Volatility of Cash Holdings and Firm Value

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Abstract

Prior studies postulate that the optimal level of firms' cash holding is dynamic and, thereby, managers should actively adjust cash holdings. I find that the more volatile a firm's cash holdings, the higher its firm value. The correlation is more pronounced in smaller firms, younger firms, and firms in high tech industries. The findings are robust when controlling for the level of cash holdings and cash flow volatility, among other factors. The positive connection between cash holdings volatility and firm value is consistent with the need for active management of cash. Specialized managers who actively adjust the amount of cash holdings help enhance the firm value more than generalist managers, consistent with the idea that specialized management has a better understanding of the firm's cash needs.

1. Introduction

A firm's value of cash and demand for cash depend on changes in the firm's external and internal environments. Since the use and value of cash are time varying, the optimal level of cash holdings is also constantly changing. The dynamic nature of optimal cash holdings should motivate firms to actively adjust cash towards the optimal level. The benefits of adjusting cash towards its optimal level can be substantial, including decreased over investment leading to depleted cash reserves, limited cash hoarding, and smoothing the effects of the economic cycle by ensuring the amount of cash is sufficient to withstand hard times. These benefits suggests that: if a firm constantly adjusts cash holdings to chase the optimal cash level and therefore increases the volatility of cash holdings, there should be a corresponding increase in firm value.

In this paper I analyze the relationship between cash volatility and firm value, and I examine the strength of this relationship across different types of firms. I measure cash volatility as the two-year quarterly standard deviation of cash holdings to account for any within year adjustments to cash. My results indicate that while the level of cash does matter in regards to firm value, the volatility of cash is also an important determinant of firm value as measured by Tobin's Q. Specifically, I identify a positive and significant relationship between cash volatility and firm value. This is consistent with the notion that cash holdings should be constantly adjusted to meet the dynamic optimal cash target.

Furthermore, the relation between cash volatility and firm value should not be homogenous across firms. Younger and smaller firms have limited access to affordable external capital and therefore cash is a more valuable asset to them. At the same time, younger and smaller firms also tend to be less profitable. Due to the high demand yet limited supply of cash, adjusting cash to its optimal level is especially important for those firms. As a result, the

relationship between cash volatility and firm value should be even stronger for smaller and younger firms. Indeed I find a stronger association between cash volatility and firm value for younger firms compared to older firms. As firm size increases, the magnitude and significance of the relationship between cash volatility and firm value decrease monotonically.

High-tech firms need to take advantage of investment opportunities quickly due to the intensity of competition in their industries and the constant creation of new products and services. The rapid changes in the external environment and investment opportunities in high tech industries imply that the optimal cash level is more volatile in high tech firms than in low tech firms. High-tech firms that actively adjust cash to its optimal level should benefit more than low-tech firms whose optimal cash level is not as volatile. Using the industry classifications of Hall and Vopel (1997) I am able to split firms based on the technological level of their corresponding industries and further determine whether or not cash volatility is related to firm value in both of these two industries. While cash volatility is positively related to firm value in both low-tech and high-tech firms, the benefit of actively adjusting cash level for high-tech firms is significantly larger than low-tech firms. Overall, by analyzing various subsamples of firms, I find a stronger relationship between cash volatility and firm value for younger, smaller, and high-tech firms than their respective counterparts.

In addition to examining the correlation between cash volatility and firm value along dimensions of firm characteristics, I also study the role of CEO experience in managing cash level. I focus on two types of CEOs: specialists and generalists[2]. Specialists are defined as CEOs with their experience focused on a minimal number of firms and industries. A CEO who has worked extensively for one firm, such as a founder, would be included in the specialist

[2] I use the Generalist Ability Index, or GA Index, of Custodio, Ferreira, and Matos (2013) to classify a CEO as either a generalist or specialist.

definition. Generalist CEOs have a broad range of experience from working in multiple industries and firms therefore they have accumulated general business skills and knowledge. CEOs who are specialized in their industry have in depth knowledge of industry-level and firm-specific risk and opportunities, therefore they should have a good understanding of the optimal level of cash for their firms. I thus expect that specialist CEOs have the ability to successfully adjust cash holdings to meet its optimal level and in turn add value to the firm. My empirical results support the benefit of specialized CEOs by presenting a positive association between firm value and cash volatility when the CEO is a specialist. On the other hand, when a firm with high cash volatility is managed by a generalist CEO, firm value is actually lower. This is an important result, especially in light of the observations from Custodio, Ferreira, and Matos (2013) who document a pay premium for generalist CEOs over specialist CEOs, but find no rise in firm value under generalist CEOs.

The positive relationship between cash volatility and firm value continues to hold even when cash flow volatility is used as an additional determinant of firm value. Cash flow volatility provides information on the riskiness of a firm via the variability in a firm's cash flows. The robustness of the relationship between cash volatility and firm value highlights the importance of the movement of cash holdings in addition to the impact of cash flow volatility.

Although cash volatility should be important to firm value, as I have proposed and established in this paper, the literature has been lacking in this area. To the best of my knowledge, my study is the first one to examine the importance of cash volatility in determining firm value. My paper contributes to the literature by filling the void in the literature. I study the connection between the movement of cash and firm value which provides insight into the role of actively managing cash. My findings suggest that an informed and active management of cash

should be beneficial to shareholders. The relation between cash volatility and firm value are strongest in small, young, and high-tech firms. CEOs' industry-specific experience also helps to generate a stronger impact of cash adjustment on firm value.

The rest of the paper is as follows: Section 2 reviews the literature and develops the hypotheses. Section 3 describes the data and methods used in the analysis. Section 4 reports the empirical results on the relationship between cash volatility and firm value. Section 5 presents the results of additional robustness checks. Section 6 concludes by summarizing the contributions of the paper and discussing potential further research in this area.

2. Literature Review and Hypothesis Development

2.1 Related Literature

The focus of this paper is centered on the cash holdings strand of finance literature. Many studies have examined the impact of cash holdings on different aspects of the firm, however none have looked at the volatility of cash holdings. Analyzing the level of cash holdings alone tells only some of the story. Understanding the variability of cash holdings within a firm can give further insight into the benefits of proactive cash management.

The increase in cash holdings literature over the past two decades is in no doubt a response to the hoarding of cash by firms. Bates, Kahle and Stulz (2009) show that there has been an increase in firm cash holdings over the past 20 years. Many of the findings related to increased cash levels paint a poor picture of the impact of high levels of cash holdings or excess cash on a firm. Opler, Pinkowitz, Stulz, and Williamson (1999) report that companies with excess cash partake in more acquisitions and increase their capital expenditures even when they appear to have poor investment opportunities. Expanding further on the findings of big spending

by cash rich firms, Harford (1999) finds that firms with large cash reserves are not only more likely to acquire another firm, but to acquire large firms. These acquisitions are followed by poor operating performance. Both Lamont (1997) and Berger and Hann (2003) present results consistent with cash rich segments cross-subsidizing poorly performing segments in diversified firms.

