Cash Flow Sensitivities and Corporate Financing Constraints

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Cash Flow Sensitivities and

Corporate Financing Constraints

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Abstract

This thesis examines different aspects of cash flow sensitivities in the context of corporate financing constraints. Despite the extensive body of literature on (i) the sensitivity of investment to cash flow (ICFS) and (ii) the sensitivity of cash to cash flow (CCFS), existing studies offer contrasting and puzzling evidence regarding cash flow sensitivities. The purpose of the thesis is to address some of the issues related to cash flow sensitivities and to contribute in elucidating cash flow sensitivities.

The first essay examines the recently documented ICFS puzzle. ICFS has significantly declined and disappeared in the U.S. market over time. However, the decline and disappearance of ICFS have not been explained and remain a puzzle. We argue that improved access to lower cost external financing (substitution between internal cash flow and external funds) and a global shift from asset tangibility to liquidity have largely contributed to the reported decline in ICFS. The results further suggest that firms rely less on both internally generated cash flows as a source of financing and tangible assets as an input of production and thus demonstrate weaker ICFS.

The second essay examines the influence of financial development on CCFS. Previous studies have found that corporate saving propensities decrease with financial advances. However, this relationship holds only if CCFS is linear, which is not a valid assumption. CCFS is highly sensitive to the cash flow environment. Once the nonlinearity of CCFS is controlled for, the association between a country's financial development and CCFS becomes insignificant. The findings highlight that endogenous CCFS reflects a multitude of saving motives and that firms persistently save cash from internal resources regardless of financial market advances.

The third paper extends the original interpretation of CCFS. We show that the corporate propensity to save is positively asymmetric. The sensitivity relationship is significantly stronger when a firm faces positive cash flow and remains positive in a negative cash flow environment. We further find that firms with different levels of financing constraints systematically save cash from their cash flows. This finding indicates that a variety of forces, along with information on financing frictions, drive CCFS.

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Three essays that constitute the thesis were presented in a number of domestic and international conferences. I would like to thank conference participants and discussants at 2013 Asian Finance Association Conference, 2nd SIRCA Young Researcher Workshop, 8th International Conference on Asia-Pacific Financial Markets, 2013 Australasian Finance and Banking Conference, 2014 Eastern Finance Association Annual Meeting, 8th World Congress of the Bachelier Finance Society, 2014 Northern Finance Association Annual Meeting, and 2014 Financial Management Association Annual Meeting for their useful comments. I would particularly like to thank Professor Terry Walter (University of Sydney) who discussed my paper at the SIRCA Young Researcher Workshop and provided a lot of constructive suggestions. I also thank Professor Vikram Nanda (Rutgers Business School) who provides very useful insights for one of the essays.

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Abstract

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The second essay examines the influence of financial development on CCFS. Previous studies have found that corporate saving propensities decrease with financial advances. However, this relationship holds only if CCFS is linear, which is not a valid assumption. CCFS is highly sensitive to the cash flow environment. Once the nonlinearity of CCFS is controlled for, the association between a country's financial development and CCFS becomes insignificant. The findings highlight that endogenous CCFS reflects a multitude of saving motives and that firms persistently save cash from internal resources regardless of financial market advances.

The third paper extends the original interpretation of CCFS. We show that the corporate propensity to save is positively asymmetric. The sensitivity relationship is significantly stronger when a firm faces positive cash flow and remains positive in a negative cash flow environment. We further find that firms with different levels of financing constraints systematically save cash from their cash flows. This finding indicates that a variety of forces, along with information on financing frictions, drive CCFS.

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1.1. Motivation of the dissertation

1.1.1. Motivation of the first essay

Starting with the seminal work of Fazzari, Hubbard, and Petersen (1988), there is a large body of literature on the impact of external financing constraints (frictions) on corporate investment demand — or the sensitivity of investments to internal cash flow (ICFS). The original interpretation states that when firms face financing constraints, investment spending will vary with the availability of internal funds, rather than merely with the availability of positive NPV investment opportunities. Accordingly, financially constrained firms should empirically demonstrate significant sensitivity of a marginal dollar of investment to a marginal dollar of internal cash flow. Given that cash flow is likely to be positively correlated with future profitability or investment opportunities, these studies have typically used Tobin's q as an independent variable to control for the unobserved correlation.

Many subsequent studies have cast doubt on the validity of ICFS as a measure of financial constraints, however. The robustness of the implications proposed by Fazzari et al. has been theoretically challenged by Kaplan and Zingales (1997), Povel and Raith (2001), Gomes (2001), and Almeida and Campello (2002). The robustness of cross-sectional evidence presented by Fazzari et al. has been questioned by Kaplan and Zingales (1999), Clearly (1999), Erickson, and Whited (2000), Alti (2003), and Moyen (2004). In a more recent study, Chen and Chen (2012)

report that ICFS has declined and completely disappeared in the U.S., even during the 2007–2009 credit crunch, and conclude that the sensitivity relationship cannot be a good measure of external financial frictions. Although the authors empirically examine several reasons for the decline (improvement in corporate governance, the introduction of new financing and investment channels, measurement error in Tobin's q), none of them is satisfactory. Therefore, the decline and disappearance of the sensitivity of capital investment to cash flow remain a puzzle.

The goal of the first essay is to address the ICFS puzzle and to find a satisfactory explanation for why the sensitivity has steadily declined and become a relatively weak measure of external financial constraints.

1.1.2. Motivation of the second essay

Almeida, Campello, and Weisbach (2004) in their influential paper examine the link between corporate financial constraints and a firm's demand for liquidity. Almeida et al. suggest that financial constraints should be related to a firm's propensity to save cash from internal cash flows, which they refer to as the cash flow sensitivity of cash (CCFS). The main implication of their study is that financially constrained firms should have a positive and significant sensitivity of cash to cash flow.

In a subsequent study, Khurana, Martin, and Pereira (2006) further examine the influence of financial development on the corporate demand for internal liquidity. Motivated by the intuition that financial constraints due to unavailable or costly external financing are more pronounced in underdeveloped financial markets, Khurana et al. document a negative relationship between the sensitivity of cash holdings to cash flows and cross-country financial development. More recent

studies by Baum, Schafer, and Talavera (2011) and Kusnadi and Wei (2011) follow the original interpretation of CCFS and report similar findings.

However evidence reported by Khurana et al. and related studies contradicts the existing knowledge that firms from developed economies persistently save liquidity and demonstrate a sharp increase in their savings behavior over time (e.g., Bates, Kahle and Stulz, 2009, Armenter and Hnatkovska, 2011, and Pinkowitz, Stulz and Williamson, 2012). Surprisingly, advanced capital markets and strong investor protection rights do not actually moderate strong saving propensities. This puzzling evidence is still not addressed in this strand of research. Regarding methodology, the approach of the prior studies suffers from econometric problems in the form of an omitted variable bias. In particular, prior studies have failed to control for the endogenous and nonlinear (asymmetric) nature of CCFS.

The goal of the second essay is to shed light on the true relationship between country-level financial development and firm-level demand for internal liquidity. The essay contributes in elucidating the forces that actually drive CCFS.

1.1.3. Motivation of the third essay

Almeida, Campello, and Weisbach (2004, 2011), Riddick and Whited (2009), and Bao, Chan, and Zhang (2012) offer contrasting conclusions regarding the corporate cash flow sensitivity of cash. The first study finds a positive sensitivity of cash to cash flow, while the second study finds a negative cash-cash flow sensitivity, and the third study finds a generally negative and asymmetric CCFS. The studies theoretically and empirically differ from each other.

Almeida et al. also argue that only financially constrained firms should have a positive and significant CCFS and that unconstrained firms' cash savings should not be systematically related to internal cash flows. This proposition implies that saving propensities reflect only external finance frictions. Thus, such a proposition is not economically valid, as the corporate propensity to save reflects a multitude of cash saving motives — in other words, the sensitivity relationship is endogenous.

Using an alternative and measurement error-consistent empirical model, the third essay investigates the true nature of the cash-cash flow sensitivity relationship in light of recent developments in the literature. Our findings help to resolve the long-lasting debate regarding whether CCFS is positive or negative, symmetric or asymmetric, and systematic or nonsystematic.

1.2. Structure of the dissertation

This dissertation is structured as follows.

Chapter 2 examines cross-country differences in the sensitivity of investment to cash flow and provides a plausible explanation for the steady decline in ICFS over time. Using cross-sectional and time-series data, the study conducts an empirical analysis on both the country and the firm level. This chapter analyzes how (i) improved access to lower cost external financing through financial and institutional development (a substitution effect between internal cash flow and external funds), (ii) the declining role of fixed capital formation and asset tangibility, and (iii) the rising importance of corporate liquidity contribute to the declining ICFS across countries and over time. Finally, the study examines whether alternative cash flow sensitivities (R&D,

inventory, and cash reserve-driven cash flow sensitivities) compensate for the disappearance of traditional ICFS.

Chapter 3 analyzes the role of financial development in mitigating the effect of strong corporate saving propensities, as measured by CCFS. The study addresses some of the existing econometric issues related to CCFS and shows how endogenous and nonlinear (asymmetric to the cash flow environment) cash-cash flow sensitivity is actually related to cross-country financial development. The chapter also discusses the economic intuition behind our empirical evidence. In particular, the analysis shows how (i) a variety of cash saving motives reflected in CCFS and (ii) the firm-level performance reflected in the sign of cash flow explain why firms from financially advanced economies find it beneficial to persistently accumulate cash from internal resources.

Chapter 4 addresses the contrasting conclusions regarding the true nature of the corporate propensity to save. The paper discusses the existing theory and empirical evidence of positive versus negative, symmetric (non-sensitive to the sign of cash flow) versus asymmetric (sensitive to the sign of cash flow), and systematic (relevant to the entire population of firms) versus nonsystematic (relevant to financially constrained firms only) CCFS. Then, the chapter analyzes how (i) firms with different levels of exposure to external financing frictions and (ii) firms operating in contrasting cash flow environments save cash from their internal cash flows. In the analysis, a measurement error- and endogeneity-consistent estimation technique is used.

Finally, Chapter 5 summarizes the most important findings and concludes the thesis.

1.3. Thesis-related presentations

The research included in this dissertation has been presented at several international conferences.

Chapter 2 was presented at the 2013 Asian Finance Association International Conference (Nanchang, China), 2nd SIRCA Young Researcher Workshop (Sydney, Australia), 8th International Conference on Asia-Pacific Financial Markets (Seoul, South Korea), and 2013 Australasian Finance and Banking Conference (Sydney, Australia).

Chapter 3 was presented at the 2014 Eastern Finance Association Meeting (Pittsburg, U.S.), 8th World Congress of the Bachelier Finance Society (Brussels, Belgium), and is scheduled for presentation at the 2014 Financial Management Association (Nashville, U.S.).

Chapter 4 is scheduled for presentation at the 2014 Northern Finance Association (Ottawa, Canada).

Chapter 2. Global Drivers of Investment-Cash Flow Sensitivity

Chapter summary:

Investment-cash flow sensitivity (ICFS) – its relation to firm-level financial constraints and documented decline in U.S. continues to attract debate. Firm-level data from 45 markets (1991-2010) is used to test explanations for what drives cross-country and time-series variation in ICFS. A strong decline in ICFS is documented for both developed and emerging market economies. Empirically weak ICFS does not necessarily reflect low financial constraints; ICFS and financial frictions are fundamentally different but have a common driver – external finance. Patterns of financial development across countries and a shift in investment toward intangible assets are important in explaining the ICFS decline: suggestive of a link (i) between ICFS and access to external finance, and (ii) between ICFS and asset tangibility. Unlike ICFS, cash-flow sensitivity of cash (CCFS) shows no decline over time: consistent with inter-temporal optimization in cash-retention.

Key words: Investment-Cash Flow Sensitivity, Financial Constraints, Cash Flow, Physical Investment, Cash Flow Sensitivity of Cash

JEL Classification Number: G01, G31, G32

2.1. Introduction

There has been an ongoing debate in the literature on the relationship between a firm's financial constraints and the sensitivity of its investment to internal cash flow (ICFS). The pioneering study of Fazzari, Hubbard, and Petersen (FHP, 1988) reports that firms that are more financially constrained exhibit a higher ICFS, i.e., their investments are more strongly influenced by the availability of internal resources. However, this linkage has been theoretically and empirically questioned in various studies.[1] More recently, Chen and Chen (2012) document a surprising decline in ICFS in the U.S. market and show that the decline is not explained by factors such as measurement error in Tobin's q, governance improvements, and the introduction of new financing and investment channels. These findings pose a further challenge to our understanding of ICFS.

To gain better insight into what drives ICFS and its downward trajectory in the US, we study its evolution over time, across several countries. A compelling reason to conduct our study in an international context is to take advantage of the considerable cross-sectional and time-series variation in country-level characteristics. In particular, our interest is in country-level variables that can potentially account for changes in ICFS: such as shifts in the nature of investment expenditures and improvements in investor protection, leading to a decrease in the cost of external financing. Using this variation allows us to test for whether these country-level changes

[1] Kaplan and Zingales (KZ, 1997) show that firms classified as financially unconstrained by Fazzari et al. actually demonstrate greater sensitivity. Cleary (1999) classifies firms into three categories: financially constrained, partially constrained and not financially constrained, and reports that cash flow estimates are largest for the not constrained firms. Gomes (2001) shows that cash flow sensitivity is neither theoretically necessary nor sufficient for financial constraints. Alti (2003) calibrates models of firms that use debt as a substitute for internal finance and shows that ICFS can be generated even if firms do not face financing constraints. Moyen (2004) shows that different criteria used to differentiate between financially constrained and unconstrained firms can lead to results consistent either with FHP (1988) or with KZ (1997). Cleary (2006) investigates several countries and provides evidence that constrained firms have lower ICFS than unconstrained firms. Other papers that criticize the interpretation of investment-cash flow sensitivity as financial constraints include Erickson and Whited (2000), Cleary, Povel and Raith (2007), Lyandres (2007) and Hovakimian (2009).

that are exogenous to the circumstances of individual firms affect their investment to cash flow sensitivity. In addition, the existing research on ICFS relies largely on US firms, with relatively few studies from other markets (Wurgler, 2000, Love, 2003, and Bond et al., 2003). By extending the study of ICFS to international markets we also shed light on whether the decline and disappearance of ICFS is specific to US markets or is part of a broader global pattern.

Next, we attempt to understand what drives the decline in ICFS over time. By doing so, we examine what factors may have a first-order effect on the response between fixed capital (physical) investment (I) and internal cash flow (CF). It is important to highlight that weak (-er) response between I and CF does not necessarily imply low (-er) financial constraints. A firm can finance (I) using cash holdings, instead of (CF), and thus have lower ICFS, but still be financially constrained. This is due to alternative financing channels. Alternatively, a firm can sharply slow (I) (and have lower ICFS) because of limited access to external financing or lack of investment opportunities. A firm can shift away from (I) (and have lower ICFS) and towards R&D, working capital investment or cash holdings, but still be financially constrained. This is due to alternative investment channels. A firm can finance (I) using external resources but have insufficient resources to finance R&D, working capital requirements or acquisitions. Finally, loss-making firms or firms with negative cash flow have, on average, significantly lower ICFS than positive cash flow firms, but they are more constrained because lenders and equity sponsors have lower proclivity to provide capital to such firms. In summary, ICFS reflect too many forces to be used to measure external finance constraints only. In the above examples, the response between (I) and (CF) (the level of ICFS) may sharply slow but financial constraints do not ease[2]. Therefore,

[2] If (I) was the only use of a firm's funds, and (CF) and external financing (debt and equity) were the only sources of funds, and Tobin's q was a perfect measure of future investment opportunities, then ICFS would be a sufficient measure of a wedge between the cost of internal and external funds.

ICFS and financial frictions are fundamentally different (in effect, ICFS cannot be a sufficient proxy for external financial frictions) but they have a *common* driver – access to lower cost external finance that reduces the role of internal cash flow as a source of financing in corporate capital expenditures and also eases the severity of (true and unobserved) financial constraints[3]. External financing alleviates *both* ICFS and financial frictions, but lower response between I and CF does not always correspond to fewer financing obstacles.

There are several groups of determinants that are potentially related to ICFS. The law and finance and economic growth literatures have persuasively established that ability of firm's to raise external capital is strongly affected by the legal and economic environment in which it operates (La Porta et al., 1997, 1998, 1999, 2000). Property rights, quality of governance and the level of financial market development are expected to affect the costs of external capital faced by firms and hence, in the end, a country's overall economic growth. In the paper we propose and test the hypothesis that these country-level factors play a significant role in accounting for the patterns in ICFS. We also examine the extent to which shifts in the pattern of investment from tangible to intangible assets affects ICFS (Almeida and Campello, 2007). Furthermore, we examine firms' cash-to-cash-flow sensitivity (CCFS) (Almeida et al., 2004, 2011). Drawing upon a simple model, we expect the CCFS to be relatively insensitive or increase gradually with a decrease in external financing costs. For our study we make use of a comprehensive sample of firm and country-level variables across 45 countries over the 1991 to 2010 period.

We begin by providing a direct cross-country and time-series analysis of investment-cash flow sensitivity. We document substantial variation in ICFS across markets, but similar pattern

[3] Other factors that may have a first-order effect on ICFS include presence (or lack) of investment opportunities, alternative financing (cash reserves, disposed assets) and investment channels (R&D, working capital, cash reserves, acquisitions), and cash flow shocks. These factors, however, do not systematically alleviate external financial constraints.

over time. For instance, over the sample period, the average ICFS is 0.04 (t = 15.8) for firms in developed markets and 0.10 (t = 17.1) for firms in emerging markets. Focusing on firms with positive cash flows only, the difference in ICFS is still substantial (0.08 and 0.11 for firms in developed and emerging markets, respectively). More telling, however, is the time-series pattern: ICFS largely disappears in developed markets, not just in the U.S., and also significantly declines in most emerging markets. While ICFS drops from 0.13 in 1991 to below 0.05 in 2010 for firms with strictly positive cash flows in developed market economies, there is also a sharp decline from 0.21 in 1992 to 0.08 in 2010 among emerging market economies. This time-series pattern is robust to sample composition, industry structure, potential problem of error-in-variables (measurement error of Tobin's q) and model specification. Importantly, the global downward trajectory is consistent to the U.S. evidence by Chen and Chen.

We next test for whether factors that have been linked to country-level costs of external financing and capital formation can explain cross-country and time-series variations in investment-cash flow sensitivity. We use these country-level variables to identify the relation between (i) external financing costs and ICFS, and (ii) asset tangibility (pledgeability) and ICFS. In particular, we construct five categories of determinant variables including stock market development, financial openness, credit market development, investor protection, and gross fixed capital formation. We find that variation in the development of stock and credit markets, financial openness and integration, and fixed capital formation are significant explanators of the time-series changes in ICFS across countries. Our findings suggest that the availability of lower-cost external finance through the financial development channel (i.e., substitution between internal cash flow and external financing) and the declining role of physical capital (i.e., substitution between asset tangibility and non-tangible assets) are significant divers of the

decline in ICFS. This evidence is new in that previous research in the area (Wurgler, 2000, Love, 2003, Islam and Mozumdar, 2007, and Almeida and Campello, 2007) does not provide a direct time-series analysis of the relation between the level of external finance availability, the tangibility of firms' assets and ICFS. Moreover, previous studies examine relatively short and early periods (clustered within 1990s and early 2000s) and document only a marginal impact of financial development on ICFS.

We next investigate how the impact of country-level financial development and fixed capital formation on ICFS is manifested at the firm level. We start by showing that capital market advances ease firms' access to external financing and thus over-reliance on internal resources to finance corporate capital expenditure. For example, the ratio of debt capital to physical assets increases from 1.1 in 1991 to 1.5 in 2010 in the subsample of firms in developed markets while the ratio improves from 0.6 in 1992 to 1.1 in 2010 in the subsample of firms in emerging markets. The time-series patterns reflect an improved access to external financing relative to asset tangibility (pledgeability) in both advanced and emerging market economies. Globally, firms tend to be less constrained in terms of financing needs and physical capital requirements. We further posit that favourable financing conditions reduce the reliance on internal cash flows, implying a lower ICFS. Next, we demonstrate that declining fixed capital formation is reflected in firms' asset tangibility and liquidity. For example, the ratio of cash liquidity to physical assets strengthens from 0.3 in 1991 to 0.5 in 2010 in the subsample of developed market firms, and the ratio improves from 0.2 in 1992 to 0.3 in the subsample of emerging market firms. Similarly, the ratio of physical capital spending to total assets declines from nearly 0.08 in 1991 to below 0.05 in 2010 in the subsample of developed market firms, and from 0.10 in 1992 down to 0.05 in 2010 in the subsample of emerging market firms. We further document that the declining trend

of asset tangibility and capital expenditure significantly contributes to the reduction in ICFS over time. Lastly, we show that our results are robust to country, industry, and firm compositions.

Finally, we link the time-series pattern of alternative cash flow-based sensitivities, namely the cash flow sensitivity of cash, R&D-cash flow sensitivity, inventory investment-cash flow sensitivity, and investment-cash reserve sensitivity with ICFS. In particular, we show that the decline in traditional ICFS is accompanied by the rising importance of R&D, inventories, and cash reserves. As we argue, a higher cash to cash flow sensitivity is not inconsistent with a reduction in the cost of external finance and optimal inter-temporal cash-retention. Our evidence also suggests that, consistent with a globally rising importance of corporate liquidity, CCFS serves as a valid complement to traditional ICFS.

The overall results of this study provide important insights into the declining pattern of the sensitivity of investment to cash flow. This paper follows past studies such as Brown and Petersen (2009), and Chen and Chen (2012) that document the decline in ICFS. We contribute the literature by using cross-country data to explicitly showing that the financial development channel (rising availability of lower cost external finance and declining role of cash flow) and fixed capital formation (declining importance of physical capital investment and corporate tangible assets) contribute to the decline in ICFS but not necessarily to unobserved financial constraints.

Furthermore, the empirical results of this study strengthen the earlier findings by Agca and Mozumdar (2008) for the U.S., and other studies such as Love (2003) and Islam and Mozumdar (2007) regarding the role of financial development in financial constraints. The study also extends findings by Almeida and Campello (2007) and Brown and Petersen (2009), provides a

direct time-series analysis on fixed capital formation and asset tangibility, and shows their role in explaining variations in investment-cash flow sensitivity.

Finally, we contribute to the literature using alternative cash flow-based sensitivities. We find strong evidence that the cash flow sensitivity of cash (Almeida et al., 2004, 2011, Khurana et al., 2006) does not decrease, and possibly increases, along with a decline in ICFS. We discuss why this is also consistent with a decline in financing costs.

The rest of the paper is organized as follows. We develop our hypotheses in section 2.2. In section 2.3, we discuss the empirical model, define variables, describe data and provide summary statistics. Section 2.4 provides the country-level analysis and shows time-series development of investment-cash flow sensitivity. In section 2.5, we explore why the sensitivity relationship declines over time. Section 2.6 presents several robustness tests and tests with alternative cash flow-based sensitivities. The last section concludes.

2.2. Hypotheses development

Our objective in this study is to use an extensive international data set to gain a better understanding of various issues surrounding firms' investment sensitivity to the availability of internal cash flow. We begin by highlighting the main questions and hypotheses that we will test to shed light on these matters, using international data.

The debate on whether ICFS captures financial constraints, as initially proposed by Fazzari, Hubbard, and Petersen (1988), can be briefly described as follows. The notion that financial frictions can affect firms' investment decisions is not controversial. There is, for instance, substantial evidence that there are costs associated with raising external capital and that the

presence of internal resources can affect investment decisions (see Lamont, 1997, Shin and Stulz, 1998, and many others). The debate regarding ICFS centers on (i) whether the level of ICFS provides a reliable measure of external financial constraints (Kaplan and Zingales, 1997, 2000, Alti, 2003, Cleary, 2006, Chen and Chen, 2012) and (ii) whether ICFS in fact measures the causal effect of cash flows on investment. One reason for these uncertainties is that internal cash flows may be correlated with unobservable future opportunities that cannot be adequately controlled for if Tobin's Q is subject to measurement error (Erickson and Whited, 2000, 2002). Other reason is that static single-equation ICFS does not acknowledge the interdependence among multiple (financing and investment) decision variables and produce inefficient estimates and provide an incomplete and potentially misleading view of true financial constraints (Gatchev et al., 2010).

Adding to the debate on the interpretation of ICFS is its documented variation over time, in particular, its largely unexplained and dramatic decline in the U.S. (Chen and Chen, 2012). It has been argued by Brown and Petersen (2009) that changes in ICFS reflect, in part, shifts in firm investments from capital expenditures to less tangible investments, for example, in R&D. Finally, it has been suggested that firms' cash to cash flow sensitivity provides an alternative, possibly less problematic, measure of firm financial constraints (Almeida et al., 2004, 2011).

We believe that studying ICFS in the context of international markets has certain advantages. With an international data series, we can use economy-wide variables, such as the level of financial market development and investor protection, as exogenous sources of variation that impact the costs of external financing of all firms in a given country (La Porta et al., 1997, 1998, 1999, 2000, Love, 2003). Hence, an improvement in a country's legal system that leads to improved investor protection would be expected to lead to an improvement in average access of

the country's firms to external capital – and hence diminish the role of internal cash flow in corporate capital expenditures for firms in the country[4].

To examine whether the availability of external finance affects ICFS, we examine whether cross-sectional and time-series changes in ICFS are related to indicators of external financing costs for each country and year. The advantage of this approach is that it enables us to identify the effects of external finance on ICFS by using country level exogenous variables. Hence, concerns about endogeneity and measurement errors associated with these tests are mitigated, as there is no particular reason to believe that large cross-country changes will affect measurement errors and their correlation in precisely the same way as would be predicted by changes in external financing costs in a panel of countries.

We can formalize the argument as follows. For every country c and year t, ICFS is denoted by $\beta_{c,t}$. Assume that $\beta_{c,t}$ can be represented as consisting of a country-year variable that captures the cost of external financing, $\Upsilon_{c,t}$, a term $\eta_{c,t}$ that represents the average of the firms' bias in ICFS caused by the correlation between the measurement of Tobin's Q and firms' internal cash flows, a term $K_{c,t}$ that represents shifts in the nature of technology and shifts from tangible to non-tangible investments, a constant α_0, and a noise term $\varepsilon_{c,t}$:

$$\beta_{c,t} = \alpha_0 + \Upsilon_{c,t} + K_{c,t} + \eta_{c,t} + \varepsilon_{c,t} \quad (1.1)$$

We estimate panel regressions of this form, where $X_{c,t}$ for simplicity represents a single country-level factor, such as investor protection, that is negatively related to the cost of external financing, $\Upsilon_{c,t}$. The variable $Z_{c,t}$ represents a country-level measure of the tangibility of the firms' investments in the economy.

[4] On the other hand, country-level fixed capital formation simply reflects business investments. Therefore, we can draw conclusion only regarding correlation between country-level fixed capital formation and firm-level asset tangibility (pledgeability).

$$\beta_{c,t} = \theta_0 + \theta_1 X_{c,t} + \theta_2 Z_{c,t} + \varepsilon_{c,t} \quad (1.2)$$

Provided there is no correlation between the bias $\eta_{c,t}$ and $X_{c,t}$, a test of the significance of the coefficient θ_1 provides a test of whether a reduction in the cost of external capital is significantly related to the ICFS[5]. Significance of the coefficient θ_2 would indicate that shifts in the nature of tangible investment have explanatory power with respect to the ICFS. A non-zero bias term $\eta_{c,t}$ would be absorbed by the intercept θ_0 and the error term $\varepsilon_{c,t}$.

We also formalize alternative model specifications for robustness check:

$$Y_{i,t} = \theta_0 + \theta_1 \Psi_{i,t} X_{c,t} + \theta_2 \Psi_{i,t} + \theta_3 X_{c,t} + \varepsilon_{i,t} \quad (1.3)$$

$$Y_{i,t} = \theta_0 + \theta_1 \Psi_{i,t} Z_{i,t} + \theta_2 \Psi_{i,t} + \theta_3 Z_{i,t} + \varepsilon_{i,t} \quad (1.4)$$

We estimate panel regressions of these forms, where the ratio of firm-level physical investment to fixed assets is denoted by $Y_{i,t}$ and the ratio of firm-level cash flow to fixed assets is denoted by $\Psi_{i,t}$. In the models (1.3) and (1.4), the estimated ICFS is $(\theta_1 + \theta_2)$. The variable $X_{c,t}$ is a country-level financial development factor and $Z_{i,t}$ represents a firm-level measure of asset tangibility (liquidity).

Based on the above discussion, we can state our first two hypotheses:

[5] We expect that ICFS is a linear function of the cost of external financing. Love (2003) and Islam and Mozumdar (2007) examine the impact of financial market development on the extent to which firms have to rely on internal capital for making investments, and find evidence of a negative and linear relationship between the two. Their evidence is consistent across different estimation procedures, alternative measures of financial constraints, and the use of bootstrapped standard errors. Agca and Mozumdar (2008) further show ICFS linearly decreases with increasing fund flows, institutional ownership, analyst following, anti-takeover amendments and with the existence of a bond rating. Ascioglu, Hegde, and McDermott (2008) also show that ICFS linearly relates to information asymmetry and probability of informed trading.

Hypothesis 1 (H1): ICFS of firms in a country will be negatively affected by country-level variables, such as investor protection and financial market development, that are associated with lower costs of raising external capital.

Hypothesis 2 (H2): The shifts in investment in tangible (physical) assets to expenditures on non-tangible or liquid assets will be associated with a drop in the average ICFS of firms in a country.

In addition to ICFS, Almeida, Campello and Weisbach (2004, 2011) have proposed that a firm's propensity to save cash from internal cash flows could be indicative of financial constraints. The notion is that financially constrained firms have an incentive to save more cash out of cash flow to fund future investment opportunities. Almeida et al. (2004, 2011), Khurana et al. (2006), and Baum et al. (2011) regard the sensitivity of cash to cash flow as a more reliable measure of financial constraints.

We argue that changes in external financing costs do not necessarily lead to an increase in firm's cash flow sensitivity. Based on a simple model (section 2.6.2.5), we use a two-period setting to show that the effect of external financing costs on CCFS may differ significantly from that on ICFS. In a multiple-period setting, the decision of whether to invest or retain internal funds for future investments depends on the anticipated relative marginal costs of raising capital across periods. Hence, if marginal costs are expected to be greater (smaller) in the future, it is desirable to retain more (less) funds for future needs.

We now consider the effect of an unexpected increase in a firm's internal cash flow. Assuming that the firm is starting from a situation in which it has equalized the inter-temporal margins, the 'optimal' retention decision will be one that again equalizes the margins, although at a different level. A decrease in the cost of external capital will affect the trade-off between

internal and external financing. However, it may have little effect on the inter-temporal trade-off, as the change in internal versus external financing affects all periods.

Hypothesis 3 (H3): CCFS is expected to be relatively insensitive to changes in the costs of external financing.

2.3. Methodology and sample construction

2.3.1 Methodology

Following Fazzari, Hubbard, and Petersen (1988, 2000), we estimate ICFS as follows:

$$\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \alpha_c + \alpha_j + \alpha_t + \beta_1 \left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \beta_2 q_{i,t-1} + \varepsilon_{i,t}, \quad (1.5)$$

where $I_{i,t}/K_{i,t-1}$ is the firm's physical (fixed) investment, $I_{i,t}$, deflated by its beginning-of-period physical (fixed or tangible) assets, $K_{i,t-1}$; $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q; $CF_{i,t}/K_{i,t-1}$ is the firm's internal (operating) cash flow, $CF_{i,t}$, deflated by its beginning-of-period physical assets, K_{it-1}; α_c controls for country fixed effects; α_j captures industry fixed effects; and α_t captures time (year) fixed effects. The coefficient β_1 is investment-cash flow sensitivity, and β_2 is investment-q sensitivity. We define the main variables in Appendix A.1.

We estimate the sensitivity of physical investment to cash flow using the OLS/WLS model with fixed effects and heteroskedasticity-consistent standard errors clustered at the firm level. To ensure that our results are not driven by a few countries with the largest numbers of observations, all reported estimation results are based on weighted least squares (WLS) (under which each country is equally weighted, so that firm-year observations receive more (less) weight in countries with fewer (more) firm-year observations). Our main variable of interest is β_1. We

document its variation in the cross-section and over time. We then test whether country and firm level variables explain the variation in β_1.

2.3.2 Sample construction

Following the literature on ICFS, we focus on publicly traded firms from Worldscope over the 1991 to 2010 period. Firms from the financial and utility industries are excluded. Firms are further subgrouped into *light* (health care, technology and consumer services) and *heavy* industries (oil and gas, basic materials, industrials, consumer goods and telecom), based on the Industry Classification Benchmark (4-digit *icbin* code). We classify firms into these two industry subgroups to differentiate them according to their levels of asset tangibility, which, as shown below, is an important driver of ICFS. Data prior to 1992 are excluded from the subsample of emerging market firms, as there is little coverage of emerging market economies.

To mitigate the effects of outliers, we require firms to have total assets, physical (fixed) assets, book common equity, and market capitalization of at least US$ 1 million. We also require firms to have at least three non-missing observations over the sample period. Moreover, we drop observations for years in which net income before extraordinary items exceeds market capitalization. Unlike many U.S.-based studies of ICFS, we do not exclude observations with sales or asset growth rates greater than 100%, given the large proportion of young and fast-growing firms in emerging economies. Finally, all variables are trimmed at the 1% level. Appendix A.2 presents details on the number of firms in the sample for each country and year.

For our country-level analysis, we divide firms into two subsamples: (i) firms from 21 developed market economies and (ii) firms from 24 emerging and frontier market economies.

The level of a country's economic development is defined according to the MSCI methodology[6]. The country subsamples help us examine cross-country differences in the availability of external finance and fixed capital formation. In some parts of our analysis, we focus on subsamples of firms with strictly positive cash flows ($CF_{i,t}/K_{i,t-1} > 0$). The rationale for examining this subsample is to control for the distortionary effects of negative cash flow, as documented by Allayannis and Mozumdar (2004).

Table A.1 reports the sample means and medians by country for the key variables used in the baseline model in Eq.(1.5). Summary statistics are provided separately for heavy and light industry subsamples. As indicated, the investment-to-physical assets ratio has median values that range from 0.05 (heavy industries, Colombia) to 0.31 (light industries, South Africa). Median cash flow-to-physical assets ratios vary from 0.11 (heavy industries, Canada) to 0.61 (light industries, South Africa). On average, firms operating in health care, technology and consumer services are more profitable. Tobin's q varies across countries and is generally higher in developed market economies than in emerging market economies.

2.4. Investment-cash flow sensitivity around the world

In this section, we document differences in the level and similarities in the trend of ICFS between developed and emerging market economies.

[6] http://www.msci.com/products/indices/market_classification.html

2.4.1 Cross-country variation

Table A.2 reports the estimation results for the baseline specification in Eq.(1.5) for each country. The estimates are presented graphically in Figure A.1. To conserve space, we report only estimates for firms operating in heavy industries. Charts A and B in Figure A.1 present estimates for the full sample of developed markets and the sub-sample with positive cash flows, respectively. Charts C and D present the corresponding estimates for emerging markets.

As indicated in Table A.2, for developed markets, ICFS averages 0.044 (t = 15.8) and ranges from 0.006 (Norway) to 0.117 (Austria). All coefficients are statistically significant at the 1% level, except those for Belgium and Norway, which are insignificant. Reflecting the distortionary effect of negative cash flow observations on the estimates, ICFS is generally higher for the subgroup of firm observations with positive cash flows. In particular, ICFS has an average value of 0.079 (t = 14.2) and ranges from 0.002 (Belgium) to 0.221 (Austria). Most coefficients are statistically significant.

Emerging market firms are characterized by significantly stronger estimates. For example, ICFS in emerging markets is on average 0.099 (t = 17.1), ranging from 0.049 (Pakistan) to 0.258 (Colombia). All coefficients are statistically significant at the 1% or 5% levels, except those for Egypt and Hungary (significant at the 10% level). ICFS in the subgroup of firms with strictly positive cash flows averages 0.112 (t = 15.3) and ranges from 0.053 (Egypt) to 0.301 (Colombia). The estimates are all statistically significant at conventionally accepted levels, except that for Portugal, which is insignificant.

As we would expect, there is a large and statistically significant difference between emerging and developed market economies. For the full sample, the estimated ICFS in emerging markets is

more than two times that of developed markets (0.099 and 0.044, respectively). For the positive cash flow subgroup, the difference between emerging and developed market ICFS is less striking (0.112 and 0.079, respectively), although it is still nearly 40% larger and statistically significant. Hence, firms from developing economies tend to exhibit, on average, stronger sensitivity of investment to cash flow compared with their peers in developed economies. Individual country observations, however, vary substantially and do not always differ significantly between the two market groups, especially in the subgroup of firms with positive cash flows. This indicates that not only cross-country but also firm-level forces may drive ICFS levels.

Our evidence is robust to sample composition. We address the fact that the number of observations differs between countries by using WLS estimation with analytical weights (see section 2.3.1). In unreported results, we also sequentially drop the U.S., Japan, China and India, due to their disproportionate representation among firm-year observations, and re-estimate the baseline specification in Eq.(1.5), with the estimates remaining largely unchanged. Next, we turn to the time-series pattern of ICFS.

2.4.2 Time-series variation

Table A.3 presents the time-series results for the baseline model in Eq.(1.5) for the developed and emerging market subsamples. Firms with strictly positive cash flows are considered separately. We further divide our sample into five consecutive four-year periods: 1991 to 1994, 1995 to 1998, 1999 to 2002, 2003 to 2006 and 2007 to 2010. The last period captures the credit squeeze of 2007-2009. To report industry-consistent estimates, we also split our sample into firms operating in heavy and light sectors.

For developed market firms (heavy industries) as a whole, ICFS is 0.09 (t = 4.87) for the 1991 to 1994 period. Between 2003 and 2006, ICFS is 0.049 (t = 11.73), and in the final reporting period, it is 0.031 (t = 8.30). The difference between ICFS in the first sub-period (0.09) and final sub-period (0.031) is statistically significant at the 1% level. The results are similar for the sub-samples of firms with strictly positive cash flows: ICFS is 0.113 (t = 4.10) for the 1991 to 1994 period. Cash flow sensitivity declines and is estimated to be 0.078 (t = 9.35) for the 2003 to 2006 period. Between 2007 and 2010, ICFS drops further to 0.067, with a t-statistic of 12.8. The difference in ICFS between the first sub-period (0.113) and last sub-period (0.067) is statistically significant at the 10% level. In unreported results, we also observe an economically and statistically significant decline in ICFS for firms operating in light industries.

Emerging market firms exhibit a similar time-series pattern with respect to ICFS: the estimated ICFS (heavy industries) is 0.138 (t = 5.46) between 1991 and 1994 and 0.073 (t = 10.68) between 2007 and 2010. The time difference is statistically significant at the 1% level. For emerging market firms with strictly positive cash flows, the ICFS coefficient is 0.15 (t = 5.58) for the 1991 to 1994 period. It declines over time, and in the final sample period, from 2007 to 2010, it is 0.086, with a t-statistic of 9.64. The difference between these two periods is statistically significant. The downward trend in ICFS is also pronounced among firms operating in light industries (not reported).

To summarize, our findings indicate that, consistent with the existing literature, a strong positive response of investment to internal cash flow is evident in the early part of the sample. ICFS has steadily declined over time, a decline that is a global trend. Although emerging market firms exhibit stronger cash flow sensitivity, declining ICFS is highly consistent across countries.

We also document that the downward bias imparted by negative cash flow observations observed earlier for the U.S. data (Allayannis and Mozumdar, 2004) extends to international data.

In untabulated results, we examine the effects of changing the sample composition. We first drop the U.S. observations and re-estimate the time-series of ICFS, as U.S. firms represent a significant portion of the total sample (nearly 24%) and thus could drive our results. Consistent with the previous findings for the sample of developed markets, there is a significant decline in estimated ICFS values over time. We repeat the procedure after dropping the observations from Japan (nearly 15% of the total sample), with the main results remaining unchanged. Finally, we remove the observations for China and India (which jointly represent 8% of total sample) in our subsample of emerging markets, with the estimates for the emerging market subsample continuing to exhibit a significant decline over time. We therefore conclude that our results are not driven by the data from a single country and are robust to sample composition.

In the above analysis, we divided the sample into five four-year periods, estimating the ICFS for each sub-period. An advantage of such groupings is that they allow us to control for time variation in firm fixed effects in the panel data. The disadvantage is that, with only five periods, we lack a more detailed picture of the time-series variation of ICFS. An alternative approach relies on cross-sectional estimation for each year over the entire 20-year sample period. However, we face a problem of insufficient observations in the subsample of emerging markets, especially in earlier years (see Appendix A.2). Hence, we estimate annual ICFS among emerging market firms over the 1992-2010 period (with 1991 dropped), when there are a sufficient number of observations (over 500 firms per year). For developed markets, we estimate annual sensitivities for the entire 20-year sample period.

For this estimation, we first demean all variables by firm to remove firm fixed effects for the entire period and then estimate a cross-sectional OLS regression of investment on internal cash flow and Tobin's q for each year. We also include country and industry fixed effects.

The OLS estimation results are plotted in Figure A.2 (Chart A and Chart B). For the subsample of developed market firms, we observe a strong and statistically significant decline in ICFS. In 1991, ICFS for all firms and firms with strictly positive cash flows are 0.102 and 0.129, respectively. Both estimates are statistically significant at the 1% level. In 2010, ICFS for all firms and firms with strictly positive cash flows are only 0.027 (t = 5.30) and 0.045 (t = 8.59), respectively. From 1998 onward, cash flow sensitivity is never higher than 0.05. The rate of decline is generally higher for this cross-sectional specification compared with the previous baseline results. We therefore conclude that there is a strong declining trend in ICFS in our subsample of most advanced economies. The trend is robust to model specification.

For the subsample of emerging market firms, we also observe a strong decline in ICFS between 1992 and 2010. In 1992, ICFS for all firms and for firms with strictly positive cash flow are 0.204 (t = 2.31) and 0.212 (t = 4.61), respectively. In 2010, the two figures are 0.07 (t = 7.65) and 0.082 (t = 7.67), respectively. As the differences between ICFS in 1992 and 2010 are statistically significant, we conclude that ICFS exhibits a robust decline over time in our subsample of emerging market economies, consistent with the earlier findings.

To address the concern of potential problem of error-in-variables (in particular, measurement error in Tobin's q) and test the robustness of our time-series analysis, we also estimate time-

series of ICFS using Erickson and Whited GMM estimators[7]. Erickson and Whited (2000, 2002) provide several different GMM estimators depending on the number of moments used in the estimation. We report the results using the GMM6 method (utilizing the second through the sixth moments). Unreported GMM5 results are qualitatively the same. High-order GMM requires numerical minimization of a nonlinear objective function and thus requires starting values. We use the OLS estimates as starting values for the mismeasured Tobin's q coefficient.

The GMM estimation results are plotted in Figure A.2 (Chart C and Chart D). The GMM coefficients are consistent to their OLS counterparts. In particular, GMM ICFS shows a time-series pattern similar to the OLS estimators in both market subsamples. Thus, we can conclude that GMM cash flow sensitivities have also significantly declined across markets and over time and still cannot be a reliable proxy for financial constraints. The question we address next is whether this drop can be explained by country-level attributes.

2.5. What drives the decline in investment-cash flow sensitivity?

2.5.1 Potential country-level explanatory variables

In this section, we seek to explain why investment-cash flow sensitivity has tended to decline over time and test whether the pattern is consistent with our hypotheses. We hypothesize two main sources of the time-series changes: first, excessive reliance on internal resources, which should be alleviated (at least partially) by country-level factors such as financial market development and protections accorded to investors. When external finance can be raised at

[7] ICFS in the traditional model specification may be due to measurement error in Tobin's Q. Therefore, the documented time-series variation in ICFS could be potentially explained by the variation in the measurement error. Erickson and Whited (2000, 2002) develop high-order GMM estimators to control for the measurement error. We further discuss the measurement error of Tobin's Q in the context of declining ICFS in section 2.6.1.

relatively low cost, the importance of internal cash flow and the statistical link between internal cash flow and physical investment is expected to decline. Our second hypothesis is that time-series variation in fixed capital formation resulting from increased expenditure on intangibles or liquidity preservation will correspond with diminished ICFS.

We first propose several country-level variables that can plausibly explain the downward time trend of ICFS explored in the previous section. We follow Ng, Solnik, Wu and Zhang (2013) in selecting many of these explanatory variables. Further, we introduce the ratio of liquid liabilities (also known as broad money or the M3 money supply) to fixed capital formation, a ratio that captures the relative levels of liquidity and physical capital accumulation in national economies. The summary statistics are presented in Appendix A.3. Next, we conduct a series of tests, both within and across broad categories of variables, to investigate the role of financial development and capital formation in the time-series decline in ICFS estimates.

We consider several country-specific variables as potential determinants of ICFS, variables that we group into five broad categories: (i) stock market development; (ii) financial openness; (iii) credit development; (iv) investor protection; and (v) liquidity accumulation and fixed capital formation. While the first four of these broad categories represent country-level attributes that are expected to be associated with lower costs of raising external capital, each category can include more than one variable. As theory offers little guidance regarding the most appropriate variables to employ, we take a pragmatic approach, based on the robustness of the relationship of these variables with ICFS, in selecting our variables. We briefly discuss these categories below:

(i) Stock market development: The importance of a domestic stock market as a source of external capital is well recognized. In addition to being a source of financing, a well-functioning stock market has several associated benefits, such as aggregating and reflecting investor

information and managerial incentive contracting, that can reduce the concerns of capital providers, including bondholders, and thus lower the cost of capital. Hence, we expect stock market development to reduce reliance on internal resources (cash flow). We capture equity market development by three ratios: the ratio of total stock market capitalization to GDP (Mcap – to – GDP), the ratio of total stock market value traded to GDP (Value traded – to – GDP) and the ratio of stock market value traded to market capitalization (Stock market turnover). Data are from the World Bank database.

(ii) Financial openness: Domestic firms are less likely to be constrained when the economy is characterized by a high degree of financial openness. As it has long been recognized in the literature, the international tradability of stocks and the free flow of capital are associated with better functioning capital markets (Bekaert and Harvey, 1995). To measure financial openness, we use the capital account openness measure (CapOpen) of Quinn and Toyoda (2008), based on the IMF capital account data. The measure ranges from 0 to 4, with 0 representing a fully closed capital account and larger values indicating progressively fewer restrictions on international capital flows. Two other financial openness measures capture the main types of capital flows, foreign direct investment (FDI – to – GDP) and portfolio equity and debt flows (Portfolio Flow – to – GDP), both relative to GDP.

(iii) Credit development: Private credit in the form of bank loans is a primary source of financing for many firms, implying that an underdeveloped banking sector could significantly hamper growth prospects (King and Levine, 1993). We measure banking sector development by the ratio of private credit provided by deposit-taking banks and other financial institutions to GDP (Private credit – to – GDP). We also include the total value of outstanding domestic debt issues, both public and private, as a share of GDP (Domestic debt – to – GDP), and the total value

of outstanding international debt issues, both public and private, as a share of GDP (Foreign debt − to − GDP). The measures are sourced from the World Bank and BIS databases.

(iv) Investor protection: The quality of the institutional environment has been shown in the academic literature to be extremely important. For instance, La Porta et al. (1997) emphasize the importance of investor protection and the legal environment for stock market development. We use three measures to capture broad dimensions of institutional quality: the Law & *Order index*, the investment profile index, and the regulatory quality index. The Law & Order index measures the strength of the legal system and the extent of popular observance and enforcement of the law (source: the International Country Risk Guide's political risk rating). The investment profile index is a broad measure of the investment profile of a country, reflecting the risk of expropriation, contract viability, payment delays, and the ability to repatriate profits. Bekaert et al. (2008, 2011) argue that this measure is most closely correlated with political risks relevant to foreign direct investments. Additionally, we use a regulatory quality index of the World Bank that captures investors' perceptions of governments' abilities to formulate and implement sound policies and regulations that promote private sector interests. Finally, we expect that in countries with relatively low levels of investor protection, investors would be reluctant to invest or lend, making it more difficult for firms to raise external finance and increasing the importance of internal cash flow.

(v) Liquidity accumulation and fixed capital formation: This category is related to the relative level of accumulated liquid liabilities and physical capital formation in a domestic economy. We use the ratio of liquid liabilities to gross fixed capital formation (M3 − to − Fixed capital) to measure the nation-wide level of accumulated liquid assets (broad cash or money supply) to the level of physical capital formation in a domestic economy. We expect that the global shift from

investment in tangible (physical) assets to liquid assets will be associated with the previously documented decline in ICFS[8].

