Existing Methods Provide Unreliable Estimates of the Marginal Value of Cash[*]

Joseph T. Halford
University of Nevada, Reno

John J. McConnell
Purdue University

Valeriy Sibilkov[**]
University of Wisconsin-Milwaukee

Nataliya Zaiats
Suffolk University

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Abstract:
Some estimates of the marginal values of cash reported in existing literature appear inconsistent with economic common sense. We establish reasonable benchmark values for the marginal value of cash based on economic theory and empirical evidence. In various samples and contexts, the estimates of the marginal value of cash violate their respective benchmarks. Furthermore, we propose a diagnostic test to examine the reliability of the estimation methodology. The estimates fail the test. The existing methodology of Faulkender and Wang (2006) for estimating the marginal value of cash is unreliable, and empirical estimates that result should be treated with caution.

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[**] Corresponding author: Sheldon B. Lubar School of Business, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201, USA, 414-229-4369, sibilkov@uwm.edu.

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To study whether cash holdings create or destroy value and under which circumstances, researchers set out to estimate the marginal value of cash – the value shareholders place on a marginal dollar of corporate cash holdings. The predominant methodology for estimating the marginal value of cash is the methodology proposed by Michael Faulkender and Rong Wang (henceforth, FW, 2006). The FW methodology has been used to argue that the level of financial constraints, corporate governance, industry unionization, insider voting and cash flow rights, CEO compensation, diversification, and creditor rights, among other characteristics, significantly affect the marginal value of cash.[1] More recently, researchers document trends in the marginal value of cash through time, and utilize the marginal value of cash to disentangle alternative explanations of their findings in other areas of finance.[2] Given the wide-ranging use and implications of the estimates of the marginal value of cash, it is important that they be reliable. However, some of the estimates produced by the FW methodology conflict with reasonable benchmark values grounded in theory, casting doubt on the reliability of the FW methodology.[3]

In this paper, we examine the reliability of the FW methodology and the possible reasons for the discrepancy between benchmark values of the marginal value of cash and empirical estimates reported in the literature. Several pieces of evidence, including a diagnostic test that we

[1] See, among others, David Denis and Valeriy Sibilkov (2010), Amy Dittmar and Jan Mahrt-Smith (2007), In-Mu Haw, Simon Ho, Bingbing Hu, and Xu Zhang (2011), Sandy Klasa, William Maxwell, and Hernán Ortiz-Molina (2009), Petri Kyröläinen, Irene Tan, and Pasi Karjalainen (2013), Yixin Liu and David Mauer (2011), Ronald Masulis, Cong Wang, and Fei Xie (2009), and Zhenxu Tong (2011).

[2] See, among others, Nihat Aktas, Christodoulos Louca, and Dimitris Petmezas (2019), Thomas Bates, Ching-Hung Chang, and Jianxin Chi (2018), Wolfgang Breuer, Marc Rieger, and Kalender Soypak (2017), Olivier Dessaint and Adrien Matray (2017), Manoj Kulchania and Shawn Thomas (2017), and Hieu Phan, Thuy Simpson, and Hang Nguyen (2017).

[3] See, for example, the predictions of FW and Christopher Hennessy and Toni Whited (2005). We provide a detailed discussion of how we utilize their theoretical frameworks to derive reasonable benchmark values of the marginal value of cash in Section 1.

propose and implement, suggest that estimates produced by the FW methodology are unreliable. While we observe minor improvement after we attempt to alleviate potential confounding effects, our attempts are insufficient to align the estimates with benchmark values.

One of the most obvious discrepancies between benchmark values and empirical estimates of the marginal value of cash manifests in the results of Dittmar and Mahrt-Smith (2007). FW predict that, at most, the marginal value of cash should equal $1/(1-f)$, where f represents the proportional transaction costs (direct and indirect) of raising cash in the capital market. Dittmar and Mahrt-Smith report estimates that appear to exceed reasonable bounds of this threshold. Specifically, they estimate the marginal value of cash to be \$1.62 or \$1.27 for the average U.S. public company with strong governance, depending on the measure of governance used. These values imply that an average U.S. public company with strong governance is severely financially constrained, facing transaction costs to access the capital market of (at least) 38% or 21% on the marginal dollar. Dittmar and Mahrt-Smith's findings also imply that the average U.S. public company with strong governance cannot fund projects that generate up to 62% or 27% risk-adjusted returns on investment. Dittmar and Mahrt-Smith's findings do not seem plausible for an average, well-governed, U.S. public company, because the reported costs of accessing the capital market are much lower.[4]

Given these implausible estimates, we propose and implement a diagnostic test to examine the overall reliability of the FW methodology. The test is derived from the definition of the marginal value, as applied to cash holdings. By definition, a dollar increase in cash holdings

[4] The average costs of seasoned equity offerings, including fees and stock price reactions, are 6 to 8% of the offering value; the average costs of issuing debt are around 1.5% (Dongcheol Kim, Darius Palia, and Anthony Saunders 2008; Espen Eckbo, Ronald Masulis, and Øyvind Norli 2007). The average initial public offering (IPO), which faces significant costs due to the information asymmetries associated with a private firm going public (Kevin Rock 1986), pays "only" around 25% (Jay Ritter 2014) to access the capital market.

should increase firm value by the marginal value of cash, whereas a dollar decrease in cash holdings should reduce firm value by the same amount. Therefore, if a methodology reliably measures the marginal value of cash, estimates of the marginal value of cash associated with cash increases and cash decreases should be equal for the same group of firms, ceteris paribus. We refer to this proposition as the "equality proposition."

We find that the equality proposition does not hold for the estimates of the marginal value of cash obtained using the FW methodology. Contrary to the proposition, the estimates during periods of cash increases (accumulation) and periods of cash decreases (spending) differ sharply, $1.07 and $0.15 for an average firm, respectively. One possible explanation of this result is that shareholders assign a lower marginal value of cash to firms that distribute cash compared to firms that accumulate cash. But the evidence is inconsistent with this explanation.

When we examine firms with cash reversals in adjacent years, that is, firms that accumulate cash one year and spend it the next year (or vice versa), we continue to find a significant difference between the marginal values of cash during accumulation and spending years. Specifically, the estimated value of cash for a given group of firms changes by a factor of seven year over year. Yet, the marginal value of cash is unlikely to be this volatile. If it were, we would also expect firm value to decline proportionately with the total amount of cash it holds. We do not observe that. Most likely, the estimates are biased by the information about firm value contained in the changes in cash – the variable used to estimate the marginal value of cash in the FW methodology – and not sufficiently controlled for by other variables in the model.

These observations prompt us to search for sources of the discrepancy between benchmark values and the empirical estimates in an effort to alleviate or even rectify a possible bias. Events which simultaneously affect both cash holdings and shareholder value may bias the estimates of

the marginal value of cash if these events are not properly controlled for. Put simply, the estimates obtained from the FW methodology may suffer from an omitted variables bias.

Our next step is to exclude certain observations which may exacerbate the bias, and assess whether the estimates improve. First, we confine the sample to small changes in cash, less than 1% of the total market value of equity. The rationale is that small cash changes are unlikely to carry substantial informational weight about firm value, and, as a result, the bias should be weaker. Surprisingly, the estimates, ranging between $3.15 and $3.33, are even less reasonable. The most likely explanation for this result is that even small changes in cash contain value-relevant information beyond information about changes in the cash balance, and other explanatory variables fail to fully control for it. Second, we attempt to exclude firms with events that may affect both cash holdings and firm value such as those involved in corporate control activity or with significant equity issues or repurchases. Excluding such firms improves the estimates, in the sense that the difference between the estimates during episodes of cash accumulation and spending declines, but not sufficiently so to eliminate the bias. The equality proposition still does not hold, and the estimates differ by a factor of up to three.

Next, we attempt to uncover potential omitted variables. Some obvious suspects are stock issues and repurchases, as well as debt issuances and reductions. In the FW methodology, these events are combined into a single variable, labeled Net Financing. Yet, stock issues differ from stock repurchases or changes in debt with regard to their correlation with shareholder value and cash holdings. Thus, it is plausible that each of these financing events contain unique information that may be not fully controlled for using the Net Financing variable. We examine whether disentangling these components and controlling for them separately aligns the estimates with theoretical predictions. Even with these changes, we do not yield estimates of the marginal values

of cash that are reasonably close to benchmark values in most instances. The equality proposition continues not to hold, the sample of small changes in cash continues to produce implausibly high estimates, and other violations of theoretical predictions still occur.

The evidence indicates that the estimates of the marginal value of cash are unreliable. But, perhaps, some conclusions of existing studies still hold? That is, can researchers draw inferences from the finding that, for example, the marginal value of cash increases with some firm characteristic, without knowing the exact absolute estimate of the marginal value of cash?

To answer these questions, we refer back to theory. Theoretical frameworks of FW and Hennessy and Whited (2005) postulate that absent market frictions, the marginal value of cash equals $1. A corollary is that deviations from $1 in either direction are a manifestation of market frictions. It follows that the interpretation of the marginal value of cash depends critically on whether the value of cash is greater or less than $1. A higher marginal value of cash is not always evidence of a decline in frictions or an improvement in overall firm value. For example, if stronger corporate governance is associated with a $0.10 increase in the marginal value of cash from $0.60 to $0.70, that can be interpreted as consistent with the hypothesis that corporate governance alleviates agency costs and improves firm value. However, if the increase advances the marginal value of cash from $1.20 to $1.30, such an outcome is consistent with strong governance exacerbating financial constraints, likely leading to lower firm value. Therefore, to interpret the effect of any characteristic on the marginal value of cash, it is imperative to know whether the marginal value of cash is higher or lower than $1. For that reason, the precise estimate of the marginal value of cash is a necessary condition for interpretation of the relation between a characteristic and the value of cash.

Overall, the evidence indicates that estimates of the marginal value of cash obtained using the FW methodology are unreliable. The methodology appears to suffer from an omitted variable bias that cannot be immediately rectified. The likely cause of the bias is the information contained in the change in cash holdings about shareholder value and returns. The results suggest that existing studies that rely on the FW methodology should be considered with caution.

We view our paper as the first step in an attempt to verify and possibly rectify the massive volume of evidence and conclusions that the literature has accumulated over the past decade while using the FW methodology. Our purpose is to draw attention to some obvious discrepancies that we observe, and to the evidence indicating that the empirical estimates of the marginal value of cash reported in the literature are unreliable. Moreover, conclusions of the extant literature about correlations of firm characteristics with the marginal value of cash depend critically on the precise estimates of the marginal value of cash. Thus, the conclusions and inferences of such studies should also be treated with caution.

The next step, which we do not pursue in this paper, is to either rectify the FW methodology to a sufficient extent so that it passes the credibility check and produces estimates that align with reasonable benchmark values and economic common sense, or to devise a new methodology for estimating the marginal value of cash. We leave these tasks to future research.

The paper proceeds as follows. The next section presents economic theory of the marginal value of cash and derives reasonable benchmark values of the marginal value of cash. It also discusses empirical methods used to estimate the marginal value of cash. Section 2 discusses the data and attempts to replicate results of Dittmar and Mahrt-Smith (2007). Section 3 presents and implements a credibility check of the methodologies used to estimate the marginal value of cash. Section 4 examines the marginal value of cash for small cash changes, and separates the Net

Financing variable into components. Section 5 examines the effects of financial constraints, CEO incentives and divergence between insider voting and cash flow rights on the marginal value of cash. Section 6 concludes.

1. The FW methodology and a diagnostic test

In this section, we derive reasonable benchmark values for the marginal value of cash in three steps. First, we start with the theoretical framework of FW and extend it to incorporate agency costs. The result is the identification of three cash regimes, which determine the likely use of a marginal dollar of cash. As pointed out by FW, identification of cash regimes is important because the marginal value of cash largely depends on which cash regime the firm is in. Second, for each cash regime, we determine theoretical boundaries of the marginal value of cash. Third, taking into account empirical evidence from the finance literature on the costs of accessing the capital market, we estimate benchmark values of the marginal value of cash that can reasonably be expected for U.S. publicly-traded companies. These values serve as benchmarks used to assess the reliability of the FW methodology and the plausibility of estimates produced by it.

This section also reviews the FW methodology, and discusses a diagnostic test that we propose to examine the reliability of any methodology used to estimate the marginal value of cash.

1.1. Marginal value of cash

The marginal value of cash, MVC, is the value that shareholders place on an additional (or marginal) \$1 of a firm's cash holdings and is equal to the present value of incremental cash flows generated by the dollar. It is determined by how the marginal dollar is used. Extending the theoretical framework of FW, we identify three cash regimes that describe the likely usage of the

marginal dollar of cash.[5] Intuitively, the marginal value of cash depends on the availability of investment opportunities and of financing to pursue those opportunities.

In addition to an examination of the effect of financing frictions or "constraints" on which FW and Hennessy and Whited (2005) focus, we incorporate agency costs into our analysis of cash regimes, as these costs are the focus of many existing studies that utilize the FW methodology. We show that the impact of market frictions and agency costs on the marginal value of cash and firm value depends on the cash regime.

1.1.1. Regime 1: Firms that raise capital

Firms in regime 1 have a supply of value-increasing investment opportunities (projects) but insufficient internal cash or cash flow to finance all of them. Firm i's marginal investment opportunity in regime 1 satisfies

$$(1 + n_{i1})(1 - a_{i1})(1 - t_{i1}) \geq 1/(1 - f_{i1}) \quad (1)$$

where subscripts i and R represent firm i and regime $R \in (1, 2, 3)$, respectively, n_{i1} is the proportional NPV of the project (excluding agency costs, transaction costs, and taxes on distributions to shareholders), $a_{i1} \in (a_h, a_l)$ indicates proportional agency costs (e.g., a_h (a_l) represents the agency costs associated with weak (strong) governance), t_{i1} represents the effective tax on distributions to shareholders, and $0 \leq f_{i1} < 1$ represents the proportional transaction cost of raising a marginal dollar in the capital market.

