Abstract: Increases in the level of corporate cash holdings over the past decade and recent liquidity crisis have attracted considerable attention from the media, investors and academic researchers to the topic of cash holdings management and optimal level of cash. As in the case of capital structure, the existence of an optimal (target) level of cash holdings is central to the trade-off theory of corporate liquidity. One way to test for the existence of the optimal level of cash holdings (or leverage) is to estimate the speed of adjustment (SOA) towards target cash holdings (or leverage). Compared to the number of studies that examine leverage SOA, investigations into cash holdings SOA are relatively limited. One of the main shortfalls of the earlier SOA studies is the assumption of homogeneous speed of adjustment for all firms. This study extends the recent work that highlights the importance of accounting for heterogeneity of the speed of adjustment of cash holdings (CH-SOA) by examining how factors such as the sign and size of deviation from the target, the sign and size of free cash flow and leverage affect CH-SOA. The results indicate that firms with cash deficits have slower CH-SOA compared to the firms with excess cash, and firms that have more excess cash adjust towards their target level of cash holdings faster. Larger free cash flow (in absolute terms) leads to faster adjustment towards target. Surprisingly, firms with financial surplus adjust slower than firms with financial deficit. Also, larger and, particularly, rated firms have slower CH-SOA. Overall, the 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 target.
1. Motivation and contribution

Increases in the level of corporate cash holdings over the past decade have attracted considerable attention from media, investors and academic researchers. Bates et al., 2009, 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 the 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 holding.

In a world of perfect capital markets the level and the dynamics of cash holdings is irrelevant (Opler et al., 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. Following Opler et al. (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. As in the case of capital structure, the existence of optimal (target) level of cash holdings is central to the trade-off theory of corporate liquidity. One way to test for the existence of the optimal level of leverage (or cash holdings) is to estimate the speed of adjustment (SOA) towards target leverage (or cash holdings). Compared to the number of studies that examine leverage SOA, investigations into cash holdings SOA are relatively limited.

One of the main shortfalls of the earlier SOA studies is the assumption of homogeneous speed of adjustment for all firms. This study extends the recent work that highlights the importance of
accounting for heterogeneity of the speed of adjustment of cash holdings (CH-SOA). The specific factors I examine are as follows. First, I examine how the sign and size of deviation from the target affects CH-SOA. Second, building on the literature that examine the “cash flow sensitivity of cash” (e.g., Almeida et al., 2004; Bao et al., 2012) I examine how sign and size of free cash flow affects the CH SOA.

The results indicate that firms with cash deficits have slower CH-SOA compared to the firms with excess cash, and firms that have more excess cash adjust towards target faster. Larger free cash flow (in absolute terms) leads to faster adjustment towards target. Surprisingly, firms with financial surpluses adjust slower than firms with financial deficits. Also, larger and, particularly, rated firms have slower CH-SOA. Overall, the 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 target.

2. Literature review

Opler et al. (1999) state that

“In a world of perfect capital markets, holdings of liquid assets are irrelevant. If cash flow turns out to be unexpectedly low, such that a firm has to raise funds to keep operating and to invest, it can do so at zero cost. Since there is no liquidity premium in such a world, holdings of liquid assets have no opportunity cost. Hence, if a firm borrows money and invests it in liquid assets, shareholder wealth is unchanged.”

Further, Acharya et al. (2007) observe that standard valuation models, which assume frictionless financing, often look at cash as “negative” debt. However, the presence of capital market
frictions (for example, costly external financing, informational asymmetry or agency problems) changes the notion of perfect substitutability of cash and debt, and makes cash holdings assume a separate role in the financial management of a firm (e.g., Opler et al., 1999; Almeida et al., 2004; Acharya et al., 2007).

Research on corporate cash holdings have used the theories originally developed for capital structure, such as trade-off, agency, financial hierarchy, and market timing to explain corporate liquidity (e.g. Opler et al., 1999; Venkiteshwaran, 2011; Dittmar and Duchin, 2011). Similar to the capital structure literature, the research on cash holdings provides evidence that elements of different theories account for the cash management behavior of the firms (e.g., Opler et al., 1999; Dittmar and Duchin, 2011). The speed of adjustment methodology is one of the main approaches used to test trade-off theory in the capital structure and cash holdings literature. Recent developments in this area include studies that focus on the factors that cause firms to adjust their leverage and cash holdings at different speeds.

This section elaborates on the literature on cash holdings. For ease of presentation the literature review is broken into several sections. The first section summarizes the main theoretical frameworks that have been used to examine corporate cash holdings and the related empirical evidence. This is followed by the section on cash holdings speed of adjustment, which is the main focus of this study. The final section is devoted to the discussion of a number of factors that can lead to the heterogeneity of cash holdings SOA.

2.1. Theories of the Corporate Cash Holdings and Related Evidence

Opler et al. (1999) extend the theories of capital structure, such as trade-off, agency, and financial hierarchy to corporate cash holdings. Thus, many studies on corporate cash holdings
interpret their findings in the framework of one (or several) of such theories. (e.g. Opler et al., 1999; Venkiteshwaran, 2011; Dittmar and Duchin, 2011).

In the trade-off theory framework, managers of a firm balance the cost and benefits of holding cash to determine an optimal level of cash that should be maintained in order to maximize shareholders’ wealth. The Transaction motive (developed in Keynes, 1936; Baumol, 1952; Kim et al., 1998) and the precautionary motive of holding cash (developed in Opler et al., 1999; Almeida et al., 2004; Riddick and Whited, 2009 among others) are usually considered within the trade-off framework of cash holdings.

Initial versions of the trade-off model were based on static framework; more recently, the dynamic version has gained favor. As with trade-off theory of capital structure, one of the main distinctions between static and dynamic trade-off theory, is that static trade-off theory assumes immediate adjustment towards target of cash holdings, while dynamic trade-off theory recognizes that due to various market frictions and adjustment costs, the immediate full adjustment is not always possible and adjusting towards target takes time.

Central to the trade-off model is the existence of an optimal or target cash balance. The target level of cash holdings is often proxied by the fitted values of the model developed in Opler et al. (1999) and Bates et al. (2009). 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 association with cash holdings. These findings have been supported, among others, by Dittmar et al. (2003) using an international dataset. Bates at 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 cash flow volatility increase is one of the main reasons behind the dramatic cash holdings increase in the recent years.

The *agency* theory (developed in Jensen and Meckling, 1976; Jensen, 1986; 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 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 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.

Similar to capital structure literature, the research on cash holdings provides evidence that the elements of different theories are present in the cash management behavior of the 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 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 that this could be due to an agency consideration¹, 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 (SOA)

The idea of optimal (target) leverage is central to the trade-off theory of capital structure. Empirical tests of the existence of target leverage include the analysis of financing and acquisition decisions, but estimating the speed of adjustment towards target leverage arguably is one of the most commonly used test of trade-off theory, and according to Huang and Ritter (2009) is “perhaps the most important issue in capital structure research today.” In the trade-off models with frictions framework the SOA represents the trade-off between adjustment costs and deviation from the target. Modern capital structure literature, which supports the trade-off theory,

¹ 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.”)
recognizes that even if firms have a target leverage, they do not adjust continuously due to adjustment costs (e.g., Flannery and Rangan, 2006; Lemmon et al., 2008; Faulkender et al., 2012). Early studies of leverage SOA focused simply on the overall speed of adjustment; recent studies elaborate on the heterogeneity of SOA conditioned on a number of factors such as adjustment costs (Faulkender et al., 2012), degree and sign of deviation from target (Byoun, 2008), and firm specific characteristics (John et al., 2011).

