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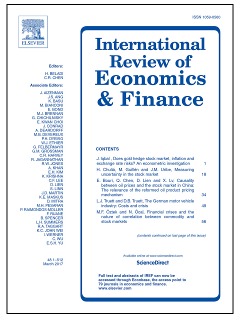

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Cash Holdings Speed of Adjustment

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Cash Holdings Speed of Adjustment

Abstract: This study examines the speed of adjustment of cash holdings and extends the recent work that highlights the importance of accounting for heterogeneity of the speed of adjustment of cash holdings. The results indicate that firms with cash deficits, rated firms and firms with financial surpluses have a slower speed of adjustment, while firms with excess cash, non-rated firms and firms that have financial deficit adjust towards the target faster. Overall, the results support the idea that firms have a target level of cash holdings, however, costs of adjustment as well as costs of non-adjustment affect the speed with which firms adjust towards the target.

1. Introduction

Increases in the level of corporate cash holdings over the past decade have attracted considerable attention from media, investors and academic researchers. Bates, Kahle, and Stulz, (2009, p.1985), note that "cash-to-assets ratio for U.S. industrial firms more than doubles from 1980 to 2006," and that starting from 2003, "the average firm can retire all debt obligations with its cash holdings." In light of these findings, the topic of cash holdings management has become increasingly important, potentially deserving the same attention as capital structure management. The recent financial downturn and liquidity crisis further emphasized the importance of liquidity management, and added another angle to the debate on the optimal level of corporate cash holdings. The level of corporate cash holdings and the factors that explain it have been the subject of considerable recent research (e.g. Opler, Pinkowitz, Stulz and Williamson, 1999; Dittmar, Mahrt- Smith, Servaes, 2003; Foley, Hartzell, Titman, and Twite, 2007; Bates, Kahle, and Stulz, 2009). But cross-sectional examination of cash holdings addresses only one aspect of cash management. Understanding the dynamic aspects of cash holdings is also important as it provides a more complete understanding of cash management policy. Specifically, answers to questions such as whether firms have and operate with target cash holdings in mind, whether managers adjust cash holdings towards such targets, and what factors influence the speed of such adjustments are all important aspects of cash holdings that are not well-understood. Only a few papers focus on the dynamic aspects of cash holdings (Dittmar and Duchin, 2011; Venkiteshwaran, 2011; Gao, Harford and Li, 2013; Bates, Chang and Chi, 2017). Our study contributes to this emerging literature.

Following the seminal paper by Opler, Pinkowitz, Stulz and Williamson (1999), several studies examine cash holdings from the perspective of the theories developed to explain corporate capital structure including: trade-off, agency, financial hierarchy, and market timing theories (e.g. Dittmar et al., 2003; Venkiteshwaran, 2011; Dittmar and Duchin, 2011; Gao, Harford and Li, 2013; Bates, Chang and Chi, 2017). As in the case of research into capital structure, the trade-off model has garnered the most attention when it comes to investigating cash holdings. In the *trade-off* theory framework, managers of a firm balance the cost and benefits of holding cash to determine an optimal (target) level of cash that should be maintained in order to maximize shareholders' wealth. As in the case of studies on capital structure, one way to test for the existence of an optimal (target) level of cash holdings is to see if, and how quickly, firms move back to their target cash holdings level over time (i.e., speed of adjustment (SOA)). A high SOA estimate (close to 1.0) would support the *static* version of the trade-off theory of cash holdings, which assumes immediate adjustment towards target of cash holdings, while CH-SOA estimates lower than 1.0, albeit significant, would support the *dynamic* version of the trade-off theory. The latter recognizes that due to various market frictions and adjustment costs, the immediate full adjustment is not always possible and adjusting towards target takes time.

Several studies dealing with capital structure argue that firms adjust towards the target leverage only when the cost of non-adjustment exceeds the adjustment costs (e.g., Fisher, Heinkel, and Zechner, 1989; Faulkender, Flannery, Hankins, and Smith, 2012; Oztekin and Flannery, 2012). A similar argument could hold for target cash holdings. In the case of cash holdings, a significant source of adjustment cost can be transaction costs associated with having to raise capital or distribute cash to shareholders in order to bring the cash holdings to the target level. Non-adjustment costs include the increased probability of financial distress if the firm is cash deficient, or foregone returns and potential agency costs (management's misuse of cash or suboptimal investment) if a firm holds excess cash. Another cost of holding too much or too little cash is a decrease in the investors' valuation of cash. Faulkender and Wang (2006) show that investors' valuation is higher for the firms that retain liquidity; however, "the value of additional cash diminishes in the level of cash (p.1988)." Faulkender and Wang's (2006) findings suggest that from investors' perspective there is an optimal value maximizing level of cash the firm should hold, and deviation from this optimal level decreases the value of the firm.

Investigations into cash holdings speed of adjustment (CH-SOA) is still a developing area of research, especially as it applies to factors that affect the heterogeneity of SOA across firms. Recent studies on corporate cash holdings showed that CH-SOA varies among different firms and changes through time (Dittmar & Duchin 2011; Gao, Harford and Li, 2013; Bates, Chang and Chi, 2017). Gao, Harford and Li (2013) find that cash holdings speed of adjustment is higher for private firms compared to private firms due to agency costs. Dittmar and Duchin (2011) show that mature firms have slower CH-SOA. Bates, Chang and Chi (2017) show that CH-SOA has been declining overtime.

Based on prior evidence we hypothesize that the majority of companies adjust their cash levels towards targets on a regular basis. However, we propose that the speed of adjustment varies with firm characteristics. We specifically focus on availability of funds, as one of the main factors that contributes to differences in CH-SOA across firms. We test the hypothesis that differences in adjustment cost as well in cost of non-adjustment among firms will lead to the different CH-SOA. While adjustment costs are difficult to measure or observe, it can reasonably be expected to vary with several firm and financial characteristics. The specific factors we examine are as follows. First, we examine how the sign and size of deviation from the target affects CH-SOA. Second, building on the prior findings on the effect of free cash flow on cash holdings (e.g., Almeida, Campello, Weisbach, 2004; Bao, Chan, Zhang, 2012) we examine how the sign and size of free cash flow affects the CH-SOA. Finally, we demonstrate that various combinations of cash deviation from target and free cash flow have different effects on the CH-SOA.

We make two contributions to the literature. First, we provide evidence of a moderately high CH-SOA, but not close to 1.0, which is consistent with firms adjusting their cash towards a target, thus supporting a version of the trade-off theory of cash holdings. Second, and more importantly, we provide evidence of variability of CH-SOA based on firms' financial characteristics. Thus, we contribute to growing literature on CH-SOA heterogeneity (e.g. Dittmar and Duchin, 2011; Venkiteshwaran, 2011; Gao, Harford, and Li, 2013; Bates, Chang and Chi, 2017).[1] We show that systematic differences in CH-SOA among the firms with different characteristics is consistent with the idea that firms adjust towards their CH target, but, as predicted by the dynamic version of the trade-off theory, the adjustment is not instantaneous since the adjustment costs affect the speed of this adjustment.

Our findings are as follows. The overall CH-SOA is relatively high at 0.54, implying that on average firms close over half of their deviation from target in one year. The results indicate that firms with cash deficits have slower CH-SOA compared to the firms with excess cash, and firms that have greater excess cash adjust towards the target faster. Larger free cash flow (in absolute terms) leads to faster adjustment towards target. We find that firms with financial surpluses adjust slower than firms with financial deficits. Also, larger and, particularly, rated firms have slower CH-SOA. These results support the idea that costs of adjustment as well as costs of non-adjustment affect the speed with which firms adjust towards their cash holdings

[1] An earlier version of the Dittmar and Duchin (2011) paper contains tests of some of the factors that we examine in our study. However, most of these results did not carry over to the 2011 version. It is not clear why these tests/results were dropped, but several of them conflict with results documented in Venkiteshwaran (2011).

target. Since the CH-SOA that we document is significant, yet lower than 1.0, and varies with firm characteristics that proxy for various market frictions, we conclude that our findings are consistent with the dynamic version of the trade-off theory of corporate cash holdings.

The rest of the paper proceeds as follows: Section 2 reviews the literature and offers several testable hypotheses. Section 3 discusses the methodology and describes variables and data used. Section 4 presents the empirical results and section 5 concludes.