Projects that satisfy equation (1) but cannot be financed internally are financed with external capital. For the purpose of determining reasonable benchmarks for the marginal value of cash, the source of capital – whether it is debt or equity – is irrelevant.[6] The capital market provides

[5] In all of our analyses, we assume that market participants are rational value maximizers and that investment opportunities are divisible up to $1.

[6] The source of capital will, however, affect firm value through its effects on capital structure.

$1 – in the form of equity or debt – only if the value of the investment is at least $1/(1 - f_{i1}) \geq 1$. As a result, only projects that satisfy equation (1) are undertaken. Projects valued below the $1/(1 - f_{i1})$ threshold are not financed externally or internally because financing them internally yields less than the savings associated with not accessing the capital market.

Equation (1) implies that the contribution of the value of firm i's marginal investment opportunity to its market value of equity (*MVE*) given its current level of cash holdings is

$$MVE_{i1}|C_o = (1 + n_{i1})(1 - a_{i1})(1 - t_{i1}) - 1/(1 - f_{i1}) \quad (2)$$

If the firm is endowed with an additional dollar of cash, the market value of equity is

$$MVE_{i1,}|C_o + 1 = (1 + n_{i1})(1 - a_{i1})(1 - t_{i1}). \quad (3)$$

The expected marginal value of cash for firms in regime 1 is the difference between equations (2) and (3). Taking the expectation over i yields,

$$E(MVC_{i1}) = E(MVE_{i1}|C_0 + 1) - E(MVE_{i1}|C_o) = E(1/(1 - f_{i1})). \quad (4)$$

For a firm in regime 1, the marginal value of cash does not depend on agency costs a_{i1}, but is entirely determined by the costs of accessing the capital market, f_{i1}. The reported average cost of a seasoned equity offering is between 6% and 8% (Kim, Palia, and Saunders 2008; Eckbo, Masulis, and Norli 2007); thus, based on these estimates, we expect the marginal value of cash for the average U.S. public firm in regime 1 to have an upper bound of about $1/(1 - 0.08) = \$1.09$. The lower bound for the marginal value of cash for firms in regime 1 is $1.

1.1.2. Regime 2: Firms with insufficient cash that do not raise capital (financially constrained firms)

Firms in regime 2 do not have sufficient internal capital to finance all valuable projects. But, unlike in regime 1, the value of the marginal project is relatively low and the costs of accessing the capital market to fund the project are relatively high. As a result, firms in regime 2 do not

access the capital market to finance the marginal project because the benefits of the project do not offset the costs of raising capital. The marginal investment opportunity satisfies $1/(1-f_{i2}) > (1+n_{i2})(1-a_{i2})(1-t_{i2}) \geq 1-t_{i2}$. As a result, these firms have unfunded projects with expected values below the threshold, $1/(1-f_{i2})$, but greater than the value of distributing cash to shareholders. For firms in regime 2, the marginal value of cash is $E(MVC_{i2}) = E(MVE_{i2}|C_0+1) - E(MVE_{i2}|C_0) = E\big((1+n_{i2})(1-a_{i2})(1-t_{i2})\big)$. That is, the marginal value of cash is equal to the expected value of the marginal investment opportunity.

In regime 2, agency costs a_{i2} determine the marginal value of cash to the extent that they affect the marginal investment opportunity. For example, if firm i has expected costs $a_{i2} = a_h > a_l$ due to weak governance, it will have a lower marginal value of cash than if it had strong governance. Furthermore, as we discuss below, higher costs of accessing the capital market may contribute to the firm's regime 2 status. However, once the firm is in regime 2, the marginal value of cash is not affected by these costs, f_{i2}, because sufficient cash is available to finance all projects with values above the financing threshold.

Empirically, we expect to observe that the lower bound for the expected marginal value of cash for firms in regime 2 is $E(1-t_{i2})$. The upper bound is $E(1/(1-f_{i2}))$. However, while the costs of accessing the capital market are observable for firms in regime 1, f_{i1}, they are not for firms in regime 2 which do not access the capital market. It is possible that firms in regime 2 face higher costs of accessing the capital market than firms in regime 1. If so, the marginal value of cash in regime 2 may be higher than that in regime 1, and higher than that implied by the average observed costs of accessing the capital market. Whether that is so is an empirical question.

1.1.3. Regime 3: Firms with excess cash

Firms in regime 3 can finance all valuable projects with internal cash, so that the marginal investment opportunity has non-positive Net Present Value $(n_{i3} \leq 0)$, and satisfies $(1 + n_{i3})(1 - a_{i3})(1 - t_{i3}) < 1 - t_{i3}$. The change in the firm's market value of equity in response to an additional dollar of cash holdings is $E(MVC_{i3}) = E(MVE_{i3}|C_0 + 1) - E(MVE_{i3}|C_0) = E\big((1 + n_{i3})(1 - a_{i3})(1 - t_{i3})\big)$. If managers act in the interests of shareholders (i.e., $a_{i3} = 0$ and the project is not undertaken) they optimally distribute any excess cash and $E(MVC_{i3}) = E(1 - t_{i3})$.

High agency costs $a_h > a_l$ reduce the marginal value of cash. Strong governance improves the marginal value of cash up to the value under $a_{i3} = 0$. The upper bound on the marginal value of cash for firms that are in regime 3 is $E(1 - t_{i3})$. Financial constraints (costs of accessing the capital market) do not affect the marginal value of cash, as firms have sufficient internal cash to finance all valuable projects. During our sample period, the maximum individual tax rate on dividends was between 15% and 70% and the maximum tax rate on share repurchases (i.e., long-term capital gains) was between 15% and 28%.[7]

1.1.4. Regime switching

We now consider the possibility that firms switch regimes due to evolving costs associated with firm characteristics or financial constraints. An examination of whether and how a firm switches regimes provides valuable insight into the potential effects of firm, industry, and market characteristics on the marginal value of cash and shareholder value. Consider, for example, that an increase in f_i to f_j will not affect the marginal value of cash if firm i is in regime 2 or 3. However, in the case that firm i's marginal investment opportunity satisfies $1/(1 - f_i) \leq (1 + n_i)(1 - a_i)(1 - t_i) < 1/(1 - f_j)$, if the increase is high enough, firm *i* originally in regime 1 may

[7] For some investors, the effective tax rates on distributions are lower than those that we report. For example, this may occur, in part, because the original dollar raised by the firm is not subject to distribution tax due to its treatment as generally untaxable return of capital.

switch to regime 2. The marginal values of cash for firm i in regimes 1 and 2 are $1/(1-f_i)$ and $E((1+n_i)(1-a_i)(1-t_i))$, respectively. Note that although the value of the firm's marginal investment opportunity is unchanged, the marginal value of cash is higher in regime 2. Therefore, changing characteristics may induce a change in regime, thereby changing the marginal value of cash. Additionally, the value of firm i is lower in regime 2 because the firm does not undertake all projects with values between $1/(1-f_i)$ and $1/(1-f_j)$. This observation reveals that higher marginal values of cash do not necessarily imply higher firm values.

Consider the alternative case in which financial constraints decline so that $f_i > f_j$. If the firm is in regime 1, it remains in regime 1, and the marginal value of cash falls to $1/(1-f_j)$. If the firm is initially in regime 2, and if the reduction in f_i is sufficiently large, it switches to regime 1, and the marginal value of cash falls to $1/(1-f_j) \leq (1+n_i)(1-a_i)(1-t_i)$. A reduction in f_i will not affect firms in regime 3. The total effect of a characteristic, financial constraints in this example, on the marginal value of cash is equal to the effect within the regime plus the effect due to regime switching.

Now suppose that firm i has $a_i = a_h > a_l$ due to weak governance. For a firm in regime 1, higher agency costs due to a decline in governance may result in the firm switching to regime 2 or 3. Such a switch lowers the marginal value of cash from $1/(1-f_i)$ to $(1+n_i)(1-a_h)(1-t_i)$. For a firm in regime 2, higher agency costs may result in a switch to regime 3, which lowers the marginal value of cash from $(1+n_i)(1-a_l)(1-t_i)$ to $(1+n_i)(1-a_h)(1-t_i)$, implying a governance effect of $(a_h-a_l)(1+n_i)(1-t_i) < 1/(1-f_i)$. An increase in a_i will not cause a regime switch for a firm in regime 3. Theoretically, in the most extreme case, which is a change between $a_l = 0$ and $a_h = 1$, the governance effect could be as large as $(1+n_i)(1-t_i) \leq 1/(1-f_i)$.

Now consider the case where $a_i = a_l < a_h$ due to strong governance. For a firm in regime 1, a reduction in agency costs does not affect the marginal value of cash. For a firm in regime 2 or 3, a reduction in these costs may result in a switch to regime 1, or to regime 1 or 2, respectively. In either case, the effect of governance on the marginal value of cash will not exceed $(1 + n_i)(1 - t_i) \leq 1/(1 - f_i)$. Corporate governance may improve the marginal value of cash, but not beyond $1/(1 - f_i)$. We expect a positive relation between measures of corporate governance and the marginal value of cash. As in the case with financial constraints, the total effect is equal to the within regime effects plus the regime switching effects. Table A summarizes the reasonable benchmark values of the marginal value of cash, and the predicted relations between the level of corporate governance and the marginal value of cash in each regime based on the current tax rates on corporate distributions.

Table A: The marginal value of cash across cash regimes

	Regime 1	**Regime 2**	**Regime 3**
$E(MVC_{iR})$	$E(1/(1-f_i))$	Between $E(1/(1-f_i))$ and $E(1-t_i)$	$\leq E(1-t_i)$
Empirical benchmark	Between \$1.00 and \$1.09	$>$ \$0.85	$<$ \$0.85
$Cov(MVC_{iR}, Gov_i)$	0	+	+
$Cov(MVC_{iR,}\, f_i)$	+	0	0

1.2. FW's and Hennessy and Whited's (2005) regimes

In modelling firms' debt policies, Hennessy and Whited (2005) derive empirical predictions similar to FW's regarding the marginal value of corporate savings. Because Hennessy

and Whited's focus is not on the value of cash per se, we focus on FW's empirical predictions. However, the similarities between the intuition and empirical predictions of Hennessy and Whited's theory as it relates to the marginal value of cash and that of FW's framework serve to re-affirm the importance of the role of cash regimes in assessing the marginal value of cash.

Hennessy and Whited construct a structural dynamic trade-off model of capital structure, which predicts that the marginal debt decision – whether or not to service debt – depends on the marginal benefit and the marginal cost of servicing debt. The cost of servicing debt is the cost of cash used to service debt. In marginal form, the marginal cost of servicing debt equals the marginal value of cash.

Hennessy and Whited show that firms can be in one of three regimes, which they refer to as "equity" regimes, possibly to reflect that regimes depend on the net cash flow to shareholders. These regimes are positive distributions (to shareholders), zero distributions, or negative distributions (i.e., equity issuance). For each of these regimes, Hennessy and Whited derive the marginal cost of servicing debt, which equals the marginal value of cash. Hennessy and Whited predict that the marginal value of cash critically depends on the regime in which a firm resides. For firms that issue equity, the marginal value of cash is $\$(1 + \lambda)$, where λ is the cost of issuing equity. For firms that pay out cash to shareholders, the marginal value of cash is $\$(1 - t)$, where t is the marginal tax that shareholders pay on dividends. For firms that neither raise equity nor pay out cash to shareholders, the marginal value of cash lies between these two values.

These predictions are similar to the predictions of FW regarding the marginal value of cash for firms that issue equity and firms that distribute to shareholders. The two studies differ in that Hennessy and Whited allow that, in certain instances, it is optimal for firms to "do nothing" and

have zero net distributions to shareholders, while FW recognize that in certain high-leverage firms, marginal cash accrues to debtholders, and the marginal value of cash to shareholders is low.

1.3. The FW methodology for estimating the marginal value of cash

The procedure used in the literature to estimate the marginal value of cash is that proposed by FW. The estimates of the marginal value of cash reported in this literature vary considerably depending on the group of firms examined and their characteristics. Appendix A provides a concise summary of this literature.

In the first step of the FW methodology, a regression is estimated in which the dependent variable is a stock's excess return over a fiscal year, defined as stock i's return during fiscal year t, less the return on its corresponding Eugene Fama and Kenneth French (1992) size/book-to-market benchmark portfolio during fiscal year t.[8] Using an ordinary least squares (OLS) regression, the excess return is regressed on the change in cash and other firm characteristics. The dependent and explanatory variables are effectively normalized by the market value of equity at the beginning of year t. The coefficient on the change in cash measures the dollar change in equity value resulting from a dollar change in the firm's cash holdings. The regression has the form:

$$\begin{aligned} r_{it} - R_{it}^{B} = {} & \gamma_o + \gamma_1 \frac{\Delta C_{it}}{M_{it-1}} + \gamma_2 \frac{\Delta E_{it}}{M_{it-1}} + \gamma_3 \frac{\Delta NA_{it}}{M_{it-1}} + \gamma_4 \frac{\Delta RD_{it}}{M_{it-1}} \\ & + \gamma_5 \frac{\Delta I_{it}}{M_{it-1}} + \gamma_6 \frac{\Delta D_{it}}{M_{it-1}} + \gamma_7 \frac{C_{it-1}}{M_{it-1}} + \gamma_8 L_{it} + \gamma_9 \frac{NF_{it}}{M_{it-1}} \\ & + \gamma_{10} \frac{C_{it-1} * \Delta C_{it}}{M_{it-1}} + \gamma_{11} \frac{L_{it} * \Delta C_{it}}{M_{it-1}} + \epsilon_{it} \end{aligned} \tag{5}$$

[8] Portfolio returns are weighted by market capitalization, and a stock is assigned to its appropriate benchmark portfolio at the beginning of a fiscal year.

where i denotes a firm, t and $t-1$ denote fiscal year-ends, r is the annual stock return, R^B is the annual return on the benchmark portfolio, ΔX denotes a change in variable X over the fiscal year, M is the market value of equity, C indicates cash holdings, E is earnings, NA are non-cash assets, RD refers to research and development expenses, I is interest expense, D indicates dividends, NF is net financing, and L is market leverage. All variables are defined in detail in Appendix B. The model includes interactions of the change in cash with lagged cash and leverage because FW hypothesize that the value of cash should decline with the amount of cash and leverage.