In addition to the role of financial market development, liquidity, and fixed capital formation, we also consider other potential determinants of investment-cash flow sensitivity. Specifically, we propose the following four control variables. First, we include GDP growth as a measure of economic growth in all our regressions. Second, GDP per capita (GDPPC) is used to capture relative economic development in a given country. Third, we consider the log value of the number of public firms (N. Firms) in a given year within a particular country. Fourth, we employ the Herfindahl Index[9] (HH Index), based on firms' sales revenues, to measure market concentration and power. Finally, we include the time trend ($T-trend$)[10] and indicator variables (dummies) for time-periods to explore the extent to which changes in country characteristics important to ICFS and fixed capital formation subsume a pure time trend.

Consistent with Figure A.2, the regression estimations in Table A.5 indicate that $T-trend$ is negative for both developed (-0.0053, t = 6.88) and emerging market economies (-0.0065, t = 4.61). Alternatively, we include time dummies that represent four sub-periods: 1995-1998, 1999-2002, 2003-2006 and 2007-2010. The first period (1991-1994) is used as a reference point to interpret time period dummies. As expected, the stand-alone time period indicative variables are all negative and largely significant.

[8] According to the World Bank, the ratio of global (world economy) gross capital formation to GDP has fallen from 26% in 1974 to 23% in 1990 and 19% in 2008. The ratio is estimated at nearly 20% in 2011. At the same time, the money supply, measured by M1, M2 or M3, has increased persistently since the early 1970s.

[9] The Herfindahl index is a measure of the size of firms relative to their industries and an indicator of the degree of competition among them. The index is defined as $\sum_{i=0}^{N} s_i^2$, where s_i is the market share of firm i, and N is the number of firms.

[10] It takes a value of 1 for 1991, a value of 2 for 1992, a value of 3 for 1993, etc.

Pairwise correlations between the main financial development metrics are provided in Panel A in Appendix A.4. As we would expect, the correlations between the variables are all positive and significant at conventionally accepted levels. Strong correlations between cross-country variables (up to 0.75) both within and across categories raise concerns about multicollinearity. Formal variance inflation (VIF) tests further indicate the risk of overinflated standard errors. We therefore use a principal component analysis (PCA), in addition to the baseline estimations, to verify our key findings.

2.5.2 Country-level analysis

Before turning to multivariate regression analysis, we note that, consistent with hypothesis 1, the pairwise correlations between ICFS estimates and the measures of financial development are negative, ranging from -0.051 ($\mathrm{FDI-to-GDP}$) to -0.214 (investment profile index), and statistically significant at the 1% level, except for the $\mathrm{FDI-to-GDP}$ correlation (Panel C in Appendix A.4). Further, the pairwise correlation of $\mathrm{M3-to-Fixed\ capital}$ is also negative (-0.153) and strongly significant, which is consistent with hypothesis 2.

In addition, we plot the time series of various financial development metrics used in the study (Figure A.3). It is evident that financial development progresses over time and across countries, corresponding with steadily declining ICFS. Not surprisingly, such progress, which is more pronounced among developed market economies than emerging market economies, is reflected in declining average ICFS of firms in a given country.

Our regression results for the determinants of the ICFS relationship are shown in Table A.4 by variable category, and the full multivariate results across categories are shown in Table A.5.

Both within and across categories, the analysis includes PCA[11]. The dependent variable is the OLS-generated ICFS for each country and year, similarly to the estimates reported in section 2.4.2. Our final sample consists of 785 observations, including 417 observations from developed market economies and 368 observations from emerging market economies.

We find that all categories of country-level explanatory variables, except for the liquidity accumulation and fixed capital formation category, include variables that significantly explain ICFS. Given the likely collinearity of the explanatory variables within each category, we reduce the number of variables by focusing on significant measures in models (4) and (5) in Panels A through D of Table A.4. We further report regression estimates with and without country fixed effects.

As indicated in Panel A of Table A.4, the ratio of stock market capitalization to GDP is negative and consistently significant at the 5% and 10% levels and thus useful in explaining ICFS. Two other proxies are negative and individually significant but turn out to be insignificant in group regressions. The first and most important principal component (PC) generated using all three proxies for stock market development is also negative and strongly significant. This result supports the notion that capital market development should help overcome over-reliance on internal cash flow.

Second, financial openness, represented by the ratio of portfolio flow to GDP is negative and significant at the conventional levels and thus is a positive force in alleviating financial obstacles (Panel B of Table A.4). Similar, PC is negative and marginally significant at the 10% level. Our results thus suggest that financial openness is economically important in explaining ICFS.

[11] We include principal components (PC) with eigenvalues above 1 or the largest possible variance. This procedure reduces the number of highly collinear explanatory variables to the one or two most important PCs and mitigates the risk of multicollinearity without significant loss of explanatory power.

Third, reliance on public and private foreign borrowing, measured by the ratio of international debt issues to GDP is negatively related to ICFS (Panel C of Table A.4). Similarly to the stock market development category, two other proxies are negative and individually significant but are insignificant in group regressions. The first-order principal component generated using all three proxies is negative and strongly significant. This result supports our hypothesis, as the explanatory variable is an indicator of the degree of financial development, reflecting the extent to which a country's institutions and firms can borrow overseas and expand their financing channels.

Fourth, we find that the investment profile of a country, a proxy for institutional quality in a country, is significantly related to ICFS (Panel D of Table A.4). The corresponding PC is also negative and statistically significant at the 1% level, a result that is consistent with the notion that the quality of institutions is crucial to supporting investment activity and hence easing ICFS.

Finally and surprisingly, we find that the ratio of liquid liabilities to gross fixed capital formation ($\mathrm{M3-to-Fixed\ capital}$) is negative but insignificant in explaining time variation in ICFS (Panel E of Table A.4). We also test the ratio of fixed capital formation to GDP, which, as expected, is positive but also insignificant (unreported). Therefore, we conclude that fixed capital formation is positively related to ICFS, while liquidity accumulation is negatively related to ICFS. However, the relationships are relatively weak in a cross-country setting. Additionally, we test the relationships at the firm level (section 2.5.3.2), as cross-country fixed capital formation and money supply should reflect business physical investments and corporate liquidity.

The set of full multivariate regressions incorporating variables across categories is selected, using a three-step approach. With limited guidance from theory, we rely on the following pragmatic approach. We first include only a time trend variable in model (1); a time trend and

country fixed effects in model (2); and finally, a time trend and the two most important PCs without and with fixed effects in models (3) – (5) in Table A.5. PCs transform only those proxies from each category and control variables that are significant in models (1) – (5) in Table A.4. We repeat the same procedure with the time period indicative variables in models (6) – (10) in Table A.5. We add a time trend variable and period dummies to examine whether our country-level determinants (transformed to principal components) are significant in explaining the declining pattern of ICFS.

The multivariate results are presented separately for developed market and emerging market economies. We begin our discussion of the multivariate results presented in Panel A of Table A.5, which includes 21 developed markets. The most important principal components, PC(1) and PC(2), account for over 60% of the variability in the underlying data. Not surprisingly, first-order PC(1) is negative and consistently significant across all models; thus, it is useful in explaining the decline in ICFS. Specifically, the negative time trend (-0.0053, with a t-statistic of 6.88) turns to be completely insignificant in models (3) to (5). Similarly, time period dummies are statistically insignificant in models (8) through (10). The estimation results are consistent both with and without country fixed effects. Mean VIF tests do not indicate a threat of excessive multicollinearity. Therefore, we conclude that there is no significant time trend in ICFS, once country-specific determinants are accounted for. Changes in country characteristics over time can at least partially account for the time-variations in ICFS.

Next, we perform a similar analysis for the subsample of 24 emerging market economies in Panel B of Table A.5. We find that PC(1) is not consistently significant across all models and that explanatory power (adjusted R^2) falls below 10%. Nevertheless, financial development determinants explain nearly 25% of the economic significance (the time trend coefficient

declines from 0.0065 to 0.0048) and almost 40% of the statistical significance. Specifically, the t-statistic drops from 4.61 in model (1) and 3.90 in model (2) to 2.78 in model (4) and 2.20 in model (5). Time period dummies also turn out to be largely insignificant, once we control for country-level determinants (transformed PC) in the model specifications. Importantly, the key findings remain robust when country fixed effects are included. The results thus further support our view that external finance, through the financial development channel, eases ICFS.

To further examine the relationship between ICFS and cross-country financial development, we test the alternative model specification:

$$\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \alpha_c + \alpha_j + \alpha_t + \alpha_i + \beta_1\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \beta_2 q_{i,t-1} + \beta_3 X_{c,t} + \beta_4 X_{c,t}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \varepsilon_{i,t}, \quad (1.6)$$

where $X_{c,t}$ is a vector of country-level financial development variables. We test this model specification using cross-country financial development metrics (their respective principal components), which potentially can explain the declining trend in ICFS. A negative β_4 should indicate that improvement of country-level financial development reduce the overall ICFS. If the declining trend of ICFS is explained by the country-level, we should observe a relatively stable β_1 after controlling $X_{c,t}$.

The estimation results with cross-country financial development metrics are reported in Table A.5, Panel C and D. Panel C corresponds to total firms in the sample while Panel D corresponds to firms with strictly positive cash flow. To save space, we report only β_1 estimates and β_4 interaction terms. First, the interaction terms between ICFS and two major principal components produce negative and statistically significant coefficients. Second, ICFS (β_1) stays largely flat after controlling for $X_{c,t}$. The results are also hold for strictly positive cash flow

firms. Therefore, we can conclude that financial development is negatively related to ICFS and, more importantly, attenuates the declining trend of ICFS.

In summary[12], financial openness, capital market development, and the ability to borrow domestically and overseas jointly work to ease financing obstacles and reduce reliance on internal resources and the strength of ICFS. We conclude that financial development and global integration, starting in the late 1950s and gaining momentum since the 1980s, played a significant role in removing capital flow and financing barriers. This development arguably led, in turn, to a steady decline in ICFS. Interestingly, capital markets and the institutional environment did not improve as much in developing as in developed economies (Figure A.3). By many metrics, emerging market economies are at the levels of the developed market economies 10-15 years earlier. A relatively subdued role of external finance eventually translates into higher levels of ICFS and a weaker relationship between financial development and ICFS.

2.5.3 Firm-level analysis

2.5.3.1 The role of external finance

In the previous section, we show that cross-country financial development has a relatively strong impact on the ICFS relationship and partially explains its declining time-series pattern. In this section, we seek to provide further support for this conclusion through firm-level analysis. We

[12] We wish to mention one conclusive remark in this section. We use a two-step estimation approach (Panels A and B of Table A.5) where country-year ICFS is regressed on a broad range of determinants. The usual drawback of such an estimation technique is that the first step coefficients may be estimated with error. Therefore, the second step estimation is equivalent to the case where there are errors of measurement in the dependent variable. It is well known that estimated variances are larger in this case (inflated standard errors) than when there are no such errors of measurement, and therefore, the estimated relationship may become insignificant. In our case, the relationship between the level of financial development and estimated investment-cash flow sensitivity is both economically and statistically significant. We therefore conclude that our results are not badly affected by the measurement-error effect of inflating the estimated standard errors.

conjecture that access to lower-cost external financing through the financial development channel and improvements in capital markets should translate into a more extensive use of external financing, a diminished likelihood of credit rationing and less severe capital constraints experienced by firms.

According to Fazzari, Hubbard, and Petersen (1988, 2000), financial constraints take the form of credit rationing. Under the credit-rationing scenario, even when the apparent costs of debt and equity are low, firms can still be financially constrained if they cannot actually borrow or issue new equity. This type of difficulty in external financing should be reflected in new issue activity of debt and equity. Specifically, less credit rationing should be reflected in more new issue activity. We now examine whether there is a difference in such issue activity over time between developed and emerging market firms and how this is reflected in cross-sectional and time-series variation of ICFS.

First, we investigate the time-series of corporate financing. We measure Leverage – to – Tangibility as the ratio of total debt to tangible assets. The ratio captures the relative level of external debt financing to pledgeable (tangible) assets. Intuitively, one should expect that firms from financially advanced countries with established access to external (debt) finance are less subject to credit rationing and thus exhibit a higher ratio of debt to tangible assets. Second, we explore time-series variation in the volume of new financing relative to capital expenditures. We define the aggregate amounts of new equity and debt raised, New financing, as the sum of changes in total debt and common equity scaled by capital expenditures. A ratio of one implies that a firm can finance its capital requirements entirely from external sources. Similarly, one should expect to see more new issue activity and a higher ratio among firms less subject to credit rationing.

As expected, developed and emerging market firms exhibit some differences in both measures. Charts A and B of Figure A.4 plot the time series of Leverage – to – Tangibility. In all years between 1992 and 2010, developed market firms enjoy relatively better access to external finance compared with their peers in emerging markets. For every $1 of tangible (pledgeable) assets, firms from developed economies raise more dollars of gross external debt than firms from developing economies. Chart C of Figure A.4 plots the time series variations of the volume of new financing relative to capital requirements, New financing. Generally, developed market firms raise more funds to cover investments than emerging market firms do. Thus, we conclude that firms from financially developed economies appear to experience relatively less credit rationing and are exposed to better financing conditions than firms from financially under-developed economies. This is one plausible reason why the level of ICFS is generally relatively low among firms from advanced countries. We test this argument next.

We now formally test whether firms with improved access to lower-cost external financing exhibit weaker ICFS. We use the total debt ratio, measured as the ratio of total debt to the value of tangible assets, to rank firms according to leverage. We ignore firms with negative or zero cash flows. We then define *high-levered firms* as those with total debt ratios equal to or above the median value in each of the four-year sub-periods. The remaining firms are classified as *low-levered firms*. To conserve space, we report only pooled estimation results for the entire period (Panel A in Table A.6). As expected, ICFS is significantly lower for high-levered firms compared with low-levered firms. In particular, ICFS among high-levered and low-levered developed market firms are 0.066 (t = 14.7) and 0.081 (t = 17.7), respectively. Similarly, ICFS

among high-levered and low-levered emerging market firms are 0.089 (t = 13.6) and 0.109 (t = 13.4), respectively.[13]

In summary, we find evidence that cross-country financial development improves access to external (corporate) financing and therefore reduces the importance of internal cash flow. This eventually contributes to weaker ICFS.

2.5.3.2 The role of fixed capital formation

In section 2.5.2, we do not document a significant relationship between declining ICFS and liquidity supply and fixed capital formation. In this section, we explore this relationship at the firm level. Because ICFS is defined in terms of investments in physical assets, we should expect lower ICFS among firms with smaller shares of physical assets, higher R&D investments (Brown and Petersen, 2009) and higher cash reserves (Almeida et al., 2004, 2011).

First, we investigate how capital investments-to-assets and cash-to-tangible assets ratios change over time and across markets. If the formation of tangible assets slows over time (and is replaced by intangible or liquid assets), then we should observe a steady decline in the first ratio and a rise in the second ratio. Second, we test the strength of the ICFS relationship for firms with different shares of fixed assets among total assets. If cash flow sensitivity is significantly driven by a firm's asset tangibility, then we should observe a strong positive relationship between the two (Almeida and Campello, 2007). Finally, we repeat our analysis for firms with different

[13] In untabulated results, we observe a steadily declining ICFS over time in our subsamples of financially developed and developing countries. The decline is also consistent among high-levered and low-levered firms but more pronounced in the subsample of high-levered firms. The time-series estimates are largely consistent with the cross-country findings reported in section 2.4.2.

levels of cash reserves. We expect to document a negative relationship between ICFS and cash reserves, as corporate liquidity is negatively related to the tangibility of a firm's assets.

We first present our ratios analysis in Charts A and B of Figure A.4. First, we discuss the time series of the ratio of physical capital investments to total assets. The ratio declines from nearly 0.075 in 1991 to 0.047 in 2010 in our subsample of developed market economies. However, the decline is even more evident in the subsample of emerging market economies. In particular, the ratio drops from nearly 0.10 in 1992 to 0.05 in 2010. Second, the ratio of cash to physical assets substantially rises from 0.32 in 1991 to 0.51 in 2010 among developed market firms, and similarly, the ratio increases from 0.20 in 1992 to 0.30 in 2010 among emerging market firms. We therefore observe a declining role of asset tangibility (both physical capital investments and tangible assets) but the growing importance of cash over time.

Next, we formally test the relationship between ICFS and asset tangibility. We use the physical assets-to-total assets ratio to sort firms according to their levels of asset tangibility. We ignore firms with negative or zero cash flows. We then define *high-tangible asset firms* as those with a physical assets-to-total assets ratio equal to or above the median value in each of the four-year sub-periods. The remaining firms are classified as *low-tangible asset firms*. To conserve space, we report only pooled estimation results for the entire period (Panel B in Table A.6). As expected, ICFS is significantly higher for high-tangible asset firms compared with low-tangible asset firms in our pooled estimation. For example, ICFS among high-tangible and low-tangible developed market firms is 0.313 (t = 23.2) and 0.055 (t = 16.7), respectively. Similarly, ICFS among high-tangible and low-tangible emerging market firms is 0.33 (t = 20.6) and 0.073 (t = 12.6), respectively. The evidence is consistent with the findings of Almeida and Campello (2007)

and supports our hypothesis that asset tangibility is a key driver of the investment-cash flow sensitivity relationship[14].

Finally, we test the relationship between ICFS and our proxy for liquidity – cash holding. As reported above, the declining role of physical assets coincides with the rising importance of cash. Thus, we expect a negative relationship between ICFS and cash reserves. We use the cash-to-total assets ratio to rank firms according to their levels of cash holding. We then define *cash-rich firms* as those with a cash-to-total assets ratio equal to or above the median value in each of the four-year sub-periods. The remaining firms are classified as *cash-poor firms*. We report only pooled estimation results for the entire period (Panel C in Table A.6). ICFS is on average significantly higher for cash-poor firms than for cash-rich firms. For example, ICFS among cash-poor and cash-rich developed market firms is 0.094 (t = 18.7) and 0.060 (t = 16.2), respectively. Similarly, ICFS among cash-poor and cash-rich emerging market firms is 0.132 (t = 14.7) and 0.082 (t = 12.6), respectively. The evidence generally supports the view that the level of cash holding is negatively related to the strength of ICFS.

To summarize, we find strong evidence that ICFS is significantly driven by asset tangibility. The declining role of asset tangibility and the rising importance of cash liquidity jointly drive ICFS down. Next, we test this relationship formally in a time-series setting.

[14] In untabulated results, we document a steadily declining ICFS over time in our subsample of financially developed countries. ICFS is 0.389 (high-tangible firms) and 0.063 (low-tangible firms) in the 1991 to 1994 period. ICFS is 0.216 (high-tangible firms) and 0.048 (low-tangible firms) between 2007 and 2010. The decline is also evident in our subsample of developing economies. In particular, ICFS is 0.466 (high-tangible firms) and 0.099 (low-tangible firms) in the 1991 to 1994 period, whereas ICFS is 0.278 (high-tangible firms) and 0.054 (low-tangible firms) in the final reporting period.

2.5.3.3 Time trend of investment-cash flow sensitivity

Thus far, we have documented that firm-specific characteristics such as leverage (external finance), physical assets (asset tangibility or pledgeability), and cash holding (liquidity) play important roles in explaining variations in the sensitivity of investment to cash flow. However, we do not provide evidence that these firm characteristics account for the reported decline in ICFS over time. In this section, we explain the time-variant decline, using firm-level determinants.

The empirical technique used in this section is similar to the two-stage estimation approach applied in section 2.5.2. The dependent variable is the OLS-generated ICFS for each country and year. To be consistent with other parts of the paper, our sample of developed market economies includes the entire 20-year period, while the sample of emerging market economies covers the 1992 – 2010 period. The final sample consists of 785 observations, including 417 observations from developed market and 368 observations from emerging market economies. The set of multivariate regressions incorporates firm-level means of the cash-to-tangible assets ratio (Liquidity – to – Tangibility) and the total debt-to-tangible assets ratio (Leverage – to – Tangibility) as explanatory variables. Control variables include a dividend dummy variable (Dividend), the log transformation of a firm's assets (Size), and the return on book assets (Profitability). Our time-series measures are time trend (T – trend) and four-year period dummies. The time trend and period dummies are set to control for the decline in ICFS. Pairwise correlations between the main explanatory variables are provided in Panel B of Appendix A.4.

The main results are reported in Table A.7. We begin our discussion with Panel A, which includes the subsample of 21 developed market economies. We first test our two explanatory variables individually and as a group in models (1) – (4). Both Liquidity – to – Tangibility and

Leverage – to – Tangibility are consistently negative and significant at the 1% level. We then transform both determinants into a principal component PC(1) in models (5) – (8) to mitigate the risk of excessive multicollinearity[15]. PC(1) is found to account for nearly 75% of the variability in the underlying data. PC(1) is also significant in explaining time-series variations of ICFS. Most importantly, time trend declines from its "original" level, -0.0053 (t = 6.88) in Table A.5, to -0.0032 (t = 2.32) and -0.0034 (t = 2.29) in models (5) and (6) in Table A.7, respectively. Time trend remains significant, but its economic significance decreases by nearly 30–40%, while its statistical significance is 66% or two-thirds. Similarly, time period indicative variables turn out to be 20–50% less significant, once we include firm-level determinants in models (7) and (8). We therefore conclude that the negative time trend in ICFS is at least partially explained by firm-specific determinants. The changes in asset tangibility and leverage over time can account for the time-variations in ICFS.

Next, we perform a similar analysis of the subsample of 24 emerging market economies (Panel B in Table A.7). We do not apply principal component analysis because only the Leverage – to – Tangibility explanatory variable is consistently negative and significant across all models. Thus, we only use this determinant and control variables to explain time-series variations in ICFS. Time trend declines from its "original" level, -0.0065 (t = 4.61) in Table A.5, to 0.0047 (t = 2.76) and -0.0019 (t = 1.03) in models (5) and (6) in Table A.7, respectively. Time trend remains significant without country fixed effects, but its economic significance decreases by almost 30%, while its statistical significance decreases by 40%. The negative time trend turns out to be insignificant, once we include firm-level determinants and country fixed effects. Additionally, all time period dummies turn out to be completely insignificant when we consider

[15] The pairwise correlation between Liquidity – to – Tangibility and Leverage – to – Tangibility is 0.50, which is statistically significant at the 1% level.

firm-specific determinants in models (7) and (8). These findings further support our hypothesis that firm-level asset tangibility and external finance (leverage) are important drivers of ICFS.

To further examine the relationship between ICFS and firm-level tangibility, liquidity and leverage, we test the alternative model specification:

$$\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \alpha_c + \alpha_j + \alpha_t + \alpha_i + \beta_1\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \beta_2 q_{i,t-1} + \beta_3 Z_{i,t} + \beta_4 Z_{i,t}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \varepsilon_{i,t}, \quad (1.7)$$

where $Z_{i,t}$ is a vector of firm-level determinants (tangibility, leverage, dividend and size). A negative β_4 should indicate that declined role of asset tangibility (increased importance of non-tangible and liquid assets) reduces the overall ICFS. If the declining trend of ICFS is explained by the proposed firm-level characteristics, we should observe a relatively stable β_1 after controlling $Z_{i,t}$ in the Eq.(1.7).

The estimation results with firm-level determinants are reported in Panel C and Panel D of Table A.7. Panel C corresponds to total firms in the sample while Panel D corresponds to firms with strictly positive cash flow. To save space, we report only ICFS (β_1) and interaction terms (β_4). First, the interaction terms between ICFS and firm-level characteristics (liquidity-to-asset tangibility ratio, leverage-to-asset tangibility ratio, and the ratio of dividends plus share repurchases to total assets) produce negative and statistically significant coefficients. The declining role of fixed assets, rising importance of liquidity and external borrowing decrease the overall ICFS. Second, ICFS (β_1) turns to be either relatively stable (in Panel D) or insignificant (in Panel C) after controlling for firm-level determinants; in other words, firm-level drivers well explain the declining trend in ICFS.

Based on the reported findings, we conclude that a firm's asset tangibility increases ICFS. The steady decline in ICFS is at least partially explained by decreasing share of tangible assets

(increasing shares of non-tangible assets and external borrowings). The results are also consistent with our cross-country findings (section 2.5.2), where we argue that access to external finance through the financial development channel and fixed capital formation are the primary drivers of ICFS.

2.6. Additional tests

2.6.1 Robustness tests

In this section, we verify our main results, using alternative sample compositions and model specifications.

First, we select four industries with very different levels of asset tangibility (measured as the ratio of physical assets to total assets) and group them into pairs: (i) basic materials (mean ratio of 0.49) and industrials (mean ratio of 0.37), and (ii) health care (mean ratio of 0.32) and technology (mean ratio of 0.20). The corresponding *icbin* codes are 1000, 2000, 4000 and 9000, respectively. The four industries jointly represent 60% of our total sample. We sort all firms in the selected industries by market capitalization (in $U.S.): small cap ($10 million to $100 million), mid cap ($100 million to $1 billion), and large cap (above $1 billion). Finally, we match our developed and emerging market firms, using these two criteria, and re-estimate the baseline specification in Eq.(1.5). It is expected that small-cap firms in the basic materials and industrials sectors will exhibit the highest ICFS estimates, while large-cap firms in the health care and technology industries will exhibit the lowest estimates. We also present time series estimation results for each sector/industry.

The results are graphically presented in Figure A.5. Charts A and B present the estimation results for the sample sorted by industry and size. As expected, firms in the health care and technology sectors, with relatively low shares of tangible assets, exhibit lower ICFS estimates. Basic materials and industrial firms, with higher shares of physical assets, by contrast, demonstrate significantly stronger cash flow sensitivity, with coefficients that are statistically significant at the 1% level. Consistent with the previous findings, ICFS is generally higher in the subsample of firms from emerging market economies. We therefore find additional evidence that asset tangibility is an important driver of the ICFS relationship. Firm size does not play a dominant role in explaining variations in ICFS sensitivity.

Charts C and D of Figure A.5 present the time series estimation results for each industry group. For developed market firms, ICFS significantly declines over time. In particular, while ICFS is nearly 0.253 (basic materials/industrials) and 0.101 (health care/technology) in the 1991-1994 period, in the final reporting period, it is 0.138 and 0.052, respectively, for these groups. For emerging market firms, ICFS exhibits a similar time-series pattern, with cash flow sensitivities of nearly 0.306 (basic materials/industrials) and 0.247 (health care/technology) in the 1995-1998 period but only 0.151 and 0.069, respectively, for these groups in the 2007-2010 period. The industry findings are consistent with our previous results. Thus, we conclude that the baseline evidence is robust to alternative sample compositions.

In unreported results, we test whether the main results differ for multinational firms. Grouping firms by shares of foreign sales in total revenues, we find that our results remain affected exclusively by local factors. In particular, the ICFS estimates are qualitatively the same for firms with a high share of foreign revenue and firms with a low share or with no foreign revenue.

Next, we discuss measurement error of Tobin's q in the context of declining ICFS. Erickson and Whited (2000, 2002) report that measurement error with respect to Tobin's q leads to a positive and overstated relationship between ICFS and external financial constraints[16]. If ICFS is due to measurement error associated with Tobin's q, the decline and even disappearance of cash flow sensitivity could be explained by a decrease in the degree of such measurement error. While important for the ICFS literature in general, we believe that this concern is not problematic for the conclusions of this study (see our time-series analysis in section 2.4.2 for further details). In particular, if q is a poor control for investment demand, it should be equally poor for both developed market and emerging market firms. Thus, problems with the q measure cannot fully explain why sensitivity differs between developed and emerging market economies. Similarly, measurement error with respect to q cannot explain the differences in the roles of financial development and fixed capital formation across developed and emerging markets. Alternatively, the correlation of q with internal cash flow also declines as a function of capital market development[17]. When we remove q from all the regressions (results not reported), the same time-series patterns in the ICFS relationship remain, suggesting that our findings are not driven by a reduction in measurement error associated with q.

Finally, we follow Almeida et al. (2004) and use the actual ratio of future investment to current investment as a proxy for investment opportunities. As noted by Khurana et al. (2006), a potential problem with the of use of q in a cross-country setting is that it may reflect not only the presence of growth opportunities but also the market's perception of a firm's ability to exploit its

[16] Given the fact that current period cash flow is likely to be positively correlated with future profitability or growth opportunities, a link between cash flow and investment for a given firm could reflect the link between expected profitability and investment rather than the sensitivity of firm investments to internal cash flow. For this reason, many studies include Tobin's q as a proxy for unobservable investment opportunities (i.e., higher expected profitability and thus investment opportunities should be reflected in a higher q ratio).

[17] The pairwise correlation between q and cash flow ranges between 0.37 and 0.50 from 1991 to 1995 and between 0.31 and 0.38 from 2006 to 2010.

growth options. Therefore, an advantage of using realized investments is that it sidesteps the issue of distinguishing between market evaluations of investment opportunities and a firm's ability to take advantage of such investment opportunities. When we re-estimate equations (1) – (5), replacing q with the actual ratio of future investment to current investment (results unreported), the main estimates are largely unchanged.

2.6.2 Alternative cash flow sensitivities

2.6.2.1 Cash flow sensitivity of cash

Almeida, Campello and Weisbach (2004) examine a firm's propensity to save cash from internal cash flows and observe that financially constrained firms save more cash out of cash flow to fund future investment opportunities than do non-financially constrained firms. Almeida et al. (2004, 2011), Khurana et al. (2006), and Baum et al. (2011) regard the sensitivity of cash to cash flow (CCFS) as a reliable measure of financial constraints. Alternative explanations of a firm's propensity to save liquid assets include precautionary motives (Bates, Kahle and Stulz, 2009), tax incentives (Foley, Hartzell, Titman and Twite, 2007) and the rising importance of R&D (Pinkowitz, Stulz and Williamson, 2012). We now study the time-series properties of cash-cash flow sensitivity of firms in our sample.

We follow Almeida et al. (2004) and estimate the modified model specification as follows:

$$\left(\frac{\Delta \text{Cash}_{i,t}}{\text{TA}_{i,t}}\right) = \alpha_c + \alpha_j + \alpha_t + \beta_1 \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}}\right) + \beta_2 q_{i,t} + \beta_3 \text{Size}_{i,t} + \beta_4 \text{Controls}_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where $\Delta \text{Cash}_{i,t}/\text{TA}_{i,t}$ represents the change in a firm's cash and cash equivalents scaled by total assets, $\text{CF}_{i,t}/\text{TA}_{i,t}$ is the firm's internal cash flow less dividends scaled by total assets, Tobin's q

is the market-to-book assets ratio and Size is the natural log of total assets. Controls include capital expenditures, share repurchases, other investments, changes in non-cash net working capital, and changes in short-term debt, all scaled by total assets. The model specification also includes country (α_c), industry (α_j) and time (α_t) fixed effects. We estimate Eq.(2) for each of the four-year sample periods from 1991 to 2010 and for each market (country) subsample.

The empirical results are reported in Table A.8. We only report estimates for the first three regressors, while the coefficients for the control variables are not tabulated (as expected, they are all negative and statistically significant at the 1% level, except for changes in short-term debt, which is positive and significant). Both emerging and developed market firms are classified into a sample that includes all firms (left panels) and a subsample of firms with positive cash flows only (right panels). In each period, the cash flow sensitivity of cash is strongly positive and statistically significant at the 1% level. We further document similarities in cash-cash flow sensitivity between our groups of developed and emerging market firms. CCFS is on average 0.245 (t = 39.3) for all developed market firms and 0.325 (t = 24.6) for developed market firms with strictly positive cash flows. On average, CCFS is 0.275 (t = 20.6) for all emerging market firms and 0.328 (t = 16.2) for emerging market firms with strictly positive cash flows. More importantly, CCFS is stable or even increasing across periods. We therefore conclude that the sensitivity of cash to cash flow may be empirically the strongest relationship among alternative cash flow-based sensitivities that we test in this study (see following sections). This evidence is consistent with prior findings reported in sections 2.5.3.2 – 2.5.3.3, where we discuss a globally rising role of cash liquidity over time. This evidence is consistent with the notion that the trade-offs involved in CCFS are inter-temporal in nature and differ from the trade-off between raising

external finance and investment. Hence, as we illustrate, there may be little change in CCFS, even when there is a substantial reduction in external financing costs and ICFS.

2.6.2.2 R&D-cash flow sensitivity

Brown and Petersen (2009) note that ICFS has significantly declined through 2006. They argue, however, that R&D is now an important form of investment, taking a growing share of total (R&D plus tangible capital expenditures) investment spending. They find that R&D-cash flow sensitivity remains comparatively strong, particularly for firms with positive cash flows. To test whether R&D-based sensitivity differs from ICFS because firms have shifted their investment from physical investment to R&D spending, we now examine the time-series property of R&D-cash flow sensitivity for our sample period. Specifically, we compare the evidence of Brown and Petersen (2009) with a broader international sample before and after 2006. Following their study, we scale R&D by total assets, as R&D is not included in physical capital. We also scale internal cash flow and previous-period cash holding by total assets and use the market-to-book assets ratio, in the form of Tobin's q, for consistency. To save space, we report only pooled estimation results for the entire 20-year period. However, below, we discuss our key findings across five four-year sub-periods. The estimated regression is as follows:

$$\left(\frac{RD_{i,t}}{TA_{i,t-1}}\right) = \alpha_c + \alpha_j + \alpha_t + \beta_1\left(\frac{CF_{i,t}}{TA_{i,t-1}}\right) + \beta_2 q_{i,t-1} + \beta_3\left(\frac{Cash_{i,t-1}}{TA_{i,t-1}}\right) + \varepsilon_{i,t}, \quad (3)$$

The results are presented in Panel A in Table A.9. To be consistent with other parts of the study, both emerging and developed market firms are classified into a subsample of all firms with cash flows and a subsample of firms with positive cash flows only. We consider only firms that report R&D spending ($RD_{i,t}/TA_{i,t-1} > 0$). In our reported pooled estimation, R&D-cash

flow sensitivity is either positive but economically insignificant (well below 0.10) or negative. In unreported results, developed market firms with positive cash flows exhibit the strongest sensitivity estimates, 0.072 (t = 3.29) between 1995 and 1998 and 0.091 (t = 4.85) between 1999 and 2002. However, these estimates decline monotonically to 0.048 (t = 2.74) in the final period. This pattern is consistent with the fall in ICFS, which, as we have argued, is partly driven by financial market development and decreases in firms' external financing costs over this period.

For the emerging markets sample, we find a coefficient of 0.028 (t = 3.06) for the 1991 to 1994 period and below 0.03 for later periods. We thus conclude that the rising importance of R&D as a form of investment is not a valid stand-alone measure of financial constraints. This is evident even for the R&D-driven developed economies.

The relationship between cash holding and R&D (β_3) is stable over time and across markets, which is consistent with the view that firms use liquid assets instead of cash flow to finance their R&D investments (Pinkowitz, Stulz and Williamson, 2012). R&D-cash reserve sensitivity is economically and statistically significant only among firms from R&D-intensive (developed) economies.

2.6.2.3 Inventory investment-cash flow sensitivity

Kashyap, Lamont, and Stein (1994) and Carpenter, Fazzari, and Petersen (1994) show that internal liquidity and cash flow also significantly impact inventory investment. We now study the time-series properties of inventory investment-cash flow sensitivity of our sample firms.

We largely follow Chen and Chen (2012) and estimate the following model specification:

$$\left(\frac{\Delta INV_{i,t}}{K_{i,t-1}}\right) = \alpha_c + \alpha_j + \alpha_t + \beta_1\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \beta_2 q_{i,t-1} + \beta_3\left(\frac{INV_{i,t-1}}{K_{i,t-1}}\right) + \beta_4\left(\frac{Cash_{i,t-1}}{TA_{i,t-1}}\right) + \varepsilon_{i,t}, \quad (4)$$

where $\Delta INV_{i,t}/K_{i,t-1}$ is the firm's change in inventory, $\Delta INV_{i,t}$, scaled by its end-of-previous period physical (fixed) capital, $K_{i,t-1}$, and $INV_{i,t-1}/K_{i,t-1}$ is the previous year's inventory scaled by the previous year's physical capital. The remaining variables are the same as in Eq.(1.5), Eq.(2) and Eq.(3), and defined in Appendix A.1.

For simplicity, we report only pooled estimation results for the 1991-2010 period in Panel B in Table A.9 but briefly discuss our key findings across five four-year sub-periods. In our pooled estimation, inventory investment-cash flow sensitivity is strong only among emerging market firms (0.132, t = 10.8) and emerging market firms with strictly positive cash flows (0.14, t = 10.42). In untabulated results, cash flow sensitivity monotonically declines (to 0.05 – 0.08) among developed market firms but remains flat (in the range of 0.10 to 0.15) among emerging market firms. We therefore conclude that inventory investment-cash flow sensitivity remains stable only in our subsample of emerging market economies. Additionally, we note that the coefficients on cash reserves (β_4) are low and not significantly different from zero. One can argue that firms finance their inventory requirements mainly from internal cash flows rather than cash holdings.

We further investigate the reported difference in inventory investment-cash flow sensitivities between our market (country) subsamples, finding that the importance of inventories is more pronounced in emerging markets. In particular, the ratio of inventories to physical assets is 0.50–0.60 in the 1990s and 0.60–0.70 in the mid-to-late 2000s in our subsample of emerging market economies. The corresponding ratios are 0.80–0.90 and 0.60–0.75, respectively, in our subsample of developed market economies. The role of inventories steadily declines in developed markets but rises in emerging markets over time. This may be a plausible reason for the observed difference in inventory investment-cash flow sensitivity.

2.6.2.4 Investment-cash flow sensitivity with cash reserves

Bates, Kahle, and Stulz (2009) show that U.S. firms now hold vast cash reserves, well above the historical average. Thus, it is possible that firms remain financially constrained but now finance their physical capital investments from cash reserves rather than internal cash flow. We study the time-series patterns of ICFS and investment-cash reserve sensitivity simultaneously. The estimated regression is the following:

$$\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \alpha_c + \alpha_j + \alpha_t + \beta_1\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \beta_2 q_{i,t-1} + \beta_3\left(\frac{Cash_{i,t-1}}{K_{i,t-1}}\right) + \varepsilon_{i,t}, \quad (5)$$

where $Cash_{i,t-1}/K_{i,t-1}$ represents a firm's cash and cash equivalents scaled by physical (fixed) assets in the previous year. The other variables are the same as in Eq.(1.5) and defined in Appendix A.1. We estimate Eq.(5) for each of the four-year sample periods from 1991 to 2010 but report only pooled estimation results in Panel C in Table A.9.

The estimated coefficients on $Cash_{i,t-1}/K_{i,t-1}$ are below 0.01 across all panels and are below 0.02 in time series analysis (not reported). The coefficients are economically insignificant across countries and over time. ICFS is slightly lower when controlling for the level of cash reserves than when not controlling for it (i.e., compared with the estimates reported in Table A.3). The time-variant (declining) patterns of ICFS are largely consistent with the baseline findings. Thus, we conclude that cash reserves are unlikely to explain the variations in ICFS.

Taken together, the tests we perform in section 2.6.2 provide time-series evidence that CCFS and, to a lesser extent, inventory investment-cash flow sensitivity and R&D-cash reserve sensitivity can be valid complements of traditional ICFS. R&D-cash flow and investment-cash reserve sensitivities are empirically weak.

2.6.2.5 Financial development model: investment-cash flow sensitivity and cash flow sensitivity of cash

We propose a simple model that draws upon the intuition in the Almeida et al. (2004), to discuss the impact of cross-sectional and time-series changes in the efficiency and development of a financial market on firms' ICFS and CCFS. The model is intended to illustrate that financial development can have fairly different effects on these two sensitivities.

(i) With respect to ICFS, a reduction in financial market distortions would be expected to reduce the importance of internal resources for investment decisions.

(ii) With respect to CCFS, however, the decision of whether to retain more cash is an *inter-temporal* one. In our model, the decision of how much cash to retain is affected by the relative marginal costs of raising capital in different periods and likelihood of market disruptions. Since it is the inter-temporal differences in marginal costs that matter, a reduction in the level of external financing costs may not have a first-order effect on the CCFS.

We illustrate our argument using a model in which a firm can invest on two dates 0, 1 with payoffs realized on a subsequent date 2. At the initial date the firm has internal cash holdings of C_0. The cash flow could be the result of past financing raised by the firm or retained earnings. Our discussion is concerned with the effect of changes in C_0 on the firm's investment and cash retention decisions.

Investments made by the firm on the dates t = 0, 1 are denoted by I_0, I_1, respectively. In addition, to its internal resources, the firm can raise (costly) external financing B_0, B_1 on the two investment dates. It can also choose to retain a cash amount H on date 0 for investment on date

1. To simplify the exposition, we assume that retention of H results in the same amount of cash being available to the firm on date 1. The firm is risk-neutral; it seeks to maximize its payoff as of date 2. We will also assume that C_0 is not so large that the firm chooses not to raise any external financing. There is taken to be no discounting of cash flow between periods.

The payoffs produced on date 2 by the investments I_0, I_1 are taken to be of the form:

$$\alpha I - \frac{1}{2}\beta I^2$$

While the quadratic form yields simple linear solutions, we expect that that our conclusions will hold for more general concave payoff functions.

We take there to be two forms of external financing frictions that affect the firm's investment. The first is that on date 1, with a probability of μ, there could be a disruption in the capital market e.g., a banking crisis, which results in the firm being unable to raise new external financing. The possibility of such a disruption would induce the firm to retain cash for precautionary reasons. The second friction corresponds to various costs that a firm might face when raising external financing in the subsequent period. For instance, weak legal systems will raise the cost of financing for the firm since providers of capital, both debt and equity investors, may have limited recourse in the face of expropriation or tunnelling by firms. To capture this we assume that the firm's costs of raising external financing are of the form:

$$\frac{1}{2}\gamma B^2$$

Here B is the amount of financing, while γ is a parameter that captures the extent of financial market development, a lower value of γ being associated with a more developed market.

We can now express the firm's value in terms of as being to maximize it expected value as of date 2:

$$V_2 = \left[\alpha I_0 - \frac{1}{2}\beta {I_0}^2 - \frac{1}{2}\gamma {B_0}^2 \right] + (1-\mu)\left[\alpha I_{11} - \frac{1}{2}\beta {I_{11}}^2 - \frac{1}{2}\gamma {B_{11}}^2 \right] + \mu\left[\alpha I_{12} - \frac{1}{2}\beta {I^2}_{12} \right]$$

where,

$$I_0 = C_0 + B_0 - H$$
$$I_{11} = B_{11} + H$$
$$I_{12} = H$$

The first bracketed term in the equation above corresponds to expected payoff from date 0 investments. The second and third bracketed terms pertain, respectively, to when the financial market is functioning on date 1 and when it is disrupted. As indicated, when the market is disrupted the firm can only invest the amount of funds H, that it had retained on date 0.

Taking derivatives w.r.t B_0, B_{11} and H, we obtain the following first-order-conditions:

$$B_0 = \frac{\alpha - \beta(C_0 - H)}{\beta + \gamma}$$
$$B_{11} = \frac{\alpha - \beta H}{\beta + \gamma}$$
$$H = \frac{C_0 + B_0 - (1-\mu)B_{11}}{2}$$

From the first-order-conditions above and some algebraic manipulation, we obtain:

$$H^* = \frac{\gamma C_0 + \alpha\mu}{2\gamma + \beta\mu}$$
$$I^*_0 = \frac{\alpha}{\beta+\gamma} + \frac{\gamma}{\beta+\gamma}\left[C_0 - H^*\right]$$

Here I_0^*, H^* are, respectively, the optimal investment and cash retention on date 0. We can now easily see the effect of an increase C_0:

$$\frac{\partial I^*_0}{\partial C_0} = \frac{\gamma}{\beta+\gamma}\left[1 - \frac{\delta H^*}{\delta C_0}\right]$$
$$\frac{\partial H^*}{\partial C_0} = \frac{\gamma}{2\gamma + \beta\mu}$$

The impact of C_0 on investment is affected by financial frictions parameterized by μ, γ. First, as $\gamma \to 0$ i.e., the marginal cost of raising external financing becomes smaller, the optimal investment I_0^* becomes less sensitive to the firm's internal resources C_0. In other words, not surprisingly, internal resources are less important in determining the firm's investment level when the financial market is more developed. Therefore, firms' investment-cash flow sensitivity (ICFS) would be expected to be lower in the cross-section and over time, in line with financial market development.

Second, perhaps more surprisingly, cash retention from an increase in cash flow C_0 may not decline and, in fact, could increase along with financial market development. From the expression for $\partial H^* / \partial C_0$, as the likelihood of a disruption $\mu \to 0$, the proportion of the retention stabilizes (in this case) to ½. This is irrespective of the marginal cost of external financing. The rationale is that the margins that determine the retention decision are the relative inter-temporal marginal costs. If there is a decrease in marginal costs of external financing in each period, the

relative margins are largely unaffected. Hence, CCFS is not expected to decrease with financial market development, it could be relatively unaffected or even increase.

2.7. Conclusion

This research is the first study to document differences in ICFS between a broad group of developed and emerging market economies and to provide a satisfactory explanation of the significant decline in cash flow sensitivity over time. We acknowledge that ICFS and financing frictions are different but they have a common driver – external finance that reduces the role of internal cash flow in financing capital expenditures. Secured external financing eases *both* ICFS and financial constraints, but lower ICFS does not necessarily correspond to lower financing frictions. Using a large sample of data from 45 countries over the period from 1991 to 2010, we have revealed the factors that drive the declining pattern of ICFS. We conclude that the joint effects of access to external finance through the financial development channel, investor protection and capital openness, and the global shift from fixed capital formation to non-tangible investment mostly explain declining ICFS. These drivers are arguably the primary factors in a significant portion of the decline in ICFS and of some of the observed differences in ICFS between developed and emerging market economies.

To provide additional evidence, the study has examined whether the impact of financial market development and changes in cross-country fixed capital formation can be verified through firm-level analysis. First, we have shown that established financial intermediation improves firms' access to lower-cost external financing and reduces over-reliance on internal cash flow, eventually contributing to lower ICFS. Second, we have demonstrated that the

declining importance of asset tangibility and the rising role of cash liquidity (non-tangible assets) drive down ICFS. The steady decline in ICFS over time is at least partially explained by firms' reduced scale of capital investment and shares of physical assets. Our main results are robust to estimation techniques, alternative sample compositions, industries selection and firm size.

Further, the study has examined alternative cash flow sensitivities, namely, the cash flow sensitivity of cash, R&D-cash flow sensitivity, R&D-cash reserve sensitivity, inventory investment-cash flow sensitivity and investment-cash reserve sensitivity. In particular, we have investigated whether the reported decline in traditional ICFS can be explained by the rising importance of R&D, inventories or increasing levels of cash reserves. The evidence suggests that, consistent with the global rise in the importance of cash, the cash flow sensitivity of cash complements ICFS in the context of financial constraints. We show that CCFS is empirically stable or even increasing because its trade-offs are inter-temporal in nature and differ from the trade-off between external financing and physical investment. Hence, as we illustrate, there may be little change in CCFS, even when there are substantial reductions in external financing costs and in ICFS.

In summary, ICFS has significantly declined in many economies (and almost disappeared in some developed economies) over the last 20 years. Improved access to lower-cost external financing and a global shift from asset tangibility to cash liquidity have significantly contributed to its decline and disappearance. This trend is more evident in financially advanced markets, where firms substantially benefit from established access to external finance and are less "tangible". It is also obvious that empirically weak ICFS cannot properly measure firm-level financial constraints.

Chapter 3. Corporate Demand for Internal Liquidity and Financial Development

Chapter summary:

Khurana, Martin, and Pereira (2006) and subsequent studies find that the sensitivity of cash holdings to cash flows (referred to as the *cash flow sensitivity of cash* or CCFS) decreases with the level of financial development; that is, firms from financially developed countries are less exposed to financing constraints and thus exhibit a lower propensity to save cash from their cash flows. While financing frictions are arguably less binding on such firms, I argue that the negative relationship between CCFS and a country's financial development holds only if CCFS is linear. Using a large sample of public firms from 44 markets and over the period from 1995 to 2010, my study reveals that (i) the corporate propensity to save cash from internal cash flows is nonlinear and highly sensitive to the sign of cash flow and that (ii) the inverse relationship between a country's financial development and cash-cash flow sensitivity becomes insignificant after the nonlinearity of cash-cash flow sensitivity is controlled for. Our findings further support the hypothesis that positive cash flow firms persistently save cash from internal resources regardless of financial market advances. Negative cash flow or loss-making firms are also insensitive to the level of financial development because their access to capital markets is generally limited or closed. In conclusion, my results indicate that corporate saving propensities reflect a multitude of factors that are independent of cross-country financial integration.