The topic of target adjustment of cash holdings is considerably less developed compared to the literature on leverage SOA. Opler et al., (1999) was one of the first studies to estimate a partial adjustment model for cash holdings. Guney et al.(2003), Venkiteshwaran (2011), and Dittmar and Duchin (2010, 2011) present further evidence of firms adjusting their cash holdings to the target level. Guney et al. (2003) show that CH-SOA differs for different countries (higher for the UK than for Japan, France and Germany). Dittmar and Duchin (2011) point out that the SOA to target cash holdings varies with the econometric technique, however, all estimators that the authors use are consistent in showing that SOA is higher for younger firms and is decreasing with firm’s age. In the earlier unpublished version of their paper Dittmar and Duchin (2010) provide evidence that adjustment costs play an important role in cash flow adjustment. The results of their test show that such factors as direction of deviation from target CH, access to bank lines of credit, size of the free cash flow, and quality of corporate governance have an impact on the speed with which firms adjust their CH towards target. Venkiteshwaran (2011) presents evidence consistent with tradeoff theory predictions for cash holdings, showing that, on average, manufacturing firms close the deviation gap within two years. However, the speed of

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2 Dittmar and Duchin (2011) show that similar to the estimates of leverage SOA, the estimates of cash holdings SOA vary significantly with econometric technique used. Thus, the OLS estimates produce average cash holdings SOA of 0.28, the fixed effects model with an average of 0.46, and GMM estimator results in an average of 0.38.
adjustment for the firms with an excess level of cash is slower than for the firms that are below their optimal level of cash holdings.

The above findings indicate the presence of heterogeneity in CH-SOA.\(^3\) In the next paragraph I further focus on the heterogeneity of SOA, summarize the development and findings in this area, discuss a number of areas where previous research had inconclusive results, and highlight the gaps in the literature.

\textbf{2.3. Factors that Affect Cash Holdings SOA Heterogeneity}

\textit{2.3.1. SOA and Deviation from Target}

Dittmar and Duchin (2010) find that firms with excess cash adjust towards their CH target faster than firms with a cash deficit. Their explanation is based on the difference in the adjustment costs. It is easier and cheaper to spend cash than to accumulate it.\(^4\) This is contrary to Venkiteshwaran (2011) who finds that firms with a cash deficit adjust towards the target relatively fast, while above target level of cash persists over time for the firms with excess cash. Based on this result and the finding that smaller firms adjust towards their target levels of cash holdings faster than older firms, Venkiteshwaran (2011) concludes that neither the agency, nor adjustment cost explanation for corporate cash policy is supported.

Dittmar and Duchin (2010) find that the SOA of cash is substantially higher when the firm is further away from its cash holding target. The authors argue that this finding is “consistent with the presence of fixed adjustment costs, which would make it optimal to rebalance only when

\(^3\) In fact, the assumption of homogeneous leverage SOA has been criticized as one of weaknesses of the studies on target leverage, and it is potentially a reason why some studies report relatively low overall leverage SOA. (Elsas and Florysiak (2011); Faulkender et al., 2012; John, Kim and Palia, 2012).

\(^4\) Dittmar & Duchin (2010): “The adjustment costs hypothesis would imply that SOA is asymmetrically lower below the target, as adjustment costs are higher below the target cash ratio due to financing constraints and the costs of external financing.”
sufficiently far away from the target, when the costs of being away from the target are high enough.” However, the authors do not examine the possibility that an increase in deviation size effect is potentially asymmetrical for firms with cash deficit and cash surplus. On the other hand, Venkiteshwaran (2011) reports that firms with the most excess cash have the lowest SOA. Thus, considering limited and conflicting evidence, I further examine the effect of sign and size of deviation on CH-SOA, as one of the potential determinants of the cash holdings SOA heterogeneity.

2.3.2. CH-SOA and Fund Availability

In the capital structure literature it has been shown that the availability of internal financing (cash flow) and access to external financing have significant impact on how fast firms adjust towards their target leverage (e.g., Byoun, 2008; Faulkender et al., 2012). Thus, availability of internal funds and the cost of external financing are other potential sources of heterogeneity of cash holdings speed of adjustment.

The effect of cash flow on cash (and changes in cash) has been examined by a number of the researchers (e.g., Almeida et al. (2004); Khurana et al. (2006); Riddick and Whited (2009); Bao et al. (2012)). Referred to as “firm’s propensity to save” or “cash flow sensitivity of cash”, the effect of cash flow on changes in cash holdings is treated as an indication of the presence of financial constraints.

Almeida et al. (2004) develop a model that predicts a positive sensitivity of cash to cash flow (defined as the ratio of earnings before extraordinary items and depreciation minus dividends to total assets) for constrained firms and lack of such sensitivity for non-constrained firms. Their empirical evidence support the model’s prediction that financially constrained firms invest in cash out of cash flow, while unconstrained firms do not. Khurana et al. (2006) reach a similar
conclusion by testing the Almeida et al. (2004) model in international settings. However, Riddick and Whited (2009) question the results of the above studies pointing out that the analyses failed to adjust for measurement error in $q$. Their model and empirical test yield negative sensitivity of cash to cash flow after controlling for Tobin’s $q$. In an attempt to reconcile the conflicting evidence, Bao et al. (2012) examine separately situations when a firm faces positive and negative cash flow. They document a nonlinear relationship between cash flow and cash holdings. The results of Bao et al. (2012) show that the cash flow sensitivity of cash is negative when a firm has a positive cash flow, but the relationship becomes positive when a firm faces negative cash flows.

Dittmar and Duchin (2010) test the relationship between CH-SOA and absolute value of free cash flow. They find that firms with higher (in absolute terms) free cash flow exhibit higher SOA. However, the authors do not develop the tests any further. One extension they do not consider is how the relationship is affected by the relative deviation from the target. This may be relevant given that Byoun (2008) and Faulkender et al. (2012) emphasize that the impact of the financial surplus and deficit in combination with the firm’s position relative to their leverage target plays an important role in the leverage SOA. Thus, in this study I consider how various combinations of free cash flow and deviation from target cash holdings affect firms’ CH-SOA.

Some studies have used other proxies for external financial constraints including firm’s size, age, and existence of credit rating. Venkiteshwaran (2011) finds that the smallest firms in his sample revert to a target cash holdings level much faster (SOA of 0.86), than largest firms (SOA of 0.59). Considering that size is often used as one of the proxies for financial constraints, the results support the idea that constrained firms adjust faster than unconstrained firms. This is also in line with results of Dittmar and Duchin (2011), who show that younger firms, which on
average are assumed to have greater external financial constraints, adjust towards the target level significantly faster than older firms. Thus, the empirical evidence suggests that constrained firms adjust towards their target cash holdings faster, despite the fact that external financing is more costly to these firms.

3. Factors that can have an impact on CH-SOA – Hypothesis Development

3.1. Deviation from target

There are a number of reasons to suggest why firms with a level of cash holding below target and above the target adjust towards the target level at different speeds.

In the dynamic tradeoff framework the adjustment towards target will happen when the cost of non-adjustment exceeds the cost of adjustment. Considering the fact that low liquidity levels can at the extreme lead to bankruptcy, the cost of non-adjustment becomes higher for firms with a cash deficit, than for firms with excess cash (for the same size deviation). Thus, even if the cost of adjusting towards target is more costly for the cash deficient firms, they might have stronger a incentive to move towards the target, as the cost of not adjusting increase faster. While the cost of non-adjustment is lower for the firms with excess cash, even though the cost of adjustment is relatively also low, it will take longer before cost of non-adjustment will exceed the adjustment costs. Thus, the size of deviation and interaction between size and sign of deviation is important to consider, as it is another potential reason for heterogeneity in the speed of adjustment.

