop a hypothesis based on previous theoretical and empirical literature that shows embedded connections among cash holdings, idiosyncratic risk, and insider ownership. Next, we present our baseline regression model to test our hypothesis. Using a large and representative sample of US firms over a 23-year period (1992 to 2014), we analyse the effect of idiosyncratic risk on cash holdings. Then, following the insights in Nikolov and Whited (2014), we test the effect of insider ownership on cash holding decisions. Finally, we investigate how the level of insider ownership influences the corporate cash holdings and idiosyncratic risk relationship.

The remainder of the paper is organised as follows. Section 3.1 describes the related literature and hypothesis development. Section 3.2 delineates the data and its implementation. Section 3.3 describes the empirical results, provides a discussion, examines potential endogeneity concerns, and includes robustness checks of the regression outcomes. Section 3.4 provides concluding remarks.

3.1 Related literature and hypothesis development

This section surveys the related literature on cash holdings, idiosyncratic risk, and insider ownership. First, some fundamentals, research, and definitions of idiosyncratic risk are presented. Next, hypotheses based on the literature of cash holdings, idiosyncratic risk, and insider ownership are developed.

3.1.1 Idiosyncratic risk: Definition, fundamentals, and related research

Idiosyncratic risk is defined as risk that is unique to a specific firm, also called firm-specific risk (Fu, 2009). In frictionless capital markets, only systematic risk is relevant, and idiosyncratic risk should not affect the valuation of corporate decisions because it cannot be a priced risk factor (Fama & French, 1993; Lintner, 1965; Sharpe, 1964).

Based on this approach, the Capital Asset Pricing Model (CAPM) considers only market risk (Sharpe, 1964; Lintner, 1965) while the Fama-French three-factor model (Fama & French, 1993) considers market, size, and growth risk (Fama & French, 1993). Both models confirm that if investors can diversify a stock's specific risk and adjust returns with an accepted risk level, idiosyncratic risk should not be a concern (Fama & French, 1993). However, following the principle of 'no free lunch', studies in Merton (1987), Malkiel and Xu (1997) and Campbell et al. (2001) show that it is difficult to hold a well-diversified portfolio and remove the influence of idiosyncratic risk from an investor's portfolio without a high transaction or information cost.

Analysing the relationship between the extent of portfolio diversification and the reduction in the risk associated with portfolio returns, Evans and Archer (1968) observed that the reduction risk effect decreases rapidly as the number of stocks increases, reaching the economic benefits of diversification when a portfolio contains 10 stocks. In Statman (1987), however, a well-diversified portfolio must include at least 30 stocks for a borrowing investor and/or 40 stocks for a lending investor. However, Campbell et al. (2001) show that investors need almost 50 stocks to achieve relatively complete portfolio diversification.

Focusing on the impact of residual effects from a single-index market model on risk premiums, (Lehmann, 1990) employs corrections for measurement error in parameter estimates finding significant residual risk effects from this market model.

Malkiel and Xu (1997) show a definite increase in volatility for individual stocks over time, concluding that idiosyncratic volatility may not be irrelevant to asset pricing. Using US stocks from the year 1963 to the year 1994, Malkiel and Xu (1997) note that idiosyncratic risk, measured by the difference between the variance of returns for individual stocks and the volatility of the S&P index, has increased over this period while the volatility of the whole market has remained stable. As a result, individual portfolios may require an extra risk premium to carry extraordinary specific risk.

Mueller (2010) find that owners in private companies demand higher compensation for incurring higher idiosyncratic risk. Although higher ownership incentivises managerial commitment, for an additional 10% in a firm's stake the manager requires an average return increase of approximately 15.7% to bear additional risk.

Testing various multifactor models based on size, value, past performance, liquidity, total volatility, and ICAPM specification of the risk-return relationship, Miffre, Brooks, and Li (2013) show that the premium for taking idiosyncratic risk varies inversely with the number of stocks included in the portfolio. Consequently, investors demand additional

returns for the idiosyncratic risk of poorly diversified portfolios.

Idiosyncratic risk has also been extensively debated in the finance literature, particularly its influence on expected returns (A. Ang et al., 2009; Fu, 2009; A. Ang et al., 2006; Bali et al., 2005; Wei & Zhang, 2005; Goyal & Santa-Clara, 2003; Xu & Malkiel, 2003; Campbell et al., 2001; Merton, 1987).

Merton (1987) argue that firms with greater common-factor exposure, greater firm-specific variance, larger size, and relatively smaller investor bases tend to present higher expected returns. Additionally, the author identifies that the size of the firm relative to the aggregate wealth of the investors in the firm is negatively associated with firm-specific variance, indicating that higher idiosyncratic-risk firms tend to have smaller and concentrated investor bases.

A significant and persistent increase on aggregate stock market volatility over time is observed by Campbell et al. (2001). Employing a disaggregated approach to investigate this upward trend, the authors split total volatility into three distinct measures, firm-specific, market, and industry variances. According to the authors, from 1962 to 1997, firm volatility increased from 65% to 76%, whereas market and industry volatilities decreased from 20% to 14% and 15% to 10%, respectively. Campbell et al. (2001) ascribe this positive trend in varying parts to the increase in the number of publicly traded companies, changes in corporate governance, and the institutionalization of equity ownership. Brandt, Brav, Graham, and Kumar (2009) further show that the increase in idiosyncratic risk from 1962 to 1997 and the subsequent reversal from 1997 to 2007 is concentrated among firms with low stock prices and high retail ownership.

Goyal and Santa-Clara (2003) show that idiosyncratic risk, measured by the arithmetic average of the monthly variance of each stock's returns, is positively significant in predicting market returns, whereas the variance of the market has no forecasting power for the market return, even after running a bootstrap analysis and controlling for business cycle fluctuations. The authors further argue that idiosyncratic equity risk may proxy for the volatility of non-traded assets, such as human capital and private businesses, and affect the risk aversion of investors towards traded assets.

Similarly, idiosyncratic risk cannot be completely hedged because of the presence of transaction costs (Malkiel & Xu, 1997; Merton, 1987), low liquidity stocks (Merton, 1987), or as a result of restrictions imposed on companies associated with insider trading (Leland, 1992). Therefore, because idiosyncratic risk should be a priced factor on portfolio returns, and investors cannot be fully diversified for the reasons described above, the influence of idiosyncratic risk on corporate policies become an important issue to be explored in the finance field.

Although well-documented literature has brought evidence that idiosyncratic risk matters for firm characteristics and corporate finance decisions, the effect of idiosyncratic risk on cash holdings has received less attention. To our knowledge, only Bates et al. (2009) analyse and ascribe directly idiosyncratic risk (measured as cash flow volatility) as a determinant of corporate cash reserves. Additionally, no prior study explores whether the relation between cash holdings and idiosyncratic risk is affected by the level of insider ownership. Thus, in the next section, we focus on examining all studies that embed firm-specific risk, corporate cash behaviour, and insider ownership to support the development of the hypothesis in this paper.

3.1.2 Idiosyncratic risk and cash holdings

Previous studies have already presented the relationship of idiosyncratic risk with firm characteristics, such as stock returns (Nath & Brooks, 2015; Guo & Savickas, 2010; A. Ang et al., 2009; Fu, 2009; A. Ang et al., 2006; Xu & Malkiel, 2003; Campbell et al., 2001), leverage (Gerlach et al., 2015; Mishra et al., 2012), credit rating (Y.-M. Lin & Shen, 2015; Abad & Robles, 2014), firm age (C.-W. Huang et al., 2014), CEO compensation (Balafas & Florackis, 2014), financial reporting quality (Rajgopal & Venkatachalam, 2011), cash flows (Babenko et al., 2015; D. Huang & Wang, 2009), diversification (Casu et al., 2015; Roussanov, 2010), human capital (Eiling, 2013), product market competition (Irvine & Pontiff, 2008), corporate sustainability (Mishra et al., 2012; K.-W. Lee & Lee, 2009), consumer voice (Luo, 2007), innovation (Mazzucato & Tancioni, 2008), stock valuation (Pastor & Pietro, 2003), ownership (Xu & Malkiel, 2003), and investor base (Chichernea et al., 2015).

Another significant part of this literature explores the impact of firm-specific risk on corporate decisions, such as investment (Panousi & Papanikolaou, 2012; Bulan, 2005; Aizenman & Marion, 1999), corporate governance (Al-Najjar, 2015; Harford et al., 2008; Ferreira & Laux, 2007), mergers and acquisitions (Zhu et al., 2014), and capital structure (Mueller, 2008).

In Bates et al. (2009), idiosyncratic risk is a factor that positively affects corporate cash holdings. The authors show that firms in industries that face greater increases in idiosyncratic risk, measured by the increase in cash flow volatility, have higher cash holdings than their counterparts. According to Bates et al. (2009), the average firms in the highest volatility quintile experienced a cash balance shift from 12.9% in 1980 to 39% in 2006.

G. Brown and Kapadia (2007) suggest that firms with persistently higher idiosyncratic risk, measured by volatility of the fundamentals cash flows, have been listed over the last 40 years. The authors then ascribe the increase in idiosyncratic risk to the idea that riskier companies that become publicly traded might reflect the increase in idiosyncratic risk in the whole sample. Bates et al. (2009) also finds that IPO firms held more cash balances over this period.

In an analysis of cash-holding behaviour by American property-liability insurers from 1993 to 1995, Colquitt et al. (1999) find that smaller insurers with restrained access to external financing, greater short-term demand for cash, riskier cash flows, and greater future investment opportunities hold more cash to meet future needs in comparison to larger insurers.

Han and Qiu (2007) estimate that higher cash flow volatility among publicly traded US firms during the period 1997 to 2002 has a positive impact on cash holdings and a negative impact on current investments for financially constrained firms but not for unconstrained firms. Therefore, the authors suggest that the effect of cash flow volatility on corporate investment and cash holdings reflect the firm's financial constraints.

Palazzo (2012) models that firms with higher correlation between cash flows and aggregate risk are likely to have higher optimal cash holdings and use costly external funds to finance their growth option exercises. According to the author, changes in a firm's systematic risk positively affect expected returns and are stronger for firms with lower expected profitability. Consequently, the riskier the firm, the higher the corporate cash savings to protect against future cash flow shortfalls.

Bigelli and Sánchez-Vidal (2012) find that cash holdings are significantly positively related to firms with higher risk (higher cash flow volatility), smaller size, and lower effective tax rates from a sample of Italian private firms. In Hugonnier et al. (2014), the corporate target for cash holdings is positively related to cash flow volatility and negatively related to tangibility and agency conflicts.

Using matching estimators and focusing on changes in corporate cash balances from a sample of firms listed on the S&P 500 index, Brisker et al. (2013) document that inclusion in the index substantially reduces the need for index firms to hold cash compared to their matched peers. The results counter the increasing trend in Bates et al. (2009), which finds that the downward tendency on cash holdings is directly attributed to the inclusion of the index effect.

Acharya et al. (2014) propose a theory of corporate liquidity to explain how cash flow, liquidity risk, credit lines, and cash holdings interact in the presence of future growth opportunities. The model predicts that firms with greater cash flow volatility are likely to experience greater liquidity risk. If these firms have a low ability to raise external funds, particularly because of their low pledgeable income, the firms might choose to retain cash instead of using credit lines. Conversely, when firms have lower cash flow variance, higher pledgeable income, and greater future growth opportunities, they are likely to face lower liquidity risk and, hence, they tend to use credit lines rather than cash holdings.

Developing a stylised continuous-time model in which firms address internal agency costs and external financing costs simultaneously, Décamps et al. (2011) show that the marginal value of cash and the stock price are negatively correlated, whereas the marginal value of cash and the volatility of the stock price are positively related.

Fresard (2011) suggests that corporate cash holdings are more sensitive to stock prices as the firm-specific return variation increases. According to the author, the firm-specific return variation is not explained by market and industry movements, and the firm return volatility provides new information that is not available to managers to investors. Thus, the return variation may positively influence cash-saving decisions via stock market learning.

Therefore, based on the argument that firm-specific volatility induces the precautionary motive for firm cash holding, our first hypothesis is the following:

H₁: Corporate cash holdings are positively related to idiosyncratic risk.

3.1.3 Managerial ownership and cash holdings

Cash can be viewed as a financing source for future projects and a form of investment within a firm. As a financing instrument, cash holdings can be used to undertake profitable investment opportunities (Ferreira & Vilela, 2004), to reduce the cost of accessing external financing (Almeida et al., 2004), to service debt during economic distress (Acharya et al., 2007), and/or as a resource to be utilized during difficult times (Campello et al., 2011, 2010). From an investment perspective, cash holdings are a less risky project although they are considered negative NPV projects because they are subject to double taxation (Nikolov & Whited, 2014; Opler et al., 1999) and produce less return than the required cost of capital (Tong, 2010).

Because financing and investment decisions are undertaken by managers, and cash-holding policy is also a matter of managerial discretion, cash balances provide uncon-

ditional liquidity available to managers at any time (Arnold, 2014) opening up various trading strategies and carrying a high transformation risk with agent misbehaviour (Myers & Rajan, 1998). When managers do not act on behalf of shareholders, cash holdings can be turned into a variety of resource diversions, such as outright stealing, excessive salaries, perquisite consumption, and/or transfer pricing (La Porta et al., 2002) at a lower cost than other assets and, thus, representing a source of enhancement to manager control within firms (Baldenius, 2006; Myers & Rajan, 1998).

Colquitt et al. (1999) suggest that managerial discretion may produce an ambiguous effect on cash holdings. If managers are risk-averse, exceeding the optimal level of cash would be appropriate to take advantage of investment opportunities. However, if managers have self-interest, holding excess cash provides discretionary power to target their own objectives at the expense of shareholders. For instance, self-interested managers in firms with large free cash flows might expropriate excess cash for their own wealth or spend it on unnecessary expenses or value-decreasing projects (Jensen, 1986).

Arnold (2014) investigates the impact of managerial cash used to fund current operations in bad times. Based on a self-preservation approach, the author designs a dynamic model whereby managers control cash flows allowing them to hold higher levels of cash holdings, defer default risk during economic distress, and preserve their incomes (their fixed salary) over an extended period at the expense of shareholders' interest.

As agency conflicts arise from the divergence of interests and risk preferences between managers and shareholders, compensation and governance mechanisms are proposed to mitigate potential insiders' ability to convert cash into private benefits and reduce the costs and stockpiles of cash holdings (Jensen & Meckling, 1976).

Exploring the determinants and consequences of excess cash holdings (endowments) by not-for-profit organizations from the year 1992 to the year 2001 Core et al. (2006) finds that not-for-profit firms maintain higher endowments associated with higher managerial compensation over time.

Y. Liu et al. (2014) identify that the impact of CEO debt compensation on cash holdings differs from the influence of CEO equity incentives on cash reserves. Using ExecuComp and Compustat data from the year 2006 to 2011, the authors find that CEO wealth, represented by inside debt, is positively related to cash holdings and that an increase of a single standard deviation in internal debt boosts cash reserves by 3.7 to 6.2%. This suggests that inside debt promotes greater risk aversion, leading to higher cash holdings by firms as a signal of alignment between the interests of managers and bondholders.

Y. Liu (2011) show that greater equity incentives, measured by the sensitivity of equity compensation to stock price volatility, are associated with higher corporate cash holdings. By matching compensation and financial data from ExecuComp and Compustat over the period 1992 to 2006, the authors find that CEO compensation has a negative effect on the value of cash, while compensation incentives positively influence cash holdings in firms facing financial constraints.

Governance factors, such as investor protection and insider and institutional ownership, also affect corporate cash holding behaviour. Pinkowitz et al. (2006) find that the value of cash holdings for minority shareholders in countries with higher investor protection is more worthwhile than for similar groups in countries with weaker governance. However, Pinkowitz et al. (2006) detect a weak relationship between cash holdings and firm value in countries with lower investor protection compared to countries with stronger

investment protection. In Kalcheva and Lins (2007), controlling managers tend to hold more cash and provide higher payouts in situations with weaker country-level external shareholder protection.

Yung and Nafar (2014), Ferreira and Vilela (2004), and Dittmar et al. (2003) provide empirical evidence that higher investor protection, better law enforcement, and more concentrated ownership are negatively related to the level of cash held by firms worldwide.

The results presented by Jain et al. (2013) suggest that stronger internal corporate governance mechanisms, such as founder CEO governance, separation of CEO and Chairman positions, board domination by external directors, and greater institutional ownership, are positively associated with higher post-IPO cash holdings, particularly in competitive product markets.

Kusnadi (2011) shows that firms in countries with weaker legal investor protection reserve more cash than their peers in a sample of companies from 39 countries over the period 1995 to 2004. However, the authors do not find evidence that greater development of the financial system influences cash-holding behaviour by firms after controlling for legal investor protection. These findings imply that the investor environment has a first-order effect in influencing international corporate policies on cash management.

An analysis of cash-holdings in developing countries Al-Najjar (2013) finds that distinct institutional frameworks may differ in their influence on cash-holding behaviour. In this context, firms in weaker capital markets with lower investor protection systems have higher cash holdings.

Using a sample of public and private US firms during the period 1995 to 2011, H. Gao et al. (2013) show that well-governed public firms with excess cash are likely to have lower leverage levels of cash disbursement to pay external debt. By contrast, poorly governed public firms with higher cash holdings spend their excess cash on investing and acquiring different assets.

Among financial incentives, La Porta et al. (2002) and Jensen and Meckling (1976) consider insider ownership as an important way to control agency problems. Moreover, Jensen and Meckling (1976) suggests that managerial ownership impacts the cost and stockpiles of corporate cash holdings by limiting potential agency conflicts. Thus, low insider ownership is noted as a key determinant in an upward cash holding trend, particularly in US firms (Nikolov & Whited, 2014). To align shareholders and manager's interest, insider ownership should be increased to mitigate potential manager misbehaviour related to corporate cash holding decisions (Nikolov & Whited, 2014; Harford et al., 2008).

Focusing on UK firms from the year 1984 to 1999, Ozkan and Ozkan (2004) provides evidence of the existence of a non-monotonic relationship between managerial ownership and cash holdings. According to the authors, corporate cash holdings first decrease as managerial ownership increases up to 24%, increase as managerial ownership increases to 64%, and then decrease again as managerial ownership increases further. Ozkan and Ozkan (2004) suggests that at lower levels of managerial ownership (24%), the interests of managers and shareholders are equalised, move from alignment to entrenchment (24 to 64%), and adjust again as managerial ownership further increases (>64%).

Analysing a sample of US firms from the year 1993 to the year 2004, Harford et al. (2008) pinpoints that firms with a high level of insider ownership and strong shareholder rights maintain higher cash holdings while firms with low levels of insider ownership and weaker shareholder rights have lower cash holdings.

Y. R. Chen (2008) studies the impact of corporate governance on cash holding decisions in firms with different growth opportunities, referred to as listed new economy and old economy companies. According to the author, listed new economy companies pertain to the computer, software, Internet, telecommunications, or networking industries that rely heavily on innovations and require large amounts of capital to ensure potential high returns. The term "old economy" refers to the traditional manufacturing industries in which cash flow volatility is lower and investment opportunities are relatively limited.

Using a sample of 1,500 US firms from Compustat and the Governance Research Service of Risk Metrics Group from the year 2000 to 2004, Y. R. Chen (2008) shows that new economy companies tend to hold more cash and present greater board independence than old economy firms. The findings also show that CEO ownership has a significant and negative impact on cash holdings in old economy firms but no effect on listed new economy firms.

Ameer (2012) finds distinct results on the relationship between cash holdings and firm value when considering the corporate ownership structure in a non-financial sample of listed Australian firms from the year 1995 to 2005. According to the author, widely held (lower ownership concentration) firms show a positive relation between cash holdings and firm value, whereas closely held (higher ownership concentration) firms display a negative relation between cash balances and firm value.

Al-Najjar (2015) affirms that governance mechanisms and insider ownership do not affect corporate cash-holding decisions in an analysis of small and medium-sized UK firms. Rather, these factors are weakly related to cash holdings, while size and leverage are negatively associated with cash retention by small and medium-sized firms.

Following the intuition in Nikolov and Whited (2014), Y. R. Chen (2008), and Ozkan and Ozkan (2004) that insider ownership may act as a monitoring tool within firms, we presume that

H₂: Corporate cash holdings are negatively related to insider ownership.

3.1.4 Idiosyncratic risk, managerial ownership and cash holdings

The premise of agency theory is that contracts reflect the costs and benefits of inducing appropriate behaviour from agents (Prendergast, 2000; Jensen & Meckling, 1976). Then, providing compensation arrangements to the executives should align manager and shareholder preferences in terms of risk. However, if the manager invests effort in a single firm, and a significant proportion of her personal wealth is linked to compensation packages based on equity shares (Eiling, 2013; Tong, 2010; Zajac & Westphal, 1994; Beatty & Zajac, 1994), the manager will be exposed to idiosyncratic risk (Panousi & Papanikolaou, 2012; Tong, 2010). While outside shareholders only bear systematic risk, the manager assumes both systematic and idiosyncratic risks (Tong, 2010).

When uncertainty about the firm's future prospects increases, the firm's exposure to firm-specific risk becomes a fundamental determinant of its liquidity choices (Acharya et al., 2013), and risk-averse managers may detain more liquid assets to minimise firm risk instead of undertaking investment opportunities or increasing firm value, consistent with the risk-related agency hypothesis (Arnold, 2014; Tong, 2010).

Beatty and Zajac (1994) suggest that managers' willingness to accept a higher risk level varies across firms and is associated with firm and manager characteristics. Accord-

ing to the authors, riskier firms are less likely to include stock options in their executive compensation contracts, and the higher the level of firm risk, the lower the level of managerial stock ownership.

Addressing the trade-off between risk and incentives, Prendergast (2002) notes that a positive relationship between uncertainty and the marginal return of agent actions explains the payment for performance in rapidly changing industries, such as the high-tech sector, than in more stable settings that employ input-based contracts.

Examining the impact of ambiguity measured by two macroeconomic variables (the dispersion in the Survey of Profession Forecasters and the variance premium from the difference between the strike price and the expected pay-off of a variance swap) on managerial investment and cash holding decisions, Neamtiu et al. (2014) show that macroeconomic ambiguity is positively related to cash holding ratios and negatively associated with investment levels. These findings suggest that ambiguity-risk-averse managers tend to shift resources from risky to riskless assets, investing less in capital expenditure and more in cash holdings as ambiguity expectations regarding future investment pay-offs arise.

In Tong (2010), risk-averse managers tend to hold more cash as a strategy to reduce firm risk. The author finds that firms with higher CEO risk incentives, measured by the sensitivity of the value of a CEO's stock options to stock return volatility, have a higher value of cash holdings and hold less cash than firms with lower CEO risk incentives.

Glover and Levine (2014) show that components of stock and option compensation combined with firm volatility produce a distortion between manager and shareholder optimal policies providing incentives to over or underinvest. In Glover and Levine (2014)'s model, as the firm's volatility increases, managers who are compensated with equity have less incentive to invest in risky assets and tend to select conservative cash holding policies under firm-specific shocks compared to a diversified shareholder.

Therefore, if managers cannot diversify their own portfolio when exposed to unhedgeable firm-specific risk, we hypothesise that

H₃: The positive relationship between cash holdings and idiosyncratic risk is stronger when managers own a greater percentage of the firm.

3.2 Empirical design and data implementation

The main goal of this article is to analyse the effects of the level of insider ownership on corporate cash holding-idiosyncratic risk sensitivity. Thus, a dataset is required that includes firm-level observations on risk, cash holdings, insider ownership, firm characteristics, and governance mechanisms to empirically test our hypothesis. We construct our baseline measures using US data from several sources.

We use all non-financial US companies that are publicly traded during the period 1992 to 2014. We exclude prior periods because ExecuComp database availability begins in the year 1992. Annual balance sheet data are from the Compustat database, and daily data on stock files are from the Center Research in Securities Prices (CRSP). We consider only ordinary common shares (share codes 10 and 11 in CRSP). Stock ownership, stock option holdings, and compensation data are collected from ExecuComp. Institutional ownership data are from the Thomson Financial Institutional (13f) Holdings database of filings derived from forms 3, 4, and 5.

We exclude utility companies (Standard Industrial Classification Code (SIC) codes

between 4900 and 4949) and financial companies (SIC codes between 6000 and 6999) from the dataset because these sectors are subject to heavy regulation. For instance, financial firms may carry cash to meet capital requirements rather than for economic reasons, and utility companies are subject to regulatory supervision in their cash holdings (Bates et al., 2009).

We also drop firm–year observations with SIC missing codes, with missing values for all variables, and with negative values for stock prices, capital expenditure, assets, and sales revenue. Following Panousi and Papanikolaou (2012), firms with fewer than 40 weekly observations in a particular year are also excluded. First, we match the firms in Compustat with firms in CRSP, ExecuComp, and Thomson Financial Database that have the same value for the security identifier GVKEY, CUSIP, or PERMNO.

We winsorise our data by year at 0.5% and 99.5% levels in all specifications to eliminate the effect of outliers. After the screening procedures, we obtain a final sample of 11,988 firms with 96,886 firm–year observations. These data include surviving and non–surviving firms that appear on databases at any time in the sample period.

3.2.1 Cash holdings

We follow the cash holding literature using the ratio of cash and marketable securities (cash and equivalents) to net assets as the measure of corporate cash holdings, (for example, Y. Chen et al., 2015; Feng & Johansson, 2014; Schauten et al., 2013; Wu et al., 2012; Y. Liu, 2011; Tong, 2010; Bates et al., 2009; Dittmar et al., 2003; Opler et al., 1999). Netting out cash from total assets allows us to capture the real effect of assets in place.

We further test alternative definitions of cash holding to check the robustness of our results. As a first alternative, we use the cash–to–total assets ratio, as in C. Kim and Bettis (2014) and Qiu and Wan (2014). As a second alternative, we employ the cash and marketable securities to sales, as suggested in Harford et al. (2008). As a third and last alternative, we use change in cash, as in Almeida et al. (2004).

3.2.2 Idiosyncratic risk

Obtaining a general measure of idiosyncratic risk is complex because firm–specific risk is an unobservable variable. When firm–specific risk is associated with the variance in the business condition, the literature uses cash flow volatility as a proxy for idiosyncratic risk (Hugonnier et al., 2014; Brisker et al., 2013; Bigelli & Sánchez-Vidal, 2012; Bates et al., 2009; Harford et al., 2008; Han & Qiu, 2007; Colquitt et al., 1999).

However, when it is associated with the changing aspects of a firm’s environment that are important to investors and managers, the proxy is the volatility of a firm’s stock returns (Bulan, 2005; Panousi & Papanikolaou, 2012). Because volatility of a firm’s stock returns is estimated relative to the systematic returns of the stock, it is model dependent (Xu & Malkiel, 2003) and, by definition, the idiosyncratic volatility of the stock is independent of the co–movement of the market (Fu, 2009).

Bulan (2005) also highlight that idiosyncratic risk measured as volatility from common stock returns should reflect variations on asset fundamentals and the firm’s future prospects and provide an adequate measure of the total uncertainty that is relevant for firm-level decisions.

Xu and Malkiel (2003) present two methods that the literature has used to measure idiosyncratic risk as the residuals from a regression model. The indirect method employed by Campbell et al. (2001), Goyal and Santa-Clara (2003), Wei and Zhang (2005), and Bali et al. (2005) uses the market model under the assumption that the betas of all securities are one and estimate idiosyncratic risk as the difference between stock and market variance. The direct method used in Xu and Malkiel (2003) assesses idiosyncratic volatility using residuals from a factor model such as the Fama–French three–factor model (Fama & French, 1993).

In Panousi and Papanikolaou (2012) and Bulan (2005), idiosyncratic risk is measured by decomposing total risk into market, industry, and firm–specific components by estimating a two–index model. Bulan (2005) employ the volatility of the firm’s equity returns from the annualised standard deviation of the firm’s daily returns in that fiscal year.

Panousi and Papanikolaou (2012) use the volatility of the residuals across weekly observations determined by regressing the firm’s return on the value–weighted market portfolio and on the corresponding value–weighted industry portfolio based on Fama and French (1997)’s 30–industry classification. According to Panousi and Papanikolaou (2012), assessing idiosyncratic risk in this way assures higher frequency data to estimate idiosyncratic volatility, avoid noisy and changing non–fundamentals produced by daily returns, and removes systematic risk factors that managers can insure against.

Although these definitions differ from each other, idiosyncratic volatility represents a component that cannot be diversified. In this paper, we follow Panousi and Papanikolaou (2012) and use idiosyncratic risk obtained from the annualised standard deviation of the firm’s weekly stock return by regressing the firm’s return on the value–weighted market portfolio return and on the corresponding value–weighted industry portfolio return.

We estimate a firm’s idiosyncratic risk from the log volatility of the regression residuals determined by regressing the firm’s return $R_{i,\tau}$ on the value-weighted market portfolio, R_{MKT} , and on the corresponding value-weighted industry portfolio, R_{IND} , based on the Fama and French (1997) 30–industry classification, as in Equation 3.1:

$$R_{i,\tau} = \alpha_{1,i} + \alpha_{2,i}F_{i,\tau} + \varepsilon_{i,\tau}, \quad (3.1)$$

where τ indexes weeks and $F_{i,\tau} = [R_{MKT}, R_{IND}]$. Each variable from this model is measured according to the following steps. First, we determine a firm’s returns ($R_{i,\tau}$) from CRSP weekly stock data from the year 1992 to the year 2014. The typical measure of a stock’s return is calculated as the per cent change in its share price (CRSP code: PRC) over a given period. Because all price data on CRSP database are unadjusted, we use a cumulative factor (CRSP code: CFACPR) to adjust the price variable after a distribution, dividing the price by the factor.

We then compute the return as the natural logarithm of adjusted share price at the end of the current Wednesday minus the natural logarithm of adjusted share price at the end of the last Wednesday, as in (Hou & Moskowitz, 2005). We consider weekly returns between adjacent Wednesdays following Chordia and Swaminathan (2000) and Hou and Moskowitz (2005) that document high autocorrelations using Friday to Friday prices and low autocorrelations using Tuesday to Tuesday prices. According to them, Wednesday close price is an appropriate compromise because it is not at extreme than other weekdays and should not be biased by non–trading issues. In sum, we construct weekly returns for

firms as in Equation 3.2:

$$R_{i,\tau} = \ln(\text{PRC}_{\text{adj}})_{\tau} - \ln(\text{PRC}_{\text{adj}})_{\tau-1} \quad (3.2)$$

We employ weekly returns as a balance between the need to use higher frequency data to estimate idiosyncratic volatility, generate more estimation error, and avoid microstructure noise (price discreteness, non-synchronous trading, bid-ask bounces and stale prices) that is likely to be present in daily returns (Panousi & Papanikolaou, 2012; G. Brown & Kapadia, 2007; Bulan, 2005).

Next, we follow the methodology used in CRSP (2015) to calculate the value-weighted market portfolio return (R_{MKT}) as the sum of the percentage of the total market capitalization that each firm contributes to their portfolio in a given week divided by the total market capitalization of all firms in each portfolio each week multiplied by each firm's weekly return.

Market capitalization is defined as price times number of shares outstanding (CRSP code: SHROUT) at the end of the previous Wednesday. In this paper, the weights of individual stocks in a value weighted market portfolio are proportional to their market capitalization considering only common shares. We consider the weights as constant within week determined at the end of the previous Wednesday. We determine weekly value-weighted market portfolio return as in Equation 3.3:

$$R_{MKT_{i,\tau}} = \sum_i^t \frac{\text{PRC}_{i,\tau-1} * \text{SHROUT}_{i,\tau-1}}{\sum \text{PRC}_{\tau-1} * \text{SHROUT}_{\tau-1}} * R_{i,\tau}. \quad (3.3)$$

We further assess the value-weighted industry portfolio return based on the Fama-French 30-industry classification methodology available in French (2015) that assigns each NYSE, AMEX, and NASDAQ stock i to an industry portfolio return j in the period t based on its four-digit SIC code at that time.

Finally, we determine the idiosyncratic risk as the log volatility of the regression residuals, as in Panousi and Papanikolaou (2012), according to Equation 3.4:

$$\log_{\sigma_{i,\tau}} = \log \sqrt{\sum_{\tau \in t} \varepsilon_{i,\tau}^2}. \quad (3.4)$$

We also examine the robustness of our results to alternative definitions of the volatility measure, such as the volatility of the residuals from a market model regression of a firm's returns on the market portfolio, $\sigma_t^{r_{mkt}}$ and the volatility of the residuals from a regression of firm returns on the Fama and French (1993) three-factors model, $\sigma_t^{r_{ff3}}$.

3.2.3 Insider ownership

Investigating how the level of insider ownership affects corporate cash holdings when idiosyncratic risk is considered requires an analysis of firms with different degrees of insider ownership. Following Panousi and Papanikolaou (2012), we consider managers as the highest-ranking firm officers, and managerial ownership is defined as the fraction of the firm's total shares held by these managers in each year. We then sort firms into quintiles based on the fraction of shares outstanding owned by these officers. The bottom quintile

of managerial ownership was considered low ownership and the top quintile was considered high ownership.

We collect managerial ownership data from Execucomp and Thomson Financial Institutional (13f) Holdings database of filings derived from forms 3, 4 and 5 over the period from 1992 to 2014 including insiders pertained to the following role classifications: O, OD, OE, OB, OP, OS, OT, OX, CEO, CFO, CI, CO, CT, H, GM, M, MD, P, EVP, VP, and SVP. All categories are described in Table 3.1.

Table 3.1: Role codes and description according to Thomson Reuters database.

Code	Description
O	Officer.
OD	Officer and director.
OE	Other Executive.
OB	Officer and Beneficial Owner of more than 10% of a Class of Security.
OP	Officer of Parent Company.
OS	Officer of Subsidiary Company.
OT	Officer and Treasurer.
OX	Divisional Officer.
CEO	Chief Executive Officer.
CFO	Chief Financial Officer.
CI	Chief Investment Officer.
CO	Chief Operating Officer.
CT	Chief Technology Officer.
H	Officer, Director and Beneficial Owner.
GM	General Manager.
M	Managing Partner.
MD	Managing Director.
P	President.
EVP	Executive Vice President.
VP	Vice President.
SVP	Senior Vice President.

We also investigate whether considering option compensation schemes with insider ownership could alter the outcomes. To this purpose, we sum the number of common shares and the number of unexercised exercisable options owned by officers divided by the firm's shares outstanding, as in Nikolov and Whited (2014).

3.2.4 Control variables

We control for variables that could jointly affect cash holdings, idiosyncratic volatility, and insider ownership to address biases because of omitted variables. In papers focusing on cash holdings and idiosyncratic risk, it is standard to control for firm characteristics such as size, cash flow, net working capital, growth opportunities, cash flow volatility, and

stock returns and for corporate policy decisions such as capital expenditures, acquisitions, leverage, dividend, and research and development (R&D).

We also consider the potential influence of industry volatility, systematic volatility, cash compensation, and institutional ownership to control the correlation of these variables with cash holdings and insider ownership.

We control for firm size because smaller firms tend to be riskier (more volatile), grow faster, and hold twice as much cash as large firms (Nikolov & Whited, 2014; Bigelli & Sánchez-Vidal, 2012; Panousi & Papanikolaou, 2012; Colquitt et al., 1999). In Malkiel and Xu (1997), the larger the size of the company, the smaller the stock's idiosyncratic volatility. Our measure of size is the logarithm of total assets in 1992 dollars and adjusted for inflation using the consumer price index (CPI), as in Opler et al. (1999). We expect firm size to be negatively associated with cash holdings.

Riddick and Whited (2009) find that corporate cash holdings and cash flows are negatively correlated after controlling for Tobin's Q measurement errors. However, Ferreira and Vilela (2004) and Opler et al. (1999) posit that cash flow is positively related to cash holdings because firms with high cash flow levels accumulate cash to finance future investment opportunities. We measure cash flow as the ratio of earnings after interest, dividend, and taxes but before depreciation scaled by total assets (Harford et al., 2008; Ferreira & Vilela, 2004; Opler et al., 1999). Given these mixed findings, we control for cash flows but do not have an expected sign for this variable.

Net working capital as a proxy of firm's liquidity captures additional liquid assets held by the firm that can act as a complement or substitute for cash holdings (Dittmar et al., 2003). We compute net working capital as current assets net of cash minus current liabilities divided by net assets, as in Harford et al. (2008).

Growing firms may hold cash to minimise the probability of financial distress, and higher cash holdings afford growing firms the opportunity to undertake future investments (Al-Najjar, 2015; Ozkan & Ozkan, 2004). Moreover, Dittmar et al. (2003) suggest that firms facing large investment opportunities prefer to hold more cash. Expecting a positive relationship between investment opportunities and cash holdings, we control growth opportunities using the market-to-book ratio measured by the ratio of common shares outstanding times the price close in the year plus the book debt divided by net total assets (book value of assets minus cash and marketable securities), as in Ozkan and Ozkan (2004) and Dittmar et al. (2003).

Cash flow volatility may influence both corporate cash behaviour and idiosyncratic risk. Firms with higher cash flow volatility maintain higher cash balance levels as a buffer to protect against cash flow shocks (Francis et al., 2014; Bates et al., 2009), whereas higher cash flow volatility might induce an increase in expected equity returns (Palazzo, 2012). We expect a positive correlation between cash holdings and cash flow volatility.

In Bates et al. (2009), firms in industries that face greater idiosyncratic risk hold more cash than firms in industries that experience lower idiosyncratic volatility. Campbell et al. (2001) and Brandt et al. (2009) also ascribe that industry volatility positively affects idiosyncratic risk. Thus, we expect a positive correlation between cash holdings and industry volatility. We measure industry volatility as the standard deviation of sales to net assets, as in Bates et al. (2009).

Acharya et al. (2013) suggest that firms more exposed to systematic risks hold more cash and Panousi and Papanikolaou (2012) also address that idiosyncratic risk is correlated positively with systematic volatility. To control a potential positive effect of systematic

volatility on cash holdings and idiosyncratic risk we include it as an additional regressor in our model. Following Panousi and Papanikolaou (2012), we measure systematic volatility as in Equation 3.5:

$$\log \sigma_{\sigma_{i,\tau-1}^{sys}} = \log \sqrt{(\sigma_{i,\tau-1}^{total})^2 - (\sigma_{i,\tau-1}^{idiosy})^2}. \quad (3.5)$$

Capital expenditures are also considered a determinant of cash holdings (Kuan et al., 2011; Tong, 2010; Dittmar et al., 2003). Capital expenditure can be employed as collateral to increase borrowing capacity influencing firms that hold less cash (Bates et al., 2009), or capital expenditure generally consumes cash decreasing the availability of cash within firms (Francis et al., 2014). Considering both possibilities, we expect a negative relationship between cash holdings and capital expenditures. We consider capital expenditures scaled by total assets, as in Bates et al. (2009) and Francis et al. (2014).

Firm leverage is controlled because equity volatility increases with leverage (Panousi & Papanikolaou, 2012), and highly leveraged firms might hold more cash to prevent future financial constraints (Acharya et al., 2007). However, a firm can use cash to reduce its debt (Francis et al., 2014). Given these mixed findings, we do not establish a predictable sign for this variable to cash holdings. We measure leverage as the ratio of total debt to total assets (Al-Najjar, 2015; Acharya et al., 2007; Ozkan & Ozkan, 2004).

Mazzucato and Tancioni (2008) and Y. R. Chen (2008) note that R&D intensive firms are characterised by higher idiosyncratic risk because of uncertainty in expected future profits produced by innovations at the firm-level. Moreover, R&D-intensive firms also tend to maintain large cash reserves for future investment demands (Y. R. Chen & Chuang, 2009). Because idiosyncratic volatility and cash holdings are affected by R&D, we include this variable in our model considering the ratio of R&D divided by sales as in Harford et al. (2008). If R&D expenditure information is missing, we set the number to zero.

In Harford et al. (2008) and Bates et al. (2009), acquisition activity indicates the propensity of managers to increase the size of their firms. According to the authors, higher acquisition activity is expected with a lower level of cash holdings. Therefore, we control the effect of acquisitions on cash balances expecting a negative relationship between these two variables. Acquisition is defined as acquisition to book assets minus cash and marketable securities, as in Bates et al. (2009) and Harford et al. (2008).

We additionally control for stock returns to ensure the effect of volatility on cash holdings rather than a mean effect from news about future profitability (Panousi & Papanikolaou, 2012).

Agency theory also emphasises dividend payout as a strategy to prevent managers from wasting cash flows and building empires using cash holdings (Jensen, 1986; B. S. Lee & Suh, 2011). Harford et al. (2008) affirm that cash holdings and dividend payments are negatively related implying that firms that pay dividends hold less cash than those that do not distribute dividends. Cash dividend-paying firms are considered less risky and have greater access to external capital, mitigating their precautionary motive to hold cash (Francis et al., 2014).

As the literature has presented mixed results from the relationship between dividend payments and corporate cash holdings, we do not have an expected sign on this variable. To capture the potential effect of the firm's dividend policy on cash holdings, we include the dividend payout considering a dividend dummy that takes a value of one if a firm pays a dividend and zero otherwise (Francis et al., 2014; Bates et al., 2009; Harford et

al., 2008; Opler et al., 1999).

W. R. Guay (1999) argues that CEOs with higher levels of cash compensation are less risk averse because they can invest more money outside their firms. To control this effect in our model, we use the sum of the CEO's salary and bonus as the measure of cash compensation.

Denis and Sibilkov (2010) point out that constrained firms hold more cash for precautionary savings and Almeida et al. (2004) show that constrained firms hold a considerable portion of cash during downturns. As financial constraints may affect corporate cash holdings we control it employing the Whited and Wu Index (Whited & Wu, 2006) that outperforms other index such as the Kaplan and Zingales index (Kaplan & Zingales, 1997) in identifying financially constrained firms. We computed the WWindex following Whited and Wu (2006) as in Equation 3.6:

$$\begin{aligned} WW_{i,\tau} = & -0.091CF_{i,\tau} - 0.062DIVPOS_{i,\tau} + 0.021TLTD_{i,\tau} - 0.044LNTA_{i,\tau} \\ & - 0.035SG_{i,\tau} + 0.102ISG_{i,\tau}. \end{aligned} \quad (3.6)$$

where for firm i in year τ , $CF_{i,\tau}$ is the ratio of cash flow to total assets minus cash and marketable securities, $DIVPOS_{i,\tau}$ is an indicator that equals one if the firms pays dividend and zero otherwise, $TLTD_{i,\tau}$ is the ratio of long-term debt to total assets minus cash and marketable securities, $LNTA_{i,\tau}$ is the natural log of total assets, $SG_{i,\tau}$ is sales growth computed as $Sales_{\tau}/Sales_{\tau-1}$, and $ISG_{i,\tau}$ is the firm's three-digit industry sales growth. As showned by Whited and Wu (2006), higher WW index values indicate greater financial constraints.

Panousi and Papanikolaou (2012) affirm that large institutional investors, such as pension funds and mutual funds, often provide an oversight of sorts for managers of firms in which they have invested. The authors show that the increase in idiosyncratic risk within firms with higher institutional ownership, regardless of the level of managerial ownership, leads to less of a reduction in investment (only 2% as opposed to 8% without controlling for the influence of institutional ownership).

Nikolov and Whited (2014) also find that higher institutional ownership indicates better governance because institutional investors are more likely to be activist shareholders. Therefore, we control for institutional investors based on the level of institutional ownership of the firm's outstanding shares.

We summarize the definitions, data sources, predicted signals, and references for all variables employed in this paper in Table 3.2.

Table 3.2: Variable name, database source, definition, predicted signal, and references.

