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THE TIME-VARYING CASH FLOW SENSITIVITY OF CASH

ABSTRACT

By using data of US manufacturing companies, we revisit the cash flow sensitivity to cash in two sub-samples of 1993-2000 and 2000-2011 to investigate the time-varying features of the cash flow sensitivity of cash. Our results show a weakening coefficient of US manufacturing firms from 1990s to 2000s. The sensitivity in the later time period is only a half of its original scale. Financially unconstrained firms seem to converge with the constrained firms in the later period, leading to the conclusion that macroeconomic conditions impact more on the cash flow sensitivity of cash than the external financial constraint does. Further, our research identifies that the overall decreasing sensitivity is driven by firms with negative cash flows.

Key Words: financial constraints, cash flow sensitivity of cash

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INTRODUCTION

One important topic in corporate finance is how financial constraints impact firms' behaviour. There has been research done on the impact of financial constraints on investment behaviour (Fazzari *et al.*, 1988; Kaplan and Zingales, 1997; Cleary, 1999), on working capital (Fazzari and Peterson, 1993; and Calmiris *et al.*, 1995), and on inventory demand (Carpenter *et al.*, 1994, and Kashyap *et al.*, 1994). In the same category is the research that investigates the impact of financial constraints on firms' liquidity demand, which is the sensitivity of cash flow to cash holding.

Why do firms save cash from cash flows and what do we know about their practices? The most influential paper on this topic is by Almeida *et al.* (2004) who investigate the US manufacturing companies and find that the sensitivity of cash flow to cash depends on the external financial constraints of firms. Almeida *et al.* (2004) find that the financially constrained firms tend to save cash while the financially unconstrained firms seem to exhibit no pattern in cash holding. Since the financially unconstrained firms do not have any concern of raising funds from external sources, the cash flow level does not affect their cash holdings at all. Further, Almeida *et al.* (2004) also find that financially constrained firms show increase in the sensitivity of cash flow to cash following negative macroeconomic shocks, but the financially unconstrained firms do not.

Following Almeida *et al.* (2004), Bates *et al.* (2009) find that US firms have increased their cash holdings from 2000. The paper argues that this increase in cash holding reflects the fact that the cash flows are becoming riskier and firms try to save out of the precautionary motive. Further, Duchin *et al.* (2010) investigate the drastic change of the economic conditions in the last decade and find that the 2008 financial crisis has raised the cost of external capital and thus negatively hurt the investments of firms. In this macroeconomic environment, firms tend to save more to alleviate the credit problem. Further, the macroeconomic conditions seem to have a larger impact on the cash flow sensitivity to cash rather than the financial constraints. Riddick and Whited (2009) argue that cash flow sensitivity of cash cannot be used to measure the external financial constraints. Supporting Riddick and Whited (2009), Bao *et al.* (2011) challenge the findings

of Almeida *et al.* (2004) by arguing their results might be driven by firms with negative cash flows. In their work, Bao *et al.* (2011) discuss the asymmetry issue in the cash flow sensitivity to cash. Their empirical results show that firms with negative cash flows versus positive cash flows may show different pattern in their sensitivities of cash flow to cash. Further, they find that when facing a positive cash flow environment, the cash flow shows a negative sensitivity to cash. This result is inconsistent with that of Almeida *et al.* (2004).

Different from the prior literature, this research focuses on the time-varying feature of the cash flow sensitivity to cash. We hypothesize that the different features found in recent literature may be driven by the data of recent time period, and influenced by the macroeconomic variables that the prior years do not see. Therefore, we revisit the cash flow sensitivity of cash topic in a different time period and different macroeconomic environment.

By using US manufacturing companies' data from 1993 to 2011, we follow mainly the methodologies used in Almeida *et al.* (2004), and revisit the cash flow sensitivity to cash with the most up-to-date data. The overall sample is then split into two sub-samples of 1993-2000 and 2000-2011. Throughout the research, we run basic and extended regressions for each of the two sub-periods respectively to verify if the sensitivity of cash flow to cash varies over time. Based on our results of both the basic regression and the augmented extended regressions (Instrumental Variables approach adopted), we find the sensitivity of cash flow to cash of US manufacturing companies has decreased to only a half of its original level from the first time period to the recent time period. There is strong evidence that the sensitivity of cash flow to cash is time varying, and actually weakening recently.

We also grouped the entire sample into financially constrained firms versus unconstrained firms based on the firm-year dividend payout ratio, Kaplan-Zingales Index, the firm size, and the debt ratio. We find that financially constrained firms behave very differently in the first time period which is a period partially overlapping with that in Almeida *et al.* (2004). However, in the recent 10 years, financially unconstrained companies seem to share similar pattern with those of the constrained. This evidence indicates, again, the time-varying feature of the cash flow sensitivity of cash, and is consistent with Duchin *et al.* (2010).