Previous empirical evidence, discussed in the preceding section, on the relation between CH-SOA and cash deviation below and above the target level of cash holdings and the size of deviation by Dittmar and Duchin (2010) and Venkiteshwaran (2011) yield opposite results.  

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5 It should be noted that Dittmar & Duchin (2010) and Venkiteshwaran (2011) studies vary in sample composition, time period and econometric technics used.
Thus, considering limited and conflicting amount of evidence I further examine the effect of sign and size of deviation on CH-SOA. The specific hypotheses I investigate are:

H1a: Firms adjusts to CH target faster if the deviation is larger.
H1b: Firm adjusts to CH target faster when they are below CH target compared to when they are above CH target.

3.2. Funds Availability

It has been shown in the leverage SOA literature that adjustment costs impact SOA heterogeneity. When firms face financial surplus (positive free cash flow) or financial deficit (negative free cash flow), this provides them with the opportunity to adjust leverage towards target with low (marginal) transaction costs (Byoun, 2008; Faulkender et al., 2012). But adjustment costs may be different for surpluses and deficits leading to different SOAs. Also, when external financing is required, difference in the cost of external financing can potentially lead to the difference in the adjustment speeds. (Faulkender et al., 2012)

3.2.1. Cash Holdings and Free Cash Flow

3.2.1.1. Effect of size and sign of free cash flow and cash holdings deviation on cash holding SOA, examined separately

Faulkender et al. (2012) show that firms with larger absolute free cash flow adjust to their leverage target faster. The explanation behind this finding is that having internal funds allows the firm to adjust leverage with lower cost while a large negative free cash flow causes the firm to raise external funds to fund the investment, thus making simultaneous leverage adjustment less costly. To a certain extent similar logic can be applied to cash holdings. 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 et al., 1999; Almeida, et al., 2004; Khurana et al., 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. Dittmar and Duchin (2010) test the relationship between CH-SOA and absolute value of free cash flow. They find that firms with higher absolute free cash flow exhibit higher CH-SOA. However, the authors do not develop the tests any further. In the leverage SOA literature, Byoun (2008) and Faulkender et al. (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. A similar effect may hold for CH-SOA.

I first test for the effect of the absolute size of free cash flow on CH-SOA. I expect to confirm Dittmar and Duchin (2010) findings that a larger absolute free cash flow is associated with higher CH-SOA.

*Test for size of financial CF in absolute terms*

H2a: SOA is higher for firms with high absolute free cash flow.

Byoun (2008) shows that the sign of financial cash flow has a significant impact on how firms adjust their capital structure. He shows that excess free cash flow leads to faster leverage SOA. Analogously, availability of internal funds should lead to a faster adjustment of cash holdings towards target.

*Test for CF Surplus vs. Deficit*

H2b: SOA is higher for the firms with positive free cash flow than with negative free cash flow.
However, Byoun (2008) also shows that it is important to consider the interaction between sign of the free cash flow and firm’s leverage position relative to target in assessing leverage SOA. I consider a similar interaction effect in the case of CH-SOA, which I address in the next section.

3.2.1.2. Interaction between sign of free cash flow and cash holdings deviation from target

If adjustment costs are important, then when firms’ cash holding deviation and free cash flow have opposite signs, I would expect faster adjustment than when the signs coincide. In other words, firms with positive free cash flow and a below-target level of cash holdings and firms with negative free cash flow and excess cash will adjust towards their cash target faster than firms with positive free cash flow and excess CH and negative free cash flow and below-target cash holdings. This is because when signs are opposite, the positive free cash flow can be used to build up cash to its target level, or in case of negative free cash flow, the excess cash can be used to reduce the funds deficit, minimizing the need for the company to access the external financial markets. If the signs coincide, it implies a potential trip to the capital markets, either to raise financing necessary to close the financial deficit and bring the CH towards target or distribute extra cash to investors, thus leading to a slower CH-SOA. In my analysis I look at how the combination of cash holdings deviation sign and free cash flow sign affects CH-SOA.

3.2.2. Differences in cost of external financing

The discussion in section 3.2.1 concentrated on the differences in adjustment costs for internal vs. external financing. 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. Almeida et al. (2004) and Acharya et al. (2007) show that only constrained firms have the propensity to save cash out of cash flows. Thus, I would expect that CH-SOA for constrained firms will be higher for non-constrained firms. I test the difference in the CH-SOA for
financially constrained vs. non-constrained firms using size, access to commercial paper market and debt market as proxies for existence of financial constraints.

H2e: Cash holdings SOA of financially constrained firms is higher than cash holdings SOA of non-constrained firms.

4. Methodology, Variables and Data

4.1. 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):

\[ \text{Cash}_{i,t+1} - \text{Cash}_{i,t} = \lambda (\text{Cash}^*_{i,t+1} - \text{Cash}_{i,t}) + \delta_{i,t+1} \]  
(1)

Where

\( \text{Cash}^* \) is the firm’s target ratio,

\( \lambda \) is the adjustment speed towards target, i.e., SOA\(^7\)

\( \delta \) is the error term

\( \text{Cash} \) and \( \text{Cash}^* \) are scaled by Net Assets defined as Total Assets minus Cash. Often the target level of cash holdings can be estimated as

\[ \text{Cash}^*_i = \beta X_i + FE_i \]  
(2)

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\(^6\) Examples of the studies that employed partial adjustment model to estimate leverage SOA include Fama and French, 2002; Flannery and Rangan, 2006; Lemmon et al., 2008; Faulkender et al., 2012; Oztekin & Flannery, 2012; Flannery and Hankins, 2013

\(^7\) The \( \lambda \) 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 \( 1-\lambda \). SOA, \( \lambda \), 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 \( \log(0.5)/\log(1-\text{SOA}) \). Thus, for example, an SOA estimate equal to 0.4 means that a typical firm closes 40% of its gap between its current level of cash holdings and target in one year, and it takes 1.36 years 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 central concept of the trade-off theory.
Where $X_t$ is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings,

$\beta$ is a vector of coefficients, and

$FE_t$ is the firm fixed effect.

Following Opler et al. (1999) and Bates at al. (2009), 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), acquisition. Cash Flow is measured as earnings less interest and taxes divided by total assets. Industry cash flow volatility is the 10-year rolling window median volatility of cash flow/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. 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. Missing values are 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.

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

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

(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 et al., 2012; Oztekin and Flannery, 2012). Second approach (separate estimation of the target) is more suitable for the purposes of this study. For most of my hypotheses I need to compare the CH-
SOA for different subsamples. Simply splitting the sample into several subsamples and estimating Eq. (3) for each one will produce misleading results. This is because, as noted by Faulkender et al. (2012), multiple estimation of Eq. (3) for different subsamples would fail to impose a consistent model of target cash holdings across the specifications. Also, I employ alternative proxies for target leverage, discussed below, which have to be estimated separately. Thus, for my main specification I am using 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 $\beta$s and $\lambda$, which are used to calculated the target level of cash holdings and the deviation from the target for each firm-year.

$$DEV_{it+1} = Cash_{it} - Cash_{it}$$ \hspace{2cm} (4)

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

$$Cash_{it+1} - Cash_{it} = \lambda_{it+1} (DEV_{it}) + \delta_{it+1}$$ \hspace{2cm} (5)

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

$$\lambda_{it+1} = \gamma_0 + \gamma_{it+1}Z_{it}$$ \hspace{2cm} (6)

Substituting Eq. (6) into Eq. (5) yields

$$Cash_{it+1} - Cash_{it} = (\gamma_0 + \gamma_{it+1}Z_{it})(DEV_{it}) + \delta_{it+1}$$ \hspace{2cm} (7)

$Z_{it}$ includes a number of firm characteristics and factors that can potentially affect the CH-SOA.