Variable	Source	Definition	Sig	Reference
Cash Holdings.	Compustat	Cash and cash equivalents (CHE) / Assets total (AT).		Bates et al. (2009); Opler et al. (1999).
Net Cash Holdings.	Compustat	Cash and cash equivalents (CHE) / Assets total (AT) minus CHE.		Bates et al. (2009); Opler et al. (1999).
Idiosyncratic risk.	CRSP	Logarithm of volatility of the residuals from two-index model.	+	Panousi and Papanikolaou (2012).
Insider Ownership.	Execucomp and Thomson Financial	Ratio of insider holdings of common stocks (Shares Owned, Options Excluded (SHROWN EXCL OPTS)) / Shares outstanding (SHROUT).	- / +	Nikolov and Whited (2014); Panousi and Papanikolaou (2012).
Insider Ownership. + Options	Execucomp	Ratio of SHROWN EXCL OPTS + Unexercised Exercisable Options (OPT UNEX EXER NUM) / SHROUT.	- / +	Nikolov and Whited (2014).
Institutional Ownership.	Thomson Financial	Ratio of shares that institutions owned inside firm / Shares outstanding (SHROUT).	-	Panousi and Papanikolaou (2012).
Cash compensation.	Execucomp	Sum of CEO's salary and bonus/AT	-	Nikolov and Whited (2014).
Firm Size.	Compustat	Logarithm natural of Assets Total (AT)/Consumer Price Index (CPI) in 1992	-	Opler et al. (1999).
Market-to-Book.	Compustat	Common shares outstanding (CSHO) times price close annual fiscal year (PRCC _F) plus book debt (BD) / Assets total (AT) minus CHE.	+	Harford et al. (2008).
Leverage.	Compustat	(Short-term debt (DLC) + long-term debt (DLTT)) / (Assets total (AT) minus CHE).	-/+	Harford et al. (2008).
Cash flow.	Compustat	Operating income before depreciation (OIBDP) / Assets total (AT) minus CHE.	-/+	Harford et al. (2008).
Cash flow Volatility.	Compustat	Firm's standard deviation of the cash-flow ratio for the past 10 years.	+	Bates et al. (2009).
Industry Volatility.	Compustat	Mean of the standard deviations of firm's cashflow over 10 years for firms in the same industry, as defined by three-digit SIC codes.	+	Bates et al. (2009).
Acquisition.	Compustat	Acquisition (AQC) / Assets total (AT) minus CHE.	-	Harford et al. (2008).
CapEx.	Compustat	Capital expenditures (CAPX) / Assets total (AT) minus CHE.	-	Harford et al. (2008).
Dividend.	Compustat	Indicator variable that equals one if firm i paid cash dividends in year t.	- / +	Bates et al. (2009).
Firm Stock Return.	CRSP	Ln(adjusted price _t) - Ln(adjusted price _{t-1}).	-	Panousi and Papanikolaou (2012).
Systematic volatility.	CRSP	Log of total volatility minus idiosyncratic volatility.	+	Panousi and Papanikolaou (2012).
R&D.	Compustat	R&D (XRD) / Sales (SALE).	+	Bates et al. (2009); Harford et al. (2008).
Net Working Capital.	Compustat	CHE -Net working capital (NWC)	-	Bates et al. (2009).
WW Index.	Compustat	$WW_{i,t} = -0.091*CF_{i,t} - 0.062*DIVPOS_{i,t} + 0.021*TLTD_{i,t} - 0.044*LNTA_{i,t} - 0.035*SG_{i,t} + 0.102*ISG_{i,t}.$	+	Whited and Wu (2006); Panousi and Papanikolaou (2012).

3.2.5 Model specification

To test the first and second study hypotheses, we follow Bates et al. (2009) and Harford et al. (2008) using Ordinary Least Squares (OLS) regressions. To satisfy the OLS assumptions concerning the presence of heteroscedasticity and autocorrelation in the model, we apply the Breusch–Pagan test and Durbin–Watson statistic. If heteroscedasticity or/and autocorrelation are present in the model, they could affect the standard errors and might bias the regression coefficients (Wooldridge, 2010).

Our OLS estimates reject the null-hypothesis of no heteroscedasticity and no autocorrelation. Therefore, we employ robust standard errors clustered at the firm level and, depending on the model specification, we include firm dummies to control firm effects, time dummies for time effects, and industry dummies to mitigate industry effects, as in Panousi and Papanikolaou (2012).

Our baseline econometric models are in line with the literature (e.g., Bates et al., 2009; Harford et al., 2008) and are defined as in Equation 3.7 and 3.8:

$$\text{Cashholding}_{i,t} = \alpha + \beta_1 \log \sigma_{i,t-1} + \gamma_1 \mathbf{Z}_{i,t} + \eta_i + \varrho_t + v_{i,t}. \quad (3.7)$$

$$\text{Cashholding}_{i,t} = \alpha + \beta_1 \text{InsOwn}_{i,t-1} + \gamma_1 \mathbf{Z}_{i,t} + \eta_i + \varrho_t + v_{i,t}. \quad (3.8)$$

Where $\log \sigma_{i,t-1}$ is the proxy for idiosyncratic risk and $\text{InsOwn}_{i,t-1}$ is insider ownership and η_i and ϱ_t capture the firm, time or time–industry fixed effects, and $v_{i,t}$ is the error term.

The vector $\mathbf{Z}_{i,t}$ includes control variables known to correlate with cash holding decisions as well idiosyncratic risk and insider ownership for firm i at time t . Following studies presented previously, $\mathbf{Z}_{i,t}$ encloses size, cashflow, net working capital, growth opportunities, cashflow volatility, stock returns, capital expenditures, leverage, dividend, research and development, acquisitions, industry volatility, and WW index. When insider ownership is considered in the model specification we also control to cash compensation, options compensation, and institutional ownership.

We include lagged cash holdings for all specifications to mitigate potential endogeneity problems and adjustment delay of cash structure, (for example, Opler et al., 1999; Harford et al., 2008; Bates et al., 2009; Y. R. Chen & Chuang, 2009; Kuan et al., 2011).

Additionally, we standardise all independent variables to better interpret the magnitude of the estimated coefficients and to compare the results (Wooldridge, 2010). Then, each independent variable is standardised to have zero mean and unit variance by subtracting its mean and dividing by its standard deviation.

Standardising all independent variables allows referring their beta coefficients to be a change in the dependent variable per standard deviation increase in the predictor variable (Brooks, 2008). This procedure also shows which predictor has a greater effect on the dependent variable, particularly when these variables are measured in different units of measurement (Wooldridge, 2010). We can also analyse values that are substantially different in terms of scale. Finally, because regression is based on correlation, any linear transformation does not change the correlation between two variables (Wooldridge, 2010).

3.2.6 Descriptive statistics

Table 3.3 reports the descriptive statistics of cash holdings, insider ownership, idiosyncratic risk, and firm characteristics that include the mean, standard deviation, median, 25th, and 75th percentiles. The sample includes all firm-years from the year 1992 to the year 2014 from matching Compustat, CRSP, ExecuComp, and Thomson Financial databases. The sample starts in 1992 because the availability of the ExecuComp dataset begins from this period. The sample excludes financial and utility firms. The dataset is composed of a final sample of 11,988 firms with 96,886 unrestricted firm-year observations. However, given the database restrictions, our sample may vary according to the variable specifications.

Table 3.3: Descriptive statistics of cash, idiosyncratic risk, insider ownership and firm characteristics from the 1992-2014 sample of US publicly traded firms.

	Mean	25th Perc	Median	75th Perc	SD*	N
Cash Holdings	0.1681	0.0277	0.0880	0.2415	0.1894	91,760
Net Cash Holdings	0.3123	0.0285	0.0965	0.3184	0.5077	91,760
Log of Idiosyncratic Risk $_{t-1}$	-0.8483	-1.2224	-0.8603	-0.4929	0.5277	105,730
Log of Systematic Volatility $_{t-1}$	-1.8400	-2.1955	-1.8016	-1.4297	0.6570	78,080
Insider ownership $_{t-1}$	0.0412	0.0026	0.0085	0.0310	0.0895	34,239
Leverage	0.2482	0.0583	0.2213	0.3789	0.2088	91,490
Market-to-Book	2.3748	1.0457	1.4525	2.4464	2.3821	91,206
Cashflow	0.0700	0.0564	0.1343	0.2056	0.2745	91,626
Acquisitions/AT	0.0193	0.0000	0.0000	0.0102	0.0421	87,464
Firm Size	4.4957	3.0881	4.4167	5.8916	1.8939	119,114
R&D	0.0361	0.0000	0.0000	0.0270	0.0741	117,473
Net Working Capital	0.1034	-0.0327	0.1003	0.2661	0.2244	89,897
Capital Expenditures	0.0818	0.0304	0.0588	0.1077	0.0722	91,760
Dividend	0.3624	0.0000	0.0000	1.0000	0.4807	119,115
Industry Volatility	0.6800	0.0579	0.1849	0.5556	1.2732	117,027
Cashflow Volatility	0.1378	0.0335	0.0647	0.1436	0.1823	108,920
Firm Stock Return	0.0055	-0.2701	0.0463	0.3185	0.4775	105,731
Whited and Wu Index	-0.1996	-0.3038	-0.2163	-0.1201	0.1416	87,290

* Standard deviation.

The average corporate cash holdings during the period from 1992 to 2014 are 16.81% of total assets and 31.23% of net assets, although the median firm's cash balances are smaller at 8.80% and 9.65%, respectively. We notice a positive time trend for the average net cash holdings ratio for the sample firms from 1992 to 2014, as plotted in Figure 3.1. Using the cash holdings measure as cash and cash equivalents divided by total assets, Bates et al. (2009) show that the evolution of cash reserves presents an increase from 10.5% in 1980 to 23.2% in 2006. Figure 3.1 reinforces Bates et al. (2009)'s findings by showing that average cash ratios continue following an upward trend among US firms over time.

Insiders, on average, own approximately 4.12% of the outstanding shares. However, the median inside ownership is 0.8% with a standard deviation of 8.95% characterising an extremely right-skewed variable. These values are in line with those reported for US firms (Harford et al., 2008; Y. R. Chen, 2008; Neamtiu et al., 2014; Nikolov & Whited, 2014). The average annual cash flows that a firm generates are approximately 7% of net assets compared with the median of 13.43%, showing that cash flow is left skewed. Firms in our sample have, on average, a total debt ratio of 24.82% of net assets, a net working

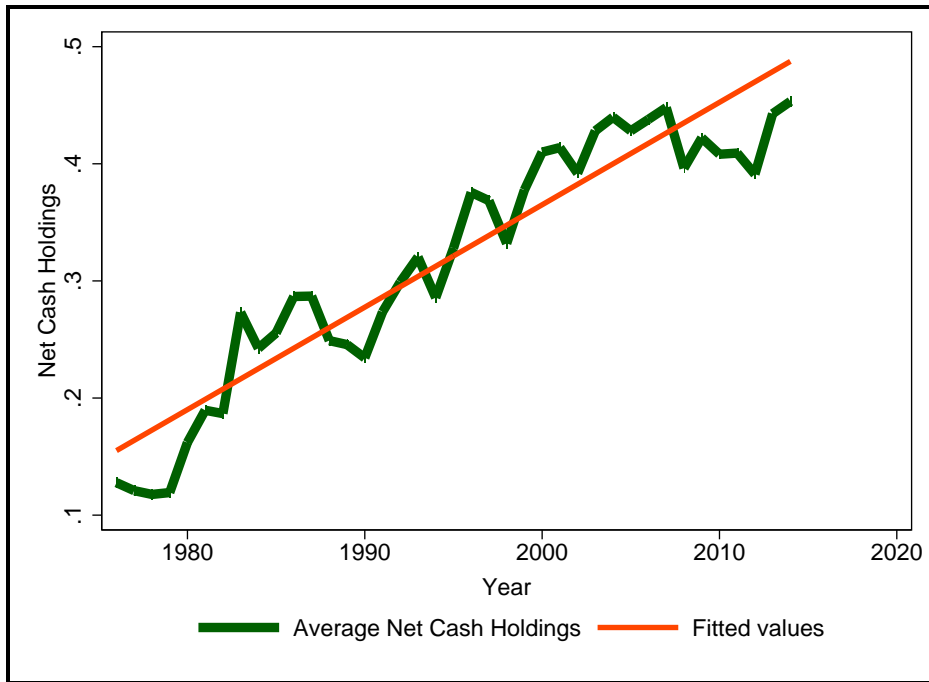


Figure 3.1: Pattern of net cash holdings ratio average (%) and its fitted values over the period from 1992 to 2014.

capital of 10.34% of net assets, and an R&D ratio of 4.19% of total sales.

The average log of idiosyncratic risk is -0.8483, and its median is -0.8603 with a standard deviation of 52.77%, a value similar to that of Panousi and Papanikolaou (2012) of 49%. The mean (median) market-to-book for our sample is 2.37 (1.45). The mean (median) firm size for our sample is 4.49 (4.41), as in Bao et al. (2012); Y. R. Chen and Chuang (2009).

For other firm characteristics, on average, capital expenditures represents 8.18% of net assets, and acquisitions represent 1.93% of net assets with a standard deviation of 4.21%. The last column of Table 3.3 reports the number of sample firms for each variable. As a result of using lags, and because of the availability of data from several sources, the variables in our study present different numbers of firm-year observations from the year 1992 to the year 2014.

Table 3.4 provides Pearson correlation coefficients between cash holdings, idiosyncratic risk, insider ownership, and firm features for the sample. Our measure of cash holdings, net cash holdings, is highly correlated (0.956) with our alternative measure for cash balances, cash, and cash equivalents divided by total assets.

As seen in the panel, cash holdings and net cash holdings are positively correlated with lagged idiosyncratic risk and insider ownership. As expected from prior studies, cash holding measures are negatively correlated with leverage, acquisitions, firm size, and net working capital. We also expect that market-to-book and R&D have positive correlations with cash reserves. However, conclusions should not be preempted from these correlations because they are a measure of the strength of the linear relationship between paired data only and do not imply a causal link between the variables (Wooldridge, 2012).

An analysis of Table 3.4 implies that a strong relationship between two explanatory variables might be a source of collinearity problems. We further check the variance inflation factor (VIF) for each of the explanatory variables within the model. Values

larger than 10, or average values of the VIF factors larger than one, suggest evidence of collinearity Wooldridge (2012).

We employ the VIF test on each regressor, and no explanatory variable presents a VIF superior to 10 or average values of the VIF factors larger than one.

Table 3.4: Pearson correlation coefficients between cash holdings, idiosyncratic risk, insider ownership, and firm characteristics.

	CH	NCH	IR	IO	Lev	Mtbb	CF	Acq	Size	R&D	Nwc	Cpex	Div	Ivol	Cvol	SR	WW
1.CH	1																
2.NCH	0.956***	1															
3.IR	0.298***	0.283***	1														
4.IO	0.0479***	0.0378***	0.0794***	1													
5.Lev	-0.297***	-0.233***	-0.0383***	-0.0973***	1												
6.Mtbb	0.621***	0.637***	0.188***	0.0595***	-0.176***	1											
7.CF	-0.434***	-0.494***	-0.402***	0.0575***	0.000758	-0.365***	1										
8.Acq	-0.103***	-0.102***	-0.119***	-0.0348***	0.0653***	-0.0685***	0.113***	1									
9.Size	-0.335***	-0.321***	-0.607***	-0.176***	0.247***	-0.283***	0.447***	0.118***	1								
10.R&D	.637***	0.628***	0.252***	-0.0461***	-0.191***	0.504***	-0.582***	-0.0454***	-0.250***	1							
11.NWC	-0.273***	-0.313***	-0.102***	0.0756***	-0.223***	-0.257***	0.364***	0.00299	-0.0440***	-0.228***	1						
12.Capex	0.155***	0.170***	0.0234***	0.0852***	0.00283	0.198***	-0.0863***	-0.131***	-0.0407***	0.0501***	-0.239***	1					
13.Div	-0.267***	-0.243***	-0.355***	-0.0334***	0.0887***	-0.153***	0.203***	0.0120**	0.345***	-0.108***	0.0109**	-0.0624***	1				
14.IVol.	0.341***	0.368***	0.167***	-0.0348***	-0.0271***	0.345***	-0.363***	-0.0600***	-0.178***	0.316***	-0.226***	0.0988***	-0.108***	1			
15.Cvol	0.585***	0.605***	0.416***	-0.00452	-0.150***	0.523***	-0.630***	-0.0850***	-0.479***	0.480***	-0.306***	0.0940***	-0.210***	0.424***	1		
16.SR	-0.0295***	-0.0398***	-0.225***	0.0155*	-0.0582***	0.106***	0.227***	0.105***	0.151***	-0.0643***	0.107***	0.104***	0.0676***	-0.0376***	-0.115***	1	
17.WW	0.393***	0.400***	0.565***	0.103***	-0.145***	0.323***	-0.584***	-0.115***	-0.800***	0.454***	-0.0770***	0.0727***	-0.507***	0.370***	0.533***	-0.148***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

1. Cash holdings; **2.** Net cash holdings; **3.** Idiosyncratic risk; **4.** Insider Ownership; **5.** Leverage; **6.** Market-to-book; **7.** Cashflow; **8.** Acquisitions; **9.** Firm size; **10.** R&D; **11.** Net working capital; **12.** Capital expenditures; **13.** Dividend dummy; **14.** Industry volatility; **15.** Cashflow volatility; **16.** Stock return; **17.** WW Index.

3.2.7 Univariate analysis

Following the intuition of Ozkan and Ozkan (2004) and Panousi and Papanikolaou (2012), we split our sample into 10 percentiles according to the level of insider ownership to examine in detail if cash holdings are more sensitive to idiosyncratic risk in firms where managers hold a larger portion of the firm's shares. For each year, we sort firms into percentiles based on the lagged fraction of shares outstanding owned by the top executives.

Table 3.5 presents time-series averages of firm characteristics within ownership percentiles. The mean level of insider ownership across the 10 groups varies from 0.027% to 26.27%. We identify that firms with higher levels of insider ownership tend to be smaller, with lower industry volatility and invest more, on average.

Table 3.5: Ten portfolios sorted on insider ownership: time-series averages of firm characteristics within ownership percentiles

Insider Own.Level	Low	2	3	4	5	6	7	8	9	High
Cash Holdings	0.1695	0.1376	0.1386	0.1389	0.1441	0.1536	0.1476	0.1619	0.1685	0.1767
Net Cash Holdings	0.2928	0.2154	0.2317	0.2303	0.2369	0.2625	0.2511	0.2821	0.2874	0.3050
Idios. Vol. _{t-1}	0.5162	0.5226	0.5161	0.5218	0.5210	0.5234	0.5139	0.5226	0.5191	0.5221
Insider Own. _{t-1}	0.0002	0.0013	0.0025	0.0043	0.0068	0.0109	0.0182	0.0334	0.0765	0.2627
Leverage	0.2376	0.2469	0.2567	0.2558	0.2363	0.2250	0.2499	0.2364	0.2021	0.1773
Market-to-book	2.6095	2.4742	2.4249	2.3219	2.3138	2.4136	2.3836	2.5516	2.6664	2.8217
Cashflow	0.1689	0.1707	0.1533	0.1608	0.1542	0.1540	0.1485	0.1546	0.1630	0.1849
Acquisition	0.0266	0.0254	0.0253	0.0257	0.0270	0.0256	0.0285	0.0274	0.0268	0.0212
Firm Size	6.0840	6.5445	6.3059	6.0483	5.8563	5.6013	5.4864	5.3214	5.1548	5.2358
R&D	0.0389	0.0382	0.0344	0.0308	0.0321	0.0297	0.0318	0.0294	0.0303	0.0236
Nwc.	0.0661	0.0561	0.0720	0.0880	0.1052	0.1143	0.1148	0.1183	0.1246	0.1190
Capex	0.0692	0.0693	0.0662	0.0688	0.0659	0.0691	0.0728	0.0769	0.0781	0.0849
Dividend	0.4136	0.4736	0.4688	0.4468	0.4285	0.4088	0.3676	0.3366	0.3200	0.3564
Ind. Vol.	0.6263	0.6736	0.6064	0.5745	0.5420	0.5586	0.5796	0.5781	0.5561	0.4620
Cflow Vol.	0.0992	0.0871	0.0931	0.0885	0.0857	0.0988	0.0972	0.1068	0.1053	0.0945
Stock Ret.	0.0654	0.0744	0.0604	0.0701	0.0710	0.0684	0.0769	0.0693	0.0787	0.0934
WW Index	-0.2880	-0.3097	-0.2973	-0.2900	-0.2777	-0.2659	-0.2562	-0.2437	-0.2375	-0.2505
Market Cap.	0.1287	0.0813	0.0768	0.0210	0.0260	0.0128	0.0158	0.0124	0.0143	0.0200
Book Assets(\$)	0.1344	0.1151	0.0653	0.0433	0.0284	0.0200	0.0201	0.0273	0.0169	0.0231

Moreover, these firms also have lower market capitalization, greater investment opportunities, and a higher net working capital ratio. Finally, firms with greater insider ownership are likely to have a lower financial leverage ratio and a higher Whited and Wu index of financial constraints. Unfortunately, we cannot predict the sensitivity of cash holdings to idiosyncratic risk from the level of insider ownership because the relationship is not clear from the analysis in Table 3.5.

Combining the information from Tables 3.4 and 3.5, we notice a monotonic positive or negative relationship between the level of insider ownership and other firm characteristics such as net working capital, firm size, capital expenditures, dividend payment, leverage, R&D, and financial constraints measured by the Whited and Wu index. However, it is not possible to predict a clear trend between the level of insider shareholding and cash reserve behaviour.

A preliminary investigation on the relationship pattern between cash holdings and insider ownership can clarify if there is a linear or non-linear association between these two variables. We plot Figure 3.2 that shows how corporate cash holdings follow insider ownership over its 10 percentile levels.

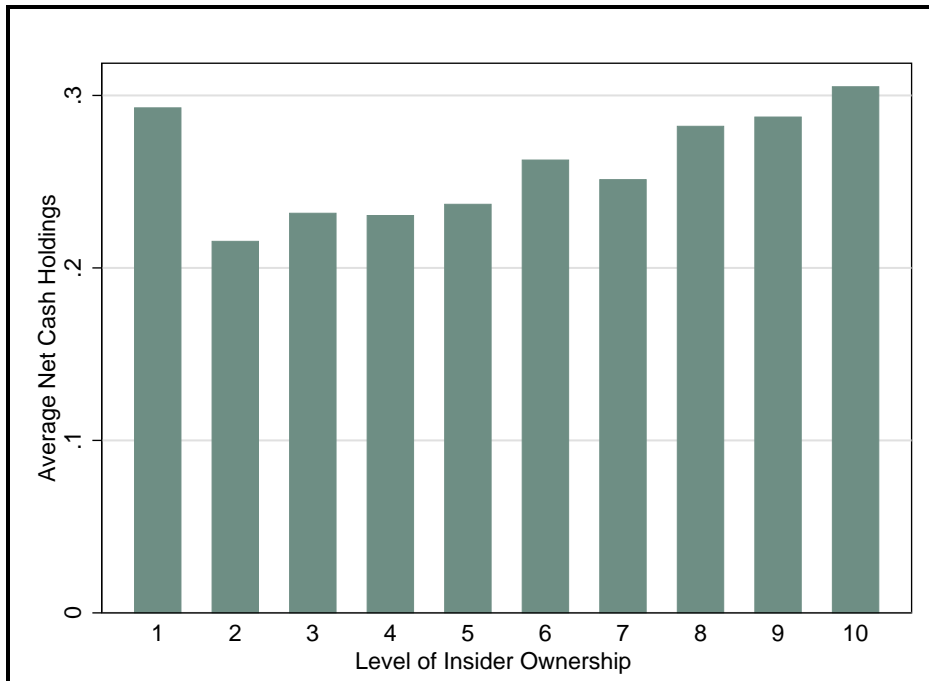


Figure 3.2: Cash holdings and insider ownership

The nature of the relationship between cash holdings and equity ownership of managers shown in Figure 3.2 is similar to Ozkan and Ozkan (2004)'s findings for UK firms during the period 1995 to 1998. Ozkan and Ozkan (2004) note a non-monotonic relation between cash balances and managerial ownership whereby corporate cash holdings decrease as managerial ownership increases up to 24%, increase as managerial ownership rises to 64%, and fall again for levels of insider ownership above 64%.

Figure 3.2 shows that, at first, cash holdings decrease from the first to the second level of insider ownership consistent with the incentive-alignment argument. This could imply that an increase in managerial ownership incentivises managers to align their interests with those of shareholders reducing the level of cash holdings. However, after reaching a minimum, the association between cash reserves and insider ownership becomes positive, moving from alignment to entrenchment until the sixth percentile, turning negative at the seventh percentile, and becoming positive from the eighth to the tenth percentile.

This suggests that as the level of insider ownership increases, managers have more direct control over the firm, more ability to resist external pressure, and more freedom to pursue their own interests Ozkan and Ozkan (2004). However, this pattern may be related to the interaction between risk-averse managers and idiosyncratic risk effect inside firms. Consequently, risk-averse managers tend to hold more cash as a strategy to reduce firm risk and protect their own wealth. It will be explored in Section 3.3.

3.3 Empirical analysis

The empirical analysis is composed of four parts. Section 3.3.1 investigates whether corporate cash holdings are driven by a firm-level measure of idiosyncratic risk after controlling for variables known to affect changes in the cash-to-net assets ratio. Section 3.3.2 analyses whether and how insider ownership influences corporate cash holding behaviour. Section 3.3.3 examines if a situation where a manager's shareholdings facing unhedgeable risk yields a stronger, positive relation between idiosyncratic volatility and cash holdings. Finally, Section 3.3.4 explores potential endogeneity issues that could distort our outcomes and Section 3.3.5 proceeds with robustness checks.

3.3.1 Cash holdings and idiosyncratic risk

Our empirical analysis first examines whether idiosyncratic risk affects corporate cash holdings. We employ a multivariate setting using cross-sectional time-series regression models. For all specifications, we report t -statistics using standard error corrected for clustering at the firm level. Depending on the specification, we use time fixed effects and industry-time fixed effects. We allow the time effects to vary by industry to capture any unobservable component varying at the industry level. In this case, variation comes from differences between a firm and its industry peers, as in Panousi and Papanikolaou (2012).

To test our first hypothesis that corporate cash holdings are positively related to idiosyncratic risk, our dependent variable is net cash holdings computed as the ratio of cash and cash equivalents to total assets minus cash and cash equivalents. We conduct a robustness check with other measures of cash holdings in Section 3.3.5. The independent variables are idiosyncratic risk measured as the log volatility of the regression residuals from a two-index model and firm-specific factors that can affect corporate cash holdings.

We test this relationship from our baseline econometric model in Equation 3.9, that is:

$$\text{Cashholding}_{i,t} = \alpha + \beta_1 \log \sigma_{i,t-1} + \gamma_1 \mathbf{Z}_{i,t} + \eta_i + \varrho_t + v_{i,t} \quad (3.9)$$

The vector $\mathbf{Z}_{i,t}$ includes control variables known to correlate with cash holding decisions and idiosyncratic risk for firm i at time t . Following studies presented previously, $\mathbf{Z}_{i,t}$ consists of proxies for size, cashflow, net working capital, growth opportunities, cashflow volatility, stock returns, capital expenditures, leverage, dividend, research and development, acquisitions, industry volatility, lagged systematic volatility and WW index. We also include lagged cash holdings to mitigate potential problems of endogeneity and adjustment delay of cash structure (e.g., Opler et al., 1999; Harford et al., 2008; Bates et al., 2009; Y. R. Chen & Chuang, 2009; Kuan et al., 2011). η_i and ϱ_t capture the firm and time fixed effects, and $v_{i,t}$ is the error term.

Because we standardise all independent variables, we refer their beta coefficients directly as a change in the dependent variable per standard deviation increase in respective predictor variables.

Table 3.6 shows the estimates of our baseline. The first column displays the findings of Model 1, where we include only idiosyncratic risk proxy and firm fixed effects. When we do not control for other firm characteristics, the coefficient on idiosyncratic risk is 2.32% and statistically and economically significant at the 99% confidence level. All else equal, a single standard deviation increase is associated with a 2.32% increase in the net

cash holdings ratio.

Table 3.6: Multivariate analysis of cash holdings and idiosyncratic risk.

Dependent Variable:	(1)	(2)	(3)	(4)
Net Cash Holdings				
Idiosyncratic Volatility _{<i>t-1</i>}	0.0232*** (4.75)	0.0121*** (2.84)	0.0121*** (2.68)	0.0109** (2.06)
Systematic Volatility _{<i>t-1</i>}				-0.0065* (-1.91)
Net Cash Holdings _{<i>t-1</i>}		0.4175*** (35.91)	0.4117*** (35.34)	0.4357*** (31.68)
Leverage.		-0.0262*** (-4.25)	-0.0240*** (-3.72)	-0.0060 (-0.84)
Market-to-Book.		0.2419*** (26.00)	0.2481*** (25.84)	0.2409*** (21.91)
Cash flow.		-0.0166 (-1.61)	-0.0122 (-1.15)	-0.0190 (-1.54)
Acquisitions.		-0.0597*** (-23.24)	-0.0603*** (-22.90)	-0.0597*** (-20.18)
Firm Size.		0.0829*** (5.87)	0.1000*** (6.40)	0.0496*** (3.18)
R&D.		0.0419*** (3.21)	0.0404*** (3.00)	0.0319** (2.04)
Net Working Capital.		-0.0985*** (-11.93)	-0.0983*** (-11.62)	-0.1037*** (-10.20)
Capital Expenditures.		-0.0022 (-0.41)	0.0005 (0.09)	-0.0015 (-0.24)
Industry Volatility.		-0.0122** (-2.17)	-0.0161** (-2.03)	-0.0109* (-1.82)
Cash flow Volatility.		0.0479*** (3.56)	0.0516*** (3.79)	0.0360** (2.21)
Dividend.		-0.0053 (-0.56)	0.0054 (0.53)	-0.0140 (-1.33)
Firm Stock Return.		-0.0070** (-2.46)	-0.0071** (-2.36)	-0.0071* (-1.95)
Whited and Wu Index.		0.0194*** (3.59)	0.0365*** (4.53)	0.0140** (2.36)
Observations	81189	62131	62131	45508
R^2	0.759	0.845	0.850	0.865
Fixed effects	F	F, T	F, IxT	F, T

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The second column shows the estimates of Model 2, which consider the vector of control variables and firm and time fixed effects. The coefficient on idiosyncratic risk is 1.21%, statistically and economically significant at the 99% confidence level. In this specification, a single standard deviation increase in idiosyncratic volatility is related to a 1.21% increase in net cash holdings ratio, all else being equal.

The third column presents the results of Model 3 that include the vector of control variables and firm, time, and industry effects. In this model, the coefficient on idiosyncratic risk remains unaffected at 1.21%.

The fourth column displays the estimates considering an additional regressor, the systematic risk. We include this regressor to rule out the potential effect of systematic risk on cash holdings that could bias our results. The coefficient on idiosyncratic risk persists and is statistically significant at the 5% level, although it is less economically significant. In this specification, a single standard deviation increase in systematic volatility decreases corporate cash holdings by 0.65%, significant at the 90% confidence level. This seems counterintuitive; we expected a positive association between cash hoardings and systematic risk because firms more exposed to systematic risks are likely to hold more cash (Acharya et al., 2013).

Most control variables show expected signs and remain statistically significant at the 1%, 5%, or 10% level, confirming their importance in determining corporate cash holdings. As expected, investment opportunities (coefficient=0.2409 and t -statistic=21.91) and lagged net cash holdings (coefficient=0.4357 and t -statistic=31.68) explain a substantial part of the current cash holdings. The results support H_1 that corporate cash holdings are positively related to idiosyncratic risk.

3.3.2 Cash holdings and insider ownership

Following the intuition in Nikolov and Whited (2014) that insider ownership may act as a monitoring tool within firms, our second hypothesis presumes that corporate cash holdings is negatively related to insider ownership. To test this hypothesis, we employ our baseline econometric model from Equation 3.10, that is:

$$\text{Cashholding}_{i,t} = \alpha + \beta_1 \text{InsOwn}_{i,t-1} + \gamma_1 \mathbf{Z}_{i,t} + \eta_i + \varrho_t + v_{i,t} \quad (3.10)$$

The vector $\mathbf{Z}_{i,t}$ includes control variables known to correlate with cash holding decisions and insider ownership for firm i at time t . Following studies already presented, $\mathbf{Z}_{i,t}$ includes lagged cash holdings, size, cash flow, net working capital, growth opportunities, cash flow volatility, capital expenditures, leverage, dividends, R&D, acquisitions, industry volatility, WW index, cash compensation, and institutional ownership. η_i and ϱ_t capture the firm and time fixed effects, and $v_{i,t}$ is the error term.

Table 3.7 lists the empirical findings for four specifications. The coefficient on insider ownership is negative and significant at the 5% level for all models after controlling for firm features, compensation scheme, and institutional ownership. The findings support our second hypothesis.

In Model 1, a single standard deviation increase in insider ownership, all else being equal, leads to a 1.26% decrease in the net cash holdings ratio, on average, when controlled for firm and time effects. In Model 2, a single standard deviation increase in insider ownership is related to a 1.47% decrease in the net cash holding ratio, on average, when controlled for firm and industry–time fixed effects.

Lagged cash holdings, market-to-book, acquisitions, and net working capital in these regressions lead to the similar inferences of earlier regressions. Cash flow and dividend remain statistically insignificant. However, leverage, cash flow volatility, industry volatility, WW Index, capital expenditures, R&D, and firm size lose statistical significance or

Table 3.7: Multivariate analysis of cash holdings and insider ownership.

Dependent Variable: Net Cash Holdings	(1)	(2)	(3)	(4)
Insider Ownership _{t-1}	-0.0126* (-1.85)	-0.0147** (-2.13)	-0.0580** (-2.42)	-0.0605** (-2.39)
Insider Ownership _{t-1} ²			0.0824* (1.89)	0.0822* (1.80)
Insider Ownership _{t-1} ³			-0.0422* (-1.78)	-0.0418* (-1.66)
Net Cash Holdings _{t-1}	0.4575*** (18.99)	0.4370*** (17.56)	0.4569*** (18.97)	0.4364*** (17.54)
Cash Compensation _{t-1}	0.0309** (2.00)	0.0392** (2.33)	0.0307** (1.99)	0.0389** (2.32)
Institutional Ownership _{t-1}	-0.0283*** (-4.92)	-0.0306*** (-4.94)	-0.0281*** (-4.91)	-0.0305*** (-4.94)
Leverage	0.0454*** (3.06)	0.0486*** (3.03)	0.0455*** (3.06)	0.0488*** (3.04)
Market-to-Book	0.2350*** (12.36)	0.2431*** (11.87)	0.2358*** (12.41)	0.2439*** (11.91)
Cashflow	0.0086 (0.30)	0.0132 (0.42)	0.0082 (0.29)	0.0129 (0.41)
Acquisitions	-0.0647*** (-14.12)	-0.0658*** (-13.06)	-0.0646*** (-14.10)	-0.0656*** (-13.02)
Firm Size	0.0590 (1.43)	0.0613 (1.37)	0.0573 (1.40)	0.0599 (1.33)
R&D	0.0198 (0.70)	0.0036 (0.12)	0.0200 (0.71)	0.0039 (0.13)
Net Working Capital	-0.1636*** (-6.90)	-0.1647*** (-6.57)	-0.1635*** (-6.89)	-0.1647*** (-6.57)
Capital Expenditures	-0.0290** (-2.54)	-0.0216* (-1.68)	-0.0285** (-2.50)	-0.0212 (-1.64)
Industry Volatility	-0.0123 (-0.99)	-0.0157 (-1.12)	-0.0119 (-0.95)	-0.0153 (-1.09)
Cashflow Volatility	0.0033 (0.10)	0.0040 (0.12)	0.0026 (0.08)	0.0033 (0.10)
Dividend	0.0033 (0.16)	0.0004 (0.02)	0.0039 (0.19)	0.0006 (0.03)
Whited and Wu Index	0.0080 (0.73)	0.0043 (0.30)	0.0081 (0.73)	0.0042 (0.30)
Observations	12364	12364	12364	12364
R ²	0.865	0.874	0.865	0.874
Fixed effects	F,T	F, TxI	F,T	F,TxI

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

change their significance and coefficient sign. We hypothesise that the ownership structure moderates the effect of these determinants on cash holdings.

From these variables, only the coefficients on leverage are positive and statistically significant at the 1% level. Acharya et al. (2007) explain that firms with higher investment opportunities and lower hedging accumulate excess cash towards debt reductions

to save/amplify debt capacity. However, this is not the case because the estimates on leverage are positive. Jensen (1986) suggest that larger cash reserves and higher leverage levels might reduce agency costs because managers are forced to pay out excess funds instead of investing in negative net present value projects.

Initially, our findings endorse the second hypothesis that insider ownership is negatively related to corporate cash holdings. These results are consistent with Jensen (1986)'s perspective that compensating managers with equity holdings may induce them to act efficiently in the interests of their firm's claimants. Consequently, insider ownership potentially acts as a monitoring tool and, therefore, motivates managers to spend the excess cash appropriately in value-increasing projects rather than holding the cash within the firm.

Although this finding provides evidence of a causal negative relationship between cash holdings and managerial ownership, we investigate whether cash holdings may vary with the level of insider ownership as in Opler et al. (1999), Ozkan and Ozkan (2004), and Harford et al. (2008).

Harford et al. (2008) argue that the true relation between cash holdings and insider ownership might be asymmetric suggesting that accurate inference from linear specification is insufficient for its capture. According to the authors, only the coefficient representing the fourth quartile of managerial ownership is significant.

Models 1 and 2 presented in Table 3.7, and the intuition formerly observed in Figure 3.2, show that cash holdings may vary with the level of insider ownership. We test if the relationship between cash and idiosyncratic volatility is non-linear.

Stock and Watson (2011) explain that one way to specify a non-linear regression function is to use a polynomial in the regressor as powers of the same dependent variable. We include higher ordered insider ownership terms, namely, InsOwn^2 and $\text{Insider Ownership}^3$, into our baseline regression to capture any potential conditional relationship from these two variables on cash holdings and its asymmetry.

Following the insights of Ozkan and Ozkan (2004), this insertion allows for the effect of insider ownership on cash holdings to alter with the level of insider ownership, which differs from the linear regression framework that examines a constant effect.

The estimated coefficients on InsOwn , InsOwn^2 , and InsOwn^3 in Models 2 and 3 are statistically significant at the 5%, 10%, and 10% level, respectively, although controlling for firm, time, and industry fixed effects. This suggests that the influence of ownership on cash holding decisions does not have a constant effect and supports the perspective of a non-linear relationship, as in Ozkan and Ozkan (2004).

These outcomes imply that firms with managerial ownership between 0.1% and 0.6% maintain the lowest cash balances. In other words, a single standard deviation increase in managerial ownership through this range is associated with a 5.8% to 6.05% decrease in the net cash holding ratio. However, after reaching a minimum, as the level of insider ownership rises, firms hold more cash.

From an insider ownership level of 0.6% to 1.09%, firms accumulate cash reserves. In this range, a single standard deviation increase in insider ownership is related to an 8.24% increase in net cash holdings. This provides evidence of an entrenchment effect at these levels, such as in Ozkan and Ozkan (2004). Between 1.09% and 1.82%, the relationship becomes negative implying a single standard deviation increase in managerial ownership leads to a 4.22% to 4.18% decrease in net cash holdings. At an insider ownership level over

3.34%, firms hold more cash. From this perspective, the literature has mixed explanations as to why managers with a higher level of ownership positively influence corporate cash holding behaviour.

Opler et al. (1999) report that managerial shareholding has a positive impact on cash holdings for low insider ownership firms, significant at the 10% level. However, there is no significant effect at higher levels of managerial ownership. In Ozkan and Ozkan (2004), the positive effect of insider ownership on cash holdings at higher levels of ownership suggests the presence of managerial risk aversion in this relationship. To Nikolov and Whited (2014), a lower level of insider ownership is a key determinant of an upward trend in US firm cash holdings.

Therefore, further investigations are required to disentangle these previous outcomes. The next section explores whether managers facing unhedgeable risk are likely to hold more cash as the level of insider ownership increases, and we examine alternative channels for the previously mixed explanations in the cash holding literature.

3.3.3 Cash holdings, idiosyncratic risk, and insider ownership

This section analyses our third hypothesis that the positive relationship between cash holdings and idiosyncratic risk is stronger when managers own a larger fraction of the firm. Given this, if the manager is also the owner of the firm, then whatever happens to that firm will matter for the manager/investor even if the risk only affects this particular firm (Panousi & Papanikolaou, 2012). Consequently, the firm will start to behave in a more risk-averse way. Then, if idiosyncratic uncertainty increases, the manager may hold cash to protect personal wealth and to avoid default risk (Arnold, 2014; Panousi & Papanikolaou, 2012).

Disentangling the impact of insider ownership on corporate cash holdings is complex. Agency theories rely, at least, on three divergent views on the role of managerial ownership on corporate cash policies.

The alignment perspective states that a high level of insider ownership and effective internal governance inhibit managerial misbehaviour in corporate decision making (Jensen, 1986).

The entrenchment view associates a high level of managerial ownership with the potential for resource diversion such as outright stealing, excessive salaries, perquisite consumption, and/or transfer pricing (La Porta et al., 2002).

Baum, Chakraborty, Han, and Boyan (2012) affirm that both governance quality and the nature of uncertainty facing the firm may play an important role on firm cash holding arrangements. According to the authors, as macroeconomics uncertainty within firms increases, entrenched managers are better positioned to use the resources of the firm to pursue their own interests. With a higher level of insider ownership, managerial discretion could be worse because greater ownership provides more direct control over the firm, and outside shareholders may find it more difficult to monitor manager actions or estimate the true value of their corporate decisions (Ozkan & Ozkan, 2004).

Holmström and Tirole (1998) highlight that while equity compensation schemes may seem to have desirable incentive/motivational properties, they also can discourage the manager from bearing risk that could be better carried by diversified stockholders. If the manager, unlike the owners, has already invested most of the non-diversifiable and

non-tradeable human capital in the firm, the manager has a tendency to be risk-averse, whereas the principal may be risk neutral (Zajac & Westphal, 1994). Therefore, while the principal only bears systematic risk, the manager bears both systematic and idiosyncratic risks (Tong, 2010). Because these risk preferences differ, it would be costly and difficult for outside shareholders to convince the manager to bear this risk.

We, henceforth, rely on this third standpoint for risk-related agency theory that predicts risk-averse managers under idiosyncratic risk prefer to reduce default and liquidity risk retaining more cash reserves towards higher levels of insider ownership to preserve their own wealth and their non-diversifiable and non-tradeable human capital within firms.

We analyse cash-idiosyncratic sensitivity to the level of insider ownership using an OLS approach. We sort firms annually into quintiles based on the fraction of shares outstanding owned by officers classified into the following categories, according to the Thomson classification: O, OD, OE, OB, OP, OS, OT, OX, CEO, CFO, CI, CO, CT, H, GM, M, MD, P, EVP, VP, and SVP. Then, we run the linear model of Equation 3.7 for each level of insider ownership.

Model 1 considers only lagged idiosyncratic risk and firm fixed effects while Model 2 includes the control variables, firm, and time effects. Table 3.8 presents the results when we sort firms into the fifth level of insider ownership. The coefficient on idiosyncratic risk is statistically significant at the 10% and 5% level in Models 1 and 2 for the second level of managerial ownership, respectively. The coefficient on idiosyncratic risk also presents statistical significance at the 5% level in Model 1 for the third level of insider ownership. Market-to-book, acquisitions, and net working capital are statistically and economically significant.

Table 3.8: Cash-idiosyncratic risk sensitivity to the level of insider ownership: cross-section time-series regressions.

