

## A study on the effects of volatility on cash holdings

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### Introduction:

If recent events are anything to go by, it is clear that volatility in markets has reached a new height. According to reports from the 13th of March of this year, European stocks had increased by more than 4% only a few days after posting their worst day in history. The article also reports that Asian shares continued to “tumble across the board” while Australia's stocks rebounded from an 8% decline to a 4% increase. It has therefore never been more crucial to understand market volatility and its effects of the firms of today.

It is for these reasons that this paper will attempt to answer whether an increase in firm money holdings can be explained by an increase in volatility. In a study performed on why cash holdings for U.S. firms has increased over the past few decades (Bates et al., 2009), it was found that the average cash ratio has increased by 2.1% from the 1980s to 2006 due to an increase in volatility. This research will be replicated in this paper in order to verify if similar results arise from doing so. To do this, a regression analysis will be performed to measure the effect of volatility on cash holdings and whether or not this effect is statistically significant.

A theoretical background will be discussed, where major theories related to the study will be explained. Next, the methodology of the analysis will be detailed including context, treatment and an empirical specification. The results will then be described so that a final conclusion can be drawn from the data and analysis.

### Theoretical Framework:

The article in question, that this paper is based on, details an increase in cash holdings for firms based in the U.S. from 1980 to 2016 (Bates et al, 2016). A regression of mean cash to assets ratio and time revealed that the mean cash to assets ratio has increased at 0.46% per year since 1980.

In order to identify why firms hold more cash today, Bates first describes the major motives for firms to hold cash at all and based on evidence concludes four major reasons for doing so. These are, the transaction motive, the precautionary motive, the tax motive and the agency motive. The transaction motive relates to everyday transactions and purchases that require cash. The precautionary motive states that firms hold cash to deal with unexpected shocks to cash flows. This motive most relates to the effect that volatility has on firms. The tax motive describes how firms with foreign earnings hold more cash due to tax repercussions related to the recovery of said earnings. Finally, the agency motive states that firms

with agency problems tend to hold more cash if they have inadequate investments, instead of increasing shareholder payouts.

It is found in the paper that firms with the highest amount of idiosyncratic risk exhibits the highest increase in cash to assets ratio. This is proved by the fact the average cash flow risk increases from 7% to 15.9% from the 1980s to the 2000s, and also since in any regressions performed, the cash flow risk (industry sigma) has a positive and significant effect on cash holdings. It is also shown that change in net working capital, change in capital expenditures and changes in R&D have significant effects on cash holdings. Through inference, it was concluded that the mean cash ratio increased by 2.1%, solely due to the increase of cash flow volatility.

The hypothesis that will be tested is that volatility has a statistically significant positive effect on cash holdings of firms from 1980 to 2016.

### Methodology:

- Context and Participants: The sample used for analysis contains financial statistics of the largest 100 firms from 1980 to 2016. These statistics are ; book value of assets, capital expenditures, cash holding, number of shares outstanding, operating income before depreciation, stock price at end of fiscal year and the book value of equity. This data is drawn from Compustat, a database of financial information on firms. A total of 3595 observations are included in the sample which allows the data observed to be reasonably applied to firms outside the sample.
- Treatment and Measures: The treatment in the sample is year which is a variable containing the year that the data for firms was recorded. The outcome is cash holdings, which is a variable containing cash holdings as a percentage of book value of assets. The regression control variable is firm-year volatility which is calculated by taking the standard deviation in cash holdings over a period of 5 years.
- Design: The data in this assessment is obtained using a regression control (RC) design assessment. This design is used as the variable we are measuring (cash holdings) is a continuous one and we want to find the effect of volatility on cash holdings independent of other effects.
- Data:
  - *Procedures:* In order to work with the dataset, some variables needed to be changed to allow them to be compared more fruitfully. Since cash volatility was already a percentage, cash holdings and capital expenditures were expressed as percentages of book value of assets. The year variable was also adjusted to allow the constant to be interpreted. Initially, it was verified that cash holdings did in fact increase over the period

and investments decreased. Graphs were created which detail an increase in cash holdings from around 7% to around 13%, while investments decreased from 9% to 3%. Next a regression was performed to analyse the yearly decrease of investments over time.

Regressions for cash holdings were then performed, the first being a regression to analyse the change in cash holdings as a percentage of assets per year. Subsequently, the variable “cash\_vol\_missing” was used to exclude observations for which volatility data was not available in the dataset, and the regression was run again. Next, the variable “cash\_vol” was included to observe the effect of volatility on cash holdings. The next regression was controlled for the five highest values of cash holdings and volatilities, to prove that the effect of volatility still remains without these outliers. Finally the book value of equity was added to the regression as a control variable to prove robustness of the analysis.