Key words: Cash Flow Sensitivity, Corporate Saving, Financing Constraints, Financial Development

JEL Classification Number: G01, G31, G32

3.1. Introduction

An important question in the corporate finance literature is whether financial development improves firms' access to lower cost external financing and reduces their reliance on internal resources. A traditional view suggests that developed capital markets with strong financial institutions and investor protection rights provide firms with the necessary resources to finance growth and thus help to ease financing constraints for firms[18]. Another important and still debatable issue concerns how to properly measure external financing constraints or frictions. Extant research focuses on corporate demand for internal liquidity, as measured by either the level of cash holdings (e.g., Keynes, 1936, Myers and Majluf, 1984, Kim et al., 1998, Opler et. al.1999, Dittmar, et al., 2003, Faulkender and Wang, 2006, Han and Qiu, 2007, and Denis and Sibilkov, 2011) or the propensity to save cash from internal cash flows, i.e., the cash flow sensitivity of cash (CCFS). The pioneering study by Almeida, Campello and Weisbach (2004) indicates that only financially constrained firms systematically save cash from current cash flow to fund future profitable investment opportunities, while unconstrained firms generally do not; in other words, cash saving is not related to cash flow. This finding is consistent with the notion that firms should hold more cash today when they anticipate having tighter financing conditions in the future. The authors also argue that CCFS is better than traditional investment-cash flow

[18] For example, Rajan and Zingales (1998) find that industries that are reliant on external financing exhibit greater growth in financially developed countries. Demirgüç-Kunt and Maksimovic (1998) find that firm growth financed by external debt and equity is positively associated with the level of a country's financial development. Wurgler (2000) shows that capital allocation is more efficient in financially developed markets. Love (2003) provides evidence that financial development affects growth by reducing financing constraints that would otherwise distort the efficient allocation of investment. See also La Porta et al. (1998), Beck et al. (2000), Demirgüç-Kunt and Levine (2001) and Levine (2005).

sensitivity (ICFS) at capturing the role of financing constraints[19,20]. Therefore, CCFS has been used extensively in subsequent studies on financing constraints and cash management policies[21]. In contrast, Riddick and Whited (2009) criticize the original interpretation of cash-cash flow sensitivity and posit that the relationship between cash holdings and cash flow may not serve as a good proxy for external financing constraints[22].

Based on alternative economic intuition and an augmented empirical model, the objective of this study is to reexamine the role of country-level financial development in a firm's demand for internal liquidity, as measured by CCFS. Previous research implicitly assumes that the measure is strictly linear; stated differently, firms operating in different cash flow environments exhibit symmetric cash-to-cash flow responses. Khurana, Martin, and Pereira (2006) and some subsequent studies (e.g., Baum, Schafer and Talavera, 2011, and Kusnadi and Wei, 2011) document a first-order effect of financial development and investor legal protection on a firm's

[19] Early research by Fazzari, Hubbard, and Petersen (1988) focuses on corporate investment demand and proposes a measure for investment-cash flow sensitivity. They suggest that financially constrained firms face higher sensitivity of investment to cash flow relative to unconstrained firms, as investment decisions are strongly influenced by the availability of internal funds under external financing constraints. However, this measure has generated numerous criticisms in the literature. Papers that criticize the interpretation of ICFS as reflecting financing constraints include Kaplan and Zingales (1997, 2000), Erickson and Whited (2000), Gomes (2001), Alti (2003), and Moyen (2004). Despite the controversy regarding this interpretation of ICFS, the relationship among financial development, capital market imperfections, and ICFS is well documented in the literature. In particular, Islam and Mozumdar (2007) and Agca and Mozumdar (2008) demonstrate that ICFS decreases as financial development increase and as capital market imperfections decrease, respectively. Mairesse et al. (1999) and Bond et al. (2003) focus on financial systems rather than on the level of financial development and report similar findings.

[20] Almeida, Campello, and Weisbach (2011) further extend their original model and show that CCFS can be either positive or negative, depending on the model assumptions.

[21] For example, Acharya, Almeida, and Campello (2007) find that CCFS depends on constrained firms' hedging needs. If hedging needs are high, then constrained firms tend to save cash from cash flows. Sufi (2009) examines information on whether a firm has access to an unused line of credit and finds that constrained firms that do not have access to a line of credit are particularly inclined to save cash from cash flows. See also Faulkender and Wang (2006) and Han and Qiu (2007).

[22] In particular, they show that income uncertainty affects corporate savings to a greater extent than external financing constraints. They conclude that although saving propensity contains some information about external financing constraints, too many forces influence this measure for it to be used as a summary proxy of financing frictions. They also find a negative cash-cash flow sensitivity and explain their results by using a different estimation methodology and measurement error correction in Tobin's q. Bao, Chan, and Zhang (2012) empirically follow the suggestion of Riddick and Whited and suggest that CCFS is asymmetric to cash flow (negative in a positive cash flow environment and positive in a negative cash flow environment).

marginal propensity to save cash. In this study, I show that such a conclusion is empirically and economically invalid. From an empirical perspective, CCFS is nonlinear and is highly sensitive to the sign of cash flow. Positive cash flow firms exhibit strong cash-to-cash flow responses, while negative cash flow firms exhibit significantly weaker responses. Using a large sample of public firms from 44 markets over the period from 1995 to 2010, the proposed study shows that CCFS is largely independent of the level of financial development after the nonlinearity (asymmetry) of CCFS is controlled for.

The lack of a statistical relationship between CCFS and level of financial development is also economically intuitive. For firms operating in a positive cash flow environment, the lack of a relationship indicates that a multitude of cash saving motives drive CCFS to the same extent as the severity of financing constraints; put it differently, financing frictions are only one of many forces that have a major impact on the cash-cash flow sensitivity. Indeed, the persistent and rising corporate saving in developed countries (with the most advanced and vibrant capital markets and arguably least binding constraints) over the last decade or so is attributed to factors not related to financing constraints. This strong "non-constraint" effect has been originally documented on *the levels* of cash. I further assume that the same "non-constraint" factors may drive *the sensitivity* of change in cash to cash flow. I further argue that although financial integration helps to overcome a firm's financing frictions, it does not actually moderate the strength of CCFS, which is driven by a variety of saving motives. The role of cross-country financial development in mitigating the effect of a strong propensity to save in the developed part of the world is insignificant and potentially misleading.

For negative cash flow or loss-making firms[23], the importance of financial market advances is even less clear because their access to equity and credit markets is limited or completely closed. The equity sponsors do not generally demonstrate a strong proclivity to provide capital to firms that generate persistently negative cash flow. Credit lenders are also reluctant to give loans to the firms that fail to meet performance criteria and covenants. This intuition further indicates that corporate saving propensities are not driven by a country's financial development.

As mentioned above, the studies that are closest to this line of research are Khurana et al. (2006), Baum et al. (2011), and Kusnadi and Wei (2011). The first paper evaluates firms' propensity to save in an international setting over the period from 1994 to 2004 and finds that CCFS linearly and marginally decreases with financial development. The authors explain the marginal effect by the fact that some firms find it difficult or suboptimal to raise funds even in developed capital markets. Therefore, the level of financial market sophistication only moderates CCFS. Next, the study by Baum et al. further documents that a country's financial system, in terms of both its structure (stock market-based or bank-based structure) and its level of development, influences the CCFS of constrained firms. They also report a linear and negative relationship between financial market advances and the severity of financing constraints, but only among constrained firms. Finally, the last study examines international data covering the period from 1995 to 2004 and documents the importance of country-level investor legal

[23] It is important to highlight that CCFS is meaningful in both positive and negative cash flow environments. When a firm faces positive cash flow, CCFS follows normal intuition (residual cash flow is a source of cash); in contrast, when a firm faces negative cash flow, CCFS differs from that in a positive cash flow environment. The negative (residual) cash flow is no longer a source of cash, but it still has a first-order effect on cash holding. Firms that face negative cash flow shock generally have limited financing options and need to dissave (spend cash reserves) to cover current obligations. On the contrary, such firms also have a stronger proclivity to save (preserve liquidity) for future needs and, therefore, find ways to optimize and reduce cash outgoings. For this reason, CCFS is informative even when cash flow is negative. I discuss CCFS in negative cash flow environment in more details in chapter 4.

protection in mitigating the effects of firm-level financial constraints and hedging needs on corporate cash management policies[24].

While prior research seemingly provides a consensus on the role of financial development in (i) easing financing constraints and (ii) attenuating cash-cash flow sensitivity, this study directly questions the second argument from both an empirical and an economic perspective. Empirically, it is difficult to argue that there is a significant linear relationship between CCFS and the level of financial development if CCFS is strongly nonlinear. I show that this measure of financing constraints is convex even in a positive cash flow environment. Existing studies fail to properly control for the true nature of CCFS, which results in a biased conclusion regarding the true correlation between CCFS and financial development metrics. I fill this research gap by relying on a performance-stratified survey of nearly 224,000 firm-year observations[25].

This study also raises two important economic questions. The first question relates to positive cash flow firms, while the second one relates to loss-making firms operating in a negative cash flow environment. First, what is the effect of financial development on the sensitivity of cash to cash flow if the measure reflects a multitude of cash saving motives, along with information about external financing frictions? This question has been partially raised by Riddick and Whited (2009), who argue that this measure may not be a good proxy for financing constraints. Although the interpretation of CCFS as financing frictions is beyond the scope of this study, I acknowledge

[24] This paper follows prior studies that examine the influence of corporate governance on the demand for internal liquidity. There is relatively mixed evidence in this strand of research. For example, Dittmar, Mahrt-Smith, and Servaes (2003) show that firms in countries with poor shareholder protection — and thus a high cost of external finance — hold substantially more cash than otherwise similar firms in high shareholder protection countries. However, Harford, Mansi, and Maxwell (2008) find an opposite relationship between firm-level shareholder rights and cash holdings in their U.S. sample.

[25] Allayannis and Mozumdar (2004) report the downward bias imparted by negative cash flow observations on traditional ICFS. They argue (p.902) that "negative cash flow is a useful proxy for characterizing firms that are in... financially distressed situations", which attenuates their investment response to changes in cash flow.

that there are alternative forces that have a first-order effect on the corporate propensity to save. Stated differently, if the cost of external finance or its availability is not the dominant driver, then CCFS should not systematically decrease with the level of financial development[26]. This argument deserves to be empirically tested, especially in light of the tendency of firms from the U.S. and other developed countries to accumulate cash over time. Indeed, firms from countries with sophisticated capital markets, established access to private credit and sound legal environments save record-high amounts of cash[27]. It is strongly evident that financial development does not serve as a mechanism to reduce a firm's marginal propensity to save. Second, what is the effect of financial development on the sensitivity of cash to cash flow if a firm faces negative cash flows and bears limited or no interest to capital providers? This question is closely related to the changing demand for internal liquidity in contrasting cash flow environments, i.e., the nonlinearity of CCFS. Prior studies implicitly assume that the entire population of firms exhibit symmetric saving propensities and experience a similar impact from a country's financial development. Both assumptions are not valid, however. I show that negative cash flows generally distort the strength of CCFS. Moreover, if the cost of external finance is unacceptably high (generating a risk of financial distress for loss-making firms), then the relationship with financial market advances is also economically weak.

The proposed research is structured as follows. First, the study discusses the fundamental reasons for the global rise in corporate saving (Foley et al., 2007, Bates et al., 2009, Riddick and

[26] Alternatively, there may be other (unobserved) cash saving motives that are correlated with the level of financial development.

[27] According to Armenter and Hnatkovska (2011), the sharp increase in U.S. firms' savings behavior has changed the net position of the (nonfinancial) corporate sector vis-à-vis the rest of the economy. The net position is defined as the difference between how much other sectors owe the corporate sector (financial assets) minus how much the corporate sector owes to other sectors (debt). In the 1970s and 1980s, the corporate sector was a net debtor, borrowing between 15 and 20 percent of the value of its productive assets from the rest of the economy. However, by the 2000s, the corporate sector had switched to being a net lender, and over the 2003-2007 period, the sector was saving more than 5 percent of the value of its productive assets.

Whited, 2009, Armenter and Hnatkovska, 2011, Pinkowitz et al., 2012, and Karabarbounis and Neiman, 2012). It reveals that corporate demand for internal liquidity, which is empirically tested by cash holdings and/or CCFS, reflects too many forces to be used as a "perfect" (mismeasured) proxy of financing frictions. In particular, the global decline in the cost of capital, tax incentives and breaks for multinational firms, the growing uncertainty in cash flows, and the rising predominance of R&D investment in the U.S. and other advanced economies affect corporate saving to the same extent as financing constraints. There are a host of factors that fortify both the levels of cash and the CCFS relationship and that make the role of financial development in attenuating the sensitivity of cash to cash flow marginal or insignificant[28]. The study further discusses why typically low CCFS among firms with negative cash flows do not correlate with a country's financial development. Based on the discussion, I formally propose a testable hypothesis.

Second, the analysis reveals that firms from financially developed countries hold more liquid assets and do not demonstrate significantly different changes in cash holdings (relative to total assets) than their counterparts from less developed countries. In particular, the ratio of cash to total assets is 12.6% in 1995 and 15.4% in 2010 for the subsample of developed market firms. The ratio is only 10.6% in 1995 and 11.2% in 2010 for the subsample of firms from financially underdeveloped markets. The year-to-year changes in cash holdings vary between -2% and +2% of total assets and are not statistically different between the two subsamples. The preliminary findings are consistent with the notion that firms from countries with a high (low) level of financial development do not exhibit a weaker (stronger) propensity to save.

[28] This economic conjecture does not challenge the role of country-level financial development in easing financing constraints but rather challenges its significance in attenuating "noisy" CCFS, which reflects a multitude of alternative forces.

Third, the study formally tests the proposed hypothesis and provides strong evidence to support it. In particular, I show that the evidence provided by Khurana et al. (2006) holds only if CCFS is linear. The sensitivity of cash holdings to cash flows decreases with financial development only in pooled data and without controlling for the nonlinearity of CCFS. Once an interaction term with negative cash flow or a quadratic version of cash flow is introduced, the relationship between CCFS and all financial development metrics becomes insignificant. The use of analytical weights mitigates the concern that the results are driven by a few countries with the highest number of observations. The use of the generalized method of moments (GMM) methodology with an appropriate number of instrumental variables rules out the possibility that the main findings are sensitive to endogeneity. Finally, the results are consistent across different model specifications.

Fourth, a variety of robustness tests show that the baseline estimation results are valid when alternative measures of financial development are used. The study also controls for the effect of the legal system, strictly profitable firms, and model misspecification (omitted variable bias). In particular, the main evidence remains largely unaltered if the level of cash holdings and the trade credit effect are introduced.

Fifth, the study explores the influence of external financing constraints on the relationship between cash-cash flow sensitivity and capital market development. Small or non-dividend paying firms are considered to be financially constrained and large or dividend paying firms are considered to be unconstrained. Firms classified as financially constrained exhibit statistically stronger CCFS than firms classified as unconstrained. This result is consistent with the existing literature (Almeida et al., 2004, 2011). Further, constrained firms are likely to spend less cash reserves to fund existing projects and operations when they have negative cash flows. The results

also replicate the findings of Bao et al. (2012). More important for this study, the originally insignificant relationship between cash-cash flow sensitivity and financial development remains unchanged for both constrained and unconstrained firms. In other words, financial integration does not serve as a mechanism to mitigate the effect of financing frictions on corporate saving.

Finally, a country-by-country analysis is used to further address the issue of different observations across countries and over time and to examine the influence of financial development on a firm's propensity to save across economic cycles. Changing economic conditions may also affect corporate saving and liquidity management policy. In this analysis, the documented relationship remains largely insignificant in different stages of the economic cycle, while an inflationary environment negatively correlates with saving propensity. This result indicates that the sensitivity of cash to cash flow is potentially sensitivity to macroeconomic factors[29] but independent of cross-country financial development.

In summary, my study contributes to the current body of literature by questioning the role of financial development in corporate cash management around the world. Prior evidence suggests that to the extent that financial development reduces financing constraints, CCFS decreases with the level of financial market development. The new empirical evidence provided in this study highlights the asymmetry in the measure of CCFS that makes the relationship between the cash flow sensitivity and the level of financial market development statistically insignificant. From an economic perspective, there is also justification to argue that the cash-cash flow relationship is not an appropriate measure to test the effect of cross-country development on a firm's liquidity. In this respect, this research contradicts previous findings in the literature and provides clearer

[29] The sample period includes only 16 years (1995-2010), which makes the conclusion regarding the relationship between economic cycles and cash management policies preliminary and subject to further testing on longer time intervals (extended business activity periods).

insight regarding what actually drives corporate demand for internal liquidity. In particular, academia should recognize that financial market development and institutional factors are not the primary forces in attaining optimal cash management policy and that their roles are not as evident as has been previously believed. Instead, there are myriad other factors that contribute to the economics of firms' savings.

The remainder of the paper is organized as follows. Section 3.2 develops the testable hypothesis. Section 3.3 describes the empirical methodology, data, and variables. In section 3.4, the empirical analysis and main findings are presented. Section 3.5 concludes the paper.

3.2. Hypothesis development

A strong liquidity preference is a common trend across developed countries. Bates et al. (2009) and Pinkowitz et al. (2012) document that firms from the U.S. and other major economies are holding record-high amounts of cash. The finance media also reports unprecedentedly high amounts of liquid assets accumulated on balance sheets around the world[30]. To present time series of corporate cash holdings, the ratio of cash to total assets and the ratio of first differences in cash to total assets over the period from 1995 to 2010 are plotted in Figure B.1[31]. A close

[30] According to the *Economist Magazine* (March 17th, 2012), "(U.K.) companies have for years had money left over from profits once they had covered their interest costs, dividend payments and other outgoings. This corporate surplus recently rose to almost 6% of GDP. It makes sense for them to hold a cash buffer if they have little faith in banks or in the broader financial system to supply cash when they need it". Next, the *Economist Magazine* (November 3rd, 2012) reports that "companies have been net suppliers, instead of users, of funds to the rest of the economy since 2008. Firms in the S&P 500 held roughly $900 billion of cash at the end of June 2012, down a bit from a year earlier but still 40% up on 2008. Japanese companies' liquid assets have soared by about 75% since 2007, to $2.8 trillion. Cash stockpiles have continued to grow in Britain and Canada, too. A rapid reversal is unlikely. That's because rising corporate saving has deeper roots than the crisis, the commodities boom or this interest-rate cycle".

[31] The sample size includes firms from 44 countries. The firms are partitioned by the median values of a country's aggregate financial development index (FD) into (i) high FD and (ii) low FD firms. The index construction methodology is described in section 3.3. The number of firms used in the sample is provided in Appendix B.1.

examination of the balance sheets of publicly traded firms across developed nations shows that their cash holdings have increased dramatically since the late 1990s, except for during a short slowdown around the global financial crisis. Intriguingly, firms from financially advanced countries hold more liquid assets than their counterparts from less developed countries. In particular, the ratio of cash to total assets is 12.6% in 1995 and 15.4% in 2010 for the subsample of firms from countries classified as financially developed. The ratio is only 10.6% in 1995 and 11.2% in 2010 for the subsample of firms from countries classified as underdeveloped. The cash ratios are statistically different between the two subsamples. The change in the cash ratios results from a secular trend rather than the recent build-up in the cash holdings of some firms. Rising corporate saving clearly has deeper roots (back to the mid- and late 1990s) than the recent global financial crisis.

In contrast, the year-to-year changes in cash holdings vary between -2% and nearly +2% of total assets and are not statistically different between the two subsamples. Based on the preliminary findings, I can argue that the proclivity to accumulate cash is sufficiently pronounced among firms from financially developed economies. This argument contradicts the prevailing view that strong saving propensity is a distinct characteristic of firms from countries with poorly established access to equity and credit—and thus a higher cost of external finance — and weak investor protection environments.

I briefly discuss the outcome of existing studies that explore the rise in corporate savings in the developed part of the world. Armenter and Hnatkovska (2011) report a sharp increase in U.S. firms' savings behavior. This rise has led to a secular shift in the financial position of U.S. firms. In the 1970s and 1980s, the corporate sector was a net debtor, borrowing between 15 and 20 percent of the value of its tangible assets from the rest of the economy. The corporate sector then

switched to being a net lender in the 2000s. Armenter and Hnatkovska conclude that firms accumulate liquid assets for precautionary reasons and attribute the rise in corporate net savings over the past 40 years to a fall in the cost of equity and dividend taxes. Karabarbounis and Neiman (2012) further document that across the 51 countries that they examine for the period between 1975 and 2007, the labor share has significantly declined. This decline is associated with a significant increase in corporate saving, which is generally the largest component of national saving. Firms' share of total private saving rose by 20 percentage points. They link the rising corporate saving to a fall in the cost of borrowing and to the shift in capital-goods production toward lower-wage developing countries that began in the early 1980s. In turn, firms have responded by substituting away from labor and toward capital, and to finance this investment, firms have steadily increased corporate saving over time. More important for this study, the rise in saving coincides with financial market development in many countries. Next, a growing number of studies show that cash flow uncertainty (risk) is a primary driver of corporate cash management policy. For example, Han and Qiu (2007) show that constrained firms' cash holdings increase with the volatility of their cash flows but find no systematic relationship between cash holdings and cash flow volatility for unconstrained firms. Bates, Kahle, and Stulz (2009) show that the increase in U.S. firms' internal liquid assets is closely related to precautionary motives, a decline in working capital, and a rise in R&D investment. They construct a measure of cash flow uncertainty and show that firms with higher uncertainty in their cash flows have higher cash and other liquid assets. The average cash ratio also increases because firms hold fewer inventories and accounts receivable and spend more on R&D. Riddick and Whited (2009) also find that income uncertainty affects corporate saving to a greater extent than external financing constraints. They report that the variability and autocorrelation of income

shocks are at least as important as the cost of external finance in determining corporate saving. Finally, Foley, Hartzell, Titman, and Twite (2007) analyze the role of foreign income and repatriation taxes. They find that firms that are subject to higher repatriation taxes hold significantly more cash. They also show that less constrained firms and those that are more technology intensive exhibit a higher sensitivity of affiliate cash holdings to repatriation tax burdens. This role of taxes is challenged by Pinkowitz, Stulz, and Williamson (2012), however. They show that while U.S. firms held less cash than comparable foreign firms in the late 1990s, by 2010, they held more cash. Their analysis also reveals that the increase in the cash holdings of multinational firms cannot be explained by the tax treatment of profit repatriations and that this increase is intrinsically linked to their R&D intensity.

The global rise in corporate saving starting in the 1980s and 1990s is primarily attributed to structural changes, such as a global decline in the cost of capital, a shift from labor to investment, tax incentives, the growing uncertainty in internal cash flows, and the rising predominance of R&D, and is unlikely to be explained by cross-country differences in financial development. Interestingly, a rising propensity to save coincides with the development of financial intermediation and positive changes in investor protection legislation in many countries. The strong "non-constraint" saving motives have been originally documented on *the levels* of cash. I further assume that the same factors may drive *the sensitivity* of cash to cash flow; in other words, the level of financial development is unlikely to mitigate the effect of strong demand for internal liquidity and to moderate CCFS.

For negative cash flow firms, the importance of a country's financial development is also expected to be insignificant. While the positive growth effects of financial integration and advances are extensively documented (e.g., Demirgüç-Kunt and Maksimovic, 1998, Beck et al.,

2000, 2005, 2006, 2008 and Giannetti and Ongena, 2009), little is known of the impact of financial integration and advances on unprofitable firms. Existing studies show a strong and positive effect of financial institutions and legal systems on firm growth, but (i) such conclusions are based on a sample of predominantly profitable firms, and (ii) these studies largely underestimate the role of bottom-line performance and internal cash flow. In contrast, this study argues that loss-making firms or firms with negative operating cash flow do not benefit from a country's level of financial sophistication. Such firms' access to traditional financing is unsustainable because both equity (investing criteria) and credit (lending criteria) capital providers generally avoid corporates with no internally generated cash flow. For example, Opler et al. (1999) report that firms that have the weakest access to the capital markets are small firms and those with low credit ratings. Beck et al. (2005) show that financial constraints affect the smallest firms most adversely. Based on these conclusions, I can expect that unprofitable firms also experience similar difficulties in securing external sources of funding. That is, a country's level of financial development is not expected to significantly ease severe financing constraints faced by such firms[32]. This prediction, both for positive and negative cash flow firms, can be expressed as follows:

Hypothesis 1 (H1): The corporate propensity to save cash from internal cash flow (referred to as the cash flow sensitivity of cash, CCFS) is not systematically related to a country's financial development, ceteris paribus.

The proposed hypothesis implies no significant relationship between a firm's propensity to save cash and a country's financial development; in other words, a strong propensity to save is

[32] For positive cash flow firms, I expect no first-order effect of financial development on CCFS. For negative cash flow firms, I expect no first-order effect of financial development on both "noisy" CCFS and true (unobserved) financing constraints.

not significantly driven by a country's financial development. The predicted weak relationship should indicate that a variety of cash saving motives, including but not limited to the severity of financing constraints, have a strong effect on CCFS.

3.3. Methodology and sample construction

3.3.1 Methodology

To test the hypothesis developed in the previous section, the empirical part of the study largely uses the model of Almeida et al. (2004) — with some modifications. The model specification is estimated as follows:

$$\left(\frac{\Delta \text{Cash}_{i,t}}{\text{TA}_{i,t}}\right) = \alpha_c + \alpha_j + \alpha_t + \beta_1 \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}}\right) + \beta_2 \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}} * \text{FinDev}_{i,t}\right) + \beta_3 \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}} * \text{Neg}_{i,t}\right) + \beta_4 \text{LeadInv}_{i,t} + \beta_5 \text{Controls}_{i,t} + \varepsilon_{i,t}, \quad (6)$$

where $(\Delta \text{Cash}_{i,t}/\text{TA}_{i,t})$ represents the change in cash and cash equivalents scaled by total assets. $(\text{CF}_{i,t}/\text{TA}_{i,t})$ or CashFlow is internal cash flow (calculated as net income before extraordinary items plus depreciation and amortization) minus dividends paid scaled by total assets. The model specification replaces the traditional Tobin's q with the actual ratio of future investments to current investments, LeadInv, as a measure of the firm's investment opportunities[33]. As mentioned by Khurana et al. (2006), a potential problem with using the proxy for Tobin's q in a cross-country setting is that it may reflect not only the presence of actual investment opportunities but also the market's perception of a firm's ability to exploit its investment options. Therefore, an advantage of using realized investments is that it sidesteps the issue of

[33] For a given firm in year t, the ratio $\text{LeadInv}_{i,t}$ is computed as $(\text{CapEx}_{i,t+1} + \text{CapEx}_{i,t+2}) / (2 * \text{CapEx}_{i,t})$, where $\text{CapEx}_{i,t}$ is the current period (physical) capital expenditures. The reported results are also robust to the use of a one-period forward horizon to measure future investment.

distinguishing between the market evaluation of investment opportunities and a firm's ability to take advantage of these investment opportunities. Another issue relates to the use of accounting numbers in computing Tobin's q. Reporting standards and practices differ substantially across countries in the sample of 44 countries. To the extent that these practices differ, the quality of Tobin's q is likely to vary across countries. Realized current and future capital expenditures are more independent of accounting standards and practices and are likely to be more consistent across countries. In addition, Almeida et al. (2004) suggest that Tobin's q also contains information about current investment opportunities and therefore is a relatively noisy measure. According to Riddick and Whited (2009), measurement error in Tobin's q can affect the cash flow coefficient because measurement error in one regressor affects all of the coefficients in a regression if the regressors are correlated.

The model specification includes country (α_c), industry (α_j), and year (α_t) indicator variables (dummies). These variables are included to control for country, industry, and year fixed effects, since these factors have been known to affect firms' cash holdings. The choice of firm-level controls is motivated by existing literature and accounts for a firm's financial characteristics that may influence its liquidity policy and cash holdings. In particular, Controls include firm size (Size, natural log of total assets), capital expenditures (CapEx), share repurchases (ShareRep), other investments (OtherInv), changes in noncash net working capital (ΔNWC), and changes in short-term debt (ΔSD), where all these control variables are scaled by total assets.

Neg is a major modification to the augmented model of Almeida et al. (2004). This is an indicator variable that is equal to unity if cash flow is negative and zero otherwise. The distortionary effect of negative cash flow observations on traditional ICFS is documented in the literature (Allayannis and Mozumdar, 2004, Bhagat et al. 2005, and Brown and Petersen, 2009).

Existing studies on CCFS largely ignore this effect and therefore report potentially misleading estimates. The interaction term between internal cash flow and the Neg variable controls for the asymmetric nature of cash-cash flow sensitivity; in other words, this interaction term controls for the changing nature of cash-to-cash flow responses between positive and negative cash flow firms. Additionally, I introduce a quadratic version of internal cash flow (NonLinearity) that also aims to control for the nonlinearity of CCFS. Both the (CashFlow $*$ Neg) interaction term and the NonLinearity quadratic variable allow me to test the true impact of financial development on CCFS[34].

FinDev is a generalized measure of financial development. Following Love (2003) and Khurana et al. (2006), as of 2013, there are five standardized financial development indices that can be obtained from the World Bank database: (i) market capitalization over GDP, (ii) total value traded over GDP, (iii) total value traded over market capitalization, (iv) ratio of liquid liabilities to GDP, and (v) ratio of the credit going to the private sector to GDP. The average of the first three standardized indices is labeled SMKT and serves as a measure of stock market development. The average of the last two standardized indices is labeled FINT and reflects financial intermediary development. FD is the sum of SMKT and FINT. Countries with higher scores for the FD index are implied to have more developed capital markets. The study also uses alternative measures of financial development for robustness tests, which are reported in the sections that follow. Previous research posits that financial development significantly attenuates the strength of the association between the change in cash holdings and internal cash flows. Under the proposed hypothesis in this study, financial advances are not significantly related to

[34] "Nonlinear" and "asymmetric" features of CCFS are used to indicate the varying relationship between changes in cash holdings and internal cash flow in different cash flow environments; in other words, both features are used as synonyms in the thesis. If *CashFlow*$*$*Neg* is a structure break rather than continuous relation between cash flow and cash, it still helps to test the asymmetric (more generally, nonlinear) nature of CCFS.

CCFS. Therefore, the expected signs on the interactions of the SMKT, FINT, and FD indices with internal cash flow are not defined.

Since the sample consists of countries with unbalanced numbers of firms (see section 3.3.2 for further details), all the regressions in empirical tests are estimated by using an analytical approach that weighs each country equally so that the firm-year observations receive more (less) weight in countries with fewer (more) firm-year observations[35]. Such an approach mitigates concerns that main results are driven by a few countries with the highest number of observations. Alternatively, the two countries with the largest number of firm-year observations, namely, the U.S. and Japan, are sequentially dropped from the sample to check whether the results are driven by the observations for these countries[36]. In case the "weighted" methodology and alternative sampling do not completely resolve the issue of different observations across countries, a country-by-country two-stage estimation approach is also used later in the study.

To deal with the potential endogeneity of the ratio of future investments to current investments, LeadInv, Eq.(6) is estimated by using the generalized method of moments (GMM) methodology with appropriate lags of CapEx as instrumental variables. Hansen's J-test of overidentifying restrictions and C-test on exogeneity jointly identify the appropriate number of instruments. Endogeneity and unbalanced data are potential concerns in the presented analysis; therefore, the GMM methodology with analytical weights is justified. Heteroskedasticity-consistent standard errors are clustered at the firm level and are also reported (corresponding t-statistics).

[35] The weights are equal to a value of one divided by the number of observations for each country.
[36] In unreported tests, the baseline results remain largely unchanged.

3.3.2 Sample construction

Annual financial data covering the period from 1995 to 2010 are from the Worldscope (Datastream) database. The full sample consists of 223,999 firm-level observations from 44 countries. The number of firms in the sample by country and by year is provided in Appendix B.1.

Consistent with the existing literature, firms operating in the financial services industry (which have different accounting policies) and utilities (which have high regulation) are excluded from the sample. Firms must have valid observations for all variables included in Eq.(6). To mitigate outliers and data errors, the sample does not include observations for which there are no data on cash holdings or for which the cash value exceeds total assets. In addition, the observations for years in which net income before extraordinary items exceeds total assets or market capitalization are removed. To alleviate backfilling bias, firms must have at least three non-missing observations during the sample period. Outliers in all regression variables are trimmed at the 1% level (1^{st} and 99^{th} percentiles).

There is substantial variation in the number of sample firms across countries and years (Appendix B.1). Specifically, the U.S., the U.K., and Japan jointly represent nearly 47% of the total sample of observations, while 26 countries individually represent less than 1% of the total sample of observations. To control for the unbalanced data, this study uses analytical weights, a country-by-country two-stage estimation approach, and alternative sample compositions.

The summary statistics for the financial development measures and firm-level financial variables across the countries are reported in Panel A of Table B.1. The financial development indices are standardized to have a mean of zero and a standard deviation of unity. Not

surprisingly, the values for the SMKT, FINT and FD indices are highest for major developed countries. The values of the aggregate FD index are highest for Hong Kong and Switzerland (5.53 and 3.09, respectively) and lowest for Venezuela and Argentina (-2.17 and -1.91, respectively).

Interestingly, firms from financially developed countries hold, on average, more cash than their counterparts from developing countries. In particular, the average cash ratios are 0.148 and 0.099 for the developed and developing country subsamples, respectively. The cash ratio is highest for Hong Kong (0.211) and the U.S. (0.186) and lowest for Portugal (0.055) and Chile (0.065). The annual change in cash holdings is similar between developed and developing economies, on average 0.7% of total assets for each country subsample. The results are consistent with those previously reported in Figure B.1 in section 3.2. Thus, (i) a positive and significant correlation between the financial development measures and corporate cash holdings and (ii) a weak correlation between the financial development metrics and changes in cash holdings are expected. In addition, firms from major developed countries are larger in size and less profitable, and they spend less on capital investments and more on share buybacks.

The firm-level descriptive statistics are reported in Panel B of Table B.1. The table provides the summary statistics for firms with strictly positive cash flows and for firms with negative cash flows. Two sub-samples are fundamentally different. Negative cash flow firms are generally more constrained (no internal source of cash) and, therefore, hold more cash. They also have to dissave to cover current cash outgoings. In addition, such firms are smaller and spend less on capital expenditures, working capital and share repurchases compared to the firms with positive cash flow. The firm-level statistics are consistent with the notion that firms behave differently in positive and negative cash flow environments.

The pairwise correlations among the country-level financial development indices and country-level means of the firm-level (selected) variables are presented in Table B.2. There are positive (on average, 0.20) and statistically significant associations between corporate cash holdings and the FinDev measures. Other pairwise correlations, except for the ones among SMKT, FINT, and FD, are relatively low (below $+/-0.25$), indicating little threat of a multicollinearity problem. The results are also consistent with my expectations. Based on the reported correlation estimates, no strong relationship among capital market advances, financial intermediation, and CCFS is expected.

3.4. Empirical results

This section investigates whether firms' cash management policies are affected by financial development, in particular by stock market and credit market advances. To be more specific, the analysis explores how development factors affect the nonlinear relationship between the change in cash holdings and cash flow innovations.

3.4.1 Baseline analysis

This section formally estimates the relationship between CCFS and the level of financial development. Table B.3 presents the estimation results for the baseline model in Eq.(6). Results

from Hansen's test are also reported in the bottom of the table[37]. J-statistics are satisfactory, ranging from 0.26 to 0.65, and pass the test for overidentifying restrictions and joint exogeneity.

Before the discussion turns to the main findings, I provide a brief overview of the results for the control variables. The coefficients for LeadInv are negative and significant at the conventional levels across all models. The estimates are consistent with those reported in the existing literature (Baum et al., 2011). The coefficients for Size provide similar results — negative and significant at the 1% level. Large firms exhibit a weaker propensity to save, which is expected. While the coefficients for CapEx, OtherInv, ShareRep, and ΔNWC are negative, consistent across model specifications, and highly significant, the coefficients for ΔSD are significantly positive. The results are also expected, as the first four drivers generally reduce cash holdings, and new borrowings add to corporate liquidity.

The main interest of this study lies in the regression coefficients, β_1 and β_2. β_1 measures the sensitivity of a firm's changes in cash holdings to its cash flow innovations. CCFS is strongly positive and statistically significant at the 1% level. The coefficients range from 0.21 to 0.36 across model specifications. This strong relationship is consistent with the notion that firms steadily save cash from their internal cash flows. Thus, the findings support the evidence reported by Almeida et al. (2004).

The main focus of this study, in terms of the testable hypothesis, is the interaction between firms' internal cash flows and the financial development indices SMKT, FINT, and FD (β_2). The results reported in models (1), (4), and (7) closely replicate the findings of Khurana et al. (2006) and Baum et al. (2011); stated differently, cash-cash flow sensitivity decreases as the level of

[37] A C-test on orthogonality (a test in which the explanatory variables are jointly exogenous) is also performed. The results generally support the test of overidentifying restrictions; that is, there are endogenous explanatory variables in the empirical model, and the GMM is more efficient relative to OLS.

financial development increases[38]. However, the nonlinearity in the measure of CCFS and the changing strength of cash-to-cash flow response are not controlled for in these results. Once I include either the interaction term with negative cash flow ($\text{CashFlow} * \text{Neg}$) or the quadratic term of internal cash flow (NonLinearity), the results change dramatically. For example, the estimated coefficients for the interaction with negative cash flow are negative (-0.23) and significant at the 1% level in models (2), (5), and (8). This result is strong support for the distortionary effect of negative cash flows that has been previously reported in the literature (Allayannis and Mozumdar, 2004, Bhagat et al. 2005, and Brown and Petersen, 2009). Firms that face a negative cash flow environment demonstrate much weaker CCFS than the firms with positive cash flow. Similarly, the estimated quadratic term of cash flow is positive and highly significant in models (3), (6), and (9), indicating the strong presence of nonlinearity in the relationship between changes in cash holdings and cash flow innovations. More important, the estimated interaction ($\text{CashFlow} * \text{SMKT}, \text{CashFlow} * \text{FINT}, \text{CashFlow} * \text{FD}$) coefficients become completely insignificant after the nonlinearity of CCFS is controlled for by using either of the two methods. Given that other explanatory and control variables remain consistent and significant, I can conclude that the relationship between CCFS and financial development is statistically weak.

While there is no statistically significant relationship between cash-cash flow sensitivity and a country's financial development, the economic significance of this association is also weak. The economic importance of the estimated effect is illustrated in the following numerical

[38] The magnitude of the estimated coefficients in this study is different (larger) because the empirical model of Khurana et al. (2006) does not include several of the control variables that are used in Almeida et al. (2004). I largely use the augmented model of Almeida et al. (2004, p.1788) who report: "...Notice that one should expect a larger estimate for α_1 (note: the cash flow sensitivity of cash) to be returned from the augmented equation.... The reason is that as we explicitly add controls for alternative uses of funds to a model of savings, we approach an accounting identity in which each new dollar that is not spent must be credit to "savings account".

example. I can compute the savings rate from Eq.(6): the fraction of a dollar of additional cash flow that is channeled to cash holdings. Given the specification, this partial derivative is a function of the SMKT, FINT, or FD variable. I evaluate the savings rate at the sample mean (μ) of each financial development variable and at (μ+1σ), where σ is the sample standard deviation of the financial development variable. The resulting savings rates are presented in the footnote of Table B.3. The strongest effect is observed in model (4), where a 1σ increase in the FINT variable decreases the saving rate from 21.5 percent to 20.1 percent — or only 6.2 percent in the relative term. Other interaction coefficients also do not significantly change the saving rate (below 5 percent). This example shows that there is a relatively weak economic effect of financial development on the saving rate.

The study also uses an alternative approach to verify the baseline results. The median values of the SMKT, FINT, and FD indices are used to partition the total sample into High and Low subsamples. The first acronym represents the firms from financially developed economies, while second acronym represents the firms from underdeveloped economies. Then, an alternative model specification is estimated for each of the two subsamples:

$$\left(\frac{\Delta \text{Cash}_{i,t}}{\text{TA}_{i,t}}\right) = \alpha_c + \alpha_j + \alpha_t + \beta_1 \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}}\right) + \beta_2 \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}} * \text{Neg}_{i,t}\right) + \beta_3 \text{LeadInv}_{i,t} + \beta_4 \text{Controls}_{i,t} + \varepsilon_{i,t}, \quad (7)$$

The main explanatory and control variables are defined in section 3.3. The prediction of the hypothesis is that CCFS (β_1 or CashFlow) should not be statistically different between the High and Low subsamples after the nonlinearity of CCFS is controlled for[39]. Table B.4 reports the

[39] CCFS should be significantly weaker for firms from financially advanced countries if the nonlinear effect is not controlled for. This estimate should replicate the evidence reported by Khurana et al. (2006) and Baum et al. (2011).

regression results. The nonlinear effect is controlled for by using the interaction term with negative cash flow ($\text{CashFlow} * \text{Neg}$) in models (7) through (12)[40].

All the control variables have estimates that are largely consistent with the results reported earlier in Table B.3. The estimated coefficients for the sensitivity of cash to cash flow are significantly lower in the High subsample of firms if the nonlinearity of CCFS is ignored. This result is consistent with the suggestions of Khurana et al. (2006) and Baum et al. (2011). Once the model estimation includes the nonlinear effect, there is no statistical difference between the two subsamples of firms. In particular, the CCFS estimates are 0.356 (t = 25.92) and 0.409 (t = 9.05) for the firms from the High SMKT and Low SMKT subsamples, respectively. Similarly, the estimates are 0.345 (t = 24.44) and 0.407 (t = 8.66) for the firms from the High FINT and Low FINT subsamples, respectively. Finally, the estimates are 0.347 (t = 27.48) and 0.407 (t = 8.74) for the firms from the High FD and Low FD subsamples, respectively. The p-values for the difference in the CCFS coefficients between the two subsamples indicate that the difference is statistically insignificant. Therefore, the proposition that the corporate propensity to save cash from cash flow is not systematically related to a country's financial development is valid.

In summary, the analysis reveals the empirical evidence that has not been previously reported in the literature. The findings strongly indicate that cash-cash flow sensitivity is not significantly lower in countries with more developed equity markets and established access to credit. As shown in the following sections, this evidence is robust.

[40] The use of the quadratic term of internal cash flow (NonLinearity) produces qualitatively similar results. The estimated results can be provided upon request.

3.4.2 Robustness checks

Robustness tests are performed to address issues related to alternative measures of financial development, the effect of the legal system, and sampling and model misspecification. First, alternative measures of financial development are used in Panel A of Table B.5. Second, the study controls for strictly positive cash flow firms and the effect of the legal system or legal traditions in Panel B. Third, Fishman and Love (2003) highlight the importance of trade credit in less financially developed countries. Therefore, the analysis includes the level of accounts payable as a proxy for trade credit and its interaction with internal cash flow in Panel C. Fourth, the one-period lagged cash-to-assets ratio and its interaction with internal cash flow are introduced as additional control variables in Panel D. This interaction term was originally introduced by Almeida et al. (2004) and allows CCFS to vary with the level of cash holding. Finally, the study examines demand for internal liquidity among multinational firms with a significant share of foreign revenue in Panel E. To be consistent with the baseline analysis, this section also applies the GMM methodology with analytical weights. Satisfactory J-statistics across the robustness tests indicate that there is little threat of an endogeneity problem. To save space, I report only the key explanatory variables in the panels.

Panel A of Table B.5 presents the estimation results with two alternative measures of financial development. FDa is defined as the average of two standardized indices from the World Bank Database as of 2013: market capitalization over GDP and the ratio of the credit going to the private sector to GDP. FDb is defined as the average of two standardized indices: total value traded over GDP and the ratio of the credit going to the private sector to GDP. In untabulated results, I also include two other metrics: (i) the average of market capitalization over GDP and the ratio of liquid liabilities to GDP and (ii) the average of total value traded over GDP and the

ratio of liquid liabilities to GDP. The estimation results with unreported financial development metrics are qualitatively and quantitatively similar to the results reported below for FDa and FDb.

The introduction of alternative metrics yields no qualitative change in the main findings. In particular, CCFS (CashFlow) remains strong and significant, with coefficients ranging from 0.218 in model (4) to 0.361 in model (5). The unreported results for the regression on the control variables remain largely unchanged and consistent with those previously reported in Table B.3. In model (1), the interaction coefficient for CashFlow $*$ FDa is negative and highly significant (-0.021, with t = -3.66), which largely replicates the finding of Khurana et al. (2006). The interaction coefficient for CashFlow $*$ FDa becomes completely insignificant once CashFlow $*$ NEG or NonLinearity is included into the model specification. Similarly, the coefficients for the interaction CashFlow $*$ FDb is originally negative and significant (-0.014 with t = -2.91) in model (4). Once the nonlinearity of cash-cash flow sensitivity controlled for, however, the impact of financial development becomes insignificant. Therefore, I can conclude that the weak relationship between the corporate propensity to save and a country's financial development remains robust to the inclusion of alternative measures of financial development.

Panel B of Table B.5 restricts the sample to positive cash flow firms and includes the legal system indicator variable (LAW) and its interaction with operating cash flow. The exclusion of firms with negative cash flow reduces the sample to 180,510 firm-year observations. LAW is equal to unity for firms in countries with an English common law origin and zero for firms in countries with a French, German, or Scandinavian civil law origin. La Porta et al. (1998) and subsequent studies (e.g., Kusnadi and Wei, 2011) document that common law countries offer stronger legal protection to investors than countries with other legal traditions and that this difference explains the development of domestic capital markets and influences firms' cash

management policies. Therefore, the purpose of this robustness test is to rule out the possibility that the main findings are purely driven (i) by loss-making firms or (ii) by differences in legal systems[41].

Consistent with the existing literature, the coefficients for the interaction $\text{CashFlow} * \text{LAW}$ are negative and statistically significant for the total sample (unreported). This result suggests that CCFS is negatively associated with a common law environment. However, the interaction coefficients become positive and significant if the sample is restricted to strictly positive cash flow firms. The coefficients range from 0.044 to 0.055 and are significant at the 1% and 5% levels. More important, the regression estimates for the interactions with the financial development indices ($\text{CashFlow} * \text{SMKT}, \text{CashFlow} * \text{FINT}, \text{CashFlow} * \text{FD}$) do not differ significantly from those in the baseline analysis. The interaction coefficients continue to be largely insignificant at the conventional levels. These results indicate that financial development is not systematically related to corporate saving, even after operating performance (a positive cash flow environment) and legal traditions are controlled for.

Panel C of Table B.5 includes the level of accounts payable and its interaction with internal cash flow to control for the trade credit effect. The coefficients for the interaction $\text{CashFlow} * \text{APAY}$ are positive and statistically significant at the 1% level in all models, which suggests that cash flow sensitivity is greater for firms with a higher level of accounts payable. In other words,

[41] In unreported results, the study also controls for differences in investor protection rights. For this purpose, the model specifications include International Country Risk Guide's (ICRG) investment profile index and capital market governance index (Bhattacharya and Daouk, 2002, Charoenrook and Daouk, 2005), as well as their respective interactions with cash flow. ICRG's investment profile index assesses factors affecting the risk to investment and includes three subcomponents: country expropriation, profits repatriation, and payment delays. The capital market governance index captures the degree of earnings opacity, the enforcement of insider laws, and the effect of removing short-selling restrictions. The baseline estimation results reported in Table B.3 largely remain unchanged after the inclusion of the indices, i.e., the interactions between internal cash flow and the financial development indices (β_2) are not significant at the conventional levels. Moreover, the interaction terms between the two corporate governance indices and internal cash flow are also largely insignificant. This result rules out the possibility that strong investor protection rights or a strong shareholder protection environment may significantly decrease cash flow sensitivity.

firms may prefer to hold more cash if they need to cover their short-term trade obligations. The main results with respect to the effect of financial development on cash-cash flow sensitivity remain robust to the inclusion of the trade credit effect. That is, CCFS (CashFlow) decreases as the level of financial development increases only if the effect from negative cash flow or the nonlinearity of CCFS is ignored. In particular, the estimated coefficient for the interaction CashFlow $*$ SMKT is -0.005 (t = -0.95) in model (1). The estimated coefficient for the interaction CashFlow $*$ FINT is -0.013 (t = -2.23) in model (4). Finally, the estimated coefficient for the interaction CashFlow $*$ FD is -0.005 (t = -1.88) in model (7). Consistent with the previous findings, financial development is weakly associated with the corporate propensity to save once the model specification includes CashFlow $*$ Neg or NonLinearity.

