The Determinants of Cash Holdings: Evidence from Meta-Regression Analysis

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Abstract

Research on corporate cash holdings regards a diverse set of underlying theories and associated determinants. Studies usually focus on specific situations of cash hoarding and derive contradictory results regarding the influence of the most common cash determinants across these situations. Consequently, it remains difficult to derive general statements on the determinants of the corporate cash level from the existing body of research. I tackle this problem by undertaking a meta-regression analysis, which is a quantitative approach to surveying literature. After controlling for a potential publication bias, I find cash holdings to decline when total assets, investment activities, net working capital, leverage, cash flow and dividends increase. The corporate cash reserves increase with an increasing market-to-book ratio, R&D expenditures, financial distress and corporate governance quality. Furthermore, I show that the geographic region and the firm-level of information asymmetries affect the association between the determinants and the level of cash. The influence of cash-determinants is similar in North America and Europe but different in Asia or international studies. Overall, this indicates that the FCF-hypothesis gains importance when the country-level of information asymmetries is high and the pecking-order and trade-off theory gain importance when country-level information asymmetries are moderate.

This draft: February 2016

Keywords: Corporate cash holdings, meta-regression, agency-theory,

JEL classification: G31, G32, G34

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1 Introduction

The cash hoarding behavior of firms has been in the focus of public media and academic research for the past 16 years.[1] Various motives to hold cash, such as, amongst others, the Free Cash Flow (FCF)-hypothesis by Jensen/Meckling (1976) or the pecking-order theory by Myers/Majluf (1984),[2] have been discussed intensively. However, these motives are heterogeneous and overlapping at the same time. They predict the association between individual determinants and the firm-level of cash in specific situations but it remains difficult to provide a general answer to the most central research question: What determines the level of cash holdings?

This study contributes to existing research by composing a more general answer to this question. I utilize the concept of meta-regression analysis (MRA) to undertake a quantitative review of the cash holding literature. MRA allows the empirical measurement of trends in research results by using the existing research as its sample. Thus, the approach is better suited to determine general effects than a firm-level analysis for various reasons. Firstly, it is difficult to obtain firm-level data with a scope that is as broad as the meta-sample, comprising a large variety of countries, time periods and explanatory variables. Secondly, even if such a firm-level sample is available, results still depend on the individual research design, i.e. the variable definitions and empirical methods used. MRA comprises results from studies using various variable definitions and econometric methods. It is therefore able to control for the effect of the individual research design. Finally, MRA also permits controlling for publication selection, which is the selective reporting of results that is undertaken to increase the chance of being published. Such selective reporting distorts primary empirical results and causes publication bias.

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[1] Opler et al. (1999) and Harford (1999) initiate the continuing empirical trend of investigating corporate cash holdings.

[2] See section 2.1.

The diesel emission fraud by the German car manufacturer Volkswagen (VW)[3] serves well to illustrate the multitude of motives and determinants in cash holding research. VW's cash ratio[4] hit a low point of 6.02% in 2002 and increased up to 10.23% in 2014, reaching its peak in 2009 at 15.57%.[5] In absolute terms VW's cash balance amounts to € 32.592 billion at the end of 2014. Thus, the company would be able to pay the rumored fine of US$ 18 billion[6] by the US' Environmental Protection Agency out of its pocket. First, this stresses the precautionary function of cash that guards a company against unexpected events as Bates et al. (2009) explain.

Secondly, VW has invested in various companies, such as Svenska Volkswagen, Skoda, Scania, Porsche, Man and Ducati, since the year 2000.[7] Consequently, the firm's cash reserves could be due to the intent of realizing future investment opportunities. This speculative motive of holding cash is among others pronounced by Iskandar-Datta/Jia (2014). However, prior to the diesel-scandal, VW was facing favorable conditions to finance these investments externally. The company was listed in Germany as well as various other stock exchanges, received favorable debt ratings and beat analyst forecasts in 2014.[8] As Denis/Sibilkov (2010), Horioka/Terada-Hagiwara (2014) and Chen et al. (2014) point out, cash is more likely used as an instrument to finance future investment opportunities, when the possibilities of external financing are constrained, which was not the case for VW. Therefore, the influence of VW's investment opportunities on the corporate cash level is ambiguous.

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3 See dpa international, „Chronology Volkswagen emissions scandal timeline", January 4. 2016.

4 The cash ratio is defined in the style of Opler et al. (1999), as cash and short-term investments scaled by net assets. Net assets equal total assets less cash and short-term investments.

5 Data is obtained from Compustat Global [che, at].

6 See Timothy Gardner & Bernie Woodall, „Volkswagen could face $18 billion penalties from EPA", Reuters, September 18, 2015.

7 See Volkswagen's history: http://en.volkswagen.com/en/company/history.html, January 7. 2016.

8 See Volkswagen group annual report 2014, February 14, 2016 and Christ Bryant, „Volkswagen beats analyst expectation for profits", Financial Times, October 30, 2014.

The FCF-hypothesis regards cash holdings as the result and an instrument of managerial discretion as Dittmar et al. (2003) point out. Thus, VW's cash ratio would have been built up because of high information asymmetries and a low quality of corporate governance. The non-dual role of VW's former CEO, Martin Winterkorn, who did not serve as the chairmen of the supervisory board, and the large size of the company's managing and supervisory board, consisting of 9 respectively 20 members[9], suggest strong governance that is associated to lower levels of cash as Harford et al. (2008) and Belghitar/Clark (2014) report. In contradiction to this, Drobetz/Grüninger (2007) and Chen/Chuang (2009)) find the cash level to increase with increasing board size. Harford et al. (2008) find cash to increase with strong shareholder protection when Dittmar et al. (2003) report a negative association. Therefore, predictions on the influence of corporate governance in general and specific instruments like board size or investor protection are conflicting.

In summary, current research identifies, amongst others, precaution, investment opportunities, financing constraints, information asymmetries and weak corporate governance as drivers of the corporate cash holding policy. Still, the common direction of how these determinants affect the cash level is ambiguous and it remains difficult to compare the overall influence of these drivers. Conflicts regarding the influence of a determinant on the level of cash may also furthermore be the results of the empirical modelling of the respective determinant.

In the course of this study, I address these ambiguities by investigating the general effect of the ten most frequently used determinants on the corporate cash ratio, namely: total assets, investment activities[10], the market-to-book ratio, R&D expenditures, net working capital, leverage, cash flow, dividends, financial distress

[9] See VW's senior management: http://www.volkswagenag.com/content/vwcorp/content/en/the_group/senior_management.html, February 2, 2016.

[10] Investment activities comprise capital expenditures and acquisition expenditures.

and the quality of corporate governance. Thus, I am able to derive an overall association between the corporate cash level and each of the respective determinants without depending on specific sample characteristics or modelling choices.

In the first part of my analysis and after controlling for a potential publication bias, I find cash holdings to decline when total assets, investment activities, net working capital, leverage, cash flow and dividends increase. The corporate cash reserves increase with an increasing market-to-book ratio, R&D expenditures, financial distress and corporate governance quality.

In the second part of my investigation, I analyze differences in the association of individual determinants to cash holdings between geographic regions. There are some examples of primary studies analyzing broad international firm-level samples. However, these studies highlight the influence of different national-levels of investor protection (Huang et al. (2013), Iskandar-Datta/Jia (2014)), political uncertainty (Julio/Yook (2012)) or diverting cultural characteristics (Chen et al. (2015) on cash holdings but remain silent on regional differences in the effect of common cash determinants.

I contribute by comparing results from primary samples[11] that either focus exclusively on North America, Europe, and Asia, or are derived from a global sample.[12] Thus, I am able to derive regional statements on the influence of the most common cash determinants. This analysis reveals that the determinants affect cash similarly in North America and Europe but different in Asia or the global sample. The Asian and global sample also do not feature uniform results.

[11] A primary sample is the data sample of a primary study that undertakes original research.

[12] These regions refer to geographical, not political regions. Thus, Europe also includes Switzerland. The global sample refers to primary samples comprising several geographic regions.

Regional differences may be the result of country-level information asymmetries, suggesting smaller information asymmetries in North America and Europe than in Asia. Overall, the regional differences indicate that the FCF-theory gains importance when country-level information asymmetries are high. In case of moderate country-level information asymmetries, trade-off and pecking-order considerations gain importance. This makes predictions based on the FCF-theory more relevant in Asia, whereas the trade-off and pecking-order predictions become more relevant in the US and Europe. Accordingly, the market-to-book ratio and investment activities, indicating high firm-level information asymmetries, are more positively associated to cash holdings in Asia than in North America or Europe. Furthermore, the substitutive, negative, association between net working capital and cash holdings as well as leverage and cash holdings is more pronounced in North America and Europe than in Asia. The only region where R&D expenditures are significantly associated with cash holdings is North America, where I find a positive relationship.

Finally, I analyze the influence of firm-level information asymmetries on the general association between determinants and cash holdings. This is done by comparing results from samples that focus exclusively on firms that are subject to high information asymmetries to results from non-focused samples. Primary studies rely on specific indicators of information asymmetry such as young firm maturity (Hoberg et al. (2014)), the firm being diversified (Duchin (2010), a high market-to-book ratio, non-investment grade ratings or high product fluidity (Qui et al. (2014)). Thus, the individual results depend on the respective measure of information asymmetry. I am able to derive results that overcome this dependence by aggregating all existing measure into one category.

I only find the association of R&D expenditures to depend (negatively) on high information asymmetries. Furthermore, the effect of dividends and corporate

governance on cash reserves is significantly affected by firm-level information asymmetries.

The remainder of this study is structured as follows: section 2 reviews theories of cash hoarding and identifies the most common determinants used in previous research. Section 3 introduces the general methodology of MRA and my specific research design, variable definitions and the sample construction. Results, consisting of descriptive statistics, graphical, univariate and multivariate analyses as well as robustness checks, are presented in section 4. I conclude in section 5.

2 Theory and literature review

2.1 Theoretical foundation

The theoretical basis of cash holding research consists of two strands. These are the classic capital structure theories and cash holding-specific theories, as table 1 shows, each comprising various theories. The prior derive statements regarding a firm's entire financing decisions and are applied by empirical research to explain cash holding. The latter are derived exclusively to describe cash hoarding behavior under particular circumstances. They do not consider the use of other financing strategies besides saving cash internally. This variety of theoretical viewpoints explains the great research interest in the decision to hold cash.

I identify three capital structure theories that are regarded in cash holding research. The trade-off theory originates from Modigliani/Miller (1963) who extend their original model by including taxes. In its basic form, the theory compares the benefits of tax-deductibility to the danger of bankruptcy and determines the optimal level of corporate debt.[13] When applied in cash holding research, the trade-off theory

[13] See Frank/Goyal (2008) for a general introduction and Bradley et al. (1984) as a classic example.

regards the costs and benefits of holding cash and assumes that firms have a specific, optimal, target level of cash.

The pecking-order theory, introduced by Myers/Majluf (1984) who build on the work of Donaldson (1961), does not feature the assumption of an optimal level of debt or a target level of cash but suggests a strict hierarchy of financing that aims to avoid underinvestment. This hierarchy is induced by ex-ante information asymmetries that prevent potential investors from assessing a firm's true value. Consequently, signaling makes external financing costly and secondary to internal financing. Within external financing, debt financing is preferred over issuing equity.

The FCF-hypothesis, according to Jensen/Meckling (1976), regards cash holdings as the result of discretionary managerial behavior. Managers that are not controlled sufficiently act in self-interest. They build up cash from internal sources because this does not increase external discipline and can easily be used in their own interest.

Furthermore, I distinguish five theories that are specifically derived to explain the level of cash held by a firm. The shareholder power hypothesis, analyzed by Harford et al. (2008) and Kuan et al. (2011), shares central characteristics with the pecking-order theory. It stresses the avoidance of underinvestment as well as the influence of information asymmetries. The hypothesis regards a situation when shareholders are sufficiently protected from expropriation and discretionary managerial actions, for example by a strong legislation that favors the shareholders' perspective. In such circumstances, shareholders allow increasing cash holdings because they do not fear exploitation by the management and acknowledge the benefits of avoiding costly external financing as well as underinvestment.

The motive of constrained liquidity refers to situations when the level of cash is changed as a reaction to changes in the cost of external financing and constrained

liquidity. There is a multitude of possible causes for the increase in the cost of external financing. Harford et al. (2014), for example, focus on the effects of credit ratings and Steiijvers/Niskanen (2013) analyze the impact of a firm's relationship to banks.

Faleye (2004) introduces the defense against hostile takeovers as a motive which expands the FCF-hypothesis by regarding how managers use cash holdings to guard their company against takeover threats. The FCF-hypothesis assumes that managerial discretion will ultimately attract external discipline in the form of a hostile takeover. According to Faleye (2004), managers anticipate this threat and respond by hoarding even more cash to facilitate the application of takeover provisions, such as buying back shares.