The second step calculates the marginal value of cash. Because of the interactions of the change in cash with cash and leverage, to estimate the marginal value of cash for an average firm in the sample, the sample means of lagged cash and leverage are multiplied by their respective coefficients, $\gamma_{10}$and γ_{11}, and summed along with the coefficient of the change in cash, γ_1. By itself, the coefficient of the change in cash, γ_1, is interpreted as an estimate of the marginal value of cash for a hypothetical firm with zero cash and zero leverage. For each subsample that we examine, we calculate the marginal value of cash using the means of lagged cash and leverage in that sample.

1.4. A diagnostic test for the FW methodology

We can judge whether a methodology is reliable by comparing the empirical estimate to a theoretical benchmark. If the empirical result is significantly outside of the range of an informed expectation, the methodology and empirical estimation should be questioned. However, in addition to comparing empirical estimates obtained using the FW methodology to a theoretical prediction of the marginal value of cash in a specific sample, we propose a diagnostic test that can be used to examine the reliability of any methodology for calculating the marginal value of cash.

By the definition of a marginal value, the marginal value of cash is the change in firm value

that occurs as a result of an incremental change in the amount of the firm's cash on hand. We recognize that regardless of whether the firm gains or loses the marginal dollar of cash, firm values should change – increase or decrease, respectively – by the marginal value of cash, holding everything else constant. That is, the value of a marginal dollar of cash is constant regardless of whether a firm acquires or loses that dollar. If the estimates are reliable, they would be (approximately) equal regardless of whether they are estimated during cash increases or cash decreases for a group of firms. This equality proposition is the basis of our diagnostic test.

2. Data and replication of Dittmar and Mahrt-Smith (2007)

In this section, we introduce and discuss the data and attempt to replicate the results of Dittmar and Mahrt-Smith (2007). Although our discussion closely focuses on Dittmar and Mahrt-Smith, this is solely because their results provide an example of the problems and concerns associated with measuring the marginal value of cash. Their analysis is in no particular way different from the approaches and analyses in other studies of the marginal value of cash.

2.1. Sample construction

We construct our sample of U.S. publicly traded companies by obtaining accounting and financial data from the *Compustat* database and stock return data from the *Center for Research in Security Prices* (*CRSP*). The sample encompasses the period 1972–2017. We exclude all firms that belong to the financial and utility industries (standard industrial classification codes between 6000 and 6999 and between 4900 and 4999) because of the possible effects of regulations in these firms. We convert all dollar data to 2012 values using the consumer price index. As do FW, we eliminate firm-years for which total book assets net of cash are negative, the market value of equity is negative, or dividends are negative. The final sample contains 129,530 observations.

The data are supplemented with antitakeover provisions data from the *Investor*

Responsibility Research Center, institutional investor ownership data from *Thomson Reuters Institutional Holdings Database*, and corporate control transactions data from the *Securities Data Company's* (*SDC*) *Mergers and Acquisitions Database*. Antitakeover provisions data are available for 16,883 observations and encompass the interval of 1990–2006. Institutional investor ownership data are available for 40,052 observations and encompass the interval of 1980–2011. We further obtain data on executive compensation from *Compustat's Execucomp* database. Andrew Metrick generously provided executive stock ownership data in dual-class companies along with voting rights. In regressions in which we attempt to replicate existing studies, we confine the sample period to the period of the study's sample, which reduces the number of observations used in those regressions. For comparison, in each instance, we also estimate corresponding regressions using the full sample period and available data.

2.2. Sample statistics

In Table 1 of the Online Appendix, we report summary statistics of firm characteristics for the full sample. The firms in the sample are representative of U.S. public firms. An average firm in the sample owns $2,060 million in total book assets and the total market value of its equity is $1,492 million. It holds 23.7% of the value of equity in cash and has a Tobin's Q of 1.58. The total value of debt comprises 24.6% of total book assets.

2.3. Replication of the estimates of Dittmar and Mahrt-Smith (2007)

We begin by attempting to replicate Dittmar and Mahrt-Smith's (2007) estimates of the marginal values of cash for strong and weak governance firms using the FW methodology. As do Dittmar and Mahrt-Smith, we add a binary variable set to 1 if a firm-year has strong governance and 0 if it has weak governance, along with its interaction with the change in cash, to the FW regression model. A firm is classified as strong governance if it is in the bottom tercile of the G-

index distribution, and weak governance if it is in the top tercile. For the second measure of governance, a firm is classified as strong governance if it is in the top tercile of the sample according to the ownership of institutional blockholders and weak governance if it is in the bottom tercile. The coefficient of the interaction term measures the effect of strong governance on the marginal value of cash. We estimate regressions for Dittmar and Mahrt-Smith's sample period of 1990–2003. For reference, we also estimate the regression for extended sample periods for which data are available, which is 1990–2006 for the regression in which G-index is included, and 1980–2011 for the regression in which blockholder ownership is included. According to Dittmar and Mahrt-Smith, they winsorize all variables used in the analyses at 1% and 99%, and we do so as well. The results are in Panel A of Table 1.[9]

[Table 1 here]

The interaction of the strong governance indicator with the change in cash is positive and significant for both the G-index and blockholder ownership measures, indicating that the marginal value of cash is higher for firms with strong corporate governance. However, the magnitudes of the governance effect (the difference between strong and weak governance firms) that we observe are lower than those reported by Dittmar and Mahrt-Smith. We estimate the marginal values of cash for an average firm with weak and strong governance to be \$0.88 and \$1.23, respectively, using the G-index as a measure of governance (versus \$0.42 and \$1.62 in Dittmar and Mahrt-Smith) and \$1.22 and \$1.37 using the blockholder ownership measure (versus \$0.88 and \$1.27 in Dittmar and Mahrt-Smith). Our estimate of the effect is \$0.35 for the G-index versus \$1.20 reported by Dittmar and Mahrt-Smith and \$0.15 for the blockholder ownership versus \$0.39,

[9] Despite our efforts to replicate the sample of Dittmar and Mahrt-Smith by following their stated procedures for sample selection, for reasons we do not understand or know, we nevertheless obtain more observations in our sample for their sample period than they report.

respectively. For the sample period that extends beyond the end of the Dittmar and Mahrt-Smith period, the interaction remains significant for the G-index measure, but becomes statistically insignificant for the blockholder ownership measure. While we are able to replicate the significant relation between strong governance and the marginal value of cash reported by Dittmar and Mahrt-Smith, the effect of blockholder ownership measure is not robust outside of the original sample period, and – more importantly – we are unable to replicate the "striking" effect of corporate governance on the marginal value of cash reported by Dittmar and Mahrt-Smith (2007, p.600).

2.4. Treatment of the outliers

In our search to replicate the results reported by Dittmar and Mahrt-Smith (2007), we attempt to modify the sample and our estimation across several dimensions. As far as we can determine, the source of our inability to replicate Dittmar and Mahrt-Smith's results likely lies in the treatment of outliers. That is, even though Dittmar and Mahrt-Smith note that they winsorize outliers, we can obtain results that are reasonably close to theirs only if we do not winsorize outliers. No other dimension of the sample construction or the estimation procedure that we examine allows us to replicate their results. In Panel B of Table 1, we report the results that do not winsorize outliers.

With outliers included and not winsorized, the estimates of the marginal value of cash are more in line with the results reported by Dittmar and Mahrt-Smith, at least for the G-index governance measure. The marginal values of cash for an average firm with weak and strong governance according to the G-index are \$0.86 and \$1.63, respectively (versus \$0.42 and \$1.62 in Dittmar and Mahrt-Smith), and \$1.54 and \$1.49 using the blockholder ownership measure (versus \$0.88 and \$1.27 in Dittmar and Mahrt-Smith). The interaction of strong governance indicators with the change in cash is positive and significant only for the G-index measure, and insignificant

for the blockholder ownership measure. One conclusion from this analysis is that we can successfully replicate some of the results reported by Dittmar and Mahrt-Smith. Importantly, we can replicate the unreasonably high estimates of the marginal value of cash which motivates our study. A further implication is that outlier treatment has a significant bearing on estimates of the marginal value of cash; thus, outlier treatment requires careful consideration.

In most studies which estimate the marginal value of cash, including FW and Dittmar and Mahrt-Smith, the authors report that they truncate or winsorize some or all variables used in the regression to alleviate the influence of outliers. Even though that is customary practice in this literature, doing so may be inappropriate. The FW methodology employs stock returns as the dependent variable, similar to many tests in the asset pricing literature. But the asset pricing literature does not usually remove outliers. Furthermore, in estimating the marginal value of cash, the actual value of the estimate is critically important, and outlier treatment may affect this value. Therefore, including outliers in the sample may be a more reasonable and appropriate practice in this setting. Henceforth, for comparison purposes, we perform the analyses with and without outlier treatment.

Our efforts to replicate the results of Dittmar and Mahrt-Smith confirm that the estimates of the marginal value of cash obtained using the FW methodology do not reconcile with reasonable benchmark values and existing evidence on the costs of raising financing. The estimates suggest that an average strong-governance publicly traded firm faces marginal costs of raising capital of 38.6%, much higher than the costs faced by an average firm undertaking an IPO. These results cast doubt on the reliability of the FW methodology.

2.5. The effect of corporate governance on the marginal value of cash by cash regimes

In their study, FW introduce a robustness check by estimating the marginal value of cash within cash regimes. Such a robustness check is an important part of the marginal value of cash estimation as interpretation of the relation between a firm characteristic and the marginal value of cash depends critically on the regime in which the relation is observed and on whether the marginal value of cash is above or below $1. Estimation within cash regimes is omitted by Dittmar and Mahrt-Smith (2007) and almost all studies that follow, with only one or two exceptions.[10] We next examine whether the unreasonably high estimates of Dittmar and Mahrt-Smith are caused by the lack of controlling for cash regimes.

To perform the examination, we identify cash regimes according to FW and assign firms to cash regimes. In the first step, we partition the sample into quartiles by the interest coverage ratio and separately by the average industry market-to-book equity, where industry is defined at the 2-digit SIC level. Firms with high interest coverage have less resources committed to debt service, thereby, having more resources available for investment or distributions. Market-to-book equity is a measure of investment opportunities. Therefore, firms in the lowest quartile of interest coverage and the highest quartile of market-to-book are likely to be in the raising cash regime with high value of cash. Firms in the highest quartile of interest coverage and the lowest quartile of market-to-book are in the distributing cash regime with low value of cash. Firms in the lowest quartile of interest coverage and the lowest quartile of market-to-book are in the debt service regime also with low value of cash. We estimate Dittmar and Mahrt-Smith's regressions in each regime and report the results in Table 2.

[Table 2 here]

Without outlier treatment, the relation between strong governance and the marginal value

[10] Several papers, for example, Aktas, Louca, and Petmezas (2019), perform estimations within cash regimes after an earlier draft of this paper appeared.

of cash is significant only in the raising cash regime and only for the G-index governance measure. In the other five instances, the relation is statistically insignificant. Furthermore, the significant relation is positive, indicating that the marginal value of cash is higher in strong governance firms as compared to weak governance firms in the raising cash regime. The estimates are $2.60 and $1.28 for strong and weak governance firms, respectively.

These estimates are inconsistent with benchmark values of the marginal value of cash and economic common sense for two reasons. First, the estimate for strong governance firms is too high, much higher than benchmark values established herein. Second, the relation is positive and the estimates are above $1, implying that strong governance leads to higher values of cash and, consequently, more severe financial constraints. Put differently, this evidence implies that strong governance firms face more severe information asymmetries and other market frictions when raising capital than do weak governance firms. Such a result is contrary to most extant empirical evidence which suggests that strong corporate governance is not associated with severe financial constraints or information asymmetries.

When outliers are winsorized the relation between strong governance and the marginal value of cash is significant only in one of six regressions. Furthermore, in that instance, the estimate of the marginal value of cash for strong governance firms is $1.70, significantly higher than the $1.00 upper limit benchmark in the distribution regime. Overall, even within cash regimes, the FW methodology produces estimates of the marginal value of cash that do not reconcile with reasonable benchmark values. Such evidence suggests that the FW methodology is unreliable.

3. Equality proposition and the reliability of the FW methodology

In this section, we perform a test of the reliability of the FW methodology with the help of

the equality proposition. The proposition stipulates that the marginal dollar of cash has the same value regardless of whether a firm gains or loses a dollar.

To test the equality proposition, we estimate and compare the marginal values of cash during cash accumulation and cash spending episodes. We partition the sample into accumulation and spending periods depending on whether cash changes are positive or negative during the fiscal year, and estimate the marginal value of cash using the FW methodology for both subsamples. All else equal, inequality in the estimates obtained during accumulation and spending periods would be consistent with the presence of a bias in the estimates of the marginal value of cash and in the methodology used to produce these estimates.

Theoretically, the equality proposition should hold. However, estimates of the average marginal value of cash in subsamples of firms separated by positive and negative changes in cash may not be the same. Differences could arise if the change in cash is not marginal and the relation between the marginal value of cash and the amount of the change in cash is nonlinear or discrete, such as during regime changes. We address this concern in the following ways. First, we recognize that non-linearity should be less pronounced within cash regimes or for marginal – or relatively small – changes in cash and provide these tests in section 3.1 and 4.1, respectively. Second, we examine firms with reversal of cash changes in consecutive years. For the same firm, an increase in cash followed by a decrease in cash of similar magnitude will produce, in absolute terms, similarly sized changes in shareholder value. The cash reversal tests are provided section 3.2.