- *Descriptive Statistics:* The mean of cash holdings seems fairly low compared to the minimum and maximum values within the variable. This could suggest a tendency of the variable to increase due to other factors as it is already low. The treatment variable, year, is merely a continuous variable of the years from 1980 to 2016 and thus it is not entirely useful to analyse its mean and standard deviation. Also included is a table showing means of the variables by year.

**Table 1**

<i>Variable</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Min</i>	<i>Max</i>
year	-2.19694	10.67166	3595	-20	16
inv	7.076433	4.429039	3595	0	41.4041
cash	10.27273	10.60529	3594	0	88.21379
cash_vol	2.755764	3.03228	3,152	.0019269	45.99311
at	60625.42	80458.97	3595	155.359	797769
capex	3812.279	5739.566	3595	0	50233.74

**Table 2**

Summary statistics: mean  
by categories of: year (year)

year	inv	cash	cash_vol	at	capex
1980	10.11794	8.102081	.	1749.138	111.8617
1981	11.08786	7.04267	1.725501	12397.92	1495.27
1982	10.04928	7.178022	1.536599	12901.79	1415.887
1983	8.489082	8.616759	1.994672	13965.46	1226.095
1984	8.628516	7.829309	2.061244	13789.31	1239.556
1985	9.032676	8.093204	2.537427	16341.76	1526.076
1986	7.719595	9.659076	2.774206	17230.46	1365.165
1987	7.244411	10.18452	2.717469	18900.43	1364.861
1988	7.59306	9.430749	2.624207	24001.93	1651.61
1989	7.659133	9.543375	2.521433	25937.74	1770.832
1990	7.888583	8.654988	2.454833	29703.76	2072.036
1991	7.743524	9.203976	2.271934	30806.93	2145.979
1992	7.516237	8.32872	1.813001	32702.33	2107.561
1993	7.182301	7.935623	2.027458	34364.97	2011.729
1994	6.929046	8.141224	2.385642	36994.19	2257.409
1995	7.434986	7.700296	2.348297	38889.76	2676.424
1996	7.532472	7.504807	2.177427	41022	3025.384
1997	8.015521	8.511255	2.086725	43011.43	3370.195
1998	7.589326	9.143476	2.441985	43751.57	3255.369
1999	6.987687	11.9278	2.888757	54112.66	3718.885
2000	6.465071	11.07448	3.060637	61231.99	3920.194
2001	6.639675	10.35009	3.41722	65425.05	3979.414
2002	5.477187	10.48088	3.436567	70617.93	3808.282
2003	5.197905	12.29359	2.989131	78486.82	3859.555
2004	5.32032	13.62036	3.685358	84964.18	4394.463
2005	5.679626	13.37655	3.477272	86271.25	4735.073
2006	6.485131	11.74308	3.532634	96216.64	6125.97
2007	6.55672	11.2579	3.64311	103939.9	6607.282
2008	6.541063	11.15529	3.52737	101554.3	6935.803
2009	5.782815	12.79864	3.379022	107332.1	6269.126
2010	5.519	13.24733	2.983319	115123.9	6650.703
2011	6.033581	12.56982	2.983022	122428	7612.874
2012	6.213569	12.24913	2.989035	126733.4	8465.17
2013	5.887521	13.05491	2.793403	131551	8757.052
2014	5.345425	13.1205	3.059248	128931.1	7996.405
2015	4.721662	13.32733	3.051305	127613.5	6910.209
2016	4.680497	12.86998	2.996936	120563	5880.506
Total	7.076433	10.27273	2.755764	60625.42	3812.279

### Empirical Specification:

The regression specification of the final regression is:  $Y_i = \beta_1 X_{1i} + \beta_2 W_{1i} + \beta_3 W_{2i}$ .  $Y_i$  is cash holdings,  $X_{1i}$  is the year and therefore  $\beta_1$  is the amount by which cash increases each year,  $W_{1i}$  is cash volatility and  $\beta_2$  is therefore the trend in cash holdings caused by cash volatility.  $W_{2i}$  is the book value of equity and  $\beta_3$  is the trend caused by this variable. As the effect of cash volatility is being assessed, the coefficient to be noted is  $\beta_2$  which depicts the amount by which cash holdings increases with every percentage increase of volatility. If we now consider the hypothesis in terms of the regression specification, we see that if  $\beta_2$  is positive and is determined to be significant, the hypothesis will be proved as true. The hypothesis in terms of this specification is as follows: It will be tested whether the  $\beta_2 > 0$  and is significant in a regression analysis for  $Y_i$ .