Including macroeconomic proxies in the extended regression, our results show that in the early time period, economic conditions negatively impact on the sensitivity of cash flow to cash, but the impact seems to be positive in recent years. Further, our results also suggest that the financially unconstrained firms seem to have a higher capacity to handle bad economic conditions in the recent time period. The sensitivity patterns exhibited in both financially constrained and unconstrained firms seem to suggest the precautionary motive to the cash saving.

In the robustness check, we further study the potential asymmetry in the cash flow sensitivity to cash suggested by Bao *et al.* (2011). We find that the asymmetry feature depends on the methodology used. When the augmented regression method is adopted, the sensitivity of cash flow to cash seems changes its pattern over time as well as across groups with different sign of cash flows. Moreover, decomposing the sample into firms with positive versus negative cash flows helps identifying the driving force of the weakening sensitivity of cash flow to cash in the overall sample. Our results document those firms with positive cash flows show stronger sensitivity, which is positive and significant in more recent years. Further, the financially unconstrained companies show positive and significant sensitivity in recent years, inconsistent with the findings of Almeida *et al.* (2004).

The overall contributions of our research are three folds. First, we investigate and find the time-varying feature of the sensitivity of cash flow to cash. We are one of the first documenting the weakening of the coefficient of US manufacturing firms from 1990s to 2000s. The sensitivity in the later time period is only a half of its original scale. Secondly, we find that the financially unconstrained firms seem to converge in behaviour with the constrained firms in later period, leading to the conclusion that macroeconomic conditions have a larger impact on the cash flow sensitivity of cash than the external financial constraint does. This result is supporting Duchin *et al.* (2010) and Riddick and Whited (2009). Third, our research is the first one separating firms with negative cash flow from those with non-negative cash flow and in different time periods. This enables us to identify the driving force - those firms with negative cash flows - of the decreasing sensitivity in the overall sample. Firms with non-negative cash flows, on the contrary, exhibit strong and significant positive sensitivity regardless of their financial constraints.

This research will proceed as follows. In the next section, we briefly review the important research done with regard to cash flow sensitivity of cash. We then discuss the methodology used in this research and the composition of our sample. In section 4, we report the empirical evidence from the tests, and section 5 concludes.

LITERATURE REVIEW

The most influential research in this area is by Almeida, Campello, and Weisbach (2004), which investigate US manufacturing companies from 1971 to 2000, and finds that the financially constrained (FC) firms have positive cash flow sensitivity to cash while non-financially constrained (NFC) firms do not exhibit any systematic link between cash flows and cash holdings. Their paper argues that the FC firms anticipate future financial constraints and future investment opportunities, so they choose to hold cash to respond to the future possible constraints. However, holding cash is costly where firms have to give up current profitability. Therefore, firms need to carefully choose the optimal policy that balances the current and future profits. In this scenario, cash holding becomes sensitive to the cash flow of a firm. On the other side, a firm facing no constraints (NFC) has no use of cash; neither will they incur any cost of holding cash. In this case of NFC firms, the cash policy is indeterminate. The paper develops a model in which cash flow sensitivity of cash is positive for FC firms and indeterminate for NFC firms.

Many research followed after Almeida *et al.* (2004) with regard to the sensitivity of cash flow to cash holdings. Bates *et al.* (2009) investigates the cash holdings of US firms and question why US firms hold so much cash than they used to. In the paper, the authors document that US firms have increased their cash holdings since 2000. They argue that the increase in average cash ratio is a result of the riskier cash flows. Bates *et al.* (2009) suggests that the precautionary motive for cash holding seems to explain the increase in cash holdings.

Duchin *et al.* (2010) further investigates the sensitivity of cash flow to cash and claims that cash holding has helped alleviate the credit constraints in recent recessions. Their study finds that corporate investment has declined significantly due to the financial crisis of 2008. With the external funds become more expensive, firms seem to adopt a policy of

saving more cash and accumulate them to satisfy the potential needs in the future. They argue that accumulating cash seems to be driven by the precautionary motive, and seems to help with reducing the pressure of credit shortage.

Riddick and Whited (2009) investigate the reasons of firm accumulating liquid assets. They establish a model showing that the trade-off between interest income taxation and the cost of external finance determines the optimal savings. Interestingly, their empirical test results suggest that the sensitivity of cash flow to cash should be negative when controlling Tobin's Q. They also argue that the income uncertainty affects the sensitivity more than the external financial constraints. More importantly, Riddick and Whited (2009) concludes that cash flow sensitivity to cash may not be used to measure the external finance constraints.

Supporting the findings of Riddick and Whited (2009), Bao *et al.* (2011) uses an augmented empirical model testing the US manufacturing companies from 1972 to 2006, and finds that the sensitivity of cash flow to cash is largely negative. They further demonstrate that firms with negative or positive cash flows may show different sensitivity of cash flow to cash. Therefore, there is an asymmetry of the sensitivity with regard to the cash flow sign. They find that cash flow sensitivity is negative when the firm is facing a positive cash flow environment. Their work also shows the asymmetry found in cash flow sensitivity of cash holds with companies with different external financial constraints.