3.1. Estimates of the marginal value of cash during cash accumulation and spending periods

In Panel A of Table 3, we report the results of the marginal value of cash regressions separately for cash accumulation and cash spending subsamples. Because the partitioning is based

on an independent variable (i.e., the realized change in cash during fiscal year t), OLS regressions are appropriate for estimating the model. The results reveal strikingly differing estimates of the marginal value of cash depending on the sample. In an unwinsorized sample of cash accumulation, the estimate of the marginal value of cash is $1.07. During spending, it is $0.15. The t-test rejects their equality at the 0.001 level. In a winsorized sample, when a firm accumulates cash, the estimate of the marginal value of cash is $1.02; when it spends, the marginal value of cash is $0.43. The t-test rejects their equality at the 0.001 level. These results are inconsistent with the equality proposition, suggesting that the FW methodology is unreliable.[11]

[Table 3 here]

Perhaps the differences in estimates during accumulation and spending episodes are a result of firms being in different cash regimes? To examine this possibility, we perform similar estimation during accumulation and spending episodes within cash regimes. The results are in panel B of Table 3. Without outlier treatment, the estimates of the marginal value of cash differ between accumulation and spending samples in their economic magnitude, $2.72 versus $1.00, $0.35 versus $0.11, and $0.36 versus $1.43 for the raising, distribution, and debt service regimes, respectively. The differences are not statistically significant. In fact, the estimate of $2.72 for firms likely to be in the raising cash regime during cash spending is not even significantly different from $1.00.

When outliers are winsorized, the estimates of the marginal value of cash are statistically significantly different between accumulation and spending episodes in two of the three regimes,

[11] When we use an unexpected change in cash, as do FW, the difference between the estimates of the marginal value of cash during accumulation and spending remains significant and similar to those obtained for raw cash changes, at $0.85 and $0.61, respectively, for an average firm. The unexpected change in cash can be computed as the residual from a regression of the change in cash on cash flow, Tobin's Q, the log of total book assets, capital expenditures, acquisitions, change in net working capital, and change in current debt.

with the debt service regime being the exception. In the debt service regime, the estimates are reasonably close, $0.49 and $0.42 during accumulation and spending periods, respectively. However, overall, even when calculated within cash regimes, the estimates of the marginal value of cash differ significantly between periods of accumulation and spending. This result is inconsistent with the equality proposition, and suggests that the FW methodology is unreliable.

3.2. Estimates of the marginal value of cash for firms with reversals in cash changes

A potential concern with partitioning the sample into accumulation and spending episodes is that firms that accumulate cash may be different from firms that spend cash. For instance, a successful company with positive cash flow might be more likely to accumulate cash, whereas a depressed firm with negative earnings might be more likely to spend cash. FW argue that firms that are more likely to distribute cash have lower marginal values of cash compared with firms that are more likely to accumulate cash for future profitable investment opportunities, due to these firms being in different cash regimes. Furthermore, dollars accumulated and dollars spent during episodes of cash accumulation and spending, respectively, may differ, violating the condition outlined in the introduction to this section.

We address these two concerns by holding the set of firms constant, and by making it more likely that dollars accumulated are equivalent to dollars spent. That is, we identify firms that accumulate cash during one fiscal year and spend cash during the subsequent fiscal year. We also identify firms that spend cash during a fiscal year and accumulate cash during the subsequent fiscal year. We then estimate the marginal value of cash in each of these years. This procedure allows estimating the marginal value of cash during cash accumulation and cash spending employing the same set of firms, precisely one year apart. It is unlikely that the marginal value of cash changes significantly over the course of one year, but we also consider that possibility below. Furthermore,

the procedure ensures that the loss (or gain) of cash that occurs in the subsequent year begins at the level at which the prior year's gain (or loss) ended, making it more likely that the gain and loss are equivalent.

The results are in Table 4. Without outlier treatment, when cash spending is followed by accumulation, the marginal value of cash is \$0.16 during spending periods and \$1.17 during accumulation periods, and the two values are significantly different at the 0.001 level. The analysis of firms with accumulation followed by spending provides similar findings. The marginal values of cash during accumulation and spending are \$1.20 and \$0.14, respectively, significantly different at the 0.001 level. This result reinforces our conclusion that when we apply the FW methodology to the same set of firms just one year apart, the estimate of the marginal value of cash during accumulation periods is statistically and economically different from its counterpart during spending periods. Such results persist in firms that first accumulate and then spend cash, and in firms that first spend and then accumulate. The results are similar when outliers are winsorized, and when regressions are estimated within cash regimes. However, within cash regimes, we are faced again with low precision and high standard errors. In seven out of twelve comparisons, the differences are not statistically significant, while in five of twelve comparisons, the estimates obtained in the same firms one year apart are different at statistically significant levels.

[Table 4 here]

Despite such large differences between estimates obtained one year apart, it is possible that the marginal value of cash changes significantly during the year. That is, the estimates of the marginal value of cash may be reliable, but the marginal values of cash could change across years. Such occurrences could be attributable to regime switching. For instance, firms that accumulate when in a regime with a relatively high value of cash switch to spending when in a regime with a

relatively low value of cash.

Several pieces of evidence are inconsistent with the above interpretation. When accumulation is followed by spending, the marginal value of cash declines by a factor of 8 over one year. In this case, the total value of cash held should decline. Consequently, the decline in total firm value during spending should be greater for firms holding more cash, suggesting a negative coefficient of lagged cash in the FW regressions for firms that spend cash. For firms that accumulate cash, the marginal value of cash increases 7 times over a year, and the increase should be greater when the firm holds more cash, implying a greater coefficient on lagged cash. None of these predictions is supported in the data. Instead, the coefficients of lagged cash during cash spending (unreported) are either positive and significant or positive and insignificantly different from zero. During cash accumulation periods, we also observe either a positive significant or an insignificant coefficient. We do not observe negative coefficients of lagged cash for firms that spend cash. Overall, the results violate the equality proposition, providing further support for the conclusion that the FW methodology is unreliable.

4. Small changes in cash and separating the components of Net Financing

What causes the apparent bias in the estimates of the marginal value of cash produced by the FW methodology? One necessary condition required for the estimates to be consistent is that changes in cash contain information about the changes in the amount of funds in the cash account, and are not correlated with variables that are correlated with stock returns but are not included in the regression. However, changes in cash holdings may occur simultaneously with events that also contain information relevant to firm value. Events that affect both cash holdings and firm value are especially likely to induce the bias if not controlled for or if control variables are not effective, which constitutes the classic omitted variables problem.

4.1. Small changes in the marginal value of cash

One possibility to control for these confounding events is to focus on small changes in cash. Small changes in cash are unlikely to convey significant information to the market about future profitability or firm value. Therefore, small changes in cash likely convey information exclusively about the change in the cash balance. The approach is similar to a regression discontinuity design. We select only observations in which the absolute change in cash is less than 1% of the total market value of equity. The results are reported in Table 5.

[Table 5 here]

In a sample without outlier treatment, the estimate of the average marginal value of cash is $3.15. When the variables are winsorized, the average marginal value of cash is $3.33. Both estimates are significantly higher than reasonable benchmark values for U.S. publicly traded companies. When we limit the absolute change in cash to 0.5% of total market value of equity, the estimates are similarly unreasonable. We also perform the estimation within the three cash regimes identified by FW. The estimates within cash regimes appear similarly unreasonable, ranging from -$1.82 to $6.66. The focus on small changes in cash, therefore, does not rectify the problem, and the FW methodology continues to produce unreasonable estimates of the marginal value of cash.

4.2. Net financing as a source of inconsistency

To control for confounding events, we incorporate stock issues and repurchases, as well as debt issuances and reductions. The FW methodology controls for these events using a single variable, Net Financing. However, each of these events may have a distinct relationship with firm value and change in cash. For example, stock price reactions to a stock repurchase likely differ greatly from stock price reactions to a debt reduction, while the Net Financing variable treats these

events equally. To reflect their heterogeneous value effects, we propose that each event be considered separately.

Accordingly, we construct four variables: *Purchases of Stock*, *Sales of Stock, Debt Issuances*, and *Debt Reductions*. These variables represent the values of stock repurchases, stock issues, debt issuances, and debt reductions during the fiscal year, respectively, deflated by the lagged market value of equity. In Table 2 of the Online Appendix, we report a correlation matrix of the change in shareholder value and the change in cash with these financing variables. All four financing variables correlate significantly with the change in cash, but only *Purchases of Stock* and *Sales of Stock* are significantly correlated with the change in shareholder value. Furthermore, the correlation coefficients of the change in cash and each of the four variables are not equal, and are distinct from the correlation coefficient of the change in cash and FW's Net Financing. This result supports the notion that the variables should appear separately in the model.

Economic theory and empirical evidence also suggest that these financing variables should be separated in the model. For example, Sudipto Bhattacharya (1979), Theo Vermaelen (1984), and Merton Miller and Kevin Rock (1985) suggest that firms tend to repurchase when firm values are relatively low. George Stigler (1964), Ritter (1991), Malcolm Baker and Jeffrey Wurgler (2000) provide evidence that firms issue stock when firm values are relatively high. Eckbo, Masulis, and Norli (2007) show that market reactions to stock issues can vary by offering type. Eugene Pilotte (1992) notes that market reactions to new financing depend on the type of security issued (debt or equity). Finally, a naïve test to determine whether the financing variables should be separated is to assess whether the estimates of those variables in the FW methodology model differ.[12] The results of the regressions and the respective updated estimates of the marginal values

[12] One cannot observe ϵ_{it}. Therefore, one cannot formally test the existence of an omitted variable bias. However, given the substantial differences in the correlation between NF_{it} and abnormal returns compared to those of its separate

of cash are given in Table 6.

[Table 6 here]

We first note that the coefficients of the purchases of stock are significantly different from the coefficients of the sales of stock, debt issuance, and debt reduction. This observation lends further support to the argument that these variables should enter the model separately, not as a part of a combined variable as their relations with the dependent variable differ dramatically. Also, each of these financing variables differs from the Net Financing variable by construction and, thus, by interpretation. Nevertheless, despite separating these variables, the estimates of the marginal value of cash do not improve sufficiently. Specifically, the difference between the estimates during accumulation and spending episodes declines, albeit weakly. The marginal values of cash during accumulation and spending periods are \$0.92 and \$0.18 if outliers are untreated, and \$0.85 and \$0.45 if outliers are winsorized, respectively. The differences between the corresponding estimates are statistically significant. Thus, while separating Net Financing components is a step in the "right direction," it is a very small step, insufficient to render the FW methodology reliable. Furthermore, when we estimate regressions for small changes in cash, the estimates of the marginal value of cash continue to be unreasonable, at \$3.11 and \$3.27 for the untreated and winsorized samples, respectively. These estimates are far too high for U.S. publicly-traded firms, underscoring the lack of reliability in the FW methodology.

4.3. Firms without corporate control transactions and without stock issues or repurchases

Any significant corporate events that simultaneously affect shareholder value and cash holdings may potentially bias the estimates of the marginal value of cash. To determine whether certain events affect or alter the results of our analyses, we perform additional tests. As mergers

components, these naïve tests, combined with the predictions of the literature, suggest that the restrictions imposed by the Faulkender-Wang methodology are likely to result in a bias.

and acquisitions may involve contemporaneous changes in a firm's value and its cash holdings, we estimate values of cash accumulation and cash spending using a sample that excludes firm-years with corporate control transactions. To construct such a sample, we exclude all fiscal years during which a corporate control transaction that involves the firm as either an acquirer or a target has been completed.[13] Furthermore, stock issues or repurchases may involve contemporaneous changes in cash holdings and firm value, because firms may be more likely to issue stock when values are relatively high, and set the proceeds aside as cash. Similarly, firms may use available cash to repurchase stock when values are relatively low (Stewart Myers and Nicholas Majluf (1984), John Graham and Campbell Harvey (2001), and Baker and Wurgler (2002)). While we include specific variables in our modified regressions to control for these events, we perform our analyses using a sample that excludes firms that issued or repurchased significant amounts of stock during the fiscal year to check whether the control variables are sufficient. We require that issues and repurchases during the fiscal year be less than 1% of the total book assets.

The results of these regressions are presented in Table 7. In both analyses, the values of cash during accumulation and spending periods differ significantly. This result is observed regardless of whether outliers are winsorized. We reject the equality of the estimates during accumulation and spending in all four pairs. The exclusion of observations with significant contemporaneous events such as corporate control transactions and stock issues and repurchases does not improve the performance of the FW methodology.

[Table 7 here]

5. Effects of financial constraints, executive incentives, and dual-class firms on the marginal value of cash

[13] We define a corporate control transaction as any transaction reported in the SDC Mergers and Acquisitions Database in which the acquirer and target are not the same firm.

In this section, we re-estimate the analyses of four additional studies which utilize the FW methodology. Our motivation for doing so is to examine whether (1) the unreasonable estimates of the marginal value of cash appear in other samples under different circumstances; (2) the results of these studies are sensitive to outlier treatment; and (3) the results are replicable outside of the original time period. We examine FW and Denis and Sibilkov (2010), which examine the effect of financial constraints on the marginal value of cash, Liu and Mauer (2011), which examines the effect of CEO incentives on the marginal value of cash, and Masulis, Wang, and Xie (2009), which examines the effect of agency conflict in dual-class firms on the marginal value of cash.

5.1. Financial constraints and the marginal value of cash

FW and Denis and Sibilkov (2010) argue and document that cash is more valuable for financially constrained firms than for unconstrained firms, potentially because it allows constrained firms to undertake projects they would otherwise forego. For this analysis, we employ four financial constraint criteria commonly used to identify constrained and unconstrained firms (Denis and Sibilkov, 2010, FW, Charles Hadlock and Joshua Pierce, 2010). Firms are financially constrained if they are in the lowest tercile of the payout ratio (payout criterion) or the lowest tercile of total book assets (size criterion), have no debt rating (debt rating criterion), or are in the lowest tercile of time since going public (age criterion). Firms are unconstrained if they are in the highest tercile of the payout ratio, of total book assets, of time since going public, or have a debt rating.