### Results:

**Table 3**

	<u>a</u>	<u>b</u>	<u>c</u>	<u>d</u>	<u>e</u>
<i>year</i>	0.169***	0.176***	0.120***	0.104***	0.150***
<i>cash_vol</i>	-	-	1.449***	1.847***	1.825***
<i>bkequity</i>	-	-	-	-	-0.000***
<i>constant</i>	10.644***	10.472***	6.417***	5.344***	6.138***
<i>N</i>	3594	3151	3151	3145	3145
<i>R-sq</i>	0.029	0.029	0.204	0.265	0.270
* $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$					

The hypothesis initially proposed was that cash volatility had a statistically significant, positive effect on cash holdings. For all regressions performed, an alpha of 5% was assumed. This meant that any results with a p value greater than 5% were deemed statistically insignificant. Initially, a regression was performed to show that investment has decreased over the sample period. This was shown to be true with mean investments decreasing at 0.12% per year. As can be seen from table 3, all results found were

statistically significant to 0.1% which is well within the alpha levels. Regression 'a' included the variable year and no control variables. This regression shows that, absent of all other variables, cash holdings as a percentage of book value of assets increases by 0.17% per year. Regression 'b' was controlled for missing values of cash volatility which becomes more useful in later regressions when volatility is included. The effect of year increases here to 0.176% when the 443 observations with missing data were removed. Regression 'c' is the first regression that includes volatility, and we see that the effect of year decreases because of this. This regression shows that for every percentage increase of volatility, cash holdings increases by 1.45%. Regression 'd' contains the same variables, but is controlled for the highest five values of cash holdings and volatility. By removing the highest outliers of these variables, it can be proved that the effect of volatility remains for the remaining firms in the sample, which it does. This regression is ultimately the regression that we analyse to verify the hypothesis. Since the effect of volatility is positive (1.85%) and statistically significant to 0.1%, the hypothesis is supported by the results found. Regression 'e' was performed as a test of robustness, and thus the control variable 'bkequity' was included, which is book value of equity. The effect of cash volatility only changes by 0.022 which is not a large amount. Finally, the amount by which volatility contributed to the trend of increase of cash holdings was calculated to be 40.65%.

### Discussion:

This analysis aimed to prove that an increase in cash holdings was largely the result of an increase in cash volatility among firms. The results therefore show that the hypothesis is proved, as it was in the analysis performed by Bates et al. (2009). As explained in the article, the main reason for this is that it allows firms to be better prepared for adverse shocks in cash flow that may occur due to increased volatility, also known as the precautionary motive for holding cash. Of course cash volatility is not the only reason for the increase in holdings, however, the analysis performed seems to suggest that it plays a major role nonetheless.

### Conclusion:

With this analysis, the aim was to prove whether or not the trend of increasing cash holdings since 1980 can be reasonably explained by an increase in cash volatility amongst firms. Multiple regression analyses were carried out to this end, allowing the hypothesis to be verified. As a result of the research performed, it can be concluded that the trend of increasing cash holdings can be explained by an increase in cash volatility, with statistical evidence backing up these claims to alpha levels of 0.1% . This

effectively means that there is a 0.1% chance of concluding that volatility has an effect when it does not have an effect. The reason that volatility affects cash holdings relates to the precautionary motive for holding cash. Firms can better cope with more volatile cash flows when a certain buffer of cash is maintained.

It should be noted that the R squared values do not provide much confidence in the results found. The final R squared value obtained was 27%, which shows that while there is a trend, there is a large amount of variation within the trend. However, since the results of the regression still show a statistically significant increasing trend of cash holdings, it is reasonable to conclude that the R squared value does not have a large effect on the conclusions drawn. In the study performed by Bates et al. (2009), a much more in-depth regression was performed which included a wide variety of variables and possible predictors. Due to limitations in the database used, this was not done in this analysis. Again, this does not discredit the conclusions drawn in this analysis as the results are still statistically sound.

A study performed by Bakke and Gu (2016) provides an interesting stepping point for further research. They concluded from a comparison of more and less diversified firms, that more diversified firms hold much less cash than relatively less diverse firms. It would be beneficial to analyse the effects of such firm characteristics in conjunction with the increase in cash volatility. Does the increase in volatility equally affect all types of firms, or some more than others?

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