2. Relevant literature and hypotheses development

This section highlights the relevant literature and details the key hypotheses to be tested. In section 2.1 we discuss the determinants of cash holdings while in section 2.2 we discuss the more closely related literature on CH-SOA and how our study contributes to the literature in this area. Sections 2.3-2.5 detail the hypotheses to be tested.

2.1. Determinants of cash holdings

Research on corporate cash holdings have used the theories originally developed for capital structure including the trade-off model to explain corporate liquidity (e.g., Opler, Pinkowitz, Stulz and Williamson, 1999; Venkiteshwaran, 2011; Dittmar and Duchin, 2011). Central to the trade-off model is the existence of an optimal or target cash balance. Opler et al. (1999) find that certain firms' characteristics such as size, net working capital, leverage, and being a dividend payer are negatively related with the level of cash holdings, while cash flow, capital expenditure, industry volatility and R&D have positive associations with cash holdings. These findings have been supported, among others, by Dittmar et al. (2003) using an international dataset. Bates et al. (2009) indicate that in addition to the determinants identified by

Opler et al. (1999), acquisition activity has a negative association with level of cash, and that industry cash flow volatility has a significant positive effect on the level of cash.

The cash holdings literature recognizes that there may be other factors at play in addition to or as an alternative to the trade-off model. We discuss several of these factors next. The *agency* theory framework developed in Jensen and Meckling, 1976 and Jensen, 1986 and applied to cash holdings (e.g., Dittmar et al., 2003; Pinkowitz et al., 2006; Hartford et al., 2008 among others) suggests that managers prefer cash to external financing, since external financing exposes them to additional scrutiny. Managerial risk aversion is another motive that has been considered under the agency theory framework (e.g., Dittmar and Duchin, 2012).

The *financing hierarchy* (or pecking order theory) suggests that there is no optimal amount of cash; firms will spend their cash reserves when faced with financial deficits and increase their cash holdings with cash flow surpluses. Dittmar and Duchin (2011) find that the financial hierarchy theory is more applicable to cash management behavior of older firms.

In the *market timing* framework, cash balances should reflect the fact that issuance of a certain type of financing is driven by market misvaluation. Dittmar and Duchin (2011) find that cash balances have significant association with market timing of security issuance, but the explanatory power of the market timing factor decreases with the firm's age. Pinkowitz et al. (2012) examine use of various types of acquisition financing by cash-rich firms, and find that such firms use the cheapest source of capital for acquisitions, providing the evidence that managers are trying to time the market with use of cash and equity.

Overall, similar to the capital structure literature, the research on cash holdings provides evidence that the elements of different theories are present in the cash management behavior of firms (e.g. Opler et al., 1999; Dittmar and Duchin, 2011). The results of Opler et al. (1999)

mainly supports the tradeoff model of cash holdings and provides evidence consistent with the idea of firms adjusting to their target level of cash holdings. However, they do find that the pecking order (financial deficit) variable is significant in explaining changes in the level of cash, even when combined with a target adjustment variable in the same regression. They also find that the financial deficit variable is "significantly higher in absolute value for firms that have liquid assets in excess of their target" (Opler et al., 1999, p.22). The authors suggest this could be due to an agency consideration[2] and that, potentially, the financial hierarchy model better predicts changes in cash for firms with a level of cash that exceeds their target.

Dittmar and Duchin (2011) also test for relationship between changes in cash holding and financial deficit. In contrast to Opler et al. (1999) they do not find a significant relation between cash and financial deficit. However, after considering the firm's age, the authors find that change in cash holdings is positively related to the financial deficit for younger firms but is negative for older firms, and that younger firms adjust to their target cash level faster than old firms. Based on the findings, Dittmar and Duchin (2011) suggest that different theoretical models to explain cash management appear to hold at different stages of the firm's life-cycle.

2.2 Speed of adjustment of cash holdings

In a world with perfect capital markets the level and the dynamics of cash holdings are irrelevant (Opler, Pinkowitz, Stulz and Williamson, 1999). However, in the presence of financing and investment frictions a number of factors have been found to be important determinants of cash held by companies and the dynamics of cash holdings. As with the trade-off theory of capital structure, one of the main distinctions between the *static* and the *dynamic* trade-

[2] Opler et al. (1999) explains these agency considerations suggest that "managers would want to keep resources within firm would let cash accumulate if the firm does well. However, this management would also take steps to remedy a situation where the firm has too little cash, relative to some target, even if the firm has a cash flow deficit."

off theory of cash holdings is that the *static* version predicts immediate adjustment towards target of cash holdings; on the other hand, the *dynamic* version recognizes the presence of various market frictions and adjustment costs that could slow down the adjustment towards the target. A high SOA is consistent with the presence of an optimal (target) leverage to which a firm adjusts regularly, thus, providing support for the trade-off theory. An SOA of 1, would be consistent with the static version of the trade-off model. However, when SOA is close to zero, it implies that the trade-off model is not a good descriptor of how firms determine their cash holdings policy. On the other hand, if it can be shown that the SOA is systematically related to the cost of adjustment, even when the SOA is below one, it would be consistent with the dynamic version of the trade-off model.

Opler, Pinkowitz, Stulz and Williamson (1999) was one of the first studies to estimate a partial adjustment model for cash holdings. Later studies present further evidence showing that at least some firms adjust their cash holdings to the target level (Dittmar and Duchin, 2011; Venkiteshwaran, 2011; Gao, Harford, and Li, 2013; Bates, Chang and Chi, 2017). Dittmar and Duchin (2011) find that the cash holdings policy is largely determined by the lifecycle stage of the firm. Of relevance to our study, they find that CH-SOA for younger firms is higher than for older firms.[3] Gao, Harford, and Li (2013) compare cash policies of private and public firms and conclude that difference CH-SOA can be mainly explained by agency costs. Bates, Chang and Chi (2017) show that CH-SOA is not constant and has been decreasing overtime. Our study offers a detailed analysis of CH-SOA across multiple subsamples of firms and suggests that differences in SOA can be attributed to differences in cost of adjustment versus cost of non-adjustment among firms. The assumption of homogeneous speed of adjustment for all firms is

[3] As noted in the previous footnote, an earlier version of this paper focused more on the sensitivity of CH-SOA to various proxies for cost of adjustment including several that we consider, but the latest version of the paper cited here focused almost entirely on the role of the firm lifecycle as a primary determinant of cash holdings.

unrealistically simplistic and that differences in adjustment cost can affect the speed with which firms with different characteristics adjust towards their cash holdings target. The specific factors we examine include sign and size of deviation from target, and availability of external and internal financing. As we argue below, these firm characteristics proxy for differences in the cost of adjustment as well as cost of non-adjustment towards the target.

2.3. Effect of sign and size of deviation from the target effect on CH-SOA

First, we examine how the sign and size of deviation from the target affects CH-SOA. It can be argued that adjustment costs are greater (lower) below (above) the target cash level. Costly financing constraints and costly external financing imply that firms below the target will be slower to adjust to the target than firms above the target. One can also argue that the cost of nonadjustment increases with the size of the deviation. For a firm above its target cash level, being further away from target increases the opportunity costs resulting from holding excess cash. Conversely, for a cash deficient firm, moving further away from the target increases liquidity concerns, as low liquidity levels can at the extreme lead to bankruptcy. More formally, our first two hypotheses with respect to the size and deviation of cash flows can be expressed as follows:

Hypothesis1a (H1a). Firms adjust to CH target faster when they are above the CH target compared to when they are below CH target.

Hypothesis1b (H1b). Firms adjusts to CH target faster if the deviation is larger.

Next, we examine how the costs and availability of external and internal financing influences CH-SOA.

2.4. Effect of availability of external financing on CH-SOA

When external financing is required, differences in the cost of external financing can potentially lead to differences in the adjustment speeds (Faulkender, Flannery, Hankins, and Smith, 2012). On the one hand, if the cost of external financing is lower for some firms, then it can be expected that, all else equal, such firms will adjust their cash holdings towards the target faster than firms with more costly external financing. However, the cost of non-adjustment is significantly higher for constrained firms. External financing for financially constrained firms is not always easily available, making the deviation from CH target dangerous. Thus, we would expect that CH-SOA for financially constrained firms will be higher than for non-constrained firms. Studies have used several proxies for external financial constraints including firm size, and existence of credit rating (e.g., Faulkender, Flannery, Hankins, and Smith, 2012). We test for the difference in the CH-SOA for financially constrained vs. non-constrained firms using size and access to debt markets as proxies for existence of financial constraints.[4]

Hypothesis 2a (H2a). CH-SOA of financially constrained firms is higher than CH-SOA of non-constrained firms.