The hedging perspective by Acharya et al. (2007) perceives cash holdings as an instrument to hedge against a future shortage of funds that would lead to the dismissal of profitable investments. When future growth opportunities are not correlated with future cash flows, cash will be held to secure the financing of upcoming investments.

Finally, the costly contracting theory according to Liu/Mauer (2011) assumes cash holdings to be the result of debt covenants. Thus, risky firms are forced to build up or maintain a specific cash ratio. Otherwise, they cannot borrow capital or their credit conditions deteriorate.

2.2 Existing empirical results

Motivated by the diversity of the underlying theories, empirical research has derived a wide set of determinants that influence the corporate cash balance. Some of these, such as management compensation or specific liquidity constraints, are explicitly investigated, others serve as control variables. The empirical results are

often either heterogeneous or ambiguous across studies, as the theoretical basis already indicates. In this section, I differentiate 9 determinants that are usually operationalized by different proxies and highlight conflicting empirical results. I chose these determinants because they are most frequently applied in models predicting the level of cash and provide sufficient observations for the MRA. In this literature review, I aggregate results on R&D expenditures and the market-to-book ratio into one category, namely “growth opportunities”, because their interpretation in the existing research overlaps. However, I focus the subsequent meta-regressions on 10 instead of 9 determinants by regarding R&D expenditures and the market-to-book ratio separately. Both proxies are used simultaneously in the primary models and thus do not exclude each other which justifies separate meta-regression analyses.

Firm size

Firm size is one of the most frequently used determinants in empirical cash holding research since it is one of the most common control variables. The determinant is in general estimated by a firm’s total assets or their logarithm. Overall, the corporate cash ratio decreases with increasing firm size as Opler et al. (1999), Lins et al. (2010) and Qiu/Wan (2015) report, amongst others. This is consistent with all major theories since a firm is believed to face cheaper possibilities of external financing and decreasing information asymmetries when it grows in size. However, there are deviations, which find a positive association between firm size and the level of cash. Examples include Ozkan/Ozkan (2004) and Liu et al. (2015). According to the shareholder power hypothesis, shareholders allow greater cash holdings to the management when their interests are sufficiently secured as it might be the case in large firms that are subject to increased external discipline. Thus, the general effect of firm size and the source of its variation remain.

Investment Activity

Investment activities comprise capital expenditures as well as a firm's acquisition expenditures. The prior are a frequent control variable, while the latter are analyzed specifically by some studies. The cash level is mostly observed to decline when investment activity increases. Dittmar et al. (2003) and Hoberg et al. (2014) report this result for capital expenditures as well as Bates et al. (2009) and Oler/Picconi (2014) for acquisition expenditures. However, Opler et al (1999) and Huang et al. (2013) find a positive coefficient for capital expenditures, shedding doubt on direction of the association.

The result of a positive association seems to conflict in particular with the pecking-order theory and the FCF-hypothesis. The prior expects cash holdings to rise with the number of investments available. The latter assumes cash holdings to cause an increase in investment activity as cash reserves are associated to less external control than debt or equity. However the negative association is likely to be the result of the empirical set up that uses cash holdings as dependent and investment activities as explanatory variable. This model recognizes the cash that is spent in the course of an investment and does not regard the association between the likelihood of undertaking an investment and the corporate cash level. This likelihood is investigated in specific investment models. Harford (1999), Mikkelson/Partch (2003) and Harford et al. (2008) find an increased investment activity in firms with high cash holdings when applying investment models, still the direction of the investment activities' influence is not clearly determined.

Growth opportunities

A firm's growth opportunities represent intangible investments, i.e. factors like innovation and know-how. They complement the aforementioned investment

activities, which are investments in tangible, “hard” assets, as a determinant of cash holdings. They are usually measured by the market-to-book ratio or R&D expenditures. Both proxies are commonly found to be positively associated to the cash level, according to Foley et al. (2007), Iskandar-Datta/Jia (2014) and Chen et al. (2015). Therefore, cash appears to be hoarded to finance corporate growth. This finding is consistent with the all major theories because high-growth firms are usually subject to high information asymmetries and aim to avoid underinvestment. Deviations from the prior observation are found by Khieu/Pyles (2012) and Bigelli/Sanchez-Vidal (2012) who point out that growth opportunities do not increase cash holdings in mature and private companies. It is unsettled which relation between growth opportunities and the level of cash is more common. Furthermore, it is questionable if both proxies equally measure growth opportunities or if they have different meanings.

Net working capital

An alternative to hoarding cash, without relying on external financing, is the maintenance of liquidity substitutes. These can be converted into cash easily, as long as the transaction costs are not severe. Such liquidity substitutes are commonly measured by the net working capital, which equals current assets less cash less current liabilities. In general, cash holdings are found to decrease with an increase in net working capital as stated by Almeida et al. (2004), Subramaniam et al. (2011) and Liu et al. (2014). This corresponds to the trade-off theory because liquidity substitutes are able to avoid the costs of hoarding cash, unless the liquidation of these substitutes is associated to high transaction costs, while preserving its benefits, i.e. financial flexibility. The negative association between cash holdings and net working capital is doubted by Horioka/Terada-Hagiwara (2013) and Bates et al.

(2009) who report a positive association for Asian firms and US firms in the period of 2000 to 2006. This indicates ambiguity regarding the influence of net working capital on the cash level as well as a regional dependence of the effect.

Leverage

Another alternative to financing via cash holdings is switching to debt financing. The degree of debt financing is estimated by a firm's leverage, measured by the relation of total debt to total assets or total equity. Empirical results concerning the influence of leverage on cash holdings are congruent with the influence of net working capital. As Kim et al. (1998), Acharya et al. (2008) and Chen et al. (2014) report, cash declines when leverage rises. This is predicted by all major theories as leverage reduces the danger of underinvestment and imposes incremental external monitoring on the management. However, a positive association between the level of cash and leverage is found in non-US firms by Kalcheva/Lins (2007) and Chen et al. (2012), again indicating ambiguity and regional dependence of the leverage sensitivity of cash holdings.

Cash Flow

Kalcheva/Lins (2007) and D'Mello et al. (2008) correspond to the majority of research by reporting a positive association between operating cash flow and the level of cash. This is in accordance with the financing hierarchy of the pecking-order theory but can also be explained in the spirit of the FCF-hypothesis by increased discretionary potential induced by increased cash flows. Duchin (2010) and Chen et al. (2012) object to prior results and find a negative relationship. This observation suggests that the need to hoard cash declines with increased cash flows, either because the cost of external financing diminish or because investments can be financed directly from current cash flows.

Dividends

Payouts to shareholders constitute the opposite of holding cash. Accordingly, the majority of research, such as Khieu/Pyles (2012) and Julio/Yook (2012), finds a negative association between the corporate cash level and dividend payments. However, there are several observations of a positive relationship (Chen et al. (2012) and Hill et al. (2014)). Thus, the signaling power of dividends might indicate the alignment of managerial and shareholder interests which encourages investors to allow a higher cash ratio to the management as proposed by the shareholder power hypothesis. The general sign of the cash level's dividend sensitivity remains ambiguous.

Financial distress and constrained liquidity

A central determinant under analysis in cash holding research is financial distress which is defined as the probability of insolvency, respectively factors that constrain a firm's liquidity. This determinant comprises many proxies such as the volatility of cash flows, credit ratings and Altman's Z-score. Two general trends are observed: First, financial distress (especially when estimated by cash flow uncertainty and credit ratings) increases the level of cash according to Opler et al. (1999), Harford et al. (2008) and Subramaniam et al. (2011). Second, according to Lins et al. (2010) and Khieu/Pyles (2012), the influence of the Altman Z-score on the corporate cash level cannot be determined unambiguously. This indicates a non-linear influence of financial distress on the level of cash. Firms that face an increased but not yet severe danger of insolvency tend to hoard more cash to avoid increases in the cost of external financing. Firms that are closer to actual insolvency are unable to hoard incremental cash and exhaust their existing cash ratio because they do not have another option of financing. It remains interesting to derive a general effect of

financial distress on cash holdings across the distinct proxies and studies to reduce the influence of the respective primary study's research design.

Corporate governance

Another central determinant that is focused by research is the quality of corporate governance. Like financial distress, it consists of a broad set of proxies including board and ownership characteristics as well as measures of shareholder and takeover protection and governance indices. The general notion is that rising governance quality is associated with a decline in the corporate cash level. This corresponds to the FCF-hypothesis that expects cash holdings to decline when the management's discretionary leeway is reduced. This is confirmed by Yu et al. (2015) for CEO duality, Harford et al. (2008) for board independence and by Ozkan/Ozkan (2004) for both indicators. Dittmar et al. (2003) and Steijvers/Niskanen (2013) report cash to increase with increasing family ownership and Kalcheva/Lins (2007) as well as Kuan et al. (2011) find it to decrease with increasing managerial ownership. Furthermore, the cash level declines with increasing shareholder rights (Chen et al. (2014)) and increased governance quality according to governance indices (Elyasiani/Zhang (2015)). However, results are not uniform. Liu et al. (2015) find cash to increase with increasing board independence. Kalcheva/Lins (2007) and Yu et al. (2015) report a positive association between managerial ownership and the level of cash. Thus, the effect of individual governance instruments is unclear. Consequently, a general relation between corporate governance and corporate cash holdings is difficult to determine.

3 Methodology

3.1 The approach of meta-regression analysis

Meta-regression analysis is well known in medical as well as psychological research. It allows the quantitative aggregation of results from distinct primary studies concerning the same research question (Stanley/Doucouliagos (2012)). This aggregation of results accounts for differences in the research design of the respective primary studies and structures conflicting results (Feld et al. (2013)) The systematic procedure of MRA allows deriving new insights regarding the influence of primary study characteristics on the empirical results (Stanley/Jarrell (1989)).

As the previous discussion of empirical results has shown, research regarding cash holdings is diverse with respect to the determinants under analysis as well as with respect to the effect a specific determinant has on the cash ratio. Furthermore, variable definitions, especially regarding financial distress and corporate governance, vary greatly which makes a comparison of results difficult. Finally, it is difficult to obtain firm-level data for all variable types in an international sample over a long time period. Even if such a sample of firm-level data would be available, the estimated results depend on the respective econometric methods and variable definitions used.

MRA is especially suited to resolve these issues by estimating the general effect of common cash holding determinants because. It comprises existing cash holding studies into one meta-sample, consisting of various time periods, countries and firm characteristics. Moreover, the MRA approach pools existing results from different primary samples that were derived using different econometric methods and different variable definitions. Thus, meta-regressions identify the relation between the level of cash and specific determinants across modelling choices. This enables an estimation that is robust to the modelling of a determinant and allows predicting the impact of

the modelling alternatives. Ultimately, this approach derives new insights from existing research and provides guidance for future research.

Economic research already picked up the instrument of MRA to investigate contrary results in individual areas of research.[14] Examples include Efendic et al. (2011) who analyze the effect of institutions on economic performance, Doucouliagos et al. (2014) who investigate the income elasticity of the value of a statistical life and Zigraiova/Havranek (2015) who regard the impact of bank competition on financial stability. However, the MRA method is not yet widespread in business and finance research, a scarce example is Feld et al. (2013) who analyze results regarding the effect of corporate taxes on capital structure.

MRA uses the association between one explanatory variable and the dependent variable found in primary studies as the dependent variable to undertake a meta-regression. Thus, MRA is the regression analysis of regression analyses. The economic association that serves as the dependent variable in a MRA is called "effect size" and can be estimated by various proxies like a regression coefficient, t-value or elasticity. The explanatory variables of a meta-regression describe the characteristics of the primary studies from which the effect sizes were derived. These characteristics include, amongst others, the econometric models used, the calculation of the dependent variable, the sample size, time period under analysis or the regional setting. Accordingly, a meta-regression model takes the following basic linear functional form,

$$Y_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k \times Z_{ikt} + \varepsilon_{it}, \quad (1)$$

where Y_{it} is the effect size of study i in year t. Z_{ikt} is a vector of k explanatory variables describing characteristics of the primary studies.

[14] See Stanley/Doucouliagos (2012) for a general introduction into MRA and its areas of application.