From an agency standpoint, Dittmar and Mahrt-Smith (2007) present evidence that when agency problems are greater within a firm, shareholders put a lower value on dollars used to increase cash holdings. Cheng, Harford, Hutton, and Shipe (2015) show that higher levels of cash holdings lead to higher levels of executive compensation regardless of firm performance, reinforcing the arguments of Jensen (1986) that higher cash holdings lead to agency problems within the firm. The results of recent literature surrounding cash rich firms seem to indicate that firms with high levels of cash experience higher and less than optimal spending.

While the literature showing the negative effect of holding large amounts of cash is vast, Mikkelson and Partch (2003) find evidence supporting the need for large cash reserves. They find that firms with persistent high cash holdings over 5 years are accompanied by greater investment and greater growth in assets without hurting corporate performance. In addition, Dittmar and Mahrt-Smith (2007) show that the negative effects of holding cash are directly related to the governance of a firm. They show that the negative impact of large cash holdings is canceled out in well governed firms.

In this paper, I examine cash holdings in a new way. My results indicate that high cash volatility is associated with higher firm value. Therefore, it is not only the level of cash a firm holds that is important, but how actively cash is managed.

2.2 Hypotheses

In testing the relationship between cash volatility and firm value there are two hypotheses. The first assumes that the amount of cash held relative to the size of the firm at any given point in time is the effect of a manager's strategic decision making and not a mechanic residual of earnings. All industries and firms are different making the optimal level of cash that should be held unique in the cross section of firms and over time. Due to this ever changing optimal cash level firms should be adjusting cash regularly to keep up. Actively managing cash and optimizing cash levels to capitalize on investment opportunities or build precautionary savings is a necessity of firm management and a major component of firm value. Therefore, the decision to adjust the amount of cash holdings and increase cash volatility should be associated with higher value to the firm. On the other hand, while prior studies have looked at the costs of holding large cash balances the consistency of these levels, regardless of whether the amount is deemed high or low, should be associated with lower firm value attributed to the lack of cash adjustment to meet the optimal level.

Hypothesis 1: Higher volatility of corporate cash holdings is associated with higher firm value.

While the first hypothesis deals with the relation between cash volatility and firm value, the second looks into the experience of the managers making these decisions. Using the intuition that the cash holdings target is dynamic, a firm should be constantly adjusting cash holdings to meet this target. In this scenario, the manager must have the knowledge to adjust to this optimal level. More specialized managers, or those with more knowledge of the firm and its industry, will have the information needed to adjust cash holdings to the correct level. Due to this information, specialized managers should be able to identify the optimal cash level and adjust cash to increase

the value of the firm better than managers with more general business experience. If a manager lacks specialized knowledge in the firm, then his choosing of the optimal level of cash could be incorrect and lead to loss of firm value. While cash volatility is an important factor in determining firm value, the degree to which this volatility helps or hurts the firm should depend on the company specific knowledge the CEO holds.

Hypothesis 2: Specialized managers who actively adjust cash holdings to meet a dynamic optimal level create more value for the firm than managers with general business experience.

These two hypotheses combine to create a new way to examine how cash is treated and used within a firm. While the level of cash holdings is important, the movement of cash as proxied by its volatility, is also a key aspect of corporate decisions that can affect the firm value.

3. Data Description

The sample includes publically traded firms for years 1992-2013 for a total sample size of 51,566 firm-years. Firms' financial characteristics are extracted from Compustat. Firms from industries of utilities (SIC code between 4900 and 4949) and financials (SIC code between 6000 and 6999) are excluded as their cash holdings may be affected by regulations, for example, capital requirements. Distressed firms with negative assets or negative book value of equity are also eliminated from the sample. All variables are winsorized at the 1% and 99% to reduce the influence of extreme observations.

To test the effect of CEO ability on cash volatility, I use the Generalist Ability Index of Custodio, Ferreira, and Matos (2013). This measure uses CEO characteristics of S&P 1500 firms including the number of past positions, firms, and industries as well as whether the CEO has

been the CEO of another firm or worked for a conglomerate to determine how much generalist knowledge a CEO has attained. A high index number identifies a more generalist CEO whose characteristics and abilities could be beneficial to many different firms and industries. The authors show that generalist CEOs are awarded a pay premium in comparison to specialist CEOs. This premium is higher when CEOs are hired to help facilitate complicated corporate changes including acquisitions and restructurings.

Industry information used to identify the technological level of firms (i.e. high-tech vs low-tech) was collected from the industry definitions of Hall and Vopel (1997). These authors combine the 131-sector manufacturing industry classification used by the Federal Trade Commission and the 1987 4-digit industrial classification of the Census of Manufactures with the purpose of aggregating industries based on similar competing technologies. Reported in their industry aggregation are the SIC codes and technological level of the industries (i.e. high-tech, stable-tech, low-tech). Examples of low-tech industries would include food, tobacco, lumber, and apparel while high-tech industries would include computers, pharmaceuticals, electrical machinery, and transportation equipment.

4. Empirical Analysis and Results

4.1 Summary Statistics

All variables used in the analyses are summarized in Table 1. Panel A reports the descriptive statistics of the variables, while Panel B shows the pair-wise correlations among them. A detailed description of all variable definitions and sources are included in Appendix A.

Insert Table 1

The average firm in the sample has assets of $2.20 billion and the average firm age is 14 years. The variable of interest, cash volatility, has a mean of .059 and a standard deviation of .068. This large standard deviation shows that cash volatility is far from being a static measure. Figure 1 plots the mean cash volatility of firms from 1992 to 2013. The firms in the sample have average cash holdings, defined as the ratio of cash and short term investments to total firm assets, of 0.206 and a leverage ratio of 0.156. Tobin's Q is used as a proxy for firm value. The mean Tobin's Q for the sample is 2.16 with a standard deviation of 1.98.

Insert Figure 1

A glance at the results of this paper may lead one to believe that the relationship found between cash volatility and firm value is simply due to the retention of a firm's cash flows that would affect the volatility of cash holdings. The relationship between cash flow volatility and cash volatility shows a correlation 0.39. The results of additional robustness tests, detailed at the end of Section 5, show that despite their positive correlation the results of the forthcoming analysis hold even when accounting for the influence of a firm's cash flow volatility.

4.2 Baseline Analysis

The first set of analyses, Table 2, reports the relationship between cash volatility and firm value, measured by Tobin's Q. I follow Coles, Lemmon, and Meschke (2012) in the choice and construction of other control variables. The controls include the natural log of assets, research and development expenses, advertising expenses, leverage, and sales growth. With the exception of cash volatility, all independent variables and Tobin's Q are measured at the end of year t. Cash volatility is calculated as the standard deviation of firm cash holdings using quarterly data over the years in t-1 and t-2[3].