\(^8\) 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)
I am going to use the following variables, which I interact with DEV term to examine the heterogeneity of CH-SOA:

- To test whether or not the speed of adjustment for cash holdings depend on the deviation from CH target I use a variable $DEV_{\text{large}}$, which is the absolute value of deviation from target cash holdings level. It takes on a value of one if it is above the median level of absolute deviation, and zero otherwise. I expect to see higher CH-SOA for firms with larger deviation, as I hypothesize that SOA increases as the deviation from target becomes larger.

- To test if the CH-SOA depends on whether the firm is above or below target, I use $negDEV$, which is an indicator variable equal to one if the firm is below its target level of cash holdings, and zero otherwise. I expect to see higher CH-SOA for firms with negative deviation from target as I hypothesize that firms adjust towards their target faster when they are below target compared to when they are above target, due to higher costs of non-adjustment.

- To identify the significance of the effect of free cash flow size on CH-SOA, I use $absFCF$, which is the absolute value of free cash flow, which I define, following Faulkender et al. (2012), as

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

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 similar to the traditional measure of a firm’s financial deficit.
suggested by Shyam-Sunder and Myers (1999). The original specification subtracts out the firm’s actual capital expenditures to identify firm’s external financing requirement. Instead, Faulkender et al. (2012) proxy for the firm’s investment opportunity set with $Ind\_CapEx$.  

I hypothesize that larger (in absolute terms) free cash flow leads to faster cash holdings SOA.

- To examine if SOA is different for firms with negative free cash flows and firms with positive free cash flows, I use $negCF$, which is an indicator variable set to one if a firm’s free cash flow is negative, and zero otherwise. I hypothesize that SOA is higher for the firms with a positive free cash flow than for the firms with a negative free cash flow.

- I employ the variables $SizeLarge$ and $Rated$, to test if CH-SOA is significantly different for the financially constrained versus non-constrained firms. $SizeLarge$ 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. I hypothesize that CH-SOA of financially constrained firms is higher than CH-SOA of non-constrained firms.

The expected signs on the interaction terms are summarized in Table 1.

[Insert table 1 here]

I am also going to address a concern of a proper choice of target level of cash holdings. Capital structure as well as the cash holding 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)

---

9 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 et al. (2012) p.638).
is unobservable. To address this concern I am using several proxies for target level of cash holdings, the targets are estimated prior to estimating the CH-SOA.

Choice of target proxies

As Mello and Farhat (2008) show, the capital structure literature has developed four measures of optimal (or target) leverage:

1) the predicted debt ratio based on the estimates of cross-sectional regression

2) the leverage ratio of the mean/median firm in the industry

3) firm mean, or the firm’s average over the sample period.

4) moving average based on a firms’ historical information only

Opler et al. (1999) use three different estimates of the cash holdings target:

1) average firm’s cash holdings in the previous five years;

2) target obtained each year from the fitted values of a cross-sectional regression of cash holdings on real firm size and industry volatility;

3) their main specification of cash holdings model using M/B, size, cash flow, net working capital without cash, capital expenditure, industry sigma, RnD, and leverage as main determinants of firm liquidity.

Since each of the measures of target cash holdings has both advantages and disadvantages, I am going to use industry median value and five-year rolling average in addition to the main model specification that was discussed above.
4.2. 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. I 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. I use Fama-French (1997) industry classification (48 industry classification available from K. French website). Detailed definitions of the variables used in the study are provided in Appendix A.

5. Results

5.1. Overall CH-SOA

Estimating the CH-SOA using the full sample produces the coefficient of 0.4598 (Table 2), which corresponds to the SOA of about 0.54, implying that on average firms close over half of the deviation from target in one year. This estimate is comparable with GMM results in Venkiteshwaran (2011), who reports CH-SOA of 0.57 for a sample of manufacturing firms for 1987-2007 timeframe, and somewhat higher than Dittmar and Duchin (2010), who report CH-SOA of 0.43 for a sample of all industrial firms for 1965-2006 period.

[Insert table 2 here]
Table 2 Panel B, shows the results of the regression of the cash changes on the deviation from target. The target level of cash holdings is proxied for by two alternative measures: industry median, and five-year rolling average cash holdings level. Based on the estimates on average the firms adjust towards industry median with SOA of 0.44, and towards its five-year rolling average with SOA of 0.76. All coefficients are significant at the 1% level.

Overall, based on the results and the estimates reported in the previous studies, it appears that CH-SOA is high enough to support an idea of existence of target (optimal) level of cash. Further, I investigate potential variation in CH-SOA.

**5.2. Deviation from Target**

**5.2.1. Sign of Deviation from Target**

In this section I examine whether the sign of deviation from target influences the cash holdings speed of adjustment. For the main specification I estimate Eq. (3) and use the estimates of $\beta$s and $\lambda$ to calculate the target level of cash holdings. For the alternative specifications I use the industry mean value of cash holding, or a firm’s five-year rolling average level of cash holdings as the target level of cash. Next, I subtract the $Cash_t$ from the estimated target. If a firm’s cash holdings exceed the target level, the firm has excess cash and I set $NegDev$ (negative deviation) equal to zero, if a firm has cash deficit, I set $NegDev$ equal to one.

The results presented in Table 3 show that the coefficient on the interaction variable is negative and statistically significant, indicating that there is significant difference in the CH-SOA for firms with excess cash and cash deficient firms. Based on the results presented in Table 3 the firms with excess cash adjust towards target with SOA of 0.65, while firms with cash deficit have CH-SOA of 0.17.
Further, the results in Table 3 indicate that for all three target proxies, the SOA of the firms with excess cash exceeds the CH-SOA of cash deficient firms. This result supports the finding by Dittmar and Duchin (2010), who suggest that it is easier to spend cash than to accumulate it.

5.2.2. Size of Deviation from Target

Next I examine if the size of the deviation from target has an impact on the CH-SOA. I use the interaction variable DEV*DEVLarge.

The results in table 4 indicate that the firms with small deviation adjust towards target with CH-SOA of 0.41. The interaction term DEV*DEVLarge is positive and significant, indicating that firms with larger deviation from target adjust towards target faster, CH-SOA= 0.64, calculated as the sum of DEV and DEV*DEVLarge coefficients.

For all three target proxies the CH-SOA for the group with large deviation is higher than for the group with small deviation. This supports the idea that the increased deviation from target will lead to faster SOA.