3.2 Publication Selection Bias

An important challenge of MRA is publication selection. This describes the selective reporting of results to increase a study's chance of being published. As Card/Krueger (1995) note, the main sources of publication selection are the intent of being compatible to the current conventions of the respective field of research and the preference of significant over insignificant results. Compatibility with the conventions of research may even be used to determine the underlying empirical model. Thus, publication selection leads to results that are distorted towards current conventions and that disregard insignificant results. This distortion is referred to as publication bias. There are numerous ways to account for publication bias in MRAs. The funnel-asymmetry test (FAT) and the precision-effect test (PET), derived by Stanley/Doucouliagos (2007) and Stanley (2008), appear to be superior according to simulations undertaken by Stanley/Doucouliagos (2014) and Moreno et al. (2009). Their intuition, introduced by Egger et al. (1997), is that the standard errors associated with an effect size should vary symmetrically around the most precise effect size and should be independent of the respective effect sizes. In the presence of publication selection, standard errors will vary asymmetrically, i.e., effect sizes that are closer to the conventional true value will have lower standard errors (Egger et al. (1997) and Stanley/Doucouliagos (2014)). The FAT-PET MRA accounts for this dependence and takes the following basic linear functional form:

$$Y_{it} = \beta_0 + \beta_1 \times ErrorTerm_{it} + \varepsilon_{it}. \quad (2)$$

$ErrorTerm_{it}$ is the standard error of the economic relation estimated in the respective primary study, which is used to calculate the effect size Y_{it}. In this univariate set-up β_0 provides an estimate of the effect size after controlling for publication selection. It indicates the economic association in the primary study if

publication bias was absent, i.e., if the effect size would not depend on its standard error. Thus, β_0 is also referred to as the precision-effect test (PET). Accordingly, β_1 determines the magnitude as well as the sign of publication selection. It is in general called the funnel-asymmetry test (FAT). Despite its simple construction, especially the PET has been proven to be "surprisingly effective in separating the wheat from the chaff" (Stanley (2008)).

3.3 Model design

I follow the approach of Stanley/Doucouliagos (2012) in designing this MRA. A first indication of the effects of distinct cash holding is provided by a graphical analysis, i.e. I derive funnel plots and box plots for each determinant-elasticity of cash. Subsequently, the impact of publication bias is controlled for, in univariate FAT-PET models that correspond to eq. (2). These models derive estimates for the individual association between the level of cash and each of the ten determinants, leading to a total of ten distinct FAT-PET models. The univariate analysis is repeated on two sets of sub-samples to identify situations that alter the general influence of the cash holding determinants. The first set of sub-samples reflects the geographical setting of the primary studies. The second set regards whether primary studies were restricted to firms facing high information asymmetries. The construction of both samples is discussed in the subsequent section on the explanatory variables of the multivariate MRAs.

Finally, I employ multivariate MRAs to examine the effect of other study characteristics and to rule out potential sources of endogeneity. The individual multivariate MRAs are determined according to the general-to-specific approach recommended by Stanley/Doucouliagos (2012) and their econometric specification is determined according to Feld/Heckemeyer (2011). A general version of these

multivariate MRAs with a control for publication selection, based on eq. (1), is depicted in eq. (3):

$$Y_{it} = \beta_0 + \beta_1 \times ErrorTerm_{it} + \sum_{k=2}^{K} \beta_k \times Z_{ikt} + \varepsilon_{it} \quad (3)$$

Heteroscedasticity, which is a frequent problem of MRA, is accounted for by using a weighted least squares (WLS) estimator. These WLS-MRAs use the standard errors of the effect size in the respective primary study as weights. I chose to include all estimates of the effect size that can be found in a primary study in my meta-sample. This allows me to refer to a higher quantity of observations per determinant and avoids a selection bias resulting from choosing one specific effect size from a primary study. Consequently, there is unobserved heterogeneity, resulting from study-level effects, that needs to be accounted for. I rely on fixed effects WLS estimators and standard errors clustered on the study-level to mitigate this dependence, as advised by Stanley/Doucouliagos (2012).

Dependent variable

Each of my models uses the effect size of an individual cash holding determinant as dependent variable, which leads to 10 distinct models. I chose the elasticity E_*_{it} as the measure of effect size Y_{it}. Elasticities are comparable across studies because they account for differences in the scaling of variables and they can be interpreted intuitively (Stanley/Doucouliagos (2012)). Exemplarily, when total assets are used to explain cash holdings in a regression model, the specification of the total assets-variable, either as the balance sheet value or its log, influences its regression coefficient. However, the total asset-elasticity of cash holdings remains unaffected by this modelling choice. It denotes the percental change of the level of cash when total assets change by 1%. The individual elasticities are calculated by the subsequent formula:

$$Y_{it} = E\_*_{it} = B\_* \times \frac{M\_*}{M\_CH} \quad (4)$$

In eq. (4), B_* is the regression coefficient of the respective cash holding determinant, taken from a primary study. In each of the ten models, the asterisk is replaced by the name of the respective cash holding determinant, as shown in Appendix A. Consequently, B_TA is the regression coefficient of total assets. M_CH denotes the mean value of cash holdings and M_* the mean value of the respective determinant in a primary study, which makes M_TA the mean of total assets of one primary study. The determinants under consideration are total assets (E_TA), investment activity (E_Inv), market-to-book ratio (E_MB), R&D expenditures (E_RD), net working capital (E_NWC), leverage (E_Lev), cash flow (E_CF), dividends (E_Div), financial distress ($E\_TotalFinDistr$) and corporate governance quality ($E\_TotalGoodGov$). Each becomes the dependent variable in a distinct MRA and is measured as an elasticity according to eq. (4).

E_Inv comprises two proxies, capital expenditures and acquisition expenditures. This means, when a primary model uses capital expenditures or acquisition expenditures, I calculate the capital expenditure-elasticity respectively the acquisition expenditure-elasticity of cash according to eq. (4) but denote it in either case as E_Inv.[15] I proceed in the same way for $E\_TotalFinDistr$, which consists of proxies such as Altman's Z-score, cash flow volatility or credit ratings as well as $E\_TotalGoodGov$, which consists of proxies such as managerial ownership, board independence or CEO duality. These distinct proxies are treated as observations of the same variable, $E\_TotalFinDistr$ respectively $E\_TotalGoodGov$. Proxies for financial distress and the quality of corporate governance are adjusted to guarantee

[15] Therefore E_Inv_{it} can result from two equations: $E\_Inv_{it} = B\_Capx \times \frac{M\_Capx}{M\_CH}$ and $E\_Inv_{it} = B\_Acqu \times \frac{M\_Acqu}{M\_CH}$.

that a high value of each proxy indicates a high probability of financial distress, respectively a high quality of corporate governance. This is achieved by multiplying the primary study regression coefficient of the respective proxy with -1 whenever high values of a proxy in a primary study indicate a low probability of financial distress, respectively a low quality of corporate governance. This is exemplarily the case for entrenchment indices as in Harford (2008). A high value for this variable indicates that CEOs are entrenched and protect themselves from external discipline, which is a sign for corporate governance of low quality

This approach is difficult to undertake for proxies of ownership because of its potential non-linear influence on the level of cash according to Drobetz/Grüninger (2007). I disregard this non-linearity of ownership proxies and assume high values to indicate high quality corporate governance. First, there is no consensus on the non-linearity of ownership and the general influence of different ownership variables. Second, it is my goal to investigate the general influence of corporate governance and not the specific implications of ownership. Finally, ownership variables are just one set out of various proxies that constitute $E\_TotalGoodGov$, therefore a potential maladjustment of few ownership observations is absorbed by the unambiguous results of the remaining majority of governance variables. The MRAs take the form of eq. (5), where * is replaced by the respective variable, i.e. E_TA_{it} is the total asset-elasticity of the cash level, which results in ten distinct models:

$$E\_*_{it} = \beta_0 + \beta_1 \times ErrorTerm_{it} + \sum_{k=2}^{K} \beta_k \times Z_{ikt} + \varepsilon_{it} \qquad (5)$$

Explanatory variables

The vector Z_{ikt} represents the characteristics of primary studies, these are mostly coded as dummies. I include dummies for each type of fixed effects considered in the primary study. There are four options: either no fixed effects (the reference category),

time-fixed effects only ($OnlyTime\_FE_{it}$), industry-fixed effects only ($OnlyIndustry\_FE_{it}$), or time- and industry-fixed effects ($Industry\&Time\_FE_{it}$) are considered. These dummy take the value of 1 if the respective type of fixed effects was controlled for in a primary model and 0 otherwise. The initial general model featured further dummies describing the primary econometric model. These, for example, indicated the application of specific estimators but had to be dropped because of multicollinearity. Furthermore, dummies for the specification of the cash holding variable are included. They indicate that cash holdings are calculated either as cash plus short-term investments scaled by net assets (the reference category),[16] cash scaled by total assets ($CHtoTA_{it}$) or cash scaled by net assets ($CHtoNetA_{it}$). The dummies take the value of 1 if the cash holding variable was calculated accordingly, otherwise 0. I also include a dummy that takes the value 1 if a determinant was in the central focus of the respective primary study ($VarCentral_{it}$). The underlying intuition is that determinants which are in the central focus of a study are potentially subject to more publication bias than the control variables of the same study. A determinant is assumed to be in the central focus if it is mentioned in the abstract, the introduction or the conclusion of an article.

Other explanatory variables are the log of the average sample year ($LogAvgSampleYear_{it}$), log of the number of observations ($LogObservations_{it}$) and dummies for the geographical region which the primary study's sample stems from. These regional dummies indicate whether the samples of primary studies are exclusively from North America (the reference category), exclusively from Asia ($Asian\ sample_{it}$) or exclusively from Europe ($EU\ sample_{it}$); if a sample expands over several of the previous regions it is labelled as Global ($Global\ sample_{it}$).

[16] Net assets equal total assets less cash.

Another dummy indicates if the primary study's sample is restricted to firms that are especially subject to information asymmetries ($HighInfoAsym_{it}$). It takes the value of 1 when the primary sample exclusively consists of high-tech, young, financially constrained, R&D-intensive, non-diversified, risky, badly-governed, small firms, firms with a high market-to-book ratio, firms with a non-investment credit rating, firms with a high standard deviation of cash flows, firms with entrenched managers, firms with CEOs that do not hold options of the respective firms, firms whose CEO compensation is highly sensitive to the stock price volatility (high vega),[17] or firms with a high product fluidity, otherwise it takes the value 0. Thus, I do not measure information asymmetries myself but rely on the measurement of primary studies that restrict their samples to firms with specific features indicating the presence of information asymmetries. This also implies that I only regard information asymmetries resulting from firm characteristics and not from country characteristics like investor protection.

I also employ a set of dummies indicating the control variables used in a primary model. The dummies take the value of 1 if a determinant was used as a control variable in the respective primary study, otherwise 0. I use the following dummies to account for the use of control variables: firm size ($Firmsize_{it}$), the market-to-book ratio (MB_{it}), R&D expenditures (RD_{it}), capital expenditures ($Capx_{it}$), net working capital (NWC_{it}), leverage (Lev_{it}), cash flow (CF_{it}), financial distress ($FinDistr_{it}$) and governance quality ($TotalGov_{it}$). Such control variable dummies are only included if the respective determinant is not the dependent variable of the MRA, because this automatically means that the determinant was part of the primary regression model. Due to multicollinearity, the multivariate MRAs do not contain all of the dummies.

[17] This high vega indicates a high incentive for managers to take risks (Liu/Mauer (2011).

However, exchanging the aforementioned dummies does not alter the regression results.

Finally, dummies indicating the databases that were used to derive the primary sample are included. They take the value of 1 if the respective database was used and 0 otherwise but for the sake of brevity are not depicted individually in the regression tables. The multivariate MRA takes the general form of eq. (6), where * is replaced by the respective variable, i.e. E_TA is the total asset-elasticity of the cash level: [18]

$$
\begin{aligned}
E\_*_{it} = {} & \beta_0 + \beta_1 \times ErrorTerm_{it} + \beta_2 \times OnlyIndustry\_FE_{it} + \beta_3 \times OnlyTime\_FE_{it} \\
& + \beta_4 \times Industry\&Time\_FE_{it} + \beta_5 \times CHtoTA_{it} + \beta_6 \times CHtoNetA_{it} \\
& + \beta_7 \times VarCentral_{it} + \beta_8 \times LogAvgSampleYear_{it} + \beta_9 \times LogObservations_{it} \\
& + \beta_{10} \times Asian\ sample_{it} + \beta_{11} \times EU\ sample_{it} + \beta_{12} \times Global\ sample_{it} \\
& + \beta_{13} \times HighInfoAsym_{it} + \beta_{14} \times Firmsize_{it} + \beta_{15} \times Capx_{it} + \beta_{16} \times MB_{it} + \beta_{17} \times RD_{it} \\
& + \beta_{18} \times NWC_{it} + \beta_{19} \times Lev_{it} + \beta_{20} \times CF_{it} + + \beta_{21} \times Div_{it} + \beta_{22} \times FinDistr_{it} \\
& + \beta_{23} \times TotalGov_{it} + \varepsilon_{it} \qquad (6)
\end{aligned}
$$

This model explains the determinant-elasticity of cash holdings by the presence of publication bias ($ErrorTerm$), the consideration of different types of fixed effects ($OnlyIndustry_{FE\,it}, OnlyTime_{FE\,it}$, $Industry\&Time\_FE_{it}$) the modelling of the cash holding variable ($CHtoTA_{it}$ $CHtoNetA_{it}$), whether the determinant was in the central focus of the respective study ($VarCentral_{it}$), the log of the average sample year of the primary study ($LogAvgSampleYear_{it}$), the log of the number of observations in the primary study ($LogObservations_{it}$), the regional characteristics of the primary study sample ($Asian\ sample_{it}, EU\ sample_{it}, Global\ sample_{it}$) and the other control variables used in the primary study ($Firmsize_{it}, Capx_{it}, MB_{it}, RD_{it}, NWC_{it}, Lev_{it}, CF_{it},$

[18] All dependent and explanatory variables and their abbreviations are introduced in Appendix A.