[3] The results of these tests hold regardless of whether cash volatility is measured quarterly over 2, 3, or 4 years.

Mean cash volatility is 0.06. This is lower than the yearly standard deviation of cash holdings reported in Table 1 of 0.22. This difference is attributed to the selection of samples used in the calculation. The variable of interest, cash volatility, is measured using the 8 quarters of each individual firm while the standard deviation of cash holdings is calculated as the standard deviation of all firm years. The volatility of cash holdings in a sample of all firm years should and does have a higher standard deviation than the variation between within firm cash holdings for two years.

Insert Table 2

To rid of any issues related to overlapping data due to the two years of rolling lagged quarterly data needed for the calculation of cash volatility, I use data from every other year for every firm in the sample. This procedure ensures cash holdings data used in the computation of cash volatility are not repeated for any one firm.

Column 1 of Table 2 reports the results of the regression of firm value on cash volatility. Cash volatility is shown to be positively related to firm value, significant at the 1% level (1.60, t stat 6.82), meaning that the higher the variability in cash holdings, the higher the value of the firm. Consistent with prior studies, coefficients on leverage and log assets are negative and significant while R&D has a positive and significant coefficient. Sales growth is added to the regression to proxy for the firm performance, the coefficient is positive and significant. The coefficient on advertising is negative, but not significant.

The importance of the level of cash holdings cannot be ignored. To ensure that the results of Column 1 are not a byproduct of the effect of the level of cash holdings on firm value, the level of cash holdings is included as an additional control. While the coefficient of cash volatility drops slightly to 1.16 it remains positive and significant at the 1% level (t stat 4.93). The

coefficient on cash holdings is positive and significant at 1.43 and t stat of 13.23. This result confirms that the relationship found between cash volatility and firm value cannot be explained by the level of a firm's cash holdings. The sign and significance of the remaining control variables are consistent with those in Column 1 with the exception of advertising which remains insignificant, but is positive.

Column 3 includes firm age to help explain firm value. Firm age has a negative relationship with firm value meaning that younger firms have higher Tobin's Q than older firms. Larger firms are more diversified and it has been shown that increased diversification is associated with loss in firm value (Berger and Ofek 1995, Lang and Stulz 1994). Denis, Denis, and Sarin (1997) attribute this value loss of diversification to agency problems while also showing that diversified firms are larger and older.

The coefficient and sign of cash volatility and the other independent variables in Column 3 remain similar to the first two regressions. When including an interaction term between cash volatility and firm age in Column 4, the coefficient is negative and significant at the 1% level. High cash volatility for an older firm will have less of an impact on firm value than a younger firm with similar high levels of cash volatility. By definition, growth firms have more opportunities than value firms which are known to be older and more likely to have exhausted internal investment opportunities (Lang and Stulz 1994). Younger firms using cash to take advantage of their vast opportunities, both internal and external, will have increased levels of cash volatility and also firm value.

The results of Table 2 confirm that cash volatility is an important determinant of firm value and firms that partake in more active cash management are rewarded with a higher value.

This relationship is strongest for younger firms that will have more investment opportunities and therefore more of a positive impact on firm value from higher cash volatility than mature firms.

To look at this relationship between cash volatility and firm value in another way, Figure 2 shows the average firm value across the cash volatility deciles of the sample. Every year *t* in the sample firms are ranked based on their cash volatility in years *t-1* and *t-2*. I then calculate the average firm value, as measured by Tobin's Q for each decile. To eliminate any year effects, the average of firm value is measured for each decile across all years in the sample. There is a clear positive monotonic relationship between cash volatility and firm value, confirming the results of Table 2.

Insert Figure 2

There is little research on cash volatility in the literature, therefore I take a step back and examine firms that have high cash volatility. Table 3 examines the determinants of a firm having a higher level of cash volatility. High Cash Volatility, the dependent variable, is a binary variable equal to 1 if the firm has future cash volatility greater than the median of that year and equal to 0 for cash volatility less than the median[4]. The independent variables used in this probit analysis are similar to those in regressions with the dependent variable being firm value.

The goal is to control for firm characteristics that could explain the choice of higher cash volatility. To truly conduct a predictive analysis, all independent variables are measured as of the year prior to the computation of the dependent variable. The results show that the level of cash holdings is positively and significantly related to high cash volatility, which is not surprising. Not only is cash holdings the most significant of the independent variables, but it is also the largest in magnitude 0.877, t stat 17.26. The coefficients on log assets, ROA, leverage, and firm

[4] Defining High Cash Volatility by using different quartiles provided similar results.

age are all negative and significant while the coefficients on cash holdings, R&D, and advertising are all positive and significant. Whether or not the firm pays a dividend, dividend payer, is positive, but not significant.

4.3 Generalist vs. Specialist CEOs

At any given time there is a decision to be made of whether or not the firm is holding the correct amount of cash. Because this correct or optimal amount of cash is always changing as the firm and its environment change, shown in Figure 3, the actual amount of cash held by the firm should be adjusted to meet this level. Optimal cash holdings levels are calculated following Dittmar and Mahrt-Smith (2007). A description of this calculation can be found in Appendix B. When a firm has cash holdings that are optimal, then the value of the firm should increase.

Insert Figure 3

Frequently moving cash holdings towards an optimal level as a way to increase firm value is one of the tasks management must complete. However, knowing when the time to adjust has come and what amount of adjustment is needed are critical to the success of cash adjustment and therefore to the value of the firm.

In Table 4, the analysis of the effect of cash volatility on firm value is expanded to include a measure of the generalist ability of the CEO. I use the Custodio, Ferreira, and Matos (2013) measure of the generalist ability of a CEO (GA Index) to classify CEO ability[5]. To further investigate the strong relationship between firm value and cash volatility shown in Table 2, it is important to examine the impact that CEOs of different abilities have on this relationship. This is particularly important due to the reliance on the CEO's knowledge of the optimal cash level as a potential explanation for these findings.

[5] Claudia Custodio has provided the GA Index data on her website.

Insert Table 4

Columns 1-4 determine the impact the generalist ability of a CEO has on firm value as determined by the dependent variable, Tobin's Q. The subsample created by the inclusion of the GA Index is mainly large firms which do not have as high of cash volatility on the average as small firms. Due to this issue, I classify all firms as high cash volatility or low cash volatility firms based on the median of the whole sample, not just the large firm subsample. High cash volatility is defined as a dummy variable taking the value of 1 for cash volatility greater than the median for the given year and a value of 0 otherwise. This ensures that in interpreting the coefficients, firms will correctly be identified as being high or low cash volatility firms and not simply firms with high or low cash volatility within this smaller sample of large firms.