2.5. Effect of availability of internal financing on CH-SOA

Next, building on the literature that examine the influence of free cash flows on the level of cash (e.g., Almeida, Campello, Weisbach, 2004; Bao, Chan, Zhang, 2012), as well as the association between cash flow and leverage SOA (Byoun, 2008; Faulkender, Flannery, Hankins, and Smith, 2012) we examine how the sign and size of free cash flow affects the CH-SOA. A number of previous studies show that the level of cash holdings is dependent on the cash flow, at least for some firms (e.g., Opler, Pinkowitz, Stulz and Williamson, 1999; Almeida, Campello,

[4] Previous finance literature showed that for rated firms the access to external capital is easier and relatively lower costs of accessing debt markets (e.g. Denis, D. J., and V. T. Mihov, 2003; Faulkender, M. and M.A. Petersen, 2006; Faulkender, Flannery, Hankins, and Smith, 2012)

Weisbach, 2004; Khurana, Martin, and Pereira, 2006; Dittmar and Duchin, 2011). Therefore, it is reasonable to suggest that free cash flow is one of the main potential determinants of CH-SOA. In the leverage SOA literature, Byoun (2008) and Faulkender, Flannery, Hankins, and Smith (2012) emphasize that the impact of financial surplus (positive Free CF) and deficit (negative Free CF) in combination with the firm's position relative to their leverage target plays an important role in the SOA.

We examine the effect of various combinations of size and sign of free cash flow and cash holdings deviation on CH-SOA. On the one hand, the availability of surplus internal funds reduces the adjustment cost, which would allow the firm to close their deviation from the target faster. On the other hand, firms with financial deficit can either use cash, if available, to close the financial deficit or turn to external financing, particularly if the financial deficit is large. While it is hard to predict if the financial surplus would lead to higher CH-SOA, we would expect that large free cash flow in absolute terms would cause the firms to adjust towards the target faster.

Hypothesis 2b (H2b). CH-SOA is different for the firms with positive free cash flow compared to the firms with negative free cash flow

Hypothesis 2c (H2c). SOA is higher for firms with high absolute free cash flow.

But, the above discussion also suggests that the size and sign of deviation relative to sign and size of free cash flow will have an influence the CH-SOA. So we hypothesize that using excess cash to close the financial deficit would cause the firm to adjust towards target faster than when they have financial surplus.

Hypothesis 2d (H2d). CH-SOA of firms with excess cash is going to be higher for the firms with financial deficit than for the firms with financial surplus.

3. Methodology, Variables and Data

3.1. Methodology

The standard partial adjustment model used in the studies on capital structure can be applied to cash holdings (as in Dittmar and Duchin, 2011)[5]:

$$Cash_{i,t+1} - Cash_{i,t} = \lambda \left(Cash^{*}_{i,t+1} - Cash_{i,t} \right) + \delta_{i,t+1} \quad (1)$$

where

*Cash** is the firm's target ratio,

λ is the adjustment speed towards target, i.e., SOA,[6]

δ is the error term, and

Cash and *Cash** are scaled by *Net Assets* defined as *Total Assets* minus *Cash.* Often the target level of cash holdings can be estimated as

$$Cash^{*}_{i,t+1} = \beta X_{i,t} \quad (2)$$

where $X_{i,t}$ is a vector of observable firm-specific factors that determine the firm's target level of cash holdings, and β is a vector of coefficients.

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[5] Examples of the studies that employ the partial adjustment model to estimate leverage SOA include Fama and French, 2002; Flannery and Rangan, 2006; Lemmon, Roberts, and Zender, 2008; Faulkender, Flannery, Hankins, and Smith, 2012; Oztekin & Flannery, 2012; and Flannery and Hankins, 2013.

[6] The λ coefficient captures the proportion of the gap between target and actual level of cash holdings that a typical firm closes each year. The reported coefficient from the model estimation is (1-λ). SOA, λ, estimates are often interpreted in terms of "half-lives". Half-life is the time that it takes a firm to adjust half of the distance to its target cash after a one unit shock to the error term. For an AR (1) process, half- life is log (0.5)/log(1-SOA). Thus, for example, an SOA estimate equal to 0.5 means that a typical firm closes 50% of its gap between its current level of cash holdings and target in one year, and it takes one year for the firm to adjust half way to its cash holdings target level. Relatively high SOA (or short "half-life") is considered to be consistent with target behavior of the firms, which is a central concept of the trade-off theory.

Following Opler, Pinkowitz, Stulz and Williamson (1999) and Bates, Kahle, and Stulz (2009), the determinants of target cash holdings include *market-to-book, size, cash flow, net working capital, CAPEX, leverage, industry cash flow volatility, R&D, dividend (dummy), acquisition,* and a firm fixed effect. *Cash Flow* is measured as earnings less interest and taxes divided by total assets. *Industry cash flow volatility* is the 5-year rolling window median volatility of cash flow/assets across industries (based on Fama-French (1997) industry classification). *Market- to-book* is the market value of assets, defined as total assets minus book equity plus market value of equity, divided by total assets. *Net Working Capital* is net working capital excluding cash, divided by total assets. *CAPEX* is capital expenditure divided by total assets. *Leverage* is short-term debt plus long-term debt, divided by total assets. *R&D* is research and development divided by sales, with missing values set to zero. *Dividend* (Dummy) is defined as 1 (one) if a firm pays dividends in a specific year, and 0 (zero) otherwise. *Size* is the natural logarithm of the book value of total assets.[7]

Substituting (2) into (1) and rearranging yields:

$$Cash_{i,t+1} = (\lambda\beta)X_{i,t} + (1-\lambda)Cash_{i,t} + \delta_{i,t+1} \quad (3)$$

Some studies that use this specification estimate the target and SOA simultaneously (e.g., Venkiteshwaran, 2011), while others estimate the target separately (e.g., Faulkender, Flannery, Hankins, and Smith, 2012; Oztekin and Flannery, 2012). The second approach (separate estimation of the target) is more suitable for the purposes of this study. For most of the hypotheses put forth in the study we need to compare the CH-SOA for different subsamples. However, simply splitting the sample into several subsamples and estimating equation (3) for

[7] The explanatory power of the model of target cash holdings varies based on the measure of cash holding, the estimation methodology and the time period used in the studies. For example, Opler, Pinkowitz, Stulz and Williamson (1999) report (Adj) R^2 between 0.10 and 0.38. Bates, Kahle, and Stulz (2009) tests have (Adj) R^2 between 0.20 and 0.45. In our sample, OLS with industry and year fixed effects yields R^2 of 0.31.

each one will produce misleading results. This is because, as noted by Faulkender, Flannery, Hankins, and Smith (2012), multiple estimations of equation (3) for different subsamples would fail to impose a consistent model of target cash holdings across the specifications. Thus, for the main model specification we use methodology similar to Oztekin and Flannery (2012), first estimating Eq. (3) using a two-step system generalized method of moments (GMM) estimator (Blundell and Bond, 1998)[8] to get the estimates of βs and λ, which we then use to calculate the target level of cash holdings and the deviation from the target for each firm-year.

$$\widehat{DEV}_{i,t+1} = \widehat{Cash}*_{i,t+1} - Cash_{i,t} \quad (4)$$

where $\widehat{DEV}_{i,t+1}$, is estimated deviation from target, calculated as the difference between current cash, $Cash_{i,t}$, and $\widehat{Cash}*_{i,t+1,}$ which is the estimated target level of cash.

The capital structure as well as the cash holdings literature highlight that identifying a good proxy for target leverage or cash holdings is not a trivial task, as the optimal level of cash holdings (or leverage) is unobservable. To address this concern, we use several proxies for target level of cash holdings. In all instances the targets are estimated prior to estimating the CH-SOA. In addition to the multivariate model discussed previously, we use industry median value and five-year rolling average as proxies for target level of cash holdings.