In this study, we attempt to revisit the sensitivity of cash flow to cash in a different perspective. This research questions whether the cash flow sensitivity to cash changes over time, especially with the volatile economic conditions in the past decade. Many prior papers recognize that the cash holding level has been increased after year of 2000, and the financial crisis in 2008 has a huge impact on the cost of external finance and thus lower the investment expenditure of firms. However, there is not a research which investigates specifically the time-varying pattern of the cash flow sensitivity of cash, and if financially constrained firms and unconstrained firms keep on behaving differently as suggested by Almeida *et al.* (2004) in recent year or if the pattern has changed. Our research attempts to fill the gap of the literature and approach the sensitivity of cash flow to cash from its possible time-varying characteristics.

DATA AND METHODOLOGY

Regression Models

In this paper, our focus is on how the sensitivity of cash flow to cash holding changes over time. Specifically, we would like to investigate if there is any different pattern in recent years due to the different economic conditions. We attempt to investigate the trend of cash holdings of US companies, as well as the sensitivity of cash flow to cash holdings in recent years. Therefore, we adopt both the basic and extended models of Almeida *et al.* (2004) and further adding in macroeconomic variables to account for the changing economic conditions.

The basic regression model regresses the change of cash holding against cash flows and other variables of the firm. The dependent variable is CashHolding, defined as sum of cash and marketable securities over total assets, and the main independent variable CF is calculated as the ratio of earning before extraordinary items and depreciation to total assets. Therefore, the basic regression model is

$$\Delta\text{CashHoldings}_{i,t} = \alpha + \beta_1\text{CF} + \beta_2\text{Q} + \beta_3\text{Size} + \varepsilon_{i,t} \quad (1).$$

In addition to CF, Size is defined as the natural log of firm's assets. Almeida *et al.* (2004) point out that the economy of scale in cash management should influence the change of the cash holdings. Usually, large and matured companies can use their synergy to better handle the difficult economic downturns. Therefore the size of a firm plays an important role in the change of cash holdings.

Q is the market value divided by book value of assets. Though there are many discussions about the possible bias that Q might introduce as in the standard investment-cash flow sensitivity research, Almeida *et al.* (2004) argue that the left hand side of the basic regression is a financial variable so including Q is less likely to introduce bias than the situation that if it is a real variable.

In addition to the basic regression, the change of cash holdings can also be viewed as results of a firm's decisions on capital expenditures and cash managements. The extended

regression includes additional variables to control for those decisions. The extended regression model is as following:

$$\Delta\text{CashHoldings}_{i,t} = \alpha + \beta_1\text{CF} + \beta_2\text{Q} + \beta_3\text{Size} + \beta_4\text{Expenditure}_{i,t} + \beta_5\text{Acquisitions}_{i,t} + \beta_6\Delta\text{NWC}_{i,t} + \beta_7\Delta\text{ShortDebt}_{i,t} + \varepsilon_{i,t} \quad (2).$$

In the equation, Expenditure i,t is the capital expenditure of the firm year scaled by total assets, Acquisitions i,t is defined as the firm's acquisition scaled by total assets, where $\Delta\text{NWC } i,t$ is the firm year change of non-cash net working capital scaled by total assets, and the $\Delta\text{ShortDebt } i,t$ is the change of short term debt scaled by total assets. Capital expenditure and acquisitions are possible reasons of a firm decreasing its cash holdings. Firms can easily lower their cash holdings to satisfy their needs of investments. In addition, change of the non-cash working capital is included since it can be a substitute of cash, while change of the short-term debt is included for the same argument that firms can borrow short term loans to increase their cash holdings.

Following Almeida *et al.* (2004), we conduct the extended regression by recognizing that cash saving is a result of not only cash flow generated that year but further the result of capital expenditure requirements and financing decisions, controlled by using capital expenditure, acquisition, change of net working capital, and change in short term debt. To control for endogeneity problem, we use the instrumental variable (IV) approach with variables that include two lags of the level of fixed capital, lagged acquisition, lagged net working capital, lagged short-term debt, and lagged 2-digits SIC industry dummy, and twice lagged sales growth. In the tests, we also use firm-fixed effects to control for simultaneity bases from the unobserved potential heterogeneity. Further, we use the Huber-White method to allow residuals be correlated within years.