The coefficient on high cash volatility is positive for three of the four regressions, but only statistically significant in one. While the significance has been lost compared to the base regressions in Table 2 which shows a positive and significant relationship between cash volatility and firm value, this can be explained by the smaller more selective sample. Further tests in Table 5 confirm that the positive and significant relationship between cash volatility and firm value is driven mainly by small firms and in addition, the actual level of cash volatility decreases monotonically to increases in firm size. The results of Table 4 indicate that even in large firms where the cash volatility relationship with firm value may not be as strong, cash volatility still plays a part in firm value, but under the right circumstances, particularly the specialization of the CEO.

Column 1 shows a negative relationship, -0.059 (t stat -2.20), between the GA Index and firm value. This negative relationship is similar to the findings of Custodio, Ferreira, and Matos (2013) in their creation of the GA Index, where despite the positive announcement effects of the

hiring of a generalist CEO and the generalist pay premium, there is no positive impact on firm value or performance. This result indicates that higher cash volatility is not always positive for the firm. Rather, the relationship between cash volatility and firm value is dependent on the management in charge of the cash volatility decisions.

To further test the impact of managerial ability on the relationship between cash volatility and firm value, the interaction between the GA Index and cash volatility is used. Confirming the previous results, in the presence of a high GA Index (more generalist) CEO, higher cash volatility is associated with lower firm value, -0.082 (t stat -2.01). This brings to question what type of CEO is needed for elevated cash volatility to be positive for a firm.

In the final two columns of the table, I create an identifier for both generalist and specialist CEOs. Generalist is a binary variable taking the value of 1 when a CEO ranks in the top 25% of the GA Index and 0 otherwise. Specialist is a binary variable taking the value of 1 when a CEO ranks in the bottom 25% of the GA Index and 0 otherwise. In Column 3 the interaction of the newly created generalist variable and cash volatility is used as a determinant of firm value. The coefficient on this interaction term is negative and significant, -0.183 (t stat -2.239). However, in Column 4, when the interaction of the specialist variable and cash volatility is used, the coefficient is positive and significant, 0.210 (t stat 2.516). These results indicate that when high cash volatility is under the control of a CEO with more specialized knowledge of the firm and industry, there is a positive association with firm value. On the other hand, if a CEO with generalist knowledge and experience in more industries has control of high cash volatility the relationship between cash volatility and firm value is actually negative

The results of Table 4 help further explain the positive relationship between cash volatility and firm value and identify the potential situations that are driving the main results.

The relationship between cash volatility and firm value is not homogenous across all management styles, but instead is restricted to situations where the CEO is a specialist. This result solidifies the importance of having management that understands the firm and therefore understands the timing and amount of adjustment needed to move cash holdings to an optimal level.

4.4 Investment Opportunity

In addition to the impact of CEO ability on the effect cash volatility can have on firm value, the amount of investment opportunities available to the firm could be a factor in determining whether or not more cash volatility is actually associated with higher firm value. Bates (2005) shows that cash retention probabilities from subsidiary sales increase with growth opportunities and expected investment. In the event that the amount of retained cash is chosen, monitored, and allocated correctly, consistent with optimal cash holdings, there should be a stronger relationship between cash volatility and firm value. To measure investment and growth opportunities available to firms, firms in the sample are separated based on size and whether or not their corresponding industry is high or low tech.

4.4.1 Firm Size

To determine the effect of firm size on the impact of cash volatility on firm value, the sample is split into 3 subsamples. For each of the terciles, firm value is regressed on cash volatility. The coefficient on cash volatility is significant in the first and second terciles, with the strongest relationships more prevalent in these small and midsize firms. This result is consistent with the greater availability and profitability of investment opportunities for smaller firms than larger firms. Lang and Stulz (1995) report a negative relationship between firm diversification and Tobin's q. Their result is consistent with the view that as firms become larger they exhaust

all internal growth opportunities and are forced to grow through diversification. In addition, Moeller, Schlingemann, and Stulz (2004) show the announcement returns for small acquirers are significantly higher than for large acquirers. Due to the large amount of investment opportunities and potential rewards for small firms, taking action to capitalize on these opportunities as indicated by high cash volatility levels has a larger impact on and is associated with higher firm value. Table 5 reports the regression results of cash volatility on firm value for each of the 3 subsamples in Panel A.

Insert Table 5

Panel B of Table 5 shows the mean cash volatility for each of these same terciles. There is a negative monotonic relationship between average cash volatility and firm size with mean cash volatility decreasing from 0.091 in the smallest size quintile to 0.027 in the largest size quintile. This decrease in cash volatility can be attributed to two possible coexistent effects: lack of investment opportunities and the diversification of investments. Duchin (2010) finds that diversified firms hold less cash than standalone firms due to the diversification of investments. Since diversified firms are generally larger and are already diversified, they do not need cash either as a safety net or to take advantage of potential growth opportunities that are less available to large firms. Also, smaller firms have less collateral and are generally more risky than larger firms. This disincentives debt which in turn increases the use of internal financing. The higher levels of cash holdings, reliance on internal financing, and more investment opportunities by smaller firms are consistent with higher amounts of cash volatility.

4.4.2 High Tech Firms

An alternative measure of investment opportunities is the nature of the firm's industry. The sample is split into two subsamples based on the technicality of the industry. High tech and

low tech industries are identified using the definitions of Hall and Vopel (1997). More technical firms, “High Tech”, tend to have more investment opportunities and a greater potential for value increasing projects due to their ability to easily substitute high-risk and low-risk projects depending on firm circumstances (Brown, Fazzari, and Peterson 2009). Being able to partake in these investments through the movement of cash is associated with high firm value. Table 6 reports the results of regressing firm value on cash volatility for firms in industries classified as high-tech and low-tech. For high-tech firms, the coefficient on cash volatility, 1.49 (t stat 3.56), is almost 50% higher that of low tech firms with a coefficient of 1.014 (t stat 3.60). The magnitude of the relationship between cash volatility and firm value is statistically different between high and low-tech firms as shown by the coefficient of 9.30 from the chi squared test.

The results of Table 6 indicate that while cash volatility still retains a significant relationship with firm value regardless of the technical level of an industry, there is a stronger relationship between cash volatility and firm value for high-tech firms where the movement of cash holdings to an optimal level can have more of an impact on firm value due to the greater availability of value increasing projects.

Insert Table 6

5. Additional Robustness Tests

5.1 Fama-MacBeth Regressions

To eliminate the effect of any time specific variables that cannot be controlled for in the main regression, I use the Fama-MacBeth procedure. I take the time series average of the cross sectional coefficient on cash volatility for every year in the sample. The results show that overtime the coefficient on cash volatility remains similar in magnitude, with a positive and significant time series average of 3.73 (t stat 8.63).