$Div_{it}, FinDistr_{it}, TotalGov_{it}$). Since there are 10 determinants under analysis, model (6) exists in 10 specifications, each with a different elasticity as dependent variable. If for example the dividend-elasticity of cash holdings (E_Div_{it}) is used as the dependent variable, Div_{it}, which indicates the use of dividends as a control variable in the primary model, drops out of the MRA.

3.2 Sample construction

I identify relevant studies by a comprehensive literature research. First, all journals in the field of finance and accounting, ranked A+, A, or B, according to the journal ranking Jourqual 2.1 of the German Academic Association for Business Research (VHB) as well as working papers from the NBER database are considered. These sources are searched for studies containing the term “cash holding” in their titles. Subsequently, the references of the studies found in the first scanning-routine are searched for additional studies related to cash holdings.

The initial, hand-collected, sample of regression coefficients, associated standard errors and other study characteristics embraces 61 studies. Since this meta-study focuses exclusively on the influence of the most frequent determinants on the level of cash, only observations using a measure of the cash level as their dependent variable are kept in the final sample. Thus, estimates related to the influence of cash holdings on firm value and estimates regarding the influence of individual determinants on the change of cash holdings are dropped. Furthermore, I drop studies that do not report mean values of the cash holding variable and the explanatory variables because these values are necessary to calculate elasticities. I also do not include interaction terms from the primary studies in my sample because these would inflate the number of explanatory variables in the meta-regression excessively and encounter problems of multicollinearity. Consequently, the final

sample contains 45 studies, which equals 3439 effect sizes (elasticity-observations). I winsorize all elasticities at 1% and 99%.

3.3 Descriptive statistics

Table 2 provides the descriptive statistics for all dependent and explanatory variables. Panel A depicts summary statistics for the determinant-elasticities of cash holdings. According to the median-value cash holdings are inelastic to cash flows, dividends and financial distress exhibiting elasticities of 0.001, -0.003 and approximately 0.00. In absolute terms, the market-to-book ratio and total assets are the determinants to which the cash level reacts most elastic. The respective determinant-elasticities of cash are -0.074 and 0.087. However, in case of total assets this high median-value is tied to a standard deviation of 1.663, hinting a high variability in this elasticity.

Distinguishing the market-to-book ratio and R&D expenditures, instead of treating them as one proxy, seems reasonable since the respective median-elasticities of 0.087 and 0.007 differ substantially. This is contrasted by the investment activities-elasticity, reported with a median of -0.053, indicating that tangible and intangible investments are financed differently.

The median of the corporate governance-elasticity -0.011 confirms the FCF-hypothesis, which assumes cash holdings to be the result of managerial discretion and thus to decrease with an increasing quality of governance. Furthermore, the elasticities of cash holdings to its potential substitutes, net working capital and leverage, are negative. Panel B reports summary statistics for all explanatory variables.

Table 2 Descriptive Statistics

Panel A - Overview of Elasticities

Elasticity of Determinant	Mean	Min.	25% Percentile	Median	75% Percentile	Max.	Std. Dev.	Obs.
E_TA	0,042	-3,785	-0,625	-0,074	0,691	6,911	1,663	390
E_Inv	-0,072	-0,661	-0,094	-0,053	0,008	0,307	0,159	301
E_MB	0,131	-0,805	-0,002	0,087	0,223	1,234	0,330	343
E_RD	0,026	-0,930	-0,046	0,007	0,131	0,460	0,180	236
E_NWC	-0,010	-0,725	-0,166	-0,043	-0,009	0,282	1,869	319
E_Lev	-0,188	-3,884	-0,372	-0,021	0,174	1,038	0,800	410
E_CF	-0,009	-0,522	-0,031	0,001	0,027	0,267	0,110	364
E_Div	0,120	-0,546	-0,038	-0,003	0,260	2,852	0,538	243
E_TotalFinDistr	-0,044	-1,776	-0,089	0,000	0,059	0,743	0,266	536
E_TotalGoodGov	-0,014	-1,789	-0,052	-0,011	0,035	0,763	0,267	297
Total								3439

Panel B - Overview of Study Characteristics

	Mean	Min.	25% Percentile	Median	75% Percentile	Max.	Std. Dev.	Obs.
ErrorTerm	0,311	0,000	0,006	0,030	0,114	19,030	1,130	3439
CHsectoNetA	0,395	0	0	0	1	1	0,489	3439
CHtoTA	0,573	0	0	1	1	1	0,495	3439
CHtoNetA	0,031	0	0	0	0	1	0,174	3439
OnlyIndustry_FE	0,094	0	0	0	0	1	0,291	3439
OnlyTime_FE	0,176	0	0	0	0	1	0,381	3439
Industry&Time_FE	0,333	0	0	0	1	1	0,471	3439
AvgSampleYear	1997,5	1979	1994	1998,5	2002	2008,5	6,677	3439
Observations	19438.87	7	2180	5100	13864	209036	34647,6	3206
HighInfoAsym	0,121	0	0	0	0	1	0,326	3439
Firmsize	0,966	0	1	1	1	1	0,182	3439
M/B	0,942	0	1	1	1	1	0,233	3439
R&D	0,740	0	0	1	1	1	0,439	3439
NWC	0,845	0	1	1	1	1	0,362	3439
Lev	0,926	0	1	1	1	1	0,263	3439
CF	0,883	0	1	1	1	1	0,321	3439
CFuncer	0,834	0	1	1	1	1	0,372	3439
FinDistr	0,074	0	0	0	0	1	0,262	3439
TotalGov	0,605	0	0	1	1	1	0,489	3439
Infl	0,104	0	0	0	0	1	0,305	3439

The variables tabulated in table 2 are defined in Appendix A.

Table 3 reports the observations of each determinant-elasticity split by geographic regions. Half of the observations stem from studies that focus exclusively on North America. The other half is evenly split between Asian, European and global studies. The small number of Australian observations is not included in the analysis of regional sub-samples because Australia only features 4 observations per determinant. However, Australia is included in the total sample.

Table 3 Regional Sample Characteristics

Region	Observations										Total
	E_TA	E_Inv	E_MB	E_RD	E_NWC	E_Lev	E_CF	E_Div	E_TotalFinDistr	E_TotalGoodGov	
Asia	55	59	48	36	59	63	66	62	95	129	672
EU	81	9	52	25	30	92	28	40	54	25	436
Global	69	43	32	40	59	59	55	13	84	8	462
Australia	4	4	4	0	4	4	12	0	8	0	40
North America	181	186	207	135	167	192	203	128	295	135	1829
Total	390	301	343	236	319	410	364	243	536	297	3439

The variables tabulated in table 2 are defined in Appendix A.

4 Results

4.1 Graphical analysis

Figure 1 depicts the funnel plot of each determinant-elasticity. Funnel plots visualize the idea of testing for publication selection by investigating the distribution of elasticities with respect to their standard errors. Since the y-axis represents the precision of an elasticity, which equals the inverse of the standard error, the distribution of elasticities should ideally mirror a funnel. This funnel is centered on the most precise estimates. Deviations from the symmetrical funnel indicate the presence of publication bias that leads to skewed results (Egger et al. (1997)). However, highly precise elasticities that deviate from the funnel represent leverage points (Stanley/Doucouliagos (2012)). Such leverage points suggest situations when the general influence of a determinant on the cash level changes. Thus, they are not unprecise outliers but rather indicate that the determinant-elasticity of cash strongly deviates as a reaction to an influencing factor. The funnel plots complement many of the observations from the summary statistics. The plots of the total asset-elasticity and of the net working capital-elasticity of cash holdings exhibit great outliers, as already indicated by their standard deviation. The outliers are in general quite large across all plots. While the median elasticities are all smaller than +/- 0.1, the extreme

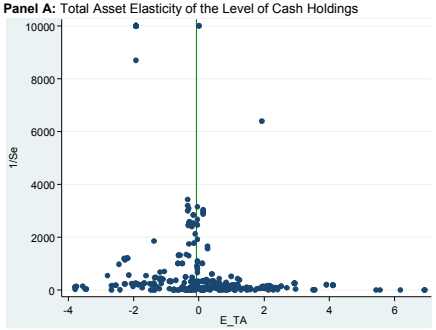
values often exceed +/- 1. Thus, the utilization of WLS estimator appears reasonable to account for these outliers.

All plots roughly resemble the shape of funnels. However, in all cases the distribution of elasticities with respect to their precision is skewed. This can especially be seen in the plots of net-working capital-elasticity, leverage-elasticity, cash flow-elasticity and dividend-elasticity of cash. The number of estimates is also skewed to the right from the median in the plots of investment-activity-elasticity and market-to-book-elasticity. Thus, publication selection is in general present but it remains impossible to determine how much it actually affects the overall trend. Furthermore, many plots exhibit leverage points indicating meaningful deviation from the general trends. Examples include the total assets-elasticity, investment acivitiy-elasticity, R&D expenditure-elasticity, financial distress-elasticity and corporate governance-elasticity of cash holdings.

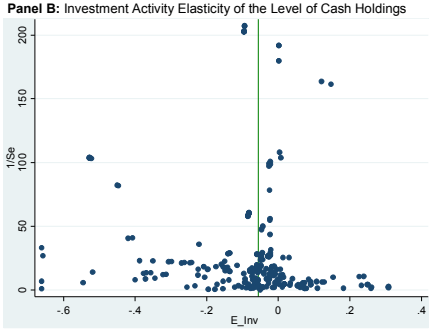
Figure 1 Funnel Plots of Determinant-Elasticities of Cash Holdings

Figure 1 exhibits the determinant-elasticities of cash holdings and their respective precisions in funnel plots. Precision is defined as the inverse of the standard error associated to a specific elasticity observation. Each of the panels A-K illustrates the funnel characteristics of a different determinant. The y-axis, i.e. the precision (1/SE), is restricted not to exceed 10000 (0.0001), respectively 1000 (0.001). This is done when extremely high precisions distort the scaling of the y-axis. The green line marks the median. All variables are defined in Appendix A.

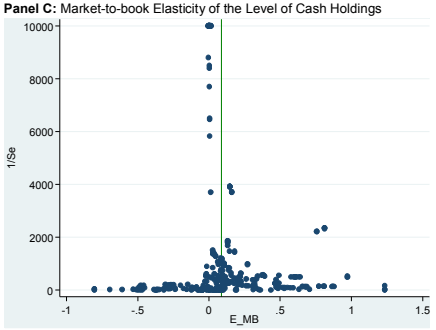
Panel A: Total Asset Elasticity of the Level of Cash Holdings



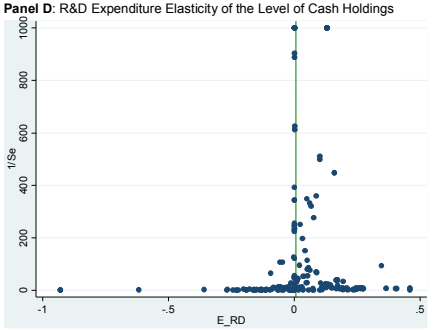
Panel B: Investment Activity Elasticity of the Level of Cash Holdings



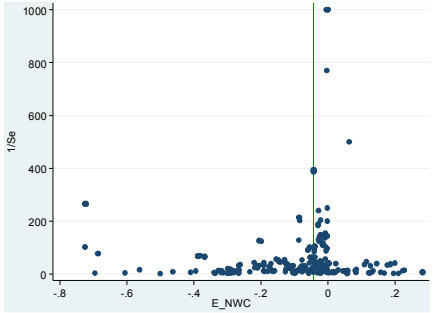
Panel C: Market-to-book Elasticity of the Level of Cash Holdings



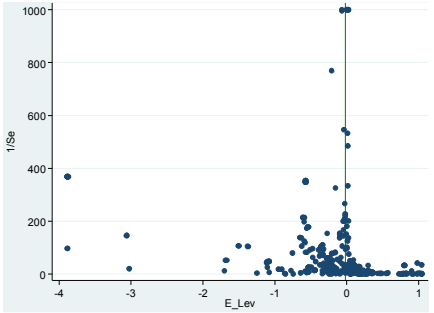
Panel D: R&D Expenditure Elasticity of the Level of Cash Holdings