Different from Almeida *et al.* (2004), this study proposes that the sensitivity of CF to cash holding may change overtime due to the change of overall economic environments. Specifically, the financial crisis in 2008 influenced the overall liquidity of the capital markets and therefore decisions of firms with regard to their cash holdings. Duchin *et al.* (2010) study the effect of 2008 financial crisis on corporate investment and find that the firms had

an important precautionary savings motive for the crisis period leading to excess cash holdings. To control for different macroeconomic conditions, this study introduces macroeconomic variables in the following regression:

$$\Delta\text{CashHoldings}_{i,t} = \alpha + \beta_1\text{CF} + \beta_2\text{Q} + \beta_3\text{Size} + \beta_4\text{Expenditure}_{i,t} + \beta_5\text{Acquisitions}_{i,t} + \beta_6\Delta\text{NWC}_{i,t} + \beta_7\Delta\text{shortDebt}_{i,t} + \beta_8\text{MacroE}_{i,t} + \varepsilon_{i,t} \quad (3).$$

We adopt two proxies for the macroeconomic conditions. The first one is the growth rate of GDP (GDPgr). This is an obvious choice as the economic recession is defined by the change of GDP, where if declines in real GDP are observed in two or more successive quarters of a year, the recession is established. The alternative measure used to control for the macroeconomic environment is the defaults spread (DSpread). This variable is defined as the difference between average BBB rated bond yield and the average AAA rated bond yields. This same variable was used in Korajczyk and Levy (2003) and Fama and French (1989) where it is found that the spread is higher during recessions and lower during expansions. Fama and French (1989) argue that the default spread can track the long-term business cycle conditions. Cook and Tang (2010) argue that firms adjust their capital structure at different speed in various economic conditions. Regardless of the financial status of the firm (financially constrained or unconstrained), firms adjust faster in good economy than in bad economy, indicating macroeconomic conditions have a significant impact on firms behaviour.

Measuring Financial Constraints

How to effectively and accurately measure the level of financial constraints so that firms can be sorted accordingly has been a long-standing debate in the investment-cash flow sensitivity literature. Not attempting to make a judgment of which method is better, this study borrows several popular methods in prior research to categorize firms into financially constrained and financially unconstrained. The different criteria adopted by this study include:

- 1) *Dividend Payout* – For each year of the time period this study investigates, firms are sorted into financially constrained (DIV C) where their dividend payout ratios are negative; firms are categorized as financially unconstrained (DIV U) if their dividend payouts are positive. This method has been widely used by prior studies in the investment-cash flow sensitivity literature (Fazzari *et al.*, 1988) where financially constrained firms are regarded to have much lower dividend payout ratios than those unconstrained firms. Almeida *et al.* (2004) used the same method, but they defined financially constrained/unconstrained firms as those at bottom/top 30 percentiles when sorted by the dividend payout ratio. In our sample, there are 2,158 firm year observations that have dividend payout ratios negative, where 9,442 observations having positive payout ratios, and the remaining 19,940 observations are those having zero dividend payout ratios. If we follow Almeida *et al.* (2004), both constrained and unconstrained groups will contain some firms with zero dividend payout ratios. Therefore, our study defines firms with positive dividend payout ratio as unconstrained firms, and firms with negative dividend ratios as constrained firms. A negative dividend payout ratio indicates that the firm has a negative operating income before dividend payments and therefore financially constrained.
- 2) *Size* – Firms with large size are usually regarded as matured while small companies are usually young and having limited access to the capital markets. Therefore, size can also serve as a criterion distinguishing financially constrained firms from those not constrained. In this study, firms in top thirty percentiles are regarded as financially unconstrained, where those at the bottom thirty percentiles are regarded as financially constrained.
- 3) *Debt Ratio* – High leverage ratio is also an indicator of financial constraints. In this study, firms are ranked based on their debt ratio for each year. Firms are assigned to the financially constrained (unconstrained) group if they belong to bottom (top) thirty percentiles of the debt ratio.
- 4) *KZ Index* – Following Almeida *et al.* (2004), we also adopt KZ index in this study to be one criterion when sorting firms. KZ index was first introduced by Kaplan and

Zingales (1997) where they used this index to categorize firms into financially constrained and unconstrained in studying the sensitivities between investment and cash flows. In this paper, we also construct the KZ index using the original variable definitions of Kaplan and Zingales (1997), and each firm year observation will be assigned a KZ score based on the following calculation:

$$KZ = -1.001909 \text{CashFlow} + 0.02826389 Q + 3.139193(\text{Long-term Debt} + \text{Debt in Current Liabilities}) / \text{Assets} - 39.3678 \text{Cash Dividend} / \text{Assets} - 1.314759 \text{Cash Holdings}.$$

When sorted by the KZ scores, firms at the bottom thirty percentiles are regarded as the financially unconstrained and those at the top thirty percentiles are regarded as financially constrained. Since we use firm year data, the sorting is done on the annual basis which allows the possibility of firms changing their financial status year by year.