Substituting equation (4) into equation (1) produces a regression that can be estimated with ordinary least squares:

$$Cash_{i,t+1} - Cash_{i,t} = \lambda_{i,t+1}\left(\widehat{DEV}_{i,t+1}\right) + \delta_{i,t+1} \quad (5)$$

[8] The GMM estimator has been shown to produce the most accurate estimate of speed of adjustment that is ”unaffected by panel imbalance, and are consistent across a range of endogeneity in the presence of serial correlation” (Flannery and Hankins, 2013, p.17)

This specification permits us to relax the assumption of speed of adjustment homogeneity, allowing CH-SOA to depend on firm specific characteristics and factors:

$$\lambda_{i,t+1} = \gamma_0 + \gamma_{i,t+1} Z_{i,t} \tag{6}$$

Substituting equation (6) into equation (5) yields

$$Cash_{i,t+1} - Cash_{i,t} = (\gamma_0 + \gamma_{i,t+1} Z_{i,t})\left(\widehat{DEV}_{i,t+1}\right) + \delta_{i,t+1} \tag{7}$$

$Z_{i,t}$ includes a number of firm characteristics and factors that we hypothesize affect the CH-SOA. Following Oztekin and Flannery (2012) we estimate equation (7) using ordinary least squares (OLS) regression. We use clustering on firm level, which produces heteroskedastically consistent standard errors and relaxes the assumption of independence of error terms within clusters.[9] We use the following variables to interact with DEV as a way to test our proposed hypotheses:

- To test whether or not the speed of adjustment for cash holdings depend on the deviation from CH target we use a dummy variable, *DevLarge*, that takes a value of one if the absolute value of deviation from target cash holdings is above the median level of absolute deviation, and zero otherwise.
- To test if the CH-SOA depends on whether the firm is above or below target, we use *NegDEV* , which is an indicator variable equal to one if the firm is below its target level of cash holdings, and zero otherwise.
- To identify the significance of the effect of free cash flow size on CH-SOA, we use the variable *AbsFCF*, which is the absolute value of free cash flow, defined following Faulkender, Flannery, Hankins, and Smith (2012) as

[9] Similar methodology is used to estimate leverage SOA across various subsamples of firms in Faulkender, Flannery, Hankins, and Smith (2012) and Oztekin (2015).

$$Free\ CF_{i,t} = \frac{OIBD_{i,t} - T_{i,t} - Int_{i,t}}{A_{i,t-1}} - Ind\_CapEx_t$$

where $OIBD_{i,t}$ is operating income before depreciation, $T_{i,t}$ is the total taxes allocated on the income statement, $Int_{i,t}$ is the interest paid, Ind_CapEx_t is the mean value of capital expenditures in year t (deflated by lagged book assets) for all Compustat firms in firm *i's* Fama and French (1997) industry, and $A_{i,t-1}$ is the value of total assets for the fiscal year ending at *t-1*. This is a version of a firm's *financial deficit* measure, suggested by Shyam-Sunder and Myers (1999), with the firm's actual capital expenditures replaced by industry capital expenditure, Ind_CapEx_t. Faulkender, Flannery, Hankins, and Smith (2012) suggests that Ind_CapEx_t can be used as a proxy for the firm's investment opportunity set.[10]

- We create an indicator variable *AbsFCFLarge*, which is equal to one if the firm's absolute value of free cash flow is above median and zero otherwise, in order to test the effect of size of free cash flow on CH-SOA.
- To examine if CH-SOA is different for firms with negative free cash flows and firms with positive free cash flows, we use *NegFCF*, which is an indicator variable set to one if a firm's free cash flow is negative, and zero otherwise.
- We employ the variables S*izeLarge* and *Rated*, to test if CH-SOA is significantly different for the financially constrained versus non-constrained firms. S*izeLarge* is an indicator variable set to one if a firm's size is above median, and zero otherwise. *Rated* is an indicator variable set to one if a firm has a debt rating, and zero otherwise.

[10] The reasoning behind using industry capital expenditure instead of a firm's capital expenditure is to control for endogeneity that can arise from the possibility that "a firm's observed expenditures reflect both the firm's investment opportunity set and its decision to access financial markets." (Faulkender, Flannery, Hankins, and Smith, (2012, p.638)).

3.2. Data

The sample consists of all U.S. firms with relevant information available from Compustat files for the period 1968-2012. For the tests that use firm debt rating, the sample is limited to 1986-2012 due to data availability. There are 14,512 unique firms in the sample. We exclude financial and utilities firms from the sample, as well as firms with missing or negative values of total assets, equity and sales. All main variables are deflated by the book value of assets and winsorized at the 1st and 99th percentiles except for dividends, R&D and acquisition, which are winsorized only at 99th percentiles since many firms have zero for these variables. We use Fama and French (1997) industry classification (48 industry classification available from French's website). Detailed definitions of the variables used in the study are provided in Appendix A. Table 1 presents summary statistics for our sample. The mean Cash is 0.43, while the median is 0.1, which is indicative of the large amount of cash (relative to assets) held by a small number of companies. This is consistent with the findings documented in Dittmar & Duchin (2012). The deviation from target variables indicate that when we construct the cash target based on the fitted model, as described in the methodology section, the mean and median deviation from target are negative, indicating that in more than half of the sample firms are cash deficient. We observe similar results when we proxy for cash with the firm's 5-year rolling average cash level. When we use the industry median to approximate target levels of cash, we observe high a positive mean value, consistent with the view that firms with excess cash hold considerable amounts of it. The correlations between the three proxies are relatively high. The correlation between the fitted model target and the industry median target is 0.55; the correlation between the fitted model target and the five-year average target is 0.65 and it is 0.43 between the industry median target and the five-year average target. The mean firm size measured as ln (Total Assets) is 4.68, which corresponds to about $108 million. The mean market-to-book ratio is 1.93 though the median is only 1.36. The mean leverage ratio is only 12.7 percent. The mean R&D ratio is 16.6%, however, the median value is close to zero. The mean free cash flow ratio is -0.079 while the median ratio is -0.5 percent. The average firm in the sample does not pay any dividends.

[Insert table 1 here]

Results

4.1. Overall CH-SOA

Estimating CH-SOA using the full sample employing the GMM procedure yields a coefficient of 0.46, which corresponds to an SOA of 0.54 (Panel A of Table 2), implying that on average firms close over half of the deviation from target in one year.[11]

[Insert table 2 here]

Panel B of Table 2 columns 1 and 2 show the results of regressing cash changes on the deviation from target (Equation (5)), when the target level of cash holdings is proxied by two alternative measures: industry median, and five-year rolling average cash holdings level. The estimates reveal that, on average, firms adjust towards the industry median (five-year rolling average) with a SOA of 0.44 (0.76). Both coefficients are significant at the 1% level.

[11] Using Pooled OLS with simultaneous estimation of target equation (3) produces a CH-SOA of 0.35, while a fixed-effects specification yields a CH-SOA of 0.6. It has been shown that pooled OLS produces the lowest SOA estimates, while fixed effects model produces the highest (e.g., Lemmon, Roberts and Zender, 2008). Our results are consistent with this pattern.

Overall, the results reported in Table 1 reconfirm prior findings that the magnitude of CH-SOA is economically meaningful and consistent with the notion that firms adjust their cash balances in line with the existence of a target (optimal) level of cash. We next focus on evidence of systematic variation in CH-SOA.

4.2. Deviation from Target

4.2.1. Sign and Size of Deviation from Target (H1a, H1b)

In this section we examine whether the sign of deviation from the target influences CH-SOA. For the main specification we estimate Equation (3) and use the estimates of βs and λ to calculate the target level of cash holdings. That is, we use the estimated values from Table 2 panel A. For the alternative specifications we use the industry mean value of cash holding and the firm's five-year rolling average level of cash holdings as the target level of cash. If a firm's actual cash holdings exceed the target level, then the firm is assumed to have excess cash and *NegDev* (negative deviation) is set equal to zero. In the case of a cash deficit, *NegDev* is set equal to one. For this, and all further tests we use OLS to estimate Equation (7).

The results presented in Table 3, Panel A show that the coefficient on the interaction variable is negative and statistically significant at the 1 % level, indicating that there is significant difference in CH-SOA for firms with excess cash and those with a cash deficit. The firms with excess cash adjust towards the target with a SOA of 0.65, while firms with cash deficit have a SOA of 0.17. In "half-life" terms, it takes only 0.66 of a year for firms with excess cash to adjust half way to their cash holdings target level compared to 3.72 years for cash deficit firms; this shows that the difference in CH-SOA is not only statistically, but also economically significant. Further, the results in Table 3 Panel A indicate that for all three target proxies, the

SOA of the firms with excess cash exceeds CH-SOA of cash deficient firms. This supports the argument that the difference in CH-SOA is due to the difference in adjustment costs.