We attempt to replicate the findings of FW and Denis and Sibilkov using the FW methodology in a sample that extends past theirs, with the results that appear in Table 8. In the unwinsorized sample, the marginal values of cash for constrained firms are between $0.96 and $1.28, and those for unconstrained firms are between $0.37 and $0.79. In the winsorized sample,

the marginal values of cash for constrained firms are between $1.01 and $1.12, and those for unconstrained firms are between $0.61 and $0.89. The estimates are comparable to those reported in FW and Denis and Sibilkov. Seven of eight estimates for unconstrained firms are significantly less than $1.00. And, in seven out of eight comparisons, the marginal value of cash for constrained firms is significantly higher than the marginal value of cash for unconstrained firms at the 0.02 or lower level. Our estimates for constrained firms are remarkably similar to those reported by FW for constrained firms; they are all greater than $1.00. For all four constraint criteria, the values of cash for constrained firms are statistically higher than for unconstrained firms at traditional levels of significance. All estimates appear to be within reasonable values, and they are mostly unaffected by winsorization or lack thereof, and by the extended time period.

[Table 8 here]

Overall, the results of the estimation of the marginal value of cash for constrained and unconstrained firms appear to reconcile with economic common sense, do not conflict with the reasonable benchmark values, and are generally robust to changes in outlier treatment and sample time periods. The studies of FW and Denis and Sibilkov, per se, and the analyses carried out within the context of their studies, therefore, provide no reason to question the reliability of the FW methodology.

5.2. Vega and the marginal value of cash

Liu and Mauer (2011) argue that chief executive officer (CEO) incentives affect cash policies and the value of cash by influencing the stockholder-bondholder conflict. Among other findings, the authors document that the sensitivity of CEO compensation to stock price volatility (i.e., vega) is negatively related to the marginal value of cash. They argue that this evidence suggests that firms with high vega hold excess cash to mitigate the risk to bondholders due to

CEO's risk-taking incentives.

As do Liu and Mauer (2011), we construct CEOs' deltas and vegas standardized by the total CEO compensation during the year using the methodology outlined by John Core and Wayne Guay (2002) and Jeffrey Coles, Naveen Daniel, and Lalitha Naveen (2006). We then reexamine the effect of delta and vega on the marginal value of cash by performing two tests. First, we include delta and vega in the FW methodology, along with the interactions of these variables with the change in cash. The coefficient of the interaction of vega with the change in cash assesses the effect of vega on the marginal value of cash. Second, we partition the sample by vega terciles, and examine the difference in the marginal value of cash between the lowest and highest vega terciles. We estimate the effect of vega on the marginal value of cash in the full sample and in partitions by cash regime. The results are in Table 9.

[Table 9 here]

The relation between the marginal value of cash and vega in all eight regressions is negative, consistent with Liu and Mauer. However, the relation is statistically significant only when vega enters the regression as an indicator variable, and only when the sample in winsorized. When the sample is not winsorized, or when the continuous version of vega is used, the relation is statistically insignificant. These results apply with the original Liu and Mauer sample period, as well as the sample period that extends beyond theirs. Furthermore, the estimates of the marginal value of cash, particularly in the winsorized sample, appear significantly higher than the benchmark values, reaching above $1.50, with one estimate as high as $1.70. Also, unrealistically, all estimates are above $1.00; specifically, these values are all above $1.20. This evidence suggests that all companies with available data on CEO incentives are raising capital and all are financially constrained.

Overall, the relation between CEO incentives and the marginal value of cash is sensitive to outlier treatment and the construction of the variable of interest, vega. Importantly for our analysis, the FW methodology produces estimates of the marginal value of cash that conflict with the reasonable benchmark values.

5.3. Dual-class firms and the marginal value of cash

Masulis, Wang, and Xie (2009) examine the relation between the marginal value of cash and agency problems in dual-class firms wherein they measure agency costs using the ratio of insider voting rights to cash flow rights. The higher the ratio, the greater the likelihood of agency conflict between insiders and other shareholders. Masulis, Wang, and Xie find that the ratio is negatively associated with the marginal value of cash, consistent with agency conflicts between insiders and the outside investors imposing costs and leading to lower values of cash.

As do Masulis, Wang, and Xie, we compute the ratio of insider voting rights to cash flow rights using data provided by Andrew Metrick. The data are for the period 1994–2002, and are available for 2,496 observations in our full sample. We include the ratio of voting to cash flow rights in the FW methodology, along with its interaction with the change in cash. The coefficient of the interaction term estimates the effect of the ratio on the marginal value of cash. In addition to unwinsorized and winsorized samples, we also estimate the model using a sample with only the voting to cash flow rights ratio winsorized. We do this because we advocate not treating outliers in the dependent variable, while the ratio of insider voting rights to cash flow rights is characterized by significant outliers. Thus, we aim to leave the dependent variable untreated, while alleviating excess tails in the primary variable of interest, the ratio of voting to cash flow rights. The results are in Table 10.

[Table 10 here]

In the samples with untreated outliers and when only the ratio of voting to cash flow rights is winsorized, the coefficient of the interaction of the ratio with the change in cash is negative and statistically significant. This result appears consistent with the finding of Masulis, Wang, and Xie and indicates that agency problems in dual-class firms are negatively associated with the marginal value of cash. When all variables are winsorized, the relation is negative but statistically insignificant.

However, an important element that is inconsistent with the interpretation that Masulis, Wang, and Xie set forth is that in samples in which the significant relation is observed, the estimates of the marginal value of cash for low agency conflict firms is significantly greater than $1.00. Furthermore, the estimates for high agency conflict firms are also greater than $1.00, albeit they are insignificant. Such a result does not align with the interpretation of Masulis, Wang, and Xie. The less the potential for agency conflict, the more extreme financial constraints appear to be for these firms. And, correspondingly, the greater the agency conflict, the less extreme financing frictions are. Furthermore, the estimates of $1.71 and $1.72 for an average low ratio of voting to cash flow rights firms are too high as compared to reasonable benchmark values. Overall, in the analysis of the marginal value of cash in dual-class firms, the FW methodology continues to produce questionable estimates of the marginal value of cash.

6. Alternative methodologies for estimating the marginal value of cash

Our analysis focuses on the FW methodology for estimating the marginal value of cash because subsequent to their paper, the FW methodology has been widely adopted as the primary methodology for estimating the marginal value of cash. We would be remiss not to note that at least two papers – one published contemporaneously with FW, and the other published several years later have exclusively employed an alternative methodology. And at least two other studies

– including Dittmar and Mahrt-Smith – have employed that alternative methodology as a supplement to their application of the FW procedure.

That alternative procedure is a modification of the regression developed by Fama and French (henceforth, FF, 1998).[14] Prudence demands that we consider whether the FF methodology overcomes the shortcomings evident in FW procedure. Had it been used, would it have obviated concerns with FW? And going forward, should it be used in place of FW?

6.1. Theoretical issues

There are several concerns with using FF regression to estimate the marginal value of cash. First, Dittmar and Mahrt-Smith (2007, p. 618) note that they "refrain from interpreting the [FF] coefficient on cash alone as representing the true marginal value of excess cash" due to their concern about endogeneity between firm value and cash holdings. The authors do, however, draw conclusions from differences in the coefficient estimates between certain groups of firms, such as those with weak and strong corporate governance.

Second, the FF methodology does not allow the marginal value of cash to vary with the amount of cash or with leverage, which is necessitated by the theoretical arguments of FW. Third, some estimates of the value of cash obtained using the FF methodology are much larger than benchmark values. Specifically, the value of positive excess cash reported by Dittmar and Mahrt-Smith (2007, p.617) starts at $2.00 and goes up from there, much higher than the $1.09 upper limit of benchmark values. With these concerns in mind, ex ante, we are not optimistic that the modified FF methodology will perform better than the FW methodology in estimating the marginal value

[14] Fama and French regress firm value on earnings, research and development expenses, dividends, and interest expenses, as well as future and forward changes in these variables. The explanatory variables also include forward changes in firm value. An augmented version includes the ratio of cash holdings to total book assets or the residual from a model of cash holdings as a measure of cash holdings, including all or positive only values of the residual. The authors who use the model argue that the coefficient of cash provides a measure of the value of cash holdings, or a measure of the value of excess cash, depending on whether cash or the residual is used.

of cash.

6.2. Empirical issues

Nonetheless, to give the methodology a fair chance, and keeping in mind that the focus of this study is applications of the FW methodology, we examine the empirical performance of the FF methodology. As do existing studies, we utilize the ratio of total cash to total book assets, excess cash, and positive excess cash as three alternative measures of cash. We perform estimations using unwinsorized and winsorized (at 1% and 99%) samples, and test the reliability of the estimates using the equality proposition. The results are in Table 3 of the Online Appendix.

In the unwinsorized sample, of the three measures of cash, only the positive excess cash measure passes the equality proposition test. In that instance, the estimates of the value of cash are \$0.245 during cash spending and \$0.366 during cash accumulation, and the difference between the estimates is statistically insignificant. Further, neither of the estimates is significantly different from zero. Finally, it is possible that the lack of a significant difference between the estimates during accumulation and spending episodes is a result of their relatively high standard errors and low precision. At face value, the estimates demonstrate that the value of excess cash is low, which is reasonable and, therefore, comforting. In the other two comparisons that use total cash and excess cash, the estimates do not satisfy the equality proposition, suggesting that these estimates are unlikely to be reliable.

In the winsorized sample, all excess cash estimates satisfy the equality proposition. However, all of those estimates are significantly negative, suggesting that adding a dollar of excess cash not only adds nothing to the value of the firm, but rather destroys the value of existing assets. Although possible, that result is not plausible for an average U.S. publicly-traded company. Thus, the FF methodology does not produce reliable estimates of the value of cash in the winsorized

sample.

Overall, the FF methodology produces reasonable estimates in one out of six tests that we perform. The estimates that pass the equality proposition and align with reasonable benchmark values are obtained in unwinsorized sample using a positive excess cash measure. Thus, in certain samples and instances, the results may appear reasonable. Their empirical use is limited, however, as they measure the value of positive excess cash, and have relatively high standard errors, which reduces their utility in cross-sectional comparison tests. Overall, though, the results support concerns of Dittmar and Mahrt-Smith about the use of FF methodology to measure the value of cash, and indicate that the FF methodology is unreliable in measuring the marginal value of cash.

7. Conclusions

Following Faulkender and Wang (2006), many researchers apply the FW methodology to estimate the marginal value cash in a wide array of research pursuits. The marginal value of cash is an appealing concept: it captures the capital market's assessment of the potential value creation or value destruction of assets at firms' immediate disposal. As such, it provides a convenient way to explore the value-creating, disciplining, or incentivizing roles of various mechanisms and environments in which firms operate. In particular, FW and Dittmar and Mahrt-Smith (2007) document that financial constraints and corporate governance have an economically and statistically significant effect on the marginal value of cash. Liu and Mauer (2011) and Masulis, Wang, and Xie (2009) document similarly significant relations of the marginal value of cash with CEO compensation incentives and dual-class firms, respectively. However, some of the estimates of the marginal values of cash that these studies produce do not reconcile well with the economic theory.

We propose a simple diagnostic test to determine whether the estimates of the marginal

value of cash obtained using the FW methodology are reliable by invoking the definition of marginal value. Specifically, the marginal value of a dollar of cash is constant regardless of whether the firm gains or loses the marginal dollar. We find that the marginal value of cash estimated using the FW methodology varies considerably, depending on whether it is estimated for firms that accumulate or for firms that spend cash. This is inconsistent with the concept of marginal value, and indicates that the estimates might be confounded with other information. We attempt to rectify the FW methodology by focusing on small changes in cash, excluding firms involved in corporate control activity, excluding firms with significant stock issues or repurchases, controlling separately for various components of financing activities by firms, and controlling for cash regimes. None of these steps sufficiently improve the FW methodology, suggesting that the biases inherent in the methodology are not easily rectified. In various samples and analyses, the methodology produces estimates that conflict with economic common sense. Our findings cast doubt on the reliability of the FW methodology and on the results of studies that use it. The methodology, the results it produces, and the inferences drawn from these results should be considered with caution.

Appendix A
Summary of literature

Authors	Methodology[16]	Sample	Marginal Value of Cash
Faulkender and Wang (2006)	FW	1971 to 2001	\$0.94 for the average firm in the sample; \$1.15–\$1.04 on average for financially constrained firms; \$0.77–\$0.46 for financially unconstrained firms.
Pinkowitz, Stulz, and Williamson (2006)	FF	1988 to 1998, 35 countries	\$0.91 in countries with greater than the median investor protections; \$0.33 in other countries.
Dittmar and Mahrt-Smith (2007)	FW and FF	1990 to 2003	\$1.09 for the average firm in the sample; \$0.42 if the firm has weak governance; \$1.62 if the firm has strong governance, based on Gompers, Ishii, and Metrick's (2003) index.[17] \$0.88 if the firm has weak governance and \$1.27 if the firm has strong governance, based on the aggregate ownership of institutional blockholders.
Klasa, Maxwell, and Ortiz-Molina (2009)	FW	1983 to 2005, Manufacturing firms	\$0.87 for the average firm in the sample; \$1.15 for firm years with below–industry median unionization; \$0.59 for firm years with above –industry median unionization.
Masulis, Wang, and Xie (2009)	FW	1993 to 2005 500 dual-class companies	\$0.72 for the average firm in the sample; a one standard deviation increase in the ratio of insider control rights to voting rights decreases the value by \$0.08.[18]

Continued on next page

[16] FW denotes the methodology proposed by Faulkender and Wang (2006), and FF denotes the methodology based on Fama and French (1998) regressions. The Fama-French-based methodology is similar except that it does not allow the marginal value of cash to vary with leverage and lagged cash holdings, and has a different set of control variables. The Fama-French-based estimation is subject to similar concerns as the Faulkender-Wang methodology.

[17] These estimates are based on the Faulkender-Wang methodology.

[18] They do not report the number of financially constrained firms; we assume 50% to compute the marginal value of cash for the average firm in the sample. The estimate does not materially change if we use 10%.