Insert Table 7

5.2 Cash Flow Volatility

The volatility of a firm's cash flows is commonly used as a measure of a firm or industry's riskiness. While there are no studies that I am aware of that specifically examine the impact of cash volatility on a firm, there have been studies related to the volatility and stability of cash flows. Minton and Schrand (1995) show that higher cash flow volatility is associated with lower investment in capital expenditures, advertising, and R&D. Furthermore they find that greater cash flow volatility increases the cost of accessing external capital markets and the likelihood that these markets would need to be used.

To ensure that the previous results are not being driven by the volatility of a firm's cash flows, I have included cash flow volatility, measured as the volatility of quarterly operating income scaled by total assets, using the 8 quarters of *t-1* and *t-2*, as an additional control variable in the baseline analysis. The results of this test are reported in Table 8.

Insert Table 8

While there is a strong positive relationship between cash flow volatility and firm value, the inclusion does not eliminate the previously found positive and significant relationship between cash volatility and firm value. This result is not surprising. There is no doubt that some amount of a firm's cash flows will be retained therefore increasing cash holdings and indirectly cash volatility, the correlation between these two measures is shown to be 0.39. However, the amount of cash holdings and cash volatility are affected by many other factors that are more directly controlled by the management of a company as opposed to the volatility of firm cash flows. These factors include precautionary savings, the anticipation of investment, and future M&A activity among others.

5.3 Generalist Ability Index, Excluding Turnover Years

In years when there is CEO turnover the interaction variables of Table 4 will include the generalist/specialist classification of the new CEO and the cash volatility established by the prior CEO, possibility a CEO of a different generalist/specialist identification. This lack of consistency is due to the use of quarterly cash holdings in years *t-1* and *t-2* in the calculation of cash volatility. To ensure that these specific turnover years do not affect the interpretation of my results I drop all observations that include an interaction between the generalist/specialist classification of the current CEO and the cash volatility of a prior CEO with a different generalist/specialist designation. After dropping these observations the results of the tests, shown in Table 9, are stronger than those originally displayed in Table 4. These results strengthen the importance of proactive cash management by specialist CEOs to increase firm value.

Insert Table 9

6. Conclusions

Cash holdings should not be treated or analyzed as a static metric or a residual of a firm's cash flows. In addition to the level of cash holdings, the movement of cash is important in the creation of firm value. The results of this paper show that cash volatility is positively and significantly related to firm value. This relationship between cash volatility and firm value can be explained by the strategic decisions of a specialized manager. Mangers should try to adjust cash holdings to an optimal target, a moving target. This constant adjustment of cash to the moving target will in turn increase the volatility of cash holdings. Managers who constantly adjust cash holdings to an optimal level, and therefore increase cash volatility, will add value to the firm. By including a measure of CEO ability, I am able to show that specialized CEOs, combined with high cash volatility, are associated with higher firm value than CEOs with more

general experience. Moreover, smaller firms, high-tech firms, and younger firms all display a stronger relationship between cash volatility and firm value than their respective counterparts.

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APPENDIX A. Variable Definitions

Variable	Source	Definition
Cash Volatility	Compustat	Standard deviation of the cash holdings from the 8 quarters of years t-1 and t-2
Cash Holdings	Compustat	Cash and short term investments divided by total assets, Compustat *che / at*
Cash Flow Volatility	Compustat	Standard deviation of the operating income scaled by total assets from the 8 quarters of years t-1 and t-2
Assets	Compustat	Total assets ($ Millions), Compustat *at*
Tobin's Q	Compustat	Book value of total assets minus the book value of equity plus market value of equity, divided by total assets, Compustat *(at-ceq+(prcc_f*csho))/at*
Dividend Payer	Compustat	Dummy variable, takes the value of 1 for firms that paid a dividend for a particular firm year and a value of 0 otherwise
Firm Age	Compustat	Age of the firm. If the firm was publically traded before 1950, then 1950 is used as the first year.
Leverage	Compustat	The sum of current and long term debt divided by total assets, Compustat *(dltt+dlc)/at*
Market to Book	Compustat	Market value of firm (share price at the end of the fiscal year multiplied by shares outstanding) divided by the book value of assets, Compusat *ceq*. Negative ratios were dropped from sample.
Research and Development (R&D)	Compustat	Annual amount spent by the firm on research and development expenses. Missing data are set to zero. Compustat *rnd*
Advertising	Compustat	Annual amount spent by the firm in advertising expenses, Compustat *adv*
Sales Growth	Compustat	The change in sales from year t-1 to year t divided by sales in year t-1
GA Index	Custodio, Ferreira, Matos (2012)	Generalist Ability Index, measures how much of a generalist a CEO is. This index is creating using variables that proxy for industry and firm experiences (i.e., the number of past positions the CEO has held, the number of industries the CEO has worked in, etc.). A higher index measure denotes a generalist CEO, whereas a lower number indicates a specialist.
High Tech	Hall & Vopel (1997)	Dummy variable that takes the value of 1 if firms are included in industries classified by their SIC codes as "high tech" and a value of 0 for firms in "low tech" industries.

APPENDIX B. Optimal Cash Holdings

Optimal cash holdings is computed following Dittmar and Smith (2007). In their paper they calculate excess cash as the difference between the observed cash holdings (natural log of cash divided by net assets) and expected cash holdings estimated using the equation below:

$$Ln\left(\frac{Cash_{i,t}}{NA_{i,t}}\right) = \beta_0 + \beta_1 Ln(NA_{i,t}) + \beta_2 \frac{FCF_{i,t}}{NA_{i,t}} + \beta_3 \frac{NWC_{i,t}}{NA_{i,t}} + \beta_4 (Industry\ Sigma)_{i,t} + \beta_5 \left(\frac{\widehat{MV}_{i,t}}{NA_{i,t}}\right) + \beta_6 \frac{RD_{i,t}}{NA_{i,t}} + Year\ Dummies + Firm\ Fixed\ Effects + \varepsilon_{i,t}$$

I use the exponential of this expected cash measure, multiply it by net assets, and then scale by total assets so that the new measure reflects the optimal cash holdings of a firm in a given year.

Variable	Source	Definition
Cash	Compustat	Cash and cash equivalents
NA	Compustat	Net assets, total assets minus cash and cash equivalents
FCF	Compustat	Operating income minus interest minus taxes
NWC	Compustat	Current assets minus current liabilities minus cash and cash equivalents
Industry Sigma	Compustat	Standard deviation of the past 10 year industry average of FCF/NA
MV	Compustat	Market value of equity, stock price multiplied by common shares outstanding plus total liabilities
RD	Compustat	Research and development expenditures (0 if missing)

Table 1: Summary statistics

This table reports the summary statistics of the variables used in the analysis. Panel A reports the descriptive statistics for the variables and Panel B reports the correlation matrix. *p*-value for the correlation coefficient are reported below the correlation. Variable definitions can be found in Appendix A. All variables are winsorized at the 1st and 99th percentiles.