The estimation results with the one-period lagged cash-to-assets ratio and its interaction with cash flow are provided in Panel D of Table B.5. Cash-cash flow sensitivity remains strong and highly significant, with coefficients ranging from 0.148 (t = 17.79) to 0.328 (t = 19.31). The coefficients for the interaction CashFlow $*$ CashHold are strongly positive and significant across all models, which suggest that saving propensities are more pronounced for firms with a higher level of cash holdings in previous periods. Stated differently, firms' saving behavior is persistent over time. The estimated coefficients for the interaction between cash flow and the financial development indices (SMKT, FINT, and FD) become negative and highly significant in models (1), (4), and (7) but insignificant or marginally significant at the 5% or 10% levels in other models in which the interaction term CashFlow $*$ Neg and NonLinearity are included. The main results pertaining to the testable hypothesis remain unaltered after the cash holdings in the previous period are controlled for.

Finally, the study tests whether the main results are different for multinational firms in Panel E of Table B.5. The cash holdings of global firms are spread across many nations into which these firms invest. Given that global companies are more likely to be headquartered in developed countries, this could bias the results. Therefore, the sample is restricted to the firms with a share of foreign sales in total revenue over 10 percent. I find that the results are still purely affected by domestic firm-level factors. While the sensitivity of cash to cash flow is strongly positive and highly significant, the effect of financial integration continues to be economically and statistically weak. The empirical results regarding $\text{CashFlow} * \text{Neg}$ and NonLinearity are also consistent with the previously reported estimates.

3.4.3 Corporate demand for internal liquidity, financial development and financing constraints

This section explores an incremental impact of financing constraints on the relationship between financial market development and CCFS. Previous studies have used firm size and dividends as measures of financial frictions. According to Gilchrist and Himmelberg (1995), large firms are generally considered to have better access to external financing than small and young firms. For the purpose of this study, the sample firms are ranked according to their asset size (the natural log transformation of the book value of total assets) in each year. Firms with total assets below the 30^{th} percentile of the distribution for country j in year t are considered to be financially constrained. Prior research (Fazzari et al., 1998) also posits that financial frictions are more binding on non-dividend paying firms than on dividend paying firms. Consequently, non-

dividend paying firms are treated as being financially constrained and dividend paying firms are treated as being unconstrained in year t.

The baseline model in Eq.(6) is modified to incorporate the constraint indicator variable Constraint (financially constrained firms have a value of unity) and its interactions with both the internal cash flow (CashFlow) and negative cash flow (Neg) variables. To estimate Eq.(6) and to determine (i) whether CCFS is significantly different between financially constrained and unconstrained firms and (ii) whether financial development serves as efficient mechanism to mitigate the effect of financing constraints, the study uses the same GMM estimation approach as is used in the baseline analysis.

Table B.6 reports the regression results. While the estimated coefficients for CCFS (CashFlow) are strongly positive and significant at the 1% level, the estimates for negative cash flow ($\text{CashFlow} * \text{Neg}$) are negative and also highly significant. My proposition regarding the different strength of cash-to-cash flow responses in different cash flow environments still holds. The control variables have the expected sign and are statistically significant in most of the cases. For example, negative estimates for Size suggest that larger firms exhibit a lower CCFS.

Not surprisingly, the coefficients for the interaction $\text{CashFlow} * \text{Constraint}$ are significantly positive, indicating that, compared to unconstrained firms, constrained firms (small and non-dividend paying firms) are less likely to invest in current projects because they find it difficult to obtain external financing and thus need to hold more cash. The findings are consistent with the notion that constrained firms are more likely to save cash from current cash flows in order to fund future investments. The results generally support the suggestions of Almeida et al. (2004, 2011).

Facing negative profit shocks, financially constrained firms save money and must forgo good investment opportunities. Here, the interaction $\text{CashFlow} * \text{Constraint} * \text{Neg}$ is negative and significant at the 1% and 5% levels with both measures of financing constraints, suggesting that financially constrained firms are likely to spend less cash reserves in order to fund existing projects when they face negative cash flows.

The prediction of the main hypothesis states that the relationship between CCFS and financial development should be insignificant across all models. As expected, the regression coefficients for the interaction between cash flow and the three financial development indices continue to be not statistically different from zero, except for the estimate (0.008, t = 1.75) in model (1). This result supports the testable hypothesis. Therefore, the findings further indicate that the weak relationship between corporate demand for internal liquidity and financial development is robust and cannot be attributed to differences in firm size or dividend payout policies.

Overall, the empirical evidence provided in Table B.6 is consistent with the view that financial development does not serve as an efficient mechanism to mitigate the effect of financing constraints on corporate saving.

3.4.4 Corporate demand for internal liquidity and business cycles

This section further addresses the issue of unbalanced data or different observations across countries. U.S., Japanese, and U.K. firms jointly represent a dominant portion of the total sample, and the main results may be driven by a few highly developed markets. However, the inclusion of these economies also makes the analysis more compelling since finding a weak

association between financial development and CCFS would be more convincing if the results held for the most advanced economies with highly developed capital markets and financial institutions. To address potential criticism, however, the study applies a two-stage estimation approach in which cash-cash flow sensitivity for each country and year is by estimated using the baseline model specification in Eq.(6)[42]. The resulting sample excludes observations for which the number of firms for country j in year t is less than twenty. The remaining observations are winsorized at the 1% level. Then, CCFS estimates are regressed on the country-level index of financial development and median firm size in a country (Size). In the first stage, the model parameters are estimated by using the GMM with instrumental variables and analytical weights (similar to the baseline analysis), while in the second stage, the model parameters are estimated by using OLS with country and time fixed effects. The results are presented in Panel A of Table B.7.

Furthermore, the study examines the testable relationship between CCFS and financial development across business cycles. Changing economic conditions may affect firms' saving and liquidity management policy. For example, firms may prefer to save more cash during recession periods. Therefore, the results with respect to the effect of financial development on the cash flow sensitivity reported earlier could differ in different stages of the countries' economic cycles. To test this proposition, the analysis uses the annual real GDP growth rate (GDP_r) as a proxy for the economic cycle and uses changes in the inflation rate (Inflation), measured by the consumer price index, as a control variable. The analysis also includes the real interest rate (IntRate or lending interest rate adjusted for inflation) as another control variable. The inclusion of this variable reduces the sample size, however, since the World Bank data suffers from a lack of

[42] The model excludes the interaction term $\left(\mathrm{CF}_{\mathrm{i,t}}/\mathrm{TA}_{\mathrm{i,t}}\right) * \mathrm{FinDev}_{\mathrm{i,t}}$. The effect of financial development is estimated in the second stage.

observations for the real interest rate for some countries and years. The regression estimates with economic controls are provided in models (4) through (6) in Panel A of Table B.7.

The country-level regressions produce insignificant coefficients for each of the financial development indices that are used in this study. The Size variable remains negative and insignificant across all model specifications, suggesting that firm size has an inverse relation to CCFS. Overall, the country-by-country analysis yields results that are similar to the baseline results reported in previous sections.

The estimated coefficients for GDP_r, reflecting changes in the sensitivity of cash to cash flow during different economic cycles, are positive but insignificant. This result is consistent with the view that rising corporate saving is independent of the state of economy. The regression coefficients for Inflation are negative and statistically significant at the 5% and 10% levels, indicating that firms prefer to save less in periods of high inflation. The estimates for IntRate are positive but not statistically different from zero. Firms may exhibit a stronger propensity to save in periods of rising real interest rates, but this effect is found to be weak in this analysis. Importantly, the estimated coefficients for financial development indices remain completely insignificant after macroeconomic influences are controlled for.

For robustness purposes, the study modifies the two-stage estimation approach by measuring cash-cash flow sensitivity for each country only (without years) in the first stage. This approach yields 44 observations — equal to the number of individual countries in the sample. The results are reported in Panel B of Table B.7. The estimated coefficients for the financial development indices are now positive and insignificant at the conventional levels. The results further reinforce the previous findings that CCFS is not systematically related to a country's financial development. Finally, I can conclude that CCFS experiences much a stronger impact from firm-

level forces, such as the sign of internal cash flow or the level of cash holdings, and is relatively insensitive to country-level or macro drivers.

3.5. Conclusion

Traditional theory predicts that fragmented capital markets, weak financial institutions, and credit rationing in the form of costly or unavailable external financing impose severe constraints on firms. Financially constrained firms in return excessively rely on their cash flows, create demand for internal liquidity, and save more cash from current period cash flows to meet future investment needs (i.e., exhibit stronger cash flow sensitivity of cash). Prior research further posits that financial market advances should increase firms' access to lower cost external financing and thus alleviate financing frictions. In other words, CCFS should decrease with the level of financial development.

However, this line of thought ignores the asymmetry of cash-cash flow sensitivity; in other words, previous studies have failed to consider that firms operating in contrasting cash flow environments exhibit asymmetric cash-to-cash flow responses. Positive cash flow firms exhibit strong sensitivity of cash to cash flows, while negative cash flow firms exhibit significantly weaker sensitivity of cash to cash flows. In this study, I show that CCFS is largely independent of a country's financial development after the nonlinearity of CCFS is controlled for.

The weak statistical relationship between CCFS and the level of financial development is also economically justified. For positive cash flow firms, cash-cash flow sensitivity may reflect a multitude of saving motives along with information on financing frictions. Such factors include a global decline in the cost of capital, tax incentives, precautionary motives and the growing

uncertainty in cash flows, and the rising predominance of R&D investment. The severity of financing constraints is only one of the drivers that have a major impact on CCFS, and, therefore, the role of cross-country financial development in mitigating the effect of a strong propensity to save is insignificant. I argue that although financial integration helps firms to overcome financing obstacles, it does not actually moderate the strength of CCFS.

For negative cash flow firms, the importance of financial market advances is not so evident. Loss-making firms' access to equity and credit markets is limited or completely closed. The investor and lender community does not generally have a strong proclivity to provide capital to firms that have no operating cash flow. This further signifies that corporate saving propensities are not significantly driven by the level of financial development. Therefore, the testable hypothesis states that cash-cash flows sensitivity is not systematically related to a country's financial development.

Consistent with the prediction, the sensitivity of cash to cash flow is not significantly lower in countries with advanced and vibrant capital markets and established access to private credit. The main findings are robust to alternative measures of financial market development, difference in legal systems, sample composition, model specification, and changes in business cycles. The results also hold for both financially constrained and unconstrained firms.

Overall, the evidence presented in the study contradicts the conventional idea that financial development moderates firms' demand for internal liquidity. The role of financial development in mitigating the effect of rising saving actually tends to be insignificant. The findings are also consistent with the notion that CCFS reflects too many forces to be used as a measure of the severity of financing constraints only.

Chapter 4. Asymmetric and Systematic Cash Flow Sensitivity of Cash

Chapter summary:

The existing literature offers contrasting evidence regarding the corporate propensity to save cash from cash flows (referred to as the *cash flow sensitivity of cash* or CCFS). Using an alternative empirical model and a large sample of U.S. firms over the period from 1972 to 2010, this study reveals that CCFS is positively asymmetric to positive (stronger response) and negative (weaker response) cash flow environments. In addition, corporate saving is systematically related to cash flow among financially constrained (stronger response) and unconstrained (weaker response) firms. These results indicate that a multitude of factors, along with external financing constraints, drive the corporate propensity to save. The findings support the hypotheses that firms (i) operating in contrasting cash flow environments and (ii) having different levels of frictions systematically save cash from their cash flows.

Key words: Cash Flow Sensitivity of Cash, Corporate Savings, Financial Constraints

JEL Classification Number: G00

4.1. Introduction

Why do firms save? Prior literature has extensively studied this question, which is economically important in light of the tendency of U.S. firms to accumulate high levels of cash. There are several explanations for the corporate propensity to save, including precautionary motives, adverse cash flow shocks, and the high cost of external financing.

Almeida, Campello, and Weisbach (2004) have developed a model to show that external financial constraints are related to a firm's propensity to save cash from a marginal dollar of cash flow (referred to as the cash flow sensitivity of cash, or CCFS). Their findings support their argument; financially constrained firms should have a positive and consistent CCFS, while unconstrained firms should not display a systematic propensity to save cash. The positive linear relationship between changes in cash and internal cash flow indicates that firms increase (decrease) cash holdings when they face positive (negative) cash flows. Riddick and Whited (2009) use an alternative theoretical model and empirically show that changes in cash saving and cash flow are negatively correlated. They also conclude that although the sensitivity of cash to cash flow contains information about the cost and availability of external finance, too many forces influence the sensitivity of cash to cash flow for it to be used as an aggregate measure of financing frictions.

Both theoretical and empirical differences lead to the different results between the two abovementioned studies. The model of Almeida et al. does not control for changing capital productivity (i.e., an increase in cash flow is not accompanied by higher capital productivity and transformation from liquid assets to physical assets), liquid forms of fixed investments (i.e., all investment are assumed to be strictly illiquid), and a variety of depreciation rates (i.e., physical

assets completely depreciate between periods). The difference in the empirical findings is largely due to the correction for measurement error in Tobin's q, which is a control variable for investment opportunities in the model specification. The information about future investment opportunities contained in internal cash flow leads to a positive correlation between Tobin's q and cash flow. Using measurement error-consistent GMM estimators (Erickson and Whited, 2000, 2002), they find a negative CCFS. Their empirical methodology is questioned by Almeida, Campello, and Galvao (2010), however[43]. Ultimately, whether cash-cash flow sensitivity is positive or negative is an empirical matter[44].

The proposed study has two major objectives. First, the study investigates whether firms exhibit symmetric (linear) or asymmetric (nonlinear) cash sensitivity when they face positive or negative cash flows. The symmetric relationship between changes in cash holdings and internal cash flow implicitly assumes that the magnitude and sign of the change in cash holdings is largely the same regardless of the direction of cash flow. None of the earliest studies explores the potential asymmetry in the sensitivity of cash to cash flow; in other words, how the relationship varies with the sign of cash flow remains largely unaddressed[45]. More recent research reports strictly negative (Riddick and Whited, 2009) or negatively asymmetric CCFS (Bao, Chan and Zhang, 2012). The negative relationship found by Riddick and Whited suggests that when a firm's cash flow is positive, the change in cash holdings is negative. This negative propensity to

[43] Almeida, Campello, and Galvao (2010) show that estimators that use higher-order moments (Erickson and Whited, 2000, 2002) return biased coefficients for both mismeasured and perfectly measured regressors. These estimators are also very inefficient. They further argue that instrumental-variable-type estimators are more robust and efficient.

[44] Almeida, Campello, and Weisbach (2011) reexamine their original model and theoretically show that CCFS can be both positive and negative. Under the new setting, fixed investments are not completely illiquid and holding cash is not the only way to transfer resources over time. In the presence of an alternative liquid investment that reduces future external financing costs, a constrained firm may respond to a positive cash flow shock by holding less cash. Therefore, cash-cash flow sensitivity is decreasing and becomes negative.

[45] Although Almeida et al. (2004) examine firms with positive free cash flow as a robustness check, they do not study the symmetric (asymmetric) nature of the relation.

save occurs because a positive productivity shock causes both cash flow and the marginal product of capital to increase. A substitution effect then induces firms to use some of their cash reserve to buy physical assets that have become more productive, that is, to dissave and invest. In contrast, a negative cash flow for a firm indicates the low productivity of the firm's existing physical assets. Thus, a firm accumulates cash holdings given that they terminate less profitable projects. Bao et al. (2012) empirically follow the suggestion of Riddick and Whited and propose that CCFS is negatively asymmetric: a firm's cash flow sensitivity is negative when a firm faces a positive cash flow environment but positive when a firm has negative cash flow[46].

The findings of our study strongly support the asymmetric or nonlinear nature of cash-cash flow sensitivity. However, we reject the negative asymmetry and suggest that CCFS remains positive when a firm faces both favorable (positive) and adverse (negative) cash flow shocks. However, it is also documented that negative cash flow conditions generally distort the strength of the cash flow-based sensitivities (Allayannis and Mozumdar, 2004, and Brown and Petersen, 2009). Based on the prior findings, we can argue that firms' cash-to-cash flow response is not static in changing cash flow environment; that is, CCFS is significantly stronger for positive cash flow firms compared to negative cash flow firms. Thus, CCFS is positively asymmetric.

When a firm faces positive cash flow, the cash-to-cash flow response is intuitive (residual cash flow is a source of cash); in contrast, when a firm faces negative cash flow, cash-to-cash flow responses may differ. According to the argument of Riddick and Whited, negative cash flow for a firm indicates the low productivity or negative net present value (NPV) of the firm's existing physical assets and projects. Thus, the firm will terminate unprofitable projects and accumulate cash holdings. This results in a negative CCFS in a negative cash flow environment.

[46] They also find that CCFS asymmetry continues to hold in both financially constrained and unconstrained firms.

According to Bao et al., a firm cannot immediately terminate all its negative NPV projects when it faces negative cash flow for several possible reasons, including binding project contracts, bad news withholding, and agency costs. The inability to terminate negative NPV projects is reflected in a positive CCFS for negative cash flow firms. Our results also show that the positive cash-to-cash flow response (i.e., a decrease in cash holdings in response to negative cash flow) is more plausible. Unproductive physical assets are largely illiquid and cannot be converted into liquid assets immediately; put differently, a persistent negative response of cash to negative cash flow is unlikely[47].

We further argue there are two counter-balancing (competing) mechanisms that drive corporate demand for internal liquidity (savings) in a negative cash flow environment. First, firms with negative cash flow have limited financing options and dissave to cover working capital, capital expenditures, and debt service requirements. This translates into a positive CCFS. Second, such firms have a stronger propensity to save and to preserve future liquidity and therefore find ways to reduce cash outgoings, to scale down investment budgets, and to optimize financing policy. This cash saving incentive should be reflected in a generally smaller decline in cash holdings in response to negative cash flow shock. Combining two mechanisms, we should observe a significantly weaker cash-to-cash flow response in negative cash flow environment[48]. The negative (residual) cash flow is no longer source of cash, but has a first-order effect on cash holding. In contrast, an increase in cash holdings is stronger when a firm faces positive cash flow as residual cash flows eventually transform into balance sheet liquidity. To summarize, positive

[47] External borrowing can potentially drive a negative CCFS (i.e., a marginal dollar of debt translates into a marginal dollar of cash holdings in a negative cash flow environment). However, the access to external financing may be limited or completely closed, as banks and other capital providers are generally reluctant to finance loss-making firms on a permanent basis.

[48] This argument is further supported by the documented distortionary effect of negative cash flow. Allayannis and Mozumdar (2004), Bhagat, Moyen, and Suh (2005), and Brown and Petersen (2009) examine the effect of negative cash flow on traditional investment-cash flow sensitivity (Fazzari, Hubbard, and Petersen, 1988).

(negative) operating cash flow mechanically translates into an increase (decline) in current period cash holdings after cash outgoings are controlled for. This reflects the positive nature of the sensitivity of cash to cash flow. Cash-cash flow sensitivity becomes significantly weaker — but usually remains positive — when a firm has negative cash flow. Thus, a positive asymmetry dominates CCFS, which contradicts the evidence provided by Riddick and Whited (2009) and Bao et al. (2012)[49].

The second objective of our study is as follows. After affirming the positive and asymmetric nature of CCFS, we reexamine whether there is a systematic relationship between CCFS and different levels of financial constraints. In contrast to Almeida et al. (2004, 2011), this study suggests that corporate saving is systematically related to cash flow because of not only the high cost or availability of external finance but a multitude of alternative reasons (factors). We therefore argue that financially unconstrained firms (i.e., firms with established access to external financing) persistently save cash from internal cash flow and exhibit systematically positive and significant CCFS.

U.S. firms save cash for multiple reasons. There are a variety of the documented motives along with the severity of financing constraints that drive the corporate propensity to save. First, Karabarbounis and Neiman (2012) find that the rising corporate saving in the U.S. over the last four decades is attributed to a decrease in the cost of borrowing and the shift in capital-goods production toward lower-wage developing countries that began in the early 1980s. In turn, firms have responded by substituting away from labor and toward capital, and to finance this investment, firms have steadily increased corporate saving over time. Second, a growing number

[49] According to their proposition of the negative CCFS, (i) profitable U.S. firms with positive cash flow do not systematically save cash from internal sources, and (ii) such firms persistently dissave cash holdings in response to a favorable cash flow position. This proposition contradicts U.S. firms' rising propensity to save (cash holdings) over the last two decades, however (Armenter and Hnatkovska, 2011).

of studies show that cash flow uncertainty (e.g., the variability and autocorrelation of income or cash flow shocks) is a primary driver of corporate cash management policy. Therefore, U.S. firms may persistently accumulate liquid assets for precautionary reasons (Han and Qiu, 2007, Bates, Kahle and Stulz, 2009, Riddick and Whited, 2009, and Armenter and Hnatkovska, 2011). Third, the increase in U.S. firms' internal liquid assets is closely related to the decline in working capital, which is a substitute for cash holdings, and the persistent rise in R&D intensity (Bates, Kahle and Stulz, 2009, and Pinkowitz, Stulz and Williamson, 2012). Finally, firms with a higher share of foreign income that is subject to repatriation tax costs may hold significantly more cash (Foley, Hartzell, Titman and Twite, 2007). The later study also shows that less financially constrained firms and more technology-intensive firms exhibit a higher sensitivity of affiliate cash holdings to repatriation tax burdens. In summary, a multitude of non-constraint drivers has the documented first-order effect on *the levels* of cash. We further expect that the same non-constraint factors may significantly drive *the sensitivity* of cash to cash flow.

Because of the global decline in the cost of capital, the structural shift from labor to investment, corporate tax incentives, the growing uncertainty in internal cash flows, and the rising predominance of R&D, U.S. firms may exhibit a consistently positive CCFS. Firms with different levels of financial constraints, from completely unconstrained to severely constrained, may persistently save cash from internal cash flow. The influence of these alternative forces does not completely eliminate the importance of the cost and availability of external finance, however. CCFS is not independent from the level of firm-level financial constraints. The response of changes in cash to internal cash flow should still can be significantly higher for the firms classified as financially constrained than for those classified as unconstrained, suggestive of a link between financing frictions and CCFS.

Using a large sample of U.S. manufacturing firms for the period from 1972 to 2010, the study formally tests our hypotheses. We examine the possibility of asymmetry in the response of changes in cash holdings between positive and negative cash flows. The findings suggest that CCFS remains positive when a firm faces both positive (significantly stronger response) and negative (weaker response) cash flow environments. Thus, the study rejects the previously documented negative asymmetry of CCFS and instead finds a positive asymmetry of CCFS with different levels of cash-to-cash flow responses. This finding is the first major contribution of the study. Next, we investigate the relationship between changes in cash holdings and cash flow for both financially constrained and unconstrained firms. Four criteria are used to classify each firm: size, payout ratio, the Whited-Wu index, and bond rating. In line with previous research (e.g., Fazzari et al., 1988, Gilchrist and Himmelberg, 1996, Almeida et al., 2004, Bao et al., 2012), we assume that (i) small firms, (ii) firms with no dividend payouts, (iii) firms with low or no bond ratings, and (iv) firms with high values of the Whited-Wu index are most likely to face binding financial constraints. Conversely, larger firms and those with dividend payouts and high ratings are much less likely to face credit rationing. The empirical evidence is consistent with our predictions: both constrained and unconstrained firms display a systematic propensity to save cash from cash flow. Financially constrained firms, compared to unconstrained firms, exhibit much a stronger cash-cash flow sensitivity because they find it difficult to obtain external financing. Nevertheless, unconstrained firms also demonstrate a positive and significant sensitivity of cash to cash flow. Thus, endogenous CCFS is not a perfect measure of financial constraints (due to "noise" from other significant cash saving incentives), but still can be used to capture relative financial frictions. This result is the second major contribution of the study to the

existing literature. Finally, the study offers several arguments as possible explanations for the positive asymmetry and systematic nature of CCFS.

We use a comprehensive empirical model that replaces Tobin's q with an alternative proxy for the firm's investment opportunity set. According to Riddick and Whited (2009), measurement error in Tobin's q can affect the cash flow coefficient because measurement error in one regressor affects all of the coefficients in a regression if the regressors are correlated. To address the issue, following the approach of Almeida et al. (2004), the baseline model replaces Tobin's q with the actual ratio of future investment to current investment[50]. To deal with possible violations of the exogeneity of this measure, our analysis applies the GMM methodology with a valid number of relevant instrumental variables. This approach is largely consistent with that of Almeida et al. (2010), who show that under certain conditions, the estimator of Erickson and Whited (2000, 2002) returns biased and inefficient coefficients for both mismeasured and perfectly measured regressors. In contrast, instrumental-variable-type (IV) estimators remain fairly unbiased under those same conditions and are more efficient. Therefore, fixed effects OLS and IV-GMM are used in the empirical part of our study.

This empirical work is related not only to Almeida et al. (2004, 2010, 2011), Riddick and Whited (2009), and Bao et al. (2012) but also to Khurana, Martin, and Pereira (2006), who examine the influence of financial development on the demand for internal liquidity; Acharya, Almeida, and Campello (2007), who analyze the relationship between firm debt and cash holdings in environments with different levels of financial constraints; and Sufi (2009), who uses

[50] Almeida et al. suggest that this measure is a valid substitute for traditional Tobin' Q, which contains useful information about a firm's growth options, but also information about current investment opportunities. Compared to other potentially noisy proxies (market-to-book equity, price-to-earnings), *LeadInv* is arguably a better measure for the firm's unobservable investment opportunity set, because it includes *actual* future period investments (information about *actual* investment decisions).

CCFS as a measure of financial constraints to investigate the role of bank lines of credit in corporate finance. The study is further related to empirical work on the level (instead of the flow) of corporate cash holdings, surveyed in Faulkender and Wang (2006), Han and Qiu (2007), Foley at al. (2007), Bates et al. (2009), Denis and Sibilkov (2010), and Pinkowitz et al. (2012).

The remainder of the paper proceeds as follows. Section 4.2 lists the hypotheses that are tested in the study. A brief overview of the methodology and data is provided in section 4.3. Section 4.4 presents the empirical tests, and section 4.5 concludes.

4.2. Hypotheses development

Our paper reexamines the previously reported negative and asymmetric CCFS (Riddick and Whited, 2009 and Bao et al., 2012). Because of the need (i) to meet current period cash outgoings and (ii) to preserve future liquidity, the magnitude of cash holding responses to negative cash flows differs from that to positive cash flows. When a firm faces positive cash flow, it saves residual cash after covering its dividend payments, working capital, investment, and debt service costs. This expectedly leads to a positive CCFS, which is consistent with the large cash stockpiles of U.S. firms. When a firm faces negative cash flow, the firm would not save the same amount of cash by terminating all its negative NPV projects or physical assets, as suggested by Riddick and Whited. Illiquidity and deep discount are among the reasons for such differences. Instead, a firm tends to draw down cash holdings to meet current obligations and aims to preserve future liquidity by reducing working capital needs, investment budgets, and debt refinancing. In other words, cash outgoings are partially balanced by tighter working capital standards, cost cuts, and savings discipline. This results in a relatively small decline in cash

reserves in response to negative operating cash flow — or weaker cash-cash flow sensitivity. In our view, CCFS should remain positive in both positive and negative cash flow environments but exhibit significantly different responses depending on the environment. The first and second hypotheses are therefore as follows:

Hypothesis 1 (H1): CCFS is consistently positive when a firm faces positive or negative cash flow.

Hypothesis 2 (H2): CCFS is asymmetric: significantly stronger (weaker) when a firm faces positive (negative) cash flow.

Next, our study extends the existing evidence presented by Almeida et al. (2004, 2011) and shows that a multitude of cash saving motives have a first-order effect on CCFS. Not surprisingly, these saving motives mitigate the role of external financial constraints. The declining cost of borrowing, decades of substitution from labor and toward capital input of production, corporate tax costs, increased uncertainty in income, and the rising importance of R&D have an equally strong impact on the cash management policies of both financially constrained and unconstrained firms. Though the importance of the cost and availability of external finance remains relatively high, it arguably declines over time owing to the rise in competing forces. Hence, the third and fourth hypotheses are as follows:

Hypothesis 3 (H3): CCFS stays systematically positive among financially constrained and unconstrained firms.

Hypothesis 4 (H4): CCFS is stronger when a firm faces financial constraints.

To summarize, the first two hypotheses explore the positive asymmetry of the sensitivity of cash to cash flow, while the last two hypotheses explore its systematic nature.

4.3. Methodology and sample construction

4.3.1 Baseline model of the cash flow sensitivity of cash

To test the hypotheses developed in section 4.2, the study uses the following empirical model:

$$\left(\frac{\Delta \text{Cash}_{i,t}}{\text{TA}_{i,t}}\right) = \alpha_i + \alpha_j + \alpha_t + \beta_1 \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}}\right) + \beta_2 \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}} * \text{Neg}_{i,t}\right) + \beta_3 \text{Neg}_{i,t} + \beta_4 \text{LeadInv}_{i,t} + \beta_5 \text{Controls}_{i,t} + \varepsilon_{i,t}, \quad (8.1)$$

where $(\Delta \text{Cash}_{i,t}/\text{TA}_{i,t})$ or ΔCashHold represents the change in cash and cash equivalents scaled by total assets. $(\text{CF}_{i,t}/\text{TA}_{i,t})$ or CashFlow is internal cash flow calculated as net income before extraordinary items plus depreciation and amortization minus dividends paid scaled by total assets. The proposed model specification replaces the traditional Tobin's q with the actual ratio of future investments to current investments, LeadInv, as a measure of the firm's investment opportunities[51]. Future investment opportunities could affect a firm's incentive to hold cash. Alti (2003) suggests that Tobin's q contains useful information about a firm's growth options and future investment opportunities. There are several significant problems with this measure, however. Almeida et al. (2004) suggest that Tobin's q also contains information about current investment opportunities and therefore is a relatively noisy measure. As mentioned by Khurana et al. (2006), another problem with using the traditional Tobin's q is that it may reflect not only the presence of actual investment opportunities but also the market's perception of a firm's ability to exploit its investment options. According to Riddick and Whited (2009), measurement error in Tobin's q can affect the cash flow coefficient because measurement error in one regressor affects all of the coefficients in a regression if the regressors are correlated. Therefore,

[51] For a given firm in year t, the ratio $\text{LeadInv}_{i,t}$ is computed as $(\text{CapEx}_{i,t+1} + \text{CapEx}_{i,t+2}) / (2 * \text{CapEx}_{i,t})$, where $\text{CapEx}_{i,t}$ is the current period (physical) capital expenditures. The reported results are also robust to the use of a one-period forward horizon to measure future investment.

an advantage of using realized investments is that (i) it distinguishes between current and future investment opportunities, (ii) it sidesteps the issue of distinguishing between the market evaluation of investment opportunities and a firm's ability to take advantage of these investment opportunities, and (iii) it does not require the use of correction techniques (Erickson and Whited, 2000, 2002) for the measurement error.

To deal with possible violations of the exogeneity of LeadInv, the baseline model is estimated with the GMM by using appropriate lags of CapEx as instrumental variables. This methodology is consistent with that of Almeida et al. (2010), who show that in the presence of individual fixed effects, under heteroskedasticity, or in the absence of a high degree of skewness in the data, the estimator of Erickson and Whited (2000, 2002) returns biased and inefficient coefficients for both mismeasured and perfectly measured regressors. In contrast, Almeida et al. argue that instrumental-variable-type (IV) estimators remain fairly unbiased under those same conditions and that they are more efficient. In this study, Hansen's J-test of overidentifying restrictions specifies the appropriate number of instruments. IV-GMM estimations are reported in addition to the ordinary least squares (OLS) in all the empirical tests. Heteroskedasticity-consistent standard errors are clustered at the firm level and are reported for both OLS (t-statistics) and IV-GMM (z-statistics) estimates.

The model specification also controls for firm (α_i), industry (α_j), and year (α_t) fixed effects since these factors have been known to affect firms' cash holdings. The choice of firm-level controls is motivated by prior research[52] and accounts for a firm's financial characteristics that may influence its liquidity policy and cash holdings. In particular, Controls include firm size (Size, natural log of total assets) to mitigate economies of scale in cash savings, capital

[52] We use the augmented model specification of Almeida et al. (2004).

expenditures scaled by total assets (CapEx), acquisitions (Acquisition)[53], changes in noncash net working capital (ΔNWC)[54], and changes in the ratio of short-term debt to total assets (ΔShortDebt). Working capital needs, investment, and acquisition activity reduce a firm's cash holdings (negative sign is expected), while a positive change in short-term debt works as a substitute for cash (positive sign is expected). Neg is an indicator variable that is equal to unity if cash flow is negative and zero otherwise. The model specification also includes an interaction term ($\text{CashFlow} * \text{Neg}$) to determine how cash flow sensitivity varies with the sign of cash flow. Therefore, the interaction term also tests the potential asymmetry or nonlinearity in the measure of CCFS[55].

In a more formal econometric analysis, we employ a sign bias test, negative size bias test and positive size bias test to check the model misspecification of the CCFS regression (Engle and Ng, 1993, Bartram, 2004). A sign bias test (along with negative size bias test and positive size bias test) is one of more general tests that are usually performed to test nonlinearity without specifying the functional form of the relationship. This is a diagnostic test of the regression residuals that can be used to check potential misspecifications of the linear regression model of CCFS in Eq.(8.1). The sign bias test employs the variable Z^- that takes a value of one when cash flow is negative or zero otherwise. It examines the impact of positive and negative cash flow shocks on changes in cash holdings $\left(\frac{\Delta \text{Cash}_{i,t}}{\text{TA}_{i,t}}\right)$ not predicted by the model. The negative size bias test considers the variable $Z^- \left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}}\right)$ and thus investigates differences in the effect of large and small negative cash flow movements on changes in cash holdings. Likewise, the positive size

[53] This variable is an indicator variable that equals one if a firm makes an acquisition in that year and zero otherwise.
[54] This variable is the ratio of non-cash working capital (working capital minus cash) to total assets.
[55] In unreported results, we also introduce a quadratic version of cash flow into the model specification. The measure also aims to control for the asymmetry of CCFS. Because the results are largely the same as the reported results, we prefer to use the interaction term with negative cash flow that explicitly determines how CCFS varies with the sign of cash flow.

bias test utilizes the variable $Z^{+}\left(\frac{CF_{i,t}}{TA_{i,t}}\right)$ where $Z^{+} = 1 - Z^{-}$. It focuses on the different impact on cash holdings that large and small positive cash flow changes have and that are not captured by the model. The distinction between negative and positive cash flow shocks allows for asymmetry in CCFS. As a result, the following model is estimated:

$$\left(\frac{\Delta Cash_{i,t}}{TA_{i,t}}\right) = \alpha_i + \alpha_j + \alpha_t + \beta_1\left(\frac{CF_{i,t}}{TA_{i,t}}\right) + \beta_2 LeadInv_{i,t} + \beta_3 Controls_{i,t} + \varepsilon_{i,t}, \quad (8.2)$$

$$\left(\frac{\varepsilon_{i,t}}{\sigma_{\varepsilon_{i,t}}}\right) = \delta_i + \delta_j + \delta_t + \theta_1 Z^{-}\theta_2 + Z^{-}\left(\frac{CF_{i,t}}{TA_{i,t}}\right) + \theta_3 Z^{+}\left(\frac{CF_{i,t}}{TA_{i,t}}\right) + \Psi_{i,t},$$

$$\text{with } Z^{-} = \begin{cases} 1 \text{ if } \dfrac{CF_{i,t}}{TA_{i,t}} < 0 \\ 0 \text{ otherwise} \end{cases}$$

$$\text{with } Z^{+} = 1 - Z^{-}$$

4.3.2 Financial constraints and the cash flow sensitivity of cash

To examine how CCFS varies between financially constrained and unconstrained firms, the study uses four measures to partition the sample.

(i) *Firm size*. The sample firms are ranked according to their asset size (the natural log transformation of the book value of total assets) in each year. Firms in the bottom quartile of the annual size distribution are considered to be financially constrained. According to Gilchrist and Himmelberg (1996), small firms are typically young and more vulnerable to capital market imperfections.

(ii) *Dividend payout ratio*. If a firm does not pay out a cash dividend in year t, the firm is classified as financially constrained. Financially constrained firms typically have significantly lower or no dividend payouts (Fazzari et al., 1998).

(iii) *Bond rating*. Firms that have never had their public debt rated and those with credit ratings below B- (Standard & Poor's long-term domestic firm credit rating) are categorized as financially constrained. This measure captures the market's assessment of a firm's credit quality (Kashyap, Lamont and Stein, 1994 and Gilchrist and Himmelberg, 1995).

(iv) *The WW index*. Whited and Wu (2006) develop an index to estimate the likelihood that a firm faces financial constraints. The WW index is constructed for sample firms in each year according to the following linearization:

$$\text{WW index}_{i,t} = -0.091\,\text{CF}_{i,t}/\text{TA}_{i,t} - 0.062\,\text{DIVPOS}_{i,t} + 0.021\text{TLTD}_{i,t} - 0.044\text{Size}_{i,t} + 0.102\,\text{ISG}_{i,t} - 0.035\text{SG}_{i,t}, \quad (9)$$

where $(\text{CF}_{i,t}/\text{TA}_{i,t})$ and Size are defined as before. DIVPOS is an indicator that takes the value of one if a firm pays cash dividends in year t. TLTD is the ratio of the long-term debt to total assets. ISG is the firm's three-digit industry sales growth, and SG is firm sales growth. Firms in the top quartile of the annual distribution are considered to be financially constrained firms. The firms are allowed to change their status over the sample period by ranking firms on an annual basis (Baker, Stein and Wurgler, 2003).

After the sample firms are partitioned into financially constrained and unconstrained firms, we use two estimation procedures: (i) the baseline model in Eq.(8.1) is applied to each subsample separately, i.e., to the subsample of financially constrained and to the subsample of unconstrained firms separately; and (ii) the baseline model in Eq.(8.1) is modified to include additional variables and then applied to the total sample. The modified model specification is as follows:

$$\left(\frac{\Delta \text{Cash}_{i,t}}{\text{TA}_{i,t}}\right) = \alpha_i + \alpha_j + \alpha_t + \beta_1\left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}}\right) + \beta_2\left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}} * \text{Neg}_{i,t}\right) + \beta_3\text{Neg}_{i,t} + \beta_4\text{Constraint}_{i,t} +$$

$$\beta_5[\left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}}\right) * \text{Constraint}_{i,t}] + \beta_6(\text{Neg}_{i,t} * \text{Constraint}_{i,t}) + \beta_7[\left(\frac{\text{CF}_{i,t}}{\text{TA}_{i,t}}\right) * \text{Constraint}_{i,t} * \text{Neg}_{i,t}] +$$

$$\beta_8\text{LeadInv}_{i,t} + \beta_9\text{Controls}_{i,t} + \varepsilon_{i,t}, \quad (10)$$

where the main and control variables are defined as before. Eq.(10) includes the constraint indicator variable Constraint (financially constrained firms have a value of unity) and its interactions with both the internal cash flow ($\text{CF}_{i,t}/\text{TA}_{i,t}$) and negative cash flow (Neg) indicator variables. To estimate Eq.(10) and to determine whether CCFS is significantly different between financially constrained and unconstrained firms, the study applies the same estimation methodology as is used for the baseline model in Eq.(8.1). The use of this estimation methodology further enables us to determine whether symmetric CCFS holds for firms with different levels of financial constraints.

In testing the asymmetry of the cash flow sensitivity, the model specification includes the Neg indicator variable and its interaction term with cash flow. We expect to find a positive β_1 and negative β_2 in Eq.(8.1) because the response to changes in cash holdings to cash flow should be noticeably lower for firms with negative cash flow. We also expect $(\beta_1 + \beta_2)$ to be positive, which indicates that CCFS is empirically positive even when a firm faces negative cash flow. Similarly, we expect β_1 and $(\beta_1 + \beta_2)$ to be positive and β_2 to be negative in Eq.(10). These results would indicate a strongly positive CCFS in a positive cash flow environment and generally lower CCFS in a negative cash flow environment; that is, there is asymmetrically positive sensitivity with different levels of the cash-to-cash flow response. The expected results should be consistent with H1 and H2.

Next, positive and statistically significantly β_1 in both Eq.(8.1) and Eq.(10) and across firms with different exposure to financial constraints should indicate the systematic nature of CCFS, which is consistent with H3. Finally, β_1 in Eq.(8.1) is expected to be significantly higher for the firms classified as financially constrained than for those classified as unconstrained; β_5 in Eq.(10) should also be positive and strongly significant because financially constrained firms have a greater propensity to save cash from cash flow. Such a result would support H4.

4.3.3 Sample construction

Following Riddick and Whited (2009), the sample includes U.S. non-financial firms with available data from Compustat for the period from 1972 to 2010. Firms with Standard Industrial Classification codes ranging from 4900 to 4999, from 6000 to 6999, or greater than 9000 are excluded from the sample. Observations with the main variables (ΔCashHold, CashFlow, and LeadInv) are trimmed at the 1% level. All other control variables are winsorized at the 1% level. The final sample includes 124,635 firm-year observations.

Panel A of Table C.1 reports the descriptive statistics for the main variables. The mean (median) change in cash holdings (ΔCashHold) is 0.012 (0.002), showing that there is a relatively small change in firms' cash holdings for the full sample. On average, cash holdings account for nearly 13% of firms' total assets. The mean CashFlow for the sample is 0.059, compared to the median of 0.075 (or 7.5% of total assets), indicating that CashFlow is left skewed. Firms with negative CashFlow represent about 15% of the total sample. The mean (median) LeadInv for the sample is 1.52 (1.16). The mean (median) firm size (Size) for the sample is 5.09 (4.87). Capital expenditure (CapEx) is right skewed, with a mean (median) of 0.071 (0.050). The mean (median)

short-term debt (ShortDebt) is 0.054 (0.022), while the annual change in short-term debt (ΔShortDebt) is very small, with a mean of 0.002 (or 0.2% of total assets). There is not much change in the firms' net noncash working capital (ΔNWC), with a mean (median) of 0.014 (0.010). Nearly 29% of the firms in the sample have conducted an acquisition.

Based on firm size, Panel B of Table C.1 compares the main variables for the firm-year observations between financially constrained and unconstrained firms. With the exception of the change in net noncash working capital, all other variables are significantly different between the two groups at the 1% level. Financially constrained (smaller) firms are less profitable firms with lower ΔCashHold and CashFlow. Such firms are more likely to face negative cash flow. Smaller firms also exhibit a higher LeadInv, indicating more growth and investment opportunities. As expected, constrained firms have lower capital expenditures and higher short-term debt. Compared to unconstrained firms, a smaller proportion of the constrained firms conduct acquisition activities.

Based on the four measures of financial constraints that are used in this study (firm size, dividend payout, the WW index, and bond rating), Panel C of Table C.1 shows the cash holdings of financially constrained versus unconstrained firms. The mean (median) of the cash holdings (CashHold) for financially constrained firms is about 0.162 (0.084) and is approximately the same for all four measures. For the unconstrained firms, the mean (median) of the cash holdings is about 0.105 (0.055). The over 50% difference in cash reserves is statistically significant between the two groups, suggesting that financially constrained firms hold more cash (i.e., have a stronger propensity to save) than unconstrained firms.

Table C.2 reports the Pearson and Spearman correlation coefficients between the main variables. The correlation between CashHold and ΔCashHold is 0.34, which is significant at the

1% level. ΔCashHold and CashFlow have a significant correlation of about 0.15. More important, LeadInv and CashFlow have very low correlations of 0.01 (the Pearson coefficient) and 0.13 (the Spearman coefficient). The low correlation between our measure of investment opportunities and internal cash flow mitigates the concern that there is strong bias in the estimated coefficient for CashFlow in the OLS regression. In addition, the actual ratio of future investment to current investment does not contain the measurement error inherent in the traditional Tobin's q. Next, the variables CashFlow and CapEx are positively correlated, indicating that firms with higher internal cash flow are more likely to invest in tangible assets. The negative relationship between ΔCashHold and ΔNWC indicates a substitution effect between the two variables. Other correlation coefficients are largely economically insignificant.

4.4. Empirical results

4.4.1 Positive and asymmetric cash flow sensitivity of cash

Panel A of Table C.3 reports the results of reduced (with fewer control variables) and augmented (with a full set of control variables) models in Eq.(8.1). The first two columns refer to the reduced model, while columns (3) and (4) refer to the augmented model.

The OLS and IV-GMM regressions exhibit a positive and highly significant coefficient for CashFlow (β_1). The OLS estimates are 0.26 and 0.34 in models (1) and (3), respectively. The IV-GMM estimates are 0.28 and 0.48 in models (2) and (4), respectively. The consistent results between the two estimation methods rule out the possibility that the results are driven by a possible violation of the exogeneity of LeadInv. Consistent with Almeida et al. (2004), the estimates of CashFlow are significantly higher in the augmented model specification. Therefore,

including all the control variables provides a stronger and more reliable test of the proposed hypotheses.

The interaction term $\mathrm{CashFlow} * \mathrm{Neg}$ (β_2) tests the degree of asymmetry of CCFS. The estimates of the interaction term in both the OLS and the IV-GMM regressions are negative and significant at the 1% level, suggesting that firms with negative cash flow experience a downward shift in cash reserves.

The sum of the coefficients for $\mathrm{CashFlow}$ and $\mathrm{CashFlow} * \mathrm{Neg}$ ($\beta_1 + \beta_2$) is consistently positive across all model specifications. In particular, the sum of the estimated coefficients ranges from 0.09 in model (2) to 0.18 in model (3), suggesting that CCFS is strong in a positive cash flow environment but significantly weaker in a negative cash flow environment. Put differently, CCFS is positively asymmetric and exhibits different levels of positive cash-to-cash flow responses. Other control variables show the expected signs and are significant at the 1% level. CapEx, $\mathrm{Acquisition}$, and $\Delta\mathrm{NWC}$ are negative, while $\Delta\mathrm{ShortDebt}$ is positive. The coefficients for $\mathrm{LeadInv}$ and Size are positive in the OLS regression but negative in the GMM regression. Given the endogeneity issue in OLS, higher priority is given to the GMM estimates.

Panel B of Table C.3 reports the results from an alternative sampling and estimation approach. The sample firms are partitioned into positive and negative cash flow firms. Then, the baseline model in Eq.(8.1) is estimated for the two subsamples separately. For both the OLS and the IV-GMM regressions, the coefficient for $\mathrm{CashFlow}$ is positive and significant at the 1% level. The estimated coefficients are significantly higher in models (1) and (2) compared to models (3) and (4), indicating that the sensitivity of cash to cash flow is stronger in a positive cash flow environment. The results support H1: CCFS is positive when a firm faces contrasting cash flows. However, the response between changes in cash holdings and cash flow significantly varies and

depends on the sign of cash flow. This result further supports H2: CCFS is stronger (weaker) when a firm faces positive (negative) cash flow.

Panel C of Table C.3 reports the estimation results from sign and size bias tests. Sign bias tests and size bias tests provide strong evidence in support of positive (asymmetric) nonlinear exposures. The sign bias is insignificant in column (4), suggesting that the linear regression model appears to be well specified. However, the positive and negative size biases are positive and significant. The clear distinction between negative and positive cash flow shocks strongly support the positive asymmetry in CCFS.

Finally, Figure C.1 plots the OLS and IV-GMM estimates of CashFlow in different cash flow conditions. The X axis contains the following categories: positive cash flows above their median value (+1), positive cash flows below their median value (+0.5), negative cash flows above their median value (-0.5), and negative cash flows below their median value (-1). The Y axis plots the estimated CCFS. Consistent with the results reported in Panel A and Panel B of Table C.3, CCFS is positively asymmetric; that is, the cash flow sensitivity is significantly stronger in a positive cash flow environment than in a negative cash flow environment. The reported OLS and IV-GMM coefficients are statistically significant at the 1% and 5% levels.

4.4.2 Systematic cash flow sensitivity of cash

Panel A of Table C.4 reports the empirical model of Eq.(10). The model specification incorporates the additional dummy Constraint (financially constrained firm has a value of one) and its interaction with both the CashFlow and CashFlow $*$ Neg variables. Four measures of financial constraints, namely, firm size, dividend payout ratio, bond rating, and the WW index,

are used to specify the Constraint variable. To compare the cash flow sensitivity between financially constrained and unconstrained firms, the study examines the coefficients associated with the interaction variables of $\text{CashFlow} * \text{Constraint}$ (β_5) and $\text{CashFlow} * \text{Constraint} * \text{Neg}$ (β_7). The first interaction term captures the marginal effect of financial frictions on CCFS. The second interaction term shows the cash holding response of constrained firms with positive and negative cash flow.

The positive and asymmetric CCFS documented in Table C.3 continues to hold for both financially constrained and unconstrained firms. The variable CashFlow (β_1) and the sum of the coefficients for CashFlow and $\text{CashFlow} * \text{Neg}$ or ($\beta_1 + \beta_2$) are consistently positive and significant at the 1% level across the OLS and IV-GMM estimations. The variable $\text{CashFlow} * \text{Neg}$ (β_2) is negative and significant at the 1% level. The findings suggest that both constrained and unconstrained firms have a systematic propensity to save cash, which is consistent with H3.