Continued from previous page

Authors	Methodology	Sample	Marginal Value of Cash
Frésard and Salva (2010)	FF	1989 to 2005 868, cross-listed firms	$0.59 is the marginal value of excess cash; if the firm is cross-listed on a U.S. exchange, it increases by $1.02; if the firm is cross-listed, it increases by $0.84
Haw, Ho, Hu, and Zhang (2011)	FW	1998 to 2004 33 countries	Not enough information to compute the marginal value of cash; higher marginal value of cash for dividends versus repurchases in countries with weak investor protection rights.
Liu and Mauer (2011)	FW	1992 to 2006	$0.99 for the average firm in the sample; a one standard deviation increase in vega/total compensation reduces the marginal value by $0.23; a one standard deviation increase in delta/total compensation increases it by $0.27.
Tong (2011)	FW	1998 to 2005	$1.02 for the average firm in the sample; $0.92 ($1.08) in diversified (single segment) firms.
Kyröläinen, Tan, and Karjalainen (2013)	FW and FF	1990 to 2008 48 countries	$1.12 for the median firm in the sample; $0.93 ($1.31) for firms in the strongest (weakest) creditor rights countries.[19]

[19] These estimates are based on the Faulkender-Wang methodology.

Appendix B
Variable definitions and construction

Variable Name	Definition
Total book assets	The total book value of assets.
Market equity	The common shares used to calculate earnings per share multiplied by price at fiscal year-end.
Cash	Cash and short-term investments normalized by the total market value of equity at the beginning of the fiscal year.
Change in cash	Change in cash and short-term investments during a fiscal year, normalized by the total market value of equity at the beginning of the fiscal year.
Tobin's Q	Total market value of equity plus total book value of assets minus total book value of equity, divided by the total book value of assets.
Total debt/total book assets	Debt in current liabilities plus long-term debt normalized over the total book value of assets.
Net investments	Capital expenditures minus depreciation and amortization normalized by the total market value of equity.
Earnings	Income before extraordinary items plus interest expense plus deferred taxes plus investment tax credit, normalized by the total market value of equity. Deferred taxes and investment tax credit are set to zero if missing.
Research and development	Research and development expenses normalized by the total market value of equity.
Change in assets	Change in the total book value of assets, net of cash and short-term investments during a fiscal year, normalized by the total market value of equity at the beginning of the fiscal year.
Change in earnings	Change in earnings during a fiscal year, normalized by the total market value of equity at the beginning of the fiscal year. Earnings equal income before extraordinary items plus interest expense plus deferred taxes plus investment tax credit. Deferred taxes and investment tax credit are set to zero if missing.
Change in R&D	Change in research and development expense during a fiscal year, normalized by the total market value of equity at the beginning of the year. Research and development expenses are set to zero if missing.
Change in interest	Change in interest expense during a fiscal year normalized by the total market value of equity at the beginning of the fiscal year.
Change in dividends	Change in the dividends on common stock during a fiscal year, normalized by total market equity at the beginning of the year.
Net financing	Sale of common and preferred stock minus purchase of common and preferred stock plus issuance of long-term debt minus reduction of long-term debt, normalized by the total market value of equity at the beginning of the fiscal year.

Leverage	Debt in current liabilities plus long-term debt, normalized by the total market value of equity at the beginning of the fiscal year.
Purchases of stock	Total purchases of common and preferred stock, normalized by the total market value of equity at the beginning of the fiscal year.
Sales of stock	Total sales of common and preferred stock, normalized by the total market value of equity at the beginning of the fiscal year.
Debt issuances	Total issuances of long-term debt normalized by the total market value of equity at the beginning of the fiscal year.
Debt reductions	Total reduction of long-term debt, normalized by the total market value of equity at the beginning of the fiscal year.
Payout ratio	The ratio of dividends and common stock repurchases to operating income.
Delta	The sensitivity of CEO compensation to stock price standardized by the total CEO compensation during the year.
Vega	The sensitivity of CEO compensation to stock price volatility standardized by the total CEO compensation during the year.
Vote-CF ratio	The ratio of insider ownership of voting rights to insider ownership of cash flow rights.
Low antitakeover	Equals 1 (0) if firm-year is in the lowest (highest) tercile of the G-index.
High blockholder ownership	Equals 1 (0) if firm-year is in the highest (lowest) tercile of the aggregate ownership of institutional blockholders.

References

Aktas, Nihat, Christodoulos Louca, and Dimitris Petmezas, 2019. CEO overconfidence and the value of corporate cash holdings, Journal of Corporate Finance 54, 85–106.

Baker, Malcolm, and Jeffrey Wurgler, 2002. Market timing and capital structure. Journal of Finance 57, 1–32.

Bates, Thomas, Ching-Hung Chang, and Jianxin Chi, 2018. Why has the value of cash increased over time? Journal of Financial and Quantitative Analysis 53, 749–787.

Bhattacharya, Sudipto, 1979. Imperfect information, dividend policy, and "the bird in the hand" fallacy. Bell Journal of Economics 10, 259–270.

Breuer, Wolfgang, Marc Rieger, and Kalender Soypak, 2017. Corporate cash holdings and ambiguity aversion. Review of Finance 21, 1933-1974.

Coles, Jeffrey, Naveen Daniel, and Lalitha Naveen, 2006. Managerial incentives and risk-taking. Journal of Financial Economics 79 (2), 431–468.

Core, John, and Wayne Guay, 2002. Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. Journal of Accounting Research, 613–630.

Denis, David, and Valeriy Sibilkov, 2010. Financial constraints, investment, and the value of cash holdings. Review of Financial Studies 23, 247–269.

Dessaint, Olivier, and Adrien Matray, 2017. Do managers overreact to salient risks? Evidence from hurricane strikes. Journal of Financial Economics 126, 97–121.

Dittmar, Amy, and Jan Mahrt-Smith, 2007. Corporate governance and the value of cash holdings. Journal of Financial Economics 83, 599–634.

Eckbo, Espen, Ronald Masulis, and Øyvind Norli, 2007. Security Offerings, in B. Espen Eckbo, ed., Handbook of Empirical Corporate Finance Volume 1, (North-Holland).

Fama, Eugene, and Kenneth French, 1998. Taxes, financing decisions, and firm value. Journal of Finance 53, 819–843.

Faulkender, Michael, and Rong Wang, 2006. Corporate financial policy and the value of cash. Journal of Finance 61, 1957–1990.

Frésard, Laurent, and Carolina Salva, 2010. The value of excess cash and corporate governance: Evidence from US cross-listings. Journal of Financial Economics 98, 359–384.

Graham, John, and Campbell Harvey, 2001. The theory and practice of corporate finance: Evidence from the field. Journal of Financial Economics 60, 187—243.

Gompers, Paul, Joy Ishii, and Andrew Metrick, 2003. Corporate governance and equity prices. Quarterly Journal of Economics 118, 107–155.

Hadlock, Charles, and Joshua Pierce, 2010. New evidence on measuring financial constraints: Moving beyond the KZ Index. Review of Financial Studies 23, 1909–1940.

Haw, In-Mu, Simon Ho, Bingbing Hu, and Xu Zhang, 2011. The contribution of stock repurchases to the value of the firm and cash holdings around the world. Journal of Corporate Finance 17, 152–166.

Kim, Dongcheol, Darius Palia, and Anthony Saunders, 2008. The impact of commercial banks on underwriting spreads: Evidence from three decades. Journal of Financial and Quantitative Analysis 43 (4), 975–1000.

Klasa, Sandy, William Maxwell, and Hernán Ortiz-Molina, 2009. The strategic use of corporate cash holdings in collective bargaining with labor unions. Journal of Financial Economics 92, 421–442.

Kulchania, Manoj, and Shawn Thomas, 2017. Cash reserves as a hedge against supply-chain risk. Journal of Financial and Quantitative Analysis 52, 1951–1988.

Kyröläinen, Petri, Irene Tan, and Pasi Karjalainen, 2013. How creditor rights affect the value of cash: A cross-country study. Journal of Corporate Finance 22, 278–298.

Liu, Yixin, and David Mauer, 2011. Corporate cash holdings and CEO compensation incentives. Journal of Financial Economics 102, 183–198.

Masulis, Ronald, Cong Wang, and Fei Xie, 2009. Agency problems at dual-class companies. Journal of Finance 64, 1697–1727.

Miller, Merton, and Kevin Rock, 1985. Dividend policy under asymmetric information. Journal of Finance 40, 1031–1051.

Myers, Stewart, and Nicholas Majluf, 1984. Corporate financing and investment decisions when firms have information that investors do not have. Journal of Financial Economics 13, 187–221.

Phan, Hieu, Thuy Simpson, and Hang Nguyen, 2017. Tournament-based incentives, corporate cash holdings and the value of cash. Journal of Financial and Quantitative Analysis 52, 1519–1550.

Pilotte, Eugene, 1992. Growth opportunities and the stock price response to new financing. The Journal of Business 65, 371–394.

Pinkowitz, Lee, René Stulz, and Rohan Williamson, 2006. Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis. Journal of Finance 61, 2725–2751.

Ritter, Jay, 2014. Initial Public Offerings: Updated Statistics.

Rock, Kevin, 1986. Why new issues are underpriced. Journal of Financial Economics 15 (1–2), 187–212.

Tong, Zhenxu, 2011. Firm diversification and the value of corporate cash holdings. Journal of Corporate Finance 17, 741–758.

Vermaelen, Theo, 1984. Repurchase tender offers, signaling and managerial incentives. Journal of Financial and Quantitative Analysis 19, 163–181.

Table 1: Corporate governance and the value of cash

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. Data on firm characteristics are from the *Compustat* database. Stock return data are from *CRSP*. The full sample period (Full) is 1990–2006 for the antitakeover sample; 1980–2011 for the blockholding sample. The Dittmar and Mahrt-Smith (DMS) sample is 1990–2003. Regressions are estimated using ordinary least squares. Firms with weak (strong) governance are in the top (bottom) tercile of the G-index distribution and in the bottom (top) tercile of the distribution of the aggregate ownership of institutional blockholders. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. Coefficient estimates are reported with standard errors in parentheses. ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. For the marginal value of cash, asterisks indicate corresponding significant difference from 1.00.

Interpretation: The results in Panel A reveal that the marginal value of cash is higher for firms with strong governance versus firms with weak governance. More importantly, many of the estimates are much higher than $1.09, which is the upper bound of what is reasonable for a wide sample of U.S. publicly traded firms. In Panel B variables are not winsorized, and the estimates of the marginal value of cash are even higher, violating economic common sense.

Table 1, Panel A

Period	DMS	Full	DMS	Full
MVC, weak govern	0.885	0.93	1.219***	1.106**
MVC, strong govern	1.229**	1.269***	1.373***	1.122***
Δ cash	1.037***	1.092***	1.470***	1.303***
	(0.125)	(0.109)	(0.095)	(0.057)
Low G-index	0.004	-0.005		
	(0.008)	(0.007)		
Low G-index*Δ cash	0.330***	0.324***		
	(0.120)	(0.107)		
High block			-0.009	-0.002
			(0.009)	(0.005)
High block*Δ cash			0.174*	0.022
			(0.101)	(0.059)
Δ assets	0.203***	0.210***	0.238***	0.224***
	(0.018)	(0.018)	(0.018)	(0.011)
Δ earnings	0.278***	0.305***	0.431***	0.372***
	(0.034)	(0.033)	(0.031)	(0.019)
Δ R&D	-0.079	0.022	-0.071	0.635***
	(0.413)	(0.371)	(0.325)	(0.207)
Δ interest	-1.363***	-1.374***	-2.069***	-1.778***
	(0.284)	(0.280)	(0.280)	(0.185)
Δ dividends	3.845***	3.422***	3.429***	3.142***
	(0.641)	(0.552)	(0.720)	(0.316)
Net financing	-0.236***	-0.270***	-0.093**	-0.100***
	(0.041)	(0.038)	(0.039)	(0.025)
Leverage	-0.044*	-0.018	-0.064***	-0.001
	(0.025)	(0.022)	(0.024)	(0.015)
Leverage*Δ cash	-0.526**	-0.587***	-0.883***	-0.734***
	(0.224)	(0.202)	(0.173)	(0.104)
Lagged cash	0.194***	0.183***	0.238***	0.215***
	(0.035)	(0.031)	(0.031)	(0.016)
Lagged cash*Δ cash	-0.150*	-0.171**	-0.306***	-0.230***
	(0.080)	(0.075)	(0.084)	(0.044)
Constant	-0.032***	-0.037***	-0.085***	-0.075***
	(0.008)	(0.007)	(0.009)	(0.005)
Observations	12717	15885	14722	36911
Adjusted R-squared	0.1096	0.1149	0.1658	0.155

Table 1, Panel B

Period	DMS	Full	DMS	Full
Winsorized	No	No	No	No
MVC, weak govern	0.861	0.871	1.542**	1.066
MVC, strong govern	1.634*	1.603**	1.494***	1.261**
Δ cash	1.233***	1.209***	1.850***	1.329***
	(0.369)	(0.306)	(0.284)	(0.130)
Low G-index	0.003	-0.006		
	(0.009)	(0.008)		
Low G-index*Δ cash	0.715***	0.677***		
	(0.220)	(0.199)		
High block			-0.027**	-0.014**
			(0.012)	(0.006)
High block*Δ cash			-0.015	0.199
			(0.215)	(0.131)
Δ assets	0.086**	0.087**	0.073*	0.119***
	(0.043)	(0.039)	(0.044)	(0.028)
Δ earnings	0.092**	0.100**	0.293***	0.260***
	(0.043)	(0.046)	(0.067)	(0.040)
Δ R&D	-2.755	-2.536	-1.674	-0.747
	(2.263)	(2.105)	(1.228)	(0.608)
Δ interest	0.281	0.284	-0.412	-0.680***
	(0.260)	(0.239)	(0.328)	(0.176)
Δ dividends	0.25	0.259	-0.075	0.081
	(0.194)	(0.186)	(0.100)	(0.085)
Net financing	-0.192***	-0.207***	0.011	-0.069
	(0.051)	(0.045)	(0.069)	(0.044)
Leverage	-0.097***	-0.066**	-0.123***	-0.029
	(0.033)	(0.029)	(0.037)	(0.021)
Leverage*Δ cash	-1.446	-1.391*	-1.367***	-1.233***
	(0.899)	(0.804)	(0.447)	(0.178)
Lagged cash	0.317***	0.297***	0.500***	0.382***
	(0.064)	(0.060)	(0.062)	(0.059)
Lagged cash*Δ cash	0.005	0.001	-0.013	0.001
	(0.099)	(0.094)	(0.077)	(0.008)
Constant	-0.029***	-0.033***	-0.082***	-0.079***
	(0.011)	(0.010)	(0.013)	(0.012)
Observations	12717	15885	14722	36911
Adjusted R-squared	0.1241	0.1183	0.1454	0.1749

Table 2: Corporate governance and the value of cash across cash regimes

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. The sample period is 1990–2006 for the antitakeover sample and 1980–2011 for the blockholder sample. Regressions are estimated using ordinary least squares. See text for the definition of cash regimes. The unreported control variables include change in assets, change in earnings, change in R&D, change in interest, change in dividends, net financing, leverage, lagged cash, change in cash*lagged cash, change in cash*leverage, and a constant. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. ***, **, and * indicate statistically significant difference from 1.00 at the 0.01, 0.05, and 0.10 levels, respectively.