Panel A: Summary of the Variables

	Mean	Std. Dev.	Min	Max	Obs
Cash volatility	0.06	0.07	0	0.36	53,879
Tobin's Q	2.08	1.96	0.50	14.64	51,478
Cash Holdings	0.19	0.22	0	0.95	53,868
Log Assets	5.26	2.35	-0.09	10.87	53,879
Total Assets ($ millions)	2,338.85	7,384.01	0.91	52,342.00	53,879
Sales Growth	0.27	1.18	-1	9.50	53,879
R&D	0.05	0.11	0	0.66	53,879
Advertising	0.01	0.03	0	0.20	53,879
Leverage	0.16	0.18	0	0.70	53,732
Firm Age	7.91	5.56	1	22.00	53,879
Dividend Payer	1.00	0.06	0	1	53,879
GA Index	-0.01	0.98	-1.50	5.85	8,242

Panel B: Correlation matrix

	Cash Volatility	Tobin's Q	Cash Holdings	Log Assets	Total Assets	Sales Growth	R&D	Advertising	Leverage	Firm Age	Cash Flow Volatility	GA Index
Cash Volatility	1.000											
Tobin's Q	0.274	1.000										
	0.000											
Cash Holdings	0.405	0.341	1.000									
	0.000	0.000										
Log Assets	-0.340	-0.190	-0.260	1.000								
	0.000	0.000	0.000									
Total Assets	-0.157	-0.060	-0.131	0.581	1.000							
	0.000	0.000	0.000	0.000								
Sales Growth	0.115	0.124	0.036	0.009	-0.027	1.000						
	0.000	0.000	0.000	0.041	0.000							
R&D	0.268	0.329	0.481	-0.265	-0.090	0.009	1.000					
	0.000	0.000	0.000	0.000	0.000	0.034						
Advertising	0.013	0.028	-0.015	-0.018	-0.013	-0.016	-0.041	1.000				
	0.002	0.000	0.000	0.000	0.002	0.000	0.000					
Leverage	-0.253	-0.207	-0.398	0.323	0.098	0.027	-0.247	-0.052	1.000			
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
Firm Age	-0.210	-0.111	-0.062	0.280	0.204	-0.104	-0.062	-0.006	0.008	1.000		
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.145	0.072			
Cash Flow Volatility	0.392	0.311	0.224	-0.296	-0.088	0.023	0.212	0.031	-0.133	-0.149	1.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
GA Index	-0.051	-0.046	-0.045	0.313	0.256	-0.045	0.017	0.036	0.080	0.067	-0.045	1.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.118	0.001	0.000	0.000	0.000	

Table 2: The effect of cash volatility on firm value

This table reports the results from regressing firm value, as measured by Tobin's Q in year *t*, on cash volatility. *Cash Volatility* is measured as the quarterly standard deviation of cash holdings over the eight quarters of years *t-1* and *t-2*. *Cash Holdings* is the ratio of cash and short term investments to total firm assets in year *t*. With the exception of *Cash Volatility*, all independent variables are measured at time *t*. To eliminate any issues with overlapping data due to the rolling cash volatility measure, the sample uses data from every other year for every firm in the sample. All variables are winsorized at the 1st and 99th percentiles. The t-statistics are reported in parentheses. Robust standard errors are adjusted for clustering at the firm-level. ***, **, * indicate the coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

	(1) Tobin's Q	(2) Tobin's Q	(3) Tobin's Q	(4) Tobin's Q
Cash Volatility	1.598***	1.161***	1.153***	2.050***
	(6.815)	(4.929)	(4.894)	(6.223)
Cash Holdings		1.433***	1.431***	1.419***
		(13.232)	(13.222)	(13.111)
Log Assets	-0.325***	-0.301***	-0.300***	-0.302***
	(-14.751)	(-13.784)	(-13.770)	(-13.867)
R&D	1.910***	2.107***	2.105***	2.091***
	(6.429)	(7.116)	(7.112)	(7.068)
Advertising	-0.030	0.246	0.252	0.225
	(-0.053)	(0.429)	(0.438)	(0.392)
Leverage	-0.930***	-0.660***	-0.658***	-0.649***
	(-11.700)	(-8.284)	(-8.251)	(-8.142)
Sales Growth	0.134***	0.136***	0.136***	0.137***
	(10.276)	(10.601)	(10.589)	(10.666)
Firm Age			-0.349***	-0.333***
			(-2.732)	(-2.615)
Firm Age * Cash Volatility				-0.160***
				(-3.754)
Constant	3.626***	3.204***	2.670***	2.642***
	(33.612)	(29.575)	(12.016)	(11.945)
Observations	51,343	51,338	51,338	51,338
R-squared	0.096	0.110	0.110	0.111
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

Table 3: Probability of high cash volatility

This table reports the results of a probit regression of high cash volatility. High Cash Volatility is a binary variable equal to 1 if a firm has future cash volatility greater than the median and equal to 0 if less than the median. Due to the predictive nature of this analysis, all independent variables are measured in the year prior to the start of the data used for the cash volatility measurement. To eliminate any issues with overlapping data due to the rolling cash volatility measure, the sample uses data from every other year for every firm in the sample. All variables are winsorized at the 1st and 99th percentiles. The t-statistics are reported in parentheses. Robust standard errors are adjusted for clustering at the firm-level. ***, **, * indicate the coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

	(1) High Cash Volatility
Cash Holdings	0.922***
	(18.565)
Log Assets	-0.120***
	(-30.352)
R&D	0.682***
	(6.946)
Advertising	1.151***
	(4.500)
Leverage	-0.000
	(-0.005)
Dividend Payer	-0.224**
	(-2.307)
Firm Age	-0.028***
	(-12.992)
Sales Growth	0.015***
	(2.615)
Constant	0.680***
	(3.944)
Observations	50,063
Year Fixed Effects	Yes
Industry Fixed Effects	Yes

Table 4: Generalist ability index

This table reports the regressions of firm value with the Generalist Ability Index as one of the explaining factors. *High Cash Volatility* is a dummy variable with a value of 1 for cash volatility above the yearly median, and 0 for cash volatility below the yearly median. *GA Index* measures the generalist ability of the CEO (from Custodio, Ferreira, and Matos 2013). Higher values of *GA Index* mean the CEO is more of a generalist and lower values indicate the CEO being a specialist. Generalist is a dummy variable with a value of 1 if the CEO has a GA Index measure above the 75th percentile and 0 otherwise. Specialist is a dummy variable with a value of 1 if the CEO has a GA Index measure below the 25th percentile and 0 otherwise. All variables are winsorized at the 1st and 99th percentiles. The t-statistics are reported in parentheses. Robust standard errors are adjusted for clustering at the firm-level. ***, **, * indicate the coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