For all the constraint measures, the coefficient for $\text{CashFlow} * \text{Constraint}$ is consistently positive, indicating that, compared to unconstrained firms, constrained firms find it difficult to obtain external financing and thus need to hold more cash. In particular, the OLS estimates range from 0.09 to 0.16, while the IV-GMM estimates range from 0.05 to nearly 0.11. The estimated regressors are significant at the 1% or 5% levels. The results support H4.

The estimated coefficients for the interaction $\text{CashFlow} * \text{Constraint} * \text{Neg}$ are mixed and not conclusive. Arguably such results are obtained is because a negative cash flow environment strongly correlates with the conventional measures for financial constraints that are used in this study. The variance inflation factor test further indicates that multicollinearity between the Constraint and Neg variables is an issue in our analysis. Therefore, splitting the sample between

financially constrained and unconstrained firms is required to properly estimate the CCFS of constrained firms with negative cash flow.

Panel B of Table C.4 reports the results of the baseline model in Eq.(8.1) for the two groups of firms with different exposure to capital constraints. The coefficients for CashFlow are positive and statistically significant at the 1% level in all the regressions. For example, the estimated regressors range from 0.19 (model 13) to 0.65 (model 8). The findings further support H3.

As expected, the group of financially constrained firms (small or non-dividend paying firms or firms with low or no rating and a high WW index) also exhibit a much stronger propensity to save, with average OLS and IV-GMM estimates of 0.42 and 0.56, respectively. In contrast, the respective estimates for the group of unconstrained firms are, on average, 0.27 and 0.32. The difference in cash flow coefficients between the two groups is statistically significant. The results support H4.

The estimated coefficient for CashFlow $*$ Neg is negative and significant at the 1% level in all individual subsamples. The sum of the coefficients for CashFlow and CashFlow $*$ Neg is positive across model specifications, indicating that CCFS remains positively asymmetric to different levels of financial constraints. The results are consistent with those reported in Table C.3. Interestingly, the estimates of CashFlow $*$ Neg are generally lower for the firms that face external financial frictions. Facing adverse profit shocks, such firms are likely to spend less cash owing to their limited or lack of access to external financing and excessive reliance on internal resources.

The overall finding of positive asymmetry in the cash flow sensitivity contradicts the results of Riddick and Whited (2009) and Bao et al. (2012). Using methodology that is free of measurement error and economic intuition that is more plausible, our study demonstrates that CCFS is *asymmetric* in positive (stronger response) and negative (weaker response) cash flow

conditions. The finding regarding the relationship between CCFS and the level of capital market frictions echoes the results of Almeida et al. (2004). The results presented in Table C.4 are generally consistent with Almeida et al.'s results. However, our analysis extends their findings by showing the systematic nature of CCFS: unconstrained firms' cash saving is *systematically* related to their operating cash flow. Strong alternative saving motives, other than external financing frictions, explain financially flexible firms' propensity to save.

4.4.3 Robustness tests

We perform a number of additional tests to examine the robustness of the asymmetric and systematic propensity to save. The prior literature motivates our selection of robustness checks. To save space, we report only the estimated coefficients for cash flow ($\mathrm{CashFlow}$), negative cash flow ($\mathrm{CashFlow} * \mathrm{Neg}$), and the interaction term with the proxies for financial constraints ($\mathrm{CashFlow} * \mathrm{Constraint}$).

In the first robustness check, we add the lagged level of firm cash holdings, as well as its interaction with the cash flow variable, to the augmented model in Eq.(10). We report the results of this model estimation in the first row of Table C.5. The unreported coefficients for lagged cash are significantly negative, indicating that higher lagged cash reduces the level of additional savings, and the coefficients for the interaction terms are positive and significant in all estimations performed. This result further indicates that saving propensity is more pronounced for firms with a higher level of cash holdings in previous periods; that is, firms' saving is persistent over time. More important, the estimates for CCFS are not significantly affected by the inclusion of the proposed controls. The positive asymmetry continues to hold in all estimations,

except in models (6), (7), and (8), where the sum of the coefficients for CashFlow and CashFlow $*$ Neg is marginally negative. This result is obtained because the inclusion of the new interaction term with the cash holdings in the previous period (L. CashHold) allows the level of saving from cash flows to vary with the level of cash reserves. Not surprisingly, the sum of unreported coefficients (CashFlow + CashFlow $*$ Neg + CashFlow $*$ L. CashHold) is strongly positive across all models. Financially constrained firms also continue to demonstrate a significantly higher CCFS (positive and significant CashFlow $*$ Constraint), which is consistent with the results reported in Table C.4.

The second robustness test estimates cash-cash flow sensitivity in a sample of firm-year observations for which internal cash flows are strictly larger than the minimum required investment spending (i.e., firm-years with positive free cash flow). We use the ratio of depreciation over assets as a proxy for required or nondiscretionary investment spending and define free cash flow as the difference between cash flow and depreciation. The results are presented in the second row of Table C.5. After eliminating those 32,767 observations for which internal cash flows are not sufficient to cover required investment outlays, we still find that cash-cash flow sensitivity is systematic in nature. Both CashFlow and CashFlow $*$ Constraint are consistently positive and significant at the 1% level across all models, except when we use the WW index in the GMM estimation (model 8). Not only constrained firms but also unconstrained firms have significant CCFS.

In the third row of Table C.5, we restrict our sample to manufacturing firms only (SICs 2000 to 3999) and reestimate the augmented model in Eq.(10). Our results are unaffected by this sampling restriction. CashFlow and CashFlow + CashFlow $*$ Neg are consistently positive in all regressions, suggesting that the asymmetric nature of CCFS is insensitive to industry selection.

$\text{CashFlow} * \text{Constraint}$ continues to be positive and largely significant, indicating that financially constrained firms exhibit a stronger saving propensity.

In the final row of Table C.5, we select only large dividend-paying firms with a high credit rating and a low WW index value. In other words, we use all four measures of financial constraints simultaneously to identify firms with the lowest possible exposure to external financing constraints. We then reestimate the model in Eq.(10) for the sample of 21,121 firm-year observations. According to Almeida et al., cash-cash flow sensitivity should be indeterminate for such financially flexible firms. However, our results continue to show a positive and statistically significant relationship in both the OLS and the GMM estimations (0.176 and 0.118, respectively). Additionally, the positive asymmetry of CCFS continues to hold.

As reported in Table C.4 and Table C.5, our empirical finding is different from that of Almeida et al. (2004). While they argue that only constrained firms exhibit positive and significant CCFS, we find that both constrained and unconstrained firms' cash saving are systematically related to their operating cash flow; however, we acknowledge that the cash-cash flow relationship is statistically and economically stronger for constrained firms. In order to examine the difference between our results and those of Almeida et al., we closely follow Almeida et al.'s sampling and estimation approach. In particular, we consider the sample of manufacturing firms (SICs 2000 to 3999) over the period from 1972 to 2000 with data available from Compustat North America. We further eliminate observations for which cash holdings exceed the value of total assets, those for which market capitalization is less than $50 million (in nominal dollars), and those displaying asset or sales growth exceeding 100%. Our final sample consists of 28,613 firm-year observations, which is nearly 5% different from Almeida et al.'s

sample size (p.1786). Next, we closely follow Almeida et al.'s model specifications[56] and estimation approach with the proposed instrumental variables (p.1787-1789). Our main conclusion continues to hold; that is, CashFlow is significantly positive among financially constrained (stronger response) and unconstrained (weaker response) firms. However, the economic significance of the estimated coefficients is 10% to 40% lower compared to what we report in Table C.4. The cash-to-cash flow sensitivity is arguably weaker in the earlier parts of the sample period.

In summary, we conclude that our finding of significant CCFS for unconstrained firms is robust and driven by several factors: (i) our larger sample size (39 years with more industries included), (ii) our augmented model specification (which includes a negative cash flow variable), and (iii) our better control for endogeneity issue (the actual ratio of future investments to current investments instead of the controversial Tobin's q plus satisfactory tests of orthogonality conditions and overidentifying restrictions).

4.4.4 Cash flow sensitivity of cash and macroeconomic patterns

Another interesting question regarding the cash flow sensitivity is whether it is driven by time-variant macroeconomic patterns or by firm-specific factors. To shed some light on the question, this study largely follows the approach of Bao et al. (2012) and conducts a simple count of negative cash flow firms by year across different business cycles. For this purpose, economic data (business cycle expansions and contractions) from the National Bureau of Economic

[56] LeadInv is replaced by Tobin's q (the ratio of the market value of assets to the book value of assets). We also use the same control variables as are used in the augmented model specification in Eq.(9) on p.1788 and the same number of instrumental variables listed on p.1789. Further, we separate firms according to the following criteria of financing constraints: scheme #1 (dividend payout ratio), scheme #2 (asset size), scheme #3 (bond rating), and modified scheme #5 (the WW index instead of the KZ index).

Research are used. A year is classified as a recession year if at least one month falls within a contraction.

There are two findings in Panel A of Table C.6. First, the percentage of firms with negative cash flow varies over time, ranging from a low of 2.5% of the sample in 1973 to a high of 29.1% in 2008. The percentage of negative cash flow firms in the sample has been relatively stable since the mid-1990s, except for a one-off spike in 2008. In 2010, the percentage of negative cash flow firms is 18%. Therefore, positive CCFS should be dominant through the entire sample, given that fewer firms have negative cash flow. Figure C.2 further supports the notion that CCFS is consistently positive though the sample period, with the OLS coefficients for CashFlow from Eq.(8.1) ranging from nearly 0.20 to 0.50[57]. The mean CashFlow value for the sample is 0.32. Similarly, the estimated sum of the coefficients for CashFlow and $\text{CashFlow} * \text{Neg}$ ranges from close to zero to 0.39, with a mean value of 0.13. Second, the result from a chi-square test of the stability of the percentage of negative cash flow firms in the sample over time is statistically insignificant ($p = 0.238$), suggesting that the percentage is relatively stable over time.

Panel B of Table C.6 presents the Pearson and Spearman correlation coefficients between (i) the mean cash flows of all firms, (ii) the mean cash holdings of all firms, (iii) the percentage of negative cash flow firms, and (iv) recession years. The mean cash holdings and the mean cash flow capture the net impact of positive and negative cash flows in a year. The correlation between the mean cash flow and recession periods is neither economically nor statistically significant. The percentage of firms with negative cash flow is also not significantly related to recession periods. Similarly, the mean level of cash holdings is negatively but insignificantly

[57] The GMM results are generally higher, ranging from 0.12 to 0.96. The time-series mean value is 0.47.

correlated with business cycle contractions[58]. The correlation analysis indicates that both cash holdings and cash flow are largely independent of the stage of business cycle.

Next, the study applies a two-stage estimation approach to examine the effect of changing macroeconomic conditions on CCFS. First, Eq.(8.1) with a full set of control variables is estimated for each year. This procedure yields 39 year-specific (1972 to 2010) CCFS estimates. Second, the year-specific cash flow coefficients (β_1) are regressed on the indicator variable (equal to unity for recessionary years) and median firm size in a year. The OLS regression results in a coefficient for the recession variable of 0.059, which is significant at the 5% level, with an adjusted R^2 of 8.3%. The estimated coefficient is roughly equal to 17% of the estimated CCFS in Table C.3. Intuitively, the results are expected because firms may exhibit a stronger propensity to save during recession periods.

Finally, when the sample is divided into expansion (27 years) and recession (12 years) years, both the asymmetric and the systematic nature of CCFS continues to hold. To conclude, CCFS is likely more driven by firm-specific rather than macroeconomic factors.

4.5. Conclusion

Prior literature has widely studied why firms hold cash and has agreed on several explanations for the corporate propensity to save. Almeida et al. (2004, 2011) and Riddick and Whited (2009) offer contrasting conclusions regarding the corporate propensity to save or the sensitivity of cash to cash flow. Using a sample of U.S. manufacturing firms from 1972 to 2010, this study

[58] The positive and significant correlation between the mean level of cash holdings and the percentage of negative cash flow firms is highly expected. Firms that face negative cash flow have, on average, a stronger propensity to save. Similarly, the negative and significant correlation between the mean cash flow and the percentage of negative cash flow firms is also expected.

reaffirms the conclusion of Almeida et al. that CCFS is highly positive for constrained firms. However, unconstrained firms' cash saving is also systematically related to cash flow, arguably owing to factors that are not related to financing constraints. Such factors include — but are not limited to — a global decline in the cost of capital, the structural shift from labor to investment, corporate tax incentives, the growing uncertainty in internal cash flow, and the rising predominance of R&D. The systematic nature of CCFS is robust to the use of different empirical techniques, model specifications, periods, and a variety of measures of financial constraints. The influence of these alternative factors does not diminish the importance of the cost and availability of external finance, however. In particular, the cash-to-cash flow response is still significantly stronger for firms that are exposed to financial constraints than for firms that are not. Combining two findings, we can conclude that CCFS is relatively noisy measure, but still can be used to capture relative financial frictions.

In addition, the study contends that the cash flow sensitivity is asymmetric to cash flow. That is, CCFS is highly positive (strong cash-to-cash flow response) when a firm faces a favorable cash flow shock. The cash-to-cash flow response is generally weaker in a negative cash flow environment. The analysis further categorizes firms as financially constrained and unconstrained and finds that the asymmetric nature of CCFS continues to hold for both types of firms.

The overall findings support the major hypotheses that are tested in this study: (i) firms that are exposed to different levels of financial constraints and (ii) firms that operate in contrasting cash flow conditions systematically save cash from their internal cash flows.

Chapter 5. Conclusion

Although the cash flow sensitivity of investment and the cash flow sensitivity of cash have long been conventional measures of external financing constraints, they have attracted much debate in the finance literature. This thesis addresses some of the controversies and concerns regarding these measures.

First, the thesis analyzes the so-called "investment-cash flow sensitivity puzzle" — or the surprisingly sharp decline in the response of (physical) capital expenditure to internal cash flow over time. So far, the existing literature has failed to provide a satisfactory explanation for this phenomenon. We discuss that the sensitivity of investment to internal cash flow and financial constraints are fundamentally different (in effect, ICFS cannot be a sufficient proxy for external financial frictions) but share some common drivers which can help to address the ICFS puzzle. We show that both established access to external finance through financial and institutional development and weakening fixed capital formation jointly and predominantly explain the declining ICFS across countries. These factors are also the primary drivers of some of the observed differences in the cash flow sensitivities between developed and emerging market economies. We further demonstrate that the documented impact of financial market development and changes in fixed capital formation can be verified with a firm-level analysis. The study also documents that, consistent with the global shift from asset tangibility to cash liquidity, CCFS complements traditional ICFS in the context of financial constraints.

Second, the thesis contradicts the conventional idea that cross-country financial development moderates firms' propensity to save cash from internal cash flow (as measured by the cash flow

sensitivity of cash). Prior studies fail to consider that the endogenous CCFS can reflect a multitude of saving motives, not just information on financing frictions. Furthermore, cash-cash flow sensitivity is nonlinear (asymmetric) and highly sensitive to the sign of internal cash flow. We show that positive cash flow firms save cash from internal cash flow for a variety of reasons and thus that the role of financial development in mitigating the effect of a strong propensity to save is insignificant. Negative cash flow or loss-making firms are also largely unaffected by the benefits of financial development since their access to equity and credit markets is either limited or completely closed. Our findings highlight that although financial advances help firms to overcome financing constraints, they do not actually moderate the strength of CCFS, which reflects too many forces to be used as a measure of the severity of financing constraints only.

Last, the thesis contributes to the debate regarding the nature of the corporate propensity to save (as measured by the cash flow sensitivity of cash). We reaffirm the robustness of the findings regarding the cash-cash flow sensitivity of financially constrained firms. However, financially unconstrained firms' saving is also systematically (although empirically more weakly) related to cash flow, arguably owing to a variety of factors that are not related to financing constraints. For this reason, CCFS is not a perfect (but still useful) measure of financial constraints. The study further contends that CCFS is asymmetric to internal cash flow. The response between cash holdings and cash flow is highly positive when a firm faces a favorable cash flow shock. The cash-to-cash flow response is usually positive but significantly weaker in a negative cash flow environment. Positive asymmetry continues to hold for both financially constrained and unconstrained firms.

Table A.1 Summary descriptive statistics

The table reports the country-level means and medians for the variables used in the baseline Eq.(1.5). $I_{i,t}/K_{i,t-1}$ is the firm's physical (fixed) investment, $I_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q. $CF_{i,t}/K_{i,t-1}$ is the firm's internal cash flow, $CF_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. EMG denotes an emerging market economy. DEV stands for a developed market economy. Nobs is the number of observations. The sample period is from 1991 to 2010.

Panel A: Heavy industries

			$I_{i,t}/K_{i,t-1}$		$CF_{i,t}/K_{i,t-1}$		$q_{i,t-1}$	
Country	Market	Nobs	Mean	Median	Mean	Median	Mean	Median
Australia	DEV	5,960	0.24	0.18	0.12	0.13	3.11	1.67
Austria	DEV	777	0.22	0.19	0.30	0.27	2.31	1.46
Belgium	DEV	1,081	0.24	0.19	0.44	0.29	2.39	1.42
Canada	DEV	8,816	0.24	0.17	0.09	0.11	2.85	1.50
Denmark	DEV	1,525	0.21	0.17	0.31	0.26	2.66	1.37
Ireland	DEV	501	0.19	0.14	0.38	0.27	2.78	1.68
Finland	DEV	1,330	0.24	0.19	0.41	0.30	3.03	1.48
France	DEV	4,984	0.26	0.22	0.53	0.38	3.29	1.49
Germany	DEV	5,107	0.25	0.21	0.36	0.30	3.42	1.89
Hong Kong	DEV	4,286	0.20	0.14	0.31	0.25	2.55	0.96
Italy	DEV	1,934	0.20	0.16	0.32	0.24	2.84	1.31
Japan	DEV	25,688	0.13	0.10	0.18	0.16	1.61	0.96
Netherlands	DEV	1,569	0.23	0.19	0.45	0.33	3.23	1.79
Norway	DEV	1,333	0.26	0.20	0.23	0.17	2.57	1.32
New Zealand	DEV	616	0.17	0.13	0.27	0.24	2.46	1.58
Singapore	DEV	3,755	0.20	0.14	0.38	0.26	2.39	1.24
Spain	DEV	1,393	0.17	0.13	0.31	0.23	2.75	1.43
Sweden	DEV	1,891	0.22	0.17	0.40	0.31	4.06	1.79
Switzerland	DEV	1,803	0.17	0.14	0.37	0.27	2.95	1.51
UK	DEV	10,779	0.21	0.16	0.40	0.29	3.78	1.95
US	DEV	32,721	0.24	0.19	0.39	0.30	4.72	2.11
Total		117,849	0.21	0.17	0.33	0.25	2.94	1.52
Argentina	EMG	515	0.15	0.10	0.25	0.19	1.73	1.01
Brazil	EMG	1,819	0.19	0.15	0.29	0.20	1.78	0.83
China	EMG	7,754	0.22	0.16	0.24	0.18	5.06	2.72
Chile	EMG	1,161	0.15	0.11	0.26	0.20	1.78	1.21
Colombia	EMG	217	0.11	0.05	0.23	0.15	1.18	0.56
Czech Rep.	EMG	178	0.15	0.11	0.24	0.17	1.27	0.67
Egypt	EMG	367	0.18	0.10	0.52	0.31	4.01	1.99
Greece	EMG	971	0.14	0.09	0.17	0.13	1.94	1.09
Hungary	EMG	158	0.24	0.19	0.29	0.24	1.65	1.18
Indonesia	EMG	2,012	0.19	0.12	0.31	0.21	2.09	1.04
India	EMG	7,334	0.25	0.18	0.35	0.23	2.84	1.15
Mexico	EMG	1,043	0.13	0.10	0.20	0.18	1.72	1.17
Malaysia	EMG	6,676	0.14	0.09	0.23	0.17	1.90	0.96
Peru	EMG	699	0.16	0.11	0.45	0.26	2.16	0.99
Pakistan	EMG	1,184	0.19	0.13	0.40	0.24	2.37	1.22
Poland	EMG	1,162	0.22	0.15	0.29	0.23	2.56	1.43
Portugal	EMG	514	0.15	0.11	0.25	0.21	1.36	1.10
Philippines	EMG	919	0.17	0.10	0.26	0.16	1.75	0.86
Russia	EMG	473	0.22	0.18	0.30	0.25	2.29	1.28
South Africa	EMG	2,023	0.25	0.21	0.51	0.33	2.89	1.53
Thailand	EMG	3,059	0.18	0.12	0.33	0.25	1.73	1.01
Turkey	EMG	1,399	0.20	0.13	0.37	0.27	2.36	1.45
Taiwan	EMG	7,471	0.17	0.11	0.29	0.21	2.21	1.23
Venezuela	EMG	186	0.11	0.07	0.18	0.14	0.74	0.54
Total		49,294	0.18	0.12	0.30	0.21	2.14	1.18

Table A.1 (continue)

Panel B: Light industries

			$I_{i,t}/K_{i,t-1}$		$CF_{i,t}/K_{i,t-1}$		$q_{i,t-1}$	
Country	Market	Nobs	Mean	Median	Mean	Median	Mean	Median
Australia	DEV	1,452	0.26	0.20	0.52	0.40	6.32	2.90
Austria	DEV	80	0.28	0.23	0.08	0.15	5.35	1.74
Belgium	DEV	354	0.29	0.23	0.48	0.33	6.57	2.60
Canada	DEV	1,976	0.25	0.20	0.27	0.27	6.29	2.49
Denmark	DEV	443	0.23	0.18	0.31	0.27	6.52	2.65
Ireland	DEV	202	0.23	0.18	0.38	0.33	6.41	2.78
Finland	DEV	477	0.27	0.21	0.62	0.37	7.09	2.39
France	DEV	2,408	0.34	0.28	0.72	0.48	7.94	3.11
Germany	DEV	2,041	0.28	0.22	0.44	0.31	6.57	2.36
Hong Kong	DEV	2,185	0.20	0.12	0.32	0.22	4.44	1.25
Italy	DEV	548	0.26	0.20	0.64	0.35	7.57	3.11
Japan	DEV	10,203	0.16	0.11	0.32	0.18	3.54	1.32
Netherlands	DEV	600	0.31	0.25	0.80	0.46	9.25	3.20
Norway	DEV	394	0.34	0.27	0.59	0.28	8.89	2.82
New Zealand	DEV	324	0.22	0.18	0.40	0.26	3.27	1.68
Singapore	DEV	1,358	0.19	0.12	0.35	0.20	3.00	1.28
Spain	DEV	307	0.21	0.17	0.65	0.42	9.46	4.08
Sweden	DEV	762	0.31	0.26	0.68	0.51	12.84	5.99
Switzerland	DEV	906	0.22	0.17	0.51	0.29	6.96	2.17
UK	DEV	6,119	0.24	0.18	0.38	0.24	6.40	2.26
US	DEV	25,647	0.30	0.25	0.32	0.35	10.21	4.42
Total		58,786	0.26	0.20	0.47	0.32	6.90	2.69
Argentina	EMG	41	0.22	0.20	0.26	0.24	2.03	1.17
Brazil	EMG	235	0.31	0.25	0.61	0.42	4.56	1.67
China	EMG	2,633	0.21	0.15	0.29	0.21	7.56	3.81
Chile	EMG	284	0.17	0.13	0.23	0.18	2.00	1.39
Colombia	EMG	39	0.16	0.12	0.20	0.16	1.31	0.70
Czech Rep.	EMG	35	0.20	0.15	0.58	0.24	3.38	0.80
Egypt	EMG	99	0.18	0.13	0.68	0.37	2.94	1.41
Greece	EMG	367	0.20	0.13	0.33	0.13	4.20	1.60
Hungary	EMG	91	0.20	0.17	0.22	0.15	1.74	0.91
Indonesia	EMG	528	0.23	0.18	0.47	0.28	2.45	1.30
India	EMG	1,568	0.30	0.25	0.61	0.36	6.70	2.56
Mexico	EMG	334	0.18	0.13	0.29	0.21	2.59	1.69
Malaysia	EMG	1,403	0.18	0.12	0.30	0.20	3.33	1.31
Peru	EMG	33	0.14	0.09	0.30	0.18	1.15	0.73
Pakistan	EMG	111	0.23	0.19	0.46	0.35	4.04	2.38
Poland	EMG	337	0.32	0.24	0.57	0.37	5.52	2.85
Portugal	EMG	190	0.21	0.16	0.36	0.21	3.76	1.60
Philippines	EMG	270	0.19	0.11	0.36	0.21	2.87	1.67
Russia	EMG	58	0.23	0.19	0.70	0.42	5.35	2.50
South Africa	EMG	763	0.34	0.31	0.94	0.61	5.57	2.91
Thailand	EMG	931	0.18	0.12	0.32	0.22	2.68	1.38
Turkey	EMG	238	0.21	0.14	0.45	0.21	4.95	2.63
Taiwan	EMG	3,508	0.20	0.13	0.51	0.34	4.82	2.08
Total		14,096	0.22	0.17	0.44	0.27	3.72	1.79

Table A.2 Country-level investment-cash flow sensitivity

The table reports coefficients estimated from regression of physical (fixed) investment on cash flow and Tobin's q: $(I_{i,t}/K_{i,t-1}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/K_{i,t-1}) + \beta_2 q_{i,t-1} + \varepsilon_{i,t}$. $I_{i,t}/K_{i,t-1}$ is the firm's physical investment, $I_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q. $CF_{i,t}/K_{i,t-1}$ is the firm's internal cash flow, $CF_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. The sample consists of non-financial and non-utility firms from 21 developed market economies and 24 emerging market economies. In Panel A, developed market firms are classified into the sample of firms with all cash flows and the subsample of firms with strictly positive cash flows. In Panel B, emerging market firms are classified into the sample of firms with all cash flows and the subsample of firms with strictly positive cash flows. The t-statistics reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. Country, industry and time fixed effects are included. Nobs is the number of observations. RSq is adjusted R^2. Time period is from 1991 to 2010.

Panel A: Developed market economies

All (heavy industry) firms						
Country	$CF_{i,t}/K_{i,t-1}$	(t-stat)	$q_{i,t-1}$	(t-stat)	RSq	Nobs
Austria	0.117	(3.57)	0.004	(1.03)	20.9%	777
Finland	0.095	(6.10)	0.005	(2.50)	21.4%	1,330
Spain	0.090	(3.08)	-0.001	(-0.39)	17.1%	1,393
Netherlands	0.084	(9.09)	0.004	(2.77)	35.1%	1,569
New Zealand	0.077	(6.09)	0.016	(8.54)	29.2%	616
Germany	0.077	(8.44)	0.003	(3.41)	20.2%	5,107
Switzerland	0.075	(6.38)	0.009	(7.22)	35.4%	1,803
France	0.074	(10.59)	0.003	(3.75)	19.3%	4,984
Denmark	0.058	(4.27)	0.002	(1.61)	10.6%	1,525
Japan	0.054	(10.68)	0.005	(6.39)	22.0%	25,688
Hong Kong	0.051	(7.37)	0.003	(3.56)	11.0%	4,286
Singapore	0.049	(6.89)	0.008	(5.79)	13.2%	3,755
Italy	0.047	(4.52)	0.005	(3.38)	15.9%	1,934
Ireland	0.047	(2.83)	0.005	(1.56)	19.8%	501
Sweden	0.042	(4.29)	0.006	(6.76)	21.8%	1,891
US	0.034	(16.07)	0.006	(18.64)	20.6%	32,721
Canada	0.030	(4.98)	0.007	(5.91)	15.0%	8,816
UK	0.027	(6.59)	0.007	(11.41)	20.4%	10,779
Australia	0.027	(4.85)	0.007	(6.64)	11.2%	5,960
Belgium	0.012	(0.65)	0.003	(1.39)	7.5%	1,081
Norway	0.006	(0.47)	0.013	(4.84)	20.3%	1,333
Total	0.044	(15.84)	0.006	(12.60)	16.0%	117,849

Heavy industry firms with $CF_{i,t}/K_{i,t-1} > 0$						
Country	$CF_{i,t}/K_{i,t-1}$	(t-stat)	$q_{i,t-1}$	(t-stat)	RSq	Nobs
Austria	0.221	(6.76)	0.000	(0.03)	26.5%	730
New Zealand	0.155	(4.14)	0.010	(2.37)	31.7%	563
Germany	0.133	(9.82)	0.000	(-0.11)	24.0%	4,580
Finland	0.130	(6.25)	0.001	(0.54)	20.9%	1,257
Spain	0.113	(2.89)	-0.003	(-0.90)	16.6%	1,283
Netherlands	0.110	(7.96)	0.002	(1.47)	36.6%	1,476
Denmark	0.104	(3.96)	0.001	(1.46)	13.4%	1,405
Switzerland	0.101	(5.47)	0.006	(5.43)	37.9%	1,670
Japan	0.091	(10.13)	0.003	(3.36)	23.5%	22,857
France	0.090	(10.78)	0.001	(2.01)	19.8%	4,651
Hong Kong	0.081	(6.61)	0.001	(1.11)	12.3%	3,493
US	0.081	(19.73)	0.003	(8.07)	23.9%	28,132
Canada	0.076	(8.44)	0.004	(1.96)	20.1%	5,504
Sweden	0.075	(4.66)	0.005	(3.27)	25.2%	1,702
Australia	0.068	(6.84)	0.004	(3.93)	17.8%	3,583
Italy	0.064	(3.89)	0.003	(2.78)	16.3%	1,713
Norway	0.061	(2.12)	0.011	(3.49)	21.9%	1,092
UK	0.054	(8.38)	0.005	(6.13)	22.0%	9,337
Singapore	0.051	(4.82)	0.008	(4.73)	12.1%	3,232
Ireland	0.050	(2.90)	0.004	(1.48)	24.8%	436
Belgium	0.002	(0.09)	0.004	(1.87)	8.2%	1,023
Total	0.079	(14.20)	0.003	(5.99)	18.2%	99,719

Table A.2 (continue)

Panel B: Emerging market economies

All (heavy industry) firms						
Country	$CF_{i,t}/K_{i,t-1}$	(t-stat)	$q_{i,t-1}$	(t-stat)	RSq	Nobs
Colombia	0.258	(4.90)	-0.015	(-1.51)	61.1%	217
Venezuela	0.209	(4.64)	0.015	(1.07)	46.8%	186
China	0.159	(13.56)	0.001	(2.43)	12.3%	7,754
Hungary	0.155	(1.79)	0.026	(1.33)	24.1%	158
Czech Rep.	0.135	(2.45)	-0.003	(-0.68)	22.9%	178
Argentina	0.118	(3.83)	0.001	(0.43)	26.7%	515
Russia	0.110	(2.63)	0.002	(1.49)	24.1%	473
Greece	0.103	(3.73)	0.003	(1.04)	18.5%	971
Peru	0.099	(4.32)	0.002	(0.59)	23.1%	699
Mexico	0.093	(5.75)	0.007	(1.50)	27.8%	1,043
Portugal	0.088	(2.02)	0.016	(2.32)	18.2%	514
Turkey	0.087	(6.04)	0.008	(2.28)	26.8%	1,399
Philippines	0.086	(3.65)	0.000	(0.00)	27.6%	919
Indonesia	0.086	(6.47)	0.003	(2.63)	21.5%	2,012
Brazil	0.084	(5.64)	0.001	(0.74)	23.0%	1,819
India	0.084	(7.16)	0.002	(2.30)	13.4%	7,334
Poland	0.078	(4.69)	0.005	(1.61)	25.4%	1,162
Chile	0.078	(2.86)	0.003	(1.14)	20.6%	1,161
Malaysia	0.073	(7.95)	0.002	(1.60)	13.6%	6,676
Taiwan	0.066	(8.35)	0.007	(3.80)	17.6%	7,471
Thailand	0.066	(5.47)	0.005	(2.66)	17.5%	3,059
South Africa	0.059	(5.13)	0.001	(0.60)	26.7%	2,023
Egypt	0.053	(1.85)	0.003	(1.38)	22.1%	367
Pakistan	0.049	(3.18)	0.009	(2.98)	18.0%	1,184
Total	0.099	(17.14)	0.003	(4.08)	18.1%	49,294

Heavy industry firms with $CF_{i,t}/K_{i,t-1} > 0$						
Country	$CF_{i,t}/K_{i,t-1}$	(t-stat)	$q_{i,t-1}$	(t-stat)	RSq	Nobs
Colombia	0.301	(5.41)	-0.018	(-1.66)	63.5%	197
Hungary	0.264	(2.59)	0.012	(0.85)	24.8%	143
Venezuela	0.251	(3.93)	0.010	(0.64)	47.8%	163
China	0.176	(9.49)	0.001	(0.98)	10.7%	7,075
Czech Rep.	0.169	(2.27)	-0.002	(-0.61)	30.0%	158
Greece	0.162	(3.31)	-0.002	(-0.81)	17.8%	778
Mexico	0.149	(4.48)	0.001	(0.11)	29.9%	922
Poland	0.142	(5.07)	0.000	(-0.07)	26.8%	1,016
Argentina	0.139	(3.61)	0.001	(0.29)	24.9%	439
Turkey	0.113	(5.86)	0.005	(1.32)	27.0%	1,200
Peru	0.112	(5.38)	0.001	(0.27)	23.0%	653
Russia	0.110	(1.98)	0.002	(1.31)	22.1%	434
Indonesia	0.093	(5.70)	0.003	(2.37)	19.8%	1,759
Brazil	0.090	(4.49)	0.001	(1.19)	23.5%	1,583
Malaysia	0.089	(7.50)	0.000	(0.48)	13.4%	5,684
South Africa	0.084	(6.18)	-0.001	(-0.72)	28.9%	1,878
India	0.081	(6.64)	0.001	(2.01)	12.4%	6,810
Thailand	0.080	(5.04)	0.004	(1.79)	17.2%	2,757
Philippines	0.076	(2.94)	0.000	(-0.26)	24.0%	737
Taiwan	0.075	(6.55)	0.005	(3.09)	17.9%	6,448
Portugal	0.075	(1.36)	0.016	(2.21)	17.7%	483
Chile	0.055	(1.82)	0.014	(3.29)	22.5%	1,084
Pakistan	0.054	(2.85)	0.009	(2.60)	18.7%	1,092
Egypt	0.053	(1.74)	0.002	(1.24)	21.3%	347
Total	0.112	(15.32)	0.002	(2.80)	18.1%	43,840

Table A.3 Investment-cash flow sensitivity by period

The table reports coefficients estimated from regression of physical (fixed) investment on cash flow and Tobin's q: $(I_{i,t}/K_{i,t-1}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/K_{i,t-1}) + \beta_2 q_{i,t-1} + \varepsilon_{i,t}$. $I_{i,t}/K_{i,t-1}$ is the firm's physical investment, $I_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q. $CF_{i,t}/K_{i,t-1}$ is the firm's internal cash flow, $CF_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. The sample consists of non-financial and non-utility firms from 21 developed market economies and 24 emerging market economies. In Panel A, developed market firms are classified into the sample of firms with all cash flows and the subsample of firms with strictly positive cash flows. In Panel B, emerging market firms are classified into the sample of firms with all cash flows and the subsample of firms with strictly positive cash flows. The t-statistics reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. Country, industry and time fixed effects are included. Nobs is the number of observations. RSq is adjusted R^2.

Panel A: Developed market economies

All (heavy industry) firms				
Period	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
1991-94	0.090	0.002	15.4%	14,847
	(4.87)	(1.23)		
1995-98	0.051	0.007	19.0%	20,020
	(6.03)	(6.70)		
1999-02	0.056	0.005	19.4%	25,119
	(10.52)	(7.60)		
2003-06	0.049	0.006	16.5%	27,800
	(11.73)	(9.09)		
2007-10	0.031	0.006	19.2%	30,063
	(8.30)	(9.60)		

Heavy industry firms with $CF_{i,t}/K_{i,t-1} > 0$				
Period	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
1991-94	0.113	0.000	16.1%	13,517
	(4.10)	(-0.18)		
1995-98	0.062	0.006	19.5%	18,211
	(4.24)	(4.79)		
1999-02	0.108	0.003	22.3%	21,193
	(12.15)	(3.29)		
2003-06	0.078	0.003	18.4%	23,784
	(9.35)	(3.98)		
2007-10	0.067	0.003	23.6%	23,014
	(12.80)	(4.19)		

All (light industry) firms				
Period	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
1991-94	0.048	0.005	19.0%	5,654
	(3.04)	(2.73)		
1995-98	0.052	0.005	28.7%	9,411
	(3.06)	(7.85)		
1999-02	0.020	0.004	23.5%	13,595
	(4.45)	(12.74)		
2003-06	0.034	0.004	25.6%	15,434
	(9.97)	(12.06)		
2007-10	0.025	0.004	24.0%	14,692
	(7.56)	(12.44)		

Light industry firms with $CF_{i,t}/K_{i,t-1} > 0$				
Period	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
1991-94	0.102	0.000	20.9%	5,100
	(4.58)	(0.03)		
1995-98	0.103	0.003	31.1%	7,835
	(8.44)	(2.52)		
1999-02	0.079	0.002	28.5%	10,251
	(8.46)	(5.69)		
2003-06	0.074	0.002	30.4%	12,659
	(13.98)	(4.20)		
2007-10	0.047	0.003	25.9%	11,955
	(8.05)	(6.38)		

Table A.3 (continue)

Panel B: Emerging market economies

All (heavy industry) firms				
Period	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
1991-94	0.138	-0.001	25.5%	1,912
	(5.46)	(-0.63)		
1995-98	0.096	0.005	22.1%	4,963
	(5.72)	(3.41)		
1999-02	0.112	0.001	25.2%	7,723
	(10.27)	(1.20)		
2003-06	0.105	0.002	20.1%	14,336
	(12.00)	(2.01)		
2007-10	0.073	0.004	18.2%	20,360
	(10.68)	(3.46)		

Heavy industry firms with $CF_{i,t}/K_{i,t-1} > 0$				
Period	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
1991-94	0.150	-0.001	25.6%	1,813
	(5.58)	(-1.03)		
1995-98	0.142	0.003	23.9%	4,418
	(8.31)	(2.52)		
1999-02	0.132	0.001	25.0%	6,560
	(9.33)	(0.79)		
2003-06	0.111	0.001	19.7%	12,885
	(10.51)	(1.26)		
2007-10	0.086	0.003	18.1%	18,164
	(9.64)	(2.51)		

All (light industry) firms				
Period	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
1991-94	0.109	0.003	29.4%	335
	(3.71)	(1.00)		
1995-98	0.122	0.005	34.8%	937
	(4.65)	(1.75)		
1999-02	0.065	0.003	25.6%	2,050
	(5.40)	(2.33)		
2003-06	0.074	0.003	25.8%	4,640
	(6.27)	(3.08)		
2007-10	0.045	0.004	22.3%	6,134
	(5.98)	(6.34)		

Light industry firms with $CF_{i,t}/K_{i,t-1} > 0$				
Period	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
1991-94	0.114	0.002	31.9%	315
	(4.00)	(0.89)		
1995-98	0.132	0.005	35.3%	834
	(4.34)	(1.47)		
1999-02	0.093	0.001	25.6%	1,742
	(6.35)	(0.68)		
2003-06	0.087	0.002	26.7%	4,067
	(5.95)	(1.95)		
2007-10	0.050	0.003	22.3%	5,445
	(4.81)	(4.65)		

Table A.4 Country-level determinants of investment-cash flow sensitivity (1)

The table reports coefficients estimated from regression of ICFS on country-level explanatory variables (including corresponding principal components, PC). Country-year ICFS coefficients are estimated using fixed effects OLS, and used as dependent variables. Panels A to E include five categories of determinant variables: stock market development, financial openness, credit market development, investor protection, and fixed capital formation. Control variables include GDP per capita (GDPPC), number of public firms in a country (N. Firms), GDP growth, and the Herfindahl Index (HH index). The t-statistics reported in parentheses adjusted for clustered standard errors at the country level. Standard errors are heteroskedasticity-consistent. Mean VIF is the mean variance inflation factor. Nobs is the number of country-year observations. RSq is adjusted R^2. Main variables are defined in Appendix A.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Stock market development							
Mcap-to-GDP	-0.010			-0.014	-0.008		
	(-1.78)			(-1.54)	(-0.80)		
Value traded-to-GDP		-0.014		0.005	-0.003		
		(-2.49)		(0.63)	(-0.29)		
Stock market turnover			-0.015	-0.017	-0.018		
			(-2.29)	(-1.90)	(-2.05)		
PC						-0.012	-0.019
						(-2.69)	(-3.23)
GDPPC	-0.017	-0.016	-0.019	-0.016	-0.021	-0.015	-0.017
	(-2.90)	(-2.81)	(-3.64)	(-2.88)	(-3.86)	(-2.75)	(-3.03)
N.Firms	-0.010	-0.008	-0.007	-0.005	-0.009	-0.006	0.001
	(-2.30)	(-1.50)	(-1.15)	(-0.89)	(-0.95)	(-1.15)	(0.14)
GDP growth	0.006	-0.031	-0.048	0.020	-0.043	0.001	-0.036
	(0.02)	(-0.13)	(-0.21)	(0.08)	(-0.15)	(0.00)	(-0.14)
HH index	0.020	0.053	0.068	0.042	-0.337	0.045	-0.258
	(0.12)	(0.34)	(0.43)	(0.26)	(-2.10)	(0.29)	(-1.67)
Country FE	No	No	No	No	Yes	No	Yes
Mean VIF	1.37	1.41	1.33	2.40	1.95	1.43	1.72
RSq	4.7%	5.0%	5.3%	5.5%	11.5%	5.4%	11.8%
Nobs	785	785	785	785	785	785	785

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel B: Financial openness							
FDI-to-GDP	-0.001			0.004	-0.001		
	(-0.29)			(0.94)	(-0.16)		
Portfolio flow-to-GDP		-0.011		-0.013	-0.008		
		(-3.14)		(-3.18)	(-1.76)		
CapOpen			-0.001	0.000	-0.014		
			(-0.08)	(0.00)	(-0.79)		
PC						-0.007	-0.006
						(-1.67)	(-1.66)
GDPPC	-0.020	-0.017	-0.020	-0.018	-0.025	-0.016	-0.037
	(-3.46)	(-3.19)	(-2.05)	(-1.90)	(-1.84)	(-2.64)	(-4.21)
N.Firms	-0.012	-0.014	-0.013	-0.014	-0.018	-0.013	-0.019
	(-2.65)	(-3.23)	(-2.57)	(-3.10)	(-2.18)	(-3.01)	(-2.31)
GDP growth	-0.047	-0.018	-0.052	-0.029	-0.094	-0.024	-0.097
	(-0.21)	(-0.08)	(-0.23)	(-0.13)	(-0.37)	(-0.10)	(-0.38)
HH index	0.039	0.036	0.040	0.034	-0.158	0.042	-0.335
	(0.25)	(0.23)	(0.26)	(0.23)	(-1.08)	(0.27)	(-2.09)
Country FE	No	No	No	No	Yes	No	Yes
Mean VIF	1.29	1.30	1.79	1.68	1.76	1.46	1.73
RSq	4.3%	4.9%	4.3%	4.7%	9.5%	4.5%	10.8%
Nobs	785	785	785	785	785	785	785

Table A.4 (continue)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel C: Credit development							
Private credit-to-GDP	-0.014			-0.006	-0.014		
	(-1.68)			(-0.69)	(-1.09)		
Domestic debt-to- GDP		-0.011		-0.007	0.003		
		(-1.83)		(-1.19)	(0.32)		
Foreign debt-to-GDP			-0.019	-0.016	-0.015		
			(-3.40)	(-2.67)	(-1.82)		
PC						-0.018	-0.021
						(-3.01)	(-2.34)
GDPPC	-0.014	-0.016	-0.014	-0.009	-0.015	-0.008	-0.015
	(-2.14)	(-2.75)	(-2.46)	(-1.29)	(-1.68)	(-1.15)	(-1.97)
N.Firms	-0.008	-0.010	-0.013	-0.010	-0.004	-0.007	-0.002
	(-1.54)	(-1.87)	(-3.02)	(-1.85)	(-0.40)	(-1.47)	(-0.23)
GDP growth	-0.087	-0.091	-0.140	-0.167	-0.221	-0.160	-0.195
	(-0.38)	(-0.40)	(-0.61)	(-0.72)	(-0.83)	(-0.69)	(-0.75)
HH index	0.032	0.040	0.079	0.070	-0.226	0.055	-0.213
	(0.21)	(0.25)	(0.50)	(0.45)	(-1.32)	(0.35)	(-1.24)
Country FE	No	No	No	No	Yes	No	Yes
Mean VIF	1.61	1.51	1.38	1.76	2.01	1.69	1.77
RSq	4.8%	4.7%	5.7%	5.7%	11.0%	5.8%	11.3%
Nobs	785	785	785	785	785	785	785

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel D: Investor protection							
Regulatory quality	-0.002			0.008	0.002		
	(-0.27)			(0.74)	(0.22)		
Law & order		0.003		-0.002	-0.016		
		(0.24)		(-0.13)	(-1.18)		
Investment profile			-0.021	-0.023	-0.025		
			(-3.89)	(-3.27)	(-3.59)		
PC						-0.019	-0.028
						(-4.27)	(-5.30)
GDPPC	-0.019	-0.022	-0.013	-0.017	-0.034	-0.022	-0.025
	(-2.22)	(-3.01)	(-2.29)	(-1.74)	(-2.24)	(-3.93)	(-6.22)
N.Firms	-0.012	-0.013	-0.011	-0.011	-0.030	-0.012	-0.005
	(-2.69)	(-2.60)	(-2.38)	(-2.20)	(-2.68)	(-2.44)	(-0.74)
GDP growth	-0.050	-0.058	-0.038	-0.039	-0.116	-0.065	-0.068
	(-0.22)	(-0.26)	(-0.17)	(-0.17)	(-0.44)	(-0.29)	(-0.26)
HH index	0.036	0.043	0.043	0.053	-0.220	0.058	-0.235
	(0.23)	(0.29)	(0.27)	(0.34)	(-1.10)	(0.36)	(-1.43)
Country FE	No	No	No	No	Yes	No	Yes
Mean VIF	1.95	1.66	1.34	2.10	2.11	1.25	1.65
RSq	4.3%	4.3%	6.2%	6.1%	10.5%	5.8%	12.9%
Nobs	785	785	785	785	785	785	785

Table A.4 (continue)

	(1)	(2)
Panel E: Capital formation		
M3-to-Fixed capital	-0.002	-0.004
	(-0.95)	(-1.33)
GDPPC	-0.019	-0.035
	(-3.16)	(-4.29)
N.Firms	-0.011	-0.023
	(-2.23)	(-2.18)
GDP growth	-0.064	-0.126
	(-0.28)	(-0.48)
HH index	0.036	-0.372
	(0.23)	(-2.34)
Country FE	No	Yes
Mean VIF	1.46	1.91
RSq	4.4%	10.9%
Nobs	785	785

Table A.5 Country-level determinants of investment-cash flow sensitivity (2)

Panel A and Panel B report multivariate regression results of ICFS on country-level explanatory variables (corresponding principal components, PC). Country-year ICFS coefficients are estimated using fixed effects OLS, and used as dependent variables. Determinant variables are selected from six categories: stock market development, financial openness, credit market development, investor protection, fixed capital formation, and control group (Table A.4). Time-series variations in ICFS are measured by time trend (T − trend) and four-year period indicator variables. Panel C and Panel D report coefficients estimated from alternative model specification: $(I_{i,t}/K_{i,t-1}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/K_{i,t-1}) + \beta_2 q_{i,t-1} + \beta_3 X_{c,t} + \beta_4 X_{c,t} (CF_{i,t}/K_{i,t-1}) + \varepsilon_{i,t}$. $I_{i,t}/K_{i,t-1}$ is the firm's physical investment, $I_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q. $CF_{i,t}/K_{i,t-1}$ is the firm's internal cash flow, $CF_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. $X_{c,t}$ is a vector of country-level financial development variables (corresponding principal components, PC). The t-statistics reported in parentheses adjusted for clustered standard errors at the country level and at the firm level in Panel A(B) and in Panel C(D), respectively. Country, industry and time fixed effects are included in Panel C(D). Standard errors are heteroskedasticity-consistent. Mean VIF is the mean variance inflation factor. Nobs is the number of country-year observations. RSq is adjusted R^2.