Level of Insider Ownership: Model Specification	Low Level		Level 2		Level 3		Level 4		High	
	1	2	1	2	1	2	1	2	1	2
Dependent Variable: Net Cash Holdings										
Idiosyncratic Volatility $_{t-1}$.	0.0288 (1.51)	-0.0078 (-0.29)	0.0381* (1.77)	0.0444** (2.00)	0.0391** (1.98)	0.0242 (1.05)	0.0148 (0.85)	0.0208 (0.82)	0.0093 (0.40)	-0.0369 (-1.38)
Leverage.		0.074 (1.44)		0.0375 (0.88)		0.0014 (0.04)		0.0514 (1.26)		0.0335 (0.91)
Market-to-Book.		0.3205*** (4.46)		0.2696*** (5.37)		0.3788*** (7.40)		0.2385*** (4.66)		0.3465*** (6.19)
Cash flow.		0.022 (0.22)		0.0268 (0.30)		-0.0499 (-0.52)		0.1092 (1.42)		0.0199 (0.21)
Acquisition.		-0.0355*** (-2.90)		-0.0321*** (-2.90)		-0.0371*** (-3.80)		-0.0338*** (-3.25)		-0.0504*** (-4.26)
Firm Size.		-0.1504 (-0.98)		-0.0761 (-0.61)		0.0688 (0.74)		0.0159 (0.16)		0.0693 (0.71)
R&D.		0.0483 (0.58)		0.0603 (0.79)		0.008 (0.09)		0.0154 (0.20)		0.2236* (1.94)
Net Working Capital.		-0.3130*** (-3.38)		-0.2086*** (-3.70)		-0.1074** (-2.17)		-0.2198*** (-4.06)		-0.2421** (-2.45)
Capital Expenditures.		0.0933** (2.30)		0.0214 (0.64)		0.012 (0.38)		-0.0148 (-0.50)		0.0015 (0.06)
Industry Volatility.		0.0135 (0.29)		0.0024 (0.13)		0.0013 (0.05)		-0.0224 (-0.39)		0.0117 (0.34)
Cashflow Volatility.		0.0282 (0.16)		-0.0189 (-0.18)		0.0794 (0.74)		0.0506 (0.55)		0.1095 (0.93)
Dividend.		0.1331 (1.10)		-0.0046 (-0.09)		-0.006 (-0.16)		0.0812 (1.40)		-0.0457 (-0.78)
Stock Return.		-0.0133 (-0.66)		0.0099 (0.58)		-0.0166 (-1.12)		-0.0035 (-0.22)		-0.0226 (-1.38)
WW Index.		0.0007 (0.02)		0.0147 (0.58)		0.0312 (0.97)		0.0522 (1.60)		-0.0560** (-2.57)
N	3603	3115	3645	3257	3566	3271	3584	3249	3421	3325
R^2	0.805	0.855	0.864	0.891	0.851	0.894	0.796	0.85		
Fixed effects	F	F, T	F	F, T	F	F, T	F	F, T	F	F, T

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Next, we interact idiosyncratic risk with the level of managerial ownership to examine its impact on cash holdings using an extended version of Equation 3.7, as shown in Equation 3.11:

$$\begin{aligned} \text{Cashholdings}_{i,t} = & \alpha + \beta_1 \log \sigma_{i,t-1} + \beta_2 \text{Ins}_{\text{OwnLow},i,t} + \beta_3 \text{Ins}_{\text{Own2},i,t} + \beta_4 \text{Ins}_{\text{Own3},i,t} + \\ & \beta_5 \text{Ins}_{\text{Own4},i,t} + \beta_6 \log \sigma_{i,t-1} * \text{Ins}_{\text{Low},i,t-1} + \beta_7 \log \sigma_{i,t-1} * \text{Ins}_{2,i,t-1} + \beta_8 \log \sigma_{i,t-1} * \text{Ins}_{3,i,t-1} + \\ & \beta_9 \log \sigma_{i,t-1} * \text{Ins}_{4,i,t-1} + \beta_{10} \log \sigma_{i,t-1} * \text{Ins}_{\text{High},i,t-1} + \gamma_1 \mathbf{Z}_{i,t} + \eta_i + \varrho_t + v_{i,t} \end{aligned} \quad (3.11)$$

In this expanded equation, we incorporate all insider ownership level dummies and the interactions between the idiosyncratic risk proxy and each insider ownership level, namely, Idiosyncratic risk x Ins_{Low} , Idiosyncratic risk x Ins_2 , Idiosyncratic risk x Ins_3 , Idiosyncratic risk x Ins_4 , and Idiosyncratic risk x Ins_{High} .

The vector $\mathbf{Z}_{i,t}$ includes size, cash flow, net working capital, growth opportunities, cash flow volatility, stock returns, capital expenditures, leverage, dividend, R&D, acquisitions, industry volatility, WW index, cash compensation (salary plus bonus) and institutional ownership for firm i at time t .

We also employ two different measures of insider ownership, separately. First, we consider the fraction of shares outstanding owned by officers, excluding options to construct the level of insider ownership for a firm across Models 1 to 4. Second, we use the shares owned by managers including options in Models 5 to 8 to test whether more convex executive compensation schemes could affect corporate cash balance retention, inhibiting the risk aversion behaviour of managers, such as in Nikolov and Whited (2014) and Panousi and Papanikolaou (2012).

Models 1 and 5 consider, respectively, the interaction between idiosyncratic risk and the level of insider ownership on cash holdings, controlling for firm fixed effects. Models 2, 3, 4, 6, and 8 include the control variables, firm, time, and industry effects, according to the specification.

Table 3.9 lists the results from these interactions on cash holdings. The parameters of the interaction variables are statistically insignificant for all level of insider ownership and insider ownership plus options. These findings do not support our third hypothesis that firms with a higher level of insider ownership exposed to idiosyncratic risk hold more corporate cash holdings.

Although our third hypothesis could not be confirmed, the insider ownership dummies have positive and statistic significant coefficients between 1% and 10% levels, depending on the model specification. Initially, the findings are counterintuitive because we found a negative, significant relationship between cash holdings and insider ownership earlier. Rather, when we observe the coefficient of each insider ownership dummy, as the level of insider ownership rises, its effect on cash holdings becomes weaker. In other words, managers with a lower level of insider ownership tend to save more cash than managers with higher shareholdings.

In Model 4, for instance, managers at the first level of insider ownership (on average 0.02% of firm's shares outstanding) retain 69.8% more cash holdings than managers at the fourth level of insider ownership (on average 0.08% of firm's shares outstanding), controlling for firm, time, and industry effects. Moreover, by incorporating options into the insider ownership measure, the coefficient on insider ownership dummies loses significance compared to the first measure. In Tong (2010), CEOs in firms with compensation schemes compounded by options hold less cash than firms that do not include them in manager

Table 3.9: Insider ownership–idiosyncratic risk interactions on cash holdings: Cross-section time-series regressions.

Dependent Variable: Net Cash Holdings	1	2	3	4	5	6	7	8
Idiosyncratic Risk _{t-1}	0.0325* (1.86)	0.0089 (0.60)	0.0080 (0.55)	0.0033 (0.22)	0.0317 (1.59)	0.0202 (1.33)	0.0190 (1.24)	0.0152 (0.98)
Insider Own Level 1	0.0337 (1.27)	0.0581*** (2.64)	0.0592*** (2.69)	0.0613*** (2.83)	0.0564* (1.82)	0.0415* (1.81)	0.0425* (1.85)	0.0438* (1.93)
Insider Own Level 2	0.0347 (1.39)	0.0526** (2.36)	0.0542** (2.44)	0.0592*** (2.68)	0.0412 (1.44)	0.0331 (1.54)	0.0348 (1.62)	0.0351* (1.66)
Insider Own Level 3	0.0356 (1.57)	0.0452** (2.10)	0.0471** (2.18)	0.0513** (2.37)	0.0411 (1.47)	0.0411* (1.92)	0.0429** (1.99)	0.0458** (2.13)
Insider Own Level 4	0.0075 (0.34)	0.0265 (1.36)	0.0278 (1.42)	0.0361* (1.85)	0.0257 (1.03)	0.0228 (1.09)	0.0241 (1.14)	0.0281 (1.32)
Idios Risk x Insider 1	0.0014 (0.06)	0.0023 (0.12)	0.0026 (0.14)	0.0035 (0.19)	-0.0091 (-0.37)	-0.0133 (-0.73)	-0.0127 (-0.69)	-0.0104 (-0.56)
Idios Risk x Insider 2	0.0121 (0.56)	0.0052 (0.30)	0.0056 (0.32)	0.0073 (0.42)	-0.0001 (-0.00)	-0.0093 (-0.51)	-0.0085 (-0.46)	-0.0091 (-0.51)
Idios Risk x Insider 3	0.0076 (0.35)	0.0099 (0.52)	0.0101 (0.53)	0.0127 (0.66)	0.0099 (0.39)	-0.0082 (-0.41)	-0.0077 (-0.39)	-0.0058 (-0.29)
Idios Risk x Insider 4	-0.0096 (-0.45)	-0.0081 (-0.43)	-0.0084 (-0.44)	-0.0032 (-0.17)	0.0129 (0.54)	-0.0173 (-0.89)	-0.0172 (-0.88)	-0.0144 (-0.74)
Net Cash Holdings _{t-1}		0.4511*** (18.85)	0.4519*** (18.82)	0.4459*** (18.39)		0.4543*** (19.12)	0.4553*** (19.09)	0.4492*** (18.63)
Leverage		0.0435*** (2.94)	0.0432*** (2.92)	0.0451*** (3.09)		0.0435*** (2.91)	0.0432*** (2.89)	0.0449*** (3.06)
Market-to-Book		0.2409*** (12.61)	0.2400*** (12.43)	0.2411*** (12.36)		0.2394*** (12.51)	0.2384*** (12.34)	0.2396*** (12.28)
Cashflow		0.0179 (0.63)	0.0177 (0.62)	0.0205 (0.70)		0.0199 (0.70)	0.0197 (0.69)	0.0219 (0.75)
Acquisitions		-0.0621*** (-14.06)	-0.0622*** (-14.00)	-0.0624*** (-13.91)		-0.0620*** (-14.06)	-0.0622*** (-14.00)	-0.0624*** (-13.91)
Firm Size		-0.0016 (-0.04)	0.0071 (0.17)	-0.0019 (-0.05)		-0.0041 (-0.10)	0.0057 (0.14)	-0.0031 (-0.07)
R&D		0.0183 (0.65)	0.0181 (0.65)	0.0166 (0.59)		0.0230 (0.83)	0.0229 (0.82)	0.0210 (0.76)
Net Working Capital		-0.1646*** (-6.95)	-0.1639*** (-6.93)	-0.1594*** (-6.80)		-0.1658*** (-7.03)	-0.1650*** (-7.00)	-0.1605*** (-6.87)
Capital Expenditures		-0.0263** (-2.34)	-0.0259** (-2.30)	-0.0252** (-2.22)		-0.0275** (-2.42)	-0.0270** (-2.38)	-0.0263** (-2.30)
Industry Volatility		-0.0103 (-0.83)	-0.0105 (-0.84)	-0.0091 (-0.71)		-0.0105 (-0.85)	-0.0107 (-0.86)	-0.0095 (-0.75)
Cashflow Volatility		-0.0001 (-0.00)	-0.0003 (-0.01)	0.0009 (0.03)		0.0041 (0.12)	0.0039 (0.12)	0.0051 (0.15)
Dividend		0.0069 (0.32)	0.0066 (0.31)	0.0046 (0.21)		0.0064 (0.30)	0.0060 (0.29)	0.0043 (0.20)
Firm Stock Return		-0.0182*** (-2.82)	-0.0179*** (-2.73)	-0.0169** (-2.55)		-0.0180*** (-2.79)	-0.0177*** (-2.70)	-0.0167** (-2.52)
WW Index		0.0068 (0.62)	0.0068 (0.62)	0.0055 (0.48)		0.0060 (0.55)	0.0060 (0.55)	0.0050 (0.43)
Cash Compensation _{t-1}			0.5162 (0.29)	0.7953 (0.43)			0.5897 (0.33)	0.8756 (0.47)
Institutional Ownership _{t-1}			-0.0072 (-0.83)	-0.0111 (-1.29)			-0.0079 (-0.91)	-0.0116 (-1.36)
Observations	17995	12388	12388	12388	16446	12356	12356	12356
R ²	0.754	0.864	0.864	0.867	0.763	0.865	0.865	0.867
Fixed Effects	F	F,T	F,T	F,T,I	F	F,T	F,T	F,T,I

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

reward schemes.

Our results corroborate Opler et al. (1999)'s study that insider shareholdings have a positive impact on cash holdings for firms with low levels of insider ownership but

no significant effect at higher levels of managerial ownership. Our results reinforce the perspective of Nikolov and Whited (2014) that a lower level of insider ownership is a key determinant of an upward trend in US firm cash holdings because the average insider ownership in our US sample is 4.12% of a firm's shares outstanding.

All these findings emphasise the prediction of agency theory that managerial ownership acts as a monitoring tool aligning manager and shareholders' interests, even under firm-specific risk.

3.3.4 Endogeneity issues

Detaching the alternative hypothesis for our results is an important step to confirm whether we can establish evidence of a causal effect among the main study variables: cash holdings, idiosyncratic risk, and insider ownership. When the unobserved characteristics, simultaneity, or measurement error are likely to be present in the regression set, potential endogeneity problems could cause biased estimation on the model parameters (Roberts & Whited, 2013).

A major concern is that insider ownership and cash holdings are, in part, jointly determined. Consequently, they could be a potential source of endogeneity. Higher cash holdings are potentially more valuable for financially constrained firms than for unconstrained firms because firms facing unpredictable future internal funds, costly external financing, and market imperfections have a propensity to invest in liquid assets as an optimal response in financing future investment opportunities (Gamba & Triantis, 2008). Therefore, our results can be driven by the likelihood that a firm is financially constrained rather than by the differences in insider ownership levels *per se*.

To rule out this possibility, we separate firms into different levels of insider ownership, controlling for the degree of financial constraints. Following Almeida et al. (2004), we double sort firms into five times five groups based on the degree of financial constraints and the level of insider ownership. Next, we use two measures for financial constraints: Whited and Wu index and firm size, measured as the logarithm of the book value of assets. Then, we estimate Equation 3.7 separately for each pooled quintile. The set of controls includes size, cash flow, net working capital, growth opportunities, cash flow volatility, stock returns, capital expenditures, leverage, dividends, R&D, acquisitions, and industry volatility.

We show the difference in the coefficients on idiosyncratic risk across quintiles 1 through 5, and the Chow-test p-value for the null hypothesis show that the coefficients are equal. Standard errors are clustered at the firm level. The sample period is 1992 to 2014. We include firm and time fixed effects for all specifications.

Table 3.10 reports the estimations related to financial constraints. The degree of financial constraints has no impact on our findings. The coefficient on idiosyncratic risk is not significantly showing that the relationship between cash holdings and idiosyncratic risk is not due to the likelihood of firm constraints.

Table 3.10: Cash holdings, level of insider ownership and degree of financial constraints.

Level of Insider Ownership Financial constraints proxies	Low		2		3		4		High	
	WW	Size	WW	Size	WW	Size	WW	Size	WW	Size
Idiosyncratic Risk _{t-1}	0.0172 (0.74)	0.0183 (0.82)	0.0157 (0.67)	0.0197 (0.87)	0.0369 (1.53)	0.0194 (0.92)	0.0056 (0.28)	0.0033 (0.18)	-0.0085 (-0.42)	-0.0003 (-0.01)
Net Cash Holdings _{t-1}	0.5606*** (11.68)	0.5330*** (10.48)	0.3112*** (4.46)	0.3456*** (5.24)	0.3363*** (5.48)	0.2860*** (3.32)	0.3369*** (4.71)	0.3396*** (5.14)	0.4553*** (6.87)	0.4481*** (6.66)
Leverage	0.0474 (1.10)	0.0281 (0.73)	0.0581 (1.50)	0.0700* (1.71)	0.0770** (2.02)	0.0069 (0.17)	-0.0036 (-0.07)	0.0780 (1.53)	0.0732* (1.77)	0.0389 (0.91)
Market-to-book	0.2666*** (4.56)	0.2526*** (4.67)	0.2419*** (4.88)	0.2605*** (5.77)	0.3020*** (4.93)	0.2462*** (4.51)	0.2247*** (3.83)	0.2186*** (3.86)	0.2127*** (4.47)	0.2248*** (4.99)
Cashflow	0.0155 (0.22)	0.0592 (0.94)	0.0058 (0.08)	0.0339 (0.38)	-0.0570 (-0.63)	-0.0300 (-0.36)	0.1043 (1.33)	0.1018 (1.37)	0.1180* (1.68)	0.0741 (1.10)
Acquisitions	-0.0740*** (-5.88)	-0.0874*** (-6.48)	-0.0631*** (-5.52)	-0.0514*** (-4.67)	-0.0527*** (-4.54)	-0.0561*** (-4.91)	-0.0499*** (-4.57)	-0.0475*** (-4.17)	-0.0606*** (-5.79)	-0.0593*** (-5.74)
Firm Size	-0.2137 (-1.55)	0.0115 (0.07)	0.0789 (0.61)	0.1073 (0.84)	0.0009 (0.01)	-0.0873 (-0.88)	0.1395 (1.64)	0.2342*** (3.04)	0.1417 (1.58)	0.1378 (1.56)
R&D	0.0606 (0.89)	0.0421 (0.62)	0.0653 (1.15)	-0.0074 (-0.12)	-0.0808 (-0.80)	-0.1369 (-1.41)	0.0496 (0.55)	0.0486 (0.51)	0.1710** (1.98)	0.1184 (1.53)
Net Working Capital	-0.2497*** (-3.57)	-0.2504*** (-3.56)	-0.1753*** (-3.44)	-0.1766*** (-3.23)	-0.0733 (-1.43)	-0.1692*** (-2.86)	-0.2416*** (-3.80)	-0.1938*** (-2.68)	-0.1468** (-2.11)	-0.1937*** (-2.77)
Capital Expenditures	-0.0317 (-1.03)	-0.0290 (-1.01)	-0.0120 (-0.35)	0.0063 (0.19)	-0.0183 (-0.36)	-0.0583 (-1.20)	-0.0483 (-1.48)	-0.0321 (-1.03)	-0.0487** (-2.25)	-0.0469** (-2.17)
Industry Volatility	0.0082 (0.28)	-0.0207 (-0.40)	-0.0103 (-0.44)	-0.0082 (-0.30)	-0.0165 (-0.61)	-0.0328 (-1.06)	-0.0798* (-1.77)	-0.0335 (-1.32)	-0.0517 (-1.16)	-0.0270 (-0.66)
Cashflow Volatility	-0.0133 (-0.11)	0.0212 (0.21)	-0.0322 (-0.31)	-0.0503 (-0.55)	-0.0005 (-0.00)	-0.0895 (-0.69)	0.0404 (0.47)	0.0286 (0.39)	0.1214 (0.89)	0.1802 (1.31)
Dividend	0.1178 (1.13)	0.1352 (1.24)	-0.0160 (-0.43)	0.0358 (0.71)	0.0860 (1.48)	0.0445 (1.38)	-0.0789 (-1.44)	0.0218 (0.54)	-0.0333 (-0.80)	-0.0599 (-1.47)
Stock Return	-0.0135 (-0.64)	-0.0173 (-0.85)	-0.0077 (-0.42)	-0.0108 (-0.65)	0.0025 (0.12)	-0.0205 (-1.17)	-0.0036 (-0.21)	-0.0036 (-0.24)	-0.0165 (-0.96)	-0.0163 (-0.96)
Idios Risk _{LowInsOwn_{t-1}} - Idios Risk _{HighInsOwn_{t-1}}	0.90 (0.3416)	1.33 (0.2484)								
R ²	0.906 F _{3,T}	0.917 F _{3,T}	0.913 F _{3,T}	0.908 F _{3,T}	0.896 F _{3,T}	0.906 F _{3,T}	0.901 F _{3,T}	0.891 F _{3,T}	0.899 F _{3,T}	0.891 F _{3,T}
Fixed Effects										

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent Variable: Net Cash Holdings

3.3.5 Robustness checks

This section subjects our estimates to robustness checks to address potential concerns on the model specification and other estimation issues.

First, we verify the results so far by replacing the dependent variable – net cash holdings – by alternative measures for cash holdings. Next, we test our specifications using alternative measures for idiosyncratic risk on the alternative cash holdings measure.

To confirm our first and second assumptions, we use the cash-to-total assets ratio, as in C. Kim and Bettis (2014) and Qiu and Wan (2014). Then, we employ cash and marketable securities to sales as a second alternative following Bates et al. (2009), Harford et al. (2008), and Y. Huang et al. (2013). Finally, as a third alternative, we use changes in cash defined as the difference between the ratio of cash holdings and marketable securities to total assets in the previous year and the current year, as in Almeida et al. (2004).

Table 3.11 reports the estimations on alternative cash holding measures. Models 1 and 2 still present the same pattern: idiosyncratic risk positively affect corporate cash holdings at the 5% significance level, holding for firm, time, and industry effects. However, the coefficient on idiosyncratic risk in Model 3 is negative and not significant.

We also examine the robustness of our results on alternative definitions of the volatility measure on different proxies for cash holdings. We consider the volatility of the residuals from a market model regression of firm returns on the market portfolio, σ_t^{mkt} , and the volatility of the residuals from a regression of firm returns on Fama and French (1993)'s three-factor model, σ_t^{rff3} . All measures are highly correlated and reach similar results on cash holdings, as shown in Table 3.12.

Table 3.11: Alternative cash holding measures: robustness check.

Dependent Variable	(1) Cash	(2) Cash/Sales	(3) Cash _t -Cash _{t-1}	(4) Cash	(5) Cash/Sales	(6) Cash _t -Cash _{t-1}
Idiosyn. Risk. _{t-1}	0.0148*** (2.84)	0.0212*** (4.12)	-0.0062 (-0.43)			
Insider Own. _{t-1}				-0.0142* (-1.69)	-0.0136* (-1.91)	-0.0324 (-1.09)
Cash. _{t-1}	0.4906*** (49.78)			0.5091*** (25.15)		
Cash/Sales. _{t-1}		0.4308*** (28.52)			0.4842*** (14.23)	
Cash. _t - Cash _{t-1}			0.0440*** (4.52)			0.0035 (0.14)
System. Vol. _{t-1}	-0.0071** (-2.15)	-0.0057* (-1.81)	-0.0027 (-0.30)			
Leverage.	-0.0123* (-1.87)	-0.0029 (-0.41)	-0.0344** (-2.32)	0.0443*** (2.93)	0.0401*** (2.99)	0.0339 (0.74)
Mtb.	0.2078*** (23.91)	0.1429*** (15.75)	0.2159*** (11.85)	0.2084*** (12.29)	0.1581*** (9.66)	0.3124*** (7.68)
Cash flow.	0.0492*** (4.82)	-0.0838*** (-7.02)	0.0649*** (2.73)	0.0730*** (2.66)	-0.1089*** (-4.26)	-0.0068 (-0.08)
Acquis.	-0.0754*** (-25.86)	-0.0290*** (-10.80)	-0.0422*** (-5.84)	-0.0802*** (-14.37)	-0.0386*** (-8.35)	-0.0430*** (-2.74)
Firm Size.	0.0180 (1.20)	0.2004*** (12.38)	-0.0615* (-1.73)	-0.0455 (-1.10)	0.1661*** (4.45)	0.0795 (0.68)
R&D.	0.0471*** (3.50)	0.1269*** (7.73)	0.0608* (1.93)	0.0136 (0.45)	0.0848*** (2.78)	0.0084 (0.09)
NWC.	-0.1000*** (-11.20)	-0.0441*** (-5.03)	-0.0983*** (-5.02)	-0.1402*** (-6.62)	-0.0842*** (-3.99)	-0.1503*** (-2.66)
Capex.	-0.0187*** (-3.36)	-0.0038 (-0.61)	0.0215* (1.70)	-0.0406*** (-3.21)	-0.0213 (-1.45)	-0.0145 (-0.40)
Ind. Vol.	0.0009 (0.13)	-0.0081 (-1.03)	-0.0467** (-2.13)	-0.0021 (-0.14)	-0.0129 (-0.94)	-0.0492 (-0.93)
CFlow Vol.	0.0314** (2.26)	0.0236 (1.57)	0.0805*** (2.67)	0.0136 (0.46)	-0.0003 (-0.01)	-0.0779 (-0.83)
Div.	-0.0156 (-1.50)	-0.0017 (-0.17)	-0.0100 (-0.35)	0.0153 (0.65)	0.0135 (0.70)	0.1027 (1.31)
Stock Return.	-0.0040 (-1.16)	0.0074** (2.02)	-0.0072 (-0.80)			
WW Index.	0.0185*** (3.25)	0.0542*** (7.69)	-0.0135 (-0.86)	0.0098 (0.75)	0.0185 (1.29)	-0.0393 (-0.79)
Cash Comp. _{t-1}				0.0093 (0.97)	0.0058 (0.63)	-0.0580* (-1.78)
Inst. Own. _{t-1}				-0.0218*** (-3.09)	-0.0159** (-2.54)	-0.0473** (-2.04)
Fixed effects	F,T&I	F,T&I	F,T&I	F,T&I	F,T&I	F,T&I
Observations	45508	45508	29416	8135	8135	4960
R ²	0.875	0.877	0.490	0.904	0.897	0.515

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.12: Alternative idiosyncratic risk measures on different cash holding proxies

Dependent Variable:	Net Cash 1	Cash 2	Cash/Sales 3	Cash _t - Cash _{t-1} 4	Net Cash 5	Cash 6	Cash/Sales 7	Cash _t - Cash _{t-1} 8
Idiosyncratic Volatility CAPM _{t-1} .	0.0089* (1.77)	0.0128** (2.69)	0.0181** (3.88)	-0.0137 (-1.05)	0.0118*** (3.38)	0.0105*** (3.07)	0.0121*** (3.70)	-0.0039 (-0.43)
Syst Vol CAPM _{t-1} .	-0.0073** (-2.34)	-0.0067** (-2.21)	-0.0055** (-2.01)	-0.0019 (-0.24)	-0.0004 (-0.11)	0.0053 (1.49)	0.0065* (1.77)	-0.0032 (-0.36)
Idiosyncratic Volatility FF3 _{t-1} .	0.4319*** (34.85)	0.4902*** (55.49)	0.4374*** (32.47)	0.0415*** (4.82)	0.4157*** (38.77)	0.4682*** (61.19)	0.4038*** (33.61)	0.0383*** (5.33)
Cash holdings _{t-1} .								-0.0537*** (-4.75)
Cash Holdings/Sales _{t-1} .								0.2252*** (16.76)
Cash _t - Cash _{t-1} .								0.0356** (2.09)
Leverage.	-0.0035 (-0.53)	-0.0120** (-1.97)	-0.0032 (-0.50)	-0.0352*** (-2.61)	-0.0244*** (-4.23)	-0.0311*** (-5.74)	-0.0161*** (-2.79)	-0.0396*** (-7.43)
Market-to-Book.	0.2465*** (24.81)	0.2095*** (27.04)	0.1438*** (17.61)	0.2211*** (13.73)	0.2438*** (28.22)	0.2156*** (31.26)	0.1432*** (19.70)	0.2252*** (16.76)
Cashflow.	-0.0128 (-1.13)	0.0517*** (5.50)	-0.0890** (-8.00)	0.0642*** (2.99)	-0.0139 (-1.46)	0.0449*** (5.69)	-0.0813*** (-9.03)	0.0356** (2.09)
Acquisitions.	-0.0595*** (-21.97)	-0.0760*** (-28.25)	-0.0293** (-11.77)	-0.0400*** (-6.14)	-0.0599*** (-25.21)	-0.0742*** (-31.74)	-0.0291*** (-13.54)	-0.0396*** (-7.43)
Firm Size.	0.0562*** (3.81)	0.0166 (1.23)	0.1970*** (13.64)	-0.0696** (-2.25)	0.0884*** (6.62)	0.0454*** (3.66)	0.2205*** (16.17)	-0.0391 (-1.47)
R&D.	0.0293** (2.09)	0.0454*** (3.78)	0.1238*** (8.48)	0.0437 (1.61)	0.0418*** (3.45)	0.0535*** (5.11)	0.1347*** (10.03)	0.0723*** (3.15)
Net Working Capital.	-0.1062*** (-11.64)	-0.1001*** (-12.46)	-0.0419*** (-5.36)	-0.1061*** (-6.04)	-0.0975*** (-12.77)	-0.0909*** (-13.25)	-0.0432*** (-6.43)	-0.0761*** (-5.37)
Capital Expenditures.	-0.0037 (-0.66)	-0.0226*** (-4.42)	-0.0083 (-1.46)	0.0254** (2.26)	-0.0011 (-0.22)	-0.0194*** (-4.38)	-0.0080 (-1.59)	0.0257*** (2.76)
Industry Volatility.	-0.0109* (-1.67)	-0.0038 (-0.61)	-0.0103 (-1.34)	-0.0514** (-2.56)	-0.0092 (-1.54)	-0.0005 (-0.09)	-0.0117* (-1.76)	-0.0416** (-2.57)
Cashflow Volatility.	0.0432*** (2.89)	0.0320** (2.51)	0.0282** (2.06)	0.0666** (2.46)	0.0493*** (3.96)	0.0406*** (3.76)	0.0277** (2.38)	0.0852*** (3.92)
Dividend.	-0.0114 (-1.19)	-0.0138 (-1.46)	-0.0068 (-0.76)	-0.0156 (-0.60)	-0.0019 (-0.22)	-0.0017 (-0.20)	0.0084 (1.01)	0.0099 (0.46)
Stock Return.	-0.0086** (-2.52)	-0.0058 (-1.81)	0.0068** (2.03)	-0.0051 (-0.62)	-0.0072*** (-2.69)	-0.0042* (-1.65)	0.0064** (2.37)	-0.0063 (-1.03)
WW Index.	0.0208*** (3.33)	0.0218*** (4.07)	0.0527*** (8.37)	-0.0162 (-1.13)	0.0250*** (5.30)	0.0253*** (5.30)	0.0607*** (10.12)	-0.0110 (-0.93)
Observations	44347	44347	44347	28557	61950	61950	61950	40236
Fixed effects	F, T & I	F, T & I	F, T & I	F, T & I	F, T & I	F, T & I	F, T & I	F, T & I

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.4 Concluding remarks

This study analyses the relationship among cash holdings, idiosyncratic risk, and insider ownership. Our primary goal is to investigate an unexplored research problem: whether and how the level of insider ownership influences the relation between corporate cash holdings and idiosyncratic risk.

First, exploring the relationship between cash holdings and idiosyncratic risk, we find that idiosyncratic risk, obtained from stock returns volatility, has a positive influence on corporate cash holdings. We also conduct a robustness check confirming this finding using alternative measures of cash holdings and idiosyncratic volatility. We identify strong evidence that as idiosyncratic risk increases, firms tend to hold cash as a precautionary motive.

Second, verifying that insider ownership influences corporate cash holdings, we find that managerial ownership negatively affects corporate cash holdings. However, following Harford et al. (2008) and Ozkan and Ozkan (2004), we find further evidence that cash holdings vary with the level of insider ownership. Our findings suggest that the influence of ownership on cash holding decisions does not have a constant effect, supporting the perspective of a non-linear relationship between ownership and cash holding decisions.

Third, examining whether the positive relationship between cash holdings and idiosyncratic risk is stronger when managers own a larger fraction of the firm, we identify that firms with a higher level of insider ownership hold less cash than firms with a lower level of managerial shareholdings, even under idiosyncratic risk effect. Our findings support the agency perspective that employing equity compensation schemes might alleviate agency problems inside firms and align managers and shareholder interests.

While our models offer an explanation as to whether idiosyncratic risk influences firms to save or not to save more cash and whether insider ownership is negatively or positively related to corporate cash holding behaviour, the results for our third hypothesis require further investigation. We recognise this result might be driven by endogeneity problems inherent in firm characteristics associated with insider ownership, idiosyncratic risk, and cash holdings that we consider in the same model. Even using control variables and fixed effects because we do not have exogenous, reliable variables to instrument these features, our specification could not completely reflect the true specification that involves idiosyncratic risk, insider ownership, and corporate cash holdings. We believe that as the literature improves the understanding of the relationship among these subjects and the databases collect more accurate data, new insights will arise, and new findings can be reached in the future.

4 Two sides of the same coin: corporate liquidity and hedging behavior on expected and unexpected shocks

A shock is any expected or unexpected change into a given system that belongs to any ongoing context (T. W. Lee & Mitchell, 1994). While expected shock can be known in advance, unexpected shock may occur but it cannot be foreseen (Norman, 2007).

Behavioral studies have coined interesting underpinnings to understand expected and unexpected shocks at individual level. T. W. Lee and Mitchell (1994) employ a turnover organizational model to show that a response of an individual on expected shocks is to link his/her prior trajectory and knowledge on organization environment to decide which decision has to be made. Then, when individual knows the potential effects of the expected event, the individual tends to react with minimal deliberation, accessing a specific decision frame that matches the expected shock with an appropriate response recalled from memory (T. W. Lee & Mitchell, 1994).

For instance, when a person move out to a new country, a expected shock related to the new culture might occur. If the individual previously learns the native language and knows the habits and rules of the new country, it is possible to quickly adjust and integrate him/her to the new culture (David, 1971). The key of expected shocks is that the individual can plan the next step before engaging into the shock per se (T. W. Lee & Mitchell, 1994).

Unexpected shocks are more complex. They refer to unpredictable events that may always occur but cannot be previously known (Norman, 2007). However, after facing unexpected events, subjects are likely to overwhelm their reactions increasing the perceived likelihood of a given event with more future precautionary than should do if they do not already experience it (Fischhoff, 1975).

For example, after experiencing a system crash and lose all information from the computer memory, an individual tends to buy several devices to backup his/her personal files and avoid future losses. In this case, although computer industry advises via manual the importance of making data backups to avoid losses from a system crash, the person is not aware until the event occurs (Norman, 2007).

Although identifying issues related to expected and unexpected events should be relevant at individual level, investigating them at organization dimension might offer appropriate answers to how firms shape corporate decisions when expected and unexpected shocks occur. Moreover, whether there are systematic differences in corporate paths prompted by expected shocks and unexpected shocks.

Finance literature has attempt to discuss corporate behaviour on expected and unexpected events. For instance, during the 2008 financial crisis, firms rely on cash savings and credit lines to enhance their investment (Campello et al., 2011). Firms tend to boost their ratios of cash reserves relative to property, plant and machine when financial distortions are likely to bind in the future (Almeida, Campello, & Weisbach, 2011).

The fallout from the September 11th attacks on the World Trade Center and the Pentagon are considered as unexpected shocks in Carter and Simkins (2004). According to the authors, several financial consequences was produced on US commercial airlines. First, consumers immediately gave up to travel in and out the country followed the events.

It produced a sudden decline in air travel and an increase in the costs for airline company. Second, market negatively reacted after the unexpected shocks. All publicly traded airlines shift their risk evaluation and airlines with lower cash holdings levels show a significant negative abnormal return.

Likewise, firms exposed to expected or unexpected events such as financial risks might use financial hedging to increase the availability of internal funds to finance investment opportunities (Carter et al., 2006; Froot et al., 1993) and/or to avoid price fluctuations from exogenous shocks that could alter the risk of the firm's current profits (DeMarzo & Duffie, 1995).

If unexpected shocks increase the likelihood of bankruptcy via cash flow variability, hedging can be also employed to reduce expected shortage in cash flow and decrease the probability of default (Smith & Stulz, 1985). As a result, by decreasing expected bankruptcy costs and the loss of growth options, hedging reduces the incentives for managers to underinvest.

Altogether when external financing is costly (Davydova & Sokolov, 2014; Denis & Sibilkov, 2010; Almeida et al., 2004), income uncertainty is higher (Bao et al., 2012; Riddick & Whited, 2009; Han & Qiu, 2007), price volatility is imminent (DeMarzo & Duffie, 1995), and/or costs of financial distress is present (Harford et al., 2014; Acharya et al., 2014; Arnold, 2014), firms will be highly motivated to protect corporate value against financial risks. In this regard, managing these risks might be an important argument for hedging via derivatives and holding liquid assets, respectively.

Hedging via derivatives might alleviate the effect of expected and unexpected shocks on corporate behaviour. However, under costly corporate hedging, firms might decide to hedge less (or not hedge at all) if the marginal benefit of hedging is smaller than the marginal cost of hedging (Bolton et al., 2011).

Equivalently, cash holdings enable firms to reduce cashflow volatility or to attempt valuable investment opportunities that might otherwise forego due to the costs of accessing external capital markets (Myers, 1984). Nonetheless, holding cash is not costless, at least, due to the presence of transaction costs, such as taxes and flotation fees, imputing a value of reserving cash (Faulkender & Wang, 2006). In addition, when holding cash produce less return than the required cost of capital, it also implies a high opportunity cost of lost other better investments by firms (Dittmar et al., 2003).

Firms then face a trade-off regarding their management risk tools. Both instruments, cash holdings and financial derivatives, reduce the variability in cash flows generate by assets in place, decrease the external dependence of external funds and minimise costs of agency conflicts and financial distress. Therefore, what is the effect of expected and unexpected shocks on corporate cash holding arrangements when financial derivatives are used? Might there be any differences in cash decisions when firms are exposed to expected and unexpected shocks? Do corporate cash holdings change when firms use financial derivatives?

Although Gamba and Triantis (2014) and Bolton et al. (2011) have recently explored the theoretical integration between cash holdings and financial derivatives as risk management instruments, they do not investigate the empirical implications on the relationship between both when firms face expected and unexpected shocks.

To analyse how firms manage their corporate liquidity and hedging policies on expected and unexpected shocks we have to identify a driving set where the conditions and exogenous source of shocks were similar but independent from each other. Further,

the external driver also has to be related to corporate financial risk. Finally, to draw inference about the causal effects of binary variables (in our case, expected and unexpected shocks) on corporate behaviour with lower concern of endogeneity issues, these binary variables have to be associated with external variations in corporate environment (Roberts & Whited, 2013).

Our identification is related to two exogenous shocks in corn market, one expected and other unexpected. These quasi-experiments produced price volatility of corn commodity, a type of financial risk that corn-dependent firm are subject to. We then use these two events as quasi-experiments as both increase corn price and its volatility, offering a random and exogenous variation to test our study hypothesis.

The first event that impacts corn prices was associated with the implementation of The Energy Policy Act of 2005 in the United States in August, 2005. The law compelled that American gasoline sold had to contain an increasing amount of renewable fuel standard (RFS), such as ethanol or biodiesel, starting with 4.0 billion gallons of renewables in 2006 rising to the level of 7.5 billion gallons in 2012 (Bamberger & Behrens, 2005).

The increased use of corn in energy production created a greater linkage between the energy markets and corn market due to demand-side phenomenon (Du & McPhail, 2012). In turn, the growing corn demand of ethanol producers increased corn price and caused an extreme corn price volatility in the corn market from mid-2005 to mid-2008 (Serra et al., 2010).

Higher corn prices lead to food price inflation, raising feed and input costs for livestock producers, food processors and corn-dependent firms. Furthermore, corn price volatility increased the risk associated with grain merchandising and dramatically increased the cost of hedging at commodity futures exchanges (Serra et al., 2010).

Although the specification of a minimum amount of ethanol from corn was required only in 2006 and a record 2004/05 corn crop led to an increase in beginning 2005/06 corn stocks (Baker & Allen, 2006), the price corn reaction was noticed in the mid-2005, when corn price shifts from U\$ 2.00 to U\$ 3.04 per bushel (USDA, 2015). The anecdotal evidence suggests that the implementation of The Energy Policy Act of 2005 in August influenced corn price volatility.

Nonetheless, the law was widely debated, at least, since 2003 until the final version in June, 2005 by the US House and Senate (Bamberger & Behrens, 2005). Following the intuition of the demand-supply market law, it was previously expected by the market that as the corn demand to ethanol production would increase, the corn price would be higher. As there was a probability that corn price volatility would occur in the future we then ascribe this first event as an expected exogenous shock.

The second event that also impacts corn price volatility is related to a significant and unexpected corn shortfall that happened in the United States in July, 2012 due to a severe drought. This unexpected climate change sharply decreases the corn supply and increases corn prices in the American market. The USDA (2015) describes the drought effect on crops in 2012 as "the most severe and extensive drought in at least 25 years that seriously affected U.S. agriculture, with impacts on the crop and livestock sectors and with the potential to affect food prices at the retail level" (page 2).

The 2012 corn shortfall caused a loss of 25% of expected corn production and reduced the corn yields by 17% from the previous year in the US corn market. It decreased corn supply severely limiting corn exports and increasing corn prices (USDA, 2015). As this second event influenced the upward movement of corn prices in the market in a significant

and totally unexpected way, we consider it as an unexpected exogenous shock .

We then use difference-in-difference approach around these two exogenous variations to identify whether and how the increase of a financial risk, represented by the corn price and its volatility, impacts corporate cash holdings and hedging behaviour on US corn-dependent firms compared to corn independent ones.

Given that cash holdings might be used to manage financial risk, we investigate whether and how firms react after experiencing unexpected shocks regarding their cash management and hedging policy. We then explore if constrained firms present different cash decisions compared to their unconstrained peers. We also examine whether and how financial hedging change firm's decision to hold cash between treatment and control groups. Finally, we investigate if there are differences in corporate risk management and cash holdings between corn-dependent firms that used financial derivatives and corn-dependent firms that do not used derivative.

We choose these quasi-experiments for several reasons. First, corn is considered the most important grain for the American economy. Babcock and Fabiosa (2011) affirm that there is a direct link between higher corn prices and food and fuel costs in the United States. It implies that higher corn prices translate directly into higher food, livestock feed and fuel costs, which eventually lead to higher prices for meat, eggs, dairy products, ethanol, gasoline, biodiesel, and transportation.

Second, both events offer natural, random and exogenous variations to test our study hypothesis and to control endogeneity problems. Third, we do not have concurrent events during this period that could affect our estimates. For instance, if an economic recession has materialized during this period we could not affirm that our results are due to these shocks (Hart, 2013). Fourth, both scenarios are useful settings for studying the relationship between exogenous shocks and corporate risk management.

The framework of financial shocks as quasi-experiment was already used for finance studies. Campello et al. (2011) investigated the interaction between internal and external sources of liquidity on corporate decision behavior using the financial 2008–2009 crisis. Francis et al. (2014) test if banking deregulation influenced the corporate cash policies in US firms employing the banking deregulations at state level from the 1970s to the Riegle–Neal Act of 1994. Kahle and Stulz (2013) use Lehman Brother's bankruptcy to assess if changes in firm investment and financing policies during the crisis was due to the credit supply shock instead the demand shock.

Finance studies have recently employed exogenous shocks linking weather events to productivity and risk management in farms (Cornaggia, 2013; Butler & Cornaggia, 2011) and energy firms (Perez-Gonzalez & Yun, 2013). However, no prior study investigated corporate financial behavior on the context of expected and unexpected shocks via corn price volatility.

Our dataset covers the 2004–2006 period and the 2011–2013 period corresponding time around the expected shock related to the 2005 energy act and the unexpected shock of the 2012 corn shortfall, respectively. Our sample is composed by firms that rely on corn and its subproducts to produce their outputs (henceforth, corn-dependent firms). To build the sample, we cross information from USDA (2015) and Center for Crops Utilization Research (2012), selecting all firms from Compustat database that pertain to the SIC codes related to this previous analysis. To control potential counterfactual outcomes, we build a matched control group (henceforth, corn independent firms) from the rest of the sample that do not belong to the corn-dependent firms.

The major and new contribution of our paper to the finance literature is to present the impact of expected and unexpected shocks related to a financial risk on corporate cash holdings and hedging policies. We also bridge an initial linkage between the behavioral literature and corporate finance to study expected and unexpected events inside corporations. We also contribute with risk management literature by showing the relationship between cash holdings and derivatives as strategic tools that firms use to manage their financial risks. Moreover, we present a new set to investigate how firms make their liquidity and hedging decisions when facing the same financial risk related two different types of shocks, one expected and another unexpected.

The paper is organized as follows. Section 2 presents some background on expected and unexpected shocks and the paper identification strategy. Section 3 describes the theoretical background and hypothesis development. Section 4 provides the empirical design of the paper. Section 5 reports the findings. Section 6 offers some concluding remarks.

4.1 Expected and unexpected shocks

A shock is something that suddenly disturbs any ongoing context (T. W. Lee & Mitchell, 1994). A shock can be expected or unexpected. Expected shock can be previously known and prepared in advance, whereas unexpected shock may occur but it cannot be predictable (Norman, 2007).

Behavioural studies have grounded interesting insights on expected and unexpected shocks at individual level. Under behavioural perspective, the basic idea is to study how individuals perceive and react to these expected and unexpected events for instance, to better know the desired effect of a given policy related to them (Slovic et al., 1975).

The psychological mechanism of employee turnover is used to explain the effects of expected shocks on individuals in T. W. Lee and Mitchell (1994). When an expected shock occur in the organisational environment such as an acquisition, the employee tends to access previous experience, decisions and learned responses from the memory to construct a decision frame for the expected shock (T. W. Lee & Mitchell, 1994). If the expected shock is previously known by the employee, it could integrate past and current efforts and activities to support the staying and leaving decisions related to his/her job. However, if the shock could not be associated with any known trajectory or personal goals, the employee is likely to quit the company (T. W. Lee & Mitchell, 1994).

Unexpected shocks are considered low-probability high-consequence events as they have low probability to occur with extremely great consequences (Slovic et al., 1975). After low-probability high-consequence events, individuals are likely to behave with precautionary and to overwhelm decisions related to the potential effects of unexpected shocks (Fischhoff, 1975).

Although identifying issues related to expected and unexpected events should be relevant at individual level, investigating them at organization dimension might offer appropriate answers to what the corporate decisions should be when expected and unexpected shocks occur.

In corporate context, Sutcliffe and Weick (2001) argue that organizations tend to modify existing activities or even so innovate completely their corporate routines when unexpected breaks through. Hendricks and Singhal (2005) affirm that unexpected supply chain disruptions increase equity risk, financial leverage and asset risk impacting directly

on firm's cost of capital.