The Sample

In this study, we investigate US manufacturing companies (SICs 2000-3999) from 1993 to 2011. Almeida *et al.* (2004) investigate the similar set of companies in the time period of 1973-2000. Our research adopts more recent data with part of the time period overlapping with that of Almeida *et al.* (2004). Specifically, we separate the overall time period into two sub-periods which are 1993-2000 and 2001-2011 respectively. Bates et al (2009) find that cash holdings of US firms have been increasing after 2000. With this separation of two sub-periods, we attempt to test if the sensitivity of cash flow to cash holding documented in Almeida *et al.* (2004) change over time given the increasing cash holdings and the volatile market conditions in the second sub-period.

We collect firms accounting data from COMPUSTAT over the years of 1993 to 2011 where data is available. The final sample contains 31,540 firm year observations after we balance the data for the IV approach adopted in the extended regression tests (Equation 2). For the tests of macroeconomic impact in Equation 3, we collect macroeconomic data from the website of Federal Reserve Board and from US Department of Commerce.

Table 1 reports descriptive data of our sample. Panel A documents the cash holding ratio in each year for the time period of 1993-2011. As we observe, the mean of cash holding is 0.2151 in 1993 with median of 0.1043, they both increase to 0.2522 and 0.1680 in 2011. During this 19 years period, we do find the overall increase of firm's cash holding ratios from 2000, which confirms the findings in Bates *et al.* (2009). Further, Bates *et al.* (2009) investigate empirical data till 2004, while in our sample, we find both mean and median of cash holding ratios keep increasing untill 2007. As expected, the ratio decrease in 2008 and 2009 when the economy was in the recession, but firms manage to bring up the cash holding ratio in 2010 and 2011. Over the 19 year period, the peak of cash holding ratio is at 2006 (the mean ratio is 0.2645) while the lowest is in year 1995 (the mean ratio is 0.1935). This table shows that firms are holding more cash in recent years, even in the recent economic crisis; the average holding is higher than that of the 1990s.

Table 1 (Panel B) reports the grouping results of our sample based on the four grouping criteria discussed above. Using dividend payout ratio, firm size, debt ratio, and KZ index, the entire sample is grouped into financially constrained firms and unconstrained firms. Since the grouping is conducted on a yearly basis, it allows firms change their financial status from year to year. Further, Panel B reports the t-test result of financially constrained firms versus unconstrained firms based on each grouping criterion. As we find the mean and median of cash holdings of the two groups are statistically different indicating the grouping methods adopted successfully distinguished firms with different financial status.

Table 1. Sample descriptions
Panel A: Cash holdings ratios on annual basis

Year	Obs.	Cash Holdings Ratio		Change in Cash Holdings Ratio	
		Mean	Median	Mean	Median
1993	780	0.2151	0.1043	-0.0138	-0.0020
1994	1004	0.1965	0.0926	-0.0273	-0.0059
1995	1092	0.1935	0.0769	-0.0047	-0.0025
1996	1149	0.2078	0.0912	-0.0021	0.0000
1997	1265	0.2358	0.1050	-0.0125	-0.0027
1998	1302	0.2242	0.0973	-0.0259	-0.0063
1999	1224	0.2115	0.0878	-0.0159	-0.0019
2000	1183	0.2489	0.1111	0.0134	0.0005
2001	1164	0.2584	0.1348	-0.0071	-0.0001
2002	1145	0.2557	0.1492	-0.0063	0.0001
2003	2464	0.2381	0.1482	0.0140	0.0051
2004	2430	0.2542	0.1622	0.0085	0.0025
2005	2388	0.2606	0.1717	0.0015	0.0000
2006	2364	0.2652	0.1686	0.0017	-0.0005
2007	2270	0.2645	0.1631	-0.0071	-0.0004
2008	2181	0.2416	0.1473	-0.0256	-0.0064
2009	2114	0.2532	0.1752	0.0192	0.0143
2010	2061	0.2609	0.1862	0.0064	0.0037
2011	1960	0.2522	0.1680	-0.0133	-0.0048

Panel B: Financially constrained versus unconstrained firms

	Cash Holdings Ratio						Change in Cash Holdings Ratio					
	N	Mean	Median	Std. Dev.	Min.	Max.	N	Mean	Median	Std. Dev.	Min.	Max.
Financial Constraints Criteria												
1. Dividend Payout Ratio												
Constrained Firms (C)	2158	0.3363	0.2368	0.3076	0	1	2158	-0.0079	-0.0053	0.1764	-0.4267	0.4298
Unconstrained Firms (U)	9442	0.1253	0.0757	0.1424	0	0.9876	9442	0.0013	0.0007	0.0730	-0.4267	0.4298
p-value (C-U not equal to 0)		0.00	0.00					0.00	0.00			
2. Firm Size												
Constrained Firms (C)	9471	0.2990	0.2040	0.2839	0	1	9471	-0.0086	-0.0028	0.1587	-0.4267	0.4298
Unconstrained Firms (U)	9471	0.1325	0.0793	0.1519	0	0.9934	9471	-0.0005	0.0008	0.0735	-0.4267	0.4298
p-value (C-U not equal to 0)		0.00	0.00					0.00	0.00			
3. Debt Ratio												
Constrained Firms (C)	9471	0.4287	0.3898	0.2644	0	1	9471	0.0032	0.0023	0.1472	-0.4267	0.4298
Unconstrained Firms (U)	9471	0.1324	0.0479	0.1966	0	1	9471	-0.0076	-0.0005	0.1102	-0.4267	0.4298
p-value (C-U not equal to 0)		0.00	0.00					0.00	0.00			
4. Kaplan-Zingales Index												
Constrained Firms (C)	9471	0.3984	0.3594	0.2792	0	1	9471	0.0203	0.0068	0.1217	-0.4267	0.4298
Unconstrained Firms (U)	9471	0.1406	0.0486	0.2071	0	1	9471	-0.0190	-0.0019	0.1263	-0.4267	0.4298
p-value (C-U not equal to 0)		0.00	0.00					0.00	0.00			