Panel A: Developed market economies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
PC(1)			-0.016	-0.015	-0.021			-0.022	-0.020	-0.027
			(-2.02)	(-1.87)	(-2.47)			(-2.60)	(-2.48)	(-3.49)
PC(2)				-0.006	-0.002				-0.005	-0.001
				(-1.06)	(-0.41)				(-0.99)	(-0.15)
T-trend	-0.005	-0.005	-0.002	-0.002	-0.001					
	(-6.88)	(-6.51)	(-0.88)	(-1.09)	(-0.37)					
T_1995-1998						-0.042	-0.044	-0.027	-0.028	-0.024
						(-1.96)	(-1.93)	(-1.36)	(-1.39)	(-1.18)
T_1999-2002						-0.068	-0.071	-0.028	-0.031	-0.019
						(-4.47)	(-4.53)	(-1.31)	(-1.46)	(-0.95)
T_2003-2006						-0.082	-0.084	-0.024	-0.027	-0.010
						(-5.10)	(-4.91)	(-0.95)	(-1.12)	(-0.44)
T_2007-2010						-0.076	-0.078	-0.003	-0.008	0.014
						(-4.37)	(-4.29)	(-0.11)	(-0.26)	(0.49)
Country FE	No	Yes	No	No	Yes	No	Yes	No	No	Yes
Mean VIF	1.00	1.90	4.11	3.15	1.73	1.62	1.89	3.22	2.90	1.85
RSq	10.2%	16.6%	11.5%	11.8%	13.7%	9.4%	16.8%	12.4%	12.5%	14.9%
Nobs	417	417	417	417	417	417	417	417	417	417

Panel B: Emerging market economies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
PC(1)			-0.006	-0.007	-0.010			-0.005	-0.006	-0.009
			(-1.37)	(-1.54)	(-2.23)			(-0.92)	(-1.17)	(-2.10)
PC(2)				-0.018	-0.004				-0.021	-0.004
				(-1.32)	(-0.31)				(-1.49)	(-0.30)
T-trend	-0.006	-0.006	-0.006	-0.005	-0.005					
	(-4.61)	(-3.90)	(-4.58)	(-2.78)	(-2.20)					
T_1995-1998						-0.037	-0.050	-0.036	-0.033	-0.048
						(-0.76)	(-0.99)	(-0.73)	(-0.63)	(-0.89)
T_1999-2002						-0.022	-0.037	-0.020	-0.010	-0.033
						(-0.51)	(-0.86)	(-0.45)	(-0.19)	(-0.65)
T_2003-2006						-0.085	-0.104	-0.081	-0.063	-0.094
						(-2.01)	(-2.33)	(-1.83)	(-1.19)	(-1.66)
T_2007-2010						-0.080	-0.097	-0.076	-0.050	-0.085
						(-2.00)	(-2.30)	(-1.80)	(-0.90)	(-1.43)
Country FE	No	Yes	No	No	Yes	No	Yes	No	No	Yes
Mean VIF	1.00	1.73	1.01	1.13	1.67	2.51	1.89	2.24	2.14	1.85
RSq	3.7%	9.1%	3.8%	4.7%	9.1%	2.4%	9.5%	2.3%	3.6%	9.5%
Nobs	368	368	368	368	368	368	368	368	368	368

Table A.5 (continue)

Panel C: Firms with positive and negative cash flows

	1991-94	1995-98	1999-02	2003-06	2007-10
$CF_{i,t}/K_{i,t-1}$	0.063	0.059	0.063	0.082	0.053
	(3.45)	(8.52)	(13.74)	(16.09)	(12.60)
$CF_{i,t}/K_{i,t-1}$*PC(1)	-0.037	-0.027	-0.019	-0.020	-0.008
	(-2.05)	(-3.28)	(-5.66)	(-8.40)	(-4.96)
$CF_{i,t}/K_{i,t-1}$*PC(2)	-0.002	-0.016	-0.008	-0.011	-0.007
	(-0.24)	(-3.00)	(-2.51)	(-4.47)	(-4.16)
PC(1)	0.037	0.045	0.018	-0.005	-0.020
	(3.03)	(6.96)	(2.88)	(-0.75)	(-3.41)
PC(2)	0.011	0.020	0.005	-0.006	0.002
	(1.00)	(2.93)	(1.00)	(-0.80)	(0.61)
TQ	0.001	0.006	0.004	0.004	0.005
	(1.43)	(11.28)	(10.85)	(11.39)	(12.91)
Country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
RSq	17.4%	23.2%	25.9%	21.9%	20.1%
Nobs	22,248	34,590	46,852	58,192	66,408

Panel D: Firms with strictly positive cash flow

	1991-94	1995-98	1999-02	2003-06	2007-10
$CF_{i,t}/K_{i,t-1} > 0$	0.109	0.079	0.109	0.100	0.072
	(4.74)	(8.04)	(16.44)	(15.83)	(13.00)
$CF_{i,t}/K_{i,t-1}$*PC(1)	-0.024	-0.039	-0.007	-0.014	-0.004
	(-1.12)	(-4.94)	(-1.75)	(-5.00)	(-2.13)
$CF_{i,t}/K_{i,t-1}$*PC(2)	0.013	-0.014	-0.011	-0.010	-0.009
	(1.07)	(-1.93)	(-2.61)	(-2.75)	(-3.76)
PC(1)	0.034	0.050	0.013	-0.008	-0.024
	(2.52)	(7.20)	(1.84)	(-1.10)	(-3.79)
PC(2)	0.003	0.013	0.009	-0.011	0.004
	(0.26)	(1.78)	(1.54)	(-1.30)	(1.14)
TQ	-0.001	0.005	0.002	0.002	0.003
	(-0.98)	(7.42)	(4.78)	(5.69)	(7.24)
Country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
RSq	18.2%	24.1%	27.5%	23.0%	21.3%
Nobs	20,292	30,631	38,415	49,947	54,351

Table A.6 Investment-cash flow sensitivity by leverage, tangibility, and cash reserves

The table reports coefficients estimated from regression of physical (fixed) investment on cash flow and Tobin's q: $(I_{i,t}/K_{i,t-1}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/K_{i,t-1}) + \beta_2 q_{i,t-1} + \varepsilon_{i,t}$. $I_{i,t}/K_{i,t-1}$ is the firm's physical investment, $I_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q. $CF_{i,t}/K_{i,t-1}$ is the firm's internal cash flow, $CF_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. The pooled regressions are estimated on a 20-year panel between 1991 and 2010. The sample consists of non-financial and non-utility firms from 21 developed market economies and 24 emerging market economies. In Panel A, firms are classified into the *high-levered group* (if total debt ratio is equal to or above corresponding median value) and the *low-levered group* (if total debt ratio is below median value). In Panel B, firms are classified into the *high-tangible asset group* (if fixed assets-to-total assets ratio is equal to or above corresponding median value) and the *low-tangible asset group* (if fixed assets-to-total assets ratio is below median value). In Panel C, firms are classified into the *cash-rich group* (if cash-to-total assets ratio is equal to or above corresponding median value) and the *cash-poor group* (if cash-to-total assets ratio is below median value). Firms with strictly positive cash flow ($CF_{i,t}/K_{i,t-1} > 0$) are considered across all panels. The t-statistics reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. Country, industry and time fixed effects are included. Nobs is the number of firm-year observations. RSq is adjusted R^2. DEV stands for developed market economies. EMG denotes emerging market economies.

Panel A: Sorted by leverage

	High-levered firms				Low-levered firms			
	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
DEV	0.066	0.003	21.4%	73,759	0.081	0.002	22.4%	73,760
	(14.71)	(9.74)			(17.77)	(7.46)		
Test for Diff.	-0.015							
p-value	0.001							
EMG	0.089	0.003	18.1%	28,121	0.109	0.002	21.4%	28,122
	(13.57)	(5.26)			(13.40)	(2.58)		
Test for Diff.	-0.020							
p-value	0.016							

Panel B: Sorted by asset tangibility

	High-tangible asset firms				Low-tangible asset firms			
	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
DEV	0.313	0.007	24.2%	73,760	0.055	0.003	23.7%	73,759
	(23.19)	(6.01)			(16.74)	(12.37)		
Test for Diff.	0.257							
p-value	0.000							
EMG	0.330	0.005	25.7%	28,121	0.073	0.002	18.5%	28,122
	(20.63)	(3.24)			(12.61)	(3.92)		
Test for Diff.	0.257							
p-value	0.000							

Panel C: Sorted by cash holding

	Cash-rich firms				Cash-poor firms			
	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	RSq	Nobs
DEV	0.060	0.003	22.2%	73,759	0.094	0.003	21.0%	73,760
	(16.16)	(11.30)			(18.66)	(6.67)		
Test for Diff.	-0.034							
p-value	0.000							
EMG	0.082	0.002	17.8%	28,122	0.132	0.003	21.0%	28,121
	(12.65)	(4.06)			(14.67)	(2.89)		
Test for Diff.	-0.050							
p-value	0.000							

Table A.7 Firm-level determinants of investment-cash flow sensitivity

Panel A and Panel B report multivariate regression results of ICFS on firm-level explanatory variables (corresponding principal components, PC). Country-year ICFS coefficients are estimated using fixed effects OLS, and used as dependent variables. Determinant variables include the ratio of cash to tangible assets (Liquidity − to − Tangibility) and the ratio of total debt to tangible assets (Leverage − to − Tangibility). Control variables include a dividend indicator variable (Dividend), the log transformation of book values of assets (Size), and the return on total assets (Profitability). Time-series variations in ICFS are measured by time trend (T − trend) and four-year period indicator variables. Panel C and Panel D report coefficients estimated from alternative model specification: $(I_{i,t}/K_{i,t-1}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/K_{i,t-1}) + \beta_2 q_{i,t-1} + \beta_3 Z_{i,t} + \beta_4 Z_{i,t} (CF_{i,t}/K_{i,t-1}) + \varepsilon_{i,t}$. $I_{i,t}/K_{i,t-1}$ is the firm's physical investment, $I_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q. $CF_{i,t}/K_{i,t-1}$ is the firm's internal cash flow, $CF_{i,t}$, deflated by its beginning-of-period physical assets, $K_{i,t-1}$. $Z_{i,t}$ is a vector of firm-level characteristics (Liquidity − to − Tangibility, Leverage − to − Tangibility, Dividend, and Size). The t-statistics reported in parentheses adjusted for clustered standard errors at the country level and at the firm level in Panel A(B) and in Panel C(D), respectively. Country, industry and time fixed effects are included in Panel C(D). Standard errors are heteroskedasticity-consistent. Mean VIF is the mean variance inflation factor. Nobs is the number of country-year observations. RSq is adjusted R^2.

Panel A: Developed market economies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liquidity-to-Tangibility	-0.126		-0.104	-0.072				
	(-4.41)		(-3.70)	(-2.00)				
Leverage-to-Tangibility		-0.045	-0.026	-0.037				
		(-3.76)	(-2.55)	(-2.39)				
PC					-0.014	-0.014	-0.017	-0.018
					(-2.79)	(-2.73)	(-3.19)	(-1.97)
Dividend	0.064	0.100	0.068	0.052	0.034	0.000	0.021	-0.048
	(2.00)	(3.76)	(2.47)	(1.47)	(1.10)	(0.00)	(0.68)	(-0.70)
Profitability	0.443	0.415	0.443	0.322	0.410	0.396	0.538	0.521
	(3.16)	(3.07)	(3.29)	(2.27)	(2.92)	(2.61)	(3.41)	(2.57)
Size	0.003	0.010	0.011	0.013	0.012	0.008	0.012	0.005
	(0.61)	(1.37)	(1.78)	(1.23)	(1.99)	(0.95)	(2.12)	(0.35)
T-trend					-0.003	-0.003		
					(-2.32)	(-2.29)		
T_1995-1998							-0.046	-0.047
							(-2.06)	(-2.04)
T_1999-2002							-0.045	-0.054
							(-2.30)	(-2.36)
T_2003-2006							-0.061	-0.069
							(-2.89)	(-2.70)
T_2007-2010							-0.041	-0.045
							(-1.75)	(-1.64)
Country FE	No	No	No	Yes	No	Yes	No	Yes
Mean VIF	1.47	1.74	1.77	1.63	1.72	1.51	1.87	2.21
RSq	11.0%	9.3%	11.5%	12.0%	13.9%	14.3%	14.9%	15.1%
Nobs	417	417	417	417	417	417	417	417

Table A.7 (continue)

Panel B: Emerging market economies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liquidity-to-Tangibility	-0.078		0.031	0.057				
	(-0.63)		(0.28)	(0.56)				
Leverage-to-Tangibility		-0.081	-0.084	-0.084	-0.065	-0.062	-0.074	-0.076
		(-3.21)	(-3.25)	(-3.10)	(-2.19)	(-1.89)	(-2.62)	(-2.40)
Dividend	0.086	0.109	0.113	0.159	0.078	0.179	0.069	0.124
	(1.72)	(2.15)	(2.15)	(2.49)	(1.34)	(2.42)	(1.20)	(1.80)
Profitability	-0.025	-0.328	-0.373	-0.664	-0.244	-0.462	-0.082	-0.393
	(-0.07)	(-0.97)	(-1.07)	(-1.51)	(-0.73)	(-1.23)	(-0.29)	(-1.15)
Size	0.002	0.009	0.009	-0.006	0.012	-0.023	0.015	0.003
	(0.15)	(1.06)	(1.08)	(-0.35)	(1.44)	(-1.42)	(1.84)	(0.17)
T-trend					-0.005	-0.002		
					(-2.76)	(-1.03)		
T_1995-1998							-0.033	-0.042
							(-0.66)	(-0.79)
T_1999-2002							-0.011	-0.020
							(-0.23)	(-0.41)
T_2003-2006							-0.073	-0.074
							(-1.56)	(-1.53)
T_2007-2010							-0.060	-0.059
							(-1.28)	(-1.13)
Country FE	No	No	No	Yes	No	Yes	No	Yes
Mean VIF	1.16	1.13	1.23	1.43	1.19	1.88	2.02	1.70
RSq	0.4%	4.3%	4.0%	5.5%	5.7%	7.6%	5.4%	6.6%
Nobs	368	368	368	368	368	368	368	368

Table A.7 (continue)

Panel C: Firms with positive and negative cash flows

	1991-94	1995-98	1999-02	2003-06	2007-10
$CF_{i,t}/K_{i,t-1}$	0.027	0.061	-0.002	0.019	0.004
	(0.50)	(1.65)	(-0.07)	(0.82)	(0.23)
$(CF_{i,t}/K_{i,t-1})$*(Liquidity-to-Tangibility)	-0.013	-0.009	-0.005	-0.006	-0.005
	(-7.11)	(-8.81)	(-6.51)	(-9.69)	(-10.98)
$(CF_{i,t}/K_{i,t-1})$*(Leverage-to-Tangibility)	-0.008	-0.008	-0.004	-0.005	-0.004
	(-4.60)	(-6.98)	(-3.73)	(-6.94)	(-7.03)
$(CF_{i,t}/K_{i,t-1})$*(Dividend)	-0.399	-0.295	-0.094	-0.157	-0.239
	(-4.17)	(-2.39)	(-1.21)	(-2.41)	(-5.92)
$(CF_{i,t}/K_{i,t-1})$*(Size)	0.011	0.005	0.007	0.006	0.006
	(2.54)	(1.41)	(2.36)	(3.11)	(4.05)
TQ	0.001	0.005	0.003	0.003	0.004
	-(1.80)	-(8.56)	-(8.20)	-(8.52)	-(10.74)
Country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
RSq	22.6%	23.7%	27.1%	22.1%	21.8%
Nobs	22,747	35,330	48,487	62,207	71,246

Panel D: Firms with strictly positive cash flow

	1991-94	1995-98	1999-02	2003-06	2007-10
$CF_{i,t}/K_{i,t-1} > 0$	0.121	0.129	0.207	0.120	0.092
	(1.81)	(2.53)	(4.59)	(4.08)	(4.14)
$(CF_{i,t}/K_{i,t-1})$*(Liquidity-to-Tangibility)	-0.012	-0.016	-0.010	-0.007	-0.008
	(-6.00)	(-8.48)	(-8.13)	(-8.40)	(-11.79)
$(CF_{i,t}/K_{i,t-1})$*(Leverage-to-Tangibility)	-0.008	-0.007	-0.008	-0.004	-0.004
	(-3.73)	(-4.11)	(-6.58)	(-4.62)	(-5.05)
$(CF_{i,t}/K_{i,t-1})$*(Dividend)	-0.597	-0.353	-0.417	-0.253	-0.371
	(-5.29)	(-2.43)	(-4.93)	(-3.46)	(-8.06)
$(CF_{i,t}/K_{i,t-1})$*(Size)	0.008	0.003	-0.004	0.000	0.002
	(1.42)	(0.69)	(-1.15)	(0.18)	(0.98)
Country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
RSq	24.1%	25.5%	29.0%	23.6%	23.7%
Nobs	20,744	31,297	39,746	53,392	58,577

Table A.8 Cash flow sensitivity of cash

The table reports coefficients estimated from regression of changes in cash reserves on cash flow, Tobin's q, size and other controls: $(\Delta Cash_{i,t}/TA_{i,t}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/TA_{i,t}) + \beta_2 q_{i,t} + \beta_3 Size_{i,t} + \beta_4 Controls_{i,t} + \varepsilon_{i,t}$. $\Delta Cash_{i,t}/TA_{i,t}$ represents a change in the firm's cash and cash equivalent scaled by total assets. $CF_{i,t}/TA_{i,t}$ is the internal cash flow less dividends scaled by total assets, and $q_{i,t}$ is Tobin's q. $Size_{i,t}$ is the natural log of total assets. $Controls_{i,t}$ include capital expenditures, shares repurchases, other investments, changes in non-cash net working capital, and changes in short-term debt, where all the control variables are scaled by total assets. The sample consists of non-financial and non-utility firms from 21 developed market economies and 24 emerging market economies. In Panel A, developed market firms are classified into the sample of firms with all cash flows and the subsample of firms with strictly positive cash flows. In Panel B, emerging market firms are classified into the sample of firms with all cash flows and the subsample of firms with strictly positive cash flows. The t-statistics reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. Country, industry and time fixed effects are included. Nobs is the number of firm-year observations. RSq is adjusted R^2.

Panel A: Developed market economies

All firms						Firms with $CF_{i,t}/TA_{i,t} > 0$					
Period	$CF_{i,t}/TA_{i,t}$	$q_{i,t}$	$Size_{i,t}$	RSq	Nobs	Period	$CF_{i,t}/TA_{i,t}$	$q_{i,t}$	$Size_{i,t}$	RSq	Nobs
1991-94	0.196	0.008	0.001	18.1%	18,893	1991-94	0.275	0.006	0.001	20.2%	17,169
	(8.62)	(5.04)	(2.18)				(9.49)	(3.32)	(2.54)		
1995-98	0.227	0.004	0.000	14.7%	26,709	1995-98	0.270	0.002	-0.001	15.9%	23,718
	(12.89)	(3.47)	(-0.82)				(6.86)	(1.37)	(-1.10)		
1999-02	0.291	0.008	0.001	20.9%	32,600	1999-02	0.333	0.005	0.001	18.1%	26,658
	(22.43)	(6.56)	(3.02)				(11.79)	(3.38)	(2.62)		
2003-06	0.233	0.011	-0.001	15.8%	40,467	2003-06	0.340	0.005	-0.001	19.3%	34,310
	(18.58)	(7.78)	(-1.60)				(13.22)	(3.96)	(-1.19)		
2007-10	0.244	0.012	0.001	18.5%	41,827	2007-10	0.352	0.004	0.001	17.8%	32,922
	(26.17)	(9.44)	(4.29)				(17.92)	(3.03)	(3.87)		
1991-10	0.245	0.010	0.000	17.1%	160,496	1991-10	0.325	0.005	0.001	17.5%	134,777
	(39.31)	(14.90)	(1.94)				(24.62)	(6.78)	(2.55)		

Panel B: Emerging market economies

All firms						Firms with $CF_{i,t}/TA_{i,t} > 0$					
Period	$CF_{i,t}/TA_{i,t}$	$q_{i,t}$	$Size_{i,t}$	RSq	Nobs	Period	$CF_{i,t}/TA_{i,t}$	$q_{i,t}$	$Size_{i,t}$	RSq	Nobs
1991-94	0.222	0.000	0.008	17.2%	2,034	1991-94	0.263	-0.002	0.008	17.3%	1,933
	(4.24)	(-0.21)	(4.62)				(4.06)	(-1.00)	(4.26)		
1995-98	0.314	-0.002	0.004	20.6%	5,362	1995-98	0.194	0.001	0.004	15.8%	4,784
	(6.65)	(-0.93)	(3.81)				(4.90)	(0.56)	(3.22)		
1999-02	0.234	0.001	0.003	15.6%	8,164	1999-02	0.314	0.000	0.003	17.4%	6,975
	(11.10)	(0.66)	(2.60)				(8.40)	(-0.15)	(2.43)		
2003-06	0.287	0.005	0.000	20.2%	15,227	2003-06	0.367	0.003	0.000	22.7%	13,621
	(10.42)	(2.86)	(0.66)				(8.67)	(1.46)	(0.55)		
2007-10	0.278	0.003	0.002	19.1%	21,947	2007-10	0.343	0.002	0.003	20.5%	19,455
	(16.61)	(2.38)	(5.02)				(10.63)	(1.28)	(4.80)		
1991-10	0.275	0.003	0.002	17.7%	52,734	1991-10	0.328	0.002	0.002	18.4%	46,768
	(20.59)	(3.83)	(6.33)				(16.16)	(2.30)	(5.89)		

Table A.9 Alternative cash flow sensitivities

The table reports alternative cash flow-based sensitivities. Panel A reports coefficients estimated from the following regression: $(RD_{i,t}/TA_{i,t-1}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/TA_{i,t-1}) + \beta_2 q_{i,t-1} + \beta_3 (Cash_{i,t-1}/TA_{i,t-1}) + \varepsilon_{i,t}$. $RD_{i,t}/TA_{i,t-1}$ is the firm's R&D expenses, deflated by its beginning-of-period total assets. $CF_{i,t}/TA_{i,t-1}$ is the firm's internal cash flow, deflated by its beginning-of-period total assets. $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q in the previous period. $Cash_{i,t-1}/TA_{i,t-1}$ is the firm's cash and cash equivalents in the previous year, scaled by the previous year's total assets. Panel B reports coefficients estimated from the following regression: $(\Delta INV_{i,t}/K_{i,t-1}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/K_{i,t-1}) + \beta_2 q_{i,t-1} + \beta_3 (INV_{i,t-1}/K_{i,t-1}) + \beta_4 (Cash_{i,t-1}/K_{i,t-1}) + \varepsilon_{i,t}$. $\Delta INV_{i,t}/K_{i,t-1}$ is the firm's change in inventory, deflated by its beginning-of-period physical assets. $CF_{i,t}/K_{i,t-1}$ is the firm's internal cash flow, deflated by its beginning-of-period physical assets. $INV_{i,t-1}/K_{i,t-1}$ is the previous year's inventory, scaled by the previous year's physical assets. $Cash_{i,t-1}/K_{i,t-1}$ is the firm's cash and cash equivalents in the previous year, scaled by the previous year's physical assets. Panel C reports coefficients estimated from the following regression: $(I_{i,t}/K_{i,t-1}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (CF_{i,t}/K_{i,t-1}) + \beta_2 q_{i,t-1} + \beta_3 (Cash_{i,t-1}/K_{i,t-1}) + \varepsilon_{i,t}$. The sample consists of non-financial and non-utility firms from 21 developed market economies and 24 emerging market economies. The pooled regressions are estimated on a 20-year panel between 1991 and 2010. Firms are classified into the sample of firms with all cash flows and the subsample of firms with strictly positive cash flows. The t-statistics reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. Country, industry and time fixed effects are included. Nobs is the number of firm-year observations. RSq is adjusted R^2. DEV stands for developed market economies. EMG denotes emerging market economies.

Panel A: R&D-cash flow sensitivity

	All firms					Firms with $CF_{i,t}/TA_{i,t} > 0$				
	$CF_{i,t}/TA_{i,t-1}$	$q_{i,t-1}$	$Cash_{i,t}/TA_{i,t-1}$	RSq	Nobs	$CF_{i,t}/TA_{i,t-1}$	$q_{i,t-1}$	$Cash_{i,t}/TA_{i,t-1}$	RSq	Nobs
DEV	-0.086	0.015	0.088	47.9%	68,154	0.060	0.010	0.051	43.1%	56,504
	(-9.19)	(15.28)	(11.19)			(5.34)	(10.80)	(7.49)		
Difference	-0.146									
p-value	0.000									
EMG	0.005	0.003	0.030	31.1%	15,003	0.030	0.002	0.024	32.8%	13,468
	(0.91)	(4.64)	(6.17)			(5.06)	(2.99)	(5.45)		
Difference	-0.024									
p-value	0.000									

Panel B: Inventory investment-cash flow sensitivity

	All firms						Firms with $CF_{i,t}/TA_{i,t} > 0$					
	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	$INV_{i,t-1}/K_{i,t-1}$	$Cash_{i,t-1}/K_{i,t-1}$	RSq	Nobs	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	$INV_{i,t-1}/K_{i,t-1}$	$Cash_{i,t-1}/K_{i,t-1}$	RSq	Nobs
DEV	0.071	0.003	0.063	0.006	11.7%	175,044	0.114	0.000	0.073	-0.005	13.9%	146,387
	(11.39)	(5.57)	(7.86)	(3.06)			(11.06)	(0.52)	(8.42)	(-1.65)		
Difference	-0.043											
p-value	0.000											
EMG	0.132	0.001	0.065	-0.007	13.3%	63,142	0.140	0.000	0.081	-0.012	15.0%	56,030
	(10.79)	(1.67)	(8.54)	(-1.41)			(10.42)	(0.45)	(11.39)	(-2.13)		
Test for	-0.008											
p-value	0.552											

Panel C: Investment-cash reserve sensitivity

	All firms					Firms with $CF_{i,t}/TA_{i,t} > 0$				
	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	$Cash_{i,t-1}/K_{i,t-1}$	RSq	Nobs	$CF_{i,t}/K_{i,t-1}$	$q_{i,t-1}$	$Cash_{i,t-1}/K_{i,t-1}$	RSq	Nobs
DEV	0.035	0.004	0.009	19.1%	176,631	0.071	0.003	0.001	21.4%	147,517
	(20.25)	(19.96)	(9.73)			(20.74)	(10.84)	(1.17)		
Difference	-0.036									
p-value	0.000									
EMG	0.084	0.003	0.003	19.2%	63,386	0.103	0.002	-0.004	19.3%	56,239
	(18.43)	(6.08)	(1.27)			(17.37)	(4.51)	(-1.39)		
Difference	-0.018									
p-value	0.002									

Table B.1 Summary descriptive statistics

Panel A reports cross-country statistics while Panel B reports firm-level statistics for the variables used in the baseline model in Eq.(6). Panel B reports descriptive statistics for positive and negative cash flow firms separately. Cash/TA is the ratio of cash and cash equivalents to total assets. ΔCash/TA is the change in cash and cash equivalents scaled by total assets. CF/TA or CashFlow is internal cash flow (calculated as net income before extraordinary items plus depreciation and amortization) minus dividends paid scaled by total assets. Other financial variables include the actual ratio of future investments to current investments (LeadInv), firm size (Size), capital expenditures (CapEx), shares repurchases (ShareRep), other investments (OtherInv), changes in non-cash net working capital (ΔNWC), and changes in short-term debt (ΔSD), where all the variables are scaled by total assets. SMKT is the average of three standardized indices from the 2013 World Bank Database: market capitalization over GDP, total value traded over GDP, and total value traded over market capitalization. FINT is the average of two standardized indices: the ratio of liquid liabilities (M3 or broad money) to GDP and the ratio of the credit going to the private sector to GDP. SMKT serves as a measure of stock market development. FINT reflects financial intermediary development. FD is the sum of SMKT and FINT. Nobs is the number of observations. The sample period covers 1995 to 2010 years.

Panel A: cross-country statistics

Country	Nobs	$\frac{\text{Cash}}{\text{TA}}$	$\frac{\Delta\text{Cash}}{\text{TA}}$	Cash Flow	LeadInv	Size	CapEx	OtherInv	Share Rep	ΔNWC	ΔSD	SMKT	FINT	FD
Australia	7,834	0.182	0.011	-0.046	1.81	10.96	0.078	0.020	0.003	0.001	0.004	0.38	0.26	0.64
Austria	761	0.131	-0.001	0.059	1.27	12.75	0.066	0.037	0.001	0.001	0.004	-0.59	0.35	-0.24
Belgium	1,317	0.130	0.008	0.065	1.40	12.94	0.065	0.028	0.004	0.005	0.002	-0.38	0.14	-0.24
Canada	10,704	0.165	0.012	-0.030	1.70	11.40	0.096	0.013	0.003	0.001	0.003	0.32	0.91	1.22
Denmark	1,664	0.133	-0.004	0.059	1.35	12.02	0.065	0.011	0.006	0.007	0.006	-0.15	0.12	-0.02
Ireland	640	0.166	0.013	0.043	1.51	12.56	0.054	0.014	0.003	0.001	0.004	-0.35	0.51	0.16
Finland	1,742	0.128	0.001	0.063	1.39	12.48	0.067	0.013	0.003	0.004	0.003	0.52	-0.40	0.12
France	7,303	0.146	0.008	0.056	1.40	12.43	0.050	0.017	0.002	0.003	0.004	0.15	0.01	0.17
Germany	7,583	0.147	0.003	0.044	1.40	12.32	0.058	0.025	0.001	0.002	0.002	0.15	0.48	0.62
Hong Kong	7,110	0.211	0.020	0.021	1.86	12.09	0.047	0.039	0.001	0.004	0.006	2.97	2.56	5.53
Italy	2,217	0.122	0.003	0.045	1.39	13.19	0.046	0.020	0.001	0.006	0.005	0.03	-0.15	-0.12
Japan	34,202	0.173	0.007	0.037	1.44	12.78	0.037	0.058	0.002	0.003	0.000	0.36	2.34	2.70
Netherlands	1,949	0.112	0.004	0.074	1.30	12.89	0.060	0.009	0.005	0.006	0.005	0.69	0.73	1.41
Norway	1,808	0.169	0.008	0.034	1.61	12.37	0.083	0.012	0.004	0.005	0.005	0.06	-0.28	-0.22
New Zealand	867	0.076	0.004	0.035	1.41	11.63	0.063	0.018	0.003	0.009	0.007	-0.49	0.38	-0.11
Singapore	5,203	0.181	0.016	0.044	1.74	11.64	0.055	0.032	0.001	0.008	0.005	0.77	0.53	1.30
Spain	1,379	0.094	0.007	0.065	1.47	13.41	0.054	0.023	0.004	0.004	0.006	0.71	0.61	1.33
Sweden	3,452	0.160	0.003	0.017	1.49	11.73	0.045	0.009	0.003	0.005	0.003	0.63	-0.06	0.57
Switzerland	2,387	0.153	0.006	0.066	1.24	13.01	0.048	0.020	0.009	0.002	-0.001	1.59	1.51	3.09
UK	15,402	0.142	0.005	0.025	1.42	11.78	0.054	0.008	0.004	0.000	0.003	0.89	0.98	1.87
US	56,367	0.186	0.006	0.025	1.40	12.41	0.056	0.019	0.016	0.001	0.002	1.54	0.74	2.28

Table B.1 (continue)

Argentina	579	0.071	0.004	0.059	1.60	12.11	0.055	0.018	0.001	0.000	-0.002	-0.75	-1.16	-1.91
Brazil	1,989	0.131	0.014	0.057	1.50	13.18	0.067	0.012	0.002	0.011	0.007	-0.42	-0.73	-1.15
China	12,239	0.185	0.015	0.052	1.79	12.47	0.065	0.009	0.000	0.005	0.024	0.45	0.98	1.43
Chile	1,359	0.065	0.006	0.051	1.39	12.28	0.059	0.008	0.000	0.007	0.000	-0.40	-0.44	-0.84
Colombia	241	0.069	0.004	0.044	1.59	12.84	0.037	0.117	0.001	0.001	0.002	-0.82	-1.06	-1.89
Czech Rep.	172	0.088	0.013	0.076	1.22	12.56	0.064	0.014	0.000	0.007	0.001	-0.51	-0.47	-0.97
Egypt	467	0.159	0.007	0.066	2.24	12.03	0.058	0.021	0.002	0.013	0.003	-0.19	-0.29	-0.48
Greece	1,083	0.081	0.006	0.029	1.46	12.16	0.049	0.023	0.001	0.002	0.011	-0.31	0.26	-0.05
Hungary	239	0.098	-0.002	0.076	1.22	11.91	0.087	0.028	0.005	0.001	0.002	-0.35	-0.64	-1.00
Indonesia	2,302	0.124	0.009	0.066	1.77	11.58	0.062	0.013	0.001	0.011	0.011	-0.48	-0.90	-1.39
India	8,523	0.070	0.010	0.073	1.66	11.47	0.081	0.043	0.001	0.015	0.011	0.30	-0.56	-0.26
Mexico	1,227	0.079	0.004	0.065	1.40	13.62	0.053	0.009	0.005	0.003	-0.001	-0.68	-1.13	-1.81
Malaysia	7,346	0.120	0.006	0.037	1.76	11.46	0.046	0.024	0.001	0.004	0.006	0.11	0.75	0.85
Peru	704	0.076	0.009	0.080	1.76	11.56	0.054	0.014	0.002	0.012	0.003	-0.72	-1.07	-1.79
Pakistan	1,274	0.101	0.005	0.065	1.72	10.91	0.064	0.012	0.000	0.001	0.004	0.42	-0.91	-0.48
Poland	1,655	0.105	0.003	0.063	1.68	11.33	0.070	0.023	0.002	0.015	0.007	-0.54	-0.77	-1.31
Portugal	612	0.055	0.006	0.055	1.40	12.76	0.053	0.024	0.003	-0.001	0.011	-0.37	0.59	0.23
Philippines	1,190	0.112	0.008	0.049	1.50	11.64	0.059	0.034	0.003	0.000	0.003	-0.59	-0.67	-1.26
Russia	631	0.087	0.011	0.099	1.55	13.90	0.086	0.037	0.004	0.008	0.001	0.01	-0.87	-0.86
South Africa	2,729	0.131	0.011	0.071	1.47	11.86	0.067	0.022	0.004	0.005	0.003	0.50	0.14	0.64
Thailand	3,886	0.097	0.006	0.060	1.66	11.30	0.059	0.028	0.001	0.009	0.005	-0.06	0.55	0.49
Turkey	1,487	0.100	0.008	0.065	1.89	12.07	0.061	0.025	0.000	0.013	0.005	0.16	-0.96	-0.80
Venezuela	174	0.075	0.002	0.046	1.73	12.37	0.044	0.019	0.001	-0.002	0.001	-0.92	-1.24	-2.17
Mean		0.122	0.007	0.050	1.54	12.23	0.060	0.023	0.003	0.005	0.004	0.08	0.04	0.12
Median		0.073	0.002	0.063	1.02	12.12	0.042	0.001	0.000	0.005	0.000	-0.09	-0.07	-0.09
Std dev		0.139	0.087	0.107	2.22	1.89	0.060	0.068	0.017	0.088	0.074	0.86	0.93	1.61
Q1		0.028	-0.019	0.026	0.63	10.92	0.019	0.000	0.000	-0.031	-0.016	-0.51	-0.70	-1.04
Q3		0.165	0.032	0.101	1.61	13.45	0.080	0.013	0.000	0.044	0.030	0.48	0.57	0.88
Nobs		223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999

Table B.1 (continue)

Panel B: firm-level statistics

	$\frac{\text{Cash}}{\text{TA}}$	$\frac{\Delta\text{Cash}}{\text{TA}}$	Cash Flow	LeadInv	Size	CapEx	OtherInv	Share Rep	ΔNWC	ΔSD
Positive cash flow firms										
Mean	0.142	0.015	0.080	1.501	12.480	0.059	0.026	0.006	0.011	0.004
Median	0.094	0.005	0.071	1.056	12.341	0.041	0.001	0.000	0.007	0.000
Std dev	0.148	0.081	0.052	1.981	1.861	0.059	0.063	0.026	0.076	0.063
Q1	0.035	-0.015	0.042	0.699	11.205	0.019	0.000	0.000	-0.023	-0.012
Q3	0.197	0.039	0.108	1.579	13.628	0.076	0.021	0.000	0.043	0.022
Nobs	180,510	180,510	180,510	180,510	180,510	180,510	180,510	180,510	180,510	180,510
Negative cash flow firms										
Mean	0.223	-0.021	-0.160	1.616	11.033	0.050	0.025	0.003	-0.027	0.004
Median	0.138	-0.008	-0.086	0.857	10.930	0.025	0.000	0.000	-0.014	0.000
Std dev	0.225	0.155	0.186	2.763	1.839	0.069	0.070	0.016	0.109	0.081
Q1	0.045	-0.079	-0.216	0.434	9.773	0.009	0.000	0.000	-0.070	-0.007
Q3	0.339	0.030	-0.031	1.573	12.151	0.058	0.014	0.000	0.025	0.022
Nobs	43,489	43,489	43,489	43,489	43,489	43,489	43,489	43,489	43,489	43,489
Diff.	-0.081	0.036	0.241	-0.115	1.447	0.008	0.000	0.004	0.038	0.000
(t-stat)	(-91.0)	(67.5)	(478.2)	(-10.0)	(145.9)	(25.34)	(1.34)	(28.4)	(85.2)	(0.03)

Table B.2 Pairwise correlations of country-level financial development and firm-level variables

The table provides the pairwise correlations between financial development indices and some selected variables presented in Table B.1. Cash/TA is the ratio of cash and cash equivalents to total assets. ΔCash/TA is the change in cash and cash equivalents scaled by total assets. CF/TA or CashFlow is internal cash flow (calculated as net income before extraordinary items plus depreciation and amortization) minus dividends paid scaled by total assets. LeadInv is the actual ratio of future investments to current investments. Size is the natural log of total assets. SMKT is the average of three standardized indices from the 2013 World Bank Database: market capitalization over GDP, total value traded over GDP, and total value traded over market capitalization. FINT is the average of two standardized indices: the ratio of liquid liabilities (M3 or broad money) to GDP and the ratio of the credit going to the private sector to GDP. SMKT serves as a measure of stock market development. FINT reflects financial intermediary development. FD is the sum of SMKT and FINT. The sample period covers 1995 to 2010 years. The superscripts * and ** indicate significance levels of 0.01 and 0.05, respectively.

Panel A. Pearson correlations

	SMKT	FINT	FD	Cash/TA	ΔCash/TA	CashFlow	LeadInv
FINT	0.6339*						
FD	0.8957*	0.9117*					
Cash/TA	0.1857*	0.1833*	0.2040*				
ΔCash/TA	0.0311*	0.0118*	0.0233*	-0.1709*			
CashFlow	-0.0720*	-0.1168*	-0.1054*	-0.1158*	0.1815*		
LeadInv	0.0125*	-0.0161*	-0.0026	0.0420*	0.0656*	-0.0043**	
Size	-0.0021	0.0267*	0.0142*	-0.1359*	0.0320*	0.2283*	-0.1147*

Panel B. Spearman correlations

	SMKT	FINT	FD	Cash/TA	ΔCash/TA	CashFlow	LeadInv
FINT	0.3979*						
FD	0.7538*	0.8726*					
Cash/TA	0.1118*	0.2138*	0.1995*				
ΔCash/TA	0.0309*	0.0127*	0.0168*	-0.1150*			
CashFlow	-0.0096*	-0.1398*	-0.1005*	-0.0598*	0.1897*		
LeadInv	-0.0088*	-0.0190*	-0.0287*	0.0218*	0.1301*	0.1330*	
Size	0.0134*	0.1172*	0.1092*	-0.1268*	0.0336*	0.1768*	0.0066*

Table B.3 Corporate demand for internal liquidity and financial development: baseline analysis (1)

The table reports coefficients estimated from the model in Eq.(6): $(\Delta \text{Cash}_{i,t}/\text{TA}_{i,t}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (\text{CF}_{i,t}/\text{TA}_{i,t}) + \beta_2(\text{CF}_{i,t}/\text{TA}_{i,t}) * \text{FinDev}_{i,t} + \beta_3(\text{CF}_{i,t}/\text{TA}_{i,t}) * \text{Neg}_{i,t} + \beta_4 \text{LeadInv}_{i,t} + \beta_5 \text{Controls}_{i,t} + \varepsilon_{i,t}$. $\Delta \text{Cash}_{i,t}/\text{TA}_{i,t}$ is the change in cash and cash equivalents scaled by total assets. $\text{CF}_{i,t}/\text{TA}_{i,t}$ or CashFlow is internal cash flow (calculated as net income before extraordinary items plus depreciation and amortization) minus dividends paid scaled by total assets. $\text{LeadInv}_{i,t}$ is the actual ratio of future investments to current investments, and used as a measure of the firm's investment opportunities. $\text{Controls}_{i,t}$ include firm size (Size), capital expenditures (CapEx), shares repurchases (ShareRep), other investments (OtherInv), changes in non-cash net working capital (ΔNWC), and changes in short-term debt (ΔSD), where all the control variables are scaled by total assets. Neg is equal to unity if cash flow is negative and zero otherwise. NonLinearity is a quadratic version of internal cash flow (CashFlow). The regressions include country (α_c), industry (α_i), and time (α_t) fixed effects. FinDev is represented by SMKT, FINT or FD indices. SMKT is the average of three standardized indices from the 2013 World Bank Database: market capitalization over GDP, total value traded over GDP, and total value traded over market capitalization. FINT is the average of two standardized indices: the ratio of liquid liabilities (M3 or broad money) to GDP and the ratio of the credit going to the private sector to GDP. SMKT serves as a measure of stock market development. FINT reflects financial intermediary development. FD is the sum of SMKT and FINT. The sample consists of non-financial and non-utility firms from 44 countries. The model in Eq.(6) is estimated using the generalized method of moments (GMM) methodology with instrumental variables and analytical weights. The Hansen's J tests of overidentifying restrictions are reported. The z-statistics reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. Nobs is the number of firm-year observations, and RSq is adjusted R^2. The sample period covers 1995 to 2010 years.

Table B.3 (continue)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CashFlow*SMKT	-0.005	0.007	0.008						
	(-1.07)	(1.38)	(1.63)						
SMKT	0.006	0.005	0.005						
	(12.44)	(9.81)	(10.47)						
CashFlow*FINT				-0.014	0.002	0.003			
				(-2.54)	(0.42)	(0.61)			
FINT				0.004	0.002	0.003			
				(7.69)	(4.49)	(5.12)			
CashFlow*FD							-0.006	0.003	0.003
							(-2.12)	(0.90)	(1.15)
FD							0.003	0.002	0.002
							(11.59)	(8.17)	(8.93)
CashFlow	0.214	0.361	0.271	0.215	0.363	0.271	0.217	0.363	0.272
	(27.65)	(21.17)	(27.71)	(29.44)	(22.49)	(29.25)	(27.89)	(21.68)	(28.08)
LeadInv	-0.009	-0.020	-0.016	-0.007	-0.018	-0.014	-0.008	-0.019	-0.015
	(-2.08)	(-3.63)	(-3.25)	(-1.69)	(-3.43)	(-2.95)	(-1.88)	(-3.51)	(-3.08)
Size	-0.002	-0.003	-0.003	-0.002	-0.003	-0.002	-0.002	-0.003	-0.002
	(-3.37)	(-4.25)	(-4.11)	(-3.09)	(-4.11)	(-3.90)	(-3.25)	(-4.17)	(-4.00)
CapEx	-0.199	-0.282	-0.257	-0.191	-0.273	-0.247	-0.195	-0.277	-0.252
	(-9.81)	(-9.81)	(-10.08)	(-9.56)	(-9.78)	(-9.93)	(-9.57)	(-9.70)	(-9.89)
OtherInv	-0.043	-0.034	-0.037	-0.044	-0.035	-0.038	-0.043	-0.034	-0.038
	(-6.03)	(-3.62)	(-4.41)	(-6.58)	(-3.96)	(-4.86)	(-6.18)	(-3.73)	(-4.56)
ShareRep	-0.356	-0.404	-0.395	-0.342	-0.390	-0.381	-0.351	-0.399	-0.390
	(-11.81)	(-12.25)	(-12.34)	(-11.50)	(-12.07)	(-12.13)	(-11.68)	(-12.18)	(-12.26)
ΔNWC	-0.231	-0.228	-0.232	-0.231	-0.228	-0.232	-0.231	-0.228	-0.232
	(-29.54)	(-27.92)	(-28.98)	(-29.62)	(-28.20)	(-29.24)	(-29.56)	(-28.01)	(-29.07)
ΔSD	0.161	0.165	0.165	0.162	0.167	0.166	0.162	0.166	0.166
	(23.59)	(22.55)	(23.18)	(23.97)	(23.06)	(23.68)	(23.77)	(22.79)	(23.42)
CashFlow*Neg		-0.229			-0.231			-0.231	
		(-11.88)			(-12.66)			(-12.26)	
Neg		0.000			0.000			0.000	
		(-0.15)			(0.07)			(-0.02)	
NonLinearity			0.237			0.237			0.239
			(11.80)			(12.41)			(12.13)
Nobs	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999
J-test	0.65	0.46	0.55	0.34	0.26	0.29	0.49	0.37	0.43
∂ΔCashHold / ∂CashFlow (μ)	0.214	0.361	0.272	0.215	0.363	0.271	0.216	0.364	0.272
∂ΔCashHold / ∂CashFlow (μ+1σ)	0.210	0.367	0.278	0.201	0.365	0.274	0.206	0.368	0.277

Table B.4 Corporate demand for internal liquidity and financial development: baseline analysis (2)

The table reports coefficients estimated from the model in Eq.(7):$(\Delta\text{Cash}_{i,t}/\text{TA}_{i,t}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (\text{CF}_{i,t}/\text{TA}_{i,t}) + \beta_2(\text{CF}_{i,t}/\text{TA}_{i,t}) * \text{Neg}_{i,t} + \beta_3\text{LeadInv}_{i,t} + \beta_4\text{Controls}_{i,t} + \varepsilon_{i,t}$. The firms are partitioned by the median values of respective financial development indices into (i) the high FinDev firms and (ii) the low FinDev firms. $\Delta\text{Cash}_{i,t}/\text{TA}_{i,t}$ is the change in cash and cash equivalents scaled by total assets. $\text{CF}_{i,t}/\text{TA}_{i,t}$ or CashFlow is internal cash flow (calculated as net income before extraordinary items plus depreciation and amortization) minus dividends paid scaled by total assets. $\text{LeadInv}_{i,t}$ is the actual ratio of future investments to current investments, and used as a measure of the firm's investment opportunities. $\text{Controls}_{i,t}$ include firm size (Size), capital expenditures (CapEx), shares repurchases (ShareRep), other investments (OtherInv), changes in non-cash net working capital (ΔNWC), and changes in short-term debt (ΔSD), where all the control variables are scaled by total assets. Neg is equal to unity if cash flow is negative and zero otherwise. The regressions include country (α_c), industry (α_i), and time (α_t) fixed effects. FinDev is represented by SMKT, FINT or FD indices. SMKT is the average of three standardized indices from the 2013 World Bank Database: market capitalization over GDP, total value traded over GDP, and total value traded over market capitalization. FINT is the average of two standardized indices: the ratio of liquid liabilities (M3 or broad money) to GDP and the ratio of the credit going to the private sector to GDP. SMKT serves as a measure of stock market development. FINT reflects financial intermediary development. FD is the sum of SMKT and FINT. The sample consists of non-financial and non-utility firms from 44 countries. The model in Eq.(7) is estimated using the generalized method of moments (GMM) methodology with instrumental variables and analytical weights. The Hansen's J tests of overidentifying restrictions are reported. The z-statistics reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. P-values indicate a statistical difference in the coefficients of CashFlow between two respective subsamples. Nobs is the number of firm-year observations, and RSq is adjusted R^2. The sample period covers 1995 to 2010 years.