Lamont (1997) show that the adverse cash flow shock of 1986 in the oil sector increases the cost of finance for oil-dependent firms and decreases the investments on non oil investments by oil companies, suggesting a dependence of non-oil-segments to internal capital markets from oil-segments.

Carter and Simkins (2004) study the market reactions to the catastrophic events of the September 11th attacks in the United States and the Air Transportation Safety and System Stabilization Act implemented after the events. The authors identify abnormal returns in airline stocks after the events. The findings suggest that the market ascribed higher concern on the increased likelihood of financial distress in the wake of the attacks related to airlines with lower level of cash reserves.

Campello et al. (2011) report that firms depend upon cash savings and credit lines to enhance their investment during the 2008 financial crisis. Investigating the interaction between internal and external sources of liquidity on corporate decisions over the financial crisis, Campello et al. (2011) find that firms with higher cash holdings drew less funds from credit lines than firms with lower cash retentions, even though the former firms could access credit lines at a lower cost.

Using weather shocks to corn productivity in US corn farms from 1959 to 2010, Bergman, Iyer, and Thakor (2015) predict that farms that faced negative weather productivity shocks in the past exhibit lower current corn yields, lower land values and higher costs of external financing. Nonetheless, after a positive weather shock, farms increase their investments, borrow less and use more internal funds to finance new investments.

As one could see, the impact of expected and unexpected shocks on corporate policies is an underexplored issue in finance field. Moreover, to the best of our knowledge, there is no prior study that examined whether there are systematic differences in corporate paths prompted by expected shocks and unexpected shocks that lead to the same financial risk.

To examine whether firms have changed their cash and hedging policies due to the presence of external shocks, we identify two exogenous events related to the corn market, one expected and other unexpected. These shocks produced price volatility of corn commodity, a type of financial risk that corn-dependent firm are subject to. We describe each event in the next section.

4.1.1 The energy policy act of 2005: The expected shock

The first event that affected corn price volatility was associated with the implementation of The Energy Policy Act of 2005 in the United States in August, 2005. The US Energy Policy Act of 2005 introduced the Renewable Fuel Standard (RFS) program in an effort to reduce greenhouse gas emissions and expand the American renewable fuels sector while reducing reliance on imported oil (Schnepf & Yacobucci, 2013).

The initial RFS required that a minimum of 4 billion gallons of biofuels, such as ethanol and biodiesel, had to be used in 2006, rising to 7.5 billion gallons by 2012. Two years later, the Energy Independence and Security Act of 2007 expanded the biofuel mandate volumes and extended the date through 2022. In this expanded law, it was established that an annual use of 9 billion gallons of biofuels had to be used in 2008, rising to 36 billion gallons by 2022, with at least 16 billion gallons from cellulosic biofuels, and a cap of 15 billion gallons for corn-starch ethanol (Schnepf & Yacobucci, 2013).

The expectation from American Congress was the RFS program might play an important role in the development of the U.S. biofuels sector, but with considerable uncertainty regarding potential spillover effects in other markets and on other important policy goals (Holt & Glover, 2006). From 2006 to 2011, corn and ethanol prices and their returns exhibit similar dynamics to crude oil, exhibiting more co-movement between ethanol and corn since 2006 (Trujillo-Barrera et al., 2012).

Although the energy costs have historically influenced agricultural markets, Trujillo-Barrera et al. (2012) and Du and McPhail (2012) show that the growth in corn-based ethanol production as an renewable fuel source strengthened the relationships among the energy and corn markets.

Trujillo-Barrera et al. (2012) identify spillovers from the crude oil market to corn and ethanol markets and from the corn to ethanol market through the cointegrating relationship among them. According to the authors, the effect of crude oil price volatility on corn and ethanol markets has ranged from 15% to 45%, on average, resulting a 38% cost increase to users of corn options during periods of high variability in the crude oil market.

After the US Energy Policy Act of 2005, corn use to produce ethanol jumps from 1,603 million bushels in 2005 to 5,200 million bushels in 2014 (USDA, 2015). The growing corn demand of ethanol producers increased corn price and caused an extreme corn price volatility in the corn market from mid-2005 to mid-2008 (Serra et al., 2010). Higher corn prices lead to food price inflation, raise feed and input costs for livestock producers, food processors and corn-dependent firms. Furthermore, corn price volatility increased the risk associated with grain merchandising and dramatically increased the cost of hedging at commodity futures exchanges (Serra et al., 2010).

Although the specification of a minimum amount of ethanol from corn was required only in 2006 and a record 2004/05 corn crop raised corn beginning stocks in 2005/06 (Baker & Allen, 2006), the price corn reaction was noticed in the mid-2005, when corn price shifted from U\$ 2.00 to U\$ 3.04 per bushel (USDA, 2015). The anecdotal evidence then suggests that the implementation of The Energy Policy Act of 2005 in August, 2005 influenced corn price volatility, as showed in Figure 4.1.

Nonetheless, the law was widely debated, at least, since 2003 until the final version in June, 2005 by the US House and Senate (Bamberger & Behrens, 2005). In 2004, the Energy Information Administration (EIA) widely disclosed through the Annual Energy Outlook 2004 the expected discussions for 2005, describing in details the US Energy Policy Act which have started in 2003 (EIA, 2004).

Following the intuition of the demand-supply market law, it was previously expected by the market that as the corn demand to ethanol production should increase, the corn price should be higher. As there was a probability that corn price volatility should be occurred in the future we then ascribe this first event as an expected exogenous shock.

4.1.2 The 2012 corn shortfall: The unexpected shock

The second event that also impacts corn price volatility is related to a significant and unexpected corn shortfall that happened in the United States in July, 2012 due to a severe drought.

Corn shortfalls are considered a type of crop shortages driven by uncontrolled

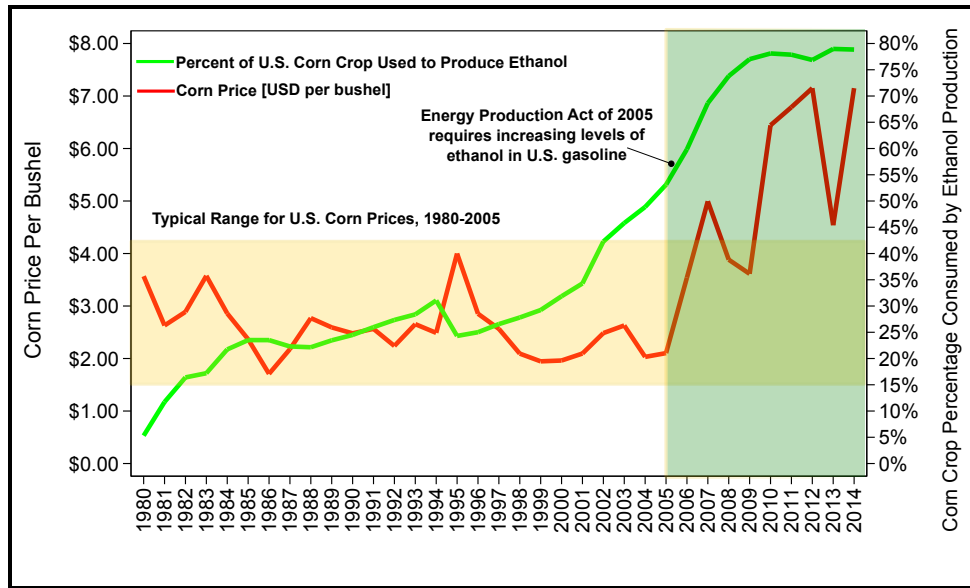


Figure 4.1: Percentage of US corn used to produce ethanol and corn prices (U\$ per bushel).

Source: Adapted from USDA agricultural prices.

events, in general due to extreme weather conditions, that generate corn production losses (Woodard et al., 2010). According to the (FAO, 2013)’s report, these shortfalls have direct and indirect economic impacts, such as reduced income for farmers and agribusiness, risk of foreclosures on bank loans to farmers and businesses, increased prices for food and timber, increased unemployment, reduced tax revenues, increased crime and insecurity, and migration from rural to urban areas.

The 2012 corn shortfall caused a loss of 25% of expected corn production and reduced the corn yields by 17% from the previous year in US market. It decreased corn supply severely limited corn exports and increased corn prices. As noticed by Westcott and Jewison (2013), reduced yields due to agricultural losses in corn fields in 2012 shifted the supply curve to the left. As a result, the new equilibrium occurred with higher prices allocating reduced quantities among corn demands.

The corn shortfall that arose in the middle of the year due to the 2012 July drought was significant and totally unexpected offering an ideal, random and exogenous variation in our research to control endogeneity problems and estimate causal effects. Likewise, there is no possibility that our dependent variable used as proxy for firm value might cause corn shortfalls. Then, corn shortfalls also do not raise concerns over reverse causality .

In contrast to other prior corn shortfalls, the consumer price index decreases after the shock. Babcock and Fabiosa (2011) affirm that the higher corn prices, the higher food and fuel costs in the United States.

However, this trend followed a different pattern during the 2012 corn shortfall in US. Figure 4.2 shows a comparative behavior over the period from 1985 to 2014 among corn market price, consumer price index for all food, corn beginning stocks, corn yield per harvested acre and corn for food, alcohol, industrial and feed uses.

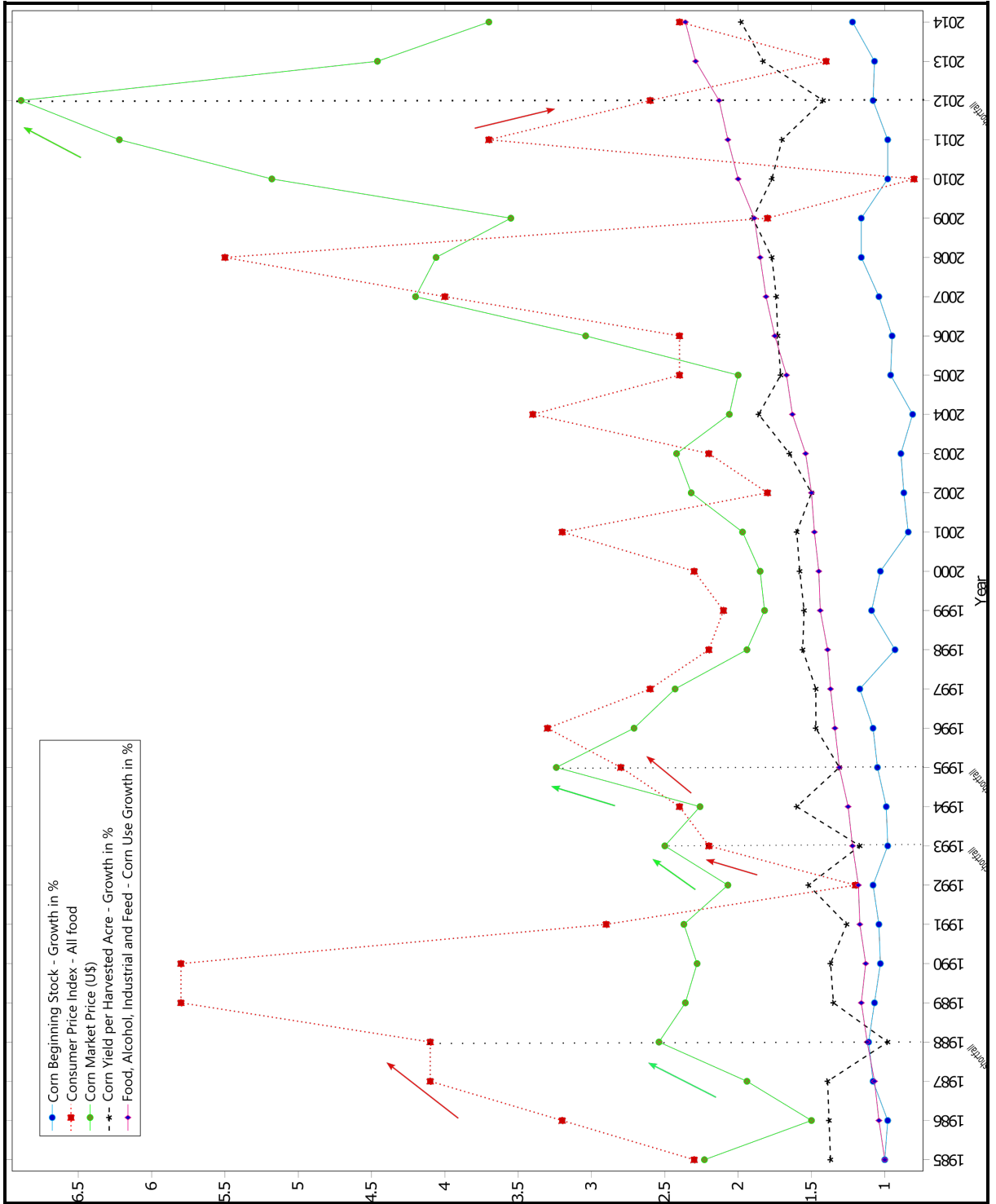


Figure 4.2: Consumer price index and corn price, yield, consume and stock behavior.
 Source: United State Department of Agriculture, USDA.

Corn shortfalls were materialized in the years of 1988, 1993, 1995 and 2012, represented by the black dashed line. All them were caused by severe climate conditions that sharply decreased the corn yield per harvested acre.

The red dotted line represents the consumer price index over the period. We indicate with red arrows the consumer price index behavior over each corn shortfall. We do the same procedure with the corn market price, flagged by the green dashed line and green arrows. As one can see, both lines follow each other during the corn shortfall of 1988, 1993 and 1995 years. Nonetheless, they took different paths in 2012.

We jointly plot either the internal corn demand related to food, alcohol, industrial and feed use of corn or the corn beginning stock to explore whether both could affect corn market price and the consumer index price. We observe a continuous increasing of internal consume of corn from 1985 to 2014. We do not notice any pattern on the corn beginning stocks that could change the corn price trend during the corn shortfalls.

In the 2012 corn shortfall, the anecdotal evidence suggests that firms might absorb the increase of corn price into production costs but they do not translate into higher final prices to consumers as they did before in the years of 1988, 1993, and 1995. We suppose these firms use financial derivative or/and cash holdings to mitigate their financial risks (e.g. price volatility, cashflow fluctuations) to provide additional operational and financial benefits that could preserve liquidity for firms undertake investment opportunities or even so amplify debt capacity. Given the totally unexpected feature of this exogenous event we then characterise this second event as an unexpected shock.

4.2 Background and hypothesis development

In this section we present theoretical and empirical studies related to cash holdings and corporate hedging that support our hypothesis development.

4.2.1 The precautionary motive for corporate cash holdings

When firms face any constraints or uncertainty related to future economic or business condition, they tend to hold cash for precautionary reasons. In this regard, firms may save cash when external financing is costly (Denis, 2011; Almeida, Campello, & Hackbarth, 2011; Almeida et al., 2004), income uncertainty is expected (Bao et al., 2012; Riddick & Whited, 2009; Han & Qiu, 2007), and hedging needs is high (Acharya et al., 2007). Precautionary cash savings also mitigate potential finance distress associated with refinancing risk (Harford et al., 2014) and liquidity risk (Acharya et al., 2014).

If markets are perfect and complete there should be no place to contracting costs, taxes, or fees and external funds can be raised costless (Fazzari et al., 1988). Under this condition, firms have to hold cash only for transactions motive (Almeida et al., 2004). However, in the presence of deadweight costs of external finance, raising external funds might be expensive increasing the firm's cost of capital (Denis, 2011). Then, if firms potentially experience costly financing in the future, they tend to shift their funds from illiquid investment (e.g. plants, properties and machines) to liquid investments (e.g. cash stocks), preserve debt capacity and bypass positive net present value projects (Almeida, Campello, & Weisbach, 2011).

Financing frictions also induce financially constrained firms maintain more cash bal-

ances than unconstrained firms. As constrained firms have less access to low-cost finance and worse balance sheet positions (Fazzari et al., 1988), they have higher cash flow sensitivity of cash than those classified as unconstrained (Almeida et al., 2004). Financially constrained firms might hold cash as a hedging instrument during poor economic conditions incorporating savings from incremental cash flows to protect its future against liquidity risk (Acharya et al., 2014, 2007; Almeida et al., 2004).

Employing a survey of CFOs from firms around the world during the 2008 financial crisis, Campello et al. (2010) show that financially constrained firms intended to cut spending in 2009 by 11% in employment, by 22% in technology, by 9% in capital expenditures and by 14% in payouts as a way to protect themselves from financial downturns. Nonetheless, financially unconstrained firms planned, on average, keep capital investment constant and cut only 2.7% their employment.

In May (2014), firms with lower levels of cash holdings and higher financial constraints have higher probability to lose more market value than cash-rich and unconstrained firms. Using Lehman Brothers' bank default as a quasi-experiment, the author identify that firms with lower cash savings and higher financial constraints under loan commitments with Lehman Brother's bank lost, on average, 3% more of their market value in the days of Lehman's default than their unconstrained peers.

Kahle and Stulz (2013) also investigate the impact of the bankruptcy of Lehman Brother's bank during the 2008 crisis on corporate capital expenditures, debt issuance, equity issuance and cash holdings of bank-dependent firms. Whereas capital expenditures, debt issuance and equity issuance sharply fall after the bankruptcy of Lehman Brother's bank, the authors find that bank-dependent firms significantly increased their cash holdings over the crisis period by 24% compared to the amount held before the crisis.

Shareholders also charge higher valuation in cash holdings as they perceive difficulty in accessing external capital markets at low costs (Faulkender & Wang, 2006). Using non-financial US firms over the 1971 to 2001 period, Faulkender and Wang (2006) show that an additional dollar of internal funds hold for constrained firms is worth more U\$ 0.27 to U\$ 0.63 a dollar than for unconstrained ones.

Gamba and Triantis (2008) theoretically design when firms do not face issuance costs, these companies might raise external capital at no cost at any time. In this scenario, there is no advantages to holding cash and the value of an additional dollar of cash balance will be close to zero. However, when the value of an additional dollar provides the same financial flexibility benefits as does the absence of external issuance costs, firms prefer to hold cash than issuing equity.

Myers (1984) argues that corporate liquidity enables firms to attempt valuable investment opportunities that might otherwise forego due to the costs of accessing external capital markets. C. S. Kim et al. (1998) show that firms facing uncertain future internal funds, costly external financing and market imperfections are likely to retain liquid assets as an optimal response to financing future investment opportunities. Then, the precautionary motive for holding cash also allows firms to undertake and finance expected value-increasing projects that should not be possible via external financing at a fair cost (J. Ang & Smedema, 2011; Denis, 2011; Gamba & Triantis, 2008; Almeida et al., 2004).

In Özgür Arslan et al. (2006), cash holdings are used by Turkish firms as hedging instruments for financially constrained firms to handle with cash flow fluctuations and fuel investment opportunities. In Denis and Sibilkov (2010) cash holdings follow a hierarchical behaviour among constrained firms. The authors identify that constrained firms with

higher cash reserves and lower cash flows have higher investment opportunities and lower costs of external financing than firms with lower cash flows and lower cash holdings.

Likewise, a key ingredient of the need of holding cash is the ex ante uncertainty (Tirole, 2006). When uncertainty arises firm's cash flows volatility tend to be positively related to corporate cash holdings Hugonnier et al. (2014). In this sense, higher variance of expected cash-flows lead to profit volatility and consequently influence more cash savings and postpone new projects by firms (Bao et al., 2012).

When uncertainty are likely to bind the future, firms with higher investment opportunities also can use their excess cash to reduce the outstanding debt (Acharya et al., 2007). By reducing debt firms amplify their debt capacity. Nevertheless, if firms have lower future investment opportunities, they prefer hold cash than pay debt to protect themselves against default risk (Acharya et al., 2007).

Opler et al. (1999) shows that firms stockpile excess cash to cover operational losses, rather than investing in new projects when they face profit shortfalls from downturns. In Palazzo (2012), cash flow volatility from sources of aggregate risk are positively correlated to corporate cash holdings.

Lins et al. (2010) also show that the cash reserves depend upon the economic conditions. If firms expected future good conditions, credit line should be choose rather than cash holdings. However, if firms are likely to experience economic downturns, they hold cash as a buffer counter to future cash flow shortfalls. In Neamtiu et al. (2014), macroeconomic ambiguity decreases firm investment and increases corporate cash holdings.

In Riddick and Whited (2009), the sensitivity of saving cash to cash are positively related to the condition of productivity shocks. Positive productivity shock increases cash flows and decreases income variability, then leads a negative propensity of saving cash from cash flows. However, on the presence of negative productivity shocks, firms are likely to increase income fluctuations and save more cash from cash flows than do external finance constraints.

Analysing the financial crises impact on corporate liquidity management in the long term in 8 East Asian countries, Song and Lee (2012) find that firms reduce their investment spending vis-a-vis an increase in their cash reserves.

J. Ang and Smedema (2011) affirm that corporate cash holdings are negatively related to the probability of a future recession. According to the authors, the negative relationship in the aggregate results are driven by financially constrained and cash poor firms. J. Ang and Smedema (2011) highlight that unconstrained and cash rich firms prepare for future recession.

Considering the precautionary motive for holding cash and the influence of the exogenous shocks, we presume the following assumptions:

H₁: Firms that face unexpected shocks hold more cash than firms do not experience those shocks.

H₂: Firms hold more cash after unexpected shocks than would do by facing expected shocks.

H₃: Financially constrained firms hold more cash than unconstrained firms after unexpected shocks.

4.2.2 Financial hedging

Corporate finance literature has offered several evidence that hedging policy affects firm's value and other financial decisions when capital markets are not frictionless (G. D. Haushalter, 2000; Froot et al., 1993; Smith & Stulz, 1985).

If on the one hand, nonfinancial firms develop capacities to handle business and associated risks, on the other side, these companies generally do not have a competitive edge in managing financial risks (Aretz et al., 2007). Then, corporate hedging might offer mechanisms that mitigate firm's exposure to these financial risks associated with, for instance, unexpected changes in interest rates, sudden movements in commodity prices, future cash flow shortfalls, or high external financing costs (Aretz et al., 2007).

Among these mechanisms, derivatives such as forwards, futures, swaps, and options are hedging instruments that can mitigate potential effects of financial risks. Thus, by using hedging instruments firms can maintain their focus on their business core and protect themselves against risks that negatively impact on corporate policies (Froot et al., 1993).

W. R. Guay (1999) shows that changes in firm risk following changes in the derivative use. After controlling core business risk on a sample of non-financial derivatives new users from Compustat and CRSP databases over the 1990 to 1994 period, the author finds that hedging through derivatives reduces firm risk.

Bartram, Brown, and Conrad (2011) also evidence that firms using financial derivatives reduce both total risk and systematic risk and have significantly higher firm value, abnormal returns, lower financial distress and larger profits during the 2000–2002 period than those firms that do not use derivatives.

Several rationales have been presented in finance literature to explain why firms hedge and how companies establish their purchase of hedging instruments.

Stulz (1984) suggests that corporate hedging alleviates the risk aversion of managers who hold a relatively large portion of their wealth in firm's stakes. If hedging reduces agency costs via lowering the risk of profitable growth opportunities and then minimising the variability in firm value, it also reflects on the risk aversion of undiversified managers reducing the likelihood of managerial engaging in decreasing-value projects (Aretz et al., 2007).

Empirically, Tufano (1996) finds that hedging via derivatives is negatively related to the number of options and positively associated with the value of stocks held by managers and directors in the gold-mining industry.

Hedging can be motivated by tax incentives. It is proposed that when firms face volatile earnings, the corporate tax structure may exhibit a convex effective tax function (Smith & Stulz, 1985; Mayers & Smith, 1982). In this perspective, firms experiencing a high probability of negative earnings are not able to fully carry forward their tax losses to subsequent periods (Froot et al., 1993). Thus, if hedging reduces tax volatility, it also positively impacts the value of the firm.

Hedging can be also an important tool for controlling underinvestment costs in firms with risky debt and low firm value (Mayers & Smith, 1987). In such cases, firms do not choose to invest even in positive net present value (NPV) projects as fixed payment obligations are high and all benefits of such investments should be captured at first place for bondholders. However, if firms stabilize their cashflows through hedging, they could ensure that positive NPV projects are accepted and as a result, firm value increases

(Mayers & Smith, 1987; Smith, 1995).

DeMarzo and Duffie (1995) supplement that hedging decreases the amount of noise and increases the informational content in the firm's profit. For instance, when firms face price fluctuations, hedging can be used to reduce this variability and consequently alter the risk of the firm's current profits. Accordingly, if manager wages are connected with the firm's performance, managers will hedge to reduce price fluctuations as a way to ensure future profits and therefore their future wages. In this sense, when managers disclose hedging positions, shareholders learn via firm's performance about managerial quality, mitigating a source of adverse selection within the firm (DeMarzo & Duffie, 1995, 1991).

Hedging can also increase debt capacity, reduce external financing costs and decrease the probability of future financial distress (Leland, 1998; Froot et al., 1993; Smith & Stulz, 1985). As greater leverage may benefit firms from tax savings, by doing hedging firms amplify their debt capacity and increase their value (Leland, 1998). Highly leveraged firms employ greater use of derivatives when facing higher expected costs of financial distress, as showed by Gay and Nam (1998). Furthermore, when firms hedge, the variance of firm value tends to decrease and thereby reduces the expected costs of financial distress (Nance et al., 1993; Smith & Stulz, 1985).

Likewise, corporate hedging behavior is influenced by greater growth opportunities. C. Geczy, Minton, and Schrand (1997) find that firms with greater investment opportunities, foreign sales, and tighter financial constraints tend to use financial derivatives. Employing logit regressions on nonfinancial firms from Fortune 500 in 1990, the authors show that the variability in cashflows or accounting earnings are likely to expose these firms to foreign-exchange risk, influencing the use of currency derivatives.

If firms have higher growth opportunities and the supply of internal funds fill up the demand on these opportunities, there is little incentives to using hedging instruments (Froot et al., 1993). Nonetheless, higher growth opportunities also induce the underinvestment problem that in turn can be mitigated by corporate hedging (Graham & Rogers, 2002).

W. Guay and Kothari (2003) present an increased use of derivatives for larger and diversified firms and for firms with greater investment opportunities. However, empirical studies in Graham and Rogers (2002) and Mian (1996) that examine the relationship between growth opportunities, measured by market-book ratio, and corporate hedging find no significant relation between them.

Froot et al. (1993) argue that the variability produced in firm's cashflows generated by assets in place when firms do not hedge must result in either oscillation in the amount of money raised externally or in the volume of investment. It could be exacerbated when a shortfall in cash met an increase in outside financing. In this regard, facing variation in internal funds and increase in costs of external financing, firms will bypass growth opportunities and decrease investment amounts. By reducing cashflow variability, hedging avoid disturbing both financing and investment plans and may increase the value of the firm (Froot et al., 1993).

Allayannis and Weston (2001) study the potential impact of the use of foreign currency derivatives on firm value in a sample US nonfinancial firms from 1990 to 1995. The authors present that firm value and corporate hedging via foreign currency derivatives are positively related. Accordingly, hedger firms have a 4.87% higher value than non hedgers even controlling for size, profitability, leverage, growth opportunities, access to external

financing, diversification, credit quality, and industry, firm and time fixed effects.

Jin and Jorion (2006) explores the impact of hedging activities on firm value in US oil and gas firms from 1998 to 2001. The authors do not find a significant effect on firm value for oil and gas producers but identify that the stock return sensitivity to commodity prices are negatively related to corporate hedging. In C. C. Geczy, Minton, and Schrand (2006), natural gas companies that use derivatives during the period from 1978 to 1995 also present lower gas price sensitivity than non-users derivative firms.

Examining US airline industry during 1992–2003 period, Carter et al. (2006) find that hedging provides airline firms with the opportunity to buy assets from distressed airlines at discounted prices during periods of high jet fuel prices and/or protects the ability to meet previously contracted purchase commitments. According to Carter et al. (2006), jet fuel hedging allows airline firms to manage a significant source of variation in their cashflows, and the amount of hedging is positively related to airline firm value.

Nevertheless, Carter et al. (2006) assign that the hedging premium on firm value reflects those airline firms with greater ability to take advantage of the benefits associated with hedging not only by increasing the amount of fuel hedged. For instance, if firm hedging policy is chosen optimally, firm enhance their ability to invest in economically profitable projects and have higher optimal valuations.

Graham and Rogers (2002) empirically test if hedging increases debt capacity and tax deduction using simultaneous equations model on a sample of 442 US firms that face ex ante currency and/or interest rate risk from 1994 to 1995 period. The authors show that high debt ratios and expected distress costs contribute to the incentive to hedge but no significant evidence is found that firms engage in hedging strategy as a response to tax function convexity.

Perez-Gonzalez and Yun (2013) estimate the effect of corporate hedging on firm value using the introduction of weather derivatives in 1997 on a sample of US utility firms as a natural experiment. Employing difference-in-differences methodology, the authors present that weather derivatives lead firms to use more debt financing, invest more, have significantly higher valuations and pursue more aggressive financing policies.

Analysing the benefits of foreign currency derivatives usage in 134 non-financial firms listed on the New Zealand Stock Exchange, Li, Visaltanachoti, and Luo (2014) find no evidence supporting the notion that the use of foreign currency derivatives can enhance a firm value in New Zealand firms.

Although corporate hedging might affect firm value and allow firms to invest more and hold less cash, firms do not engage in corporate hedging most of the time due to the hedging cost. Under costly corporate hedging, firms might decide hedge less (or not hedge at all) when the marginal benefit of hedging is smaller than the marginal cost of hedging (Bolton et al., 2011).

Alternatively, firms might substitute the using of costly hedging instruments when other strategies via financial policies are available and become more attractive. Then, instead of using off-balance-sheet hedging, firms could manage their financial risks by structuring their assets and liabilities to decrease their exposure to these volatilities (Nance et al., 1993).

Employing liabilities to manage risk, firms can use straight debt, preferred stock or convertible debt. Although these financial policies carry some advantages such as producing tax shields (straight debt), omitting a preferred dividend (preferred stock) and

reducing the sensitivity of equity value to firm–value changes (convertible debt), all three choices might lead to bankruptcy costs if an interest payment on the debt is not met (Nance et al., 1993).

Rather than using derivative instruments and liabilities, firms also could reduce financial risks by investing in more liquid assets, such as cash holdings (Froot et al., 1993).

In Tufano (1996) and Gay and Nam (1998), there are evidence supporting the role of cash as a determinant of derivative usage. Tufano (1996) identifies that corporate hedging appears to be higher for firms in gold–mining industries with smaller outside block holdings and lower cash balances, and whose senior financial managers have shorter job tenures.

Gay and Nam (1998) suggest that firms with lower cash holdings and higher growth opportunities are likely to have a greater level of sensitivity between derivative usage and growth opportunities. The authors show that firms with higher investment opportunity use derivatives more when they also have relatively lower levels of cash. C. C. Geczy et al. (2006) show that natural gas producers who use financial derivatives also employ other strategies such as storage, holding cash and engaging in diversification to reduce risk exposures.

Opler et al. (1999) examine derivative hedging among the S&P 500 companies in 1994 and found no relation between derivatives and cash holdings. Disatnik, Duchin, and Schmidt (2013) also do not find evidence between corporate derivative hedging and cash policies and only a weak relationship between hedging and credit lines, marginally significant at the 10% level. However, Disatnik et al. (2013) document an increase of one standard deviation in cash flow hedging corresponds to an increase by 11.0% in credit lines and a decrease by 9.6% in corporate cash holdings, at the 5% level.

J. Lee (2014) explores the effect of derivatives speculation on liquidity holdings, measured as the sum of cash holdings and credit lines, using the issuance of SFAS 133 in 1998 that requiring firms to disclose the fair amounts and purpose of all derivatives holdings in financial statements. The author identifies a decrease in the liquidity ratio for derivative users from 10.2% to 9.3% during the experiment period (1998–2000) but a stable level at 11.2% for derivative non–users. According to J. Lee (2014), the SFAS 133 increases the cost of derivatives speculation, decreases firm’s liquidity and risk confirming the complementary relationship between derivatives speculation and liquidity holdings.

Based the perspective that cash holdings and derivative instruments are used as substitutes to manage financial risks, we hypothesise that:

H₄: Cash holdings are negatively related to the use of derivative instruments.

Focusing on the interplay among investment, marginal q and financing frictions, Bolton et al. (2011) show under higher costs of external financing, the value of firm is sensitive to systematic and idiosyncratic risk. Then, firms may limit systematic risk exposure by engaging in dynamic hedging via derivatives and mitigate idiosyncratic risk by holding cash, by selling assets or even so by delaying cash payouts to shareholders to ensure their investment spendings. Therefore, in Bolton et al. (2011)’s model financial hedging towards derivatives and cash holdings play complementary roles in corporate risk management.

Gamba and Triantis (2014) present a dynamic model that risk management strategy involving liquidity management, derivatives hedging, and operating flexibility, in the presence of several frictions. Using a Monte Carlo simulation, the authors suggest that distress costs are a key motivation for managing risk and firms may use liquidity as the main risk management instrument regardless of derivatives contribute to eliminate the negative impacts on firm value.

Although hedging via derivatives alleviates the effect of financial constraints by enhancing the corporate liquidity when firms need at most, Mello and Parsons (2000) argue that the use of derivatives is efficient only for certain firms. According to the authors, firms have to access lowest costs of external financing and maintain cash resources to support hedging strategies that otherwise could not be achieved in an optimal way.

Following the intuition that firms experiencing financial risk from uncontrolled exogenous shocks tend to hold more cash when they do not use derivatives, we hypothesis that:

H₅: Firms that do not use derivatives have more cash holdings than their peers that use derivatives.

4.3 Empirical research design

The research questions we explore in this paper are: Might there be any differences in cash decisions when firms are exposed to expected and unexpected shocks? What is the effect of expected and unexpected shocks on corporate cash holding arrangements when financial derivatives are used? Do corporate cash holdings change when firms use financial derivatives?

Our primary aim is to investigate whether and how corporate cash holdings are related to the use of financial derivatives on expected and unexpected shocks. If we observe that firms hold cash and use financial hedge via derivatives to manage their risks, a positive relationship between derivatives use and cash holdings should be noticed. In this regard, cash holdings and derivative instruments will perform a complementary role in risk management policy. Following the literature, the complementary role between cash holdings and financial hedging are likely to be present among companies with higher investment opportunities.

However, if firms that use financial derivatives reduce the amount of cash reserves on exogenous shocks, it is expected a negative relationship between derivatives use and corporate cash holdings. Hereof, cash holdings and financial derivatives play a substitute role on corporate risk management. It should be also observed that these firms might have lower investment opportunities.

We therefore follow the model specification of Opler et al. (1999) that account to the impact of derivative usage on the level of cash holdings. To this end, we consider the difference-in-differences approach around two natural experiments that impact corn price volatilities and offer a random and exogenous variation to test our study hypothesis.

4.3.1 Identification strategy

To examine how firms manage their liquidity and hedging policies on expected and unexpected shocks, we identify two exogenous shocks in corn market, one expected and other unexpected, that produced price volatility of corn commodity, a type of financial risk that corn-dependent firm are subject to. Employing scenarios where price variability increased offer a natural and exogenous source to test the influence of this financial risk on corporate policy and allow the research shows the importance of risk management strategies to decision makers (Trujillo-Barrera et al., 2012).

The first event is associated with the implementation of The Energy Policy Act of 2005 in August, 2005. The second event is related to a significant and unexpected corn shortfall due to a intense drought that happened in the United States in July, 2012.

In the subsequent sections, we present in detail our identification strategy. We start showing the importance and wide use of corn in the United States to justify our choice by the corn production. We then present our dataset sources and our screening procedures. Further, we describe our empirical model specification. Finally, we expose the dependent variable and the control variables using in this study.

4.3.2 The importance and use of corn in US economy

Corn is the most important crop for US agricultural sector as well for the world scenario. The United State Department of Agriculture (USDA) presents a complete report every year about corn production, yield and use in the United States. According to (USDA, 2015) circular series, the United States is a major player in the world corn trade market, with about 20% of the corn crop exported to other countries. US corn crops perform 24.36% of harvested world area, 55.08% of the world production, and they yield 126% more than the world yield, on average.

The USDA (2015) report also shows that corn has food, seed, and industrial (FSI) uses. As food, corn is the major component of livestock feed and account for about one-third of American domestic use. Feed use, a derived demand, is closely related to the number of animals (cattle, hogs, and poultry) that are fed by corn. The amount of corn used for feed also is highly dependent on the crop's supply and price, the amount of supplemental ingredients used in feed rations, and the supplies and prices of competing ingredients (USDA, 2015).

Corn is also an important ethanol coproduct. As ethanol production increases, the supply of ethanol coproducts will also increase. Both the dry-milling and wet-milling methods of producing ethanol use corn to produce distillers dried grains with solubles (DDGS), which can be used as a feed ingredient for livestock. Each 56-pound bushel of corn used in dry-mill ethanol production generates about 17.4 pounds of DDGS. In the United States, cattle (both dairy and beef) have been the primary users of DDGS as livestock feed, but increasingly larger quantities of DDGS are making their way into the feed rations of hogs and poultry (USDA, 2015).

Table 4.1 lists the food, seed, and industrial use in the United States in million bushels. During processing for human consumption and other industrial uses, corn is either wet or dry milled depending on the desired end products, such as:

- Wet millers process corn into high-fructose corn syrup (HFCS), glucose and dextrose, starch, corn oil, beverage alcohol, industrial alcohol, and fuel ethanol(USDA,

2015);

- Dry millers process corn into flakes for cereal, corn flour, corn grits, corn meal, and brewers grits for beer production (USDA, 2015).

Table 4.1: Corn: Food, seed, and industrial use in US (million bushels).

Year	High-fructose corn syrup	Glucose/dextrose	Starch	Alc. fuel	Alc. beverages/industry	Cereals/others	Seed	Total
1980/81	165.00	156.00	151.00	35.00	78.00	54.00	20.20	659.20
1981/82	183.00	160.00	146.00	86.00	86.00	53.00	19.40	733.40
1982/83	214.00	165.00	150.00	140.00	110.00	60.00	14.50	853.50
1983/84	265.00	167.00	161.00	160.00	88.00	70.00	19.10	930.10
1984/85	310.00	167.00	172.00	232.00	84.00	81.00	21.20	1,067.20
1985/86	327.00	169.00	190.00	271.00	83.00	93.00	19.50	1,152.50
1986/87	338.00	171.00	214.13	289.99	94.59	109.00	16.70	1,233.41
1987/88	358.00	173.00	226.49	279.15	84.81	113.00	17.20	1,251.65
1988/89	361.00	182.00	214.63	287.45	117.28	117.00	18.40	1,297.76
1989/90	368.00	193.00	219.29	321.45	129.40	120.00	18.90	1,370.04
1990/91	379.00	200.00	218.56	349.07	135.19	124.00	19.30	1,425.12
1991/92	391.82	209.65	224.66	398.26	160.91	128.00	20.20	1,533.51
1992/93	414.79	214.47	217.63	425.51	135.66	129.00	18.70	1,555.75
1993/94	440.96	219.18	224.91	458.26	110.05	139.70	20.10	1,613.15
1994/95	458.63	224.49	230.44	532.79	100.14	150.40	18.30	1,715.20
1995/96	472.85	227.30	226.20	395.68	125.00	161.00	20.15	1,628.17
1996/97	492.28	232.86	238.29	428.72	130.00	171.70	20.26	1,714.11
1997/98	527.99	236.48	248.08	487.73	133.00	182.40	20.42	1,836.10
1998/99	544.02	226.29	242.54	517.82	127.13	184.20	19.74	1,861.73
1999/00	551.93	229.30	253.43	565.85	129.70	185.00	20.25	1,935.45
2000/01	536.16	226.66	249.97	629.83	130.00	185.00	19.30	1,976.91
2001/02	542.23	226.55	248.82	707.24	131.00	186.00	20.06	2,061.89
2002/03	532.20	231.04	258.17	995.50	131.00	186.90	19.97	2,354.79
2003/04	529.85	238.27	273.27	1,167.55	132.00	187.40	20.56	2,548.89
2004/05	525.07	234.48	282.04	1,323.21	132.80	189.00	20.79	2,707.40
2005/06	545.02	245.12	280.37	1,603.32	135.00	190.20	19.90	3,018.93
2006/07	535.33	259.41	276.90	2,119.49	135.82	190.42	23.75	3,541.12
2007/08	522.77	255.96	264.66	3,049.21	135.40	192.40	21.84	4,442.25
2008/09	489.06	245.12	234.09	3,708.89	134.00	192.10	21.95	5,025.22
2009/10	512.13	257.28	250.44	4,591.16	134.00	193.66	22.34	5,961.00
2010/11	521.05	272.36	258.38	5,018.74	135.00	197.00	23.00	6,425.52
2011/12	513.37	294.36	254.01	5,000.03	136.50	198.13	24.53	6,420.93
2012/13	491.49	291.92	249.39	4,641.13	140.00	199.42	24.58	6,037.92
2013/14	477.56	306.97	218.73	5,133.72	140.43	200.51	23.00	6,500.91
2014/15	490.00	290.00	250.00	5,200.00	141.71	200.07	23.22	6,595.00

Source: USDA, Economic Research Service.

Corn is the largest component of global coarse grain (corn, sorghum, barley, oats, rye, millet, and mixed grains) trade, generally accounting for about two-thirds of the volume over the past decade (USDA, 2015). A complete picture of corn processing and usage is provided by the Center for Crops Utilization Research (2012), as illustrated in Figure 4.3. As one can see, corn reaches a large range of industry showing a high dependence of corn raw materials and its subproducts by the American economy.

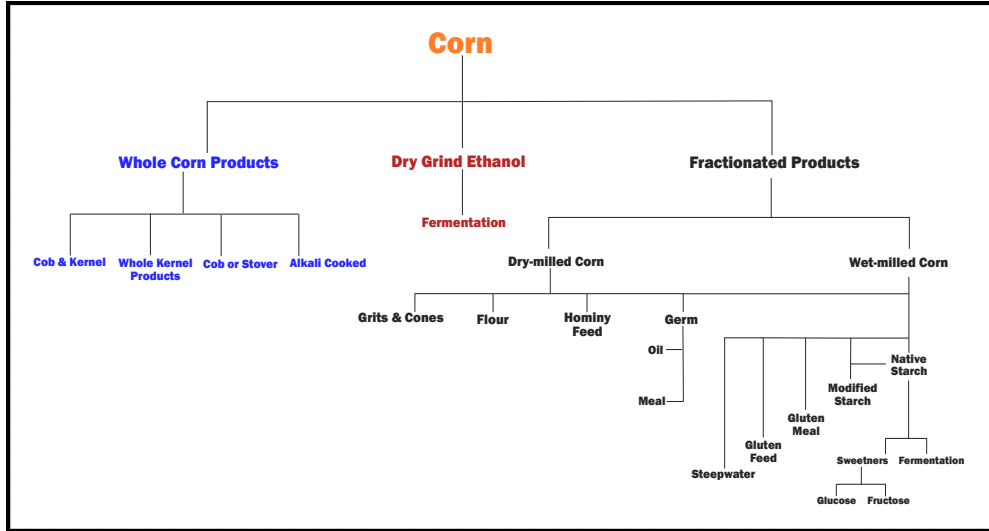


Figure 4.3: Corn processing and utilization in the United States.

Source: Center for Crops Utilization Research, Iowa State University.

4.3.3 Data

Our dataset covers the period of 2004–2006 period and 2011–2013 period corresponding a time around the two exogenous shocks. We use all American companies that are publicly traded over the analysed period. Annual balance sheet data come from Compustat database.

To gather information on derivatives usage, we collect data from three different sources. From Compustat we use variables such as, derivative assets current (derac), derivative assets long-term (deralt), and gains/losses on derivatives and hedging (derhedgl). We manually collect derivatives data from WRDS SEC Analytics Suite and 10-Ks using EDGAR search tool. If the firm reports the use of derivatives at least once per year in the Compustat database, WRDS SEC Analytics Suite, or in 10-Ks, we assign a value of one and zero otherwise.

We exclude from the dataset utilities companies (Standard Industrial Classification Code (SIC) codes between 4900 and 4949) and financial companies (SIC codes between 6000 and 6999). We also drop firm-year observations with SIC-missing codes, with missing values for all variables and with negative values of stock prices, capital expenditure, assets and sales revenue. We winsorize our data by year at 0.5% and 99.5% levels in all specifications as a way to eliminate the effect of outliers. After all procedures and the matching process, we obtain a final sample of 4,039 firms and 7,046 firm-year observations.