[Insert table 3 here]

Next we examine if the size of the deviation from target has an impact on CH-SOA. The results in Table 3, Panel B indicate that firms with a smaller deviation have a CH-SOA of 0.41 (half-life of 3.1 years) for the fitted model. Comparatively, firms with a larger deviation from target adjust towards the target faster as revealed by the statistically significant positive coefficient for the interaction term *DEV*DevLarge.* For firms with a larger deviation, CH-SOA is 0.64 (half-life of 0.68 of a year), calculated as the sum of *DEV* and *DEV*DevLarge* coefficients. A similar pattern is observed for the other two target proxies. Overall, Table 3 Panel B supports the view that, for the sample as a whole, greater deviation from the target is associated with more rapid SOA as was hypothesized and the effect appears to be economically meaningful. Next, we examine if these results are symmetric for cash surplus and cash deficit firms.

Table 3, Panel C shows the effects of including two way interaction terms between sign and size of deviation from target on SOA. On the surplus side, the results for all three target proxies consistently show that firms with larger surplus cash (deviation) adjust towards the target faster than firms with small positive deviation from target mirroring the results for the full sample in Panel B.

For firms with a cash deficit our results are less consistent across the different target proxies. When we proxy for the target with a fitted regression and industry median, the results indicate that CH-SOA is actually higher for the firms with larger deviation from target. For the moving average target specification, CH-SOA is slightly lower as deviation increases. However, it can argued that the difference in CH-SOA between firms with large cash deficit and small cash deficit is not that different from an economic significance perspective, particularly when we proxy for the target with industry median and five-year moving average. The asymmetric results for the effect of deviation on SOA across the cash deficit and cash surplus groups further highlights the presence of and importance of accounting for heterogeneity in CH-SOA. One of the potential explanations of the fact that higher levels of excess cash leads to higher CH-SOA is that the excess cash is being accumulated to close the financial deficit. Thus, the availability of internal funds as well as access to external financing are potential factors that can lead to difference in CH-SOA, we examine these factors in the next sections.

4.3. Access to Capital

4.3.1. Access to External Capital (H2a)

We use size and existence of debt rating as a proxy for ease of access to external capital. We use the interaction variable *DEV*SizeLarge* to test if the speed of adjustment varies with firm size. The results in Table 4 show that for all three target proxies CH-SOA decreases with size, meaning that CH-SOA of smaller firms are higher than for larger firms, as expected. On average it takes larger firms 0.82 of a year to close half of their deviation gap, compared to 0.75 of a year for smaller firms. Our finding is consistent with Dittmar and Duchin (2011), who show that younger firms, which on average are assumed to have greater external financing constraints, adjust towards the target level significantly faster than older firms. However, based on the half-lives, the differences do not appear to be economically meaningful.

[Insert table 4 here]

We also use the existence of debt rating as a proxy for ease of access to external capital. Data availability in Compustat restricts the sample for this test to the 1986-2012. The indicator variable *Rated* is set equal to one if a firm has a rating, and zero otherwise. The results presented in Table 4 Panel B show that rated firms have lower speed of adjustment, CH-SOA=0.14, than non-rated firms, CH-SOA=0.51. In half-life terms, it takes non-rated firms about a year to get half way to their cash target, while it takes 4.5 years for rated firms. These results are in line with those using firm size as a proxy for access to external capital, albeit economically more meaningful.

4.3.2. Availability of Internal Capital

4.3.2.1 Size and sign of FCF (H2b, H2c)

Table 4 presents test results for the effect of size and sign of free cash flow on CH-SOA. For all three cash holdings target proxies the interaction variable *DEV*AbsFCFLarge* coefficient is positive and significant, as shown in Table 5, Panel A, indicating that CH-SOA is increasing as free cash flow increases in absolute terms. This is similar to the result that Faulkender, Flannery, Hankins, and Smith (2012) document for leverage SOA.

[Insert table 5 here]

Table 5, Panel B tests for differential effects between financial deficit and surplus firms. The indicator variable *DEV*NegFCF* is positive and significant at the 1% level for all three models indicating that firms with financial deficit adjust towards the target faster than firms with financial surplus. For the main specification, CH-SOA for financial surplus firms is equal to 0.34 in contrast to 0.53 for financial deficit firms, which translates to a half-life of 1.67 years and 0.91 year accordingly. The documented higher CH-SOA financial deficit firms compared to financial surplus firms is opposite to the findings in Faulkender, Flannery, Hankins, and Smith (2012) for leverage SOA.

Next, we examine how the combination of sign and size of FCF affect CH-SOA. The results in Table 5, Panel C show that for firms with financial surplus the relationship still holds for all three cash holdings target proxies, while for firms with financial deficit the results indicate virtually no effect of financial deficit size on CH-SOA. The difference between CH-SOA for firms with small and large financial deficits is insignificant for the fitted and moving average models. For the industry average model the difference is significant at the 5% level, however economic significance appears to be small. It appears that firms with financial deficit adjust towards the target faster than firms with financial surplus, but there is almost no difference between firms with large financial deficit and firms with a small financial deficit.

The result that larger positive free cash flow leads to higher CH-SOA supports the argument that adjustment costs are an important determinant of CH-SOA. Higher positive free cash flow reduces adjustment costs by providing an opportunity to adjust cash towards the target without raising costly external financing, leading to higher CH-SOA. On the other hand, when firms experience negative free cash flow, excess cash can be used to close the financial deficit, which leads to higher CH-SOA for firms with negative free cash flow compared to firms with financial surplus. We test this suggested explanation in the next section.

4.3.2.2 Combination of FCF and cash holdings deviation effect on CH-SOA (H2d)

We next examine the sensitivity of CH-SOA to various combinations of free cash flow and cash deficit or surplus. We calculate CH-SOA for four different groups of firms: firms with financial surplus and cash holdings below target; firms with financial surplus and cash holdings above target; firms with financial deficit and cash holdings below target; and, firms with financial deficit and cash holdings above target.

[Insert table 6 here]

Table 6 presents the results for the three target proxies. The results are consistent across all proxies, therefore, we focus our discussion on the estimates from the fitted regression model. The highest CH-SOA is observed for firms with a financial deficit and excess cash holdings (CH- SOA=0.68), followed by firms with a financial surplus and excess cash (CH- SOA=0.48) Additionally, cash deficit firms adjust much slower towards the target with the subset of financial deficit firms adjusting somewhat faster (CH-SOA=0.20) than the subset of firms with a financial surplus (CH-SOA=0.02).

From the results it appears that firms use their excess cash to cover their financial deficit, which leads to faster adjustment towards target. It could be argued that the use of cash to close the financial deficit is consistent with the financial hierarchy theory. However, financial theory also predicts that firms would increase their cash holdings with financial surpluses, which is not supported by our findings in as much as we find that cash deficit firms with financial surplus have a very low CH-SOA of 0.02. Even though the financial deficit effect on the cash holdings (and leverage) behavior is traditionally interpreted within a financial hierarchy framework, it can also be considered an “adjustment cost” factor in the dynamic trade-off theory framework. But the “adjustment cost” framework also does not explain completely why firms only partially close their cash deviation gap when they have a positive cash flow. One potential explanation is that the size of cash flow is not large enough to close the cash deviation completely.

Based on the above results, overall CH-SOA is relatively high at 0.54, implying that on average firms close over half of their deviation from target in one year. Such a high value for SOA is higher than any documented speed of adjustment observed for leverage. A high SOA is evidence that firms do have a target level of cash holdings and regularly adjust towards it. However, given that the estimated SOA value is less than 1.00, the evidence is consistent with the dynamic rather than the static version of the trade-off theory of cash holdings. Further investigation shows that the SOA varies significantly for the firms with different characteristics. For example, firms with a cash deficit have a CH-SOA of 0.17, while firms with excess cash adjust towards their target with SOA of 0.65. This can be explained by higher adjustment costs (financial constraints and the costs of external financing) when the firm is below target compared to the firms with excess cash. Also, the results of the test for the whole sample show that an increase in deviation from target is associated with a higher CH-SOA, supporting the notion that the cost of non-adjustment increases as firms move away from the target level. The results are particularly pronounced for firms with a financial surplus. One of the potential explanations as to why higher levels of excess cash leads to higher CH-SOA is that the excess cash is being accumulated to be spent to close the financial deficit.