Table B.4 (continue)

	SMKT		FINT		FD		SMKT		FINT		FD	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CashFlow	0.199	0.266	0.191	0.276	0.194	0.279	0.356	0.409	0.345	0.407	0.347	0.407
	(36.87)	(11.92)	(32.26)	(12.29)	(33.70)	(12.06)	(25.92)	(9.05)	(24.44)	(8.66)	(27.48)	(8.74)
LeadInv	-0.001	-0.025	0.004	-0.026	0.002	-0.024	-0.013	-0.038	-0.006	-0.039	-0.009	-0.035
	(-0.27)	(-2.75)	(1.17)	(-2.29)	(0.59)	(-2.27)	(-2.39)	(-2.96)	(-1.39)	(-2.44)	(-2.11)	(-2.43)
Size	-0.001	-0.003	-0.001	-0.003	-0.001	-0.003	-0.003	-0.004	-0.002	-0.005	-0.002	-0.004
	(-2.61)	(-2.66)	(-1.89)	(-2.15)	(-2.40)	(-2.02)	(-3.74)	(-2.87)	(-3.27)	(-2.30)	(-3.92)	(-2.21)
CapEx	-0.154	-0.315	-0.121	-0.331	-0.132	-0.321	-0.230	-0.414	-0.194	-0.421	-0.207	-0.403
	(-8.24)	(-6.26)	(-7.45)	(-5.21)	(-8.33)	(-5.33)	(-9.29)	(-5.54)	(-9.40)	(-4.62)	(-10.31)	(-4.78)
OtherInv	-0.064	-0.024	-0.054	-0.035	-0.056	-0.032	-0.057	-0.014	-0.045	-0.027	-0.046	-0.025
	(-7.69)	(-1.63)	(-8.50)	(-2.27)	(-10.27)	(-2.22)	(-6.24)	(-0.68)	(-6.99)	(-1.29)	(-8.05)	(-1.29)
ShareRep	-0.376	-0.243	-0.384	-0.204	-0.383	-0.204	-0.431	-0.268	-0.440	-0.220	-0.444	-0.214
	(-14.97)	(-2.88)	(-13.60)	(-2.81)	(-16.45)	(-2.38)	(-15.42)	(-2.86)	(-15.12)	(-2.67)	(-17.64)	(-2.28)
ΔNWC	-0.243	-0.216	-0.231	-0.229	-0.238	-0.225	-0.241	-0.212	-0.229	-0.224	-0.236	-0.221
	(-32.46)	(-14.42)	(-32.54)	(-15.08)	(-37.55)	(-14.75)	(-30.96)	(-12.61)	(-31.66)	(-12.94)	(-35.50)	(-13.24)
ΔSD	0.160	0.161	0.126	0.189	0.139	0.176	0.165	0.164	0.134	0.189	0.147	0.176
	(21.66)	(12.51)	(20.03)	(12.90)	(23.30)	(11.92)	(21.62)	(11.20)	(20.96)	(11.04)	(23.81)	(10.59)
CashFlow*Neg							-0.217	-0.259	-0.205	-0.251	-0.207	-0.254
							(-13.39)	(-4.98)	(-11.55)	(-5.63)	(-12.77)	(-5.41)
Neg							0.003	-0.003	0.005	-0.005	0.003	-0.003
							(1.77)	(-0.74)	(2.65)	(-1.10)	(1.83)	(-0.70)
Diff. in CashFlow		-0.067		-0.085		-0.085		-0.053		-0.062		-0.061
p-value		(0.00)		(0.00)		(0.00)		(0.25)		(0.19)		(0.19)
Nobs	185,621	38,378	186,437	37,562	192,541	31,458	185,621	38,378	186,437	37,562	192,541	31,458
J-test	0.11	0.04	0.47	0.33	0.15	0.62	0.08	0.08	0.44	0.24	0.14	0.81

Table B.5 Corporate demand for internal liquidity and financial development: robustness checks

In Panel A, the baseline model in Eq.(6), $(\Delta \text{Cash}_{i,t}/\text{TA}_{i,t}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (\text{CF}_{i,t}/\text{TA}_{i,t}) + \beta_2(\text{CF}_{i,t}/\text{TA}_{i,t}) * \text{FinDev}_{i,t} + \beta_3(\text{CF}_{i,t}/\text{TA}_{i,t}) * \text{Neg}_{i,t} + \beta_4 \text{LeadInv}_{i,t} + \beta_5 \text{Controls}_{i,t} + \varepsilon_{i,t}$, is modified to include alternative measures of financial development: FDa and FDb. FDa is the average of two standardized indices from the 2013 World Bank Database: market capitalization over GDP and the ratio of the credit going to the private sector to GDP. FDb is the average of two standardized indices: total value traded over GDP and the ratio of the credit going to the private sector to GDP. In Panel B, the sample is restricted to positive cash flow firms, and the baseline model is modified to include the legal system indicator variable (LAW) and its interaction with internal cash flow, $\text{CF}_{i,t}/\text{TA}_{i,t}$ (CashFlow). LAW is equal to unity for firms in countries with a common law origin and zero otherwise. In Panel C, the baseline model is modified to include the trade credit (APAY) and its interaction with internal cash flow. APAY is the ratio of accounts payable to total assets. In Panel D, the baseline model is modified to include the previous period cash holding (CashHold) and its interaction with internal cash flow. In Panel E, the sample is restricted to multinational firms with a share of foreign sales in total revenue over 10 percent. The Hansen's J tests of overidentifying restrictions are reported. Nobs is the number of firm-year observations. The main explanatory and control variables are the same as reported in Table B.3 and Table B.4.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Alternatives measures of financial development						
CashFlow*FDa	-0.021	-0.005	-0.004			
	(-3.66)	(-0.93)	(-0.69)			
CashFlow*FDb				-0.014	0.003	0.004
				(-2.91)	(0.54)	(0.77)
CashFlow	0.221	0.361	0.273	0.218	0.361	0.271
	(27.9)	(21.7)	(28.2)	(28.4)	(21.9)	(28.6)
CashFlow*Neg		-0.221			-0.229	
		(-12.0)			(-12.2)	
NonLinearity			0.228			0.236
			(11.8)			(12.0)
J-test	0.40	0.30	0.34	0.44	0.30	0.36
Nobs	223,999	223,999	223,999	223,999	223,999	223,999
Panel B. Sample is restricted to positive cash flow firms + legal system effect						
CashFlow*SMKT	0.011	0.010				
	(0.97)	(0.90)				
CashFlow*FINT			0.012	0.017		
			(1.13)	(1.69)		
CashFlow*FD					0.008	0.010
					(1.30)	(1.59)
CashFlow*LAW	0.055	0.052	0.054	0.047	0.050	0.044
	(2.64)	(2.53)	(2.92)	(2.49)	(2.53)	(2.24)
CashFlow	0.368	0.239	0.369	0.238	0.371	0.241
	(16.9)	(7.07)	(18.4)	(7.20)	(17.8)	(7.22)
NonLinearity		0.607		0.624		0.613
		(4.31)		(4.50)		(4.40)
J-test	0.23	0.23	0.08	0.08	0.16	0.17
Nobs	180,510	180,510	180,510	180,510	180,510	180,510

Table B.5 (continue)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel C. Trade credit effect									
CashFlow*SMKT	-0.005	0.009	0.010						
	(-0.95)	(1.78)	(2.05)						
CashFlow*FINT				-0.013	0.006	0.008			
				(-2.23)	(1.13)	(1.36)			
CashFlow*FD							-0.005	0.004	0.005
							(-1.88)	(1.50)	(1.78)
CashFlow*APAY	0.197	0.250	0.256	0.197	0.254	0.260	0.195	0.250	0.256
	(6.79)	(7.99)	(8.58)	(6.87)	(8.26)	(8.87)	(6.73)	(8.05)	(8.65)
CashFlow	0.171	0.315	0.220	0.171	0.315	0.218	0.173	0.317	0.220
	(16.2)	(16.8)	(18.6)	(16.9)	(17.8)	(19.3)	(16.4)	(17.2)	(18.8)
CashFlow*Neg		-0.248			-0.251			-0.251	
		(-12.2)			(-13.0)			(-12.6)	
NonLinearity			0.261			0.262			0.263
			(12.4)			(13.1)			(12.8)
J-test	0.49	0.29	0.37	0.24	0.16	0.36	0.18	0.23	0.28
Nobs	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999
Panel D. Cash reserve effect									
CashFlow*SMKT	-0.018	-0.005	-0.004						
	(-3.79)	(-1.02)	(-0.93)						
CashFlow*FINT				-0.031	-0.012	-0.011			
				(-5.71)	(-2.14)	(-2.15)			
CashFlow*FD							-0.015	-0.005	-0.005
							(-5.48)	(-1.92)	(-1.86)
CashFlow*CashHold	0.269	0.338	0.340	0.280	0.344	0.345	0.277	0.341	0.343
	(9.06)	(11.3)	(11.9)	(9.45)	(11.7)	(12.3)	(9.26)	(11.4)	(12.0)
CashFlow	0.148	0.326	0.205	0.148	0.326	0.204	0.151	0.328	0.206
	(16.9)	(18.7)	(20.0)	(17.8)	(20.1)	(21.10)	(17.4)	(19.3)	(20.4)
CashFlow*Neg		-0.302			-0.303			-0.303	
		(-16.4)			(-17.4)			(-16.8)	
NonLinearity			0.302			0.300			0.301
			(15.4)			(16.0)			(15.6)
J-test	0.66	0.42	0.55	0.28	0.18	0.47	0.23	0.32	0.40
Nobs	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999	223,999
Panel E. Sample is restricted to multinational firms									
CashFlow*SMKT	-0.008	-0.006	-0.004						
	(-1.11)	(-0.72)	(-0.59)						
CashFlow*FINT				0.002	0.008	0.009			
				(0.19)	(0.83)	(1.00)			
CashFlow*FD							-0.003	-0.001	0.000
							(-0.63)	(-0.10)	(0.06)
CashFlow	0.250	0.361	0.294	0.241	0.355	0.283	0.249	0.362	0.291
	(14.9)	(10.3)	(13.3)	(14.5)	(10.8)	(13.3)	(14.3)	(10.5)	(13.1)
CashFlow*Neg		-0.156			-0.163			-0.161	
		(-4.41)			(-4.93)			(-4.66)	
NonLinearity			0.172			0.178			0.176
			(4.47)			(4.81)			(4.64)
J-test	0.31	0.21	0.24	0.20	0.13	0.15	0.25	0.17	0.20
Nobs	75,234	75,234	75,234	75,234	75,234	75,234	75,234	75,234	75,234

Table B.6 Corporate demand for internal liquidity and financial development: the role of financing constraints

The baseline model in Eq.(6), $(\Delta \text{Cash}_{i,t}/\text{TA}_{i,t}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 (\text{CF}_{i,t}/\text{TA}_{i,t}) + \beta_2(\text{CF}_{i,t}/\text{TA}_{i,t}) * \text{FinDev}_{i,t} + \beta_3(\text{CF}_{i,t}/\text{TA}_{i,t}) * \text{Neg}_{i,t} + \beta_4 \text{LeadInv}_{i,t} + \beta_5 \text{Controls}_{i,t} + \varepsilon_{i,t}$, is modified to incorporate the constraint indicator variable, Constraint (financially constrained firms have a value of unity), and its interactions with internal cash flow (CashFlow) and negative cash flow (Neg) variables. $\Delta \text{Cash}_{i,t}/\text{TA}_{i,t}$ is the change in cash and cash equivalents scaled by total assets. $\text{CF}_{i,t}/\text{TA}_{i,t}$ or CashFlow is internal cash flow (calculated as net income before extraordinary items plus depreciation and amortization) minus dividends paid scaled by total assets. $\text{LeadInv}_{i,t}$ is the actual ratio of future investments to current investments, and used as a measure of the firm's investment opportunities. $\text{Controls}_{i,t}$ include firm size (Size), capital expenditures (CapEx), shares repurchases (ShareRep), other investments (OtherInv), changes in non-cash net working capital (ΔNWC), and changes in short-term debt (ΔSD), where all the control variables are scaled by total assets. Neg is equal to unity if cash flow is negative and zero otherwise. The regressions include country (α_c), industry (α_i), and time (α_t) fixed effects. FinDev is represented by SMKT, FINT or FD indices. SMKT is the average of three standardized indices from the 2013 World Bank Database: market capitalization over GDP, total value traded over GDP, and total value traded over market capitalization. FINT is the average of two standardized indices: the ratio of liquid liabilities (M3 or broad money) to GDP and the ratio of the credit going to the private sector to GDP. SMKT serves as a measure of stock market development. FINT reflects financial intermediary development. FD is the sum of SMKT and FINT. The sample consists of non-financial and non-utility firms from 44 countries. The model is estimated using the generalized method of moments (GMM) methodology with instrumental variables and analytical weights. The Hansen's J tests of overidentifying restrictions are reported. The z-statistics reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. Nobs is the number of firm-year observations, and RSq is adjusted R^2. The sample period covers 1995 to 2010 years.

Table B.6 (continue)

	Firm size			Payout ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
CashFlow*SMKT	0.008			0.006		
	(1.75)			(1.27)		
SMKT	0.005			0.005		
	(10.32)			(9.79)		
CashFlow*FINT		0.005			0.002	
		(0.97)			(0.26)	
FINT		0.002			0.002	
		(5.24)			(4.56)	
CashFlow*FD			0.004			0.002
			(1.42)			(0.74)
FD			0.002			0.002
			(8.93)			(8.19)
CashFlow	0.325	0.327	0.328	0.347	0.350	0.351
	(18.49)	(19.63)	(19.02)	(19.29)	(20.56)	(19.85)
CashFlow*Constraint	0.057	0.057	0.056	0.049	0.047	0.046
	(2.84)	(2.90)	(2.81)	(2.26)	(2.16)	(2.14)
Constraint	-0.007	-0.008	-0.008	-0.001	-0.001	0.000
	(-3.72)	(-4.02)	(-3.83)	(-0.45)	(-0.28)	(-0.22)
Constraint*Neg	-0.002	-0.002	-0.002	0.011	0.011	0.011
	(-0.67)	(-0.60)	(-0.68)	(2.57)	(2.58)	(2.53)
CashFlow*Constraint*Neg	-0.076	-0.075	-0.075	-0.121	-0.116	-0.117
	(-2.77)	(-2.79)	(-2.74)	(-2.55)	(-2.44)	(-2.46)
LeadInv	-0.012	-0.010	-0.011	-0.021	-0.019	-0.020
	(-2.29)	(-1.92)	(-2.11)	(-3.76)	(-3.58)	(-3.65)
Size	-0.002	-0.002	-0.002	-0.003	-0.003	-0.003
	(-3.81)	(-3.61)	(-3.73)	(-4.09)	(-3.94)	(-4.00)
CapEx	-0.242	-0.231	-0.236	-0.288	-0.279	-0.284
	(-8.86)	(-8.66)	(-8.71)	(-9.78)	(-9.79)	(-9.68)
OtherInv	-0.037	-0.038	-0.038	-0.033	-0.033	-0.033
	(-4.77)	(-5.25)	(-4.91)	(-3.42)	(-3.73)	(-3.51)
ShareRep	-0.394	-0.382	-0.390	-0.403	-0.389	-0.398
	(-12.46)	(-12.30)	(-12.42)	(-12.15)	(-11.97)	(-12.08)
ΔNWC	-0.232	-0.232	-0.232	-0.228	-0.227	-0.227
	(-29.30)	(-29.52)	(-29.37)	(-27.45)	(-27.73)	(-27.52)
ΔSD	0.168	0.169	0.169	0.165	0.166	0.166
	(23.92)	(24.41)	(24.15)	(22.28)	(22.79)	(22.50)
CashFlow*Neg	-0.184	-0.187	-0.187	-0.142	-0.147	-0.147
	(-8.38)	(-8.87)	(-8.68)	(-3.21)	(-3.35)	(-3.32)
Neg	0.001	0.001	0.001	-0.008	-0.008	-0.008
	(0.62)	(0.75)	(0.72)	(-2.25)	(-2.18)	(-2.19)
Nobs	223,999	223,999	223,999	223,999	223,999	223,999
J-test	0.41	0.21	0.32	0.38	0.22	0.31

Table B.7 Corporate demand for internal liquidity and financial development: business cycles

The table reports coefficients estimated using the two-stage estimation approach: (i) the cash flow sensitivity of cash is estimated for each country and year using the baseline model in Eq.(6); (ii) the cash flow sensitivity coefficients are regressed on the financial development indices (SMKT, FINT, FD) and the median firm size (Size) in a country. In the first stage, the model parameters are estimated using GMM with instrumental variables and analytical weights. In the second stage, the model parameters are estimated using OLS. Panel A reports the estimation results for each country and year. Panel B reports the estimation results for each country only. SMKT is the average of three standardized indices from the 2013 World Bank Database: market capitalization over GDP, total value traded over GDP, and total value traded over market capitalization. FINT is the average of two standardized indices: the ratio of liquid liabilities (M3 or broad money) to GDP and the ratio of the credit going to the private sector to GDP. SMKT serves as a measure of stock market development. FINT reflects financial intermediary development. FD is the sum of SMKT and FINT. GDP_r is the annual real GDP growth rate. Inflation is measured by the consumer price index. IntRate is the lending interest rate adjusted for inflation. GDP_r, Inflation and IntRate are sourced from the 2012 World Development Indicators. The t-statistics reported in parentheses adjusted for clustered standard errors at the country level. Standard errors are heteroskedasticity-consistent. Nobs is the number of firm-year observations, and RSq is adjusted R^2. The sample period covers 1995 to 2010 years.

Panel A: Country-year estimations

	(1)	(2)	(3)	(4)	(5)	(6)
SMKT	0.054			0.069		
	(0.68)			(0.83)		
FINT		-0.053			-0.020	
		(-0.42)			(-0.14)	
FD			0.022			0.039
			(0.45)			(0.77)
GDP_r				0.084	0.139	0.214
				(0.06)	(0.10)	(0.16)
Inflation				-1.820	-1.686	-1.790
				(-1.97)	(-1.80)	(-1.93)
IntRate				0.373	0.451	0.388
				(0.39)	(0.48)	(0.41)
Size	-0.057	-0.044	-0.056	-0.091	-0.078	-0.091
	(-0.56)	(-0.47)	(-0.56)	(-0.87)	(-0.82)	(-0.90)
RSq	5.2%	5.2%	5.1%	5.4%	5.3%	5.3%
Nobs	483	483	483	483	483	483

Panel B: Country estimations

	(1)	(2)	(3)
SMKT	0.027		
	(0.69)		
FINT		0.019	
		(0.66)	
FD			0.013
			(0.72)
Size	-0.026	-0.028	-0.027
	(-0.71)	(-0.78)	(-0.74)
RSq	2.6%	2.4%	2.7%
Nobs	44	44	44

Table C.1 Summary descriptive statistics

The reported calculations are based on a sample of U.S. non-financial and non-utility firms from the Compustat database from 1972 to 2010. Internal cash flow (CashFlow), the cash stock (CashHold), the change in the cash stock (ΔCashHold), capital expenditures (CapEx), the change in non-cash net working capital (ΔNWC), and the change in short-term debt (ΔShortDebt) are deflated by total assets. LeadInv is the actual ratio of future investments to current investments, and used as a measure of the firm's investment opportunities. Acquisition is an indicator variable that is equal to unity if a firm makes an acquisition in that year and zero otherwise. Neg is an indicator variable that is equal to unity if cash flow is negative and zero otherwise. FC is assigned to financially constrained firms, and FUC is assigned to unconstrained firms.

Panel A: Descriptive statistics

Variable	Acronym	Nobs	Mean	Median	St dev	Q1	Q3
Cash holding	CashHold	124,635	0.131	0.065	0.162	0.023	0.174
ΔCash holding	ΔCashHold	124,635	0.012	0.002	0.090	-0.016	0.034
Cash flow	CashFlow	124,635	0.059	0.075	0.103	0.035	0.112
Negative cash flow	Neg	124,635	0.152	0.000	0.359	0.000	0.000
Future-to-current invest.	LeadInv	124,635	1.524	1.157	1.432	0.778	1.734
Firm size	Size	124,635	5.090	4.872	1.963	3.562	6.396
CapEx	CapEx	124,635	0.071	0.050	0.067	0.026	0.091
Acquisition	Acquisition	124,635	0.285	0.000	0.452	0.000	1.000
ΔNCWC	ΔNCWC	124,635	0.014	0.010	0.081	-0.021	0.051
Short-term debt	ShortDebt	124,635	0.054	0.022	0.086	0.003	0.065
ΔShort-term debt	ΔShortDebt	124,635	0.002	0.000	0.064	-0.007	0.013

Panel B: Mean comparison of financially constrained and unconstrained firms based on firm size

Variable	Acronym	N	Small	Large	Diff.	t-stat
ΔCash holding	ΔCashHold	124,635	0.009	0.013	-0.005	(-7.42)
Cash flow	CashFlow	124,635	0.033	0.068	-0.035	(-45.25)
Negative cash flow	Neg	124,635	0.260	0.115	0.145	(58.41)
Future-to-current invest.	LeadInv	124,635	1.828	1.422	0.406	(36.70)
CapEx	CapEx	124,635	0.062	0.073	-0.011	(-27.09)
Acquisition	Acquisition	124,635	0.145	0.332	-0.187	(-93.79)
ΔNWC	ΔNWC	124,635	0.014	0.013	0.001	(1.78)
Short-term debt	ShortDebt	124,635	0.077	0.047	0.030	(48.33)
ΔShort-term debt	ΔShortDebt	124,635	0.000	0.003	-0.003	(-5.76)

Table C.1 (continue)

Panel C: Summary statistics of cash holdings

Variable	Mean	Median	St dev	Nob
1. Firm size				
FC	0.170	0.093	0.191	31,146
FUC	0.118	0.058	0.149	93,489
Difference	0.052			
t-stat	(48.32)			
2. Payout ratio				
FC	0.166	0.085	0.192	61,197
FUC	0.096	0.053	0.117	63,438
Difference	0.070			
t-stat	(89.83)			
3. WW index				
FC	0.168	0.084	0.198	31,170
FUC	0.118	0.060	0.146	93,465
Difference	0.050			
t-stat	(44.56)			
4. Bond rating				
FC	0.145	0.073	0.174	92,643
FUC	0.089	0.047	0.113	31,992
Difference	0.057			
t-stat	(99.10)			

Table C.2 Pairwise correlations of firm-level variables

The table reports the pairwise correlations between the firm-level financial variables presented in Table C.1. Panel A reports the Pearson coefficients, and Panel B reports the Spearman coefficients. The superscripts * and ** indicate significance levels of 0.01 and 0.05, respectively.

Panel A. Pearson correlations

	CashHold	ΔCashHold	CashFlow	LeadInv	Size	CapEx	Acquisition	ΔNWC
ΔCashHold	0.3390*							
CashFlow	-0.1282*	0.1456*						
LeadInv	0.1028*	0.1253*	0.0101*					
Size	-0.1347*	0.0026	0.0968*	-0.1540*				
CapEx	-0.1455*	-0.0614*	0.2086*	-0.1992*	0.0195*			
Acquisition	-0.0676*	-0.0495*	0.0186*	-0.0299*	0.2652*	-0.1093*		
ΔNWC	-0.1001*	-0.1573*	0.2482*	0.0154*	-0.0664*	0.0179*	0.0720*	
ΔShortDebt	-0.0315*	-0.0351*	-0.0463*	-0.0566*	0.0113*	0.0576*	0.0717*	0.2582*

Panel B. Spearman correlations

	CashHold	ΔCashHold	CashFlow	LeadInv	Size	CapEx	Acquisition	ΔNWC
ΔCashHold	0.3468*							
CashFlow	0.0777*	0.1708*						
LeadInv	0.1097*	0.1740*	0.1294*					
Size	-0.1292*	0.0217*	0.0468*	-0.0730*				
CapEx	-0.1260*	-0.0675*	0.3474*	-0.2760*	0.0904*			
Acquisition	-0.0515*	-0.0451*	-0.0073*	0.0012	0.2720*	-0.0923*		
ΔNWC	-0.1042*	-0.2109*	0.1937*	0.0166*	-0.0955*	0.0505*	0.0713*	
ΔShortDebt	-0.0832*	-0.0769*	-0.0548*	-0.0936*	-0.0002	0.0800*	0.0862*	0.2446*

Table C.3 Asymmetric cash flow sensitivity of cash

Panel A and Panel B report coefficients estimated from the model in Eq.(8.1). Panel C reports a sign bias test, negative size bias test and positive size bias test (diagnostic tests) for the model in Eq.(8.2). Panel A corresponds to the full sample. Panel B corresponds (i) to the firms with strictly positive cash flow, and (ii) to the firms with strictly negative cash flow. The model is estimated using OLS and IV-GMM. The Hansen's J tests of overidentifying restrictions are reported for the IV-GMM estimates. The t-statistics (z-statistics) reported in parentheses adjusted for clustered standard errors at the firm level in Panel A(B). Standard errors are heteroskedasticity-consistent in all panels. The sign and size bias tests employ the variable Z^- that takes a value of one when cash flow is negative or zero otherwise. $Z^+ = 1 - Z^-$. Nobs is the number of firm-year observations, and RSq is adjusted R^2. The sample excludes non-financial and non-utility firms. The sample period covers 1972 to 2010.

Panel A

	OLS	GMM	OLS	GMM
Variable	(1)	(2)	(3)	(4)
CashFlow	0.258	0.282	0.343	0.477
	(28.31)	(23.41)	(36.46)	(22.24)
CashFlow * Neg	-0.145	-0.196	-0.162	-0.338
	(-10.22)	(-10.79)	(-11.41)	(-13.63)
Neg	0.002	0.003	-0.005	0.004
	(1.22)	(1.35)	(-3.26)	(1.94)
LeadInv	0.007	-0.006	0.005	-0.049
	(24.78)	(-10.15)	(16.59)	(-7.46)
Size	0.004	-0.059	0.005	-0.004
	(8.33)	(-9.18)	(9.46)	(-7.44)
CapEx			-0.187	-0.443
			(-25.58)	(-13.26)
Acquisition			-0.014	-0.012
			(-18.76)	(-13.80)
ΔNWC			-0.285	-0.283
			(-49.38)	(-42.58)
ΔShortDebt			0.081	0.048
			(15.02)	(5.52)
RSq	9.6%		16.1%	
J-test		0.15		0.50
Nobs	124,635	104,018	124,635	112,436

Table C.3 (continue)

Panel B

	Firms with $CF_{i,t}/TA_{i,t} > 0$		Firms with $CF_{i,t}/TA_{i,t} < 0$	
	OLS	GMM	OLS	GMM
Variable	(1)	(2)	(3)	(4)
CashFlow	0.353	0.450	0.145	0.103
	(36.51)	(22.20)	(8.96)	(8.39)
LeadInv	0.004	-0.033	0.006	-0.011
	(14.16)	(-5.42)	(6.30)	(-0.79)
Size	0.003	-0.004	0.016	0.005
	(5.78)	(-7.13)	(5.63)	(3.48)
CapEx	-0.201	-0.390	-0.174	-0.180
	(-27.09)	(-12.58)	(-4.32)	(-2.20)
Acquisition	-0.013	-0.011	-0.017	-0.015
	(-17.43)	(-14.60)	(-4.09)	(-5.18)
ΔNWC	-0.337	-0.345	-0.202	-0.193
	(-51.48)	(-49.43)	(-13.08)	(-12.28)
ΔShortDebt	0.128	0.119	0.020	0.019
	(19.02)	(14.13)	(1.69)	(1.04)
RSq	20.1%		2.0%	
J-test		0.50		0.24
Nobs	105,750	95,949	18,885	10,572

Panel C

Variable	(1)	(2)	(3)	(4)
Z^-	-0.130			0.005
	(-12.96)			(0.38)
Z^-*CashFlow		0.693		0.406
		(10.09)		(4.56)
Z^+*CashFlow			1.084	0.922
			(18.82)	(14.18)
Nobs	124,635	124,635	124,635	124,635

Table C.4 Systematic cash flow sensitivity of cash

Panel A and Panel B report coefficients estimated from the model in Eq.(10). Panel A corresponds to the full sample. Panel B corresponds (i) to the firms classified as financially constrained, and (ii) to the firms classified as financially unconstrained. Constraint indicator variable has a value of unity if a firm is financially constrained. There are four measures of financial constraints: firm size, dividend payout ratio, the WW index and bond rating. FC acronym is assigned to financially constrained firms, and FUC acronym is assigned to unconstrained firms. The model is estimated using OLS and IV-GMM. Hansen's J tests of overidentifying restrictions are reported for the IV-GMM estimates. The t-statistics (z-statistics) reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent. Nobs is the number of firm-year observations, and RSq is adjusted R^2. The sample excludes non-financial and non-utility firms. The sample period covers 1972 to 2010.

Panel A

	Firm size		Payout ratio		WW index		Bond rating	
	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CashFlow	0.304	0.418	0.281	0.396	0.313	0.408	0.217	0.370
	(29.48)	(19.39)	(26.51)	(18.85)	(30.67)	(21.17)	(13.51)	(15.77)
CashFlow*Neg	-0.158	-0.309	-0.172	-0.359	-0.247	-0.383	-0.122	-0.299
	(-9.13)	(-12.51)	(-8.44)	(-11.61)	(-13.25)	(-15.22)	(-4.22)	(-8.82)
Neg	-0.004	0.004	0.001	0.004	-0.005	0.002	-0.001	0.007
	(-2.57)	(2.08)	(0.40)	(1.66)	(-2.84)	(1.31)	(-0.35)	(2.07)
CashFlow*Constraint	0.123	0.065	0.106	0.099	0.090	0.050	0.165	0.111
	(7.00)	(3.64)	(7.25)	(6.68)	(5.08)	(2.87)	(8.85)	(6.35)
Constraint	-0.015	-0.009	-0.011	0.003	-0.018	-0.009	-0.018	-0.013
	(-6.81)	(-4.72)	(-7.55)	(2.18)	(-9.18)	(-5.09)	(-5.86)	(-7.07)
Constraint*Neg	-0.002	-0.004	-0.009	-0.005	-0.004	-0.005	-0.005	-0.005
	(-0.68)	(-1.10)	(-3.21)	(-1.61)	(-1.22)	(-1.48)	(-1.39)	(-1.19)
CashFlow*Constraint*Neg	-0.071	-0.023	-0.014	0.030	0.051	0.088	-0.070	-0.040
	(-2.56)	(-0.84)	(-0.54)	(1.04)	(1.87)	(3.24)	(-2.15)	(-1.21)
LeadInv	0.005	-0.033	0.004	-0.042	0.005	-0.029	0.005	-0.041
	(16.84)	(-5.26)	(16.47)	(-7.13)	(16.64)	(-5.04)	(16.63)	(-7.37)
Size	0.004	-0.004	0.005	-0.003	0.003	-0.004	0.005	-0.004
	(6.63)	(-6.92)	(8.70)	(-6.15)	(5.07)	(-7.17)	(8.61)	(-7.03)
CapEx	-0.184	-0.369	-0.186	-0.406	-0.189	-0.347	-0.186	-0.404
	(-25.19)	(-11.47)	(-25.49)	(-13.39)	(-25.78)	(-11.92)	(-25.49)	(-14.08)
Acquisition	-0.014	-0.011	-0.014	-0.012	-0.014	-0.011	-0.014	-0.012
	(-18.73)	(-14.61)	(-18.58)	(-14.98)	(-19.04)	(-15.19)	(-18.76)	(-14.77)
ΔNWC	-0.287	-0.284	-0.289	-0.285	-0.291	-0.286	-0.288	-0.284
	(-49.57)	(-46.70)	(-49.93)	(-44.71)	(-50.15)	(-48.21)	(-49.62)	(-44.84)
ΔShortDebt	0.082	0.061	0.083	0.055	0.081	0.065	0.084	0.057
	(15.07)	(7.54)	(15.27)	(6.79)	(14.94)	(8.57)	(15.37)	(7.24)
RSq	16.3%		16.5%		16.7%		16.4%	
J-test		0.22		0.38		0.18		0.36
Nobs	124,635	112,436	124,635	112,436	124,635	112,436	124,635	112,436

Table C.4 (continue)

Panel B

	Large (FUC)		Small (FC)		Dividend (FUC)		No dividend (FC)		WW index (FUC)		WW index (FC)		Bond rating (FUC)		Bond rating (FC)	
	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
CashFlow	0.294	0.394	0.449	0.573	0.305	0.283	0.401	0.649	0.298	0.384	0.433	0.517	0.193	0.219	0.390	0.517
	(27.16)	(17.40)	(23.23)	(13.29)	(25.93)	(16.08)	(28.07)	(12.21)	(27.63)	(19.65)	(21.30)	(9.54)	(11.65)	(12.13)	(35.18)	(24.34)
CashFlow*Neg	-0.146	-0.286	-0.241	-0.420	-0.156	-0.219	-0.215	-0.484	-0.212	-0.356	-0.238	-0.356	-0.086	-0.147	-0.202	-0.376
	(-8.33)	(-11.35)	(-9.16)	(-8.65)	(-7.57)	(-8.57)	(-10.76)	(-8.74)	(-11.21)	(-14.33)	(-9.27)	(-6.24)	(-2.95)	(-5.48)	(-12.48)	(-14.92)
Neg	-0.005	0.003	-0.006	0.002	-0.002	0.000	-0.007	0.001	-0.006	0.002	-0.005	0.000	-0.003	0.001	-0.006	0.004
	(-2.62)	(1.79)	(-1.96)	(0.56)	(-0.92)	(-0.13)	(-3.26)	(0.40)	(-3.27)	(0.86)	(-1.88)	(-0.11)	(-0.99)	(0.54)	(-3.22)	(1.92)
LeadInv	0.006	-0.030	0.002	-0.050	0.004	-0.006	0.004	-0.097	0.006	-0.022	0.003	-0.040	0.006	-0.001	0.004	-0.047
	(16.19)	(-4.06)	(5.47)	(-4.43)	(10.69)	(-1.21)	(10.90)	(-5.36)	(16.20)	(-3.46)	(5.57)	(-2.83)	(9.59)	(-0.20)	(14.11)	(-8.00)
Size	0.002	-0.004	0.025	-0.003	0.006	-0.002	0.009	-0.007	0.001	-0.003	0.017	-0.001	0.000	-0.002	0.008	-0.003
	(3.70)	(-6.28)	(10.35)	(-1.02)	(8.52)	(-3.69)	(9.05)	(-3.77)	(2.02)	(-6.37)	(8.19)	(-0.39)	(0.20)	(-4.40)	(10.41)	(-5.76)
CapEx	-0.167	-0.319	-0.255	-0.612	-0.210	-0.213	-0.204	-0.703	-0.178	-0.298	-0.227	-0.495	-0.149	-0.155	-0.200	-0.483
	(-19.64)	(-9.85)	(-15.52)	(-7.12)	(-22.60)	(-8.65)	(-17.40)	(-7.54)	(-20.90)	(-10.61)	(-13.22)	(-4.79)	(-11.63)	(-9.50)	(-22.70)	(-14.37)
Acquisition	-0.012	-0.010	-0.026	-0.020	-0.009	-0.007	-0.020	-0.021	-0.012	-0.009	-0.022	-0.020	-0.010	-0.007	-0.016	-0.014
	(-15.70)	(-12.40)	(-10.24)	(-7.41)	(-11.73)	(-10.81)	(-14.36)	(-9.20)	(-15.98)	(-13.31)	(-8.72)	(-7.96)	(-10.07)	(-8.38)	(-15.98)	(-12.97)
ΔNCWC	-0.279	-0.278	-0.319	-0.295	-0.344	-0.319	-0.275	-0.260	-0.303	-0.300	-0.291	-0.264	-0.267	-0.268	-0.294	-0.286
	(-41.79)	(-40.79)	(-28.38)	(-24.03)	(-38.98)	(-39.83)	(-34.76)	(-21.48)	(-43.24)	(-43.40)	(-26.91)	(-24.34)	(-22.68)	(-23.57)	(-44.67)	(-39.16)
ΔShortDebt	0.094	0.076	0.070	0.032	0.123	0.096	0.073	0.012	0.100	0.087	0.068	0.035	0.097	0.100	0.081	0.046
	(14.52)	(8.49)	(6.71)	(1.96)	(14.07)	(10.06)	(10.01)	(0.64)	(14.30)	(10.00)	(7.13)	(2.25)	(7.77)	(8.03)	(13.26)	(4.97)
p-value for Diff. in *CashFlow*	(0.00)	(0.00)			(0.00)	(0.00)			(0.00)	(0.00)			(0.00)	(0.00)		
p-value for Diff. in *CashFlow*Neg*	(0.00)	(0.00)			(0.00)	(0.00)			(0.18)	(0.99)			(0.00)	(0.00)		
RSq	16.2%		21.4%		26.5%		14.4%		19.7%		18.3%		13.0%		16.7%	
J-test		0.67		0.09		0.70		0.49		0.23		0.62		0.29		0.95
Nobs	93,489	86,698	31,146	25,738	63,438	58,595	61,197	53,841	93,465	86,111	31,170	26,325	31,992	30,014	92,643	82,422

Table C.5 Robustness tests

The table reports coefficients estimated from the modified model specifications. In Row 1, the model in Eq.(10) is modified to include the previous period cash holding (L. CashHold) and its interaction with the cash flow variable (CashFlow). In Row 2, the sample is restricted to the firms with positive free cash flow. In Row 3, the sample is restricted to manufacturing firms (SICs 2000 to 3999). In Row 4, the sample is restricted to the firms with the lowest possible exposure to external financing frictions: large dividend-paying firms with a high credit rating and a low WW index value. The models are estimated using OLS and IV-GMM. The Hansen's J tests of overidentifying restrictions are reported for the IV-GMM estimates. The t-statistics (z-statistics) reported in parentheses adjusted for clustered standard errors at the firm level. Standard errors are heteroskedasticity-consistent.

			Firm size		Payout ratio		WW index		Bond rating	
Variable	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. Lagged cash holding and its interaction with internal cash flow are added to the model										
CashFlow	0.272	0.464	0.250	0.409	0.243	0.399	0.254	0.399	0.182	0.366
	(25.98)	(19.60)	(21.90)	(17.42)	(21.37)	(17.30)	(22.43)	(18.93)	(11.05)	(14.86)
CashFlow*Neg	-0.199	-0.389	-0.194	-0.370	-0.209	-0.401	-0.276	-0.435	-0.156	-0.336
	(-14.27)	(-16.85)	(-11.18)	(-15.62)	(-10.32)	(-13.05)	(-14.17)	(-17.57)	(-5.22)	(-9.53)
CashFlow*Constraint			0.078	0.055	0.058	0.090	0.054	0.043	0.122	0.102
			(4.43)	(2.98)	(3.96)	(5.95)	(3.11)	(2.41)	(6.53)	(5.70)
J-test		0.48		0.23		0.37		0.18		0.34
2. Sample restricted to the firms with positive free cash flow										
CashFlow	0.329	0.440	0.288	0.380	0.292	0.364	0.305	0.407	0.197	0.354
	(28.43)	(21.76)	(22.33)	(18.93)	(22.77)	(17.66)	(23.96)	(19.47)	(10.08)	(14.44)
CashFlow*Constraint			0.144	0.073	0.067	0.089	0.080	0.027	0.174	0.097
			(6.84)	(4.05)	(3.81)	(5.80)	(3.76)	(1.44)	(7.68)	(5.20)
J-test		0.42		0.16		0.40		0.25		0.29
3. Sample restricted to manufacturing firms										
CashFlow	0.399	0.510	0.361	0.470	0.335	0.437	0.374	0.460	0.280	0.424
	(31.66)	(20.20)	(25.53)	(16.74)	(24.63)	(17.01)	(27.05)	(17.85)	(12.52)	(14.08)
CashFlow*Neg	-0.207	-0.397	-0.182	-0.373	-0.216	-0.415	-0.289	-0.445	-0.211	-0.404
	(-10.71)	(-12.63)	(-7.67)	(-11.02)	(-7.71)	(-10.41)	(-11.21)	(-12.76)	(-5.08)	(-8.61)
CashFlow*Constraint			0.119	0.046	0.111	0.096	0.066	0.019	0.155	0.098
			(5.19)	(1.94)	(5.70)	(4.94)	(2.83)	(0.84)	(6.12)	(3.99)
J-test		0.85		0.98		0.90		0.92		0.94
4. Sample restricted to the firms with the lowest possible exposure to external financing constraints										
CashFlow	0.176	0.118								
	(11.22)	(3.23)								
CashFlow*Neg	-0.116	-0.095								
	(-4.27)	(-3.28)								
J-test		0.26								

Table C.6 The cash flow sensitivity of cash and macroeconomic patterns

Panel A reports the annual distribution of the number of firm-year observations (Nobs) and the number of firm-year observations with strictly negative cash flow (N_negative). %_negative is the percent of firm-year observations with strictly negative cash flow. The recession data (business cycle contractions) is taken from the U.S. National Bureau of Economic Research. Recession is equal to one if at least one month in year t is within the contraction and zero otherwise. Panel B reports the Pearson and Spearman correlation coefficients between cash holdings (CashHold), cash flow (CashFlow), macroeconomic condition (Recession) and %_negative. The superscripts * and ** indicate significance levels of 0.01 and 0.05, respectively.

Panel A

Year	N_negative	%_negative	Nobs	Recession
1972	85	3.2%	2,659	0
1973	68	2.5%	2,756	1
1974	161	5.7%	2,848	1
1975	211	6.5%	3,268	1
1976	150	4.7%	3,191	0
1977	151	4.8%	3,121	0
1978	124	4.1%	3,048	0
1979	161	5.4%	2,972	0
1980	186	6.3%	2,932	1
1981	205	6.9%	2,968	1
1982	310	10.7%	2,908	1
1983	321	11.2%	2,878	0
1984	314	10.8%	2,912	0
1985	394	13.7%	2,882	0
1986	461	15.5%	2,966	0
1987	425	14.1%	3,020	0
1988	435	14.4%	3,030	0
1989	451	14.9%	3,027	0
1990	507	16.3%	3,116	1
1991	566	17.8%	3,186	1
1992	531	15.8%	3,362	0
1993	609	17.0%	3,583	0
1994	547	14.8%	3,707	0
1995	628	16.6%	3,789	0
1996	689	17.1%	4,018	0
1997	770	19.1%	4,034	0
1998	797	21.1%	3,769	0
1999	661	18.7%	3,544	0
2000	688	19.8%	3,479	0
2001	892	25.8%	3,464	1
2002	887	25.7%	3,453	0
2003	792	23.3%	3,405	0
2004	701	20.8%	3,375	0
2005	707	21.7%	3,264	0
2006	631	20.0%	3,155	0
2007	603	19.7%	3,060	1
2008	857	29.1%	2,945	1
2009	742	25.2%	2,941	1
2010	467	18.0%	2,600	0
Chi-square for Year and %_negative		(1.50)		
p-value		0.238		
Total	18,885	15.2%	124,635	

Table C.6 (continue)

Panel B

	CashHold	CashFlow	%_negative
1. Pearson correlations			
%_negative	0.8829*	-0.9758*	
Recession	-0.1524	-0.0346	-0.0445
2. Spearman correlations			
%_negative	0.9209*	-0.9779*	
Recession	-0.2172	0.0148	-0.0296

Figure A.1 Country-level investment-cash flow sensitivity

The figure plots estimates reported in Table A.2. Chart A refers to the developed market firms with all cash flows. Chart B refers to the developed market firms with strictly positive cash flows. Chart C refers to the emerging market firms with all cash flows. Chart D refers to the emerging market firms with strictly positive cash flows. The pooled estimated coefficients (dashed line) are provided on each chart.

Chart A. Developed market firms

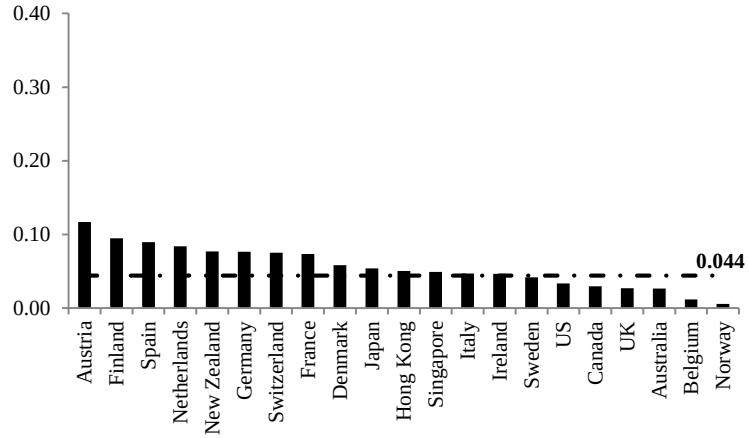


Chart B. Developed market firms with positive cash flows

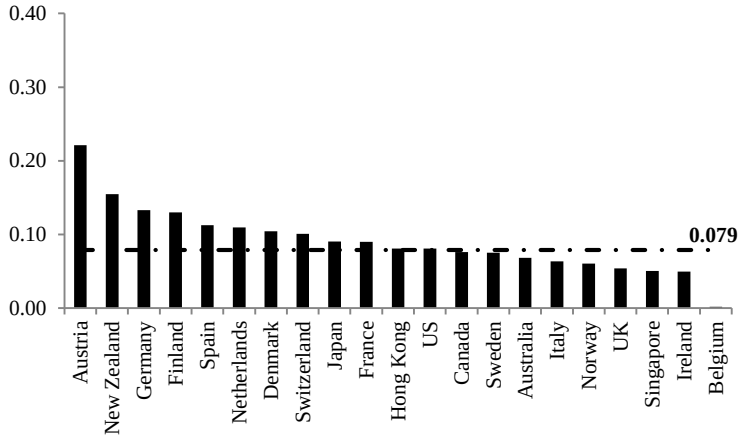


Chart C. Emerging market firms

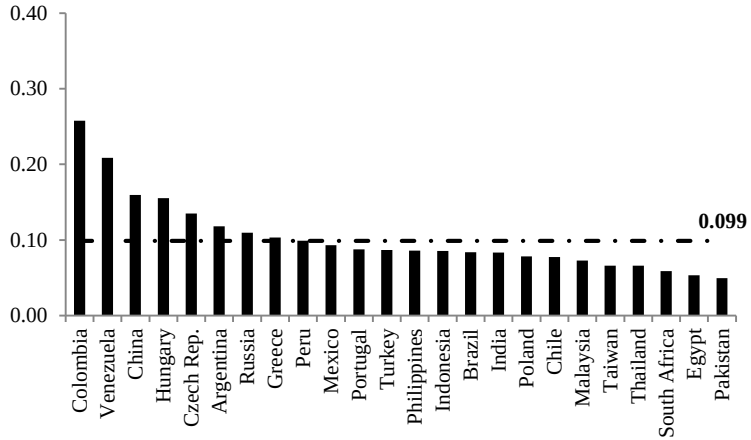


Chart E. Emerging market firms with positive cash flows

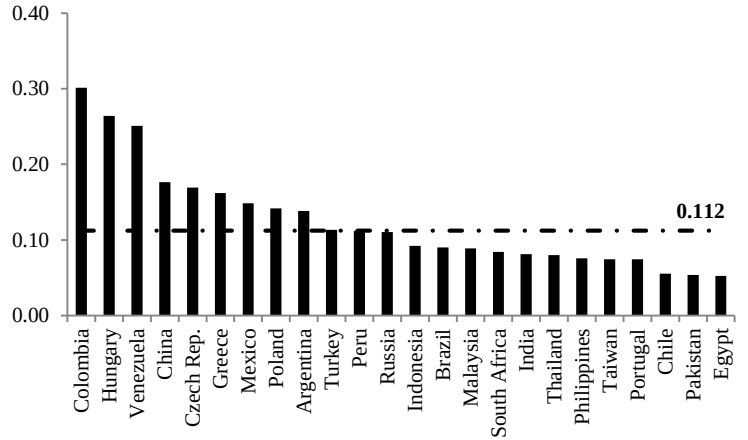


Figure A.2 Investment-cash flow sensitivity by year

The figure plots OLS and GMM cross-sectional annual estimates: $(I_{i,t}/K_{i,t-1}) = \beta_0 + \beta_1 (CF_{i,t}/K_{i,t-1}) + \beta_2 q_{i,t-1} + \varepsilon_{i,t}$. $I_{i,t}/K_{i,t-1}$ is the firm's physical (fixed) investment, deflated by its beginning-of-period physical assets. $q_{i,t-1}$ is a proxy for investment demand, measured by Tobin's q. $CF_{i,t}/K_{i,t-1}$ is the firm's internal cash flow, deflated by its beginning-of-period physical assets. OLS investment-cash flow sensitivities (plotted against the left axis) are reported in Chart A and Chart B. GMM investment-cash flow sensitivities (plotted against the left axis) are reported in Chart C and Chart D. GMM investment-cash flow sensitivities are the estimated coefficients β_1 from the Erickson and Whited (2000) GMM6 (using the second to the sixth moments) estimators. Chart A and Chart C refer to the subsample of developed market firms (solid line refers to the firms with all cash flows while dashed line refers to the firms with strictly positive cash flows). Chart B and Chart D refer to the subsample of emerging market firms (solid line refers to the firms with all cash flows while dashed line refers to the firms with strictly positive cash flows). The sample consists of non-financial and non-utility firms from 21 developed market economies and 24 emerging market economies. All variables are demeaned to remove the firm fixed effects. Country and industry fixed effects are included. Standard errors are heteroskedasticity-consistent. RSq (plotted against the right axis) is adjusted R^2.