Interpretation: The estimates of the marginal value of cash violate reasonable benchmarks. Specifically, many estimates in the cash raising regime are above $1.09, and many estimates in the cash distribution regime are above $1.00. Furthermore, inconsistent with prior studies and their interpretation, the interaction of low G-index and change in cash, which measures the relation between strong governance and the marginal value of cash, is significantly positive in raising regime and insignificant in distribution regime when variables are not winsorized. In similar vein, the interaction of high blockholder ownership and change in cash is insignificant across regimes.

Cash regime	Raising regime				Distribution regime				Debt service regime			
Winsorized	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
MVC, weak govern	1.284	1.048	0.926	1.454	0.663	0.542	0.865	1.341	0.332***	0.677**	0.246***	0.652*
MVC, strong govern	2.596**	1.011	1.723*	1.027	1.139	0.724	1.697**	1.048	0.516***	0.490***	0.447***	0.470***
Δ cash	2.874***	1.268***	2.131***	1.774***	0.628*	0.426	0.901***	1.384***	0.251	0.938***	0.341	0.649***
	(0.860)	(0.441)	(0.748)	(0.406)	(0.359)	(0.295)	(0.314)	(0.243)	(0.236)	(0.204)	(0.222)	(0.248)
Low G-index	-0.065		-0.071		0.033		0.011		-0.091***		-0.099***	
	(0.064)		(0.056)		(0.033)		(0.031)		(0.031)		(0.030)	
Low G-index*Δ cash	1.307**		0.797		0.489		0.859**		0.191		0.201	
	(0.553)		(0.639)		(0.524)		(0.421)		(0.174)		(0.223)	
High block		0.020		0.032		-0.016		0.002		0.017		0.015
		(0.039)		(0.034)		(0.026)		(0.022)		(0.022)		(0.020)
High block*Δ cash		0.001		-0.368		0.150		-0.279		-0.175		-0.180
		(0.333)		(0.342)		(0.302)		(0.240)		(0.169)		(0.203)
Observations	345	1087	345	1087	493	1287	493	1287	849	2174	849	2174
Adjusted R-squared	0.1968	0.104	0.1717	0.1611	0.1488	0.7094	0.1834	0.1753	0.1437	0.1656	0.2046	0.1493

Table 3: Value of cash during cash accumulation and spending

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. Data on firm characteristics are from the *Compustat* database. Stock return data are from *CRSP*. The sample period is 1972–2017. Regressions are estimated using ordinary least squares. Accumulate (increase) samples include only observations with positive change in cash over the fiscal year, and spend (decline) samples include observations with negative change in cash over the fiscal year. See text for the definition of cash regimes. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. Coefficient estimates are reported with standard errors in parentheses. ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. For the marginal value of cash estimates, asterisks indicate corresponding significant difference from 1.00.

Interpretation: The estimates of the marginal value of cash violate the equality proposition, which stipulates that the marginal value of cash of a dollar lost should be equal to the marginal value of cash when that dollar is gained. Specifically, the estimates during cash accumulation episodes are significantly different from the estimates during cash spending episodes. This evidence indicates that the FW methodology used to produce these estimates is unreliable.

Winsorized Cash	No Decline	No Increase	Yes Decline	Yes Increase
MVC, average	0.154***	1.074	0.434***	1.020
P-value (dec vs inc)	0.00		0.00	
Δ cash	0.119	1.364***	0.455***	1.257***
	(0.092)	(0.204)	(0.041)	(0.038)
Δ assets	0.063***	0.127***	0.180***	0.207***
	(0.009)	(0.015)	(0.006)	(0.007)
Δ earnings	0.022**	0.013	0.256***	0.370***
	(0.010)	(0.009)	(0.011)	(0.014)
Δ R&D	0.153	-0.179	0.706***	1.372***
	(0.147)	(0.328)	(0.123)	(0.166)
Δ interest	-0.318***	-0.657***	-1.134***	-1.449***
	(0.072)	(0.104)	(0.083)	(0.102)
Δ dividends	0.159**	0.152	3.844***	3.887***
	(0.066)	(0.107)	(0.218)	(0.238)
Net financing	-0.052***	-0.015	-0.107***	-0.016
	(0.015)	(0.032)	(0.014)	(0.014)
Leverage	0.098***	-0.088**	0.125***	-0.087***
	(0.017)	(0.034)	(0.011)	(0.012)
Leverage*Δ cash	0.119	-1.137***	-0.056	-0.769***
	(0.111)	(0.287)	(0.076)	(0.073)
Lagged cash	0.190***	0.222***	0.181***	0.173***
	(0.053)	(0.057)	(0.014)	(0.016)
Lagged cash*Δ cash	0.016*	0.012	-0.027	-0.264***
	(0.010)	(0.023)	(0.030)	(0.039)
Constant	-0.176***	-0.027*	-0.167***	-0.050***
	(0.007)	(0.016)	(0.004)	(0.004)
Observations	64510	65020	64510	65020
Adjusted R-squared	0.023	0.0711	0.0891	0.1575

Table 3, Panel B

Cash regime	Raising		Distribution		Debt service	
Changes in cash	Decline	Increase	Decline	Increase	Decline	Increase
Outliers included						
MVC, average	2.717	0.998	0.349***	0.109*	0.358***	1.427
P-value (dec vs inc)	0.18		0.61		0.27	
Observations	1819	1942	1622	1374	2927	2816
Adjusted R-squared	0.1104	0.136	0.05	0.3186	0.0448	0.1231
Winsorized						
MVC, average	0.685	1.208	0.376***	1.084	0.420***	0.491***
P-value (dec vs inc)	0.09		0.00		0.69	
Observations	1819	1942	1622	1374	2927	2816
Adjusted R-squared	0.0937	0.1827	0.0689	0.1585	0.0649	0.1162

Table 4: Value of cash for firms with reversal in cash changes

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. Data on firm characteristics are from the *Compustat* database. Stock returns data are from *CRSP*. The sample period is 1972–2017. Regressions are estimated using ordinary least squares. See text for the definition of cash regimes. Accumulate then Spend (Spend then Accumulate) regressions include observations with a positive (negative) change in cash in the fiscal year that is followed by a negative (positive) change in cash in the next fiscal year. Cash increase models use the data of the fiscal year of positive change in cash; cash decrease models use the data of the fiscal year of negative change in cash. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. Coefficient estimates are reported with standard errors in parentheses. ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. For the marginal value of cash, asterisks indicate corresponding significant difference from 1.00.

Interpretation: The estimates of the marginal value of cash violate the equality proposition even for the same sample of firms. Contrary to the predictions, the estimates during cash accumulation episodes that immediately follow cash spending episodes in same firms differ significantly. Same is observed for cash spending episodes that immediately follow cash accumulation episodes. This evidence indicates that the FW methodology used to produce these estimates is unreliable.

Outliers included

Cash regime	All regimes		Raising		Distribution		Debt service	
Changes in cash	Initial	Subsequent	Initial	Subsequent	Initial	Subsequent	Initial	Subsequent
Spend then accum								
MVC, average	0.157***	1.166	2.867**	2.112***	-0.84**	1.673	0.62	0.572
P-value (init vs subseq)	0.00		0.42		0.03		0.93	
Observations	32181	32181	349	349	272	272	694	694
Adjusted R-squared	0.0408	0.1336	0.1541	0.2225	0.0838	0.3405	0.2111	0.1164
Accum then spend								
MVC, average	1.202	0.138***	1.113	2.105**	0.428***	-0.36***	6.323***	0.100***
P-value (init vs subseq)	0.00		0.24		0.08		0.00	
Observations	32683	32683	299	299	351	351	571	571
Adjusted R-squared	0.1881	0.0337	0.1327	0.0937	0.1036	0.0986	0.7153	0.0212

Winsorized

Cash regime	All regimes		Raising		Distribution		Debt service	
Changes in cash	Initial	Subsequent	Initial	Subsequent	Initial	Subsequent	Initial	Subsequent
Spend then accum								
MVC, average	0.362***	0.989	2.523*	1.536	-0.650**	1.199	0.401	0.508***
P-value (init vs subseq)	0.00		0.27		0.07		0.79	
Observations	32181	32181	349	349	272	272	694	694
Adjusted R-squared	0.0937	0.1568	0.1565	0.1918	0.0842	0.2772	0.1116	0.1228
Accum then spend								
MVC, average	0.929**	0.376***	1.201	1.931*	0.854	-0.001**	0.395	0.342**
P-value (init vs subseq)	0.00		0.35		0.05		0.91	
Observations	32683	32683	299	299	351	351	571	571
Adjusted R-squared	0.1624	0.0918	0.1374	0.1099	0.1335	0.0777	0.1113	0.0804

Table 5: Small changes in cash

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. The sample period is 1972–2017. The sample excludes observations with absolute changes in cash greater than 1% of total market value of equity. Regressions are estimated using ordinary least squares. See text for the definition of cash regimes. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. ***, **, and * indicate statistical significance of the difference of the marginal value of cash from 1.00 at the 0.01, 0.05, and 0.10 levels, respectively.

Interpretation: The estimates obtained for firms that experience small changes in cash, which should be devoid of significant information, violate reasonable benchmark values. Specifically, in distribution and debt service regimes, the estimates are far greater than $1.00. This evidence indicates that the FW methodology used to produce these estimates is unreliable.

Cash regime	All regimes		Raising		Distribution		Debt service	
Winsorized	No	Yes	No	Yes	No	Yes	No	Yes
MVC, average	3.153***	3.329***	-1.82	2.403	6.633*	6.639*	6.664**	5.953**
Observations	28433	28433	914	914	459	459	1518	1518
Adjusted R-squared	0.0532	0.0888	0.1212	0.0868	0.098	0.0895	0.0318	0.083

Table 6: Value of cash during cash accumulation and spending

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. Data on firm characteristics are from the *Compustat* database. Stock return data are from *CRSP*. The sample period is 1972–2017. Regressions are estimated using ordinary least squares. Accumulate (increase) samples include only observations with positive change in cash over the fiscal year, and spend (decline) samples include observations with negative change in cash over the fiscal year. Small cash changes sample excludes observations with absolute changes in cash greater than 1% of total book assets. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. Coefficient estimates are reported with standard errors in parentheses. ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. For the marginal value of cash, asterisks indicate corresponding significant difference from 1.00.

Interpretation: When we control for additional information contained in the Net Financing variable by separating the variable into its components, we continue to observe that marginal values of cash during cash accumulation and cash spending episodes differ significantly, contrary to the predictions of the equality proposition, and the estimates of the marginal value of cash during small changes in cash are much higher than the reasonable upper bound of $1.09. This evidence indicates that the FW methodology used to produce these estimates is unreliable.