Panel C: Annual mean cash holdings ratios of financially constrained versus unconstrained firms

YEAR	DIV C		DIV U		Size C		SIZE U		Debt C		Debt U		KZ C		KZ U	
	Obs.	Cash Holdings Ratio	Obs.	Cash Holdings Ratio	Obs.	Cash Holdings Ratio	Obs.	Cash Holdings Ratio	Obs.	Cash Holdings Ratio	Obs.	Cash Holdings Ratio	Obs.	Cash Holdings Ratio	Obs.	Cash Holdings Ratio
1993	50	0.3680	287	0.1070	234	0.3022	234	0.1028	234	0.4346	234	0.0630	234	0.3739	234	0.0677
1994	55	0.3405	368	0.0949	302	0.2925	302	0.0853	302	0.3678	302	0.0663	302	0.3359	302	0.0872
1995	74	0.3177	389	0.0917	328	0.2677	328	0.0843	328	0.3724	328	0.0631	328	0.3514	328	0.0693
1996	86	0.3334	386	0.1016	345	0.2584	345	0.0936	345	0.4008	345	0.0672	345	0.3799	345	0.0744
1997	99	0.3490	384	0.1103	380	0.2839	380	0.1028	380	0.4570	380	0.0915	380	0.4189	380	0.1040
1998	114	0.3757	376	0.0906	391	0.2968	391	0.1005	391	0.4145	391	0.0971	391	0.3851	391	0.1172
1999	114	0.3413	339	0.0958	368	0.2998	368	0.0964	368	0.4007	368	0.0964	368	0.3560	368	0.1092
2000	114	0.3532	306	0.0953	355	0.2929	355	0.1359	355	0.4865	355	0.1042	355	0.4600	355	0.1219
2001	99	0.3646	301	0.1140	350	0.2939	350	0.1582	350	0.4807	350	0.1080	350	0.4552	350	0.1199
2002	97	0.3654	292	0.1201	344	0.2891	344	0.1550	344	0.4444	344	0.1338	344	0.4149	344	0.1376
2003	168	0.3392	692	0.1185	740	0.2755	740	0.1475	740	0.4092	740	0.1429	740	0.3950	740	0.1380
2004	160	0.3762	712	0.1312	729	0.3033	729	0.1464	729	0.4307	729	0.1546	729	0.4078	729	0.1629
2005	167	0.3761	729	0.1382	717	0.3069	717	0.1490	717	0.4381	717	0.1632	717	0.4138	717	0.1725
2006	144	0.3541	713	0.1356	710	0.3174	710	0.1411	710	0.4561	710	0.1578	710	0.4161	710	0.1659
2007	140	0.3346	677	0.1328	681	0.3195	681	0.1399	681	0.4465	681	0.1593	681	0.4177	681	0.1712
2008	151	0.2522	654	0.1262	655	0.2982	655	0.1238	655	0.4153	655	0.1463	655	0.3724	655	0.1608
2009	133	0.2665	603	0.1531	635	0.3015	635	0.1507	635	0.4156	635	0.1548	635	0.3895	635	0.1599
2010	100	0.3018	608	0.1609	619	0.3126	619	0.1542	619	0.4262	619	0.1618	619	0.3984	619	0.1622
2011	93	0.2884	626	0.1594	588	0.3181	588	0.1428	588	0.4270	588	0.1628	588	0.3869	588	0.1641

Table 1 (Panel C) reports the annual mean of cash holding ratios of financially constrained firms versus financially unconstrained firms based on dividend payout ratio, firm size, debt ratio, and KZ index. It is very interesting to see that financially constrained firms have a higher average cash holding ratio than that of the unconstrained firms, usually by 2-3 times, and regardless of the grouping criteria used each year. Over time, it seems a general trend of increasing cash holding ratio for both financially constrained and unconstrained firms where ratios for either group dropped during the recession period of 2008 and 2009. More interestingly, this table indicates that financially unconstrained firms can better handle the difficult time of recession, where their cash holding ratios in 2010 and 2011 quickly came back to a similarly high level (or even higher in the group based on dividend payout ratio) to those years prior to crisis.