5.2.3. Combination of Sign and Size of the Deviation from Target

Next, I examine if there is an asymmetry in impact of the size of deviation on the CH-SOA for the firms with excess cash versus firms with cash deficit.
Table 5 shows the results of estimates for firms with large and small cash deficit as well as for firms with large and small cash surplus. I use deviation for all three target proxies that were discussed in the previous section. On the surplus side the results for all three target proxies consistently show that firms with larger surplus cash adjust towards target faster than firms with small positive deviation from target. On the negative side the results are less consistent, as when I proxy for target with fitted regression the results indicate that the CH-SOA is actually higher for the firms with larger deviation from target, while other two specifications show that the CH-SOA decreases as the deviation increases. Some of the inconsistency in results arises from the fact that I use median values of the deviation from each target to distinguish between small and large deviation. When I measure deviation from the predicted value of the target, the median value of the deviation is 0.16, for deviation from industry median target the median value of the deviation is 0.08 and for five-year rolling average it is 0.03. Closer examination shows that in all three cases the relationship is not linear. For very small deviations the CH-SOA is virtually indistinguishable from zero, as deviation increases the CH-SOA increase for a while, and then starts to decline. Based on the observation that firms with very small deviation from target (in both directions) have virtually zero speed of adjustment is consistent with the idea that some firms might have target range, rather than strict target. Further, as deviation increases the cash deficient firms appear to try to close the deviation from the target, in some cases exceeding the CH-SOA for the firms with excess cash, which have the same size deviation. However, as deviation from target becomes large, the CH-SOA of cash deficient firms drops, while firms with excess cash increase their CH-SOA. The discussed results further highlight that presence of and importance to account for heterogeneity in cash holding speed of adjustment. The non-linearity of relationship between CH-SOA and size of negative deviation can potentially be explained by
availability of internal funds as well as access to external financing, I examine those factors in the next section.

5.3. Access to the Capital

5.3.1. Availability of the Internal Capital

5.3.1.1 Size of FCF

To test for the effect of size of free cash flow on the CH-SOA I use the interaction variable DEV*AbsFCF, where AbsFCF is the absolute value of free cash flow. For all three cash holdings target proxies the interaction variable coefficient is positive and significant, as shown in table 6, indicating that CH-SOA is increasing as free cash flow increases in absolute terms. This is similar to the result that Faulkender et al., 2012 document for leverage SOA.

[Insert table 6 here]

In the next section I test if the sign of FCF has an effect on the CH-SOA, and I examine if the increase in FCF leads to increase in the CH-SOA for the firms with financial surplus as well as firms with financial deficit.

5.3.1.2 Sign of FCF

To test for the effect of sign of the FCF on the CH-SOA I use the interaction variable DEV*NegFCF, where NegFCF is an indicator variable, equal to one if a firm has financial deficit in the previous year, and zero otherwise. The results presented in table 7 indicate that firms with financial deficit adjust towards target faster than the firms with financial surplus.

[Insert table 7 here]
Thus, for the main specification, the CH-SOA for firms with financial surplus is equal to 0.34 and it is 0.53 for firms with financial deficit. Overall, the results in Table 7 show that for all three target proxies the CH-SOA of the firms with financial deficit is higher than for the firms with financial surplus. This is opposite to the prediction, as I expected that similar to leverage the firms will be able to adjust their cash holdings towards target faster if they have additional internal funds. To examine this issue further, I examine how the combination of sign and size of FCF affect CH-SOA, and how the combination of sign of FCF and deviation from target affect the CH-SOA.

5.3.1.3 Combination of FCF sign and size effect on the CH-SOA

Next I examine if the increase in size of free cash flow leads to the increase in speed of adjustment for firms with financial surplus, as well as financial deficit. The results in table 8 show that for firms with financial surpluses the relationship still holds for all three CH target proxies, while for firms with financial deficit the results are less conclusive.

[Insert table 8 here]

It appears that firms with financial deficits are adjusting towards target faster than firms with financial surplus, but there is almost no difference between firms with large financial deficit and firms with small financial deficit.

5.3.1.4 Combination of FCF and CH Deviation effect on the CH-SOA

Next, I consider the interaction between the sign of the free cash flow and firm’s cash holdings position relative to target and the effect of such interactions on the CH-SOA.
I calculate the CH-SOA for four different groups of firms: firms with financial surplus and are below their cash holdings target; firms with financial surplus and are above their cash holdings target; firms with financial deficit and are below their cash holdings target; firms with financial deficit and are above their cash holdings target.

[Insert table 9 here]

Table 9 presents the results for the three target proxies. In all the cases the firms with financial deficit and that are above their cash holdings target have the highest SOA, followed by the firms with financial surplus and excess cash. Cash deficient firms are adjusting 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. 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 looks like firms are able to only partially close their cash deficit with positive free cash flow.

5.3.2. Access to the External Capital

First I use size and existence of rating as a proxy for the ease of access to the external capital. I use interaction variable $DEV*Size$ to test if the speed of adjustment changes based on the firms’ size. The results in table 10 show that for all three target proxies the CH-SOA decrease with size, meaning that CH-SOA of smaller firms are higher than for larger firms. This supports previous findings by Dittmar and Duchin (2011), who show that older firms have slower speed of adjustment, as well as findings by Vinketeshwaran (2011).

[Insert table 10 here]
I also use the existence of debt rating as proxy for the ease of access to the external capital. The data availability in Compustat restricts the sample for this test to 1986-2012 period when I use rating as a proxy for access to external capital. I distinguish between rated and non-rated firms, based on the Compustat data. I set the indicator variable $\text{Rated}$ equal to one if a firm has a rating, and zero otherwise. The results support the findings in the previous tests, showing that rated firms have lower speed of adjustment than non-rated firms.

6. Conclusion

This paper examines the CH-SOA and extends the recent work that highlights the importance of accounting for heterogeneity of the speed of adjustment of cash holdings (CH-SOA). The examination of specific factors indicates that such factors as the deviation from the target, access to internal and external capital and leverage affect the CH SOA. Firms with cash deficit have slower CH-SOA compared to the firms with excess cash, and firms that have more excess cash adjust towards target faster. Larger free cash flow (in absolute terms) leads to faster adjustment towards target. Surprisingly, firms with financial surplus adjust slower than firms with financial deficit. Also, larger and, particularly, rated firms, have slower CH-SOA. Overall, the 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 target.
Appendix A: Variable Definitions

Compustat data items are given in parentheses

**Cash** is cash and short-term investments (che) scaled by Net Assets

**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), acquisition

**absDev** is the absolute value of deviation from target cash holdings level

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

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

**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 (at) minus book equity (ceq) plus market value of equity (csho*prcc), divided by total assets (at)

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

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

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

**R&D** is research and development (xrd) divided by sales (sale). Missing values are set to 0.

**Dividend** (Dummy) is defined as “1 “(one) if firm pays dividends in specific year, and “0” (zero) otherwise.

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

**Free Cash Flow** 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.
**Industry Expenditure** is the average 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

**Leverage** is the target value of leverage, it is an estimated value given the following firm characteristics at \(t-1\): income before interest and taxes \((ebit)\), market-to-book, size, depreciation and amortization \((dp)\), \(R&D\), dividend \((dummy)\), Net PPE \((ppen)\), **Industry Median Leverage**.

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

**LEVabove** is an indicator variable set to one if a firm is over-levered, and zero otherwise.

**Rated** is an indicator variable that is set to “1” (one) one if the firm has debt rating (based on Compustat database) and “0” (zero) otherwise.