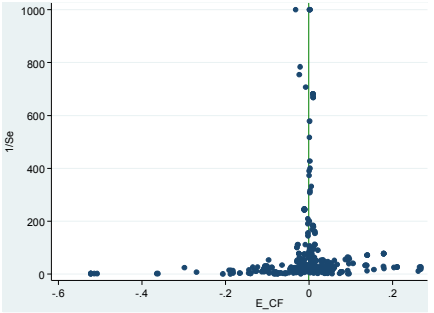
Panel E: Net Working Capital Elasticity of the Level of Cash Holdings



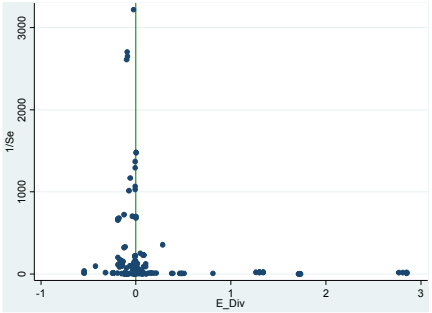
Panel F: Leverage Elasticity of the Level of Cash Holdings



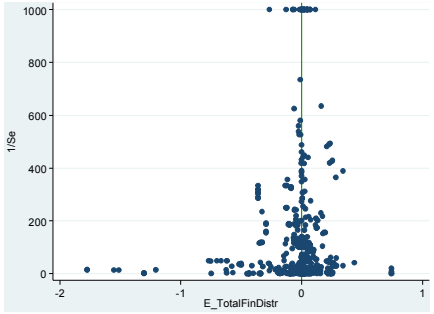
Panel G: Cash Flow Elasticity of the Level of Cash Holdings



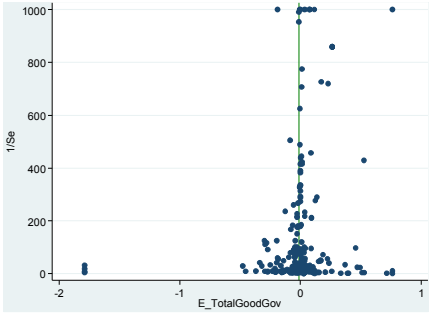
Panel H: Dividend Elasticity of the Level of Cash Holdings



Panel I: Financial Distress Elasticity of the Level of Cash Holdings



Panel J: Corporate Governance Elasticity of the Level of Cash Holdings



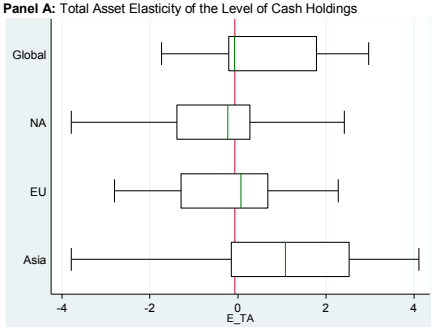
The difference in median-elasticities is small in absolute terms when leverage is concerned. However, the sign of the elasticities switches. Global and North American results are reported to be negative but European and Asian results are positive. As the box plots and the scaling of the x-axis show, the elasticities have large outliers and especially observations from the Asian sample are split broadly between -1 and +1. The cash flow-elasticity of the cash ratios reports another switch of signs in elasticities. In this case, Global and Asian samples tabulate a positive median-elasticity but North American and European results are negative. The same differences are confirmed for the financial distress- and the corporate governance-elasticity. Asian and Global samples report negative median-values, when results from North American and European are positive.

In order to provide further insights into these deviations, I compute box plots of the determinant-elasticities by geographic regions. This allows comparing the quartiles, dispersion, and skewness of determinant-elasticities across regions. Figure 2 reports these box plots and reveals that various elasticities differ depending on geographic regions. The total asset-elasticity of cash is negative in North America but positive in the EU and Asia. However, the elasticities in North America and the EU are, unlike the elasticity in Asia, still close to each other. The investment activity-elasticity is negative across all regions. However, cash reacts more strongly in North America, exhibiting a median elasticity close to -0.2, compared to all other regions, which have median elasticities smaller than -0.1. North America takes another distinct position when the R&D-elasticity of cash is regarded. European and Global studies report negative elasticities and object strongly to the positive results that are derived from North America. Corporate cash ratios in Asia appear to be rather inelastic to R&D expenditures.

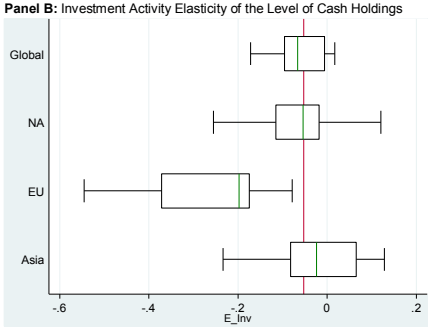
Figure 2: Box Plots of the Determinant-Elasticities of Cash Holdings by Regions

Figure 2 exhibits box plots of the determinant-elasticities of cash holdings split by geographic regions. Panel A-K show the determinant- elasticity of the level of corporate cash holdings for 10 distinct determinants. Geographic regions are defined in section 3.2 – explanatory variables. Red lines mark the overall median of a determinant-elasticity, green lines indicate the median within a geographic region. All variables are defined in Appendix A.

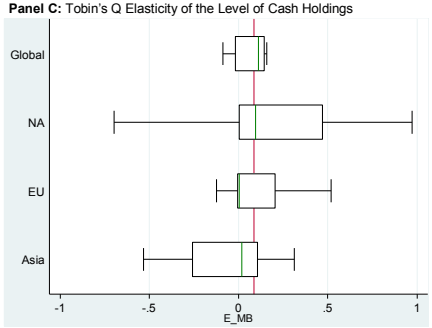
Panel A: Total Asset Elasticity of the Level of Cash Holdings



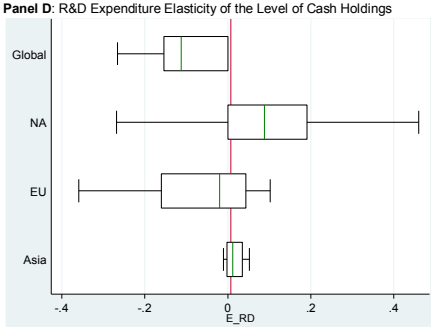
Panel B: Investment Activity Elasticity of the Level of Cash Holdings



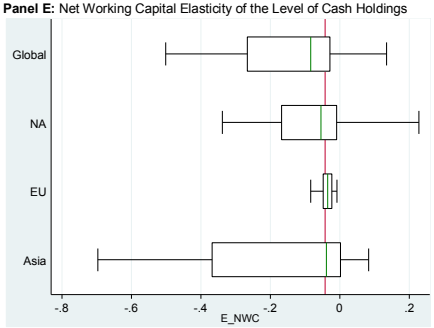
Panel C: Tobin's Q Elasticity of the Level of Cash Holdings



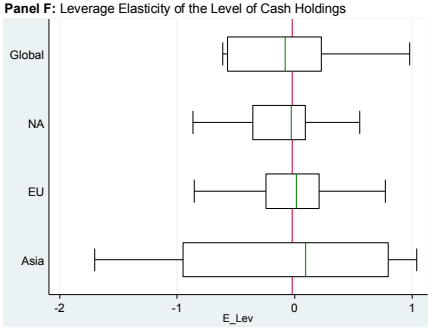
Panel D: R&D Expenditure Elasticity of the Level of Cash Holdings



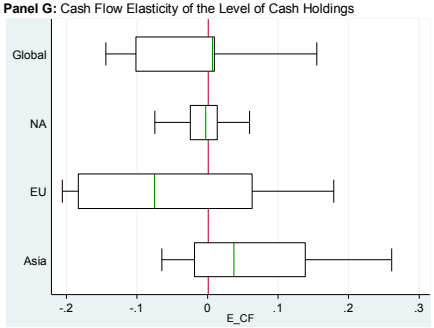
Panel E: Net Working Capital Elasticity of the Level of Cash Holdings



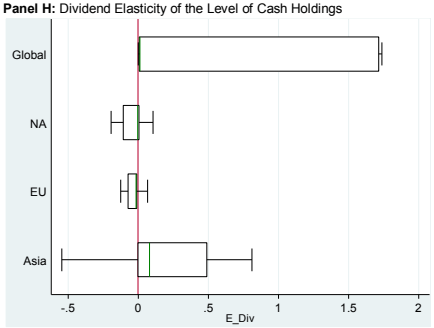
Panel F: Leverage Elasticity of the Level of Cash Holdings



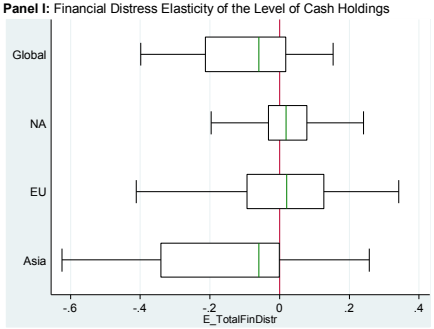
Panel G: Cash Flow Elasticity of the Level of Cash Holdings



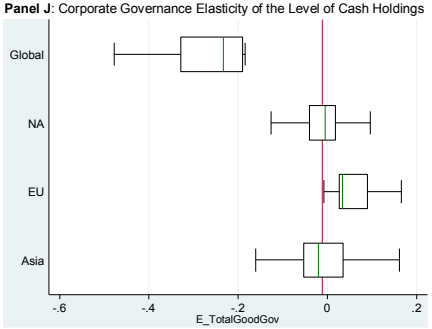
Panel H: Dividend Elasticity of the Level of Cash Holdings



Panel I: Financial Distress Elasticity of the Level of Cash Holdings



Panel J: Corporate Governance Elasticity of the Level of Cash Holdings



This is especially interesting regarding the corporate governance-elasticity of cash holdings because a positive elasticity conflicts with predictions from the FCF-theory. Accordingly, declining information asymmetries that are caused by increases in the quality of corporate governance, decrease cash holdings in Global and Asian studies, but increase them in European and North American studies. A possible explanation is country-level corporate governance consisting of shareholder protection and legal enforcement, that is on average stronger in purely North American and European samples than in Asian and Global samples (La Porta et al (1997) and Leuz et al. (2008). Thus, strongly protected shareholders might acknowledge a firms need for cash to avoid costly external financing as suggested by the shareholder power hypothesis. Results that are uniform across geographic regions are derived for the market-to-book-, net working capital- and dividend-elasticity.

4.2 Univariate analysis

Table 4 reports the results for the univariate FAT-PET MRAs. Panel A tabulates WLS-MRA models with heteroscedasticity-robust standard errors, panel B reports fixed effects WLS-MRAs with standard errors clustered at the study-level, and panel C exhibits the results of random effects WLS-MRA models with standard errors modified as suggested by Knapp/Hartung (2003). The Hausman test reveals that correlated unobserved heterogeneity affects the all univariate models variables. Thus, the fixed effects models (panel B) derive the most robust results.

Overall, cash holdings increase when the market-to-book ratio, R&D expenditures, financial distress and the quality of corporate governance increase. The corporate level of cash declines when total assets, investments expenditures, net working capital, leverage, cash flow and dividends diminish.

The determinant-elasticities after controlling for publication bias are mostly robust across all econometric specifications. According to panel A, the market-to-book ratio (model 3), net working capital (model 5) and leverage (model 6) do not have a significant influence on the corporate cash reserves. However, all these determinants turn out to have significant influence on the level of cash after controlling for the study-level dependence of results in panel B and C. Cash flow (model 7), dividends (model 8), financial distress (model 9) and corporate governance (model 10) are reported to have significant influence in panel A and B but this significance decreases and their sign switches in the random effects model. Consequently, all determinants significantly impact the corporate cash level in the fixed effects models.

Table 3 Univariate FAT-PET MRA

This table presents results from the basic univariate FAT-PET regressions. Panel A uses WLS-regressions and heteroscedasticity-robust standard errors. Panel B uses fixed effects WLS-regressions, clustered at the study level and standard errors which are also clustered at the study level. Finally, Panel C uses random effects WLS-regressions and standard errors modified as suggested by Knapp/Hartung (2003). All variables are defined in Appendix A. ***, **, and * represent significance at the 0.01, 0.05, and 0.10 levels. The t-statistics are shown in parantheses.