	(1) Tobin's Q	(2) Tobin's Q	(3) Tobin's Q	(4) Tobin's Q
High Cash Volatility	0.046	0.041	0.090**	-0.010
	(1.182)	(1.056)	(2.021)	(-0.209)
Cash Holdings	1.930***	1.929***	1.941***	1.939***
	(6.043)	(6.044)	(6.005)	(6.085)
Log Assets	-0.400***	-0.400***	-0.410***	-0.408***
	(-6.978)	(-6.995)	(-7.092)	(-7.155)
R&D	0.099	0.088	0.063	0.189
	(0.070)	(0.062)	(0.044)	(0.133)
Advertising	0.707	0.731	0.708	0.590
	(0.513)	(0.526)	(0.510)	(0.430)
Leverage	-1.501***	-1.503***	-1.521***	-1.499***
	(-7.360)	(-7.361)	(-7.347)	(-7.341)
Firm Age	-0.033	-0.033	-0.030	-0.033
	(-0.863)	(-0.857)	(-0.777)	(-0.857)
Sales Growth	0.415***	0.415***	0.412***	0.414***
	(5.825)	(5.826)	(5.769)	(5.821)
GA Index	-0.059**	-0.029		
	(-2.200)	(-1.166)		
Generalist			-0.046	
			(-0.990)	
Specialist				-0.044
				(-0.793)
GA Index * High Cash Vol		-0.082**		
		(-2.014)		
Generalist * High Cash Vol			-0.183**	
			(-2.239)	
Specialist * High Cash Vol				0.210**
				(2.516)
Constant	4.917***	4.920***	4.938***	4.976***
	(7.182)	(7.188)	(7.321)	(7.307)
Observations	8,197	8,197	8,096	8,165
R-squared	0.191	0.192	0.194	0.193
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 5: Large vs. small firms

This table reports the effect of cash volatility on firm value for small, median, and large firms. Panel A reports the results of regressing firm value on cash volatility in each of the sample terciles. A chi squared test is used to test if these coefficients on Cash Volatility of the largest and smallest terciles are statistically different. Mean cash volatility for each of these subsamples is reported in Panel B. The t-statistics are reported in parentheses. Robust standard errors are adjusted for clustering at the firm-level. ***, **, * indicate the coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

Panel A: Quintile Regressions of Firm Size

	(1)	(2)	(3)
	Tobin's Q (Small firms)	Tobin's Q (Median firms)	Tobin's Q (Large firms)
Cash Volatility	0.998**	1.029***	0.612
	(2.527)	(2.819)	(1.541)
Cash Holdings	1.155***	1.765***	1.586***
	(6.541)	(10.822)	(7.368)
Log Assets	-0.573***	-0.160***	-0.302***
	(-10.222)	(-3.939)	(-9.525)
R&D	2.174***	0.387	2.714**
	(5.533)	(0.730)	(2.222)
Advertising	0.705	-1.597**	0.023
	(0.742)	(-1.989)	(0.025)
Leverage	-0.585***	-0.826***	-1.008***
	(-2.696)	(-6.797)	(-9.314)
Sales Growth	0.143***	0.146***	0.113***
	(6.359)	(7.310)	(5.880)
Firm Age	-1.059**	0.006	-0.082
	(-2.561)	(0.022)	(-0.988)
Constant	2.278***	2.429***	3.781***
	(4.249)	(4.254)	(14.775)
Observations	17,225	17,361	16,752
R-squared	0.104	0.122	0.146
Firm Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Chi Squared Test (Q1-Q3)	54.99***		

Panel B: Mean Cash Volatility by Terciles

	Small (1)	(2)	Large (3)
Mean Cash Volatility	.091	.072	.027

Table 6: High tech firms

This table reports the relationship between cash volatility and firm value in high-tech and low-tech firms. The sample is split into two subsamples based on whether or not a firm is classified as High-tech or Low-tech. High-tech and Low-tech firms are defined as by Hall and Vopel (1997). A chi squared test reporting the statistical difference between the coefficient on Cash Volatility for high and low-tech firms is included at the bottom of the table. The t-statistics are reported in parentheses. Robust standard errors are adjusted for clustering at the firm-level. ***, **, * indicate the coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

	(1)	(2)
	Tobin's Q (High-tech firms)	Tobin's Q (Low-tech firms)
Cash Volatility	1.487***	1.014***
	(3.557)	(3.595)
Cash Holdings	1.308***	1.499***
	(7.286)	(11.118)
Log Assets	-0.324***	-0.296***
	(-7.948)	(-11.538)
R&D	2.655***	1.025**
	(7.424)	(1.989)
Advertising	2.846	-0.137
	(1.438)	(-0.245)
Leverage	-0.881***	-0.550***
	(-4.737)	(-6.753)
Sales Growth	0.175***	0.110***
	(7.507)	(7.333)
Firm Age	-0.457	-0.309***
	(-1.556)	(-2.874)
Constant	2.610***	2.697***
	(5.147)	(13.287)
Observations	15,039	36,299
R-squared	0.138	0.103
Firm Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Chi Squared Test (high-tech – low-tech)	9.30***	

Table 7: Fama-MacBeth regressions

This table reports the time series of the yearly coefficients from the regression of firm value on cash volatility, also known as the Fama-MacBeth procedure. The *t*-statistic of whether or not the mean is equal to zero is reported in parentheses. *** indicates the coefficient is statistically significant at the 1% level.

Year	Cash Volatility Coefficient
1992	4.545
1993	1.197
1994	2.743
1995	4.535
1996	2.131
1997	0.643
1998	1.756
1999	2.112
2000	1.384
2001	3.255
2002	2.68
2003	7.877
2004	5.236
2005	5.364
2006	4.493
2007	2.582
2008	2.49
2009	3.293
2010	5.953
2011	3.979
2012	7.78
2013	5.931
Average	3.73*** (8.627)

Table 8: Cash flow volatility

This table reports the impact the addition of cash flow volatility has on the relationship between cash volatility and firm value. Using the same time frame as the calculation of Cash Volatility, Cash Flow Volatility is measured as the quarterly standard deviation of cash flow over the eight quarters of years *t-1* and *t-2*. Cash flow is measured as operating income of the firm scaled by total assets. The *t*-statistics are reported in parentheses. *** indicates the coefficient is statistically significant at the 1% level.