4.3.4 Model specification

To test our hypothesis we employ difference-in-differences methodology around the two exogenous variations on corn market that caused the corn price volatility during these events, the 2005 Energy Policy Act and the 2012 corn shortfall.

Difference-in-differences estimators integrate the advances of the fixed effects estimators with the causal inference analysis when unobserved events or characteristics confound the interpretations (Angrist & Pischke, 2009). Using difference-in-differences, we can compare the average effect of the use of derivatives on corporate cash holdings for groups affected by the shocks (henceforth, treated) with those that are not affected by the shocks (henceforth, control).

Our treated group is composed by firms that rely on corn and its subproducts to produce their outputs. To build the treatment group, we cross information from USDA (2015) and Center for Crops Utilization Research (2012), selecting all firms from Compu-stat database that pertain to the SIC codes related to this previous analysis. We use the 30-industry classification available at French (2015)'s website to classify each segment in our sample, as showed in Table 4.2. Our control group is all firms that do not belong to the SIC codes listed in Table 2.

Table 4.2: Standard industry classification (SIC) codes of corn-dependent firms

Industry segment	SIC code	Description
Agriculture.	0100-0299	Agric production - crops & livestock.
	0700-0799	Agricultural services.
	0910-0919	Commercial fishing.
	2048-2048	Prepared feeds for animals.
Food Products.	2000-2009	Food and kindred products.
	2010-2019	Meat products.
	2020-2029	Dairy products.
	2030-2039	Canned-preserved fruits-vegs.
	2060-2063	Sugar and confectionery products.
	2070-2079	Fats and oils.
	2090-2092	Misc food preps.
	2095-2095	Roasted coffee.
	2098-2099	Misc food preparations.
	Candy & Soda.	2064-2068
2086-2087		Bottled-canned soft drinks and flavouring syrup.
2096-2097		Potato chips and manufactured ice.
Beer & Liquor.	2080-2080	Beverages.
	2082-2085	Malt beverages, wine, distilled and blended liquors.
Smoke.	2100-2199	Tobacco products.
Consumer Goods.	2840-2843	Soap and other detergents.
	2844-2844	Perfumes cosmetics.
	3172-3172	Personal leather goods, except handbags.
	3190-3199	Leather goods.
Apparel.	3020-3021	Rubber and plastics footwear.
Pharmaceutical Products.	2830-2834	Drugs, biological products, medicinal chem. and pharmac. preparations.
Chemicals.	2850-2879	Paints, industrial organic chems, agriculture chemicals.
	2890-2899	Misc chemical products.
Rubber and Plastic Products.	3031-3031	Reclaimed rubber.
	3041-3041	Rubber and plastic hose and belting.
	3050-3053	Gaskets, hoses, etc.
	3060-3069	Fabricated rubber products.
	3070-3099	Misc rubber and plastic products.
Textiles.	2200-2279	Textile mill products, floor covering mills.
	2280-2284	Yarn and thread mills.
	2290-2295	Misc textile goods.
	2297-2298	Nonwoven fabrics, cordage, twine, and misc textile products.
	2393-2395	Textile bags, canvas products.
2397-2399	Misc textile products.	
Construction Materials.	2660-2661	Building paper and board mills.
Wholesale.	5100-5100	Wholesale - nondurable goods.
	5110-5113	Wholesale - paper and paper products.
	5120-5122	Wholesale - drugs.
	5140-5149	Wholesale - groceries and related prods.
	5150-5159	Wholesale - farm products.
	5160-5169	Wholesale - chemicals and allied prods.
	5180-5182	Wholesale - beer, wine.
	5400-5400	Retail - food stores.
Retail.	5410-5411	Retail - grocery stores.
	5420-5429	Retail - meat, fish mkt.
	5430-5439	Retail - fruit and vegetable markets.
	5440-5449	Retail - candy, nut, confec. stores.
	5450-5459	Retail - dairy product stores.
	5460-5469	Retail - bakeries.
	5540-5549	Retail - gasoline service stations.
	5910-5912	Retail - drug and proprietary stores.
	5920-5929	Retail - liquor stores.
	5980-5989	Retail - fuel and ice stores.
Meals.	5800-5819	Retail - eating places.
	5890-5899	Eating and drinking places.

We also further test whether corn-dependent firms that used derivative instruments retain less cash than corn-dependent firms that do not use derivatives. To do so, we run cross-section regressions with a similar specification of the DID approach for every year from the shocks to compare the average effect of the use of derivatives on cash holding levels for the corn-dependent firms.

In our model, the dependent variable is net cash holdings, measured by the ratio of cash and cash equivalents (CHE in Compustat) to total assets (AT) less CHE, as traditionally used by cash holding literature (e.g., Bates et al., 2009; Opler et al., 1999). The independent variables are the derivative usage dummy that takes the value of one when firms employ derivatives as financial risk instrument and zero otherwise, such as in (Opler et al., 1999), and control variables employed for prior studies that influence cash holdings such as leverage, cash flow, R&D, net working capital, acquisitions, firm size, capital expenditures, market-to-book, dividend, cash flow volatility and industry variability (e.g., Bates et al., 2009; Harford et al., 2008; Opler et al., 1999).

To proceed the empirical analysis of our hypothesis we use the following baseline regression model as in Equation 4.1:

$$\text{Cashholdings}_{i,t} = \beta_1 + \beta_2 \text{Treat}_i + \beta_3 \text{Post}_{i,t} + \beta_4 (\text{Treat} * \text{Post})_{i,t} + \beta_5 \text{Hedge}_{i,t} + \gamma_1 \mathbf{Z}_{i,t} + \eta_i + \varrho_t + v_{i,t}. \quad (4.1)$$

Where: *Cash holdings*_{*i,t*} = cash holdings measured by cash and cash equivalents divided by total assets minus cash and cash equivalents (net assets).

*Treat*_{*i*} = a dummy equal one if the observation is in the treatment group and zero if otherwise.

*Post*_{*i,t*} = a dummy equal one if the observation occurred the year after the shock.

*Treat*Post*_{*i,t*} = interaction between treatment group and period post shock.

Hedge = 1 if firm uses financial derivatives; 0 otherwise.

*Z*_{*i,t*} = vector of control variables.

*η*_{*i*} = firm fixed effects.

*ρ*_{*t*} = industry fixed effects.

*v*_{*i,t*} = error term.

The variable of interest for the DID analysis is the β_4 , which captures the difference-in-differences effect. To test our third hypothesis related to the presence of financial constraints we consider three measures of financial constraints as in Riddick and Whited (2009) and Almeida et al. (2004): size, bond rating and Whited and Wu index. Size is measure as the logarithm of book value of assets. Bond ratings represent credit worthiness of corporate evaluated by agencies based on the history of financial and operating performance (Riddick & Whited, 2009).

Whited and Wu index is computed as in Whited and Wu (2006), according to Equation 4.2:

$$\text{WW}_{i,\tau} = -0.091\text{CF}_{i,\tau} - 0.062\text{DIVPOS}_{i,\tau} + 0.021\text{TLTD}_{i,\tau} - 0.044\text{LNTA}_{i,\tau} - 0.035\text{SG}_{i,\tau} + 0.102\text{ISG}_{i,\tau}. \quad (4.2)$$

Where for firm *i* in year τ , *CF*_{*i,τ*} is the ratio of cash flow to total assets minus cash and marketable securities, *DIVPOS*_{*i,τ*} is an indicator that equals one if the firms pays dividend and zero otherwise, *TLTD*_{*i,τ*} is the ratio of long-term debt to total assets minus cash and marketable securities, *LNTA*_{*i,τ*} is the natural log of total assets, *SG*_{*i,τ*} is sales

growth computed as $\text{Sales}_\tau / \text{Sales}_{\tau-1}$, and $\text{ISG}_{i,\tau}$ is the firm's three-digit industry sales growth. The higher WW index value, the greater financial constraint degree (Whited & Wu, 2006).

We sort firms annually into three groups, based on the degree of financial constraints. For size and Whited and Wu index, we assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the size distribution, as in (Almeida et al., 2004). For bond rating, we ascribe firms that never had their public debt rated during our sample period as financially constrained, and unconstrained otherwise Riddick and Whited (2009).

We employ Equation 4.1 separately for each pooled tercile. The set of controls includes size, cashflow, net working capital, growth opportunities, cash flow volatility, capital expenditures, leverage, dividend, research and development, acquisitions, and industry volatility.

To satisfy the linear specification assumptions concerning the presence of heteroscedasticity and autocorrelation in the model, we apply the Breusch–Pagan test and Durbin–Watson statistic. The parameters reject the null–hypothesis of no heteroscedasticity and no autocorrelation. Therefore, we employ robust standard errors clustered at the firm level and, depending on the model specification, we include firm dummies to control firm effects and industry dummies to mitigate industry effects.

We also use the variance inflation factor (VIF) for each of the explanatory variables within the model to check the presence of collinearity. Values larger than 10, or average values of the VIF factors larger than one, suggest evidence of collinearity Wooldridge (2012). The VIF test on each regressor does not present a VIF superior to 10 or average values of the VIF factors larger than one (our average VIF is 1.67).

4.3.5 Identification assumptions for difference-in-differences methodology

The key assumption for the differences–in–differences strategy is that the outcome in treatment and control group would follow the same time trend in the absence of the treatment (Angrist & Pischke, 2009). Figure 4.4 shows the parallel trends for treatment and control group before each shock.

Figure 4.4 plots the parallel trend of net cash holdings between the treatment and control group and the potential trendline in the absence of both shocks. As can be seen, there is no trends between both groups before the exogenous shocks in 2005 and 2012. Nonetheless, the net cash holdings of treatment group increase after the 2005 Energy Act and decrease followed the 2012 corn shortfall.

From the model specification in Equation 4.1, the dummy variable **Treat** captures the differences between the treatment and control groups prior to the shock. The time period dummy, **Post**, captures aggregate factors that would cause changes in cash holdings even in the absence of the shock. The coefficients of our interest, **TreatxPost**, multiply the interaction term, **Treat x Post**, which is the same as a dummy variable equal to one for those observations in the treatment group in the second period. The difference-in-differences estimate is given to Equation 4.4:

$$\text{Treatxpost}_1 = \bar{y}_{\text{Post,Treated}} - \bar{y}_{\text{Post,Control}} - \bar{y}_{\text{Before,Treated}} - \bar{y}_{\text{Before,Control}}. \quad (4.3)$$

However, even though no trends should be observed, for efficient causal inference

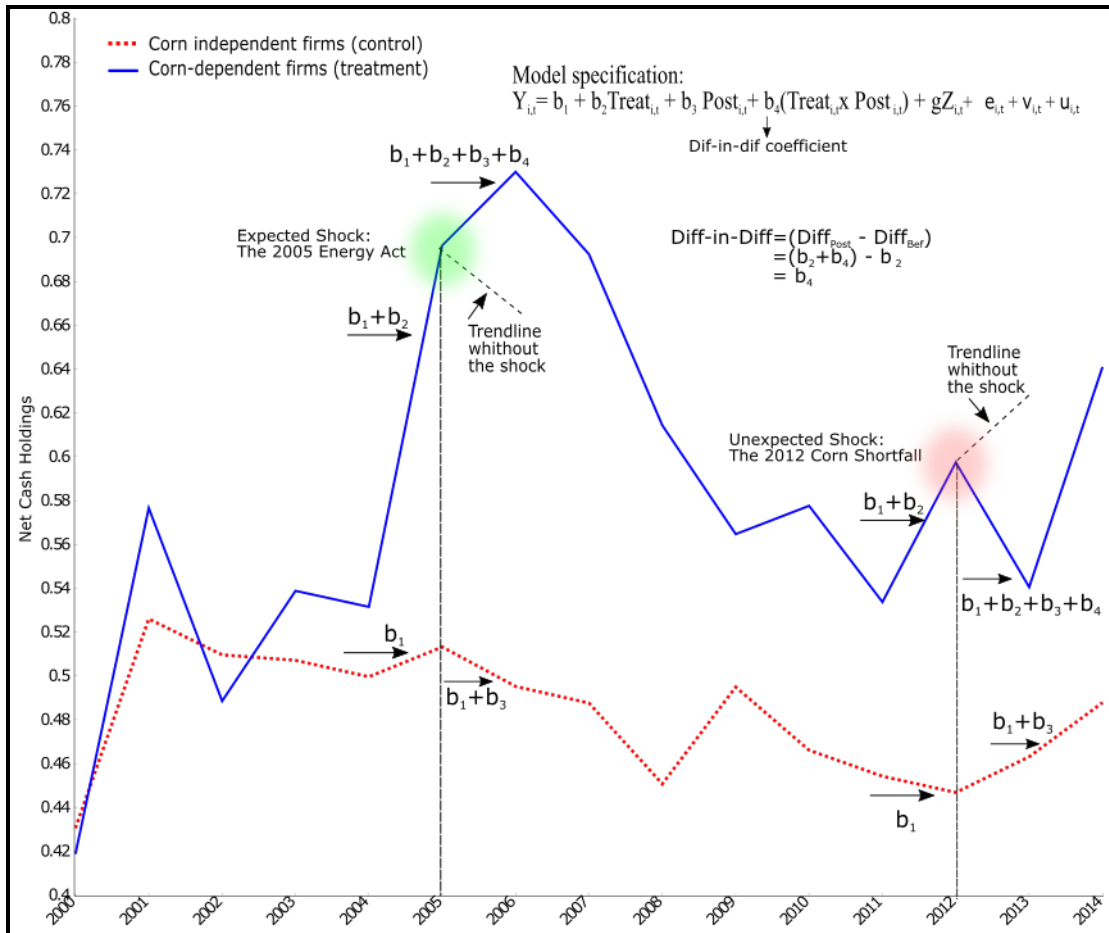


Figure 4.4: The parallel trend of net cash holdings (dependent variable): treatment and control group

and good estimation of the unobserved potential outcomes, treated and control groups have to be as similar as possible (Stuart, 2010).

In this regard, if the groups are very different from each other, the prediction of $y_{Post,Control}$ for the control group will be made using information from firms who look very different from themselves, and likewise for the prediction of $y_{Before,Treated}$ for the treated group. Then, designing a nonexperimental study as would be a randomized experiment, it is suggested the use of matching methods (Stuart, 2010).

Among matching methods, the propensity score facilitates the construction of matched sets with similar distributions of the covariates, without requiring close or exact matches on all of the individual variables (Stuart, 2010). We then implement propensity score matching to ensure that our results are driven by the chance error not due to the different distribution of characteristics of treated and untreated group (Roberts & Whited, 2013).

Following Stuart (2010), we implement the propensity score matching in three steps:

- Determining the "closeness". In other words, to choose the distance measure used to determine whether a firm is a good match for another;
- Implementing a matching method, given that measure of closeness;
- Assessing the quality of the resulting matched samples.

The closeness involves two procedures: which covariates to include and how to combine those covariates into one distance measure. To satisfy there are no unobserved differences between the treatment and control groups, conditional on the observed covariates, it is important to include in the matching procedure the variables known to be related to both treatment assignment and the outcome (Roberts & Whited, 2013). Nevertheless, Rosenbaum (1984) explains that should not be included in the matching process any variable that may have been affected by the treatment of interest.

The distance measure indicates the proximity that treated and matched observations are from each other. Moreover, observing the distance measure is an important step to ensure the overlap assumption across the treatment and comparison groups. The overlap assumption states that each firm has to have a positive probability of receiving the treatment level. In other words, the treatment and control groups have to pertain to the same common support.

If observations lie outside of that range, it could suggest that there are some individuals who always receive a treatment and some who would never receive a treatment. Thus, it could produce biased estimators (Roberts & Whited, 2013).

We then build our matched sample based on firm size measured as logarithm of firm's total assets, as in Y. Chen et al. (2015) and Irani and Oesch (2013). We then start running a logistic model to predict the probability that a firm is treated based on its pre-treatment characteristics. As affirmed by Stuart (2010), logistic model regression is a common procedure used to estimate propensity score.

The matching method that yields the best balance was the Nearest-Neighbor Matching (NN Matching) with replacement. This approach allows us to select a control unit that could be a best match for more than one treated unit (Stuart, 2010). Indeed, this matching algorithm do not narrow the sample as other methods, such as Kernel and exact matching, did. The final matched sample based on these requirements is 7,000 observations which 1,800 observations from treatment group and 5,200 from control group over the whole period.

Even if pre-trends and treatment and control groups are similar one still has to worry about other shocks that occur at the same time. We control firm and industry effects to avoid estimator bias that could be associate with differences at firm or industry levels. We further do not identify any other simultaneous shocks that might affect our economic outcomes.

Hart (2013) examines the factors that shape the cyclical patterns in corn crop returns over the period from 1968 to 2012. The author points the years of 1970, 1974, 1980, 1982, 1990, 2001 and 2008 as periods that general economy was in recession and in turn could affect corn yields. However, Hart (2013) shows that the large price swings during recessions were no larger than those were during good economic times. Thus, corn prices are not driven by recession periods. Moreover, there is no recession during our sample period either from 2004 to 2006 or from 2011 to 2013.

After considering all identification assumptions required by difference-in-difference methodology, it may be possible observe the treatment effect on treated group and infer that the differences between treated and control group is due to the chance error and not related to selection bias or counterfactual outcomes (Roberts & Whited, 2013).

Although the DID specification allows us to control for omitted variables that affect both the treatment and the control group in a similar manner, identification of the causal effect requires controlling for any systematic shocks to the treatment group that are

correlated with the cash holdings. To avoid that our estimates reflect other differences between the treatment and control groups that could be not related to the effect of each shock, we include control variables associated with firm-specific factors into regression model, as in Bates et al. (2009). We present our model variables in the next section.

4.3.6 Dependent and independent variables

We build all dependent and independent variables based on prior literature related to the cash holdings and financial derivatives (e.g., Bates et al., 2009; Opler et al., 1999).

Following Bates et al. (2009), the dependent variable in our model is net cash holdings measured as the ratio of cash and equivalents to total assets less cash and equivalents. The main independent variable is the derivative usage measured as a dummy variable that equals 1 for firms that use financial derivatives and 0 otherwise.

We also built dummies to evaluate the observation of treatment group ($Treat_i$), the period post shocks ($Post_i$) and the interaction between both ($Treat*Post_{i,t}$). The interaction between the treatment group and post period shock is the variable that captures the difference-in-differences effect.

The vector of controls $Z_{i,t}$ includes lagged cash holdings, leverage, R&D, capital expenditures, net working capital, dividend dummy, acquisitions, firm size, market-to-book, cash flow volatility and industry volatility.

We control for firm size because of standard arguments of economies of scale in cash holding literature that larger firms have lower issuance and external financing costs that enable them to hold less cash (Almeida et al., 2004). Firm size is measured as the logarithm of total assets.

We control for capital expenditures and acquisitions because firms might decrease cash savings to pay investments and acquisitions (Opler et al., 1999). We also control net working capital as it might be a substitute for cash (Bates et al., 2009). We expect all coefficients from these variables to be negative.

As cash flow volatility and industry volatility are likely to positively affect cash holdings (Harford et al., 2008; Opler et al., 1999), we control them in the model. We also include lagged net cash holding ratio to minimise potential endogeneity concerns and delayed adjustments of cash structure that could bias our estimates.

We also control R&D as firms with higher R&D expenses tend to hold more liquid assets (Opler et al., 1999). Dividend payments are likely to affect negatively cash holdings as firms that pay dividends tend to be less riskier and have higher access to capital markets (Bates et al., 2009). We then control dividend payout through dividend dummy into the model.

Leverage may produce two different effects on cash holdings. Highly leveraged firms might hold more cash to avoid future financial constraints (Acharya et al., 2007) or it also might incentive firms to hold less cash to decrease its debt (Francis et al., 2014). We control leverage in the model but we do not define an expected signal from this variable.

Firms with higher cash flows are likely to reserve more cash and have better investment opportunities. We then control cash flows and investment opportunities into the model. We use market-to-book ratio as proxy for investment opportunities (Bates et al., 2009).

We describe all dependent and independent variables in Table 4.3.

Table 4.3: Variable name, database source, definition, predicted signal, and references.

Variable	Definition	References
Net Cash Holdings (Net Cash).	Cash and cash equivalents (CHE) / Total Assets (AT) - CHE.	Bates et al. (2009).
Treat.	Treat=1 if corn-dependent firm; treat=0, otherwise.	
Treated	Treated=1 if corn-dependent firm. & derivative user; treated=0, corn-dependent firm & non derivative user.	
Hedge.	Equal one if firm use derivative in that year; 0 otherwise.	10Ks from SEC.
Leverage (Lev).	(Short-term debt (DLC) + long-term debt (DLTT)) / (DLC + DLTT + Market Value).	Faulkender and Wang (2006).
Market-to-Book (Mtb).	Common shares outstanding (CSHO) times price close annual fiscal year (PRCC _F) plus book debt (BD) / Assets total (AT) minus CHE.	Harford et al. (2008).
Cashflow (Cflow).	Operating income before depreciation (OIBDP) / Assets total (AT) minus CHE.	Harford et al. (2008).
Firm Size.	Logarithm of total assets (AT).	Bates et al. (2009).
R&D.	R&D (XRD) / Sales (SALE), which equals zero if missing.	Bates et al. (2009).
Net Working Capital (Nwc).	Current assets (ACT) minus CHE minus current liabilities (LCT) / Assets total (AT) minus CHE.	Bates et al. (2009).
CapEx.	Capital expenditures (CAPX) / Assets total (AT) minus CHE.	Harford et al. (2008).
Industry Volatility (Indvol).	Mean of the standard deviations of firm's cash-flow over 10 years for firms in the same industry, as defined by three-digit SIC codes.	Bates et al. (2009).
Cash flow Volatility (Cfvol).	Firm's standard deviation of the cashflow ratio for the past 10 years.	Bates et al. (2009).
Acquisition (Acq).	Acquisition (AQC) / Assets total (AT) minus CHE.	Harford et al. (2008).
Dividend (Div).	Indicator variable that equals one if firm i paid cash dividends in year t.	Bates et al. (2009).
Whited Wu Index (WW).	$WW_{i,t} = -0.091*CF_{i,t} - 0.062*DIVPOS_{i,t} + 0.021*TLTD_{i,t} - 0.044*LNTA_{i,t} - 0.035*SG_{i,t} + 0.102*ISG_{i,t}$.	Whited and Wu (2006).

4.3.7 Descriptive statistics

Table 4.4 reports summary statistics for variables used in the analysed period. Firms are classified as corn-dependent if they depend on corn at any production level. Panel A reports summary statistics (mean, standard deviation, median, and number of observations) for the whole sample used in the analysis. Panel B describes the descriptive statistics for corn-dependent firms and corn independent firms. Panel C presents summary statistics for corn-dependent firms that used or not used derivatives as financial instrument risk. All variables are winsorised at 5st and 95th percentile to mitigate the effect of any outliers.

The average and the median corporate cash holdings of net assets for all firms is 52.59% and 16.74% respectively. Corn-dependent firms hold, on average, 58.95% of their

Table 4.4: Summary statistics for variables around the expected and unexpected shocks: 2004, 2006, 2011 and 2013.

Panel A: All firms.				
Variable	Mean	Median	Std Deviation	N. Obs
Net Cash.	0.5259	0.1674	0.8598	7,046
Lev.	0.1654	0.101	0.1897	7,015
Mtb.	1.8621	1.4731	1.2038	7,022
Cflow.	0.0596	0.1065	0.182	7,043
Firm Size.	6.0487	5.9322	1.9007	7,046
R&D.	0.1108	0.0053	0.2458	6,903
Nwc.	0.0296	0.048	0.2503	6,963
Capex.	0.0479	0.0315	0.0475	7,046
Indvol.	0.1684	0.0876	0.2583	6,996
Cfvol.	0.0861	0.0517	0.0932	7,005
WW.	-0.2672	-0.2703	0.1171	6,793
Panel B: Corn dependent firms (treatment group).				
Variable	Mean	Median	Std Deviation	N. Obs
Net Cash Holdings.	0.5895	0.1318	1.0075	1,796
Lev.	0.1625	0.1227	0.1663	1,788
Mtb.	2.1072	1.6728	1.3242	1,790
Cflow.	0.0466	0.1189	0.2194	1,794
Firm Size.	6.2304	6.1387	2.1311	1,796
R&D.	0.1573	0.0081	0.319	1,752
Nwc.	0.0026	0.0422	0.267	1,793
Capex.	0.0449	0.0319	0.0429	1,796
Indvol.	0.1698	0.0642	0.1667	1,773
Cfvol.	0.0898	0.0451	0.1073	1,779
WW.	-0.2647	-0.272	0.1355	1,715
Panel C: Corn independent firms (control group).				
Variable	Mean	Median	Std Deviation	N. Obs
Net Cash.	0.5042	0.1819	0.8021	5,250
Lev.	0.1664	0.0918	0.1971	5,227
Mtb.	1.7783	1.4207	1.1479	5,232
Cflow.	0.0641	0.1023	0.167	5,249
Firm Size.	5.9866	5.8953	1.8112	5,250
R&D.	0.095	0.0038	0.213	5,151
Nwc.	0.0389	0.0498	0.2435	5,170
Capex.	0.0489	0.0313	0.0489	5,250
Indvol.	0.1679	0.0904	0.2828	5,223
Cfvol.	0.0849	0.0544	0.0879	5,226
WW.	-0.268	-0.2696	0.1102	5,078

net assets in cash and cash equivalents while corn-independent firms maintain 50.42%. On average, corn-dependent firms and corn-independent firms have similar leverage ratio, size, cash flows, capital expenditures, industry volatility, cash flow volatility and financial constraint index (Whited and Wu index). However, there are apparent differences in means on R&D and net working capital between the sample groups.

R&D ratio is 15.73% of sales for corn-dependent firms and 9.5% for corn-independent firms, on average. On the one hand, firms with higher R&D expenditures consume more cash to ensure the operational viability of R&D projects (Opler et al., 1999). On the flip side, higher R&D spending ratios indicate those firms with greater costs of financial

distress and could influence more cash retention (Bates et al., 2009).

Net working capital (current assets less current liabilities) is 2.96% of net assets, on average, for all firms, 0.26% for corn-dependent firms and 3.89% for corn independent firms. Net working capital captures multiple dimensions of firms' adjustments to operating and financial conditions. It measures the company's ability to pay off its current liabilities with current assets and signs the firm's short-term liquidity position (Sagan, 1955).

Basically, if firm's net working capital position is tight but firm can postpone tax liabilities and other payables to the next period, it should be not a financial concerning as there is no need to borrow funds from the market. Nonetheless, if firm's net working capital is low and unexpected inventories spending or/and receivable volatilities are likely to bind firm's balance sheet, it might be forced the firm to borrow funds to meet short-term obligations (Sagan, 1955). We further investigate when corn-dependent firms might have a higher difference in means of net working capital related to the control group.

In this regard, we apply a two-tailed t-test to compare if the means of variables for corporate decisions between corn-dependent firms and control group are the same. We further analyse if the means of corporate policies between corn-dependent firms that used derivatives and corn-dependent firms that do not used derivatives are the same.

Table 4.5 presents the univariate analysis with the difference in means between sample groups. In Panel A, the treated variable is coded as 1 if the firm is affected by the exogenous shock (corn-dependent) and zero if the firm is not affected by the shock (corn independent). In Panel B, the treated variable is coded as 1 if the firm is affected by the exogenous shock and it uses derivative instruments and zero if the firm is affected by the shock however it does not use derivative instruments.

The results of both panels show a simple "pre" and "post" analysis using time-averages before and after the shocks. It can be seen in Panel A that there are, at least, a 90% chance that the average between corn independent firms and corn dependent firms around expected shock on lagged net cash holdings, market-to-book, acquisitions, R&D, net working capital, capital expenditures, and Whited and Wu index variables are different.

The initial concern on the large difference between the average net working capital for corn-dependent firms and corn-independent firms is basically restricted to the post period of the expected shock.

In Panel B, the analysis considers the corn-dependent firms that used and not used financial derivatives. We observe there are differences in means on net cash holding and leverage on whole period. We also regard that there are differences in means on market-to-book former the expected shock, on capital expenditures after the expected shock and on net working capital before the expected shock and prior and after the unexpected shock.

Next, to test our hypothesis we employ difference-in-differences regressions around the two events, the expected shock from the 2005 Energy Act and the unexpected shock from the 2012 Corn Shortfall.

4.4 Results and discussions

Following the univariate analysis, we examine the influence of expected and unexpected exogenous shocks on corporate cash holding and hedging policies considering

Table 4.5: Univariate analysis – Difference in means between sample groups.

Panel A:				
Difference in means: Corn independent firms versus Corn–dependent firms.	Expected shock		Unexpected shock	
	2004	2006	2011	2013
L. Net Cash.	-0.0239 (-0.55)	-0.201*** (-4.23)	-0.0382 (-0.79)	-0.0636 (-1.30)
Lev.	-0.00805 (-0.85)	-0.000777 (-0.09)	0.00966 (0.79)	0.0190 (1.73)
Mtb.	-0.211*** (-3.37)	-0.247*** (-4.08)	-0.381*** (-5.84)	-0.527*** (-7.24)
Cflow.	0.0122 (1.36)	0.0461*** (4.47)	0.00290 (0.29)	0.00270 (0.26)
Acq.	0.00484* (2.13)	0.00606** (2.75)	0.00550* (2.36)	0.000239 (0.11)
R&D.	-0.0611*** (-4.63)	-0.0970*** (-7.15)	-0.0440** (-3.29)	-0.0392** (-2.89)
Nwc.	0.0253* (2.00)	0.0572*** (4.28)	0.0363* (2.54)	0.0227 (1.55)
Capex.	0.000336 (0.14)	0.00569* (2.24)	0.00721** (2.65)	0.00311 (1.10)
Cfvol.	0.00759 (1.60)	-0.00643 (-1.30)	-0.00800 (-1.46)	-0.0149** (-2.80)
WW.	0.0283*** (4.78)	-0.0199** (-3.08)	-0.0237*** (-3.52)	-0.00131 (-0.19)
Panel B:				
Difference in means: Corn–dependent firms non–derivative user versus Corn–dependent firms derivative user	Expected shock		Unexpected shock	
	2004	2006	2011	2013
Net Cash	0.539*** (5.80)	0.711*** (3.48)	0.636*** (7.15)	0.603*** (6.75)
Lev	-0.0850*** (-5.07)	-0.0939*** (-3.36)	-0.0847*** (-4.60)	-0.0487** (-3.30)
Mtb	0.357** (2.75)	0.359 (1.59)	0.126 (0.94)	0.242 (1.70)
Cflow	-0.120*** (-6.12)	-0.135** (-3.16)	-0.124*** (-6.12)	-0.129*** (-6.18)
Acq	-0.00943* (-2.24)	-0.0192** (-2.74)	-0.0125** (-3.30)	-0.00289 (-0.72)
R& D	0.181*** (5.59)	0.202** (3.22)	0.153*** (5.42)	0.113*** (3.95)
Nwc	-0.0554* (-2.23)	-0.0683 (-1.35)	-0.0885** (-3.27)	-0.0919*** (-3.51)
Capex	-0.00175 (-0.40)	-0.0215** (-2.68)	-0.00302 (-0.77)	0.000836 (0.19)
Cfvol	0.0609*** (6.41)	0.0559** (2.91)	0.0742*** (6.87)	0.0725*** (6.85)
WW	0.108*** (9.13)	0.116*** (4.62)	0.134*** (10.79)	0.125*** (10.67)

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

multivariate regression through difference-in-differences approach. Our intuition is that unexpected shock tend to influence firms hold more cash on the post period than does expected shocks. We control for prior known determinants of cash holdings as suggested by Bates et al. (2009). We also include firm and industry fixed effects to control for cross-sectional systemic variations in cash holding policies across firms and sectors. We clustered robust standard errors at firm level.

4.4.1 The impact of expected and unexpected shocks on corporate cash holdings

When firms face any uncertainty related to future economic or business condition, they tend to hold cash for precautionary reasons. Then, we test our first hypothesis that firms that face unexpected shocks hold more cash than firms do not experience those shocks. Table 4.6 reports our findings.

Table 4.6: The impact of expected and unexpected shocks on cash holdings.

Panel A:	Expected shock		Unexpected shock	
Dep Variable: Net Cash				
Treat. ^a	-0.0698**	-0.1126***	-0.1053***	-0.1881***
	(-2.18)	(-2.72)	(-2.84)	(-3.44)
After2005.	-0.0011	-0.0028		
	(-0.06)	(-0.14)		
Treatxafter2005.	0.0343	0.0348		
	(0.91)	(0.93)		
After2012.			-0.0613***	-0.0593***
			(-2.80)	(-2.70)
Treatxafter2012.			0.0726*	0.0692*
			(1.79)	(1.71)
L. Net Cash.	-0.0040	-0.0037	0.1138***	0.1144***
	(-0.27)	(-0.26)	(4.39)	(4.42)
Lev.	-0.9874***	-1.0035***	-0.6537***	-0.6650***
	(-15.04)	(-15.00)	(-8.96)	(-9.14)
Mtb.	-0.0113	-0.0124	-0.0117	-0.0105
	(-0.84)	(-0.91)	(-0.73)	(-0.65)
Cflow.	0.2153	0.2195*	0.5829***	0.5846***
	(1.61)	(1.65)	(3.66)	(3.70)
Acq.	-1.9225***	-1.8484***	-1.4949***	-1.4612***
	(-9.79)	(-9.30)	(-7.31)	(-7.03)
Firm Size.	-0.0380***	-0.0396***	-0.0414***	-0.0441***
	(-5.22)	(-5.41)	(-4.97)	(-5.15)
R&D.	1.5393***	1.4743***	1.5440***	1.4388***
	(14.29)	(13.21)	(12.41)	(11.09)
Nwc.	-0.8075***	-0.8638***	-0.8423***	-0.9265***
	(-11.20)	(-10.86)	(-8.77)	(-9.08)
Capex.	-2.2580***	-2.0895***	-2.1461***	-2.0559***
	(-9.65)	(-8.26)	(-8.17)	(-7.19)
Indvol.	0.1049*	0.0975*	0.0229	0.0133
	(1.84)	(1.73)	(0.68)	(0.40)
Cfvol.	0.4273**	0.4008*	0.5427*	0.4227
	(1.97)	(1.86)	(1.93)	(1.50)
Div.	-0.0079	-0.0157	-0.0194	-0.0260
	(-0.32)	(-0.64)	(-0.77)	(-1.02)
Observations	3612	3612	2887	2887
R ²	0.731	0.733	0.754	0.757
Firm fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	No	Yes	No	Yes

t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

^a Treat=1 if firm is corn-dependent (treated); 0 if firm is corn independent (control).

The dummy variable **Treat** captures the differences between the treatment and control groups prior to the shock. The time period dummies, **After2005** and **After2012**, capture aggregate factors that would cause changes in cash holdings even in the absence of the shock. The coefficients of our interest, **Treatafter2005** and **Treatafter2012**, multiply the interaction term, **Treat x After2005** for the expected shock and **Treat x After2012** for the unexpected shock, which is the same as a dummy variable equal to one for those observations in the treatment group in the second period. The difference-in-differences estimate is given to Equation 4.4:

$$\text{Treatxpost}_1 = \bar{y}_{\text{Post,Treated}} - \bar{y}_{\text{Post,Control}} - \bar{y}_{\text{Before,Treated}} - \bar{y}_{\text{Before,Control}} \quad (4.4)$$

As we predict the coefficient on **Treatafter2012** suggests that firms experiencing unexpected shock retain more cash than firms do not face the shock. Corn-dependent firms held 7.26% more cash, on average, than corn-independent firms after the unexpected shock, statistically significant at the 10% level. It confirms our first hypothesis.

The coefficient on **Treatafter2005**, that represents the expected shock on treated group, has no statistical significant impact on cash holdings. Considering only this finding, we cannot confirm our second hypothesis that firms hold more cash after unexpected shocks than would do by facing expected shocks. Nonetheless, we can infer that as the expected shock is not statistical significant firms might anticipate their corporate decisions preparing for the expected shock. Therefore, it is expected that the 2005 Energy Act would have low impact on corporate decisions.

From Table 4.6 we notice other statistically and economically significant impact at the 1% level on lagged net cash holdings, leverage, cash flows, acquisitions, firm size, R&D, net working capital and capital expenditures for corn-dependent firms after the unexpected 2012 corn shortfall .

We assess that a single standard deviation increase in leverage, all else equal, is associated with a 16.97% and 25.6% decrease in the net cash holdings ratio after the unexpected and expected shock, respectively. The effect of leverage ratio of corn-dependent firms on cash holdings are higher after the expected shocks than the unexpected shocks. The intuition is that corn-dependent firms maintain less cash to decrease its debt and increase their debt capacity.

When firms make acquisitions or finance new investments, it is expected a decrease of cash holdings. We capture that a single standard deviation increase in capital expenditures, all else equal, is associated with a 12.16% decrease in the net cash holding ratio after the unexpected shock.

As we prior observed, R&D and net working capital highly impact corporate cash holdings either on unexpected or expected shocks. We appraise that a single standard deviation increase in R&D after the 2012 corn shortfall, all else equal, is related to a 42.72% increase in the net cash holding ratio. Likewise, a single standard deviation increase in net working capital after the unexpected shock is associated with a 27.65% decrease in the net cash holding ratio.

Other interesting result we assess was the impact of the R&D spending on cash holdings after the 2005 Energy Act for corn-dependent firms. Following the expected shock, a single standard deviation increase in R&D is related to 42.59% increase in the net cash holdings. The results suggest that corn-dependent firms after the expected shock also rely more on cash holdings rather than external financing to sustain their

R&D projects as they did after the unexpected shock.

Nonetheless, the impact of the 2005 Energy Act on the relationship between cash holdings and net working capital was less intense than R&D spending. We assess that one single standard deviation increase in net working capital after the expected shock decreases cash holding ratio by 25.35%.

Analysing the relationship between cash flows and cash holdings after the 2012 corn shortfall, we estimate that a single standard deviation increase in cash flows, all else equal, is associated with a 12.89% increase in the net cash holdings ratio. We also find that cash holdings are negatively related to firm size and acquisitions, corroborating findings in Bates et al. (2009) and Harford et al. (2008).

4.4.2 The effect of expected and unexpected shocks on corporate cash holdings for financially constrained and unconstrained firms

Bates et al. (2009) highlight that firms with higher R&D spendings are assumed to have greater costs of financial distress and higher cash holdings. As the coefficient on R&D from the previous analysis indicates that firms with higher R&D ratios hold more cash, we explore the influence of financial constraints around these two events. Considering that, we also investigate our third hypothesis that financially constrained firms hold more cash than unconstrained firms after unexpected shocks.

To this end, we sort firms annually into three groups, based on the degree of financial constraints. For size and Whited and Wu index, we assign to the financially constrained (unconstrained) group those firms in the bottom (top) three terciles of the size distribution. For bond rating, we ascribe firms that never had their public debt rated during our sample period as financially constrained, and unconstrained otherwise. We next employ Equation 4.1 separately for each pooled tercile. The set of controls includes size, cash-flow, net working capital, growth opportunities, cash flow volatility, capital expenditures, leverage, dividend, research and development, acquisitions, and industry volatility.

Table 4.7 shows the findings for our third hypothesis. The coefficient on **Treatx-after2005** is not statistical significant at any financial constraint measure, confirming that financial constraints do not influence corn-dependent firms after the expected shock. Nonetheless, the result related to the coefficient on **Treatxafter2012** regarding size suggest that financially constrained corn-dependent firms reserve 14.66% more cash holdings than financially constrained corn-independent firms after the 2012 corn shortfall, statistically significant at 10% level. Moreover, the coefficient on financially unconstrained firms is not statistically different from zero, such as in Almeida et al. (2004), where unconstrained firms show no change in their cash-cash flow sensitivities in response to macroeconomic shocks.

Table 4.7: The effect of expected and unexpected shocks on cash holdings for constrained and unconstrained firms.

Dep. Var.: Net Cash	Expected shock				Unexpected shock						
	Const	Unconst	Const	Unconst	Const	Unconst	Const	Unconst			
	Size	WW	Rating	Size	WW	Rating	Size	WW			
Treat.	-0.2244** (-1.97)	-0.0291 (-0.74)	-0.3068** (-2.28)	-0.0136 (-0.39)	-0.1254** (-2.16)	-0.0577* (-1.67)	-0.2562*** (-3.03)	-0.3547*** (-4.01)	-0.0114 (-0.41)	-0.1325*** (-3.11)	-0.0294 (-1.36)
After2005.	0.0023 (0.05)	-0.0180 (-0.82)	-0.0201 (-0.33)	-0.0045 (-0.21)	-0.0181 (-0.68)	-0.0195 (-0.95)					
Treatxafter2005.	-0.0447 (-0.45)	0.0510 (1.34)	0.0494 (0.45)	0.0289 (0.73)	0.0652 (1.19)	0.0302 (1.12)					
After2012.							-0.1498*** (-3.28)	-0.1117** (-2.39)	-0.0020 (-0.10)	-0.0690*** (-2.95)	0.0172 (1.03)
Treatxafter2012.							0.1466* (1.67)	0.1025 (1.26)	0.0351 (1.11)	0.0715 (1.44)	-0.0010 (-0.05)
L. Net Cash.	0.0003 (0.01)	0.0306 (1.48)	0.0253 (0.82)	0.0393* (1.84)	0.0420** (2.46)	0.0188 (0.80)	0.0442** (2.01)	0.0614*** (2.70)	0.0649** (2.27)	0.0714*** (4.82)	0.0016 (0.10)
Lev.	-1.6686*** (-9.33)	-0.4815*** (-4.32)	-1.7572*** (-8.53)	-0.5426*** (-4.58)	-1.3305*** (-13.41)	-0.2636*** (-3.95)	-1.3386*** (-11.32)	-1.4104*** (-11.45)	-0.4428*** (-6.12)	-0.9921*** (-15.47)	-0.2382*** (-5.89)
Mtb.	-0.0407 (-1.60)	0.0088 (0.31)	-0.0341 (-1.28)	-0.0331 (-1.34)	-0.0137 (-0.88)	0.0202 (0.98)	-0.0228 (-1.26)	-0.0145 (-0.78)	0.0264 (1.57)	-0.0026 (-0.23)	-0.0071 (-0.57)
Cflow.	0.2167 (0.96)	-0.5664 (-1.34)	0.4175* (1.86)	0.1002 (0.30)	0.2971** (1.98)	-0.5512** (-2.10)	0.2724* (1.66)	0.4332*** (2.73)	0.0835 (0.32)	0.4259*** (3.74)	-0.1889 (-1.27)
Acq.	-3.1850*** (-4.59)	-0.6655*** (-2.77)	-3.6834*** (-4.93)	-0.7982*** (-3.49)	-2.5509*** (-8.76)	-0.6529*** (-3.07)	-2.7347*** (-5.43)	-0.7857*** (-4.93)	-0.8061*** (-5.25)	-2.3458*** (-11.09)	-0.5361*** (-4.31)
Firm Size.	0.0776* (1.65)	-0.0208 (-1.38)	0.0401 (1.10)	-0.0356** (-2.55)	-0.0272** (-2.21)	-0.0283** (-2.40)	0.0607* (1.91)	-0.0381*** (-3.61)	0.0010 (0.04)	-0.0289*** (-3.36)	-0.0274*** (-3.45)
R&D.	1.3551*** (7.43)	0.6967** (2.18)	1.3501*** (7.36)	0.7807*** (2.70)	1.3972*** (11.30)	1.3506*** (4.11)	1.3368*** (10.16)	0.8844*** (4.12)	1.3053*** (10.24)	1.4121*** (15.04)	1.4513*** (4.91)
Nwc.	-1.0682*** (-7.49)	-0.4322*** (-3.39)	-1.1849*** (-7.81)	-0.3935*** (-3.18)	-0.9378*** (-10.04)	-0.2802*** (-2.94)	-1.1021*** (-10.66)	-0.5099*** (-4.51)	-1.1342*** (-11.29)	-0.9570*** (-13.65)	-0.3357*** (-4.74)
Capex.	-2.8099*** (-4.20)	-0.7663** (-2.05)	-2.7790*** (-3.60)	-1.2500*** (-3.90)	-2.5488*** (-7.45)	-0.4134 (-1.35)	-2.7838*** (-5.82)	-1.1962*** (-4.29)	-2.6420*** (-5.40)	-1.6188*** (-5.50)	-0.6350*** (-3.30)
Indvol.	-0.0738 (-0.83)	0.0933* (1.90)	0.0229 (0.22)	0.0745 (1.34)	0.1118 (1.51)	-0.0624 (-0.88)	-0.0213 (-0.43)	0.0267 (0.92)	-0.0165 (-0.33)	0.0554 (1.30)	-0.0311 (-0.80)
Cfvol.	0.3229 (0.90)	1.8534*** (2.75)	0.2423 (0.63)	1.1147** (2.03)	0.3479 (1.42)	0.9472 (1.24)	-0.0161 (-0.06)	1.4705*** (3.90)	-0.1457 (-0.56)	1.7580*** (5.28)	0.7231*** (1.97)
Div.	0.0397 (0.50)	-0.0692** (-2.56)	0.1041 (0.75)	-0.0755** (-2.58)	-0.0231 (-0.65)	-0.0104 (-0.35)	-0.0373 (-0.74)	-0.0386** (-2.12)	0.0066 (0.08)	-0.0533** (-2.47)	0.0093 (0.52)
Obs.	1220	1163	1233	1146	2577	933	2167	2106	2207	4571	1733
R ²	0.802	0.664	0.786	0.774	0.729	0.707	0.770	0.594	0.754	0.709	0.640
Firm fix effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind fix effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Although we do not reject our third hypothesis that financially constrained firms hold more cash than unconstrained firms after unexpected shocks, we do not reach strong statistical evidence towards the other financial constraint measures.