We find that for all three target proxies, CH-SOA of the firms with financial deficit is higher than for the firms with financial surplus. When we include the deviation from target into the analysis, we find that firms with financial deficit and excess cash holdings have the highest SOA, followed by firms with financial surplus and excess cash. Cash deficient firms adjust towards target with relatively slow speed, and the firms with financial deficit adjust faster than the firms with financial surplus. From the results it appears that firms use their excess cash to cover their financial deficit, which leads to faster adjustment towards target. This supports the idea that low adjustment costs lead to higher speed of adjustment. For cash deficient firms, the combination of being low on cash and the need for funds to finance investment opportunities most likely results in the trip to capital market to address both concerns.

It could be argued that the above result that firms use cash to close their financial deficit is consistent with financial hierarchy theory. However, another part of the prediction based on such a hypothesis is that firms would increase their cash holdings with financial surpluses, is not supported by our findings. Our results indicate that firms are able to only partially close their cash deficit with positive free cash flow. One explanation of why firms are not closing the cash deficit with internal cash flow is firms need to adjust leverage. Since previous studies document that firms use their free cash flows to adjust their leverage towards target (e.g. Byoun, 2008; Faulkender et al., 2012), it is conceivable that firms try to distribute their internal funds between adjusting capital structure and cash holdings towards their respective targets. Whether this is the case will depend upon further examination of the relationship between leverage and cash holdings SOA, which we leave to future research.

We also find that, on average, large and, particularly, rated firms have lower speed of adjustment than non-rated firms. This finding is consistent with Dittmar and Duchin (2011), who show that older firms have slower CH-SOA. Since non-rated firms are considered constrained in their ability to raise external funds, it makes it particularly dangerous for such firms to deviate away from the target, leading to an increase in speed with which firms try to adjust their cash holdings towards target. This supports the idea that the adjustment cost and cost of non-adjustment is an important determinant of CH-SOA.

Overall, the discussed results demonstrate the importance to account for heterogeneity of the CH-SOA. This study provides more detailed analysis of several factors that contribute to heterogeneity of CH-SOA.

4. Conclusion

This study extends the recent work that highlights the importance of accounting for heterogeneity of the speed of adjustment of cash holdings (CH-SOA). Given that previous literature on CH-SOA is very limited and offer conflicting results, we use multiple cash holding target proxies and recently developed methodology to test for differences in CH-SOA for various subsamples of firms. While some of the results have been reported elsewhere, these have been done on a piecemeal basis and over different samples and periods.

Based on the results of the study, overall CH-SOA is relatively high at 0.54, implying that on average firms close over half of their deviation from target in one year. This is higher than any documented for leverage SOA. A high SOA is traditionally interpreted as evidence that firms do have a target level of cash holdings and regularly adjust towards it, thereby supporting the trade-off theory of cash holdings. Since the SOA value is less than 1.00, the dynamic rather than the static trade-off model is better supported by our evidence.

Further investigation shows that SOA varies significantly for the firms with different characteristics. Firms with cash deficit have slower CH-SOA compared to firms with excess cash, and firms that have more excess cash adjust towards the target faster. Larger and, particularly, rated firms, have slower CH-SOA. Larger free cash flow (in absolute terms) leads to faster adjustment towards target. Also, the results indicate that CH-SOA of firms with financial deficit is higher than for firms with financial surplus. This is opposite to what Faulkender, Flannery, Hankins, and Smith (2012) found for leverage SOA. When we include the deviation from target into our analysis, we find that the firms with financial deficit and excess cash holdings have the highest SOA, followed by the firms with financial surplus and excess cash. Cash deficient firms adjust towards target relatively slowly, and the firms with financial deficit adjust faster than the firms with financial surplus. From the results it appears that firms use their excess cash to cover their financial deficit, which leads to faster adjustment towards target. However, firms are able to only partially close their cash deficit with positive free cash flow.

In sum, we demonstrate that overall CH-SOA is high enough to justify the existence of a target cash holding, but the adjustment speed varies systematically with firm characteristics in a way that supports a dynamic version of the trade-off model where firms take into account the cost of adjustment and non-adjustment in achieving the target balance.

Appendix A.

Variable Definitions

Note: Compustat data items are given in parentheses

CapEx is capital expenditure (capx) divided by total assets (at).

Cash is cash and short-term investments (*che*) scaled by net assets, defined as *Total Assets (at)* minus *Cash (che)*

Cash* is the target value of cash holdings, it is an estimated value given the following firm characteristics at *t-1*: *market-to-book, size, cash flow, net working capital, capital expenditures, leverage, industry sigma, R&D, dividend (dummy),* and *acquisitions.*

Cash Flow is measured as earnings less interest and taxes (ib+dp), divided by total assets (at).

DEV, is deviation from target, which is the difference between current Cash and target level of cash.

DevLarge is an indicator variable equal to one if the firm's deviation from its target level of cash holdings is above median, and zero otherwise.

Dividend is an indicator variable set equal to one if firm pays dividends in specific year, and zero otherwise.

FCF **(*Free Cash Flow*)** is defined as operating income before depreciation (oibdp) minus tax (tlcf) and interest expense (xint), all scaled by lagged value of total assets (at), minus *industry capital expenditure*.

AbsFCFLarge is an indicator variable equal to one if the firm's absolute value of free cash flow is above median, and zero otherwise.

NegFCF is an indicator variable equal to one if the firm has a negative free cash flow, and zero otherwise.

ForeignTax equal to one if the firm pays any foreign taxes and zero otherwise.

Industry cash flow volatility is the 5-year rolling window median volatility of cash flow/assets across industries (based on Fama-French (1997) industry classification).

Industry Capital Expenditure is the mean value of capital expenditures (*capex*) in year *t* (deflated by lagged book assets (*at*)) for all Compustat firms in firm *i's* Fama and French (1997) industry.

Industry Median Leverage is median debt ratio for the firm's Fama and French (1997) industry.

Leverage is short-term debt (dlc) plus long-term debt (dltt), divided by total assets (at).

Market to book is the market value of assets, defined as total assets (at) minus book equity (ceq) plus market value of equity (csho*prcc), divided by total assets (at).

NegDEV is an indicator variable equal to one if the firm is below its target level of cash holdings, and zero otherwise.

Net Working Capital is net working capital (wcap) excluding cash (che), divided by total assets (at).

Rated is an indicator variable that set equal to one if the firm has a debt rating (in the Compustat database), and zero otherwise.

R&D is research and development expense (xrd) divided by sales (sale). Missing values are set to zero.

Size is the natural logarithm of the book value of total assets (at).

SizeLarge is an indicator variable equal to one if the firm's size is above median, and zero otherwise.

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Table 1

Summary Statistics

This table provides summary statistics for the sample, which comprises all industrial firms in the Compustat file from 1968 to 2012, with non-missing observations on total assets and cash. *Cash* is cash and marketable securities divided by Net Total Assets. *Deviation* is the difference between current *Cash* and target level of cash. For the main specification (fitted model) target values are estimated by the BB GMM estimator (Blundell and Bond, 1998):

$$Cash_{i,t+1} = (\lambda\beta)X_{i,t} + (1-\lambda)Cash_{i,t} + \delta_{i,t+1}$$

where *Xi,t* is a vector of observable firm-specific factors that determine the firm's target level of cash holdings, β is a vector of coefficients. The determinants of target cash holdings include market-to-book, size, cash flow, net working capital, capital expenditures, leverage, industry sigma, R&D, dividend dummy, acquisitions, and a firm fixed effect. For alternative specifications the target is calculated as an industry median level of cash holdings or as firm's five-year rolling average. *FreeCF* is operating income before depreciation minus taxes minus interest paid and minus the mean value of industry capital expenditures in year t (all deflated by lagged book assets). *Industry CF volatility is* the 10-year rolling window median volatility of cash flow/total assets across 2 digit SIC industries. *Market- to-book* is the market value of assets, defined as total assets minus book equity plus market value of equity, divided by total assets. *Leverage* is short-term debt plus long-term debt, divided by total assets. *Net Working Capital* is net working capital excluding cash, divided by total assets. *CAPEX* is capital expenditure divided by total assets. Leverage is short-term debt plus long-term debt, divided by total assets.