Panel A - FAT-PET WLS										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable:	E_TA	E_Inv	E_MB	E_RD	E_NWC	E_Lev	E_CF	E_Div	E_Total FinDistr	E_Total GoodGov
Intercept: $\hat{\beta}_1$ (**Fat**)	895.7***	-0.514*	108.9***	10.03***	-8.403***	-45.02***	0.656***	3.340*	-9.545**	55.38**
	(7.50)	(-2.13)	(6.75)	(3.71)	(-5.29)	(-5.04)	(3.59)	(2.01)	(-2.71)	(2.63)
1/SE: $\hat{\beta}_0$ (**Pet**)	-1.916***	-0.0885***	0.000677	0.000986***	-0.00592	-0.0127	-0.00106	-0.0644***	0.0324***	0.0398***
	(-143.71)	(-4.49)	(1.11)	(5.85)	(-1.25)	(-0.74)	(-0.46)	(-4.82)	(5.71)	(4.26)
Adj. R-sq	0.081	-0.000	0.112	0.049	0.062	0.041	0.021	0.009	0.002	-0.000
Panel B - Fixed Effects FAT-PET WLS										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept: $\hat{\beta}_1$ (**Fat**)	206.8	-1.444	2.401	0.443	-0.620	-2.443	1.338	4.605	-1.948	114.6
	(0.76)	(-2.05)	(0.27)	(1.10)	(-1.26)	(-0.71)	(1.18)	(1.37)	(-0.17)	(0.93)
1/SE: $\hat{\beta}_0$ (**Pet**)	-1.902***	-0.0796***	0.00215***	0.00123***	-0.0110***	-0.0347***	-0.00204	-0.0655***	0.0320***	0.0395***
	(-352.52)	(-11.70)	(17.75)	(119.48)	(-34.45)	(-19.41)	(-1.26)	(-23.47)	(59.15)	(70.56)
Adj. R-sq	0.807	0.933	0.966	0.995	0.990	0.996	0.676	0.609	0.753	-0.057
Panel C - Random Effects FAT-PET WLS										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept: $\hat{\beta}_1$ (**Fat**)	0.450**	0.427***	-0.213	0.0673	0.253	0.594***	-0.264*	0.424	-0.115	-0.173
	(2.61)	(3.42)	(-1.32)	(0.67)	(1.41)	(4.14)	(-2.50)	(1.92)	(-1.17)	(-0.85)
1/SE: $\hat{\beta}_0$ (**Pet**)	-0.0662	-0.129***	0.151***	0.0549***	-0.118***	-0.334***	0.0247***	0.0753*	-0.0254*	-0.0105
	(-0.81)	(-9.66)	(7.75)	(7.36)	(-8.81)	(-7.53)	(4.51)	(2.06)	(-2.08)	(-0.59)
Adj. R-sq	0.017	0.032	0.005	0.007	0.007	0.044	-0.002	0.014	0.002	0.006
# observations	390	302	343	236	319	410	364	243	536	297
# studies	38	27	36	21	34	39	33	25	38	21

Furthermore, only corporate governance affects cash differently than the median-value suggests in table 2. The PET reports corporate governance to be positively associated to cash holdings (0.0395 in panel B) while table 2 tabulates a negative governance-elasticity of cash (-0.011). This confirms the controversial role of the corporate governance-elasticity of cash that is already indicated by the presence of leverage points in the funnel plot and the geographic differences found in the box plot analysis.

4.2.1 Sub-sample by regions

In the next step, the previous fixed-effects univariate FAT-PET is repeated for the geographic sub-samples. In case of the Global region, it is not possible to derive estimates for the dividend- as well as for the corporate governance-elasticity of cash holdings because there are too few observations. The results are tabulated in table 5.

I derive two key observations from the sub-sample analysis that indicate regional differences in corporate cash policies. Firstly, the North American sample is characterized by several unique features suggesting the influence of low country-level information asymmetries. Accordingly, I find the investment-elasticity of cash (model 2) to be negative and significant in all regions, except Europe. North America exhibits the most negative investment-elasticity of cash (-0.144). The market-to-book ratio has a significant positive association with cash in North American and Global studies but no significant relation in European and Asian studies. Furthermore, North America differs from all other regions regarding the R&D- (model 4), the cash flow-, the dividend- and the financial distress-elasticity of cash holdings. Cash holdings increase with increasing R&D expenditures (0.00119) and financial distress (0.0327) but decrease with increasing cash flows (-0.00382) and dividends (-0.0695), in North America.

Table 5 Univariate FAT-PET MRA split by Region

This table presents results from the basic univariate FAT-PET regressions on samples that are split up by region. Panel A-D use fixed effects WLS-regressions, clustered at the study level, and standard errors also clustered at the study level. Panel A regards studies that focus exclusively on North America, panel B regards an exclusively Asian sample, panel C considers an exclusively European sample. Finally, Panel D covers studies that analyze samples from different regions. All variables are defined in Appendix A. ***, **, and * represent significance at the 0.01, 0.05, and 0.10 levels. The t-statistics are shown in parantheses.

Panel A - North America - FE										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable:	E_TA	E_Inv	E_MB	E_RD	E_NWC	E_Lev	E_CF	E_Div	E_Total FinDistr	E_Total GoodGov
Intercept: $\hat{\beta}_1$ (**Fat**)	598.8	-1.667	-7.921	1.890	-0.187	3.149	0.385	0.592	-2.795	-12.90
	(0.88)	(-1.78)	(-0.61)	(1.88)	(-0.38)	(0.91)	(1.10)	(0.40)	(-0.13)	(-1.41)
1/SE: $\hat{\beta}_0$ (**Pet**)	-1.913***	-0.144***	0.00200***	0.00119***	-0.00945***	-0.567***	-0.00382***	-0.0695***	0.0327***	0.255***
	(-151.83)	(-8.90)	(14.29)	(47.01)	(-41.90)	(-79.76)	(-9.33)	(-25.91)	(31.93)	(24.00)
Adj. R-sq	0.779	0.928	0.968	0.995	0.999	0.998	0.847	0.964	0.735	0.968
Panel B - Asia - FE										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept: $\hat{\beta}_1$ (**Fat**)	-53.89	-1.898	26.51	0.707	-1.395	-26.56*	6.646*	13.92*	14.04	-1.397*
	(-1.42)	(-1.65)	(1.05)	(2.61)	(-1.28)	(-2.61)	(2.51)	(2.58)	(1.15)	(-3.35)
1/SE: $\hat{\beta}_0$ (**Pet**)	1.818***	-0.0138	0.0357	0.00237	-0.165***	0.0379	-0.0112	-0.00788	-0.185***	-0.00142
	(9.99)	(-0.57)	(1.82)	(0.48)	(-9.12)	(0.45)	(-0.72)	(-1.23)	(-33.07)	(-0.50)
Adj. R-sq	0.826	0.334	0.284	0.810	0.623	0.579	0.598	0.526	0.023	0.151
Panel C - Europe - FE										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept: $\hat{\beta}_1$ (**Fat**)	-41.10	-3.198***	9.635	-0.791	-0.595	-0.657	-1.404	2.684	-10.06	1160.7
	(-0.86)	(-2.50e+15)	(0.79)	(-0.99)	(-2.30)	(-0.86)	(-1.31)	(0.59)	(-0.60)	(2.58)
1/SE: $\hat{\beta}_0$ (**Pet**)	-1.723***	0.00561***	-0.000365	0.0211	-0.0216**	0.0161***	0.0633	-0.0702***	0.191**	0.0349**
	(-33.75)	(3.45e+13)	(-0.46)	(3.75)	(-9.14)	(67.09)	(3.13)	(-34.11)	(4.14)	(17.54)
Adj. R-sq	0.705	1.000	0.209	-0.106	0.444	0.839	0.688	-0.094	0.193	-0.081
Panel D - Global - FE										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept: $\hat{\beta}_1$ (**Fat**)	21.76	-0.0347	-19.53	-0.237	0.873	0.355	0.613	1.931	-9.759	
	(0.78)	(-0.58)	(-0.91)	(-2.47)	(0.87)	(0.35)	(1.77)	(4.97)	(-1.51)	
1/SE: $\hat{\beta}_0$ (**Pet**)	-0.212***	-0.0666***	0.150***	0.00113	-0.0483***	-0.550***	0.00812***	-0.0264	0.000824	
	(-17.26)	(-212.32)	(20.72)	(2.16)	(-14.04)	(-141.88)	(12.72)	(-4.47)	(0.43)	
Adj. R-sq	0.734	0.998	0.811	0.611	0.458	0.983	0.102	0.891	0.260	
					North American Sample					
# observations	181	187	207	135	167	192	203	128	295	135
# studies	22	16	24	16	20	22	19	13	22	10
					Asian Sample					
# observations	55	59	48	36	59	63	66	62	95	129
# studies	7	7	6	3	7	8	8	8	8	7
					European Sample					
# observations	81	9	52	25	30	92	28	40	54	25
# studies	6	2	5	3	4	6	4	4	6	3
					Global Sample					
# observations	69	43	32	40	59	59	55	13	84	8
# studies	6	4	4	3	6	6	5	2	5	1

R&D expenditures do not have a significant association to cash in any other region, which indicates a unique approach to financing R&D expenditures in North America. The FCF-hypothesis suggests cash holdings to increase investment expenditures when the management has discretionary leeway. This use of cash holdings is perceived as value destroying by shareholders. It is furthermore in the

interest of the management to hoard free cash flows. Consequently, the observation of a large negative association between cash and investment expenditures, the value increasing effect of cash indicated by a positive market-to-book-elasticity and the finding that incremental cash flow does not increase cash holdings can be related to a stronger shareholder protection in North America.

Corporate governance does not affect the level of cash in Asia but it has a positive influence on the cash hoarding behavior in Europe (0.0349) and North America. A cash-increasing effect of good corporate governance is in line with predictions from the shareholder power hypothesis and signals, corresponding to the previous discussion, lower country-level information asymmetries in North America and Europe than in Asia.

Secondly, A substitutive relation between cash and leverage as well as cash and net working capital, shown by negative elasticities, is most consistently reported in North America. The direction of net working capital-elasticity (model 5) remains constant across all regions and model variations, varying between -0.00945 and -0.165. I report a positive association between leverage and cash holdings in Europe (0.0161) and an insignificant in Asia. Thus, the substitutive relation between cash and leverage is most pronounced in North America (panel A). Overall, this observation indicates a greater relevance of pecking-order and trade-off considerations in North America since net working capital and leverage act as alternatives to cash in this region.

The total asset-elasticity of cash reserves (model 1) is negative in the North American sample (-1,913) but positive in the Asian sample (1.818). Results for the EU and Global sample correspond to the North American results (panel C and D).

In summary, I find that North America exhibits determinant-elasticities of cash that are congruent to prediction from the FCF-hypothesis and especially the

shareholder power hypothesis for firms that are subject to low information asymmetries. Accordingly, the net working capital- as well as leverage-elasticity have the most negative association to cash holdings in North America, indicating a greater relevance of pecking-order and trade-off thoughts in this region, respectively the presence of low information asymmetries. Thus, a high country-level of information asymmetries increases the impact of classic FCF-considerations, whereas low information asymmetries are associated to an increased relevance of the shareholder power hypothesis as well as the trade-off and pecking-order theory.

4.2.2 Sub-sample by information asymmetry

The observation of a positive relationship between governance quality and cash holdings in North America and Europe indicates that country-level of investor makes shareholders allow the management to hold more cash when firm-level governance quality increases further in the rese regions. To isolate the effect of firm-level information asymmetries, which are assumed to be high when the quality of corporate governance is low, I repeat the univariate fixed-effects FAT-PET MRA on a sub-sample split by information asymmetry. This means I run the MRA separately for results derived from samples that exclusively contain firms believed to be subject to high information asymmetries and for elasticities from broad samples.[19] Table 6 reports the results for the sub-samples split by information asymmetry.

There are two general observations that I derive from this sub-sample analysis. First, the reaction of the market-to-book-, R&D-, investment activity-, the leverage- and dividend-elasticity of cash holdings indicate the influence of firm level information asymmetries in the spirit of the FCF-hypothesis and support interpretations from table 5 suggesting country-level information asymmetries to affect the determinants

[19] For an illustration of the sample construction see the explanation of the high information asymmetry dummy in section 3.2 – explanatory variables.

of cash. The market-to-book-elasticity of cash decreases in high information asymmetry-firms but remains positive and highly significant.

Table 6 Univariate FAT-PET MRA split by Information Asymmetry

This table presents results from the basic univariate FAT-PET regressions run on a sample of studies that focus on firms subject to high information asymmetries.Table 6 uses fixed effects WLS-regressions, clustered at the study level and standard errors clustered at the study level. All variables are defined in Appendix A. ***, **, and * represent significance at the 0.01, 0.05, and 0.10 levels. The t-statistics are show n in parantheses.