The results in Table 4.7 also reinforce prior financial constraint literature. We assess that a single standard deviation increase in leverage for financially constrained firms after the 2005 Energy Act, all else equal, is associated with 33.45% to 44.83% decrease in the net cash holdings ratio, on average. The impact depend on the financial constraint measure used but all proxies are statistically significant at 1% level. Whereas a same increase in leverage for financially unconstrained firms over the shock decreases the cash holdings ratio only by 12.84%.

The relationship between cash flow and cash holdings is positive, statistically significant for constrained firms at 5% level. Nevertheless, the coefficient on cash flows for unconstrained firms are not statistical significant in all financial constraint measures.

It confirms findings in Almeida et al. (2004) that present a strong positive relation between cash flow and cash holdings for financially constrained firms but no relation for unconstrained firms. As unconstrained firms should depend neither on current cash flows nor on future investment opportunities, no systematic patterns in cash policies might also be noticed.

A significant impact through all measures is noticed on acquisitions, R&D, net working capital and capital expenditure coefficients for financially constrained firms. Although we previously find that these variables are significant determinants of corporate cash holdings behaviour, Table 4.7 presents separated parameters that allow us to compare financially constrained and unconstrained firms.

We measure that a single standard deviation increase in acquisitions for financially constrained firms following the 2005 Energy Act, all else equal, is associated with 16.68% decrease in the net cash holdings ratio, on average, statistically significant at 1% level. While the same increase in acquisitions for unconstrained firms decreases the cash holding ratio only by 3.61%, statistically significant at 1% level. By estimating the impact of 2012 corn shortfall on the relationship between acquisitions and cash holdings for both groups we observe the same pattern between expected and unexpected shocks. It could suggest that firms though affected by the shocks do not follow different policies regarding acquisitions during these two periods.

After both shocks, constrained firms retain more cash, on average, than unconstrained firms to support their R&D spending. A single standard deviation increase in R&D ratio leads to, on average, a 38.66% and 37.37% increase in cash holdings for financially constrained and unconstrained firms, respectively, statistically significant at 1% level. Nevertheless, as we do not find a significant difference between the coefficients on R&D for constrained and unconstrained firms under the influence of both shocks, it is difficult to affirm that firms rely on cash holdings to pursue their R&D projects due to external financial constraints.

The effect of both shocks on relationship between capital expenditures and cash holdings, in turn, was more economically significant for constrained firms than for unconstrained ones. A single standard deviation increase in capital expenditures for financially constrained firms reduces their corporate cash holdings by 15.92% while decreases only by 7.08% for their unconstrained peers, on average.

Finally, the relationship between net working capital and cash holdings is extremely more sensitive for financially constrained firms than unconstrained ones. On both ex-

ogenous events, a one-standard deviation increase in net working capital ratio leads to a 34.78% decrease in cash ratio for financially constrained firm while reduces only by 12.68% the cash holdings reserved by unconstrained firms. In this regard, firms with lower cash holdings and lower net working capital might have difficult to borrow money at low cost (Sagan, 1955).

4.4.3 The impact of expected and unexpected shocks on the relationship between corporate cash holdings and derivatives use

So far we have shown a positive effect of unexpected shocks on corporate cash holding behaviour regardless of firm's financial constraint status. We then propose to explore the relationship between cash holdings and derivative use posterior expected and unexpected shocks. Specifically we will test whether cash holdings are negatively related to the use of derivative instruments and if firms that do not use derivatives rely more on cash holdings than do their peers that use derivatives.

The effects of expected and unexpected shocks on the relationship between cash holdings and derivatives use are presented in Table 4.8.

Derivatives use and cash holdings are not related to each other following the expected shock in 2005. Nonetheless, we find that cash holdings and derivative instruments are negatively related after the 2012 corn shortfall. It endorses our fourth hypothesis that cash and derivatives are used as substitute to manage corporate risk. The coefficient on derivative user shows that firms that rely on derivative instruments decrease by 9.66% their cash reserves compared to firms who employ no financial derivative.

To confirm the prior result of Table 4.8, we further investigate what would be the impact of expected and unexpected shocks on cash holdings considering firms that use derivatives and those do not use separately. We then sort firms annually into two groups, based on the derivatives use, running difference-in-differences regressions separately for each one in both shocks. We employ firm and industry fixed effects and also control for other determinants that could affected cash holdings. The set of controls includes size, cashflow, net working capital, growth opportunities, cash flow volatility, capital expenditures, leverage, dividend, research and development, acquisitions, and industry volatility.

Table 4.9 displays the influence of expected and unexpected shocks on cash holdings regarding the use of derivatives. Table 4.9 offers a clear and separated effect between derivative users and non derivative users. We therefore could exploit interesting results from it.

First, the expected shock did not impact differently cash holdings between corn-dependent firms and corn-independent firms. Although the coefficient on **Treatxafter-2012** for derivative user is not statistical significant as well, the parameter on non derivative user show what we are looking for.

Corn-dependent firms that do not employ derivative instruments hold 14.53% more cash than corn-independent firms following the unexpected shock. It suggests that as derivative users hedge their financial risks they do not need to hold cash for precautionary reasons. Unlikely, corn-dependent firms that do not use derivatives instruments are much more exposed to the unexpected price volatilities than firms that use derivative.

We also observe different effects on other corporate policies between both groups.

Table 4.8: The relationship between cash holdings and derivatives use: Expected and unexpected shocks.

Dependent variable: Net cash holdings	Expected shock		Unexpected shock	
Treat.	-0.0699**	-0.1126***	-0.1039***	-0.1850***
	(-2.18)	(-2.72)	(-2.80)	(-3.38)
After2005.	-0.0079	-0.0096		
	(-0.37)	(-0.45)		
Treatafter2005.	0.0353	0.0359		
	(0.94)	(0.96)		
After2012.			-0.0543**	-0.0515**
			(-2.48)	(-2.34)
Treatafter2012.			0.0753*	0.0722*
			(1.86)	(1.79)
Derivative user.	-0.0294	-0.0290	-0.0882***	-0.0966***
	(-1.41)	(-1.37)	(-3.86)	(-4.22)
L.Net Cash.	-0.0036	-0.0033	0.1103***	0.1105***
	(-0.25)	(-0.23)	(4.29)	(4.30)
Lev.	-0.9812***	-0.9968***	-0.6278***	-0.6338***
	(-14.91)	(-14.84)	(-8.68)	(-8.80)
Mtb.	-0.0114	-0.0124	-0.0110	-0.0094
	(-0.84)	(-0.91)	(-0.69)	(-0.59)
Cflow.	0.2127	0.2170	0.5789***	0.5820***
	(1.59)	(1.63)	(3.65)	(3.70)
Acq.	-1.9132***	-1.8389***	-1.4668***	-1.4338***
	(-9.71)	(-9.23)	(-7.18)	(-6.90)
Firm Size.	-0.0366***	-0.0383***	-0.0315***	-0.0334***
	(-4.94)	(-5.14)	(-3.58)	(-3.72)
R&D.	1.5364***	1.4715***	1.5474***	1.4400***
	(14.25)	(13.17)	(12.46)	(11.13)
Nwc.	-0.8067***	-0.8631***	-0.8342***	-0.9223***
	(-11.19)	(-10.85)	(-8.71)	(-9.09)
Capex.	-2.2383***	-2.0750***	-2.1390***	-2.0535***
	(-9.52)	(-8.18)	(-8.16)	(-7.23)
Indvol.	0.1069*	0.0991*	0.0224	0.0114
	(1.88)	(1.77)	(0.67)	(0.34)
Cfvol.	0.4288**	0.4013*	0.5434*	0.4166
	(1.98)	(1.86)	(1.93)	(1.48)
Div.	-0.0075	-0.0153	-0.0198	-0.0255
	(-0.31)	(-0.63)	(-0.79)	(-1.00)
Observations	3612	3612	2887	2887
R^2	0.731	0.733	0.755	0.759
Firm fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	No	Yes	No	Yes

t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Subsequently to the unexpected shock, leverage, acquisitions, R&D, net working capital and capital expenditures have lower impact on cash holdings for firms that use derivative

Table 4.9: Expected and unexpected shocks on cash holdings regarding the use of derivatives.

Depend. variable: Net cash holdings	Expected shock		Unexpected shock	
	Non user ^a	User	Non user	User
Treat.	-0.1423*** (-2.74)	0.0097 (0.20)	-0.2974*** (-3.28)	-0.1297* (-1.95)
After2005.	-0.0129 (-0.54)	-0.0086 (-0.20)		
Treatxafter2005.	0.0346 (0.75)	0.0357 (0.64)		
After2012.			-0.0941*** (-2.59)	-0.0073 (-0.24)
Treatxafter2012.			0.1453* (1.92)	0.0045 (0.12)
L. Net Cash.	-0.0028 (-0.17)	-0.0139 (-0.62)	0.1247*** (3.50)	-0.0503 (-1.23)
Lev.	-1.1077*** (-13.85)	-0.3893*** (-2.69)	-0.7055*** (-6.11)	-0.4578*** (-4.78)
Mtb.	-0.0103 (-0.70)	-0.0534 (-1.22)	-0.0212 (-0.93)	0.0269 (0.89)
Cflow.	0.2477* (1.72)	0.5368 (1.01)	0.8158*** (3.58)	0.3243 (1.24)
Acq.	-2.1487*** (-8.62)	-0.6860* (-1.93)	-2.2948*** (-5.49)	-0.6555*** (-3.09)
Firm Size.	-0.0363*** (-4.22)	-0.0066 (-0.49)	-0.0366** (-2.32)	-0.0278** (-2.31)
R&D.	1.3906*** (11.79)	1.5085*** (3.96)	1.4641*** (8.52)	1.1185*** (3.76)
Nwc.	-0.9372*** (-11.12)	-0.0441 (-0.18)	-0.9794*** (-7.38)	-0.6330*** (-3.94)
Capex.	-2.1772*** (-7.40)	-1.1781** (-2.24)	-2.2520*** (-4.59)	-1.2984*** (-2.73)
Indvol.	0.1352** (1.97)	0.0771 (0.87)	0.0158 (0.28)	-0.0495 (-0.81)
Cfvol.	0.3709 (1.56)	1.2210* (1.91)	0.3036 (0.81)	1.4501*** (2.72)
Div.	-0.0278 (-0.94)	0.0119 (0.28)	-0.0669 (-1.45)	-0.0280 (-0.87)
Observations	3066	546	1735	1152
R^2	0.737	0.821	0.802	0.790
Firm fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes

t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ^aNon-user is the firm that not use derivative instrument and user is the firm that use derivative instrument.

than for those do not use derivatives.

We assess that a single standard deviation increase in acquisitions leads to a 10.39% decrease in cash holdings for non derivative users. While this increase influence only a 2.97% decrease in cash ratio for derivative users. We also estimate that a single standard deviation increase in net working capital is associated with a 28.74% decrease in cash holdings for non derivative users. Whereas it could be evaluated that the same increase

reduces the cash holdings for derivative user only by 18.58%, statistically significant at 1% level.

We find that cash holdings for firm that do not use derivatives are more sensitive regarding capital expenditures. A single standard deviation increase in capital expenditures leads to a 12.36% decrease in capital expenditures for non derivative users and 7.36% decrease for derivative user.

The findings on acquisitions and capital expenditures suggest that hedging mitigates financial risks and induces firms to invest more. According to C.-M. Lin, Phillips, and Smith (2008), firms that use financial hedging invest more in risky projects and use less debt in order to maximise their comparative advantage. In Carter et al. (2006), hedging improves the airline firm's ability to invest in economically profitable projects and have higher optimal valuations.

Analysing the impact of leverage on cash holdings after the unexpected shock, we appraise that a single standard deviation increase in leverage leads to respectively a 18% decline in cash reserves for non derivative users and 11.68% for derivative users, statistically significant at 1% level. Following the expected shock, a single standard deviation increase in leverage leads to respectively a 28.26% decline in cash reserves for non derivative users and 9.93% for derivative users, statistically significant at 1% level.

It suggests that firms using derivatives have more debt capacity and internal funds. In turn, it also leads to reduce external financing costs and decrease the probability of future financial distress (Leland, 1998; Froot et al., 1993; Smith & Stulz, 1985).

We further notice that cash flow volatility affects cash holdings for derivative users, statistically significant at 1% level. A single standard deviation increase in cash flow volatility induces derivative users to increase their cash holdings by 17.71%. Although hedging via derivatives provide corporate liquidity when firms need at most, Mello and Parsons (2000) argue that the use of derivatives is efficient only when firms have lower costs of external financing and higher cash resources to support hedging strategies.

Froot et al. (1993) suggest that firms do not hedge must affect the amount of money raised externally or the volume of investment. If firms have variation in cash holdings and cash flows and there is an increase in costs of external financing, firms will bypass growth opportunities and decrease investment amounts.

Lastly, we evaluate that a single standard deviation increase in R&D ratio is related to a 37.24% increase in cash holdings for non derivative user. While the same increase in R&D spendings leads to a 34.65% decrease in cash ratio.

In this regard, the results suggest that firms with lower cash holdings and higher growth opportunities, represented for higher R&D ratios, are likely to have a greater level of sensitivity between derivative usage and growth cash holdings. Therefore, with higher investment opportunity use derivatives more when they also have relatively lower levels of cash.

Nonetheless, when we analyse the relationship between growth opportunities, represented by the market-to-book ratio, cash holdings do not find significant relation as in Graham and Rogers (2002) and Mian (1996).

4.4.4 Further analysis

As further research, we explore the relationship between cash holdings and derivative use between corn-dependent firms that used and not used derivative instruments. To this end, we split our initial sample into two groups, corn-dependent firms that employ derivative as financial instrument risk and corn-dependent firms that do not use derivatives. We use a modified version of our model as showed in Equation 4.5:

$$\text{Cashholdings}_{i,t} = \beta_1 + \beta_2 \text{Treated}_i + \gamma_1 \mathbf{Z}_{i,t} + \eta_i + \varrho_t + v_{i,t}. \quad (4.5)$$

Where: *Cash holdings*_{*i,t*} = cash holdings measured by cash and cash equivalents divided by total assets minus cash and cash equivalents (net assets).

*Treated*_{*i*} = a dummy equal one if corn-dependent firm uses derivatives; 0 if corn-dependent firm does not use derivatives

*Z*_{*i,t*} = vector of control variables.

*η*_{*i*} = firm fixed effects.

*ρ*_{*t*} = industry fixed effects.

*v*_{*i,t*} = error term.

We confirm our prior results in Table 4.10. After the unexpected shock, corn-dependent firms that used derivatives retained less cash than their peers that do not use derivatives. The findings also show that corn-dependent firms that used derivatives engage more in R&D activities and have higher cash flows than firms that did not use derivatives.

4.5 Concluding remarks

In this paper, we propose to analyse several important issues related to corporate cash holdings using two exogenous variation that produce expected and unexpected shocks on corn price volatilities in the American market. The first expected shock on corn prices was the implementation of The Energy Policy Act of 2005 and the second unexpected shock on corn prices was the corn shortfall caused by a drought that happened in the United States in July, 2012.

Employing difference-in-differences approach around these two shocks we find interesting results. First, we show that there are differences in cash holdings for firms exposed to expected and unexpected shocks compared to firms that are not exposed by the shocks. Corn-dependent firms (exposed to the shocks) retained 7.26% more cash than corn independent firms (control group).

We also find that expected and unexpected shocks differently affect corporate cash holding arrangements when financial derivatives are used by firms. Corn-dependent firms that used financial derivatives significantly decreased the amount of cash reserves after both exogenous shocks compared to corn independent firms. This finding suggest that cash holdings and financial derivatives are substitute instruments to manage corporate risk.

We also show that hedging enabled corn-dependent firms to have more debt capacity, increase their R&D activities and invest more. We further find that corn-dependent firms were less affected by the expected shock than to the unexpected shock. It may imply that firms could previously prepare their corporate decisions to the impact of the 2005 Energy Act (expected shock).

Table 4.10: Further analysis: Cash holdings and derivative use on expected and unexpected shocks for corn-dependent firms

Dependent variable: Net cash holdings	Expected shock		Unexpected shock	
	2004	2006	2011	2013
Treated*	0.0322 (1.38)	0.0366 (0.82)	-0.0117 (-0.41)	-0.1054** (-2.11)
L. Net Cash	0.5154*** (7.43)	0.5502*** (6.87)	0.5113*** (6.04)	0.4363*** (5.03)
Lev	-0.6469*** (-3.80)	-0.6494*** (-3.97)	-0.3507*** (-2.95)	-0.4821*** (-3.23)
Mtb	-0.0100 (-0.31)	-0.0085 (-0.29)	0.0015 (0.05)	-0.0540** (-2.23)
Cflow	0.0084 (0.03)	0.1186 (0.43)	0.6318*** (2.59)	0.5064** (1.97)
Acq	-2.4310*** (-3.76)	-2.1495*** (-4.46)	-1.7288*** (-4.34)	-1.4895*** (-3.33)
Firm Size	-0.0165 (-1.49)	-0.0042 (-0.30)	-0.0217* (-1.73)	-0.0259 (-1.54)
R&D	0.7775*** (3.63)	0.8489*** (3.09)	0.6902*** (2.87)	1.2129*** (4.26)
Nwc	-0.5026*** (-3.04)	-0.4866*** (-3.32)	-0.4244** (-2.49)	-0.6714*** (-4.11)
Capex	-2.0355*** (-2.85)	-3.0119*** (-4.84)	-1.1998** (-2.30)	-1.2010** (-2.58)
Indvol	0.1456 (0.69)	0.0094 (0.06)	-0.0889 (-0.58)	0.1238 (0.91)
Cfvol	-0.5556 (-1.19)	-0.7403* (-1.83)	0.8144 (1.36)	-0.3863 (-0.81)
Dividend	-0.0187 (-0.57)	-0.1241*** (-3.10)	0.0091 (0.26)	0.0143 (0.34)
Observations	429	457	376	353
R^2	0.814	0.844	0.784	0.824
Firm fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes

t statistics in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Treated=1 if corn-dependent firm uses derivatives; 0 if corn-dependent firm does not use derivatives.

In sum, our evidence, both anecdotal as well as statistical, indicates that corn-dependent firms facing an unexpected shock reserve more cash than the matched group that do not experience the shock. We further find that financially constrained firms also maintain higher cash balances than unconstrained firms. Our results shows that cash

holdings and derivatives play a substitute role on risk management strategy for corn-dependent firms. The findings suggest that firms that used derivatives are less sensitive to exogenous shocks than firms that did not use these financial hedging instruments.

We also face limitations in this study. The lack of derivative usage database limited our research to explore long-term effects of both shocks. There are few data covering corn shortfall and its economic impact. We cannot infer the results for other types of firms rather than corn-dependent. Finally, we do not consider the derivative notional amount in our paper. For instance, it could show how firms interact corporate hedging, liquidity and financing strategies after experiencing exogenous shocks.

Although we notice that net working capital and R&D activities perform a strong influence on cash holdings for firms that use derivatives, we recognise these points require further investigations as they might influences other corporate decisions such as short-term leverage and long-run investments.

We also do not examine the effects of expected and unexpected shocks on firm value. It could be fruitful for future research to analyse how corporate liquidity and hedging strategies adopted by firms enhance corporate value.

References

- Abad, P., & Robles, M. D. (2014, Sep). Credit rating agencies and idiosyncratic risk: Is there a linkage? Evidence from the Spanish Market. *International Review of Economics & Finance*, *33*, 152–171.
- Acharya, V., Almeida, H., & Campello, M. (2007). Is cash negative debt? A hedging perspective on corporate financial policies. *Journal of Financial Intermediation*, *16*(4), 515–554.
- Acharya, V., Almeida, H., & Campello, M. (2013). Aggregate risk and the choice between cash and lines of credit. *The Journal of Finance*, *68*(5), 2059–2116.
- Acharya, V., Almeida, H., Ippolito, F., & Perez, A. (2014, Jun). Credit lines as monitored liquidity insurance: Theory and evidence. *Journal of Financial Economics*, *112*(3), 287–319.
- Acharya, V., & Bisin, A. (2009, Mar). Managerial hedging, equity ownership, and firm value. *The RAND Journal of Economics*, *40*(1), 47–77.
- Acharya, V., Davydenko, S. A., & Strebulaev, I. A. (2012, Oct). Cash Holdings and Credit Risk. *Review of Financial Studies*, *25*(12), 3572–3609.
- Aizenman, J., & Marion, N. (1999, May). Volatility and Investment: Interpreting Evidence from Developing Countries. *Economica*, *66*(262), 157–1179.
- Alimov, A. (2014). Product market competition and the value of corporate cash: Evidence from trade liberalization. *Journal of Corporate Finance*, *25*(2), 122–139.
- Allayannis, G., & Weston, J. P. (2001, Jan). The Use of Foreign Currency Derivatives and Firm Market. *Review of Financial Studies*, *14*(1), 243–276. Retrieved from <http://dx.doi.org/10.1093/rfs/14.1.243> doi: 10.1093/rfs/14.1.243
- Almeida, H., & Campello, M. (2010). Financing frictions and the substitution between internal and external funds. *Journal of Financial and Quantitative Analysis*, *45*(3), 589–622.
- Almeida, H., Campello, M., Cunha, I., & Weisbach, M. S. (2014). Corporate liquidity management: A conceptual framework and survey. *Annual Review of Financial Economics*, *6*(1), 135–162.
- Almeida, H., Campello, M., & Hackbarth, D. (2011). Liquidity mergers. *Journal of Financial Economics*, *102*(3), 526–558.
- Almeida, H., Campello, M., & Weisbach, M. S. (2004). The cash flow sensitivity of cash. *The Journal of Finance*, *59*(4), 1777–1804.
- Almeida, H., Campello, M., & Weisbach, M. S. (2011). Corporate financial and investment policies when future financing is not frictionless. *Journal of Corporate Finance*, *17*(3), 675–693.
- Al-Najjar, B. (2013). The financial determinants of corporate cash holdings: Evidence from some emerging markets. *International Business Review*, *22*(1), 77–88.
- Al-Najjar, B. (2015). The effect of governance mechanisms on small and medium-sized enterprise cash holdings: Evidence from the United Kingdom. *Journal of Small Business Management*, *53*(2), 303–320.
- Ameer, R. (2012). Impact of cash holdings and ownership concentration on firm valuation: Empirical evidence from Australia. *Review of Accounting and Finance*, *11*(4), 448–467.

- Anderson, R. W., & Carverhill, A. (2012). Corporate liquidity and capital structure. *Review of Financial Studies*, 25(3), 797–837.
- Ang, A., Hodrick, R. J., Xing, Y., & Zhang, X. (2006, Jan). The Cross-Section of Volatility and Expected Returns. *The Journal of Finance*, 61(1), 259–299.
- Ang, A., Hodrick, R. J., Xing, Y., & Zhang, X. (2009, Jan). High idiosyncratic volatility and low returns: International and further U.S. evidence. *Journal of Financial Economics*, 91(1), 1–23.
- Ang, J., & Smedema, A. (2011, Jun). Financial flexibility: Do firms prepare for recession? *Journal of Corporate Finance*, 17(3), 774–787.
- Angrist, J. D., & Pischke, J.-S. (2009). *Mostly harmless econometrics: An empiricist's companion*. Princeton University Press.
- Aretz, K., Bartram, S. M., & Dufey, G. (2007, Nov). Why hedge? Rationales for corporate hedging and value implications. *The Journal of Risk Finance*, 8(5), 434–449.
- Arnold, M. (2014). Managerial cash use, default, and corporate financial policies. *Journal of Corporate Finance*, 27(4), 305–325.
- Babcock, B. A., & Fabiosa, J. F. (2011). *The impact of ethanol and ethanol subsidies on corn prices: Revisiting history*. (Tech. Rep.). Food and Agricultural Policy Research Institute at Iowa State University.
- Babenko, I., Boguth, O., & Tserlukevich, Y. (2015, May). Idiosyncratic Cash Flows and Systematic Risk. *The Journal of Finance*, in press, n/a.
- Baker, A., & Allen, E. (2006). *Feed situation and outlook yearbook* (Tech. Rep.). United States Department of Agriculture.
- Balafas, N., & Florackis, C. (2014, Jun). CEO compensation and future shareholder returns: Evidence from the London Stock Exchange. *Journal of Empirical Finance*, 27, 97–115.
- Baldenius, T. (2006). Ownership, incentives, and the hold-up problem. *The RAND Journal of Economics*, 37(2), 276–299.
- Bali, T. G., Cakici, N., Yan, X. S., & Zhang, Z. (2005, Apr). Does Idiosyncratic Risk Really Matter? *The Journal of Finance*, 60(2), 905–929.
- Bamberger, R. L., & Behrens, C. E. (2005). Energy Policy: Comprehensive Energy Legislation (H.R. 6, S. 10) in the 109th Congress. In *Crs issue brief for congress* (pp. 1–18).
- Bao, D., Chan, K. C., & Zhang, W. (2012). Asymmetric cash flow sensitivity of cash holdings. *Journal of Corporate Finance*, 18(4), 690–700.
- Bartram, S. M., Brown, G. W., & Conrad, J. (2011, May). The Effects of Derivatives on Firm Risk and Value. *J. Financ. Quant. Anal.*, 46(04), 967–999.
- Bates, T. W., Kahle, K. M., & Stulz, R. M. (2009). Why do U.S. firms hold so much more cash than they used to? *The Journal of Finance*, 64(5), 1985–2021.
- Baum, C. F., Chakraborty, A., Han, L., & Boyan. (2012). The effects of uncertainty and corporate governance on firms' demand for liquidity. *Applied Economics*, 44(4), 515–525.
- Beatty, R. P., & Zajac, E. J. (1994, Jun). Managerial Incentives, Monitoring, and Risk Bearing: A Study of Executive Compensation, Ownership, and Board Structure in Initial Public Offerings. *Administrative Science Quarterly*, 39(2), 313–335.
- Bergman, N., Iyer, R., & Thakor, R. (2015, Apr). Financial Accelerator at Work: Evidence from Corn Fields. *Working paper*, 1–47.
- Bigelli, M., & Sánchez-Vidal, J. (2012). Cash holdings in private firms. *Journal of Banking & Finance*, 36(1), 26–35.
- Bolton, P., Chen, H., & Wang, N. (2011, Sep). A Unified Theory of Tobin's q, Corporate Investment, Financing, and Risk Management. *The Journal of Finance*, 66(5),

1545–1578.

- Boutin, X., Cestone, G., Fumagalli, C., Pica, G., & Serrano-Velarde, N. (2013). The deep-pocket effect of internal capital markets. *Journal of Financial Economics*, *109*(1), 122–145.
- Brandt, M. W., Brav, A., Graham, J. R., & Kumar, A. (2009, Dec). The Idiosyncratic Volatility Puzzle: Time Trend or Speculative Episodes? *Review of Financial Studies*, *23*(2), 863–899.
- Brav, A., Jiang, W., & Kim, H. (2011, Oct). The Real Effects of Hedge Fund Activism: Productivity, Asset Allocation, and Labor Outcomes. *Working paper*, 17517.
- Brisker, E. R., Çolak, G., & Peterson, D. R. (2013). Changes in cash holdings around the S&P 500 additions. *Journal of Banking & Finance*, *37*(5), 1787–1807.
- Brooks, C. (2008). *Introductory econometrics for finance* (Second Edition ed.). Cambridge University Press.
- Brown, G., & Kapadia, N. (2007, May). Firm-specific risk and equity market development. *Journal of Financial Economics*, *84*(2), 358–388.
- Brown, J. R., & Petersen, B. C. (2011). Cash holdings and R&D smoothing. *Journal of Corporate Finance*, *17*(3), 694–709.
- Bulan, L. T. (2005, Jan). Real options, irreversible investment and firm uncertainty: New evidence from U.S. firms. *Review of Financial Economics*, *14*(3-4), 255–279.
- Bureau, U. C. (2012). *Statistics of U.S. businesses* (Tech. Rep.). : Author.
- Butler, A. W., & Cornaggia, J. (2011, Jan). Does access to external finance improve productivity? Evidence from a natural experiment. *Journal of Financial Economics*, *99*(1), 184–203.
- Campbell, J. Y., Lettau, M., Malkiel, B. G., & Xu, Y. (2001, Feb). Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk. *The Journal of Finance*, *56*(1), 1–43. Retrieved from <http://dx.doi.org/10.1111/0022-1082.00318> doi: 10.1111/0022-1082.00318
- Campello, M., Giambona, E., Graham, J. R., & Harvey, C. R. (2011). Liquidity management and corporate investment during a financial crisis. *Review of Financial Studies*, *24*(6), 1944–1979.
- Campello, M., Graham, J. R., & Harvey, C. R. (2010). The real effects of financial constraints: Evidence from a financial crisis. *Journal of Financial Economics*, *97*(3), 470–487.
- Carter, D. A., Rogers, D. A., & Simkins, B. J. (2006). Does hedging affect firm value? Evidence from the US airline industry. *Financial Management*, *35*(1).
- Carter, D. A., & Simkins, B. J. (2004, Sep). The market’s reaction to unexpected, catastrophic events: the case of airline stock returns and the September 11th attacks. *The Quarterly Review of Economics and Finance*, *44*(4), 539–558. Retrieved from <http://dx.doi.org/10.1016/j.qref.2003.10.001> doi: 10.1016/j.qref.2003.10.001
- Casu, B., Dontis-Charitos, P., Staikouras, S., & Williams, J. (2015, Mar). Diversification, Size and Risk: the Case of Bank Acquisitions of Nonbank Financial Firms. *Eur Financial Management*, *in press*, n/a. Retrieved from <http://dx.doi.org/10.1111/eufm.12061> doi: 10.1111/eufm.12061
- Center for Crops Utilization Research, C. (2012). *Corn processing and utilization posters* (Tech. Rep.). Iowa State University.
- Chen, D., Li, S., Xiao, J. Z., & Zou, H. (2014). The effect of government quality on corporate cash holdings. *Journal of Corporate Finance*, *27*(4), 384–400.
- Chen, Q., Chen, X., Schipper, K., Xu, Y., & Xue, J. (2012). the sensitivity of corporate cash holdings to corporate governance. *Review of Financial Studies*, *25*(12), 3610–

3644.

- Chen, Y., Dou, P. Y., Rhee, S. G., Truong, C., & Veeraraghavan, M. (2015). National culture and corporate cash holdings around the world. *Journal of Banking & Finance*, *50*(1), 1–18.
- Chen, Y. R. (2008). Corporate governance and cash holdings: Listed new economy versus old economy firms. *Corporate Governance: An International Review*, *16*(5), 430–442.
- Chen, Y. R., & Chuang, W.-T. (2009). alignment or entrenchment? corporate governance and cash holdings in growing firms. *Journal of Business Research*, *62*(11), 1200–1206.
- Chichernea, D. C., Ferguson, M. F., & Kassa, H. (2015, Mar). Idiosyncratic Risk, Investor Base, and Returns. *Financial Management*, *44*(2), 267–293. Retrieved from <http://dx.doi.org/10.1111/fima.12067> doi: 10.1111/fima.12067
- Chordia, T., & Swaminathan, B. (2000). Trading volume and cross-autocorrelations in stock returns. *The Journal of Finance*, *55*(2), 913–935.
- Colquitt, L., Sommer, D., & Godwin, N. (1999). Determinants of cash holdings by property-liability insurers. *Journal of Risk and Insurance*, *66*(3), 401–415.
- Core, J. E., Guay, W. R., & Verdi, R. S. (2006). Agency problems of excess endowment holdings in not-for-profit firms. *Journal of Accounting and Economics*, *41*(3), 307–333.
- Cornaggia, J. (2013, Aug). Does risk management matter? evidence from the u.s. agricultural industry. *Journal of Financial Economics*, *109*(2), 419–440. Retrieved from <http://dx.doi.org/10.1016/j.jfineco.2013.03.004> doi: 10.1016/j.jfineco.2013.03.004
- CRSP. (2015, August). *CRSP Calculations* (Technical report). Center for Research in Security Prices.
- Custódio, C., & Metzger, D. (2014). Financial expert CEOs: CEO's work experience and firm's financial policies. *Journal of Financial Economics*, *114*(1), 125–154.
- David, K. H. (1971, Dec). Culture shock and the development of self-awareness. *Journal of Contemporary Psychotherapy*, *4*(1), 44–48. Retrieved from <http://dx.doi.org/10.1007/BF02110274> doi: 10.1007/bf02110274
- Davis, S. J., Haltiwanger, J., Handley, K., Jarmin, R., Lerner, J., & Miranda, J. (2014). private equity, jobs, and productivity. *American Economic Review*, *104*(12), 3956–3990.
- Davydova, Y., & Sokolov, V. (2014). The real effects of financial constraints: Evidence from a debt subsidization program targeted at strategic firms. *Journal of Empirical Finance*, *29*(5), 247–265.
- Décamps, J.-P., Mariotti, T., Rochet, J.-C., & Villeneuve, S. (2011). Free cash flow, issuance costs, and stock prices. *The Journal of Finance*, *66*(5), 1501–1544.
- DeMarzo, P. M., & Duffie, D. (1991, Apr). Corporate financial hedging with proprietary information. *Journal of Economic Theory*, *53*(2), 261–286. Retrieved from [http://dx.doi.org/10.1016/0022-0531\(91\)90156-X](http://dx.doi.org/10.1016/0022-0531(91)90156-X) doi: 10.1016/0022-0531(91)90156-x
- DeMarzo, P. M., & Duffie, D. (1995, Jul). Corporate incentives for hedging and hedge accounting. *Review of Financial Studies*, *8*(3), 743–771. Retrieved from <http://dx.doi.org/10.1093/rfs/8.3.743> doi: 10.1093/rfs/8.3.743
- Denis, D. J. (2011, Jun). Financial flexibility and corporate liquidity. *Journal of Corporate Finance*, *17*(3), 667–674. Retrieved from <http://dx.doi.org/10.1016/j.jcorpfin.2011.03.006> doi: 10.1016/j.jcorpfin.2011.03.006

- Denis, D. J., & Sibilkov, V. (2010). Financial constraints, investment, and the value of cash holdings. *Review of Financial Studies*, 23(1), 247–269.
- Disatnik, D., Duchin, R., & Schmidt, B. (2013, Apr). Cash flow hedging and liquidity choices. *Review of Finance*, 18(2), 715–748. Retrieved from <http://dx.doi.org/10.1093/rof/rft006> doi: 10.1093/rof/rft006
- Dittmar, A., & Mahrt-Smith, J. (2007). Corporate governance and the value of cash holdings. *Journal of Financial Economics*, 83(3), 599–634.
- Dittmar, A., Mahrt-Smith, J., & Servaes, H. (2003). International corporate governance and corporate cash holdings. *The Journal of Financial and Quantitative Analysis*, 38(1), 111–133.
- D’Mello, R., Krishnaswami, S., & Larkin, P. J. (2008). Determinants of corporate cash holdings: Evidence from spin-offs. *Journal of Banking & Finance*, 32(7), 1209–1220.
- Drobetz, W., Grüninger, M. C., & Hirschvogel, S. (2010). Information asymmetry and the value of cash. *Journal of Banking & Finance*, 34(9), 2168–2184.
- Du, X., & McPhail, L. L. (2012). Inside the black box: the price linkage and transmission between energy and agricultural markets. *The Energy Journal*, 33(2), 171–194.
- Duchin, R. (2010). Cash holdings and corporate diversification. *The Journal of Finance*, 65(3), 955–992.
- Dyregang, S. D., Hanlon, M., & Maydew, E. L. (2008, Jan). Long-run corporate tax avoidance. *The Accounting Review*, 83(1), 61–82. Retrieved from <http://dx.doi.org/10.2308/accr.2008.83.1.61> doi: 10.2308/accr.2008.83.1.61
- EIA. (2004). *Annual energy outlook 2004 with projections to 2025*. (Tech. Rep.). Energy Information Administration.
- Eiling, E. (2013, Jan). Industry-Specific Human Capital, Idiosyncratic Risk, and the Cross-Section of Expected Stock Returns. *The Journal of Finance*, 68(1), 43–84. Retrieved from <http://dx.doi.org/10.1111/j.1540-6261.2012.01794.x> doi: 10.1111/j.1540-6261.2012.01794.x
- Evans, J. L., & Archer, S. H. (1968, Dec). Diversification and the reduction of dispersion: An empirical analysis. *The Journal of Finance*, 23(5), 761–767. Retrieved from <http://dx.doi.org/10.1111/j.1540-6261.1968.tb00315.x> doi: 10.1111/j.1540-6261.1968.tb00315.x
- Faleye, O. (2004). Cash and corporate control. *The Journal of Finance*, 59(5), 2041–2060.
- Fama, E. F., & French, K. R. (1993, Feb). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33(1), 3–56. Retrieved from [http://dx.doi.org/10.1016/0304-405X\(93\)90023-5](http://dx.doi.org/10.1016/0304-405X(93)90023-5) doi: 10.1016/0304-405X(93)90023-5
- Fama, E. F., & French, K. R. (1997, Feb). Industry costs of equity. *Journal of Financial Economics*, 43(2), 153–193. Retrieved from [http://dx.doi.org/10.1016/S0304-405X\(96\)00896-3](http://dx.doi.org/10.1016/S0304-405X(96)00896-3) doi: 10.1016/S0304-405X(96)00896-3
- FAO. (2013). *Drought facts - food and agriculture organization* (Tech. Rep.). Food and Agriculture Organization.
- Faulkender, M., & Wang, R. (2006). Corporate financial policy and the value of cash. *The Journal of Finance*, 61(4), 1957–1990.
- Fazzari, S. M., Hubbard, R. G., & Petersen, B. C. (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, 1988(1), 141–195.
- Feng, X., & Johansson, A. C. (2014). Escaping political extraction: Political participation, institutions, and cash holdings in China. *China Economic Review*, 30(3), 98–112.
- Ferreira, M. A., & Laux, P. (2007, Apr). Corporate Governance, Idiosyncratic Risk, and Information Flow. *The Journal of Finance*, 62(2), 951–989. Retrieved from

<http://dx.doi.org/10.1111/j.1540-6261.2007.01228.x> doi: 10.1111/j.1540-6261.2007.01228.x

- Ferreira, M. A., & Vilela, A. S. (2004). Why do firms hold cash? Evidence from EMU Countries. *European Financial Management*, 10(2), 295–319.
- Fischhoff, B. (1975). Hindsight is not equal to foresight: The effect of outcome knowledge on judgment under uncertainty. *Journal of Experimental Psychology: Human Perception and Performance*, 1(3), 288–299. Retrieved from <http://dx.doi.org/10.1037/0096-1523.1.3.288> doi: 10.1037/0096-1523.1.3.288
- Foley, C. F., & Manova, K. (2014, Oct). international trade, multinational activity, and corporate finance. *Working paper*, 20634.
- Francis, B., Hasan, I., & Wang, H. (2014). Banking deregulation, consolidation, and corporate cash holdings: U.S. evidence. *Journal of Banking & Finance*, 41(4), 45–56.
- French, K. R. (2015). *Detail for 30 Industry Portfolios* (Tech. Rep.). Keneth R. French Website.
- Fresard, L. (2010). Financial strength and product market behavior: The real effects of corporate cash holdings. *The Journal of Finance*, 65(3), 1097–1122.
- Fresard, L. (2011). Cash savings and stock price informativeness. *Review of Finance*, 16(4), 985–1012.
- Frésard, L., & Salva, C. (2010). The value of excess cash and corporate governance: Evidence from US cross-listings. *Journal of Financial Economics*, 98(2), 359–384.
- Fritz Foley, C., Hartzell, J. C., Titman, S., & Twite, G. (2007). Why do firms hold so much cash? A tax-based explanation. *Journal of Financial Economics*, 86(3), 579–607.
- Froot, K. A., Scharfstein, D. S., & Stein, J. C. (1993, Dec). Risk Management: Coordinating Corporate Investment and Financing Policies. *The Journal of Finance*, 48(5), 1629–1658.
- Fu, F. (2009, Jan). Idiosyncratic risk and the cross-section of expected stock returns. *Journal of Financial Economics*, 91(1), 24–37.
- Furrer, O., Thomas, H., & Goussevskaia, A. (2008). the structure and evolution of the strategic management field: a content analysis of 26 years of strategic management research. *International Journal of Management Reviews*, 10(1), 1–23.
- Gamba, A., & Triantis, A. (2008). The value of financial flexibility. *The Journal of Finance*, 63(5), 2263–2296.
- Gamba, A., & Triantis, A. J. (2014, Jan). Corporate Risk Management: Integrating Liquidity, Hedging, and Operating Policies. *Management Science*, 60(1), 246–264.
- Gao, H., Harford, J., & Li, K. (2013). Determinants of corporate cash policy: Insights from private firms. *Journal of Financial Economics*, 109(3), 623–639.
- Gao, N. (2011). The adverse selection effect of corporate cash reserve: Evidence from acquisitions solely financed by stock. *Journal of Corporate Finance*, 17(4), 789–808.
- Gay, G. D., & Nam, J. (1998). The underinvestment problem and corporate derivatives use. *Financial Management*, 27(4), 53–69.
- Geczy, C., Minton, B. A., & Schrand, C. (1997, Sep). Why Firms Use Currency Derivatives. *The Journal of Finance*, 52(4), 1323–1354.
- Geczy, C. C., Minton, B. A., & Schrand, C. (2006). The use of multiple risk management strategies: evidence from the natural gas industry. *The Journal of Risk*, 8(3), 19–54.
- Gerlach, R., Obaydin, I., & Zurbrugg, R. (2015, Jul). The impact of leverage on the idiosyncratic risk and return relationship of REITs around the financial crisis. *International Review of Economics & Finance*, 38, 207–219.