Variables	Mean	25th percentile	Median	75th percentile	Standard Deviation
Cash	0.436	0.035	0.104	0.332	1.046
Deviation from target (main specification)	-0.027	-0.280	-0.093	0.013	0.821
Deviation from industry average	0.280	-0.056	0.000	0.187	0.995
Deviation from 5-year moving average	-0.046	-0.054	-0.003	0.018	0.469
FreeCF	-0.079	-0.121	-0.005	0.061	0.309
Size	4.679	3.344	4.595	5.926	1.937
Market-to-Book	1.935	0.980	1.364	2.174	1.691
Capex	0.077	0.020	0.046	0.091	0.110
Leverage	0.127	0.003	0.091	0.213	0.132
NWC	0.146	0.006	0.144	0.290	0.203
Industry Volatility	0.075	0.033	0.058	0.108	0.054
R&D	0.166	0.000	0.001	0.052	0.762
Dividends	0.009	0.000	0.000	0.012	0.017
Acquisitions	0.018	0.000	0.000	0.000	0.068

Table 2

Full Sample Cash holdings Speed of Adjustment

This table presents estimates of the speed of adjustment of the cash holdings. In column 1of Panel A, SOA is estimated using the BB GMM estimator (Blundell and Bond, 1998). We estimate the following model:

$Cash_{i,t+1} = (\lambda\beta)X_{i,t} + (1-\lambda)Cash_{i,t} + \delta_{i,t+1}$

where *Xi,t* is a vector of observable firm-specific factors that determine the firm's target level of cash holdings, β is a vector of coefficients, and λ is the speed of adjustment. The determinants of target cash holdings include market-to-book, size, cash flow, net working capital, capital expenditures, leverage, industry volatility, R&D, dividend (dummy), acquisition, a firm fixed effect. The full model estimates are presented in Panel A. In columns 1 and 2 of Panel B CH-SOA is estimated using the following model:

$Cash_{i,t+1} - Cash_{i,t} = \lambda(\widehat{DEV}_{i,t+1}) + \delta_{i,t+1}$

where $\widehat{DEV}_{i,t+1} = \widehat{Cash}*_{i,t+1} - Cash_{i,t}$ and Cash* is target cash holdings. The target is calculated as an industry median level of cash holdings or as firm's five-year rolling average (columns 1 and 2, respectively). The sample consists of all industrial firms in the Compustat file from 1968 to 2012, with non-missing observations on total assets and cash. The standard errors are heteroskedasticity consistent, clustered at the firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

Panel A. Results of BB GMM estimation of partial adjustment model

Cash lag	0.4598	***
	(0.0030)	
Size	-0.2692	***
	(0.0037)	
Tobin Q	0.0052	***
	(0.0010)	
Cash Flow	-0.1666	***
	(0.0092)	
R&D	-0.0147	**
	(0.0062)	
Capex	0.0297	*
	(0.0162)	
Leverage	0.1253	***
	(0.0165)	
Div_D	-0.0044	
	(0.0037)	
NWC	0.0003	***
	(0.0000)	
Acquisitions	0.3778	***
	(0.0106)	
Industry Volatility	0.7711	***
	(0.0430)	
Constant	1.3464	***
	(0.0184)	
Number of Obs.	125,575	

Panel B. Estimates of the CH-SOA based on two alternative target proxies

	Industry Median		5 year average	
DEV	0.4418	***	0.7642	***
	(0.0087)		(0.0115)	
R^2	0.225		0.335	
Number obs.	125,575		125,575	

Table 3

Relationship between size and sign of deviation and CH-SOA

This table presents sensitivity of CH-SOA to size and sign of deviation from target CH. The following model is estimated using ordinary least squares (OLS) regression with firm clustering:

$Cash_{i,t+1} - Cash_{i,t} = (\gamma_{0+}\gamma_{i,t+1} Z_{i,t})(\widehat{DEV}_{i,t+1}) + \delta_{i,t+1}$,

where $\widehat{DEV}_{i,t+1} = \widehat{Cash}*_{i,t+1} - Cash_{i,t}$ and Cash* is target cash holdings.

For the fitted model (column 1) target values are estimated by the BB GMM estimator (Blundell and Bond, 1998):

$Cash_{i,t+1} = (\lambda\beta)X_{i,t} + (1-\lambda)Cash_{i,t} + \delta_{i,t+1}$

where *Xi,t* is a vector of observable firm-specific factors that determine the firm's target level of cash holdings, β is a vector of coefficients. The determinants of target cash holdings include market-to-book, size, cash flow, net working capital, capital expenditures, leverage, industry volatility, R&D, dividend dummy, acquisitions, and a firm fixed effect. For alternative specifications the target is calculated as an industry median level of cash holdings (column 2) or as firm's five-year rolling average (column 3). In Panel A we test the sensitivity of SOA to sign of deviation by including an interaction term between $\widehat{DEV}_{i,t+1}$ and *NegDev* where the latter is an indicator variable that is set to one if the deviation from target is negative, and zero otherwise. In Panel B we test the sensitivity of SOA to size of deviation by including an interaction term between $\widehat{DEV}_{i,t+1}$ and *DevLarge*, where the latter is an indicator variable that is set to one if the deviation from target is above median, and zero otherwise. Panel C tests if the sensitivity of SOA to size of deviation varies across subsamples classified by the sign of the deviation by including an interaction term between $\widehat{DEV}_{i,t+1}$ *NegDev (PosDev)* and *DevLarge*. The sample consists of all industrial firms in the Compustat file from 1968 to 2012, with non-missing observations on total assets and cash. The standard errors are heteroskedasticity consistent, clustered at the firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

Panel A. Effect of Sign of Deviation from Target on CH-SOA

	Fitted Model		Industry Median		5 year average	
DEV	0.6452	***	0.4860	***	0.9464	***
	(0.0138)		(0.0033)		(0.0039)	
DEV*NegDEV	-0.4791	***	-0.3541	***	-0.2356	***
	(0.0180)		(0.0119)		(0.0028)	
R^2	0.245		0.264		0.332	
Number obs.	125,575		125,575		125,575	

Panel B. Effect of Size of Deviation from Target on CH-SOA

	Fitted Model		Industry Median		5 year average	
DEV	0.4102	***	0.2047	***	0.7925	***
	(0.0090)		(0.0117)		(0.0227)	
DEV*DEVLarge	0.2292	***	0.2596	***	0.0426	***
	(0.0086)		(0.0133)		(0.0038)	
R^2	0.244		0.232		0.291	
Number obs.	125,575		125,575		125,575	

Panel C. Effect of Size and Sign of Deviation from Target on CH-SOA

	Fitted Model		Industry Median		5 year average	
DEV	0.3943	***	0.3662	***	0.8186	***
	(0.0280)		(0.0083)		(0.0787)	
DEV*NegDEV	-0.3115	***	-0.4284	***	-0.1568	***
	(0.0335)		(0.0199)		(0.0047)	
DEV*PosDEV*DEVLarge	0.2588	***	0.1095	***	0.1435	***
	(0.0309)		(0.0149)		(0.0166)	
DEV*NegDEV*DEVLarge	0.1095	***	0.0333	***	-0.0051	*
	(0.0149)		(0.0043)		(0.0029)	
R 2	0.246		0.232		0.296	
Number obs.	125,575		125,575		125,575	

Table 4

Access to External Capital effect on CH-SOA

This table presents sensitivity of CH-SOA to access to external capital. The following model is estimated using ordinary least squares (OLS) regression with firm clustering:
$Cash_{i,t+1} - Cash_{i,t} = (\gamma_0 + \gamma_{i,t+1} Z_{i,t})(\widehat{DEV}_{i,t+1}) + \delta_{i,t+1}$,
where $\widehat{DEV}_{i,t+1} = \widehat{Cash}*_{i,t+1} - Cash_{i,t}$ and Cash* is target cash holdings.
For the fitted model (column 1) target values are estimated by the BB GMM estimator (Blundell and Bond, 1998):
$Cash_{i,t+1} = (\lambda\beta)X_{i,t} + (1-\lambda)Cash_{i,t} + \delta_{i,t+1}$
where *Xi,t* is a vector of observable firm-specific factors that determine the firm's target level of cash holdings, β is a vector of coefficients. The determinants of target cash holdings include market-to-book, size, cash flow, net working capital, capital expenditures, leverage, industry volatility, R&D, dividend dummy, acquisitions, and a firm fixed effect. For alternative specifications the target is calculated as an industry median level of cash holdings (column 2) or as firm's five-year rolling average (column 3). In Panel A we test the sensitivity of SOA to access to external capital using firm size as a proxy for access to external capital. Specifically, we include an interaction term between $\widehat{DEV}_{i,t+1}$ and *SizeLarge* where the latter is an indicator variable that is set to one if the firm size is greater than the median for the sample, and zero otherwise. In Panel B we test the sensitivity of SOA to access to external capital using the presence of rated debt as a proxy for access to external capital. Specifically, we include an interaction term between $\widehat{DEV}_{i,t+1}$ and *Rated,* where the latter is an indicator variable that is set to one if the firm has rated debt, and zero otherwise. The indicator variable *Rated* equals to one if a firm have a debt rating, and zero otherwise. The sample consists of all industrial firms in the Compustat file from 1968 to 2012, with non-missing observations on total assets and cash. For panel B sample is limited to 1986 to 2012 due to data availability. The standard errors are heteroskedasticity consistent, clustered at the firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