EMPIRICAL RESULTS

Basic Regression Results

Following Almeida *et al.* (2004), we first run the basic regressions (Equation 1) for the two sub-periods where cash holdings of financially constrained or unconstrained firms are regressed against cash flow of the firm, Tobin's Q, and the firm size. Table 2 reports the regression results of 1993 to 2000 and 2001 to 2011 separately.

As we find from the results, the overall samples in both the two time periods show strong and positive coefficients of cash flow to the cash holding ratios. However, the coefficient (0.016) of the recent time period of 2001-2011 is only half of that (0.033) in the early period, indicating a decreased overall contribution of cash flow to the increased cash holding levels. Further, when comparing the financially constrained firms with those unconstrained firms, we find that in the early period, financially constrained firms show significant and positive relations between cash flow and cash holdings in three out of four groupings, where KZ group has financially unconstrained firms have a positive and significant coefficient of cash flow to cash holdings.

Table 2. Basic regression results for financially constrained and unconstrained firms

	1993-2000								
	All (C&U)	Div C	Div U	Size C	Size U	Debt C	Debt U	KZ C	KZ U
CFL	0.033*** [0.005]	0.026** [0.013]	0.007 [0.028]	0.034*** [0.006]	0.007 [0.008]	0.042*** [0.011]	0.027*** [0.008]	0.002 [0.014]	0.026*** [0.006]
Q	0.003*** [0.001]	0.005*** [0.002]	0.004** [0.002]	0.004*** [0.001]	0.003 [0.002]	0.003*** [0.001]	0.006*** [0.002]	0.004*** [0.001]	0.004*** [0.001]
Size	0.001** [0.001]	0.004 [0.005]	0 [0.001]	-0.003 [0.003]	0 [0.001]	0 [0.002]	0.002* [0.001]	-0.006*** [0.001]	0.005*** [0.001]
Constant	-0.021*** [0.003]	-0.026 [0.020]	-0.009* [0.005]	-0.014* [0.008]	-0.010* [0.006]	-0.01 [0.008]	-0.029*** [0.006]	0.034*** [0.007]	-0.047*** [0.007]
Obs.	8999	706	2835	2703	2703	2703	2703	2703	2703
R-sq.	0.03	0.04	0.02	0.04	0.01	0.04	0.04	0.03	0.05
	2001-2011								
	All (C&U)	Div C	Div U	Size C	Size U	Debt C	Debt U	KZ C	KZ U
CFL	0.016*** [0.002]	0.001 [0.005]	0.047** [0.019]	0.013*** [0.003]	0.060*** [0.015]	0.023*** [0.006]	0.010*** [0.003]	0.018* [0.011]	0.006** [0.003]
Q	0.002*** [0.000]	0.001 [0.001]	0.002** [0.001]	0.002*** [0.001]	-0.001 [0.001]	0.002*** [0.001]	0.001** [0.001]	0.004*** [0.001]	0.001** [0.001]
Size	0 [0.000]	0.004* [0.002]	-0.001** [0.000]	0.003* [0.002]	0 [0.000]	-0.003*** [0.001]	0.001 [0.001]	-0.006*** [0.001]	0.003*** [0.001]
Constant	0 [0.002]	-0.019* [0.010]	0.003 [0.003]	-0.009* [0.005]	-0.002 [0.004]	0.020*** [0.005]	-0.008** [0.004]	0.045*** [0.004]	-0.029*** [0.004]
Obs.	22541	1452	6607	6768	6768	6768	6768	6768	6768
R-sq.	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.02

*significant at 10%; **significant at 5%; ***significant at 1%

Almeida *et al.* (2004) also reports that their KZ group seems to behave differently than other groups with alternative grouping criteria, thus our results here with KZ group is not uncommon. In the group based on debt ratio, we see that both financially constrained and unconstrained firms show significant and positive coefficients of cash flow though the size of the coefficient of the unconstrained firms is almost half of that of the constrained firms.

When checking the recent time period, the interesting finding is that almost all subgroups, financially constrained or unconstrained, show positive and significant coefficients of cash flow to cash holdings, with only one exception of the constrained firms grouped by dividend payout ratio. This result is not consistent with that in Almeida *et al.* (2004) that argue only financially constrained firms would exhibit positive and significant correlations of cash flow and cash holding, meaning only financially constrained firms save from cash inflow while unconstrained firms do not. Our new evidence from the recent years show both two groups of firms save cash flows and the clear distinction of behaviours between the financially constrained and unconstrained firms is no longer supported by the data.