**References:**


Table 1. Interaction variables, relevant hypothesis, and expected signs

<table>
<thead>
<tr>
<th>Variable of interest</th>
<th>Relevant Hypothesis</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEV*DEVLarge</td>
<td>H1a: Firms adjusts to CH target faster if the deviation is larger</td>
<td>+</td>
</tr>
<tr>
<td>DEV*negDEV</td>
<td>H1b: Firm adjusts to CH target faster, when they are below target, compared to when they are above target</td>
<td>+</td>
</tr>
<tr>
<td>DEV*absCF</td>
<td>H2a: SOA is higher for firms with high (abs value) free CF</td>
<td>+</td>
</tr>
<tr>
<td>DEV*negCF</td>
<td>H2b: SOA is higher for the firms with positive free cash flow than for the firms with negative free cash flow.</td>
<td>-</td>
</tr>
<tr>
<td>DEV<em>SizeLarge, DEV</em>Rated</td>
<td>H2c: Cash holdings SOA of financially constrained firms is higher than cash holdings SOA of non-constrained firms.</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 2. Full sample Cash holdings Speed of Adjustment

Panel A

The table presents estimates cash holdings SOA. The model estimated

\[ \text{Cash}_{i,t+1} = (\lambda \beta) \text{X}_{i,t} + (1-\lambda) \text{Cash}_{i,t} + \delta_{i,t+1} \]

where: \( \text{X} \) is a vector of control variables following the model in Bates, Kahle, and Stulz (2009), which includes industry cash flow volatility, cash flow, the market-to-book ratio, a foreign income dummy, net working capital (excluding cash), capital expenditure, debt, R&D expenditures, acquisitions, payout, and firm size. The estimator used is Blundell - Bond GMM estimator (Blundell and Bond, 1998). The sample consists of all industrial firms in the Compustat/Crsp file from 1968 to 2012, with non-missing observations on total assets and cash. The standard errors (in brackets) are heteroskedasticity consistent. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash lag</td>
<td>0.4598***</td>
</tr>
<tr>
<td></td>
<td>(0.0030)</td>
</tr>
<tr>
<td>Size</td>
<td>-0.2692***</td>
</tr>
<tr>
<td></td>
<td>(0.0037)</td>
</tr>
<tr>
<td>Tobin Q</td>
<td>0.0052***</td>
</tr>
<tr>
<td></td>
<td>(0.0010)</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>-0.1666***</td>
</tr>
<tr>
<td></td>
<td>(0.0092)</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>-0.0147**</td>
</tr>
<tr>
<td></td>
<td>(0.0062)</td>
</tr>
<tr>
<td>Capex</td>
<td>0.0297*</td>
</tr>
<tr>
<td></td>
<td>(0.0162)</td>
</tr>
<tr>
<td>Leverage</td>
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<tr>
<td></td>
<td>(0.0165)</td>
</tr>
<tr>
<td>Div_D</td>
<td>-0.0044</td>
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<tr>
<td></td>
<td>(0.0037)</td>
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<tr>
<td>Net Working Capital</td>
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<td></td>
<td>(0.0000)</td>
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<tr>
<td>Aquisitions</td>
<td>0.3778***</td>
</tr>
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<td></td>
<td>(0.0106)</td>
</tr>
<tr>
<td>Industry Volatility</td>
<td>0.7711***</td>
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<td></td>
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<tr>
<td>Constant</td>
<td>1.3464***</td>
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<tr>
<td></td>
<td>(0.0184)</td>
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<tr>
<td>Number of Obs.</td>
<td>125,575</td>
</tr>
</tbody>
</table>
**Panel B. Estimates of CH-SOA using alternative proxies for target level of cash holdings**

The table presents estimates of cash holdings SOA. The model estimated

\[ \Delta \text{Cash} = \lambda \text{DEV} + \varepsilon_{i,t}, \text{ where } \text{DEV} = (\text{Cash}^* - \text{Cash}_{i,t-1}) \]

Cash* is target cash holdings. The target is calculated as a industry median level of cash holdings or as firm's five-year rolling average. The sample consists of all industrial firms in the Compustat/Crsp file from 1968 to 2012, with non-missing observations on total assets and cash. The standard errors (in brackets) are heteroskedasticity consistent, clustered on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
<tr>
<th></th>
<th>Industry Median</th>
<th>5 year average</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH Deviation</td>
<td>0.4418 ***</td>
<td>0.7642 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0087)</td>
<td>(0.0115)</td>
</tr>
<tr>
<td>R Squre</td>
<td>0.225</td>
<td>0.335</td>
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<tr>
<td>Number obs.</td>
<td>125,575</td>
<td>125,575</td>
</tr>
</tbody>
</table>
Table 3. Estimates of CH-SOA for firms with negative and positive deviation from target

The table presents estimates cash holdings SOA. The model estimated
\[
\text{Cash}_{lt+1} - \text{Cash}_{lt} = (\gamma_0 + \gamma_l L_{lt+1}) (\text{DEV}_{lt}) + \delta_{lt+1}, \text{ where}
\]
\[
\text{DEV}_{lt+1} = \text{Cash} \ast_{lt+1} - \text{Cash}_{lt} \text{ and Cash} \ast \text{ is target cash holdings.}
\]

For fitted model target values are estimated by BB GMM estimator (Blundell and Bond, 1998) from \[
\text{Cash}_{lt+1} = (\lambda \beta) X_{lt} + \lambda FE_{lt} + (1 - \lambda) \text{Cash}_{lt} + \delta_{lt+1}
\]
where \(X_i\) is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings, \(\beta\) is a vector of coefficients, and \(FE_i\) is the firm fixed effect. 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), acquisition. For alternative specifications the target is calculated as an industry median level of cash holdings or as firm’s five-year rolling average. The indicator variable \(NegDev\) equals to one if the deviation from target is negative, 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 on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
<tr>
<th></th>
<th>Fitted Model</th>
<th>Industry Median</th>
<th>5 year average</th>
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<tbody>
<tr>
<td>DEV</td>
<td>0.6452 ***</td>
<td>0.4860 ***</td>
<td>0.9464 ***</td>
</tr>
<tr>
<td>(0.0138)</td>
<td></td>
<td>(0.0033)</td>
<td>(0.0039)</td>
</tr>
<tr>
<td>DEV*NegDEV</td>
<td>-0.4791 ***</td>
<td>-0.35414 ***</td>
<td>-0.2356 ***</td>
</tr>
<tr>
<td>(0.0180)</td>
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<td>(0.0119)</td>
<td>(0.0028)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0412 ***</td>
<td>-0.0502 ***</td>
<td>-0.0246 ***</td>
</tr>
<tr>
<td>(0.0027)</td>
<td></td>
<td>(0.0019)</td>
<td>(0.0018)</td>
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<tr>
<td>R 2</td>
<td>0.245</td>
<td>0.264</td>
<td>0.332</td>
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<tr>
<td>Number obs.</td>
<td>125,575</td>
<td>125,575</td>
<td>125,575</td>
</tr>
</tbody>
</table>
Table 4. CH-SOA and size of deviation from target

The table presents estimates cash holdings SOA. The model estimated

\[ Cash_{t+1} - Cash_{t} = (\gamma_0 + \gamma_1 Dev_{t+1} Z_{t,t}) (DEV_{t,t}) + \delta_{t+1} \]

where

\[ DEV_{t+1} = \frac{Cash^*_{t,t} - Cash_{t,t}}{Cash^*_{t,t}} \] and Cash* is target cash holdings.