Winsorized	No	No	Yes	Yes	No	Yes
Changes in cash	Decline	Increase	Decline	Increase	Small changes	
MVC, average	0.181***	0.919	0.451***	0.854***	3.107***	3.267***
P-value (dec vs inc)	0.00		0.00			
Δ cash	0.143	1.182***	0.466***	1.042***	5.438***	5.976***
	(0.092)	(0.198)	(0.041)	(0.038)	(1.194)	(0.870)
Δ assets	0.065***	0.130***	0.176***	0.201***	0.171***	0.236***
	(0.010)	(0.016)	(0.006)	(0.007)	(0.028)	(0.016)
Δ earnings	0.021**	0.013	0.254***	0.361***	0.217***	0.396***
	(0.010)	(0.009)	(0.011)	(0.013)	(0.052)	(0.028)
Δ R&D	0.140	-0.134	0.710***	1.362***	0.561**	1.411***
	(0.148)	(0.345)	(0.123)	(0.164)	(0.269)	(0.285)
Δ interest	-0.315***	-0.545***	-1.109***	-1.273***	-1.219***	-1.946***
	(0.074)	(0.125)	(0.083)	(0.102)	(0.256)	(0.192)
Δ dividends	0.154**	0.149	3.677***	3.868***	0.428	3.441***
	(0.065)	(0.107)	(0.218)	(0.237)	(0.283)	(0.374)
Sales of stock	0.292***	0.365***	0.300***	0.428***	0.246**	0.255***
	(0.060)	(0.096)	(0.042)	(0.029)	(0.118)	(0.071)
Purchases of stock	0.649***	0.587**	1.286***	0.925***	0.883***	1.264***
	(0.064)	(0.291)	(0.059)	(0.084)	(0.085)	(0.093)
Debt issuances	-0.055***	-0.095***	-0.076***	-0.086***	-0.123***	-0.128***
	(0.014)	(0.028)	(0.014)	(0.014)	(0.034)	(0.026)
Debt reductions	0.069***	0.148***	0.107***	0.114***	0.133***	0.134***
	(0.015)	(0.036)	(0.014)	(0.014)	(0.034)	(0.026)
Leverage	0.073***	-0.142***	0.090***	-0.116***	0.014	0.030*
	(0.017)	(0.033)	(0.012)	(0.012)	(0.018)	(0.015)
Leverage*Δ cash	0.133	-1.027***	-0.029	-0.588***	-7.767**	-7.247***
	(0.109)	(0.259)	(0.076)	(0.073)	(3.259)	(2.614)
Lagged cash	0.184***	0.211***	0.173***	0.173***	0.179***	0.188***
	(0.052)	(0.053)	(0.014)	(0.016)	(0.048)	(0.031)
Lagged cash*Δ cash	0.014	0.005	-0.030	-0.243***	-6.265	-13.843**
	(0.009)	(0.019)	(0.030)	(0.037)	(9.638)	(5.661)
Constant	-0.186***	-0.033**	-0.184***	-0.062***	-0.122***	-0.133***
	(0.007)	(0.014)	(0.004)	(0.004)	(0.006)	(0.005)
Observations	64211	64783	64211	64783	28325	28325
Adjusted R-squared	0.031	0.0819	0.099	0.1699	0.0603	0.0961

Table 7: Value of cash for firms with no acquisitions and no stock issues or repurchases

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. Data on firm characteristics are from the *Compustat* database. Stock return data are from *CRSP*. The sample period is 1972–2017. Regressions are estimated using ordinary least squares. Accumulate (increase) samples include only observations with positive change in cash over the fiscal year, and spend (decline) samples include observations with negative change in cash over the fiscal year. Variables are defined in Appendix B. Marginal value cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. Coefficient estimates are reported with standard errors in parentheses. ***, **, and * indicate statistical significance of the difference of the marginal value of cash from 1.00 at the 0.01, 0.05, and 0.10 levels, respectively.

Interpretation: When we remove companies involved in acquisitions or those that issue or repurchase shares from the sample, as they may confound the estimates with additional information that may be contained in changes in cash, the marginal values of cash during cash accumulation and cash spending episodes differ significantly, contrary to the predictions of the equality proposition. This evidence indicates that the FW methodology used to produce these estimates is unreliable.

Sample	No acquisitions		No acquisitions		No issues or repurchases		No issues or repurchases	
Winsorized	No		Yes		No		Yes	
Changes in cash	Decline	Increase	Decline	Increase	Decline	Increase	Decline	Increase
MVC, average	0.147***	1.058	0.428***	0.952	0.157***	0.454***	0.437***	0.582***
P-value (dec vs inc)	0.00		0.00		0.01		0.01	
Observations	45887	45817	45887	45817	38030	34776	38030	34776
Adjusted R-squared	0.028	0.1432	0.0883	0.1579	0.0244	0.0641	0.0923	0.1243

Table 8: Financial constraints and the value of cash

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year for subsamples of unconstrained and constrained firms identified according to the respective constraints criterion. See text for definitions of financial constraint criteria. The sample period is 1972–2017. Data on firm characteristics are from the *Compustat* database. Stock return data are from *CRSP*. Regressions are estimated using ordinary least squares methodology. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. ***, **, and * indicate statistical significance of the difference of the marginal value of cash from 1.00 at the 0.01, 0.05, and 0.10 levels, respectively.

Interpretation: The marginal value of cash is significantly higher for constrained firms than for unconstrained firms, confirming and replicating evidence in existing studies. These results are not sensitive to the treatment of outliers.

Outliers included	Constraints criterion							
	Payout		Size		Debt rating		Paper rating	
	Con	Uncon	Con	Uncon	Con	Uncon	Con	Uncon
MVC, average	0.962	0.794	1.166	0.370***	1.283*	0.384***	1.089	0.638***
P-value (con vs uncon)	0.41		0.00		0.00		0.02	
Observations	57089	40767	30161	43816	59141	20650	72742	7049
Adjusted R-squared	0.1012	0.0769	0.0629	0.1479	0.0623	0.17	0.0601	0.0504

Winsorized	Constraints criterion							
	Payout		Size		Debt rating		Paper rating	
	Con	Uncon	Con	Uncon	Con	Uncon	Con	Uncon
MVC, average	1.062***	0.783***	1.013	0.734***	1.118***	0.888**	1.085***	0.606***
P-value (con vs uncon)	0.00		0.00		0.00		0.00	
Observations	57089	40767	30161	43816	59141	20650	72742	7049
Adjusted R-squared	0.1599	0.1227	0.1613	0.1262	0.1513	0.1361	0.1482	0.0567

Table 9: Vega and the value of cash

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. The LM sample period is 1992–2006. The Full sample period is 1992–2011. Regressions are estimated using ordinary least squares. The unreported control variables include change in assets, change in earnings, change in R&D, change in interest, change in dividends, net financing, leverage, lagged cash, change in cash*lagged cash, change in cash*leverage, and a constant. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample means of leverage and lagged cash. Standard errors are clustered at the firm level. ***, **, and * indicate statistically significant difference from $1.00 at the 0.01, 0.05, and 0.10 levels, respectively. For the marginal value of cash, ***, **, and * indicate statistical significance of the difference of the marginal value of cash from 1.00 at the 0.01, 0.05, and 0.10 levels, respectively.

Interpretation: Although the relation between **t**he marginal value of cash and vega is negative, it is significant only when the sample is winsorized and only when vega enters the regression as an indicator variable. The estimates of the marginal value of cash violate the reasonable upper bound of $1.09, suggesting that the FW methodology used to produce these estimates is unreliable.

Winsorized	No	No	No	No	Yes	Yes	Yes	Yes
Period	LM	Full	LM	Full	LM	Full	LM	Full
MVC, low vega	1.399	1.323	1.414	1.289	1.654***	1.425***	1.700***	1.465***
MVC, high vega	1.292	1.317	1.255	1.301**	1.541***	1.348***	1.418***	1.279***
Δ cash	1.452***	1.374***	1.539***	1.329***	1.955***	1.629***	1.785***	1.461***
	(0.526)	(0.422)	(0.340)	(0.303)	(0.122)	(0.091)	(0.128)	(0.093)
Vega	-0.440***	-0.438***			-0.303***	-0.330***		
	(0.147)	(0.114)			(0.109)	(0.088)		
Vega*Δ cash	-1.921	-0.007			-2.846	-2.415		
	(5.377)	(5.065)			(1.989)	(1.631)		
Delta	0.033***	0.036***			0.026***	0.029***		
	(0.006)	(0.005)			(0.004)	(0.004)		
Delta*Δ cash	0.237**	0.269**			0.148**	0.165**		
	(0.098)	(0.119)			(0.073)	(0.064)		
High vega			-0.094***	-0.084***			-0.068***	-0.064***
			(0.011)	(0.009)			(0.008)	(0.006)
High vega*Δ cash			-0.182	-0.070			-0.436***	-0.379***
			(0.382)	(0.350)			(0.140)	(0.109)
High delta			0.204***	0.196***			0.168***	0.157***
			(0.011)	(0.010)			(0.008)	(0.006)
High delta*Δ cash			0.047	0.254			0.548***	0.615***
			(0.404)	(0.403)			(0.140)	(0.112)
Observations	14495	21703	14495	21703	14495	21703	14495	21703
Adjusted R-squared	0.1385	0.1904	0.1558	0.2071	0.1488	0.1402	0.1729	0.1645

Table 10: Dual-class firms and the value of cash

Description: This table reports the results of regressions of excess stock return on changes in firm characteristics over the fiscal year. The sample period is 1994–2002. Regressions are estimated using ordinary least squares. The unreported control variables include change in assets, change in earnings, change in R&D, change in interest, change in dividends, net financing, leverage, lagged cash, change in cash*lagged cash, change in cash*leverage, Vote-CF ratio, and a constant. Variables are defined in Appendix B. Marginal value of cash (MVC) is calculated at the sample mean values of leverage and lagged cash. Standard errors are clustered at the firm level. ***, **, and * indicate statistically significant difference from $1.00 at the 0.01, 0.05, and 0.10 levels, respectively. For the marginal value of cash, ***, **, and * indicate statistical significance of the difference of the marginal value of cash from 1.00 at the 0.01, 0.05, and 0.10 levels, respectively.

Interpretation: The relation between **t**he marginal value of cash and the ratio of voting to cash flow rights is negative and significant, consistent with existing evidence. However, the estimates of the marginal value of cash violate the reasonable upper bound of $1.09, suggesting that the FW methodology used to produce these estimates is unreliable.

	Outliers included	Voting/CF ratio winsorized	All vars winsorized
MVC, low V/CF ratio	1.710**	1.717***	0.915
MVC, high V/CF ratio	1.296	1.302	0.756*
Δ cash	2.298***	1.805***	1.107***
	(0.514)	(0.344)	(0.269)
Voting/CF ratio	0.001	0.011	0.012
	(0.006)	(0.011)	(0.008)
Voting/CF ratio*Δ cash	-0.221*	-0.100***	-0.080
	(0.122)	(0.036)	(0.068)
Observations	2251	2251	2251
Adjusted R-squared	0.3155	0.3255	0.1889

Online Appendix Table 1: Summary statistics of firm characteristics

Description: This table reports summary statistics of firm characteristics for the full sample and for subsamples partitioned by increase in cash and decrease in cash. Data on firm characteristics are from the *Compustat* database. The sample period is 1972–2017. Accumulate (Spend) subsamples include firms with positive (negative) change in cash over the next fiscal year. Variables are defined in Appendix B.

Interpretation: The main characteristics of our sample are comparable to those in other studies that use the sample.

	Full sample		Accumulate		Spend	
	Mean	Median	Mean	Median	Mean	Median
Total book assets	2060	260	2184	295	2052	258
Market equity	1492	176	1628	207	1447	172
Cash	0.237	0.106	0.185	0.077	0.274	0.137
Change in cash	-0.010	0.000	-0.018	-0.001	0.003	0.005
Tobin's Q	1.582	1.233	1.617	1.249	1.538	1.211
Total debt/total book assets	0.246	0.221	0.243	0.221	0.246	0.222
Leverage	0.889	0.303	0.832	0.294	0.892	0.309
Net investments	0.028	0.007	0.031	0.008	0.032	0.009
Earnings	0.033	0.078	0.062	0.082	0.041	0.079
Research and development	0.030	0.000	0.029	0.000	0.031	0.000

Online Appendix Table 2: Correlation matrix of change in value and change in cash with financing variables

Description: This table reports a correlation matrix of the excess stock returns and the change in cash with financing variables. Data on firm characteristics are from the *Compustat* database. The sample period is 1972–2017. Variables are defined in Appendix B. Correlation coefficients reported with p-values for the significance in parentheses.

Interpretation: The components of Net Financing – purchases of stock, sales of stock, issuances and reductions of long-term debt – exhibit varying correlations with excess stock returns and change in cash, prompting these components to enter as separate variables in the regression.

	Excess stock return	Change in cash	Purchases of stock	Sales of stock	Issuances of long-term debt	Reductions of long-term debt
Change in cash	0.179	1				
	(0.00)					
Purchases of stock	0.045	-0.052	1			
	(0.00)	(0.00)				
Sales of stock	0.120	0.172	-0.033	1		
	(0.00)	(0.00)	(0.00)			
Issuances of long-term debt	-0.001	0.028	0.010	0.037	1	
	(0.76)	(0.00)	(0.00)	(0.00)		
Reductions of long-term debt	0.002	0.009	0.009	0.035	0.956	1
	(0.63)	(0.01)	(0.01)	(0.00)	(0.00)	
Net financing	0.031	0.134	-0.164	0.401	0.235	-0.032
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Online Appendix Table 3:

Description: This table reports the results of regressions of spread of value over cost on levels and changes in firm characteristics over past and future years following Fama and French (1998). Data on firm characteristics are from the *Compustat* database. The sample period is 1972–2017. Regressions are estimated using ordinary least squares. Accumulate (increase) samples include only observations with positive change in cash over the fiscal year, and spend (decline) samples include observations with negative change in cash over the fiscal year. Standard errors are clustered at the firm level. Coefficient estimates are reported with standard errors in parentheses. ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

Interpretation: The estimates of the marginal value of cash violate the equality proposition, which stipulates that the marginal value of cash of a dollar lost should be equal to the marginal value of cash when that dollar is gained. Specifically, the estimates during cash accumulation episodes are significantly different from the estimates during cash spending episodes. The exceptions are the regression that uses positive excess cash measure in the unwinsorized sample, and the regressions that use excess cash measures in the winsorized sample. The former is the only one that provides reasonable estimates of the value of cash. This evidence indicates that the modified Fama-French methodology used to produce these estimates may provide reasonable estimates in limited instances.

Outliers included

Sample	All observations		All observations		Positive excess cash	
Changes in cash	Decline	Increase	Decline	Increase	Decline	Increase
Cash	-0.183*	1.287***				
	(0.102)	(0.297)				
Excess cash			-0.052	0.255**	0.245	0.366
			(0.088)	(0.100)	(0.189)	(0.259)
P-value (dec vs inc)	0.00		0.02		0.71	
Observations	50119	52235	45057	47412	20726	30282
Adjusted R-squared	0.3778	0.5513	0.3538	0.514	0.4871	0.5527

Winsorized

Sample	All observations		All observations		Positive excess cash	
Changes in cash	Decline	Increase	Decline	Increase	Decline	Increase
Cash	0.492***	0.958***				
	(0.131)	(0.144)				
Excess cash			-0.198***	-0.229***	-0.633***	-0.548***
			(0.020)	(0.026)	(0.072)	(0.060)
P-value (dec vs inc)	0.02		0.36		0.34	
Observations	50119	52235	45057	47412	20882	30590
Adjusted R-squared	0.3447	0.4102	0.3446	0.3934	0.3293	0.3574