Fixed Effects FAT-PET WLS										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable:	E_TA	E_Inv	E_MB	E_RD	E_NWC	E_Lev	E_CF	E_Div	E_Total FinDistr	E_Total GoodGov
Sample of Firms Subject to High Information Asymmetry										
Intercept: $\hat{\beta}_1$ (**Fat**)	-24.58	-3.468	-18.48*	-7.072	-0.000429	-1.445	-0.193	0.0801	30.67	169.2
	(-0.48)	(-1.84)	(-2.47)	(-1.32)	(-0.00)	(-0.65)	(-1.06)	(0.26)	(0.78)	(0.80)
1/SE: $\hat{\beta}_0$ (**Pet**)	-1.926***	0.153	0.00145***	0.0706*	-0.0141***	-0.00213	0.00769	-0.00691	0.0302***	0.0381***
	(-1052.97)	(1.00)	(20.90)	(3.07)	(-7.08)	(-0.67)	(1.67)	(-1.80)	(13.49)	(50.99)
Adj. R-sq	0.992	0.380	0.628	0.568	0.943	0.887	0.860	0.893	-0.036	-0.082
Sample of Firms Not Subject to High Information Asymmetry										
Intercept: $\hat{\beta}_1$ (**Fat**)	226.9	-1.391	5.171	0.566	-0.874	-2.706	1.387	4.707	-3.831	104.8
	(0.74)	(-1.79)	(0.52)	(1.27)	(-1.36)	(-0.66)	(1.05)	(1.36)	(-0.36)	(0.89)
1/SE: $\hat{\beta}_0$ (**Pet**)	-1.900***	-0.0804***	0.00272***	0.00123***	-0.0108***	-0.0360***	-0.00202	-0.0655***	0.0321***	0.0403***
	(-335.66)	(-11.21)	(16.13)	(108.43)	(-27.18)	(-18.39)	(-1.12)	(-23.54)	(63.49)	(66.46)
Adj. R-sq	0.806	0.936	0.968	0.995	0.990	0.996	0.679	0.609	0.769	-0.070
				Firms subject to High Information Asymmetry						
# observations	38	35	41	16	36	48	52	24	61	66
# studies	8	6	10	6	7	9	7	4	10	6
				Firms not subject to High Information Asymmetry						
# observations	352	267	302	220	283	362	312	219	475	231
# studies	36	26	35	21	32	37	32	24	36	19

The R&D-elasticity of cash loses its significance in the presence of high information asymmetries. On the one hand, this sheds further doubt on the simultaneous usage of the market-to-book ratio and R&D expenditures as proxies for growth opportunities. On the other hand, the observation of higher and more significant market-to-book- and R&D-elasticities of cash in North America confirms the suggestion of a unique approach of financing R&D investments in North America. This approach can as well be caused by lower firm- and country-level information asymmetries. The FCF-theory suggests managers, whose interests are aligned with shareholders, to invest profitably with a long-term perspective, which is represented by R&D activities. Consequently, cash is positively associated to R&D investments when firms are well governed and situated in an environment of strong shareholder

protection. Furthermore, cash is valued more when it is held by firms that are subject to low information asymmetries as reported by Dittmar/Mahrt-Smith (2007) and Frésard/Salva (2010). This explains the observation of higher market-to-book-elasticities in North America (table 5) and in the presence of a low firm-level of information asymmetries (table 6).

Investments activities lose their significant negative association to cash in the high information asymmetry sample. This association between firm-level information asymmetries and the significance of the investment expenditure-elasticity of cash resembles differences found between the North American sample and the other regions in table 5. The prior region exhibits the most negative investment-elasticity by far, compared to the residual regions. According to the FCF-hypothesis, cash holdings are an instrument of managerial discretion and used for value-destroying investments when information asymmetries are high. Consequently, cash is expected to increase investment expenditures when information asymmetries are high. Thus, the regional differences in the magnitude and direction of the investment-elasticity could be due to country-level information asymmetries.

The leverage-elasticity of cash is in general found to be highly significant and negative. However, the elasticity loses its significance when high information asymmetries are present. This suggests that the cash and leverage behave less strongly as substitutes when shareholders have more difficulties to assess firm policies. Again, this confirms the interpretation from table 5, that the results in North America, which exhibit the most negative and significant association to cash, are influenced by a comparably strong shareholder protection. Leverage-elasticities in Asia, which is in general characterized by weaker shareholder protection than North America, are reported to be insignificant.

Dividends are shown to lose their influence on the corporate cash ratio in firms that are subject to high information asymmetries. Thus, dividends signal alignment with shareholder interests and are therefore accompanied by a reduction in cash, which limits the discretionary leeway for the management in the spirit of the FCF-hypothesis. This association is not found in an environment of high information asymmetries, which suggests that dividends lose their role as a reliable signal. This corresponds to the observation of negative significant dividend-elasticities in North America as well as Europe and a lack of significance in Asian and global studies.

Second, the total assets-, net working capital-, cash flow-, financial distress- and corporate governance-elasticity of cash holdings is not affected by firm-level information asymmetries. Consequently, the highly significant positive association between total assets and the cash ratio (1.818), the negative financial distress-elasticity (-0.185) and the insignificant corporate governance-elasticity (-0.00142) that is found in Asia do not correspond to the effect of firm-level information asymmetries. However, this does not dismiss the possibility of country-level information asymmetries being associated to the regional effects in table 5.

4.3 Multivariate analysis

I complement previous analyses by a fixed-effects multivariate MRA reported in table 7. Because of the multivariate character of the models, the constant cannot easily be interpreted as the elasticity after controlling for heterogeneity. Thus, it is difficult to derive statements on the general determinant-elasticity and its significance. I rather focus on the influence of the geographic regions and high information asymmetries on the individual determinant-elasticities and compare it to the univariate results.

Table 7 Multivariate FAT-PET MRA using WLS

This table presents results from multivariate FAT-PET MRAs. Table 7 uses fixed effects WLS-regressions and standard errors clustered at the study-level. All variables are defined in Appendix A. ***, **, and * represent significance at the 0.01, 0.05, and 0.10 levels. The t-statistics are shown in parantheses.

FAT-PET WLS-FE										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable:	E_TA	E_Inv	E_MB	E_RD	E_NWC	E_Lev	E_CF	E_Div	E_Total FinDistr	E_Total GoodGov
Publication selection										
ErrorTerm	-41.82	-1.192*	4.613	0.325	-0.781	-3.647	2.821	6.012	-10.28	106.7
	(-1.07)	(-2.23)	(0.38)	(0.81)	(-0.98)	(-0.93)	(1.46)	(1.26)	(-1.33)	(0.91)
Model characteristics										
OnlyIndustry_FE	-0.211	-0.000497	-0.00700	-0.00704	-0.00529		-0.00471	-0.0325	-0.0327***	-0.140
	(-1.15)	(-0.03)	(-0.12)	(-1.05)	(-0.26)		(-0.55)	(-0.32)	(-168.97)	(-0.76)
OnlyTime_FE	-0.444***	0.134*	-0.00000415	0.00526	0.0341		-0.00340	-0.0220***	0.0777***	-0.532*
	(-7.32)	(2.35)	(-0.00)	(1.84)	(1.11)		(-0.45)	(-29.42)	(10.20)	(-2.52)
Industry&Time_FE	-0.459***	0.144*	0.00107	0.00487	0.0339		-0.00331	-0.0421***	0.0640***	-0.482*
	(-8.39)	(2.36)	(0.40)	(1.70)	(1.10)		(-0.44)	(-27.30)	(6.10)	(-2.47)
Sample characteristics										
LogAvgSampleYear	-234.4*	88.26**	-34.00		5.735	-53.51*	17.78	-5.620	-61.43	
	(-2.30)	(3.12)	(-0.45)		(0.39)	(-2.69)	(1.33)	(-0.18)	(-1.47)	
LogObservations	0.0561***	-0.0160*	0.00761	-0.00229	-0.0165	-0.0531	0.00389	0.01000	0.00335***	0.0488***
	(3.95)	(-2.67)	(1.12)	(-1.70)	(-1.12)	(-1.23)	(0.97)	(0.67)	(71.39)	(1056.01)
Asian sample	1.064***	0.258***	0.294***	-0.516	-0.0796***	-0.898***	-0.343	-0.0101	9.369	
	(14.09)	(6.47)	(3.72)	(-0.74)	(-4.84)	(-11.37)	(-1.37)	(-1.19)	(1.36)	
EU sample	0.610	-0.0455	-0.342	-0.401	0.0372	0.549	-2.220	-0.554	33.24	
	(0.63)	(-0.24)	(-0.44)	(-0.73)	(0.31)	(0.53)	(-1.44)	(-1.42)	(1.32)	
Global sample	0.441***	0.00504	-0.0535***	0.00144	0.144***	0.0824***	-0.00861**		0.00869	
	(26.02)	(0.57)	(-15.46)	(1.51)	(18.93)	(4.58)	(-2.84)		(0.35)	
HighInfoAsym	0.190	-0.0125	-0.0388	-0.0158***	0.0197	0.0176	0.0106	0.127***	-0.0270	0.0320***
	(1.45)	(-0.41)	(-0.98)	(-8.10)	(0.74)	(0.22)	(0.49)	(6.96)	(-0.58)	(222.90)
Moderating variables of primary study										
Firmsize					-0.0138***		-0.00138			
					(-6.06)		(-0.48)			
Capx			-0.000820***	0.0181	0.00314	0.0270	0.0402***			
			(-7.60)	(0.81)	(0.83)	(0.50)	(7.66)			
MB				-0.00703	0.0212***	0.445	0.00937*			-1.519
				(-0.81)	(31.99)	(0.49)	(2.23)			(-0.96)
NWC			-0.0646				0.469		-0.512***	
			(-0.21)				(1.56)		(-5.29)	
Lev		0.103***		-0.0181	-0.00730		-0.0396***			
		(21.84)		(-0.81)	(-1.99)		(-7.53)			
CF										
FinDistr			4.636			-8.314	-3.945	-3.146		
			(0.39)			(-0.98)	(-1.53)	(-1.26)		
TotalGov	1.389**	-0.0263	0.0187	-0.00184*	-0.00476	-0.0667	-0.412*	0.00405	0.00139	
	(3.56)	(-0.27)	(0.87)	(-2.43)	(-0.47)	(-0.82)	(-2.45)	(0.59)	(1.32)	
Constant	1779.8*	-670.8**	258.6	0.0289	-43.44	413.6*	-135.4	43.31	466.0	1.245
	(2.30)	(-3.12)	(0.45)	(1.81)	(-0.39)	(2.70)	(-1.33)	(0.18)	(1.47)	(0.79)
Database Dummies	No	No	No	No	No	No	No	No	No	No
# observations	366	258	339	236	295	406	352	243	507	297
# studies	36	25	35	21	32	38	32	25	36	21
Adj. R-sq	0.894	0.962	0.971	0.996	0.994	0.997	0.711	0.656	0.947	0.259

Both panels mostly confirm observations derived from the univariate MRA. The total asset-elasticity of cash is strongly different in Asia and to a smaller degree also different in the Global sample compared to North America. North American observations are substantially more negative than Asian as well as Global

observations. Information asymmetries are not found to impact the relationship of total assets and cash holdings. Correlated unobserved heterogeneity is only present in the multivariate models of cash flow-, dividend-, market-to-book-, net working capital- and financial distress-elasticity.

The investment-elasticity of cash holdings in Asia is significantly different from North America. High information asymmetries do not have a significant impact on the association of investment activities and cash. Overall, these observations confirm the previous result the investment-elasticity of cash increases with country-level information asymmetries.

The market-to-book-ratio is found to influence the corporate cash significantly different in Asia and the Global sample than in North America. Differences between North America and the EU, which were found in the univariate fixed effects sub-sample analysis, are shown to be not significant. This confirms the aforementioned indication that differences between determinant-elasticities are mostly found between North America and the EU on the one side and Asia and the Global sample on the other side. There is no effect of firm-level information asymmetries on the market-to-book-elasticity of cash and the effect of the Asian sample switches its sign in comparison to the univariate regional analysis.

The geographic characteristics of the R&D-elasticity are lost in the multivariate model. However, it is shown that the R&D-elasticity of cash decreases in presence of high information asymmetries. This complements the finding of a lacking significance of the R&D-elasticity in the high information asymmetry sub-sample. Apparently, the distinct influence of R&D expenditures on cash in North America is rather associated to low firm-level information asymmetries than to a unique habit of financing research and development or strong investor protection, which still corresponds to the previous FCF-interpretation.

There is a highly significant difference in the net working capital- as well as the leverage-elasticity between the Global as well as the Asian sample on the one side and the North American sample on the other side. Both determinants act more strongly as a substitute to cash in Asia than in North America while their substitutive relation to cash is less pronounced in the Global sample. However, univariate results suggest the networking capital-elasticity to be more negative for Asia as well as the Global sample when compared to North America and the leverage-elasticity to be less negative. Corresponding to the univariate results, high information asymmetries are neither found to influence the net working capital-elasticity nor the leverage-elasticity. Consequently, country-level information asymmetries affect the substitutive relation between cash and net working capital as well as leverage but the predicted direction of this effect found in the univariate and multivariate models are contradictory.