	Tobin's Q
Cash Volatility	0.434*
	(1.736)
Cash Holdings	1.272***
	(11.199)
Log Assets	-0.272***
	(-12.082)
R&D	2.409***
	(7.705)
Advertising	0.294
	(0.469)
Leverage	-0.651***
	(-7.966)
Sales Growth	0.120***
	(9.104)
Firm Age	-0.298**
	(-2.263)
Cash Flow Volatility	3.112***
	(9.749)
Constant	2.579***
	(11.493)
Observations	47,218
R-squared	0.121
Firm Fixed Effects	Yes
Year Fixed Effects	Yes

Table 9: Generalist ability index, excluding turnover years

This table repeats the Table 4 regressions of firm value with the Generalist Ability Index as one of the explaining factors, but now excludes management turnover years when there was a change in CEO identification from a specialist to a generalist or visa versa. Definitions for GA Index, Generalist, and Specialist can be found in the description of Table 4. All variables are winsorized at the 1st and 99th percentiles. The t-statistics are reported in parentheses. Robust standard errors are adjusted for clustering at the firm-level. ***, **, * indicate the coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

	(1) Tobin's Q	(2) Tobin's Q	(3) Tobin's Q	(4) Tobin's Q
High Cash Volatility	0.045	0.039	0.091**	-0.013
	(1.122)	(0.986)	(1.994)	(-0.267)
Cash Holdings	1.974***	1.972***	1.983***	1.976***
	(6.100)	(6.100)	(6.054)	(6.118)
Log Assets	-0.397***	-0.398***	-0.407***	-0.405***
	(-6.813)	(-6.830)	(-6.933)	(-6.997)
R&D	0.244	0.229	0.214	0.300
	(0.167)	(0.157)	(0.145)	(0.205)
Advertising	0.706	0.735	0.702	0.594
	(0.506)	(0.523)	(0.500)	(0.428)
Leverage	-1.529***	-1.532***	-1.548***	-1.531***
	(-7.291)	(-7.299)	(-7.283)	(-7.293)
Firm Age	-0.033	-0.033	-0.030	-0.033
	(-0.855)	(-0.850)	(-0.772)	(-0.851)
Sales Growth	0.414***	0.413***	0.411***	0.413***
	(5.815)	(5.816)	(5.759)	(5.816)
GA Index	-0.067**	-0.036		
	(-2.330)	(-1.290)		
Generalist		-0.087**		
		(-2.074)		
Specialist			-0.047	
			(-0.953)	
GA Index * High Cash Vol			-0.190**	
			(-2.252)	
Generalist * High Cash Vol				-0.044
				(-0.720)
Specialist * High Cash Vol				0.223***
				(2.621)
Constant	4.893***	4.897***	4.918***	4.959***
	(7.092)	(7.100)	(7.236)	(7.232)
Observations	8,105	8,105	8,004	8,073
R-squared	0.193	0.193	0.195	0.194
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Figure 1: Cash volatility through time

This graph shows the mean of cash volatility for all firms across the sample period of 1992-2013.

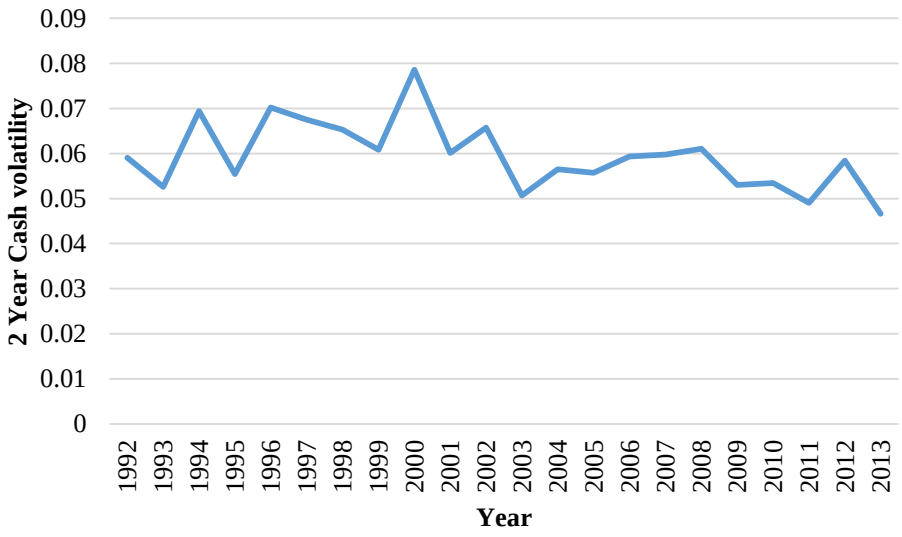

Figure 2: Firm value and cash volatility deciles

For each year, the sample firms are ranked into cash volatility deciles based on the standard deviation of their quarterly cash holdings for years *t-2* to *t-1*. The average Tobin's Q across each of the deciles is then calculated. The graph shows this average measure of firm value for each of these cash volatility deciles.

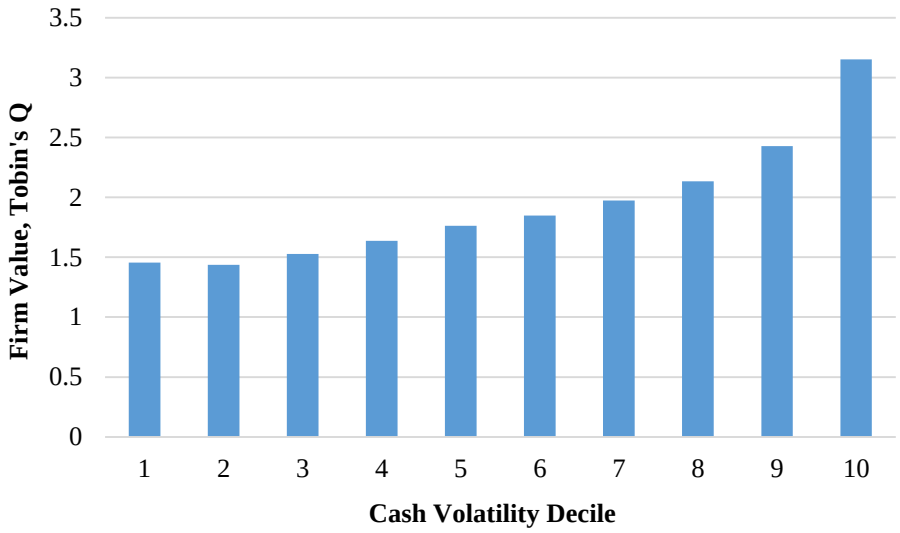

Figure 3: Optimal cash holdings through time

This graph plots the optimal cash holdings in each year from 1993 to 2012 highlighting the dynamic optimal level and the need for regular cash adjustment. The computation of optimal cash holdings is detailed in Appendix B.