For fitted model target values are estimated by BB GMM estimator (Blundell and Bond, 1998) from

\[ Cash_{t+1} = (\lambda \beta) X_{t,t} + \lambda FE_{t,t} + (1 - \lambda) Cash_{t,t} + \delta_{t+1} \]

Where \( X_i \) is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings, \( \beta \) is a vector of coefficients, and FEi is the firm fixed effect. 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), acquisition. For alternative specifications the target is calculated as an industry median level of cash holdings or as firm’s five-year rolling average. The indicator variable \( DevLarge \) equals to one if the deviation from target is above median, 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 on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
<tr>
<th>Fitted Model</th>
<th>Industry Median</th>
<th>5 year average</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEV</td>
<td>0.4102 ***</td>
<td>0.2047 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0090)</td>
<td>(0.0117)</td>
</tr>
<tr>
<td>DEV*DEVLarge</td>
<td>0.2292 ***</td>
<td>0.2596 ***</td>
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<tr>
<td></td>
<td>(0.0086)</td>
<td>(0.0133)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0292 ***</td>
<td>-0.0969 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0024)</td>
<td>(0.0023)</td>
</tr>
<tr>
<td>R 2</td>
<td>0.244</td>
<td>0.232</td>
</tr>
<tr>
<td>Number obs.</td>
<td>125,575</td>
<td>125,575</td>
</tr>
</tbody>
</table>


Table 5. Relationship between size and sign of deviation and CH-SOA

The table presents estimates cash holdings SOA. The model estimated
\[ \text{Cash}_{t+1} - \text{Cash}_{t} = (\gamma_0 + \gamma_1 \text{Z}_{t+1})(\text{DEV}_{t+1}) + \delta_{t+1} \]
where
\[ \text{DEV}_{t+1} = \text{Cash}_{t} * \text{Cash}_{t+1} \text{ and Cash}^* \text{ is target cash holdings.} \]
For fitted model target values are estimated by BB GMM estimator (Blundell and Bond, 1998) from
\[ \text{Cash}_{t+1} = (\lambda \beta)X_{t+1} + \lambda FE_{t+1} + (1 - \lambda)\text{Cash}_{t} + \delta_{t+1} \]
Where Xi is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings, \( \beta \) is a vector of coefficients, and FEi is the firm fixed effect. 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), acquisition. For alternative specifications the target is calculated as an industry median level of cash holdings or as firm's five-year rolling average. The sample is split based on the value of AbsDevLarge variable, which is an indicator variable that takes a value of one if the deviation from target is above median value, and zero otherwise, and on the value of NegDev variable, which is an indicator variable that takes a value of one if the deviation from target is negative, 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 on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
<tr>
<th></th>
<th>Below</th>
<th>Above</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large Deviation</td>
<td>Small Deviation</td>
</tr>
<tr>
<td>Fitted Reg</td>
<td>0.2135 ***</td>
<td>0.1340 ***</td>
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<tr>
<td></td>
<td>(0.0064)</td>
<td>(0.0335)</td>
</tr>
<tr>
<td>Industry Median</td>
<td>0.0448 **</td>
<td>0.4739 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0204)</td>
<td>(0.0724)</td>
</tr>
<tr>
<td>5-year average</td>
<td>0.7121 ***</td>
<td>0.8917 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0068)</td>
<td>(0.0470)</td>
</tr>
</tbody>
</table>
Table 6. CH-SOA and size of Free Cash Flow

The table presents estimates cash holdings SOA. The model estimated
\[
\begin{align*}
\text{Cash}_{t+1} - \text{Cash}_{t} &= (\gamma_0 + \gamma_1 Z_{t+1}) (\text{DEV}_{t+1}) + \delta_{t+1}, \\
\text{DEV}_{t+1} &= \text{Cash}^*_{t} - \text{Cash}_{t} \quad \text{and Cash}^* \quad \text{is target cash holdings.}
\end{align*}
\]

For fitted model target values are estimated by BB GMM estimator (Blundell & Bond, 1998) from
\[
\text{Cash}_{t+1} = (\lambda \beta)X_{t} + \lambda FE_{t} + (1 - \lambda)\text{Cash}_{t} + \delta_{t+1}
\]

Where \(X_i\) is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings, \(\beta\) is a vector of coefficients, and \(FE_i\) is the firm fixed effect. 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), acquisition. For alternative specifications the target is calculated as an industry median level of cash holdings or as firm’s five-year rolling average. The variable \(AbsFCF\) equals to the absolute value of free cash flow (financial deficit). 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 on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
<tr>
<th>Fitted Model</th>
<th>Industry Median</th>
<th>5 year average</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEV</td>
<td>0.4300 ***</td>
<td>0.3813 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0128)</td>
<td>(0.0108)</td>
</tr>
<tr>
<td>DEV*AbsFCF</td>
<td>0.1803 ***</td>
<td>0.1388 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0239)</td>
<td>(0.0169)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.0419 ***</td>
<td>-0.0803 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0023)</td>
<td>(0.0022)</td>
</tr>
<tr>
<td>R 2</td>
<td>0.220</td>
<td>0.230</td>
</tr>
<tr>
<td>Number obs.</td>
<td>125,575</td>
<td>125,575</td>
</tr>
</tbody>
</table>
Table 7. CH-SOA and sign of Free Cash Flow

The table presents estimates cash holdings SOA. The model estimated

\[ \text{Cash}_{t+1} - \text{Cash}_{t} = (\gamma_0 + \gamma_1 \text{Z}_t) (\text{DEV}_{t}) + \delta_{t+1} \],

\[ \text{DEV}_{t+1} = \text{Cash*}_{t} - \text{Cash}_{t} \text{ and Cash* is target cash holdings.} \]

For fitted model target values are estimated by BB GMM estimator (Blundell & Bond, 1998) from \n
\[ \text{Cash}_{t+1} = (\lambda \beta)X_{t} + \lambda FE_{t} + (1 - \lambda)\text{Cash}_{t} + \delta_{t+1} \]

Where \( X_i \) is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings, \( \beta \) is a vector of coefficients, and \( FE \) is the firm fixed effect. 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), acquisition. For alternative specifications the target is calculated as an industry median level of cash holdings or as firm’s five-year rolling average. The indicator variable \( \text{NegFCF} \) equals to one if the free cash flow is negative, 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 on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
<tr>
<th></th>
<th>Fitted Model</th>
<th>Industry Median</th>
<th>5 year average</th>
</tr>
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<tbody>
<tr>
<td>DEV</td>
<td>0.3449 ***</td>
<td>0.3233 ***</td>
<td>0.7396 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0177)</td>
<td>(0.0167)</td>
<td>(0.0314)</td>
</tr>
<tr>
<td>DEV*NegFCF</td>
<td>0.1880 ***</td>
<td>0.1377 ***</td>
<td>0.1711 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0205)</td>
<td>(0.0187)</td>
<td>(0.0341)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.0383 ***</td>
<td>-0.0803 ***</td>
<td>0.0097 **</td>
</tr>
<tr>
<td></td>
<td>(0.0023)</td>
<td>(0.0022)</td>
<td>(0.0008)</td>
</tr>
<tr>
<td>R 2</td>
<td>0.219</td>
<td>0.228</td>
<td>0.550</td>
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<tr>
<td>Number obs.</td>
<td>125,575</td>
<td>125,575</td>
<td>125,575</td>
</tr>
</tbody>
</table>
Table 8. Combination of Free Cash Flow sign and size effect on CH-SOA

The table presents estimates cash holdings SOA. The model estimated
\[ \text{Cash}_{t+1} - \text{Cash}_{t} = (\gamma_0 + \gamma_1 Z_{t+1}) (\text{DEV}_{t+1}) + \delta_{t+1} \]
where
\[ \text{DEV}_{t+1} = \text{Cash}^*_{t} - \text{Cash}_{t} \]
and Cash\(^*\) is target cash holdings.