- Glover, B., & Levine, O. (2014). Idiosyncratic Risk and the Manager. *SSRN Journal*.
- Gore, A. (2009). Why do cities hoard cash? Determinants and implications of municipal cash holdings. *Accounting Review*, 84(1), 183–207.
- Goyal, A., & Santa-Clara, P. (2003, Jun). Idiosyncratic Risk Matters! *The Journal of Finance*, 58(3), 975–1007.
- Graham, J. R., & Rogers, D. A. (2002, Apr). Do Firms Hedge in Response to Tax Incentives? *The Journal of Finance*, 57(2), 815–839.
- Guay, W., & Kothari, S. (2003, Dec). How much do firms hedge with derivatives? *Journal of Financial Economics*, 70(3), 423–461.
- Guay, W. R. (1999, Jul). The sensitivity of CEO wealth to equity risk: an analysis of the magnitude and determinants. *Journal of Financial Economics*, 53(1), 43–71.
- Guo, H., & Savickas, R. (2010, Jul). Relation between time-series and cross-sectional effects of idiosyncratic variance on stock returns. *Journal of Banking & Finance*, 34(7), 1637–1649.
- Han, S., & Qiu, J. (2007). Corporate precautionary cash holdings. *Journal of Corporate Finance*, 13(1), 43–57.
- Harford, J. (1999). Corporate cash reserves and acquisitions. *The Journal of Finance*, 54(6), 1969–1997.
- Harford, J., Klasa, S., & Maxwell, W. F. (2014). Refinancing risk and cash holdings. *The Journal of Finance*, 69(3), 975–1012.
- Harford, J., Mansi, S. A., & Maxwell, W. F. (2008). Corporate governance and firm cash holdings in the US. *Journal of Financial Economics*, 87(3), 535–555.
- Hart, C. (2013). *A Crop Marketing Perspective*. (Tech. Rep.). Iowa State University.
- Haushalter, D., Klasa, S., & Maxwell, W. F. (2007). The influence of product market dynamics on a firm's cash holdings and hedging behavior. *Journal of Financial Economics*, 84(3), 797–825.
- Haushalter, G. D. (2000, Feb). Financing Policy, Basis Risk, and Corporate Hedging: Evidence from Oil and Gas Producers. *The Journal of Finance*, 55(1), 107–152.
- Haw, I.-M., Ho, S. S., Hu, B., & Zhang, X. (2011). the contribution of stock repurchases to the value of the firm and cash holdings around the world. *Journal of Corporate Finance*, 17(1), 152–166.
- Hendricks, K. B., & Singhal, V. R. (2005, Mar). An Empirical Analysis of the Effect of Supply Chain Disruptions on Long-Run Stock Price Performance and Equity Risk of the Firm. *Production and Operations Management*, 14(1), 35–52.
- Hoberg, G., Phillips, G., & Prabhala, N. (2014). Product market threats, payouts, and financial flexibility. *The Journal of Finance*, 69(1), 293–324.
- Holmström, B., & Tirole, J. (1998). Private and public supply of liquidity. *Journal of Political Economy*, 106(1), 1–40.
- Holt, M., & Glover, C. (2006). *Energy policy act of 2005: Summary and analysis of enacted provisions* (Tech. Rep.). CRS Report for Congress.
- Hou, K., & Moskowitz, T. J. (2005). Market Frictions, Price Delay, and the Cross-Section of Expected Returns. *Review of Financial Studies*, 18(3), 981–1020.
- Huang, A. G. (2009, Jun). The cross section of cashflow volatility and expected stock returns. *Journal of Empirical Finance*, 16(3), 409–429.
- Huang, C.-W., Ho, P.-H., Lin, C.-Y., & Yen, J.-F. (2014). Firm age, idiosyncratic risk, and long-run SEO underperformance. *International Review of Economics & Finance*.
- Huang, D., & Wang, F. (2009). Cash, investments and asset returns. *Journal of Banking & Finance*, 33(12), 2301–2311.
- Huang, Y., Elkinawy, S., & Jain, P. K. (2013). Investor protection and cash holdings: Evidence from US cross-listing. *Journal of Banking & Finance*, 37(3), 937–951.

- Hugonnier, J., Malamud, S., & Morellec, E. (2014). Capital supply uncertainty, cash holdings, and investment. *Review of Financial Studies*, 28(2), 391–445.
- Irani, R. M., & Oesch, D. (2013, Aug). Monitoring and corporate disclosure: Evidence from a natural experiment. *Journal of Financial Economics*, 109(2), 398–418.
- Irvine, P. J., & Pontiff, J. (2008, Apr). Idiosyncratic Return Volatility, Cash Flows, and Product Market Competition. *Review of Financial Studies*, 22(3), 1149–1177.
- Itzkowitz, J. (2013). Customers and cash: How relationships affect suppliers' cash holdings. *Journal of Corporate Finance*, 19(1), 159–180.
- Jain, B. A., Li, J., & Shao, Y. (2013). Governance, product market competition and cash management in IPO firms. *Journal of Banking & Finance*, 37(6), 2052–2068.
- Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *The American Economic Review*, 76(2), 323–329.
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305–360.
- Jin, Y., & Jorion, P. (2006, Mar). Firm Value and Hedging: Evidence from U.S. Oil and Gas Producers. *The Journal of Finance*, 61(2), 893–919.
- Johnson, R. A., & Wichern, D. W. (2007). *Applied multivariate statistical analysis* (6th ed.). Prentice-Hall.
- Kahle, K. M., & Stulz, R. M. (2013). Access to capital, investment, and the financial crisis. *Journal of Financial Economics*, 110(2), 280–299.
- Kalcheva, I., & Lins, K. V. (2007). International evidence on cash holdings and expected managerial agency problems. *Review of Financial Studies*, 20(4), 1087–1112.
- Kaplan, S. N., & Zingales, L. (1997, Feb). Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints? *The Quarterly Journal of Economics*, 112(1), 169–215.
- Keynes, J. M. (1936). *General theory of employment, interest and money*. London: Palgrave Macmillan.
- Kim, C., & Bettis, R. A. (2014). Cash is surprisingly valuable as a strategic asset. *Strategic Management Journal*, 35(13), 2053–2063.
- Kim, C. S., Mauer, D. C., & Sherman, A. E. (1998). The determinants of corporate liquidity: Theory and evidence. *The Journal of Financial and Quantitative Analysis*, 33(3), 335–359.
- Klasa, S., Maxwell, W. F., & Ortiz-Molina, H. (2009). The strategic use of corporate cash holdings in collective bargaining with labor unions. *Journal of Financial Economics*, 92(3), 421–442.
- Kuan, T.-H., Li, C.-S., & Chu, S.-H. (2011). Cash holdings and corporate governance in family-controlled firms. *Journal of Business Research*, 64(7), 757–764.
- Kuan, T.-H., Li, C.-S., & Liu, C.-C. (2012). Corporate governance and cash holdings: A quantile regression approach. *International Review of Economics & Finance*, 24(0), 303 – 314.
- Kusnadi, Y. (2011). Do corporate governance mechanisms matter for cash holdings and firm value? *Pacific-Basin Finance Journal*, 19(5), 554 – 570.
- Lamont, O. (1997). Cash flow and investment: Evidence from internal capital markets. *The Journal of Finance*, 52(1), 83–109.
- La Porta, R., Lopez-De-Silanes, F., Shleifer, A., & Vishny, R. (2002, Jun). Investor Protection and Corporate Valuation. *The Journal of Finance*, 57(3), 1147–1170.
- Larkin, Y. (2013). Brand perception, cash flow stability, and financial policy. *Journal of Financial Economics*, 110(1), 232–253.

- Lee, B. S., & Suh, J. (2011). Cash holdings and share repurchases: International evidence. *Journal of Corporate Finance*, 17(5), 1306–1329.
- Lee, E., & Powell, R. (2011). Excess cash holdings and shareholder value. *Accounting & Finance*, 51(2), 549–574.
- Lee, J. (2014). Does Derivatives Speculation Affect Liquidity Holdings? *SSRN Journal*.
- Lee, K.-W., & Lee, C.-F. (2009). Cash holdings, corporate governance structure and firm valuation. *Review of Pacific Basin Financial Markets and Policies*, 12(3), 475–508.
- Lee, T. W., & Mitchell, T. R. (1994). An alternative approach: The unfolding model of voluntary employee turnover. *The Academy of Management Review*, 19(1), 51–89.
- Lehmann, B. N. (1990, Jul). Residual risk revisited. *Journal of Econometrics*, 45(1-2), 71–97.
- Leland, H. E. (1992, Jan). Insider Trading: Should It Be Prohibited? *The Journal of Political Economy*, 100(4), 859–887.
- Leland, H. E. (1998, Aug). Agency Costs, Risk Management, and Capital Structure. *The Journal of Finance*, 53(4), 1213–1243.
- Levitas, E., & McFadyen, M. A. (2009). Managing liquidity in research-intensive firms: signaling and cash flow effects of patents and alliance activities. *Strategic Management Journal*, 30(6), 659–678.
- Li, H., Visaltanachoti, N., & Luo, R. H. (2014). Foreign Currency Derivatives and Firm Value: Evidence from New Zealand. *Journal of Financial Risk Management*, 03(03), 96–112.
- Lin, C.-M., Phillips, R. D., & Smith, S. D. (2008, Aug). Hedging, financing, and investment decisions: Theory and empirical. *Journal of Banking & Finance*, 32(8), 1566–1582.
- Lin, Y.-M., & Shen, C.-A. (2015, Apr). Family firms' credit rating, idiosyncratic risk, and earnings management. *Journal of Business Research*, 68(4), 872–877.
- Lins, K. V., Servaes, H., & Tufano, P. (2010). What drives corporate liquidity? An international survey of cash holdings and lines of credit. *Journal of Financial Economics*, 98(1), 160–176.
- Lintner, J. (1965, Feb). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *The Review of Economics and Statistics*, 47(1), 13–37.
- Liu, J. S., Lu, L. Y., Lu, W.-M., & Lin, B. J. (2013). Data envelopment analysis 1978–2010: A citation-based literature survey. *Omega*, 41(1), 3–15.
- Liu, Y. (2011). Founding family ownership and cash holdings. *Journal of Financial Research*, 34(2), 279–294.
- Liu, Y., Mauer, D. C., & Zhang, Y. (2014). Firm cash holdings and CEO inside debt. *Journal of Banking & Finance*, 42(5), 83–100.
- Locorotondo, R., Dewaelheyns, N., & Hulle, C. V. (2014). Cash holdings and business group membership. *Journal of Business Research*, 67(3), 316–323.
- Louis, H., Sun, A. X., & Urcan, O. (2012). Value of cash holdings and accounting conservatism. *Contemporary Accounting Research*, 29(4), 1249–1271.
- Luo, X. (2007, Jul). Consumer Negative Voice and Firm-Idiosyncratic Stock Returns. *Journal of Marketing*, 71(3), 75–88.
- Malkiel, B. G., & Xu, Y. (1997, Jan). Risk and Return Revisited. *Portfolio Management*, 23(3), 9–14.
- Marcel, J. J., & Cowen, A. P. (2013). Cleaning house or jumping ship? Understanding board upheaval following financial fraud. *Strategic Management Journal*, 35(6), 926–937.

- May, A. D. (2014). Corporate liquidity and the contingent nature of bank credit lines: Evidence on the costs and consequences of bank default. *Journal of Corporate Finance*, 29(6), 410–429.
- Mayers, D., & Smith, C. W. (1982). On the Corporate Demand for Insurance. *Huebner International Series on Risk, Insurance and Economic Security*, 190–205.
- Mayers, D., & Smith, C. W. J. . (1987). Corporate insurance and the underinvestment problem. *The Journal of Risk and Insurance*.
- Mazzucato, M., & Tancioni, M. (2008, Jul). Innovation and idiosyncratic risk: an industry- and firm-level analysis. *Industrial and Corporate Change*, 17(4), 779–811.
- Meggingson, W. L., Ullah, B., & Wei, Z. (2014). State ownership, soft-budget constraints, and cash holdings: Evidence from China's privatized firms. *Journal of Banking & Finance*, 48(11), 276–291.
- Mello, A. S., & Parsons, J. E. (2000, Jan). Hedging and Liquidity. *Review of Financial Studies*, 13(1), 127–153.
- Meltzer, A. H. (1963). The demand for money: A cross-section study of business firms. *Quarterly Journal of Economics*, 77(3), 405–422.
- Merton, R. C. (1987, Jul). A Simple Model of Capital Market Equilibrium with Incomplete Information. *The Journal of Finance*, 42(3), 483–510.
- Mian, S. L. (1996, Sep). Evidence on Corporate Hedging Policy. *The Journal of Financial and Quantitative Analysis*, 31(3), 419–439.
- Miffre, J., Brooks, C., & Li, X. (2013, Dec). Idiosyncratic volatility and the pricing of poorly-diversified portfolios. *International Review of Financial Analysis*, 30, 78–85.
- Mikkelson, W. H., & Partch, M. M. (2003). Do persistent large cash reserves hinder performance? *The Journal of Financial and Quantitative Analysis*, 38(2), 275–294.
- Miller, M. H., & Orr, D. (1966). A model of the demand for money by firms. *Quarterly Journal of Economics*, 80(3), 413–435.
- Mishra, A. K., Harris, J. M., Erickson, K. W., Hallahan, C., & Detre, J. D. (2012, Nov). Drivers of agricultural profitability in the USA. *Agricultural Finance Review*, 72(3), 325–340.
- Mueller, E. (2008, Mar). How does owners' exposure to idiosyncratic risk influence the capital structure of private companies? *Journal of Empirical Finance*, 15(2), 185–198.
- Mueller, E. (2010, Mar). Returns to Private Equity - Idiosyncratic Risk Does Matter! *Review of Finance*, 15(3), 545–574.
- Mulligan, C. B. (1997, October 1997). Scale Economies, the value of time, and the demand for money: Longitudinal evidence from firms. *Journal of Political Economy*, Vol. 105(5), 1061–1079.
- Myers, S. C. (1984). The capital structure puzzle. *The Journal of Finance*, 39(3), 574–592.
- Myers, S. C., & Rajan, R. G. (1998, Aug). The paradox of liquidity. *The Quarterly Journal of Economics*, 113(3), 733–771.
- Nance, D. R., Smith, C. W., & W., S. C. (1993, Mar). On the Determinants of Corporate Hedging. *The Journal of Finance*, 48(1), 267–284.
- Nath, H. B., & Brooks, R. D. (2015, Jul). Assessing the idiosyncratic risk and stock returns relation in heteroskedasticity corrected predictive models using quantile regression. *International Review of Economics & Finance*, 38, 94–111.
- Neamtii, M., Shroff, N., White, H. D., & Williams, C. D. (2014). The impact of ambiguity on managerial investment and cash holdings. *Journal of Business Finance &*

- Accounting*, 41(7-8), 1071–1099.
- Nikolov, B., & Whited, T. M. (2014). Agency conflicts and cash: Estimates from a dynamic model. *The Journal of Finance*, 69(5), 1883–1921.
- Nooy, W. d., Mrvar, A., & Batagelj, V. (2005). *Exploratory network analysis with pajek*. Cambridge University Press.
- Norman, D. (2007). *The design of future things*. Basic Books.
- Opler, T., Pinkowitz, L., Stulz, R., & Williamson, R. (1999). The determinants and implications of corporate cash holdings. *Journal of Financial Economics*, 52(1), 3–46.
- Özgür Arslan, Florackis, C., & Ozkan, A. (2006). The role of cash holdings in reducing investment-cash flow sensitivity: Evidence from a financial crisis period in an emerging market. *Emerging Markets Review*, 7(4), 320–338.
- Ozkan, A., & Ozkan, N. (2004). Corporate cash holdings: An empirical investigation of UK companies. *Journal of Banking & Finance*, 28(9), 2103–2134.
- Palazzo, B. (2012). Cash holdings, risk, and expected returns. *Journal of Financial Economics*, 104(1), 162–185.
- Panousi, V., & Papanikolaou, D. (2012, May). Investment, Idiosyncratic Risk, and Ownership. *The Journal of Finance*, 67(3), 1113–1148.
- Pastor, L., & Pietro, V. (2003, Oct). Stock Valuation and Learning about Profitability. *The Journal of Finance*, 58(5), 1749–1790.
- Perez-Gonzalez, F., & Yun, H. (2013, Sep). Risk Management and Firm Value: Evidence from Weather Derivatives. *The Journal of Finance*, 68(5), 2143–2176.
- Pinkowitz, L., Stulz, R. M., & Williamson, R. (2006). Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis. *The Journal of Finance*, 61(6), 2725–2751.
- Pinkowitz, L., Sturgess, J., & Williamson, R. (2013). Do cash stockpiles fuel cash acquisitions? *Journal of Corporate Finance*, 23(6), 128–149.
- Pinkowitz, L., & Williamson, R. (2001). Bank power and cash holdings: Evidence from Japan. *Review of Financial Studies*, 14(4), 1059–1082.
- Prendergast, C. (2000, May). What Trade-off of Risk and Incentives? *American Economic Review*, 90(2), 421–425.
- Prendergast, C. (2002, Oct). The Tenuous Trade-off between Risk and Incentives. *Journal of Political Economy*, 110(5), 1071–1102.
- Qiu, J., & Wan, C. (2014). Technology spillovers and corporate cash holdings. *Journal of Financial Economics*(0), 1 – 16.
- Rajgopal, S., & Venkatachalam, M. (2011, Feb). Financial reporting quality and idiosyncratic return volatility. *Journal of Accounting and Economics*, 51(1-2), 1–20.
- Ramírez, A., & Tadesse, S. (2009). Corporate cash holdings, uncertainty avoidance, and the multinationality of firms. *International Business Review*, 18(4), 387–403.
- Rapp, M. S., Schmid, T., & Urban, D. (2014). The value of financial flexibility and corporate financial policy. *Journal of Corporate Finance*, 29(6), 288–302.
- Riddick, L. A., & Whited, T. M. (2009). The corporate propensity to save. *The Journal of Finance*, 64(4), 1729–1766.
- Roberts, M. R., & Whited, T. M. (2013). Endogeneity in Empirical Corporate Finance1. *Handbook of the Economics of Finance*, 493–572.
- Rosenbaum, P. R. (1984). The consequences of adjustment for a concomitant variable that has been affected by the treatment. *Journal of the Royal Statistical Society*, 147(5), 656–666.
- Roussanov, N. (2010, Sep). Diversification and Its Discontents: Idiosyncratic and Entrepreneurial Risk in the Quest for Social Status. *The Journal of Finance*, 65(5),

1755–1788.

- Sagan, J. (1955, May). Toward a theory of working capital management. *The Journal of Finance*, 10(2), 121–129.
- Schauten, M. B., van Dijk, D., & van der Waal, J.-P. (2013). Corporate governance and the value of excess cash holdings of large European firms. *European Financial Management*, 19(5), 991–1016.
- Schnepf, R., & Yacobucci, B. D. (2013). *Renewable Fuel Standard (RFS): Overview and Issues*. (CRS Report for Congress). CRS Report for Congress.
- Serra, T., Zilberman, D., Gil, J. M., & Goodwin, B. K. (2010, May). Nonlinearities in the U.S. corn-ethanol-oil-gasoline price system. *Agricultural Economics*, 42(1), 35–45.
- Seuring, S. (2013). A review of modeling approaches for sustainable supply chain management. *Decision Support Systems*, 54(4), 1513–1520.
- Sharpe, W. F. (1964, Sep). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance*, 19(3), 425–442.
- Slovic, P., Fischhoff, B., & Lichtenstein, S. (1975). *Cognitive processes and societal risk taking* (Tech. Rep.). Oregon Research Institute.
- Smith, C. W. (1995, Jan). Corporate Risk Management: The theory and practice. *The Journal of Derivatives*, 2(4), 21–30.
- Smith, C. W., & Stulz, R. M. (1985, Dec). The Determinants of Firms' Hedging Policies. *The Journal of Financial and Quantitative Analysis*, 20(4), 391–405.
- Song, K., & Lee, Y. (2012). Long-term effects of a financial crisis: Evidence from cash holdings of East Asian firms. *Journal of Financial and Quantitative Analysis*, 47(3), 617–641.
- Statman, M. (1987, Sep). How Many Stocks Make a Diversified Portfolio? *The Journal of Financial and Quantitative Analysis*, 22(3), 353–363.
- Stock, J. H., & Watson, M. W. (2011). *Introduction to econometrics*. Pearson/Education.
- Stuart, E. A. (2010, Feb). Matching Methods for Causal Inference: A Review and a Look Forward. *Statist. Sci.*, 25(1), 1–21.
- Stulz, R. M. (1984, Jun). Optimal Hedging Policies. *The Journal of Financial and Quantitative Analysis*, 19(2), 127–140.
- Subramaniam, V., Tang, T. T., Yue, H., & Zhou, X. (2011). Firm structure and corporate cash holdings. *Journal of Corporate Finance*, 17(3), 759–773.
- Sutcliffe, K. M., & Weick, K. E. (2001). *Managing the unexpected: Assuring high performance in an age of complexity* (Tech. Rep.). Michigan School of Business.
- Tirole, J. (2006). *The theory of corporate finance*. Princeton.
- Tong, Z. (2010). CEO risk incentives and corporate cash holdings. *Journal of Business Finance & Accounting*, 37(9-10), 1248–1280.
- Tong, Z. (2011). Firm diversification and the value of corporate cash holdings. *Journal of Corporate Finance*, 17(3), 741–758.
- Trujillo-Barrera, A., Mallory, M., & Garcia, P. (2012). Volatility spillovers in U.S. crude oil, ethanol, and corn futures markets. *Journal of Agricultural and Resource Economics*.
- Tufano, P. (1996, Sep). Who Manages Risk? An Empirical Examination of Risk Management Practices in the Gold Mining Industry. *The Journal of Finance*, 51(4), 1097–1137.
- USDA. (2015). *Corn report and U.S. Drought 2012: Farm and Food Impacts*. (Tech. Rep.). Author.
- Wei, S. X., & Zhang, C. (2005, Mar). Idiosyncratic risk does not matter: A re-examination of the relationship between average returns and average volatilities. *Journal of Banking & Finance*, 29(3), 603–621.

- Westcott, P. C., & Jewison, M. (2013). *Weather effects on expected corn and soybean yields* (Tech. Rep.). USDA.
- Whited, T. M., & Wu, G. (2006, Jan). Financial Constraints Risk. *Review of Financial Studies*, *19*(2), 531–559.
- Woodard, J. D., Schnitkey, G. D., Sherrick, B. J., Lozano-Gracia, N., & Anselin, L. (2010, Nov). A Spatial Econometric Analysis of Loss Experience in the U.S. Crop Insurance Program. *Journal of Risk and Insurance*, *79*(1), 261–286.
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (Second edition ed.). The MIT Press.
- Wooldridge, J. M. (2012). *Introductory econometrics: A modern approach (upper level economics titles)* (5th Edition ed.). South-Western College Pub.
- Wu, W., Rui, O. M., & Wu, C. (2012, Nov). Trade credit, cash holdings, and financial deepening: Evidence from a transitional economy. *Journal of Banking & Finance*, *36*(11), 2868–2883.
- Xu, Y., & Malkiel, B. G. (2003, Oct). Investigating the Behavior of Idiosyncratic Volatility. *J BUS*, *76*(4), 613–645.
- Yun, H. (2009). The Choice of Corporate Liquidity and Corporate Governance. *Review of Financial Studies*, *22*(4), 1447–1475.
- Yung, K., & Nafar, N. A. (2014, Sep). Creditor rights and corporate cash holdings: International evidence. *International Review of Economics & Finance*, *33*, 111–127.
- Zajac, E. J., & Westphal, J. D. (1994). The Costs and Benefits of Managerial Incentives and Monitoring in Large U.S. Corporations: When is More not Better? *Strategic Management Journal*, *15*(S1), 121–142.
- Zhu, P., Jog, V., & Otchere, I. (2014, Jun). Idiosyncratic volatility and mergers and acquisitions in emerging markets. *Emerging Markets Review*, *19*, 18–48.

A Table of data classification

to be continued.

Study	Category									
	1	2	3	4	5	6	7	8	9	10
Acharya et al. (2007).	E	B	A,B,D	C	A,B	D	B	A	A,D	A,B
Acharya et al. (2013).	D	B	A,B,D	B	A,B,C	D	B	A	C	A,B
Acharya et al. (2014).	D	B	A,B,D	B	A,B	D	B	A	A,B	A,B
Acharya et al. (2012).	D	B	A,D	B	A,B,C	D	B	A	A	A,B
Alimov (2014).	C	B	D	B	A,B,D	D	B	B	D	A,B
Almeida and Campello (2010).	D	B	B,D	B	A,B	D	B	A	A	A,B
Almeida et al. (2004).	A	B	A,B,D	C	A,B,D	D	B	A	B	B
Almeida, Campello, and Hackbarth (2011).	A,E	B	A,B,D	C	A,B	C	B	A	A,D	A,B
Almeida, Campello, and Weisbach (2011).	E	B	A	D	A,B	D	H	E	A	A
Almeida et al. (2014).	E	A	A,E	D	F	E	H	E	D	G
Al-Najjar (2013).	C	B	B	A	A	A,D	D,E	B	D	B,C,D
Al-Najjar (2015).	A	B	B	A	A,B,D	D	C	B	A	B
Anderson and Carverhill (2012).	A	B	A,B,C	D	A,B	D	B	A	A	A,B
Arnold (2014).	E	B	A	D	A,B,D	D	H	E	C	B
Özgür Arslan et al. (2006).	E	B	B	A	A,B,D	B	D	C	C	B,C
Baldenius (2006).	B	B	A	D	A,B,D	D	H	E	D	A
Bao et al. (2012).	E	B	B,D	C	A,B	D	B	A	D	A,B
Bates et al. (2009).	A	B	B,D	A	A,B	D	B	A	A	B
Bigelli and Sánchez-Vidal (2012).	B	B	B,D	A	A,B,C,D	C,D	C	B	D	B
Boutin et al. (2013).	D	B	B,D	C	A,B,C,D	B	C	B	D	A,B
Brisker et al. (2013).	A	B	D	C	A,B,D	D	B	A	D	A,B
J. R. Brown and Petersen (2011).	A	B	B	C	A,B	D	B	A	D	A,B

continuation.

Study	Category									
	1	2	3	4	5	6	7	8	9	10
Campello et al. (2010).	E	B,F	D	C	A,B,E	D	A	D	A	A,B,E
Campello et al. (2011).	A,E	B,F	D	C	A,B,E	D	A	D	C	A,B,E
Y. R. Chen (2008).	B	B	B	A	A,B,D	D	B	C	C	A,B
Y. R. Chen and Chuang (2009).	B	B	B	A	A,B	D	B	B	D	B
Q. Chen et al. (2012).	B	B	B	A	A,B,D	D	D	B	D	A,B
D. Chen et al. (2014).	C	B	B	A	A,B,C,D	D	D	D	D	A,B
Y. Chen et al. (2015).	C	B	B	A	A,C,F	A, D	A	A	C	A,B,E
Colquitt et al. (1999).	B,D	B	B	A	A,B	D	B	D	C	B
Core et al. (2006).	B	B	B	B	A	D	B	A	D	B,C
Custódio and Metzger (2014).	B	B	B,D	B	A,B,D	D	B	A	A,D	A,B
D'Mello et al. (2008).	A	B	B,D	A	A,B,D	C,D	B	A	C	A,B
Davydova and Sokolov (2014).	E	B	D	B	A,B,C,D	D	G	B	A,B	A,B
Décamps et al. (2011).	B	B	A	D	A, B	D	H	E	C,D	A
Denis and Sibilkov (2010).	E	B	B	C	A,B	D	B	A	C	B
Dittmar and Mahrt-Smith (2007).	B	B	B	C	A,B	D	B	A	C	B,C
Dittmar et al. (2003).	B	B	D	A	A,B,C	A,D	A	D	C	B,E
Drobetz et al. (2010).	E	B	B	B	A,B	A,D	A	A	C	B,C,E
Duchin (2010).	A	B	B	A	A,B	C,D	A	A	C	B,E
Faleye (2004).	B	B	B,D	B	A,B,D	D	B	A	C	A,B
Faulkender and Wang (2006).	A	B	B,D	C	A,B	D	B	B	C	A,B
Feng and Johansson (2014).	C	B	B,D	A	A,B	D	D	A	C	B
Ferreira and Vilela (2004).	B	B	B	A	A,B,D	A,D	C	A	A, C	A,B
Francis et al. (2014).	D	B	D	A	A,B,D	D	B	A	D	A,B
Frésard and Salva (2010).	B	B	D	B	A,B,D	C,D	B	A	C	A,B
Fresard (2011).	A	B	B	C	A,B	D	B	A	C	A,B
Fresard (2010).	B	B	B	B	A,B,C	A,D	A	A	D	B,E

continuation.

Study	Category									
	1	2	3	4	5	6	7	8	9	10
Fritz Foley et al. (2007).	A	B	B	A	A,B,D	D	B	A	C	B
Gamba and Triantis (2008).	A	B	A	D	A,B	D	H	E	D	A
N. Gao (2011).	E	B	B	C	A,B	D	B	A	C	A,B
H. Gao et al. (2013).	B	B	B	A	A,B	C,D	B	A	C	A,B
Gore (2009).	B	B	B	A	A,B	C	B	B	C	A,B
Han and Qiu (2007).	A	B	B	A	A,B	D	B	B	C	A,B
Harford (1999).	A	B	B	C	A	C,D	B	A	A	A,B
Harford et al. (2008).	B	B	B,D	A	A,B	D	B	A	C	B
Harford et al. (2014).	E	B	D	B	A,B,D	C,D	B	A	C	A,B
D. Haushalter et al. (2007).	B	B	B,D	A	A,B	C,D	B	B	D	A,B
Haw et al. (2011).	A	B	D	B	A,B,C,D	D	A	B	A,B	A,B
Hoberg et al. (2014).	C	B	B	C	A,B	C,D	B	A	D	A,B
Holmström and Tirole (1998).	B	B	A,C	D	G	D	H	E	A	A
A. G. Huang (2009).	A	B	A,B,D	C	A,B	D	B	A	A	A,B
Y. Huang et al. (2013).	B	B	D	A	A,B,C	D	A	A	C	A,B
Itzkowitz (2013).	C	B	B	A	A,B	D,E	B	A	A	B
Jain et al. (2013).	B,C	B	B	A	A,B	D	B	B	D	B
Kahle and Stulz (2013).	E	B	D	C	A,B,D	D	B	A	C	B
Kalcheva and Lins (2007).	B	B	B	A	A,B	D	A	D	C,D	B
C. Kim and Bettis (2014).	A	B	B	B	A	D	B	A	C	B
C. S. Kim et al. (1998).	A	B	B	A	A,B	C,D	B	A	A,D	A,B
Klasa et al. (2009).	C	B	D	C	A,B	D	D	A	D	B
Kuan et al. (2011).	B	B	D	A	A,B	D	D	A	D	B

Study	Category									
	1	2	3	4	5	6	7	8	9	10
Kusnadi (2011).	A,B	B	B	C	A,B,D	D	A	B	D	B,E
Lamont (1997).	D	B	D	C	A	C,D	B	D	D	A,B
Larkin (2013).	C	B,F	B	B	A,B	D	B	A	C,D	B
E. Lee and Powell (2011).	A	B	D	B	A,B,C	A,D	A	B	C	B
Levitas and McFadyen (2009).	A	B	D	C	A,B	D	B	B	D	B
Lins et al. (2010).	D	B,F	D	C	A	D	A	D	D	A,B
Y. Liu (2011).	B	B	A	A	A,B	D	B	A	A	B
Y. Liu et al. (2014).	B	B	B	A	A,B	B	C	B	D	B
Locorotondo et al. (2014).	B	B	B	B	A,B	B	C	B	D	B
Louis et al. (2012).	A	B	B	C	A,B	D	B	A	D	B
May (2014).	D	B	B	B	A,B	D	B	D	D	A,B
Megginson et al. (2014).	B, E	B	B	A	A,B	A,C,D	D	A	D	A,B
Meltzer (1963).	A	B	B	D	A	C,D	B	A	D	A,B
Mikkelson and Partch (2003).	A	B	B	C	A,B	C,D	B	A	C	B
Neamtiu et al. (2014).	E	B	A,D	A	A,B,C	D	B	A	A	B
Nikolov and Whited (2014).	B	B	A,D	C	A,B,C	D	B	A	C	A,B
Opler et al. (1999).	A	B	B	A	A,B	C,D	B	A	D	A,B
Ozkan and Ozkan (2004).	B	B	B	A	A,B	D	C	A	D	B
Palazzo (2012).	E	B	A,B	B	A,B	D	B	A	E	A,B
Pinkowitz and Williamson (2001).	D	B	B	A	A,B	A,B,D	A	A	A,D	A,B
Pinkowitz et al. (2006).	B	B	B	C	A,B,C	A,D	A	A	A	B
Pinkowitz et al. (2013).	A	B	D	C	A,B,D	D	B	A	C	A,B
Qiu and Wan (2014).	A	B	B	A	A,B	C,D	B	A	D	A,B
Ramírez and Tadesse (2009).	C,E	B	B	A	A,B,C	A,D	A	A	A	A,B
Rapp et al. (2014).	A	B	D	C	A,B	D	B	A	A,D	B
Riddick and Whited (2009).	A	B	A,B,C,D	C	A,B	D	A	A	B,C	A,B
Schauten et al. (2013).	B	B	B	C	A,B	A,C,D	C	A	C	B
Song and Lee (2012).	E	B	D	A	A,B,D	D	D	A	D	B
Subramaniam et al. (2011).	B	B	B	C	A,B	C,D	B	A	D	B
Tong (2010).	B	B	B	B	A,B,C	D	B	B	C	B
Tong (2011).	A	B	B	C	A,B	C,D	B	B	C	B
Wu et al. (2012).	D	B	B	A	A,B,C	D	D	A	C	A,B
Yun (2009).	B	B	D	A	A,B	D	D	A	C	A,B

Table A.1: Data classification and categorization for each paper.

B Resume of papers – Table B.1

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Acharya et al. (2007).	To study how firms allocate cash flows across their cash and debt accounts.	To present that both firms, constrained and unconstrained, use excess cash flows to reduce the amount of outstanding debt when their hedging needs are low. In this state, a firm has high investment opportunities; thus, it may allocate its cash flow towards debt reductions to save/amplify its debt capacity. However, firms will prefer higher cash to lower debt if their hedging needs are higher, that is, in a state of low future investment opportunities.	To suggest firms have to use cash and debt as hedging tools. Acharya et al. (2007)'s paper is one of the first to empirically operationalise the notion of hedging needs as the key determinant of the firms' preferences (hold or not hold cash).	
Acharya et al. (2013).	To develop a theoretical novel on the trade-offs between cash and credit lines moderate by aggregate risk and liquidity premiums.	To suggest as aggregate risk increases firms are more exposed to systematic risks holding more cash and decreasing the demand for credit lines .	To complement the theoretical literature by explaining why firms have used pledged sources such as cash and credit lines to manage their liquidity needs.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
<p>Acharya et al. (2014).</p> <p>To design a theoretical model on corporate liquidity and empirically test the effect of liquidity risk on credit lines and liquidity management.</p>	<p>To characterise how cash-based liquidity management firms tend to invest in illiquid projects . As a result of greater liquidity risk, higher costs for borrowing bank credit lines are required from these firms. Therefore, liquidity riskier firms are likely to rely on cash instead of credit lines for liquidity management. On the contrary, firms with low hedging needs are associated with the probability of using a credit line.</p>	<p>To present a new identification strategy for liquidity risk tests and hedging needs tests addressing the role of credit lines as a financial monitor in handling the illiquidity transformation problem.</p>		
<p>Acharya et al. (2012).</p> <p>To study the interactions between cash holdings and credit risk from a theoretical framework and empirical test.</p>	<p>To suggest that firms with larger cash holdings are associated with higher levels of credit risk.</p>	<p>To present that the correlation between cash and credit risk reverses the sign for periods longer than one year, thus becoming positive and strongly statistically significant . That is, higher cash holdings reduce the probability of a cash shortfall; however, they increase the long-term probability of default because higher cash savings require reductions in valuable investments. Consequently, there are no future incremental cash flows to support its business cycle and the firm can become financially bankrupt.</p>		

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Alimov (2014).	To investigate the interaction amongst product market competition, trade liberalisation and corporate cash holdings.	To point out that trade liberalisation leads to positive and causal effects between the intensity of market competition and corporate cash holdings. To report a degree of complementarity between internal and external financing funds amongst financially constrained firms relative to those unconstrained that might evidence an endogenous connection between investment and financing decisions. To demonstrate the cash flow sensitivity of cash is close to and not statistically different from zero for the unconstrained firms but positive and significantly different from zero for the constrained firms. Additionally, constrained firms hold considerable portions of cash during downturns, while unconstrained firms do not display changes in their cash policies.	To show first-hand the influence of product market competition on corporate cash holdings from a quasi-experiment.	
Almeida and Campello (2010).	To examine the relationship amongst financial constraints and internal and external sources of financing.		To provide evidence that investment and financing decisions might be interdependent.	
Almeida et al. (2004).	To design a liquidity model of cash flow sensitivity of cash that captures the effect of financial constraints on corporate policies.		To pursue the approach of the sensitivity of cash holdings to cash flow on corporate liquidity literature.	
Almeida, Campello, and Harth (2011).	To propose a theoretical relationship amongst corporate liquidity, asset re-allocation and acquisitions.	To empirically examine the role of alternative liquidity instruments in the financing acquisitions.	To predict that financially distressed firms are likely acquired by firms in the same industry are more prevalent amongst asset specificity industry firms and using bank credit lines as a financing mechanism for these acquisitions.	To present credit lines as an effective tool to transfer liquidity across states, particularly financing investment opportunities such as acquisitions.

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Almeida, Campello, and Weisbach (2011).	To frame a novel about how real corporate investment decisions are affected by intertemporal financing frictions.	To theoretically state a positive relationship amongst financial constraints, cash holdings and types of investment.	To increment the literature by providing a theoretical framework that supports patterns tested previously by empirical works on risk-taking behaviour, capital structure choices, hedging strategies and cash management policies.	
Almeida et al. (2014).	To present a model and a survey from empirical findings on liquidity management such as the agency-based theories of liquidity, the real effects of liquidity choices and the impact of the 2008-2009 Financial Crisis on firms' liquidity management.	To reinforce the importance of today's liquidity management research in terms of academic purposes as well as the financial manager's job. Although the liquidity management literature has addressed several topics, there are other unsolved issues; for example, the increased ratio of cash over assets in the last years, the way in which firms hold cash or the lack of information about the use of credit lines and derivatives by firms as a potential substitute source of cash.	To present an almost complete survey on liquidity management divided by clustered areas on the field that allow for a picture of the liquidity management literature.	To cover only a part of the literature on liquidity management, while remaining silent on issues such as the estimates of the value of cash, the asset pricing implications of corporate liquidity and dynamic models of cash.
Al-Najjar (2013).	To investigate the effect of capital structure and dividend policy on cash holdings in developing countries such as Brazil, Russia, India and China while comparing the results with a sample from the U.S. and the UK.	To show that the leverage, dividend payout, profitability, asset liquidity and firm size have affected corporate cash holdings in both emerging markets and developed countries (U.S. and UK).	To ascribe the differences among countries with different industrial and institutional settings because the financial decisions vary among firms.	To concentrate on emerging markets (Brazil, Russia, India and China) in terms of the effect of capital structure and dividend policy on cash holdings.

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Al-Najjar (2015).	To focus on the relationship amongst governance mechanisms, ownership and cash holdings in British small and medium-sized enterprises (SMEs).	To report that cash holdings are affected positively by CEO compensation and R&D and negatively by leverage and liquidity. Contrary to the prior literature, growth opportunities, cash flows and capital expenditures are not related with SMEs cash holdings.	To focus on the importance of internal governance mechanisms in cash holding decisions inside SMEs.	To limit in affirming that SME firms have cash holding targets but not display what these targets are and how firms fit these cash reserve levels. The author further exposes that the equal weight methodology adopted to design the governance index might lead to an insignificant relationship in his study. Other restrictions are reserved by the limited availability of the financial and governance information for SMEs.
Anderson and Carverhill (2012).	To dynamically determine the optimal level of cash holding and leverage the policy in a firm with the given assets in place and long-term outstanding debts.	To theoretically design that firms have a negative marginal propensity to save cash at a higher profitability scenario and independently of their investment projects; whereas, at a lower profitability frame, the relationship between investment and cash holdings becomes highly path dependent.	To shed light on the optimal level of cash holdings as a decreasing function of profitability scenarios.	
Arnold (2014).	To extend and test a trade-off model of capital structure incorporating corporate cash management and agency conflicts between managers and shareholders.	To theoretically predict that managers hold an excess of cash to defer default risk by liquidating a debt instead of employing these cash holdings in investment opportunities during economic distress.	To aggregate through modelling another insight other than the agency framework as to why managers hold excess cash inside companies.	To present only a simulation from his framework.

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Özgür Arslan et al. (2006).	To explore the interaction amongst financing constraints, investment cash flow sensitivities and cash holdings in Turkish firms.	To suggest that cash is a hedging instrument that leads with cash flow fluctuations and fuels investment opportunities. Financially constrained firms hold less cash and display higher investment-cash flow sensitivity than unconstrained ones in the Turkish context.	To present a view that cash holdings is considered a proxy for financial constraints.	
Baldenius (2006).	To frame a theoretical insight to explore how agency relationships affect corporate cash decisions inside vertically integrated firms.	To present insight into how ownership affects the manager's behavior in vertically integrated firms that alleviate cash hold-up and underinvestment problems.	To lay out the vertical integration settings that demonstrate how compensation design varies across organizational forms and can influence firm performance and cash holdings.	
Bao et al. (2012).	To examine the relationship between the cash flow sensitivity of cash and cash flow environment faced by the firm (negative or positive).	To show that firms have different levels of responses to their cash holdings when facing positive and negative cash flows. Further, to identify that constrained firms facing profit shocks must save money and give up investing in new projects.	To display a nonlinear perspective on the cash flow sensitivity of cash, meaning that firms respond asymmetrically to their cash holdings as they face different cash flow environments.	
Bates et al. (2009).	To investigate the causes of why U.S. firms have held more cash than they used to.	To identify a significant increase in the cash holdings and decrease in the net debt of U.S. firms from 1980 to 2006.	To pinpoint that this increase has been driven by precautionary savings, especially into industries with higher idiosyncratic risk and those that do not pay dividends and are not influenced by agency conflicts.	To document a broad comparative view as to why different types of American corporations have maintained more cash than they effectively need.

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Bigelli and Sánchez-Vidal (2012).	To study the determinants of corporate cash holdings in private Italian firms.	To display that smaller, riskier, higher financing deficits and younger Italian firms tend to hold more cash reserves and less noncash components (such as bank debt and net working capital) than the other firms (larger and richer companies). To exhibit that firms from financially strong business groups have their entry into facilitated markets because they are supported by internal capital markets provided by other affiliated firms.	To contribute to the literature on cash holding by analysing the determinants of cash holdings in Italian private firms.	
Boutin et al. (2013).	To investigate the relationship between internal capital markets operating within business groups and entrant firms into market.	To present that firms tend to hold on average 7% less cash after the inclusion into the S&P 500 Index, while firms in the top-size-decile of Computat increase their cash holdings over time.	To empirically assess the impact of business group cash holdings on product market competition.	To set up a unique dataset that allows to reach new conclusions on French business groups.
Brisker et al. (2013).	To analyse if the addition to the S&P 500 Index affects the firm's liquidity policy, specifically in cash holdings management.	To show that younger firms facing financing constraints rely on cash holdings to buffer their R&D flows from financial downturns.	To document first-hand that the cash holding policy of the firm is affected by inclusion into the S&P 500 Index.	Not to present that the empirical support of the declining investment opportunities hypothesis can be explained by other issues such as the increase of acquisitions found by the authors into indexed firms.
J. R. Brown and Petersen (2011).	To examine the role of corporate cash holdings on R&D investments during financial shocks.		To provide insight into the importance of cash holdings to R&D-intensive firms, especially for younger companies.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Campello et al. (2010).	To develop a survey-based measure of financial constraint that identifies cross-sectional variations in liquidity and spending plans for public and private firms around the world during the 2008 crisis.	To assess constrained firms' reported plans of cutting more spending in employment (by 11%), technology (by 22%), capital investment (by 9%) and dividend payments (by 14%) in 2009. Firms facing financial constraints hold more cash to protect themselves from financial downturns than unconstrained peers.	To contribute with a new perspective on the real corporate decisions and financial constraints from a survey of CFOs from firms around the world during the 2008 financial crisis.	To confirm that uncontrolled firms' heterogeneity may confound the final inferences. The authors also emphasise that research based on surveys may be compromised if questions are misunderstood by the audience.
Campello et al. (2011).	To investigate the interaction between internal and external sources of liquidity on corporate decision behaviour, such as investment, technology and employment expenditures, during the financial 2008-2009 crisis.	To display that smaller, private, non-investment grade and unprofitable firms draw significantly larger amounts of funds under their line facilities than their larger, public, investment-grade and profitable counterparts. Further, to expose the substitution effects of internal funds to the external ones during the crisis.	To lay out the role of drawdown activity and the dynamics of covenant violations on corporate management liquidity. By deeply analysing the influence of liquidity on corporate real decisions, the authors shed light on how liquidity management and real-side decisions are interconnected.	To be limited on one cross-section of firms. By using the survey to gather previous information from corporate managers, <i>"it is still possible that some of the questions were misunderstood or otherwise produced noisy measures of the variables of interest"</i> .
Y. R. Chen (2008).	To study the influence of governance on corporate cash holding policies in listed new economy and old economy firms.	To present that listed new economy and old economy behaved differently regarding the interaction between cash holdings and corporate governance. Firms with higher board independence hold more cash than their counterparts for risk-aversion reasons and investment opportunities.	To be the first paper to distinguish the effects of corporate governance on cash holdings in listed new economy and old economy firms.	To perform inference on a small sample and the measurement of the anti-takeover index.