Regional differences in the cash flow-elasticity between North America and the EU as well as Asia, found in the univariate analysis, are not found to be significant in the multivariate model. The Global sample exhibits a reaction of the cash ratio to cash flow that can significantly be distinguished from North America. As expected from previous indications, the influence of cash flows on cash holdings does not depend on the firm-level of information asymmetries.

Regional differences in the effect of dividend-, financial distress- and corporate governance-elasticity on cash, which were found in the univariate analysis, do not persist in the multivariate model. In accordance with the univariate analysis, high firm-level information asymmetries also do not affect the financial distress-elasticity. However they significantly increase the dividend- and corporate governance-elasticity.

4.4 Robustness

I conduct two sets of robustness checks on the multivariate analysis. Firstly, I alter the control for publication selection by exchanging the estimate's standard error with the squared standard error. The PET estimator then becomes the so-called precision-effect estimate with standard error (PEESE) estimator. According to Stanley/Doucouliagos (2007 and 2014) and Moreno et al. (2009), this estimator provides an improved correction for publication selection, when there actually is a publication bias. However, the FAT-PET model is more precise when there is no publication selection.

Secondly, I vary the effect size by utilizing the t-values of the primary regression coefficients instead of its elasticities. T-values are just like elasticities robust to differences in scaling across estimates but are not as easy to interpret from an economic viewpoint.

The results from my previous analysis are essentially confirmed by both robustness checks.[20] The fixed effects PEESE model stresses the difference between the Asian and Global samples on the one side and the North American and European sample on the other side even stronger. They also confirm significant differences between these regions for the dividend and financial distress-elasticity.

The multivariate fixed effects WLS using the t-value confirms the results of its counterpart which uses elasticities. However, it stresses the influence of high information asymmetries even stronger.

5 Conclusion

This article aims to contribute to existing research on corporate cash holdings by deriving more general statements regarding the determinants of the corporate cash

[20] Results are available upon request.

level, which are not bound to specific situations, time periods, sample characteristics, the econometric modelling of primary studies or variable definitions. These statements are obtained by aggregating the quantitative results from primary research in a meta-regression analysis and deal with influence of the most prominent cash determinants on the level of cash. Thus, they help overcoming the ambiguity and heterogeneity of existing results. Moreover, I identify regional differences and similarities in the effects of cash holding determinants as well as the impact of firm-level information asymmetries on the cash holding determinants. This differentiation helps identifying sources of variation in the general association between a determinant and the level of cash as well as pointing out the general influence of firm-level information asymmetries across different approaches of modelling such asymmetries.

I analyze the influence of 10 determinants on the level of cash, respectively the determinant-elasticity of cash. These determinants are total assets, investment activities, the market-to-book ratio, R&D expenditures, net working capital, leverage, cash flow, dividends, financial distress and corporate governance. After controlling for publication selection, all determinants are found to significantly affect corporate cash hoarding in a univariate MRA setting. In summary, cash holdings decrease with increases in total assets, investment activities, net working capital, leverage, cash flow and dividends. Moreover, the corporate cash ratio increases with the market-to-book ratio, R&D expenditures, financial distress and the quality of corporate governance.

Graphical and univariate sub-sample analysis as well as multivariate MRAs reveal the influence of the geographical region and the presence of firm-level information asymmetries on cash holdings. In general, determinant-elasticities are shown to behave similar in North America and the EU but different in the Asian or

Global sample. In Asia, the FCF theory gains importance while the trade-off and pecking-order theory are more relevant in Europe and the US. The Asian and the Global sample also derive results that are frequently distinct from each other. The difference between North America and the EU on the one hand and Asia and the Global sample on the other hand persists for total assets, investment activities, the market-to-book ratio, net working capital, and leverage. In some cases a direction of the difference can be identified: Cash holdings in the Global and Asian sample are reported to have a less negative, in case of Asia even a positive, total asset-elasticity. The investment activity-elasticity of cash also increases in the Asian as well as the Global region when compared to North America and the EU. The market-to-book ratio increases in Asia and decreases in the Global sample, in comparison to the North American and the European sample. The latter two findings correspond to the FCF-hypothesis as well as the shareholder power hypothesis when information asymmetries are low. However, the direction of the previous effects is more ambiguous in the multivariate MRAs.

The net working capital and the leverage-elasticity of cash increase when the Global sample is compared to North America and the EU, but decrease when Asia is compared to the latter. Thus, trade-off and pecking-order considerations, which focus on weighing up financing possibilities and avoiding underinvestment, gain importance when the country-level of information asymmetries is moderate. Finally, R&D expenditures only have a significant, positive, association to cash in North America which indicates a regional preference of financing intangible investments.

Evidence from univariate and multivariate analysis reports the R&D expenditure-elasticity of cash to decrease significantly in the presence of high firm-level information asymmetries. This indicates the significant and positive R&D expenditure-elasticity of cash in North America to be the results of low information

asymmetries in the spirit of the FCF-hypothesis. The dividend- and corporate governance-elasticity of cash are as well affected by firm-level information asymmetries, although it is not possible to derive unambiguous estimates regarding the direction of the effect.

6 Appendix

Appendix A Variable Descriptions

Variable	Description
Data-variants of cash holding determinants *- always combined with one of the suffixes below*	
B_*	Regression coefficient of the respective determinant in the primary study.
E_*	Determinant-elasticity of cash holdings. The determinant is specified by the suffix that replaced the asterisk
M_*	Mean value of the respective determinant in the primary study.
Cash holding determinants - always combined with one of the prefixes above	
*CF	Cash flow
*CFuncer	Cash flow uncertainity
*CH	Cash holdings
*Div	Dividends
*Inv	Investment expenditures
*Lev	Leverage
*MB	Market-to-book ratio
*NWC	Net working capital
*RD	Research & development expenditures
*TA	Total assets
*TotalGoodGov	Total good corporate governance
*TotalFinDistr	Total financial distress
Explanatory variables	
Asian sample	Dummy variable that takes the value 1 if a primary regression analysis considered exclusively Asian firms and 0 otherwise.
CHsectoNetA	Dummy variable that takes the value 1 if cash holdings were calculated as cash + short-term investment scaled by net assets (total assets less cash), in the respective primary regression model, and 0 otherwise
CHtoNetA	Dummy variable that takes the value 1 if cash holdings were calculated as cash scaled by net assets (total assets less cash), in the respective primary regression model, and 0 otherwise
CHtoTA	Dummy variable that takes the value 1 if cash holdings were calculated as cash scaled by total assets, in the respective primary regression model, and 0 otherwise
ErrorTerm	Standard error of a determinant's regression coefficient, taken from primary studies
EU sample	Dummy variable that takes the value 1 if a primary regression analysis considered exlusviely firms that are geographically located in Europe and 0 otherwise.
Global sample	Dummy variable that takes the value 1 if a primary regression analysis did not focus exclusively on one of the defined regions (NA, Asia, EU) and 0 otherwise.
HighInfoAsym	Dummy variable that takes the value 1 if a primary regression analysis focusses exlcusively on firms that are subject to high information asymmetries and 0 otherwise.
Industry&Time_FE	Dummy variable indicating that the regression model of the primary study contained industry- and time-fixed effects
LogAvgSampleYear	Logarithm of the average sample year of a primary regression analysis.
LogObservations	Logarithm of the observations (firm years) of a primary regression analysis.
OnlyIndustry_FE	Dummy variable indicating that the regression model of the primary study only contained industry-fixed effects.
OnlyTime_FE	Dummy variable indicating that the regression model of the primary study only contained time-fixed effects.

Appendix A Continued

Variable	Description
VarCentral	Dummy variable that takes the value 1 if a determinant was a treatment variable and the value 0 if a determinants was a control variable, in the respective primary study.
Capx	Dummy variable that takes the value 1 if a primary regression model contained a measure of capital expenditures as control variable and 0 otherwise.
CF	Dummy variable that takes the value 1 if a primary regression model contained a measure of cash flow as control variable and 0 otherwise.
Database Dummies	Various Dummy variables that take the value 1 if a primary regression analysis used data from a specific database and 0 otherwise.
Div	Dummy variable that takes the value 1 if a primary regression model contained a measure of dividends as control variable and 0 otherwise.
FinDistr	Dummy variable that takes the value 1 if a primary regression model contained a measure of financial distress as control variable and 0 otherwise.
Firmsize	Dummy variable that takes the value 1 if a primary regression model contained a measure of firm size, usually total assets, as control variable and 0 otherwise.
Lev	Dummy variable that takes the value 1 if a primary regression model contained a measure of leverage as control variable and 0 otherwise.
MB	Dummy variable that takes the value 1 if a primary regression model contained the market-to-book ratio as control variable and 0 otherwise.
NWC	Dummy variable that takes the value 1 if a primary regression model contained a measure of net working capital as control variable and 0 otherwise.
RD	Dummy variable that takes the value 1 if a primary regression model contained a measure of R&D expenditures as control variable and 0 otherwise.
TotalGov	Dummy variable that takes the value 1 if a primary regression model contained a measure of corporate governance as control variable and 0 otherwise.

Appendix A briefly describes all variables used in this study. The construction of the cash holding determinants is explained in more detail in section 3.2.

Appendix B Final Sample of Primary Studies

Study	Countries	Region	Period
Kim/Mauer/Sherman (1998)	US	NA	1975-1994
Opler/Pinkowitz/Stulz/Williamson (1999)	US	NA	1971-1994
Pinkowitz/Williamson (2001)	US, Ger, Japan	Global, EU, Asia, NA	1971-1994
Ozkan/Ozkan (2004)	UK	EU	1998-1995
Acharya/Almeida/Campello (2007)	US	NA	1971-2001
Dittmar/Mahrt-Smith/Servaes (2007)	US	NA	1990-2003
Drobetz/Grüninger (2007)	Swiss	EU	1995-2004
Foley/Hartzell/Titman/Twite (2007)	US	NA	1982-2004
Kalcheva/Lins (2007)	Broad international sample	Global	1996
Chen (2008)	US	NA	2000-2004
D'Mello/Krishswami/Larkin (2008)	US	NA	1985-2000
García-Teruel/Martínez-Solano (2008)	Spain	EU	1996-2001
Harford/Mansi/Maxwell (2008)	US	NA	1993-2004
Bates/Kahle/Stulz (2009)	US	NA	1980-2006
Chen/Chuang (2009)	US	NA	1997-2003
Lee/Lee (2009)	UK	EU	2001-2005
Duchin (2010)	US	NA	1990-2006
Tong (2010)	US	NA	1993-2000
Al-Najjar/Belghitar (2011)	UK	EU	1991-2008
Kuan/Li/Chu (2011)	UK	EU	1997-2008
Kusnadi (2011)	Malaysia, Singapore	Asia	2000-2005
Lee/Powell (2011)	Australia	Australia	1990-2008
Subramaniam/Tang/Yue/Zhou (2011)	US	NA	1988-2006
Álvarez/Sagner/Valdivia (2012)	Chile	Global	1986-2009
Chen/Chen/Schipper/Xu/Xue (2012)	China	Asia	2000-2008
Julio/Yook (2012)	Broad international sample	Global	1980-2005
Khieu/Pyles (2012)	US	NA	1985-2009
Brisker/Colak/Peterson (2013)	US	NA	1971-2006
Huang/Elkiwy/Jain (2013)	Broad international sample	Global	1992-2009
Steijvers/Niskanen (2013)	US	NA	1998
Sun/Yung/Rahman (2013)	US	NA	1980-2005
Yu/Sopranzetti/Lee (2015)	Taiwan	Asia	1991-2005
Belghitar/Clark (2014)	UK	EU	2000-2004
Chen/Li/Xiao/Zou (2014)	China	Asia	2005-2007
Harford/Klasa/Maxwell (2014)	US	Asia	1980-2008
Hill/Fuller/Kelly/Washam (2014)	US	Asia	1999-2006
Hoberg/Phillips/Prabhala (2014)	US	Asia	1997-2008
Iskandar-Datta/Jia (2014)	Broad international sample	Global	1985-2008
Liu/Mauer/Zhang (2014)	US	NA	2006-2011
Neamtiu/Shroff/White/Williams (2014)	US	NA	1987-2009
Oler/Picconi (2014)	US	NA	1989-2008
Qiu/Wan (2014)	US	NA	1982-2001
Chen/Dou/Rhee/Truong/ Veeraraghavan (2015)	Broad international sample	Global, NA	1989-2009
Elyasiani/Zhang (2015)	US	NA	1996-2008
Liu/Luo/Tian (2015)	China	Asia	2004-2011

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