For fitted model target values are estimated by BB GMM estimator (Blundell & Bond, 1998) from
\[ \text{Cash}_{t+1} = (\lambda \beta) X_{t} + \lambda FE_{t} + (1 - \lambda) \text{Cash}_{t} + \delta_{t+1} \]
where \(X_i\) is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings, \(\beta\) is a vector of coefficients, and \(FE_i\) is the firm fixed effect. 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), acquisition. For alternative specifications the target is calculated as an industry median level of cash holdings or as firm’s five-year rolling average. Sample is split based on the indicator variable \(\text{NegFCF}\), which is equal to one if the free cash flow is negative, and zero otherwise. FCFLarge is an indicator variable, which is equal to one if the free cash flow is above the median value, 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 on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
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<th>Fitted Model</th>
<th>Industry Median</th>
<th>5 year average</th>
</tr>
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<tbody>
<tr>
<td><strong>Financial Surplus</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEV</td>
<td>0.2345 ***</td>
<td>0.2129 ***</td>
<td>0.6127 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0209)</td>
<td>(0.0202)</td>
<td>(0.0467)</td>
</tr>
<tr>
<td>DEV*FCFlarge</td>
<td>0.1855 ***</td>
<td>0.1564 ***</td>
<td>0.2260 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0327)</td>
<td>(0.0317)</td>
<td>(0.0596)</td>
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<tr>
<td>Constant</td>
<td>0.0227 ***</td>
<td>-0.0324 ***</td>
<td>0.0062 **</td>
</tr>
<tr>
<td></td>
<td>(0.0027)</td>
<td>(0.0019)</td>
<td>(0.0008)</td>
</tr>
<tr>
<td>R 2</td>
<td>0.106</td>
<td>0.104</td>
<td>0.483</td>
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<td>Number obs.</td>
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<td><strong>Financial Deficit</strong></td>
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<td></td>
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<tr>
<td>DEV</td>
<td>0.5159 ***</td>
<td>0.5316 ***</td>
<td>0.8203 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0272)</td>
<td>(0.0240)</td>
<td>(0.0354)</td>
</tr>
<tr>
<td>DEV*FCFlarge</td>
<td>0.0208</td>
<td>-0.0645 **</td>
<td>0.1035 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0298)</td>
<td>(0.0263)</td>
<td>(0.0397)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.0501 ***</td>
<td>-0.1322 ***</td>
<td>0.0129 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0037)</td>
<td>(0.0036)</td>
<td>(0.0018)</td>
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<td>0.258</td>
<td>0.565</td>
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<tr>
<td>Number obs.</td>
<td>62,829</td>
<td>62,829</td>
<td>62,829</td>
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</tbody>
</table>

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Table 9. Combination of Free Cash Flow and Deviation from target effect on CH-SOA

The table presents estimates cash holdings SOA. The model estimated:
\[ \Delta \text{Cash} = \lambda \text{DEV} + \varepsilon_{i,t}, \text{where DEV} = (\text{Cash}^* - \text{Cash}_{i,t-1}) \]
Cash* is target cash holdings. For fitted model target values are estimated first by OLS:
\[ \text{Cash}_i^* = \beta \Xi_i + \text{FE}_i \]
Where Xi is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings, \( \beta \) is a vector of coefficients, and FEi is the firm fixed effect. 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), acquisition. For other specifications the target is calculated as a industry median level of cash holdings or as firm’s five-year rolling average. The sample is split based on the value of AbsDevLarge variable, which is an indicator variable that takes a value of one if the deviation from target is above median value, and zero otherwise, and on the value of NegDev variable, which is an indicator variable that takes a value of one if the deviation from target is negative, and zero otherwise. The sample consists of all industrial firms in the Compustat/Crsp file from 1968 to 2012, with non-missing observations on total assets and cash. The standard errors (in brackets) are heteroskedasticity consistent, clustered on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

<table>
<thead>
<tr>
<th>Below Target</th>
<th>Above Target</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fitted Reg</strong></td>
<td><strong>Financial Surplus</strong></td>
</tr>
<tr>
<td></td>
<td>0.1088 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0118)</td>
</tr>
<tr>
<td><strong>Industry Median</strong></td>
<td>0.0465 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0160)</td>
</tr>
<tr>
<td><strong>5-year average</strong></td>
<td>0.5523 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0482)</td>
</tr>
</tbody>
</table>
Table 10. Access to External Capital effect on CH-SOA

The table presents estimates cash holdings SOA. The model estimated
\[ \text{Cash}_{it+1} - \text{Cash}_{it} = (\gamma_0 + \gamma_{it+1}Z_{it})(\text{DEV}_{it}) + \delta_{i,t+1}, \]
where
\[ \text{DEV}_{it+1} = \text{Cash}^*_{it} - \text{Cash}_{it} \] and Cash* is target cash holdings.

For fitted model target values are estimated by BB GMM estimator (Blundell & Bond, 1998) from
\[ \text{Cash}_{it+1} = (\lambda \beta)X_{it} + \lambda FE_{it} + (1 - \lambda)\text{Cash}_{it} + \delta_{i,t+1} \]
Where Xi is a vector of observable firm-specific factors that determine the firm’s target level of cash holdings, \( \beta \) is a vector of coefficients, and FEi is the firm fixed effect. 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), acquisition. For alternative specifications the target is calculated as an industry median level of cash holdings or as firm’s five-year rolling average. 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. The standard errors are heteroskedasticity consistent, clustered on firm level. Significance levels are indicated as follows: * = 10%, ** = 5%, *** = 1%.

Panel A

<table>
<thead>
<tr>
<th></th>
<th>Fitted Model</th>
<th>Industry Median</th>
<th>5 year average</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEV</td>
<td>0.6019 ***</td>
<td>0.5967 ***</td>
<td>0.9357 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0229)</td>
<td>(0.0202)</td>
<td>(0.0278)</td>
</tr>
<tr>
<td>DEV*Size</td>
<td>-0.0287 ***</td>
<td>-0.0432 ***</td>
<td>-0.0232 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0054)</td>
<td>(0.0048)</td>
<td>(0.0064)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.0427 ***</td>
<td>-0.0811 ***</td>
<td>0.0169 **</td>
</tr>
<tr>
<td></td>
<td>(0.0023)</td>
<td>(0.0021)</td>
<td>(0.0009)</td>
</tr>
<tr>
<td>R 2</td>
<td>0.217</td>
<td>0.230</td>
<td>0.525</td>
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<tr>
<td>Number obs.</td>
<td>125,575</td>
<td>125,575</td>
<td>125,575</td>
</tr>
</tbody>
</table>

Panel B

<table>
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<th>Fitted Model</th>
<th>Industry Median</th>
<th>5 year average</th>
</tr>
</thead>
<tbody>
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<td>DEV</td>
<td>0.5059 ***</td>
<td>0.4509 ***</td>
<td>0.8847 ***</td>
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<td>(0.0108)</td>
<td>(0.0082)</td>
<td>(0.0138)</td>
</tr>
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<td>DEV*Rated</td>
<td>-0.3668 ***</td>
<td>-0.3471 ***</td>
<td>-0.2381 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0339)</td>
<td>(0.0452)</td>
<td>(0.0462)</td>
</tr>
<tr>
<td>Constant</td>
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<td>-0.0123 ***</td>
<td>0.0141 **</td>
</tr>
<tr>
<td></td>
<td>(0.0033)</td>
<td>(0.0032)</td>
<td>(0.0012)</td>
</tr>
<tr>
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<td>0.227</td>
<td>0.548</td>
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<td>125,575</td>
<td>125,575</td>
</tr>
</tbody>
</table>