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Y. R. Chen and Chuang (2009).	To analyse the interaction between corporate cash holdings and governance mechanisms in high-tech firms.	To exhibit that CEO ownership, VC directors and independent directors positively affect corporate cash holdings.	To show that the effects of corporate governance on corporate cash holdings are different between high-tech and non-high-tech firms, especially in cases where venture capitalists (VCs) and founders play a role in their governance mechanisms.	
Q. Chen et al. (2012).	To shape the sensitivity of cash holdings from corporate governance inside Chinese firms.	To show that corporate cash holding decreased from 23.5% of noncash assets to 20.8% of noncash assets after the 2005 share reform, particularly in firms with weaker corporate governance and tighter financial constraints.	To present the change of corporate cash holding behaviour after a share reform in 2005 and its relationship with corporate governance and financial constraints in China.	
D. Chen et al. (2014).	To analyse the effects of government quality on cash holdings in China.	To present that government quality is negatively related to corporate cash holdings in firms facing financial constraints. Moreover, a better quality of government boosts firms' access to bank loans and trade credit, thus reducing financial constraints and allowing less cash holdings by private local firms in China.	To combine the law and finance literature to evidence how the government quality might mitigate firm financial constraints and reduce the level of cash holdings by firms in China.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
<p>Y. Chen et al. (2015).</p> <p>To evaluate the impacts of national cultural dimensions (individualism and uncertainty avoidance) on corporate cash hoardings around the world.</p>	<p>To display that higher individualism index country-firms or lower uncertainty avoidance index country-firms detain less cash than their counterpart groups. Moreover, higher individualism rated firms tend to invest more in capital expenditures, acquisitions and repurchases, yet they spend less in dividend payments. Firms in higher uncertainty avoidance index countries reserve more cash but do not engage it in repurchases.</p>	<p>To lay out the distinct literature from the corporate cash holdings, cross-cultural psychology and behavioural finance and present firsthand the effects of the national culture on corporate decisions, particularly on the cash holding policy.</p>	<p>To outline the specification of features such as the quality or risk level of corporate investment around the world related to the money that is spent in acquisitions, capital expenditures and repurchases.</p>	
<p>Colquitt et al. (1999).</p> <p>To investigate the variation in cash holdings amongst American property-liability insurers from 1993 to 1995.</p>	<p>To demonstrate that smaller insurance firms, insurers with shorter-tail liability durations, riskier cash flows and greater future investment opportunities hoard more cash for liquidity needs. On the other hand, mutual insurers, larger insurance companies, insurers with higher best's ratings and highly levered insurers sustain less cash for accessing more easily alternative financial resources.</p>	<p>To approach the main differences in cash holdings across insurance firms in the U.S.</p>		

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Core et al. (2006).	To study if growth opportunities, monitoring and agency problems are determinants in explaining why not-for-profit firms have persistent cash holdings over time.	To show that excess endowments are negatively related to growth opportunities and positively related to CEO compensation. However, firms that hold more cash are likely less efficient, thus suggesting the presence of agency conflicts.	To research cash holdings on the unexplored context of not-for-profit firms and report that the endowment holdings by not-for-profit firms are, on average, larger than cash holdings by for-profit firms.	
Custódio and Metzger (2014).	To analyse the relationship between CEO's work experience and corporate financial policies.	To present that nonfinancial firms with financial expert CEOs have on average lower cash holdings (by 12% less), a higher leverage ratio (by 6% more), higher repurchase shares (by 7% more) and lower investment-to-cash flow sensitivity. Furthermore, financial CEO experts have better communication with other organisations and better access to external financial funds.	To describe an interesting connection between firms with financial expert CEOs and corporate financial policies.	
D'Mello et al. (2008).	To examine, from the setting of a spin-off, the forward factors that determine cash holding policies and decisions, especially the initial cash allocation around a new company.	To evidence that the cash ratio is negatively correlated with size and leverage, and positively related to rated debt in spin-offs. Furthermore, to find that cash allocation in a spin-off is not affected by market-to-book ratio, capital expenditures and financial distress costs.	To address their focus on the setting of a spin-off.	Not to present an explanation as to why the cash ratio is not affected by financial distress costs, but it is, at same time, very relevant towards the firms' ability to access external capital for their cash allocation decision.

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Davydova and Sokolov (2014).	To analyse the impact of the corporate subsidisation program implemented by Russian government on firms' investment and cash policies during the financial crisis.	To present that the Russian government subsidised larger firms from smaller cities with lower employment opportunities. However, this subsidy does not mobilise any corporate investment and employment change inside these firms, but it increases the corporate cash holdings for precautionary purposes, particularly for constrained firms.	To set a new insight demonstrating the government agenda's influence on corporate policies.	
Décamps et al. (2011).	To propose a dynamic model settling the linkage amongst corporate cash holdings, dividend payments, new equity issuances and market frictions.	To develop a stylised, continuous-time model of a firm facing internal agency costs and external financing costs.	To show how market imperfections influence corporate cash holdings, payout policies, new equity issuance and stock prices.	To offer a new theoretical insight highlighting how corporate cash holding is affected by market frictions and its repercussion on risk management and dividend policies, and likewise on cash flows and stock price dynamics.
Denis and Sibilkov (2010).	To explore why cash hoardings are more valuable for constrained firms than unconstrained peers.	To show that constrained firms hold more cash for precautionary savings. Further, there is a hierarchical cash holding behaviour amongst constrained firms. In this sense, lower cash constrained firms facing high costs of external financing hold less cash than higher cash constrained ones, particularly because these former firms produce lower cash flow than those later ones.	To present the reasons why constrained firms generally hold more cash than the unconstrained ones.	

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Dittmar and Mahrt-Smith (2007).	To propose analysing the influence of cash holdings and corporate governance on market firm value.	To point out that poorly governed firms hoard approximately one-half of the market value of excess cash than the firms that are well governed, thus suggesting that these extra cash reserves are being wasted by potentially entrenched managers who are engaging firms in a poor operating performance over time. To describe how firms with higher market-to-book ratios, higher R&D expenditures, higher profitability and smaller size save more cash than their counterparts. Firms inside countries with more developed financial markets and the lowest level of shareholder protection hold more cash than those firms settled in other countries.	To reinforce that poorly governed firms hold more cash, experience lower operating performance and quickly spend their cash excess on inefficient investment projects.	
Dittmar et al. (2003).	To examine the influence of corporate governance on cash holdings in firms throughout the world in 1998.	To identify the marginal value of cash holdings as negatively related to asymmetry of information measured by dispersion of analysts' earnings forecasts.	To emphasise the role of corporate governance on cash reserves held by firms around the world, which impute to the agency the conflicts and central reason for these cash stockpiles.	To address the limited availability of data, especially related to the variable of the insider-agency problem measured by country-level family control.
Drobetz et al. (2010).	To evaluate the dynamic effect of asymmetry of information on corporate cash holdings over time throughout the world.		To associate the marginal value of cash holdings with the presence of information asymmetry within firms over time.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Duchin (2010).	To debate the linkage between liquidity management and corporate diversification, exploring the influence of investment risk opportunities on corporate cash holdings.	To show that firms with cross-divisional diversification hold less cash, efficiently spending their cash flows in better investment opportunities and being less exposed to investment risks. Firms that are less diversified in their cash flows and investment opportunities face more investment risk and hold more cash for precautionary savings.	To highlight the role of cash reserves in decreasing corporate exposure to investment risk in multidivisional firms.	
Falaye (2004).	To study the relationship between the takeover-deterrence effects of excess cash holdings and a control mechanism called proxy contest.	To suggest that firms holding excess cash are more likely to become targets of proxy fights. Moreover, managerial ownership reduces the probability of a proxy contest, whereas outside block ownership marginally increases this probability.	To provide evidence on the role of proxy fights in dealing with specific agency issues and management's control of the firm.	To provide additional data for advanced research related to proxy fights.
Faulkender and Wang (2006).	To examine the value of additional cash on capital structure under financial friction.	To explain why the marginal value of cash is higher for constrained firms that have valuable investment opportunities and lower cash holdings than unconstrained companies.	To analyse the relationships amongst the marginal value of cash, changes in corporate liquidity, capital structure and accessibility of external financing.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Feng and Johansson (2014).	To study the effect of the risk of political extraction on corporate cash holdings in Chinese firms.	To demonstrate that firms with private entrepreneurs who have connections with politicians hold lower cash holdings than their counterparts. As a result, the former firms might derive competitive advantage and protection from the risk of political extraction.	To show politician participation in Chinese private firms is positively correlated to corporate cash behaviour and firm value.	
Ferreira and Vilela (2004).	To research the main determinants of corporate cash holdings in the context of EMU countries.	To describe cash-holding levels for EMU firms, which are positively related to investment opportunities and cash flow and negatively influenced by the amount of liquid asset substitutes, size, leverage and bank debt.	To show that agency conflicts do not influence the determination of cash holdings in EMU countries.	
Francis et al. (2014).	To test whether banking deregulation influences corporate cash policies in U.S. firms.	To assess whether banking deregulation negatively affects the level of liquid assets held by U.S. firms; this effect might be ascribed to financially constrained firms with different hedging needs.	To investigate first-hand the response of corporate cash policies to changes in banking deregulation and consolidation.	
Frésard and Salva (2010).	To study the impact of cash hoarding on product market behaviour regarding firm performance.	To present the positive impact cash holdings have on corporate market share expansion and firm performance, particularly in firms experiencing exogenous unexpected changes in product market competition and weaker financial positions.	To supply evidence that firms in highly competitive industry environments with constrained access to financing tend to hold more cash than other industry groups.	Not to discern the impact of either competition or investors on cash reserves.

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Fresard (2011).	To explore the connection between corporate cash savings and the informativeness of stock prices.	To suggest corporate cash holdings are more sensitive to stock prices as firm-specific return variation become higher. Indeed, firm-specific return variation-unexplained by market and industry movements-grants new information to investors that is not available from managers for whom stock-market learning positively influences their cash-saving decisions.	To focus on the relationship amongst information managerial learning, stock market and corporate cash holding behaviour emphasising the informational role played by stock price in changing the amount of cash saved by firm managers.	To do not expose a complete explanation about the premium that investors place on the excess cash of cross-listed firms. The authors assume that it could have alternative approaches on the relationship amongst better external monitoring tools, private benefit decrease and cash reserve behaviour.
Fresard (2010).	To study how corporate governance mechanisms can mitigate potential managerial private benefits related to corporate cash holding behaviour across the world.	To display U.S. cross-listing firms boost corporate governance mechanisms bounding insiders' actions and preventing these insiders extract private benefits from corporate cash holdings.	To show the influence of the implementation of corporate governance mechanism from U.S. cross listings on cash holding behaviour performed by firms' insiders.	
Fritz Foley et al. (2007).	To investigate the relationship between corporate cash holdings and repatriation taxes.	To discuss that U.S. multinational firms in countries with low tax rates and technology-intensive firms are retaining more cash; yet firms facing financial constraints hold less cash.	To display the potential impact of repatriation taxes on corporate cash holdings.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Gamba and Triantis (2008).	To design a dynamic structural model of the interplay between liquidity management and financial flexibility at firm level.	To suggest the marginal value of liquidity is negatively related to liquidity, and positively correlated to investment opportunities and financial constraints. Additionally, to show that as a firm faces higher costs of external financing it might hold more cash in order to boost its internal resource savings and invest in new investment opportunities.	To provide evidence that internal liquidity is a relevant source of financial flexibility, especially because these internal funds can mitigate firms' financial friction problems.	
N. Gao (2011).	To address the adverse selection effect of corporate cash holdings from acquisition transactions.	To assess the strong, negative informational effect excess cash holdings can have on stock prices, with the worst price reactions occurring at the time of acquisition announcements.	To point out that excess cash holdings have an adverse selection effect on stock prices by signalling an overvaluation when issuance financing is employed.	
H. Gao et al. (2013).	To explore the determinants of cash holding policies in private and public U.S. firms.	To find private firms hold less cash than public firms which may be due to reduced agency problems and the increase of financing frictions for the former.	To employ a large sample of American firms, both private and public, to identify and compare the determinants of corporate cash holdings as well as assess the effects of agency costs on their cash reserves.	
Gore (2009).	To identify the determinants and consequences of cash holding in American municipal contexts.	To show how governments with higher variation in revenues, lower state revenues and higher growth accumulate more cash than their counterpart municipalities.	To explore the determinants and effects of cash holdings in government contexts.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Han and Qiu (2007).	To frame a theoretical model of the interactions between corporate cash holdings, cash flow uncertainty and financial constraints through the lens of corporate precautionary cash holding.	To show that financially constrained firms hold more cash for precautionary savings as the volatility of cash flows increases, while such volatility has no significant effect on unconstrained firms.	To study the relationship amongst corporate cash holdings, cash flow uncertainty and financial constraints.	
Harford (1999).	To examine whether managers from cash-rich firms have engaged in value-decreasing acquisitions.	To show that cash-rich, large firms and firms with abnormal returns and higher sales growth are likely to become unexpected bidders. Nonetheless, these unexpected acquisitions tend to involve unattractive and/or diversifying targets with high costs and low transaction benefits, leading the destruction of shareholder value.	To investigate methodically the use of cash reserves in acquisitions. To determine the results for the smaller sample size of insider ownership.	
Harford et al. (2008).	To assess how corporate governance influences firms' cash stockpile management.	To demonstrate that firms with higher insider ownership, stronger investor protection, and higher likelihood of becoming bidders hold more cash than other groups.	Claiming that firms with weaker governance are likely to hold less cash, this paper identifies an opposite trend relative to prior literature. Furthermore, to shed light on how country-level shareholder rights can interplay with firm-level agency problems and shareholder power.	
Harford et al. (2014).	To study whether corporate decisions on cash holding and debt maturity alleviate a firm's refinancing risk.	To display firms with shorter maturity debt hold more cash to avoid refinancing risk and related costs.	To highlight maturity debt and refinancing risk as important determinants of corporate cash holdings over time.	

Studies	Goal	Main Conclusions	Main Contribution	Limitations
		To show that predation risk is more likely to occur in oligopolistic industries and technological core companies given their greater interdependence in investment opportunities with product market rivals. Further, firms with higher investment opportunities have higher predation risks, hold more cash and use derivatives to decrease the risk of predation by cash-rich companies and gain market share from these rival groups, especially during economic downturns.	To present the linkage amongst market competition, investment strategy and corporate cash holdings showing how firms react to the probability of predation risk.	
D. Haushalter et al. (2007).	To investigate the relationship between predation risk and corporate financial policies.			
Haw et al. (2011).	To examine the role of share repurchases on firm value and corporate cash holdings around the word.	To reveal higher marginal cash values are positively associated with investor protection.	To support that tax effects and agency costs play a relevant role in determining the marginal value of cash.	
Hoberg et al. (2014).	To examine the influence of product markets on firm payout and corporate cash holding policies.	To address how firms in more competitive markets tend to have higher cash balances, pay less in dividends and repurchase fewer shares than their rival counterparts.	To capture the fluidity and dynamism that some product markets display over time, explaining corporate policy behaviours beyond static cross-sectional measures of competition.	
Holmström and Tirole (1998).	To model a theoretical insight on how firms provide for future liquidity needs.	To explain that liquidity shocks might require firms to hold reserves as a way of arranging external financing in the future and as an alternative for preventing liquidity risk.	To shed light on the way that firms project their liquidity needs (e.g., cash holdings and credit lines) under liquidity shocks from a unified model of moral hazard in the context of financial demand.	To point out that intermediaries play a passive role in their model, recognising the importance of studying their performance in monitoring investment and liquidity needs.

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
A. G. Huang (2009).	To investigate whether corporate investment levels and cash-holding behaviours influence firms' equity returns.	To demonstrate that cash holdings increase future returns on physical capital and firm stocks.	To emphasise the importance of cash reserves for corporate investment and expected stock returns, displaying that cash-rich firms tend to have lower levels of physical assets and generate higher expected returns for precautionary savings, lowering future external-financing costs.	
Y. Huang et al. (2013).	To study the relationship between investor protection and a firm's level of cash holdings around the world.	To reveal that stronger investor-protection methods associated with straightforward accounting standards are positively correlated to corporate cash holdings.	To debate the relevance of shareholder protection for corporate cash-holding policy.	
Hugonnier et al. (2014).	To model the impacts of capital supply frictions on corporate financial policies.	To present that target cash holdings increase as cash-flow volatility increases and decrease as agency conflicts arise within a firm.	To consider a theoretical model integrating corporate financing, investment and liquidity policy behaviour under capital supply friction.	
Itzkowitz (2013).	To examine how buyer-supplier interaction affects corporate cash-holding management.	To show that buyer-supplier relationships with higher sales concentrations imply higher cash holdings by suppliers over time, particularly due to the increased financial distress risk that comes from these interactions.	To expose the role of buyer-supplier relationships in firms' cash-holding policies, showing the positive influence these synergies have on corporate cash reserves.	
Jain et al. (2013).	To assess the linkage amongst CEO governance heterogeneity, power structure of the firm, product market competition and corporate cash holdings in IPO firms over time.	To show that stronger internal corporate governance mechanisms are positively associated with higher post-IPO cash holdings, especially in competitive product markets.	To explain how corporate governance, ownership and market competition might wield strong positive influence on the levels, marginal values and uses of post-IPO cash reserves.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Kahle and Stulz (2013).	To investigate the impact of the credit-supply shock from the 2008 crisis on capital expenditures, debt issuance, equity issuance and cash holdings.	To present that unleveraged firms' decreased capital expenditures by 39% subsequent to the bankruptcy of Lehman Brothers, and bank-dependent firms significantly increased their cash holdings over the crisis period. To exhibit that controlling managers tend to hold more cash and pay higher payouts in the context of weaker country-level protections for external shareholders. As a result, these two conditions, higher cash reserves and weak investor-protection environments, also induce lower levels of firm value.	To clarify the role of a credit-supply shock on corporate financial and investment policies during the 2008 crisis.	
Kalcheva and Lins (2007).	To analyse the impact of managerial control rights on the net costs and benefits of cash hoardings.	To reveal that higher R&D, capital expenditures, sales growth rates and leverage contribute to higher firm performance, measured by Tobin's Q; larger firms tend to retain higher cash holdings as a strategic valuable resource for market competition.	To show the combination of weak country-level shareholder protections, expected managerial agency conflicts and higher cash holding levels negatively impact firm value around the world.	
C. and Bettis (2014).	To assess the relationship between firm performance and corporate cash holdings.		To present a strategic view about the influence of cash holdings on firm performance.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
C. S. Kim et al. (1998).	To design and test a model of optimal corporate investment in liquidity based on the trade-offs amongst liquid asset holdings, investment opportunities and future firm liquidity needs.	To explain why firms facing uncertain future internal funds, costly external financing and market imperfections are likely to invest in liquid assets as an optimal response to financing future investment opportunities. To demonstrate that firms with less union bargaining power reserve larger cash holdings than other corresponding firms. Moreover, the negative interaction between unionisation ratios and corporate cash holdings is more pronounced in more concentrated industries.	To establish that firms calculate their optimal liquidity amounts according to the cost of external funds, the variance of expected cash-flows, and the profitability of investment opportunities they expect to have in the future.	
Klasa et al. (2009).	To examine if the firm-level unionisation ratios influence the level of cash holding by U.S. manufacturing firms.	To show that the shareholders of family-controlled firms with higher board independence are likely to hold more cash for their operating strategies than their counterparts in non-family-controlled firms. On the other hand, family-controlled firms with higher pledge rates tend to hold less cash due to the enhancement of agency conflicts that comes from higher director-ownership-in-pledge, whereas the pledge rate shows no effect in non-family controlled firms.	To highlight the negative impact of unionisation on corporate cash holdings in a collective-bargaining setting.	
Kuan et al. (2011).	To study whether the effect of corporate governance on cash holdings in family-controlled firms differs from that in non-family-controlled firms in Taiwan from 1997 to 2008.		To display that a higher separation of board-seat rights tends to increase cash holdings in low cash-holding family-controlled firms, but reduces cash holdings in high cash-holding family-controlled firms in Taiwan.	

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Kusnadi (2011).	To analyse the influence of the system of investor protection on corporate cash policies in 39 countries from 1995 to 2004.	To point out that firms in weaker investor-protection legal systems receive less cash than their counterparts.	To emphasise the role of the investor-protection environment on international corporate cash management behaviours.	To propose that segment-level accounting data may contain more noise than firm-level accounting data. Moreover, the effects of the oil crisis could not be separated from the effects of other events.
Lamont (1997).	To test whether large cash flow/collateral value decreases a corporation's oil segment following a decrease investment in its non-oil segment.	To show oil companies significantly reduced their non-oil investments in 1986.	To discuss how diversified companies tend to subsidise and overinvest in poorly-performing segments.	
Larkin (2013).	To investigate the role of a firm's brand on financial policy regarding expected cash flow volatility, performance, credit riskiness, leverage and cash holdings.	To present how stronger brand perception is negatively related to the volatility of expected cash flow, increasing the probability of lower future financial-friction levels and lower cash holdings.	To shed light on influence of intangible assets on corporate liquidity, firm risk and corporate financial structure.	
E. Lee and Powell (2011).	To explore the effects of corporate cash holdings on share repurchase behaviour in seven leading countries - Australia, Canada, France, Germany, Japan, the U.K., and the U.S - from 1998 to 2006.	To identify evidence that repurchasing firms hold more excess cash for at least two purposes: to reduce the value of capital expenditures, decreasing the amount available for overinvestment, and as a flexible mechanism of distributing cash as dividends.	To expose the sources that impact share repurchasing behaviours inside firms, across countries and over time.	
Levitas and McFadyen (2009).	To evaluate the influence of research and development (R&D) activities on holding and management of corporate liquid assets.	To find that firms with higher R&D intensity are likely to hold higher levels of liquid assets.	To report the reciprocal influence between research-intensive firms and firms' internal holding of liquid assets.	To disentangle the signalling effects of patenting from the real cash flows derived from exploiting those patents.

Continued on next page.

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Lins et al. (2010).	To investigate what drives corporate liquidity around the world, particularly regarding the use of credit lines rather than operating-cash holding purposes.	To present that both credit lines and cash holdings are employed as precautionary motives. Credit lines that are used to hedge against future financial frictions may restrain a firm's spending in investment opportunities in potential future good times, while cash holdings are employed as insurance against future cash-flow shortfalls during poor economic conditions.	To provide evidence that both credit lines and cash holdings are used as buffers for future liquidity needs; however, the ways in which each liquidity instrument is employed might vary according to the potential state of the world.	
Y. Liu (2011).	To examine the effect of CEO compensation on corporate cash holdings.	To reveal that higher CEO risk-taking incentives positively influence higher liquidity levels.	To find that CEO compensation has a negative effect on cash values, whereas compensation incentives positively influence cash holdings by firms facing financial constraints.	
Y. Liu et al. (2014).	To study whether compensation incentives, such as pensions and deferred compensation, influence corporate cash holdings.	To demonstrate that CEO debt compensation incentives have a negative effect on cash holdings for firms with higher leverage levels, while such debt incentives may induce higher cash reserves in poorly governed firms.	To shed light on the way that compensation incentives should be designed to minimise agency conflicts proceeding from corporate cash policy decisions.	

Continued on next page.

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Locorotondo et al. (2014).	To grasp the role of group membership on corporate cash policy within Belgian firms.	To show business groups hold less cash than non-affiliated firms, indicating that these membership groups have access to funds from internal capital markets when they face financial constraints in Belgium.	To exhibit that intra-groups guarantees influence affiliated firms to reserve less cash. In this setting, financial-constraint-affiliated groups might rely on the internal capital markets when they deal with financial friction, maintaining cash holdings equivalent to other non-constraint business group.	To point out as future research agenda the use of internal capital markets by membership groups as buffer mechanisms to protect them against the predatory behaviour of competitors.
Louis et al. (2012).	To assess the impact of accounting conservatism on the marginal market value of cash holdings.	To explain that accounting conservatism might recognise previously inefficient investment decisions from financial reporting, signalling investors and shareholders on new projects undertaken by managers, mitigating the destruction of firm value related to cash reserves and minimising agency conflicts.	To empirically test, first-hand, the effect of accounting conservatism on corporate cash hoardings.	To examine only the effect of conservatism, which might be related to other governance aspects for which there are no reliable, readily and available proxies.
May (2014).	To study the effects of Lehman Brothers' bank default on corporate liquidity in firms under their loan commitments.	To show firms with credit line commitments in Lehman Brother's bank lost, on average, 3% of their market value in the days of Lehman's default. Moreover, these losses are significantly higher for firms with lower levels of cash holdings and higher financial constraints.	To offer new insight on the interaction of a bank's risk of default and loan commitments to borrowers.	

Continued on next page.

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Meggison et al. (2014).	To explore the relationship between state ownership and corporate cash holdings in privatised firms in China from 2000 to 2012.	To demonstrate that state ownership is negatively related to corporate cash holdings in privatised Chinese firms over time. The higher soft-budget constraint effect that arises when financially constrained firms are supported by the government promotes lower cash holdings and lower marginal value of cash by these firms. To show that sales, business cycle, interest rates, financial assets and the yield on private capital are considered important determinants of cash holdings in business firms.	To emphasise the negative impact of soft-budget constraints on cash holding behaviour in Chinese firms.	
Meltzer (1963).	To explain how cyclical economic changes affect the demand for money by industry firms.	To report no difference between the ownership of cash-rich firm and their peers regarding operating performance and governance mechanisms. However, firms with higher cash reserves have higher R&D expenditure levels and lower levels of debt financing.	To find that firms must maintain cash reserves in order to support their transactions needs.	
Mikkelsen and Partch (2003).	To examine the effects of large cash holdings on operating performance, governance mechanisms and firm features such as size, related industry, investment, and R&D expenditures.	To find that as macroeconomic ambiguity increases firms tend to hold more cash and invest less in capital expenditures over time.	To show that persistent large corporate cash holdings do not lead to poor operating performance and agency conflicts in cash-rich firms compared to lower cash firms.	
Neamtii et al. (2014).	To investigate how macroeconomic ambiguity can affect firm investment behaviours and corporate cash holdings.		To discern the effects of ambiguity from risk on corporate cash holdings and investment; in the presence of ambiguity, firms are likely to decrease their investment levels and increase their cash reserves.	

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Nikolov and Whited (2014).	To explore theoretically and empirically the link between corporate cash policy and agency issues such as limited managerial ownership, managerial perquisite consumption, and compensation based on firm size.	To show firms with higher blockholder and institutional ownership ratios are likely to experience greater loss of shareholder value, higher cash holdings, and higher managerial perquisite consumption.	To point out that the mechanisms of agency conflicts are associated with corporate cash holdings.	
Opler et al. (1999).	To investigate the precedent and subsequent cash holding factors amongst publicly traded U.S. firms.	To reveal firms with less access to capital markets, strong growth opportunities, higher business risk, and smaller sizes hold more cash than their counterparts. Further, cash-rich firms spend excess cash in payouts to shareholders, new projects and acquisitions even when they have poor investment opportunities.	To systematically study the determinants of cash holdings providing support to the trade-off theory.	
Ozkan and Ozkan (2004).	To empirically examine the relationship between managerial ownership and corporate cash holdings.	To suggest a non-monotonic relationship between managerial ownership and cash holdings in British firms. Further, higher cash holdings are associated with higher growth opportunities and cash flows, and lower leverage and banking debt.	To supply evidence of the existence of a non-monotonic relationship between ownership and cash holdings.	
Palazzo (2012).	To assess how the correlation between cash flows and a source of aggregate risk affects optimal corporate cash holding policy.	To point out that riskier firms hold more cash as a buffer against expected cash flow shortfalls.	To highlight the positive and strong correlation between cash flows and aggregate risk, which positively impacts corporate cash hoarding behaviour.	

Continued on next page.

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Pinkowitz and Williamson (2001).	To evaluate the influence of a bank-centred system on cash holdings in Japanese firms.	To display firms under bank-centred systems hold more reserves to provide rents for the main bank and reduce the costs of bank monitoring.	To show that banking power and cash holdings are positively related in Japanese firms over time.	
Pinkowitz et al. (2006).	To investigate how corporate governance influences the effects of cash holdings and dividends on firm values around the world.	To reveal that the value of cash holdings for minority shareholders in higher investor-protection countries is greater than that for similar groups in countries with weaker governance.	To link the value of cash holdings with governance mechanisms around the world.	To include alternative explanations for their findings, such as the effects of financial reporting in countries with poor investor protection.
Pinkowitz et al. (2013).	To explore the influence of corporate cash holdings on the payment method for acquisitions.	To find that firms holding more cash are 23% less likely to employ cash to finance acquisitions than similar firms holding less cash. Further, more cash-rich firms tend to acquire their targets with stocks, assuring more financial flexibility.	To shed light on the influence of cash stockpiles on acquisitions payment methods, exposing that firms prefer using stocks rather than cash holdings in acquisitions.	Not to provide a clear argument to explain why cash richer firms choose stocks over other payment methods to invest in acquisitions.
Qiu and Wan (2014).	To analyse the role of technology spillovers and market rivalry on corporate cash holdings.	To present that technology spillover and market competition are positively related to corporate cash holdings.	To distinguish between the effects of technology spillovers and market competition on corporate cash holdings. Indeed, firms respond to technology spillover and market rivalry by holding more cash to ensure financial flexibility for funding profitable future investment opportunities.	

Continued on next page.

Studies	Goal	Main Conclusions	Main Contribution	Limitations
Ramírez and Tadesse (2009).	To examine the impact of national culture and firm multinationality on corporate cash holdings.	To show that the higher a firm's level of multinationality, the higher its corporate cash holdings will be, particularly in countries with higher degrees of uncertainty avoidance.	To introduce an interdisciplinary perspective on corporate liquidity, especially cash holding behaviour, under the effects of national culture, firm multinationality and uncertainty avoidance.	
Rapp et al. (2014).	To investigate the relationship between financial flexibility and corporate cash policy.	To exhibit that firms with higher financial flexibility are likely to hold more cash, pay less dividends, maintain low leverage levels, and prefer share repurchases over dividend distributions.	To explain theoretically and empirically the relevant role of financial flexibility in corporate financial policy, particularly regarding decisions related to payout behaviour, capital structure and cash management.	
Riddick and Whited (2009).	To theoretically frame and empirically test the interactions amongst cash-holding antecedents, income uncertainty, and financing external costs.	To show that firms have negative propensity to save cash as positive productivity shocks increase their cash flow and marginal product of capital.	To offer a new theoretical perspective that firms have different propensities to save cash according to their predicted future productivity.	
Schaute et al. (2013).	To study the influence of corporate governance on the value of excess cash holdings by European firms.	To identify firms with more takeover defences are likely to hold higher levels of cash reserves while other governance instruments-such as shareholder rights, disclosure, and board functioning-do not present significant effect on the value of cash.	To pinpoint specifically which governance mechanisms influence the value of cash holdings in large, publicly listed European firms.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Song and Lee (2012).	To evaluate whether and how financial crises impact corporate liquidity management in the long term in 8 East Asian countries.	To find a significant negative relation between corporate cash holdings and investment, implying firms reduce their investment spending vis-a-vis an increase in their cash reserves.	To suggest firms that experience exogenous shocks tend to boost their cash stockpiles according to changes in their demand function for cash holdings-particularly for constrained firms rather than the unconstrained ones.	
Subramaniam et al. (2011).	To explore the link between firm organisational structure and corporate cash holdings.	To show that diversified firms have significantly lower cash-holding levels and higher agency costs than focused firms due to their internal market access, which allows them to fund their financial needs from available cash flow across segments.	To identify non-governance factors regarding firm organisational structure, agency conflicts and investment opportunities that may affect corporate cash management and investment decisions inside firms.	
Tong (2010).	To investigate the relationship between CEO risk incentives and corporate cash holdings under agency theory.	To reveal how firms with higher CEO risk incentives hold less cash, although these firms hold higher values of cash holdings.	To debate the impact of CEO risk incentives on cash management from the perspective of corporate cash-holding investment and agency conflicts.	
Tong (2011).	To focus on the effects of firm diversification on corporate cash holdings in the context of financial constraint and agency problems.	To display how firm diversification has a negative impact on the value of cash holdings and a positive relation with cash-reserve levels.	To study the value impact of diversification strategies through corporate cash holdings under conditions of financial constraint.	

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Studies	Goal	Main Conclusions	Main Contribution	Limitations
Wu et al. (2012).	To analyse the influence of financial deepening on the sensitivity of cash reserves to trade credit amongst Chinese listed firms from 1999 to 2009.	To describe how Chinese firms in regions with more developed financial sectors hold less cash to cover trade payables and have a higher substitute ratio of credit receivables for cash, especially following the introduction of the new receivables policy in 2007.	To show a higher level of financial deepening are negatively related to cash holding behaviour and positively associated to short-term credit such as payables and receivables, improving the short-term financing function of trade credit.	
Yun (2009).	To assess whether and how corporate governance influences corporate liquidity management through the analysis of a firm's choice between cash and credit lines.	To explain how state-level changes in takeover protection lead poorly governed firms to switch from credit lines to cash holdings. Further, anti-takeover laws and managerial discretion within poorly governed firms induce these firms to hold more cash relative to lines of credit.	To identify the specific characteristics of the link between corporate governance and cash holdings.	

Table B.1: Paper goal, main conclusions, contributions, and limitations.

C Paper statistics: year, journal, knowledge center and absolute citation account.

to be continued.

No [†]	Paper	Year	Journal	IF (SCR) [‡]	Knowledge Center	Citations - Scopus*	Citations - ISI*	Citations - Google*
1	Opler et al. (1999).	1999	Journal of Financial Economics.	3,769	The Ohio State University and Georgetown University.	423	352	1940
2	Almeida et al. (2004).	2004	The Journal of Finance.	6,033	New York University, University of Illinois.	333	284	1536
3	Lamont (1997).	1997	The Journal of Finance.	6,033	University of Chicago.	306	264	1173
4	Holmström and Tirole (1998).	1998	Journal of Political Economy.	3,617	Massachusetts Institute of Technology.	245	229	1188
5	Harford (1999).	1999	The Journal of Finance.	6,033	University of Oregon.	292	205	1229
6	Dittmar and Mahrt-Smith (2007).	2007	Journal of Financial Economics.	3,769	University of Michigan and University of Toronto.	238	190	930
7	Bates et al. (2009).	2009	The Journal of Finance.	6,033	Arizona State University, University of Georgia and The Ohio State University.	170	143	951
8	C. S. Kim et al. (1998).	1998	The Journal of Financial and Quantitative Analysis.	1,877	Yonsei University, Southern Methodist University, and Hong Kong University of Science and Technology.	193	134	783
9	Dittmar et al. (2003).	2003	The Journal of Financial and Quantitative Analysis.	1,877	Indiana University, University of Toronto, and London Business School.	164	132	796
10	Harford et al. (2008).	2008	Journal of Financial Economics.	3,769	University of Washington, Virginia Tech, and University of Arizona.	171	125	793
11	Pinkowitz et al. (2006).	2006	The Journal of Finance.	6,033	Georgetown University and Ohio University.	156	119	514
12	Faulkender and Wang (2006).	2006	The Journal of Finance.	6,033	Washington University.	151	117	706

continuation.

No [†]	Paper	Year	Journal	IF (SCR) [‡]	Knowledge Center	Citations - Scopus*	Citations - ISI*	Citations - Google*
13	Campello et al. (2010).	2010	Journal of Financial Economics.	3,769	University of Illinois and Duke University.	144	112	710
14	Acharya et al. (2007).	2007	Journal Financial Intermediation.	1,625	London Business School, New York University, and University of Illinois.	95	82	537
15	Ozkan and Ozkan (2004).	2004	Journal of Banking & Finance.	1,362	University of York and University of Bristol.	100	73	491
16	Kalcheva and Lins (2007).	2007	Review of Financial Studies.	3,532	University of Utah and University of Arizona.	87	63	384
17	Mikkelson and Partch (2003).	2003	The Journal of Financial & Quantitative Analysis.	1,877	Oregon University.	76	61	386
18	Denis and Sibilkov (2010).	2010	Review of Financial Studies.	3,532	Purdue University and University of Wisconsin.	71	53	344
19	Gamba and Triantis (2008).	2008	The Journal of Finance.	6,033	University of Verona and University of Maryland.	57	49	306
20	Fritz Foley et al. (2007).	2007	Journal of Financial Economics.	3,769	Harvard Business School, University of Texas at Austin, and Australian National University.	70	46	358
21	Ferreira and Vilela (2004).	2004	European Financial Management.	1,313	ISCTE Business School.	44	44	290
22	Riddick and Whited (2009).	2009	The Journal of Finance.	6,033	American University and University of Rochester.	51	43	259
23	Pinkowitz and Williamson (2001).	2001	Review of Financial Studies.	3,532	Georgetown University.	57	37	247
24	Han and Qiu (2007).	2007	Journal of Corporate Finance.	1,4	McMaster University.	40	36	271
25	Lins et al. (2010).	2010	Journal of Financial Economics.	3,769	University of Utah, London Business School, and Harvard University.	42	34	241
26	Campello et al. (2011).	2011	Review of Financial Studies.	3,532	Cornell University, University of Amsterdam, and Duke University.	42	32	241
27	Faleye (2004).	2004	The Journal of Finance.	6,033	Northeastern University.	39	29	143

No [†]	Paper	Year	Journal	IF (SCR) [‡]	Knowledge Center	Citations - Scopus*	Citations - ISI*	Citations - Google*
28	D. Haushalter et al. (2007).	2007	Journal of Financial Economics.	3,769	Pennsylvania State University and University of Arizona.	35	29	206
29	Frésard and Salva (2010).	2010	The Journal of Finance.	6,033	HEC School of Management.	38	28	214
30	J. R. Brown and Petersen (2011).	2011	Journal of Corporate Finance.	1,4	Iowa State University and Washington University.	27	26	147
31	Duchin (2010).	2010	The Journal of Finance.	6,033	University of Michigan.	34	21	184
32	Almeida, Campello, and Weisbach (2011).	2011	Journal of Corporate Finance.	1,4	University of Illinois and The Ohio State University.	24	20	119
33	Levitass and McFadyen (2009).	2009	Strategic Management Journal.	3,78	University of Wisconsin-Milwaukee and University of Texas at Arlington.	21	18	54
34	Core et al. (2006).	2006	Journal of Accounting and Economics.	2,833	University of Pennsylvania.	24	16	80
35	Drobetz et al. (2010).	2010	Journal of Banking & Finance.	1,362	University of Hamburg, University of Basel and KPMG.	20	16	79
36	Klasa et al. (2009).	2009	Journal of Financial Economics.	3,769	University of Arizona, Southern Methodist University, and University of British Columbia.	14	13	113
37	Tong (2011).	2011	Journal of Corporate Finance.	1,4	University of Exeter.	11	12	62
38	Colquitt et al. (1999).	1999	Journal of Risk and Insurance.	1	Auburn University and University of Georgia.	16	11	57
39	D'Mello et al. (2008).	2008	Journal of Banking & Finance.	1,362	Wayne State University, University of New Orleans, and Fayetteville State University.	17	11	50

Table C.1: Paper statistics: year, journal, knowledge center and absolute citation account.

[†] Order.

[‡] Impact factor.

* Considering 02/16/2015.

D Main significant relationships reported between cash holdings (dependent variable) and several independent variables by paper (Part A).

Dependent Variable: cash holdings	Independent Variables																				
	Paper	CF	Size	NWC ¹	Sales Gth ²	Profit (ROA) ³	Mktbo ⁴	Inv. Op. ⁵	Lev ⁶	Cpx ⁷	Cred. Spr	Inv ⁸	Age	Own ⁹	Gov ¹⁰	CEO Comp ¹¹	SOE ¹²	Stk Ret ¹³	UNA ¹⁴	GQ ¹⁵	
Francis et al. (2014).	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H. Gao et al. (2013).	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gore (2009).	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Han and Qiu (2007).	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harford et al. (2008).	+	+	-	-	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
D. Haushalter et al. (2007).	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y. Huang et al. (2013).	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Itzkowitz (2013).	-	+	-	-	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Jain et al. (2013).	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalcheva and Lins (2007).	+	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
C. S. Kim et al. (1998).	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kuan et al. (2011).	+	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y. Liu (2011).	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y. Liu et al. (2014).	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megginson et al. (2014).	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neamtiu et al. (2014).	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-
Opler et al. (1999).	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ozkan and Ozkan (2004).	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-

Dependent Variable: cash holdings	Independent Variables																				
	Paper	CF ¹	Size	NWC ²	Sales Gth ³	Profit (ROA) ⁴	Mktbo ⁵	Inv. Op. ⁶	Lev ⁷	Cpx ⁸	Cred. Spr	Inv ⁹	Age	Own ¹⁰	Gov ¹¹	CEO Comp ¹²	SOE ¹³	Stk Ret ¹⁴	UNA ¹⁵	GQ ¹⁶	
Pinkowitz and Williamson (2001).	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Qiu and Wan (2014).					-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ramírez and Tadesse (2009).	-	-	-	-			+	-	-	-	-	-	+	-	-	-	-	-	-	-	+
Song and Lee (2012).	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wu et al. (2012).	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yun (2009).		-	-	-																	

Table D.1: Main significant relationships reported between cash holdings (dependent variable) and several independent variables by paper (Part A).

Note 1: All relationships are reported by the papers when cash holdings are considered as a dependent variable. All findings are also gathered from the main paper results.

Note 2: We describe only variables pointed out as significant at 1%, 5% or 10% level on cash holding regressions.

¹ Cash flow.

² Net working capital.

³ Sales growth.

⁴ Profitability (*ROA*).

⁵ Market-to-book.

⁶ Investment opportunity (*Q*).

⁷ Leverage.

⁸ Capital expenditure.

⁹ Investment.

¹⁰ Managerial ownership.

¹¹ Governance index.

¹² CEO compensation.

¹³ Stated-owned firms.

¹⁴ Stock return.

¹⁵ Uncertainty-Avoidance index.

¹⁶ Government quality.

E Main significant relationships reported between cash holdings (dependent variable) and several independent variables by paper (Part B).

Dependent Variable: cash holdings	Independent Variables																				
	Paper	Liq ¹	Risk ²	CF	Vol ³	R&D	FC ⁴	Div ⁵	Bus. G. ⁶	Acq ⁷	SD ⁸	SR ⁹	Tax ¹⁰	CC Cycle ¹¹	Bd Ind ¹²	IPO	C Line ¹³	Rat ¹⁴	Cor ¹⁵	Inf ¹⁶	
Al-Najjar (2015).	-						-														
Al-Najjar (2013).	-				+																
Özgür Arslan et al. (2006).							+	+													
Bates et al. (2009).		+				+	-														
Bigelli and Sánchez-Vidal (2012).		+				+	+						-	+							
Y. R. Chen (2008).		+				+	-								+						
Y. R. Chen and Chuang (2009).					+	+	+								+						
Q. Chen et al. (2012).				+			+									+					
D. Chen et al. (2014).				+			+														+
Y. Chen et al. (2015).				+		+															
Colquitt et al. (1999).																					
Dittmar et al. (2003).																					
D'Mello et al. (2008).																					
Duchin (2010).																					
Feng and Johansson (2014).				+																	
Ferreira and Vilela (2004).																					
Fritz Foley et al. (2007).				+																	

Dependent Variable: cash holdings	Independent Variables																				
	Paper	Liq ¹	Risk ²	CF	Vol ³	R&D	FC ⁴	Div ⁵	Bus. G. ⁶	Acq ⁷	SD ⁸	SR ⁹	Tax ¹⁰	CC Cycle ¹¹	Bd Ind ¹²	IPO	C Line ¹³	Rat ¹⁴	Cor ¹⁵	Inf ¹⁶	
Neamtii et al. (2014)	+	+	+	+	+	-	-	-							+						
Opler et al. (1999)					+	+		-						-							-
Ozkan and Ozkan (2004)		+					-														
Pinkowitz and Williamson (2001)		+			+	+		-													
Qiu and Wan (2014)																					
Ramírez and Tadesse (2009)					+	+															
Song and Lee (2012)								+													-
Wu et al. (2012)								+													
Yun (2009)	+																				

Table E.1: Main significant relationships reported between cash holdings (dependent variable) and several independent variables by paper (Part B).

Note 1: All relationships are reported by the papers when cash holdings are considered as a dependent variable. All findings are also gathered from the main paper results.

Note 2: We describe only variables pointed out as significant at 1%, 5% or 10% level on cash holding regressions.

¹ Asset liquidity to current liability.

² Industry volatility.

³ Cashflow volatility.

⁴ Financial constraints.

⁵ Dividend dummy.

⁶ Business group.

⁷ Acquisitions.

⁸ Short-term debt.

⁹ Shareholder rights.

¹⁰ Taxes.

¹¹ Cash conversion cycle.

¹² Board independence.

¹³ Credit line.

¹⁴ Rating.

¹⁵ Corruption.

¹⁶ Inflation.