Panel A. Firm size effect on CH-SOA

	Fitted Model		Industry Median		5 year average	
DEV	0.6019	***	0.5967	***	0.9357	***
	(0.0229)		(0.0202)		(0.0278)	
DEV*SizeLarge	-0.0287	***	-0.0432	***	-0.0232	***
	(0.0054)		(0.0048)		(0.0064)	
R^2	0.217		0.230		0.525	
Number obs.	125,575		125,575		125,575	

Panel B. Firm debt rating effect on CH-SOA

	Fitted Model		Industry Median		5 year average	
DEV	0.5059	***	0.4509	***	0.8847	***
	(0.0108)		(0.0082)		(0.0138)	
DEV*Rated	-0.3668	***	-0.3471	***	-0.2381	***
	(0.0339)		(0.0452)		(0.0462)	
R^2	0.217		0.227		0.548	
Number obs.	76,410		76,410		76,410	

Table 5

Effect of size and sign of Free Cash Flow on CH-SOA

This table presents sensitivity of CH-SOA to absolute size and sign of free cash flow. The following model is estimated using ordinary least squares (OLS) regression with firm clustering:

$Cash_{i,t+1} - Cash_{i,t} = (\gamma_0 + \gamma_{i,t+1} Z_{i,t})(\widehat{DEV}_{i,t+1}) + \delta_{i,t+1}$,

where $\widehat{DEV}_{i,t+1} = \widehat{Cash}*_{i,t+1} - Cash_{i,t}$ and Cash* is target cash holdings.

For the fitted model (column 1) target values are estimated by the BB GMM estimator (Blundell and Bond, 1998):

$Cash_{i,t+1} = (\lambda\beta)X_{i,t} + (1-\lambda)Cash_{i,t} + \delta_{i,t+1}$

where *Xi,t* is a vector of observable firm-specific factors that determine the firm's target level of cash holdings, β is a vector of coefficients. The determinants of target cash holdings include market-to-book, size, cash flow, net working capital, capital expenditures, leverage, industry volatility, R&D, dividend dummy, acquisitions, and a firm fixed effect. For alternative specifications the target is calculated as an industry median level of cash holdings (column 2) or as firm's five-year rolling average (column 3). In Panel A we test the sensitivity of SOA to the absolute size of FCF by interacting $\widehat{DEV}_{i,t+1}$ and *AbsFCFLarge* where the latter is an indicator variable that is set to one if the firm's absolute value of FCF is greater than the median for the sample, and zero otherwise. In Panel B we test the sensitivity of SOA to the sign of FCF by interacting $\widehat{DEV}_{i,t+1}$ and *NegFCF* where the latter is an indicator variable that is set to one if the free cash flow is negative, and zero otherwise. Panel C tests if the sensitivity of SOA to size of the FCF varies depending whether the firm experiences a financial deficit or surplus (positive or negative FCF). The test is conducted by interacting $\widehat{DEV}_{i,t+1}$, *NegFCF(PosFCF)* and *AbsFCFLarge* variables. *PosFCF* is an indicator variable that is set to one if the free cash flow is positive, and zero otherwise. The sample consists of all industrial firms in the Compustat file from 1968 to 2012, with non-missing observations on total assets and cash. The standard errors are heteroskedasticity consistent, clustered at the firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

Panel A. Size of Free Cash Flow effect on CH-SOA

	Fitted Model		Industry Median		5 year average	
DEV	0.4300	***	0.3813	***	0.6619	***
	(0.0128)		(0.0108)		(0.0154)	
DEV*AbsFCFLarge	0.1803	***	0.1388	***	0.2319	***
	(0.0239)		(0.0169)		(0.0263)	
R^2	0.220		0.230		0.259	
Number obs.	125,575		125,575		125,575	

Panel B. Sign of Free Cash Flow Effect on CH-SOA

	Fitted Model		Industry Median		5 year average	
DEV	0.3449	***	0.3233	***	0.7396	***
	(0.0177)		(0.0167)		(0.0314)	
DEV*NegFCF	0.1880	***	0.1377	***	0.1711	***
	(0.0205)		(0.0187)		(0.0341)	
R^2	0.219		0.228		0.550	
Number obs.	125,575		125,575		125,575	

Panel C. Sign and size of Free Cash flow effect on CH-SOA

	Fitted Model		Industry Median		5 year average	
DEV	0.2457	***	0.2331	***	0.6085	***
	(0.0202)		(0.0200)		(0.0365)	
DEV*NegFCF	0.2674	***	0.2800	***	0.1531	***
	(0.0322)		(0.0304)		(0.0384)	
DEV*NegFCF*FCFLarge	0.0231		-0.0601	**	0.0214	
	(0.0297)		(0.0265)		(0.0505)	
DEV*PosFCF*FCFLarge	0.1806	***	0.1588	***	0.2494	***
	(0.0325)		(0.0313)		(0.0484)	
R 2	0.220		0.229		0.255	
Number obs.	125,575		125,575		125,575	

Table 6

Effect of Free Cash Flow Surplus and Deficits on CH-SOA for subsamples classified by deviation from target.

The table presents sensitivity of SOA to surplus and deficit free cash flow firms classified by deviation from CH target. The following model is estimated using ordinary least squares (OLS) regression with firm clustering:

$Cash_{i,t+1} - Cash_{i,t} = (\gamma_{0+}\gamma_{i,t+1}Z_{i,t})(\widehat{DEV}_{i,t+1}) + \delta_{i,t+1}$, where

$\widehat{DEV}_{i,t+1} = \widehat{Cash}*_{i,t+1} - Cash_{i,t}$ and Cash* is target cash holdings. For the fitted model (column 1) target values are estimated by the BB GMM estimator (Blundell and Bond, 1998):

$Cash_{i,t+1} = (\lambda\beta)X_{i,t} + (1-\lambda)Cash_{i,t} + \delta_{i,t+1}$

where *Xi,t* is a vector of observable firm-specific factors that determine the firm's target level of cash holdings, β is a vector of coefficients. The determinants of target cash holdings include market-to-book, size, cash flow, net working capital, capital expenditures, leverage, industry volatility, R&D, dividend dummy, acquisitions, and a firm fixed effect. For alternative specifications the target is calculated as an industry median level of cash holdings (column 2) or as firm's five-year rolling average (column 3). We test the sensitivity of SOA to the sign of FCF and deviation by interacting $\widehat{DEV}_{i,t+1}$ and *NegFCF* where the latter is an indicator variable that is set to one if the free cash flow is negative, and zero otherwise. Further we interact $\widehat{DEV}_{i,t+1}$, *NegFCF(PosFCF)* and *NegDev* variable, where *NegDev* is an indicator variable that takes a value of one if the deviation from target is negative, and zero otherwise; *PosFCF* is an indicator variable that is set to one if the free cash flow is positive, and zero otherwise. The sample consists of all industrial firms in the Compustat file from 1968 to 2012, with non-missing observations on total assets and cash. The standard errors (in brackets) are heteroskedasticity consistent, clustered at the firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

	Fitted Model		Industry Median		5 year average	
DEV	0.4822	***	0.3138	***	0.8269	***
	(0.0278)		(0.0171)		(0.0111)	
DEV*NegFCF	0.1938	***	0.1443	***	0.1783	***
	(0.0304)		(0.0190)		(0.0245)	
DEV*NegFCF*NegDev	-0.4808	***	-0.2295	***	-0.1923	***
	(0.0195)		(0.0143)		(0.0146)	
DEV*PosFCF*NegDev	-0.4570	***	-0.0392	***	-0.2819	***
	(0.0319)		(0.0121)		(0.0144)	
R 2	0.249		0.229		0.299	
Number obs.	125,575		125,575		125,575	