Chart A. OLS estimates: Developed market firms

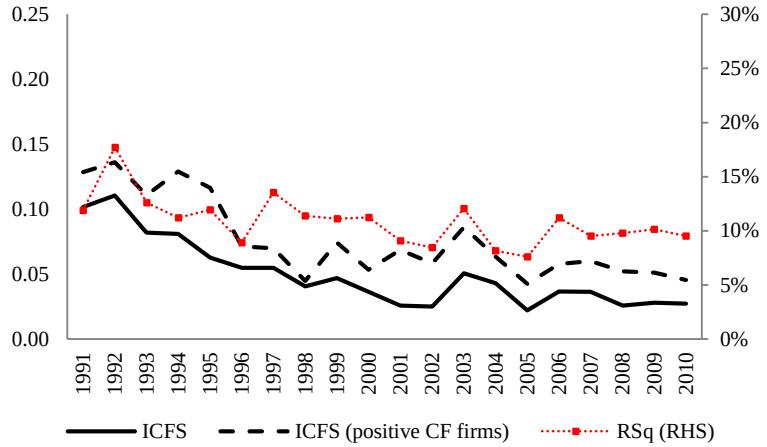


Chart B. OLS estimates: Emerging market firms

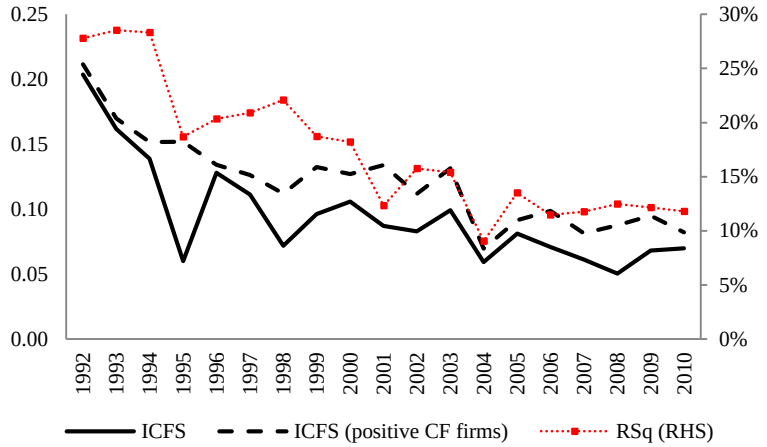


Figure A.2 (continue)

Chart C. GMM estimates: Developed market firms

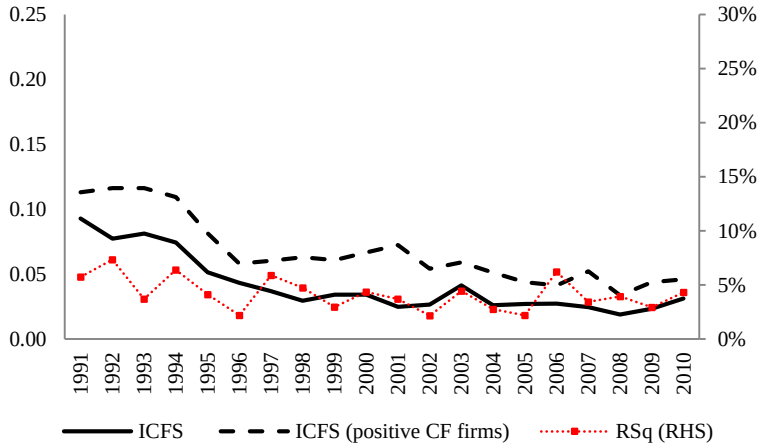


Chart D. GMM estimates: Emerging market firms

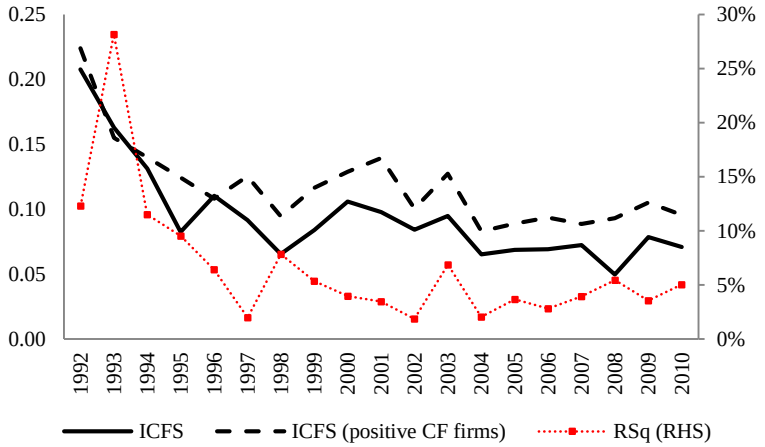


Figure A.3 Time-series of financial development metrics

The figure plots the time series of selected financial development metrics used in Chapter 2. Chart A refers to 21 developed market economies. Chart B refers to 24 emerging market economies.

Chart A. Developed market economies

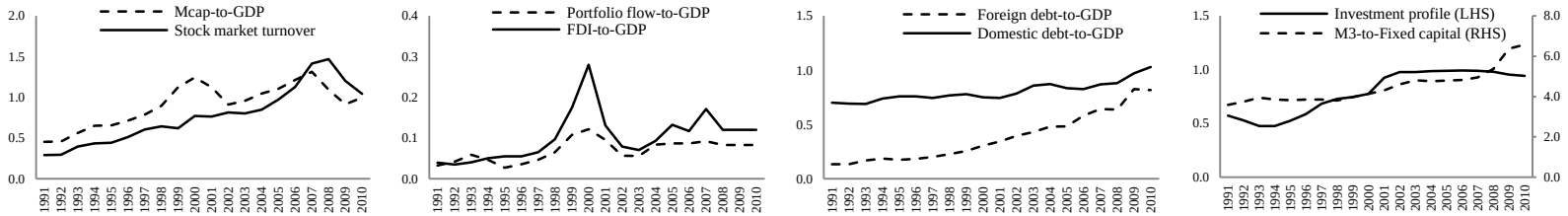


Chart B. Emerging market economies

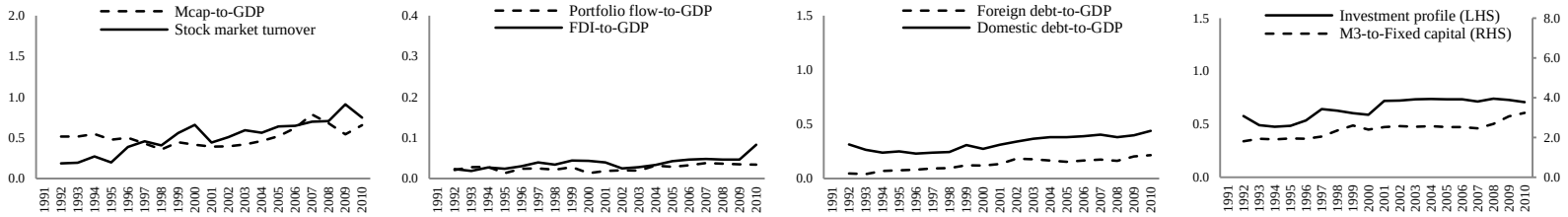


Figure A.4 Time-series of external financing, tangibility and investment spending

The figure plots the time series of external financing (Leverage – to – Tangibility and New financing), asset tangibility (Liquidity – to – Tangibility) and investment spending (CapEx – to – Assets). Leverage – to – Tangibility is the ratio of balance sheet debt to tangible assets. New financing is the volume of new financing relative to capital requirements. Liquidity – to – Tangibility is the ratio of cash holdings to tangible assets. CapEx – to – Assets is the ratio of capital expenditures to total assets. Chart A refers to 21 developed market economies. Chart B refers to 24 emerging market economies. Chart C refers to both groups of economies. DEV stands for developed market economies. EMG denotes emerging market economies.

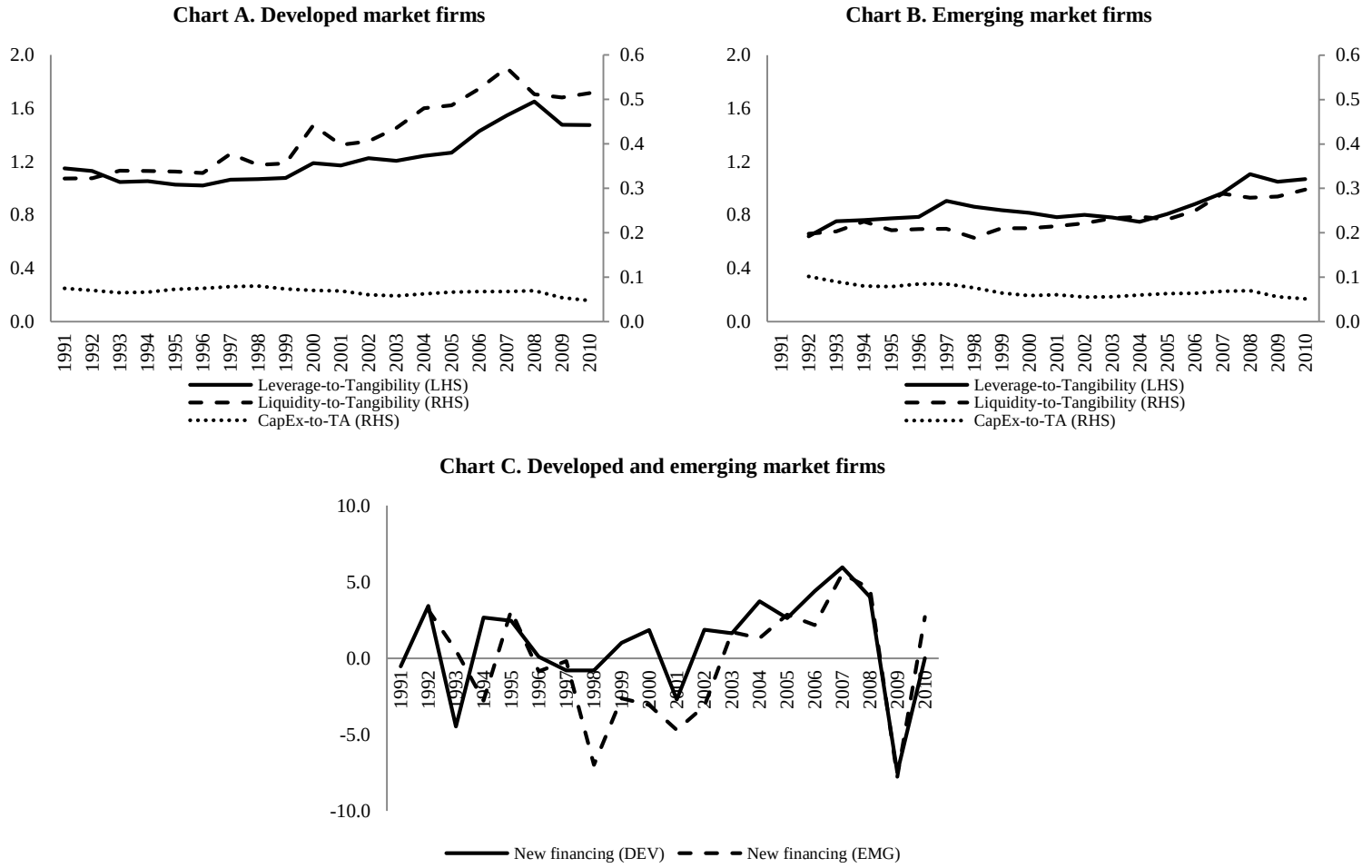


Figure A.5 Investment-cash flow sensitivity by industry and size

The figure plots ICFS estimates of Eq.(1.5) for firms matched by market subsample, industry and size. Chart A refers to the subsample of developed market firms sorted by two groups of industries: (i) industrials and basic materials, and (ii) technology and health care. Then, all firms in the selected industries are sorted by market capitalization (in $U.S.): small cap ($10 million to $100 million), mid cap ($100 million to $1 billion) and large cap (above $1 billion). Chart B refers to the subsample of emerging market firms. Chart C refers to the subsample of developed market firms sorted by two groups of industries and presented in five four-year periods: 1991-1994, 1995-1998, 1999-2002, 2003-2006 and 2007-2010. Chart D refers to the subsample of emerging market firms (without 1991-1994).

Chart A. Developed market firms (sorted by industry and size)

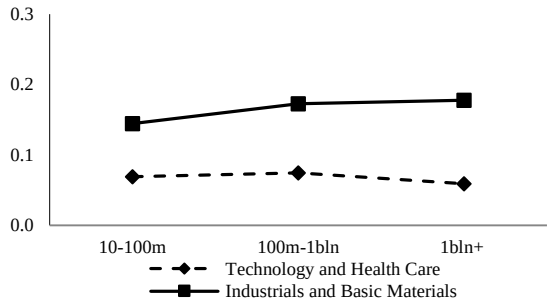


Chart B. Emerging market firms (sorted by industry and size)

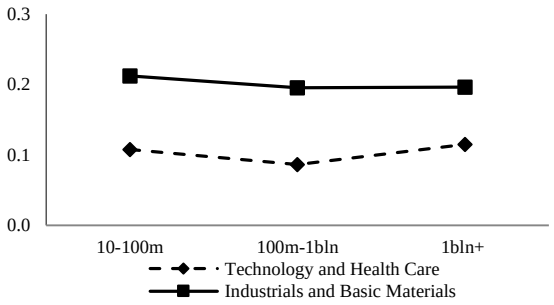


Chart C. Developed market firms (sorted by industry and time)

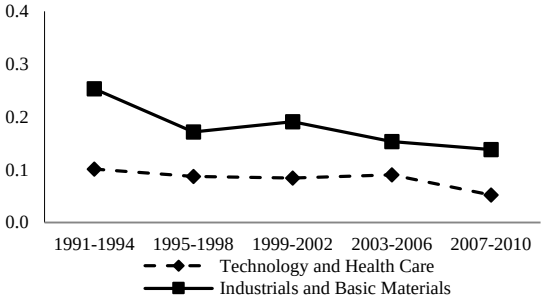


Chart D. Emerging market firms (sorted by industry and time)

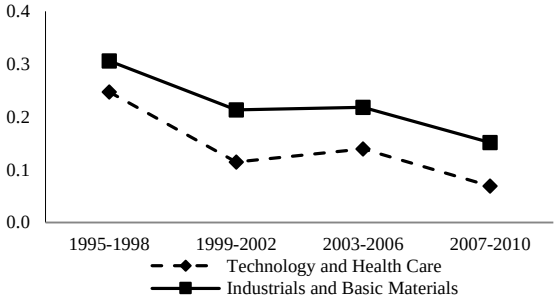


Figure B.1 Cash-to-assets ratio and changes in cash-to-assets ratio

The figure plots the ratio of cash holdings to total assets (Chart A) and the ratio of changes in cash holdings to total assets (Chart B). Both ratios are used in Chapter 3. The firms are partitioned by the median values of the financial development index, FD, into (i) high FD firms (solid line) and (ii) low FD firms (dashed line). The FD index construction methodology is described in section 3.3. The number of firms in the sample is provided in Appendix B.1. The sample size includes firms from 44 countries. The sample period covers 1995 to 2010 years.

Chart A. Cash-to-assets ratio

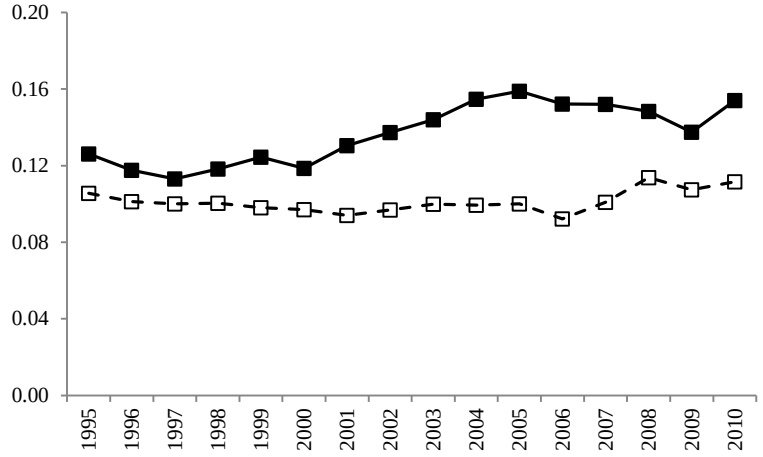


Chart B. ΔCash-to-assets ratio

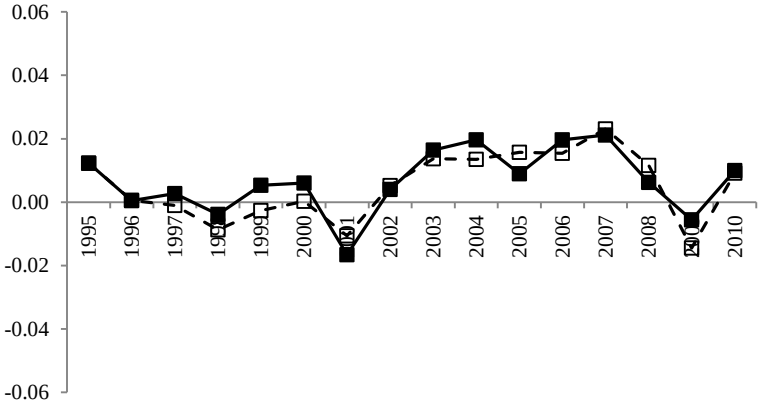


Figure C.1 Asymmetric cash flow sensitivity of cash

The figure plots the OLS (squares and solid trend line) and the IV-GMM (circles and dashed trend line) estimates of the cash flow sensitivity of cash in different cash flow environments. The X axis contains the following four categories: positive cash flows above their corresponding median value (1), positive cash flows below their corresponding median value (0.5), negative cash flows above their corresponding median value (-0.5), and negative cash flows below their corresponding median value (-1). The Y axis plots the estimated CCFS.

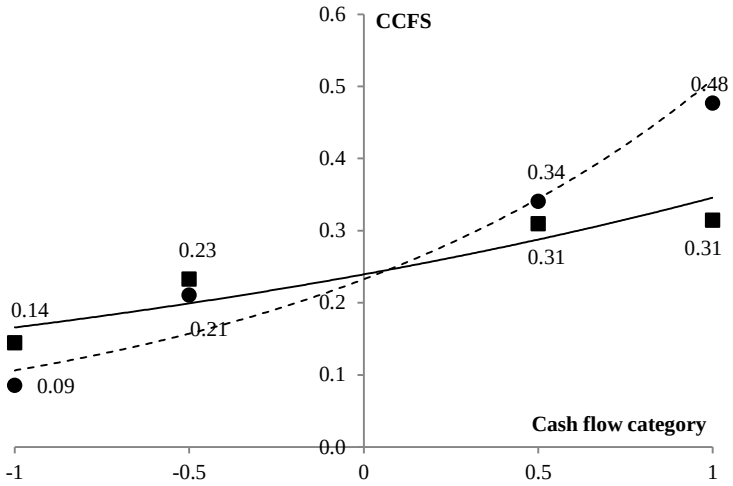


Figure C.2 Time-series variation of the cash flow sensitivity of cash

Chart A and Chart B plot the CashFlow coefficients and the sum of (CashFlow + CashFlow ∗ Neg) coefficients estimated from the model in Eq.(8.1). The coefficients are estimated using OLS (Chart A) and IV-GMM (Chart B). The solid line corresponds to the estimates for CashFlow. The dashed line corresponds to the estimates for (CashFlow + CashFlow ∗ Neg).

Chart A. Time-series OLS estimates, 1972-2010

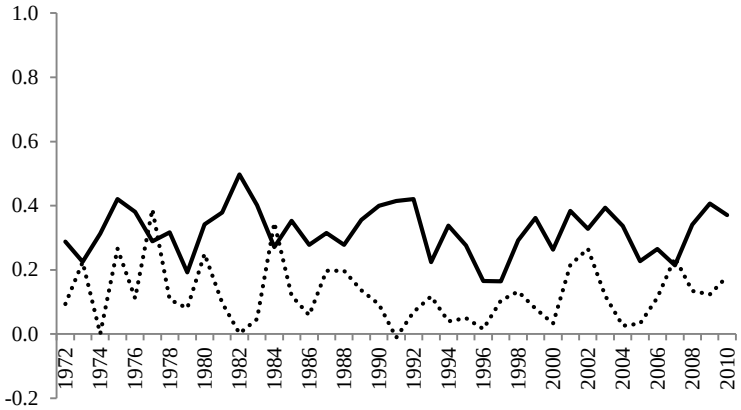
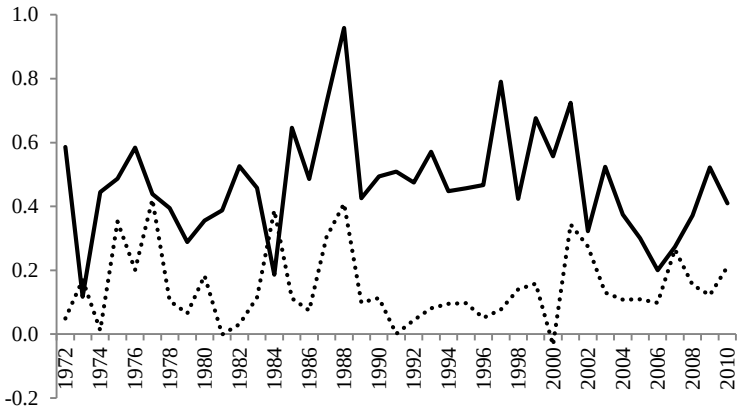


Chart B. Time-series GMM estimates, 1972-2010



Appendix A.1

Variable	Acronym	Description and Source of Information
Panel A: Investment equation		
Physical (fixed) investment	$I_{i,t}$	A firm's physical investment in PP&E (*cex*). Source: Worldscope
Physical (fixed) asset	$K_{i,t-1}$	Beginning-of-period physical assets (*ppe*). Source: Worldscope
Tobin's Q	$q_{i,t-1}$	Ratio of the market value (*mv*) minus book value of equity (*ceq*) plus physical assets (*ppe*) to physical assets. Source: Worldscope
(Internal) cash flow	$CF_{i,t}$	Internal cash flow measured as the sum of net income before extra items (*nibep*) and D&A (*dp*). Source: Worldscope
Panel B: Stock market development		
Market capitalization to GDP	$\text{Mcap} - \text{to} - \text{GDP}$	Total value of all listed shares in a stock market as a percentage of GDP. Source: Standard & Poor's, Global Stock Markets Factbook
Stock market value traded to GDP	$\text{Value traded} - \text{to} - \text{GDP}$	Total value of shares traded during the period as a percentage of GDP. Source: Standard & Poor's, Global Stock Markets Factbook
Stock market turnover	$\text{Stock market turnover}$	The ratio of market capitalization to stock market value traded. Source: Standard & Poor's, Global Stock Markets Factbook
Panel C: Financial openness		
Capital account openness	CapOpen	Capital account openness measure ranges from 0 to 4 and is constructed from annual publication of IMF. Source: Quinn and Toyoda (2008)
FDI to GDP	$\text{FDI} - \text{to} - \text{GDP}$	Ratio of the sum of absolute values of FDI inflows and outflows to GDP. Source: World Development Indicators
Portfolio flows to GDP	$\text{Portfolio flow} - \text{to} - \text{GDP}$	Ratio of the sum of absolute values of investment inflows and outflows to GDP. Source: World Development Indicators
Panel D: Credit development		
Private credit to GDP	$\text{Private credit} - \text{to} - \text{GDP}$	Private credit by banks and other financial institutions to GDP. Source: IMF, International Financial Statistics
Domestic debt issues to GDP	$\text{Domestic debt} - \text{to} - \text{GDP}$	Total value of outstanding domestic debt issues both public and private, as a share of GDP. Source: BIS
International debt issues to GDP	$\text{Foreign debt} - \text{to} - \text{GDP}$	Total value of outstanding international debt issues both public and private, as a share of GDP. Source: BIS
Panel E: Investor protection		
Regulatory quality index	$\text{Regulatory quality}$	Regulatory quality index which captures investors' perceptions of the government's ability to formulate and implement sound policies and regulations that permit and promote private sector development. Source: Kaufmann, Kraay, and Mastruzzi (2009)
Law & order index	$\text{Law \& } Order$	ICRG's law and order index which measures the strength and impartiality of the legal system and popular observance of the law. Source: International Country Risk Guide (ICRG)
Investment profile index	$\text{Investment profile}$	ICRG's investment profile index which assesses factors affecting the risk to investment and includes three subcomponents: country expropriation, profits repatriation, and payment delays. Source: ICRG
Panel F: Capital formation		
Liquid liabilities (M3) to GDP	$\text{M3} - \text{to} - \text{GDP}$	Liquid liabilities (broad money, M3) as a percentage of GDP. Source: World Development Indicators
Panel G: Control variables		
GDP per capita	GDPPC	Absolute value of GDP scaled by number of citizens, per year
Number of firms	N. Firms	Log transformation of a number of publicly traded firms in a country, per year
Herfindahl index	HH index	Measure of the size of a firm (by sales) in relation to the industry. The index is an indicator of competition within an industry
GDP growth	GDP growth	Annual GDP growth in a year. Source: World Development Indicators

Appendix A.2

The table reports the number of firms in the sample sorted by country and year. DEV stands for a developed economy. EMG denotes an emerging market economy.

Country	Market	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Australia	DEV	126	127	134	128	142	159	174	179	211	240	314	463	487	500	546	594	602	662	812	812
Austria	DEV	36	37	41	38	39	41	53	54	52	53	52	48	39	41	38	38	38	42	42	35
Belgium	DEV	39	57	67	71	67	70	61	70	70	78	81	75	77	71	77	79	80	81	85	79
Canada	DEV	242	250	246	253	255	269	272	282	391	438	486	531	571	585	644	859	982	1,048	1,130	1,058
Denmark	DEV	79	88	103	108	109	106	125	127	124	110	105	102	93	93	82	81	82	83	85	83
Finland	DEV	67	67	70	67	69	75	85	91	96	99	108	109	107	98	100	97	100	97	103	102
France	DEV	306	314	345	338	328	329	362	378	398	393	424	422	414	389	376	378	377	381	377	363
Germany	DEV	234	250	279	304	300	311	343	355	356	402	459	448	426	409	383	373	382	388	390	356
Hong Kong	DEV	42	56	72	70	92	169	222	238	246	262	345	427	454	470	501	524	552	574	571	584
Ireland	DEV	34	36	38	36	35	34	36	38	41	43	41	35	39	37	34	33	29	25	30	29
Italy	DEV	111	113	104	98	93	98	95	98	106	104	124	148	136	137	136	151	153	162	158	157
Japan	DEV	262	295	322	361	383	422	1,073	1,087	1,083	1,118	2,694	2,945	2,950	2,935	2,974	2,983	3,039	3,065	3,002	2,898
Netherlands	DEV	114	116	114	118	112	123	124	130	125	117	120	116	110	100	93	93	97	86	85	76
New Zealand	DEV	16	20	22	24	33	33	38	41	44	47	43	57	61	59	66	67	64	69	68	68
Norway	DEV	49	52	63	64	56	62	78	96	101	87	88	94	90	89	82	89	110	128	128	121
Singapore	DEV	47	63	80	79	99	141	156	168	174	182	278	330	340	358	399	425	436	442	459	457
Spain	DEV	62	71	73	74	80	83	95	91	91	95	104	97	94	90	82	81	80	87	85	85
Sweden	DEV	58	66	83	86	98	99	113	138	149	138	153	169	161	162	155	149	166	161	172	177
Switzerland	DEV	91	89	91	98	110	113	124	139	141	153	160	165	159	158	154	152	155	155	150	152
UK	DEV	940	940	918	932	955	934	977	962	933	848	845	822	791	750	744	763	766	747	718	613
US	DEV	1,768	1,917	2,026	2,116	2,845	3,142	3,425	3,525	3,785	3,487	3,435	3,441	3,328	3,145	3,020	2,936	2,857	2,791	2,769	2,610
Argentina	EMG	3	8	11	12	18	19	23	26	28	26	33	30	32	37	40	41	45	42	42	40
Brazil	EMG	27	51	59	64	75	92	90	78	88	132	135	128	124	129	128	129	124	123	139	139
Chile	EMG	14	18	31	36	43	48	51	57	67	88	93	95	99	101	99	101	101	104	97	102
China	EMG	0	0	2	14	19	57	77	98	100	137	208	233	989	1,062	1,129	1,139	1,177	1,227	1,333	1,386
Colombia	EMG	4	5	7	12	12	13	12	13	13	14	15	15	20	22	15	13	12	13	15	11
Czech Rep.	EMG	0	0	0	0	0	7	23	26	21	18	13	13	15	14	14	14	12	10	6	7
Egypt	EMG	0	0	0	0	0	0	0	1	3	5	9	10	13	18	25	59	75	86	87	75
Greece	EMG	0	0	2	4	9	8	9	6	6	9	26	49	53	50	89	215	218	203	200	182
Hungary	EMG	0	0	0	3	3	6	10	12	17	22	20	19	19	19	17	16	15	17	16	18
India	EMG	4	13	70	131	154	217	243	241	245	252	266	267	315	358	417	478	1,119	1,320	1,388	1,404
Indonesia	EMG	2	42	56	58	75	95	96	82	100	103	138	157	174	180	183	184	191	202	214	208
Malaysia	EMG	62	94	133	139	148	207	252	262	275	298	465	515	550	595	640	693	691	688	692	680
Mexico	EMG	24	37	43	54	64	56	66	72	82	89	90	84	85	79	85	81	85	84	85	32
Pakistan	EMG	1	10	19	36	41	51	49	51	50	48	54	62	64	66	67	117	133	136	128	112
Peru	EMG	0	0	10	14	16	17	20	21	26	40	49	50	47	50	47	63	68	63	69	62
Philippines	EMG	6	10	15	20	34	48	56	58	63	71	84	82	80	77	79	79	78	79	85	85
Poland	EMG	0	0	0	3	8	33	34	33	41	43	43	50	67	86	98	145	153	198	232	232
Portugal	EMG	7	7	12	25	36	40	47	47	43	46	46	48	46	40	39	38	36	34	34	33
Russia	EMG	0	0	0	0	0	0	1	6	6	8	9	16	20	24	36	53	75	89	105	83
South Africa	EMG	88	90	88	105	105	105	99	109	167	198	176	169	154	156	143	146	141	165	191	191
Taiwan	EMG	2	8	21	40	94	178	194	190	196	285	396	703	823	928	1,084	1,115	1,126	1,170	1,213	1,213
Thailand	EMG	6	32	70	105	143	162	144	137	156	157	210	218	238	255	283	323	335	337	336	343
Turkey	EMG	2	5	12	13	13	20	24	30	44	65	74	63	114	132	149	163	179	181	176	178
Venezuela	EMG	1	3	5	7	7	9	10	9	12	12	17	13	12	11	11	12	12	11	6	6
Total		4,976	5,457	5,957	6,358	7,417	8,301	9,661	9,952	10,566	10,660	13,128	14,133	15,080	15,165	15,603	16,362	17,348	17,856	18,308	17,737
% of Total		2.1%	2.3%	2.5%	2.6%	3.1%	3.5%	4.0%	4.1%	4.4%	4.4%	5.5%	5.9%	6.3%	6.3%	6.5%	6.8%	7.2%	7.4%	7.6%	7.4%

Appendix A.3

The table reports descriptive statistics for the explanatory variables used in Table A.4 and Table A.5. DEV stands for a developed market economy. EMG denotes an emerging market economy. The variables are defined in Appendix A.1

Country	Market	Mcap-to-GDP, %	Value traded-to-GDP, %	Stock market turnover, %	FDI-to-GDP, %	Portfolio flow-to-GDP, %	CapOpen	Private credit-to-GDP, %	Domestic debt-to-GDP, %	Foreign debt-to-GDP, %	Regul. quality	Law & Order	Invest. profile	M3-to-fixed capital	GDP per capita, $	Number of public firms	GDP growth, %	HH index
Australia	DEV	90.3	59.2	60.5	5.2	4.6	0.75	87.2	59.7	33.0	1.58	0.98	0.76	2.8	21,535	1406	3.2	0.04
Austria	DEV	20.9	10.0	43.9	8.6	3.5	0.88	102.0	68.0	51.0	1.50	1.00	0.82	4.0	23,406	101	2.2	0.09
Belgium	DEV	57.1	19.0	30.8	35.6	15.2	0.94	74.9	126.6	56.7	1.27	0.88	0.78	4.3	22,185	171	1.8	0.06
Canada	DEV	90.9	58.5	59.6	6.2	2.5	1.00	123.6	89.3	29.9	1.52	0.99	0.80	4.8	22,866	2381	2.4	0.02
Denmark	DEV	51.2	35.9	64.1	7.9	4.7	1.00	106.4	165.1	24.2	1.68	1.00	0.78	3.1	28,983	220	1.6	0.08
Ireland	DEV	49.4	23.9	43.8	13.1	28.6	0.97	116.3	64.5	76.3	1.82	0.97	0.80	4.5	27,248	69	4.9	0.11
Finland	DEV	89.7	79.8	78.5	6.9	3.7	0.98	69.8	48.2	40.9	1.69	1.00	0.79	2.9	23,137	115	2.0	0.06
France	DEV	64.0	53.8	75.2	7.2	2.7	0.92	91.0	88.6	34.1	1.07	0.87	0.79	3.5	21,252	754	1.6	0.02
Germany	DEV	39.6	46.1	111.1	4.1	2.7	1.00	107.9	77.3	47.8	1.36	0.90	0.79	4.7	22,736	664	1.5	0.03
Hong Kong	DEV	323.3	222.5	68.9	32.9	17.4	1.00	146.6	21.8	20.7	1.85	0.82	0.78	9.2	27,135	824	4.1	0.03
Italy	DEV	33.1	34.6	90.4	2.1	2.8	0.99	74.1	121.9	29.8	0.97	0.80	0.76	3.1	18,733	264	1.0	0.08
Japan	DEV	75.1	58.7	75.6	1.2	2.4	0.74	194.7	145.0	7.4	1.00	0.90	0.74	8.5	37,658	2771	1.0	0.01
Netherlands	DEV	93.1	101.9	99.8	12.6	7.4	1.00	131.3	91.9	79.6	1.70	1.00	0.82	4.9	23,371	203	2.3	0.13
Norway	DEV	40.7	39.0	85.4	4.9	8.7	1.00	78.9	39.8	24.9	1.24	1.00	0.77	2.7	36,482	173	2.6	0.12
New Zealand	DEV	41.2	15.4	38.5	4.7	3.3	0.96	109.5	25.9	12.8	1.77	0.97	0.83	3.8	13,755	137	3.0	0.09
Singapore	DEV	162.8	93.2	59.6	20.6	9.4	0.96	100.0	42.6	17.5	1.86	0.91	0.84	3.9	24,141	378	6.5	0.05
Spain	DEV	62.1	92.0	124.9	7.4	4.2	0.79	112.3	62.7	48.3	1.24	0.82	0.81	3.8	14,042	1813	2.4	0.07
Sweden	DEV	89.9	86.7	89.9	11.5	5.0	0.88	103.5	87.5	48.9	1.43	1.00	0.76	2.9	27,627	266	2.2	0.04
Switzerland	DEV	196.1	176.2	85.2	11.3	5.7	1.00	160.8	62.9	45.4	1.53	0.92	0.78	6.7	34,581	241	1.4	0.06
UK	DEV	127.5	114.8	93.7	9.2	8.4	1.00	137.4	47.1	51.5	1.88	0.96	0.82	6.5	24,665	2188	2.4	0.04
US	DEV	114.3	177.7	147.5	3.1	3.6	1.00	162.1	145.7	20.7	1.63	0.93	0.81	3.8	33,989	6463	2.6	0.01

Appendix A.3 (continue)

Country	Market	Mcap-to-GDP, %	Value traded-to-GDP, %	Stock market turnover, %	FDI-to-GDP, %	Portfolio flow-to-GDP, %	CapOpen	Private credit-to-GDP, %	Domestic debt-to-GDP, %	Foreign debt-to-GDP, %	Regul. quality	Law & Order	Invest. profile	M3-to-fixed capital	GDP per capita, $	Number of public firms	GDP growth, %	HH index
Argentina	EMG	32.1	3.3	11.0	3.3	3.6	0.99	16.6	20.4	32.9	-0.23	0.59	0.52	1.5	8,179	116	2.9	0.14
Brazil	EMG	35.9	17.6	39.7	3.0	2.3	0.49	36.6	42.9	10.5	0.28	0.40	0.56	2.5	3,846	458	3.2	0.07
China	EMG	44.9	57.1	143.6	4.3	0.9	0.42	102.4	24.2	1.4	-0.34	0.77	0.59	3.5	1,277	1153	10.1	0.05
Chile	EMG	92.5	11.4	10.2	8.7	3.4	0.51	69.5	38.0	6.2	1.47	0.81	0.82	1.8	5,061	257	5.0	0.05
Colombia	EMG	22.6	2.3	8.1	4.0	1.0	0.80	28.8	16.9	8.1	0.11	0.26	0.59	1.4	2,718	130	3.4	0.19
Czech Rep.	EMG	21.8	12.7	54.3	6.6	2.2	0.83	45.0	25.2	2.7	0.95	0.85	0.84	2.4	6,147	123	3.4	0.16
Egypt	EMG	62.7	27.0	59.5	6.8	3.7	0.80	46.9	46.9	3.9	-0.34	0.63	0.54	4.6	1,765	495	5.6	0.07
Greece	EMG	54.1	30.0	53.5	1.6	6.4	0.93	68.1	64.7	61.5	0.74	0.67	0.83	4.0	13,020	304	2.2	0.09
Hungary	EMG	23.5	16.5	61.7	15.2	3.5	0.58	36.7	50.6	20.1	1.18	0.75	0.88	2.1	4,937	52	3.6	0.34
Indonesia	EMG	24.6	11.1	39.9	2.0	1.9	0.70	32.2	14.7	5.2	-0.28	0.51	0.56	1.8	863	303	4.6	0.04
India	EMG	47.4	46.2	106.4	1.9	2.0	0.49	30.6	26.5	2.1	-0.26	0.66	0.61	2.1	512	5206	7.0	0.04
Mexico	EMG	27.9	8.7	23.7	2.9	2.0	0.63	20.3	22.2	13.7	0.48	0.43	0.76	1.3	5,660	164	2.5	0.04
Malaysia	EMG	161.7	71.6	37.8	6.4	4.3	0.52	114.9	71.8	15.9	0.33	0.66	0.68	4.5	4,115	785	5.7	0.02
Peru	EMG	32.7	3.9	13.3	3.6	1.8	0.99	20.3	10.1	7.2	0.37	0.50	0.63	1.3	2,279	215	5.3	0.09
Pakistan	EMG	19.6	36.2	185.5	1.7	1.0	0.38	23.7	32.7	1.1	-0.42	0.51	0.46	2.6	551	708	3.8	0.09
Poland	EMG	20.0	7.9	40.3	4.1	1.4	0.48	28.0	28.2	8.1	0.68	0.75	0.86	2.0	4,905	245	4.6	0.08
Portugal	EMG	34.5	22.2	55.5	4.6	4.3	0.87	115.1	59.8	50.3	1.14	0.86	0.84	4.2	10,990	99	1.7	0.09
Philippines	EMG	49.9	12.2	20.2	2.0	2.5	0.71	34.8	32.0	20.3	0.08	0.48	0.67	2.6	1,108	223	4.1	0.09
Russia	EMG	48.7	24.8	59.9	4.6	2.1	0.75	24.9	3.4	10.5	-0.83	0.62	0.69	1.6	2,358	268	4.5	0.14
South Africa	EMG	173.5	59.4	33.5	2.6	5.5	0.46	121.5	51.8	8.0	0.64	0.43	0.74	2.9	3,222	524	2.9	0.02
Thailand	EMG	56.0	42.1	75.3	3.7	2.7	0.55	114.3	30.5	6.5	0.30	0.66	0.61	3.7	2,141	437	4.3	0.06
Turkey	EMG	21.7	29.7	96.8	1.5	1.4	0.63	19.4	23.3	7.9	0.24	0.70	0.61	1.6	4,396	277	4.0	0.07
Taiwan	EMG	n/a	n/a	n/a	2.5	2.2	n/a	n/a	n/a	n/a	1.04	0.77	0.82	n/a	n/a	n/a	n/a	0.02
Venezuela	EMG	5.9	0.8	4.8	3.0	2.0	0.68	11.4	24.8	21.7	-0.71	0.52	0.36	1.1	4,919	71	3.0	0.26

Appendix A.4

Panel A reports the pairwise correlations of cross-country explanatory variables used in Table A.4 and Table A.5. Panel B reports the pairwise correlations of country-level means of firm-level explanatory variables used in Table A.7. Panel C provides the pairwise correlations between investment-cash flow sensitivity, cross-country and firm-level explanatory variables. The variables are defined in Appendix A.1. The superscripts * and ** indicate significance levels of 0.01 and 0.05, respectively.

Panel A: Pairwise correlations between cross-country explanatory variables

	Mcap-to-GDP	Value traded-to-GDP	Stock market turnover	FDI-to-GDP	Portfolio flow-to-GDP	CapOpen	Private credit-to-GDP	Domestic debt-to-GDP	Foreign debt-to-GDP	Regul. quality	Law & Order
Value traded-to-GDP	0.7573*										
Stock market turnover	0.1432*	0.5568*									
FDI-to-GDP	0.4430*	0.3386*	0.0505								
Portfolio flow-to-GDP	0.2645*	0.1644*	0.0121	0.4530*							
CapOpen	0.1865*	0.2456*	0.0036	0.2282*	0.2682*						
Private credit-to-GDP	0.4920*	0.5196*	0.3005*	0.1851*	0.2695*	0.3424*					
Domestic debt-to-GDP	0.0838**	0.2107*	0.2286*	0.1016*	0.1365*	0.3560*	0.5396*				
Foreign debt-to-GDP	0.1210*	0.2825*	0.2340*	0.2403*	0.3367*	0.4228*	0.4551*	0.3570*			
Regulatory quality	0.4030*	0.3992*	0.0966*	0.3309*	0.2941*	0.5945*	0.5905*	0.4462*	0.4235*		
Law & Order	0.1696*	0.2210*	0.1463*	0.1867*	0.2175*	0.5414*	0.5168*	0.4111*	0.2973*	0.6850*	
Investment profile	0.3235*	0.4085*	0.2923*	0.2513*	0.2261*	0.2883*	0.4235*	0.2932*	0.4765*	0.5073*	0.2438*
M3-to-fixed capital formation	0.5740*	0.5705*	0.2605*	0.3221*	0.2559*	0.3195*	0.7360*	0.3955*	0.4124*	0.4669*	0.3515*

Panel B: Pairwise correlations between firm-level explanatory variables

	Liquidity-to-Tangibility	Leverage-to-Tangibility	Dividend intensity	Profitability
Leverage-to-Tangibility	0.5147*			
Dividend intensity	-0.0211	0.1037*		
Profitability	-0.1843*	-0.2093*	0.3664*	
Size	0.3862*	0.5392*	0.1503*	-0.2332*

Appendix A.4 (continue)

Panel C: Pairwise correlations between ICFS, cross-country and firm-level explanatory variables

	ICFS
Mcap-to-GDP	-0.1584*
Value traded-to-GDP	-0.1847*
Stock market turnover	-0.1522*
FDI-to-GDP	-0.0510
Portfolio flow-to-GDP	-0.1161*
CapOpen	-0.1251*
Private credit-to-GDP	-0.2054*
Domestic debt-to-GDP	-0.1819*
Foreign debt-to-GDP	-0.1666*
Regulatory quality	-0.1587*
Law & Order	-0.1291*
Investment profile	-0.2140*
M3-to-fixed capital formation	-0.1531*
Liquidity-to-Tangibility	-0.2008*
Leverage-to-Tangibility	-0.2093*
Dividend intensity	0.1197*
Profitability	0.1545*
Size	-0.0788*

Appendix B.1

The table reports the number of firms in the sample by country and year. The sample size includes firms from 44 countries. The sample period covers 1995 to 2010 years.

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Australia	132	140	161	190	192	226	262	433	657	666	662	726	771	815	840	961	7,834
Austria	40	43	42	53	54	62	56	51	45	49	46	47	41	46	47	39	761
Belgium	82	80	73	78	86	86	84	81	77	75	87	89	88	84	87	80	1,317
Canada	263	259	284	299	300	417	508	567	622	724	759	812	1,209	1,234	1,254	1193	10,704
Denmark	112	109	111	132	130	114	104	106	100	93	88	87	96	98	93	91	1,664
Ireland	36	36	35	40	42	40	47	44	47	44	40	45	43	37	34	30	640
Finland	84	90	87	106	109	108	115	124	124	116	119	114	112	114	110	110	1,742
France	352	339	343	418	458	483	498	507	495	490	513	504	498	490	480	435	7,303
Germany	365	359	348	437	470	505	522	536	522	505	506	516	540	522	495	435	7,583
Hong Kong	79	104	170	222	238	233	254	371	505	607	661	716	722	741	749	738	7,110
Italy	102	97	96	101	112	119	131	148	143	152	153	173	185	173	168	164	2,217
Japan	379	398	403	1,025	1,045	1,048	1,086	2,779	3,181	3,165	3,266	3,331	3,380	3,330	3,243	3143	34,202
Netherlands	128	133	137	158	158	138	131	129	118	113	110	112	108	99	92	85	1,949
Norway	66	66	69	119	117	107	110	111	109	122	120	128	151	148	138	127	1,808
New Zealand	25	31	34	40	45	42	42	49	67	61	62	73	77	76	70	73	867
Singapore	85	107	144	160	174	163	173	292	361	422	493	520	512	528	546	523	5,203
Spain	74	77	82	91	90	87	91	91	86	86	85	87	91	88	89	84	1,379
Sweden	109	116	116	167	192	184	206	231	236	234	233	245	294	300	293	296	3,452
Switzerland	106	108	119	140	149	137	151	168	164	169	169	164	169	163	156	155	2,387
UK	928	936	895	1,016	991	917	910	947	955	981	992	1,053	1,067	1,029	960	825	15,402
US	2,259	3140	3,429	3,695	3,804	4,304	4,177	3,984	3,893	3,768	3,662	3,539	3,402	3,191	3,182	2938	56,367

Appendix B.1 (continue)

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Argentina	20	20	19	24	25	25	34	31	42	42	45	46	51	54	52	49	579
Brazil	63	74	86	84	77	91	155	156	148	146	150	159	156	145	149	150	1,989
China	18	26	59	78	89	99	759	941	1,000	1,104	1,244	1,271	1,290	1,323	1,410	1528	12,239
Chile	41	45	49	53	57	71	99	101	102	105	105	107	108	107	106	103	1,359
Colombia	16	15	16	16	12	15	12	18	21	24	17	14	12	11	12	10	241
Czech Rep.	0	0	7	19	17	15	10	10	12	13	14	16	16	8	8	7	172
Egypt	0	0	0	0	1	4	3	10	10	14	26	31	88	97	93	90	467
Greece	5	8	6	5	3	4	4	18	38	41	56	78	214	211	206	186	1,083
Hungary	3	3	6	8	11	15	19	19	20	20	16	18	18	21	21	21	239
Indonesia	79	78	83	23	77	72	104	159	176	180	191	199	206	223	229	223	2,302
India	150	171	235	246	252	242	250	251	275	295	408	528	623	1,519	1,549	1529	8,523
Mexico	55	57	59	62	63	79	91	89	94	89	93	95	92	89	87	33	1,227
Malaysia	147	162	225	233	269	250	278	459	528	560	635	702	734	722	728	714	7,346
Peru	13	14	14	21	20	29	45	54	53	52	49	42	75	78	76	69	704
Pakistan	54	55	57	58	63	57	57	66	71	72	74	77	130	140	135	108	1,274
Poland	7	10	30	33	32	39	41	46	51	79	134	177	228	248	250	250	1,655
Portugal	27	33	38	40	39	37	41	47	46	43	40	38	39	38	35	31	612
Philippines	37	39	55	53	58	63	73	86	88	85	87	89	91	92	96	98	1,190
Russia	0	0	0	3	6	7	11	11	18	28	43	62	111	113	119	99	631
South Africa	107	110	97	93	97	203	213	203	206	188	184	184	197	210	221	216	2,729
Thailand	139	150	135	127	137	144	152	219	243	265	328	369	377	371	364	366	3,886
Turkey	20	16	20	26	39	45	48	76	90	129	140	141	168	168	182	179	1,487
Venezuela	6	5	6	10	9	12	14	15	15	13	15	16	15	12	6	5	174
Total obs.	6,813	7,859	8,480	10,002	10,409	11,138	12,171	14,834	15,854	16,229	16,920	17,540	18,595	19,306	19,260	18,589	223,999
%	3.0%	3.5%	3.8%	4.5%	4.6%	5.0%	5.4%	6.6%	7.1%	7.2%	7.6%	7.8%	8.3%	8.6%	8.6%	8.3%	100%

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