Other than the cash flow, our basic regression results also document that Q has been stable and consistently a significant contributor to the cash holdings. This is similar to the results of Almeida *et al.* (2004). In addition, size of the firm seems not significant in Almeida *et al.* (2004) tests, but in our tests of the recent period, firm size seems to contribute significantly to the cash holdings. The confusing part though, is the sign of coefficients. In 1993-2000 periods, the coefficient is overall positive and significant. But in the recent period, firm size seems have no impact at all to cash holdings if we check only the entire sample. When investigating the financially constrained and unconstrained firms, we find size is significant but has different signs in constrained and unconstrained groups. The different impacts are not consistent across different grouping criterion, and eventually cancelled out each other in the pooled sample.

Extended Regression Results

Acknowledging that cash holding ratios can also be changed out of the firms decisions, we run the extended regression using the augmented regression approach following Almeida *et al.* (2004). The results of regression (Equation 3) are reported in Table 3, where Panel A reports the results for 1993-2000 and Panel B reports the results for 2001-2011.

Comparing the results of the entire sample of the first period and the recent period, we find that similar pattern repeats with the IV approach used. Firms have highly significant and positive coefficients in cash flows in both periods, but the size of the coefficient is only a half in the recent period (0.033) than in the first period (0.072). When comparing the financially constrained versus unconstrained firms, we find that in the first period, financially constrained firms exhibit significant and positive coefficients in three out of four different grouping criterions. In the recent period, all financially unconstrained firms show consistent significant and positive coefficients regardless of the grouping criterion used, but the financially constrained firms are only significant in the Size and Debt ratio groups.

The results are consistent with those in the basic regressions, indicating that though we still observe the positive relationship between cash flow and cash holdings, it seems the contribution of cash flow to cash holding is decreasing. In addition, financially unconstrained firms seem to have a much stronger connection between cash flow and cash holdings, though as we observed in Panel C of Table 1 the unconstrained firms have a lower average cash holding ratio on average. For example, in the dividend payout group, the financially constrained firms do not show a significant cash flow coefficient on cash holding in the recent period, but unconstrained firms have a positive and significant cash flow coefficient as high as 0.244. This feature of financially unconstrained firms having a much larger coefficient is true in three out of four groups except in debt ratio group where the coefficients of constrained and unconstrained are close to each other.

**Table 3. Extended regression results for financially constrained and unconstrained firms
Panel A: 1993 – 2000**

	All (C&U)	Financial Constrained (C) or Unconstrained (U)							
		Div C	Div U	Size C	Size U	Debt C	Debt U	KZ C	KZ U
CFL	0.072*** [0.012]	0.064* [0.035]	0.121 [0.084]	0.049*** [0.014]	-0.033 [0.047]	0.064** [0.028]	0.111*** [0.021]	0.031 [0.038]	0.079*** [0.016]
Q	0.005*** [0.001]	0.006*** [0.002]	0.005*** [0.002]	0.005*** [0.001]	0.003** [0.002]	0.005*** [0.001]	0.013*** [0.003]	0.006*** [0.001]	0.008*** [0.002]
Size	0.003*** [0.001]	0.006 [0.008]	-0.001 [0.001]	0.008 [0.005]	-0.001 [0.001]	0.007* [0.004]	-0.001 [0.001]	-0.001 [0.001]	0.003* [0.002]
Capxr	-0.492*** [0.031]	-0.795*** [0.126]	-0.303*** [0.054]	-0.589*** [0.067]	-0.233*** [0.044]	-0.846*** [0.068]	-0.206*** [0.050]	-0.715*** [0.079]	-0.305*** [0.056]
Acqr	-0.316*** [0.025]	-0.624*** [0.149]	-0.257*** [0.034]	-0.490*** [0.095]	-0.192*** [0.028]	-0.597*** [0.093]	-0.195*** [0.031]	-0.500*** [0.068]	-0.208*** [0.035]
Dncnwcr	-0.216*** [0.021]	-0.171*** [0.042]	-0.324*** [0.056]	-0.180*** [0.024]	-0.228*** [0.032]	-0.299*** [0.047]	-0.187*** [0.030]	-0.340*** [0.045]	-0.168*** [0.026]
Dstdr	-0.026 [0.016]	0.029 [0.043]	0.04 [0.041]	-0.047* [0.025]	-0.014 [0.022]	-0.330*** [0.091]	0.031* [0.018]	-0.156** [0.069]	0.001 [0.017]
Constant	0.004 [0.004]	0.011 [0.035]	0.011* [0.006]	-0.011 [0.012]	0.020*** [0.006]	0.002 [0.014]	-0.003 [0.007]	0.051*** [0.007]	-0.017* [0.009]
# Obs.	8999	706	2835	2703	2703	2703	2703	2703	2703
R-sq.	0.13	0.14	0.17	0.14	0.11	0.19	0.03	0.17	0.1

Note: Robust standard errors in brackets.

*significant at 10%; ** significant at 5%; *** significant at 1%.

Panel B: 2001-2011

	All (C&U)	Financial Constrained (C) or Unconstrained (U)							
		Div C	Div U	Size C	Size U	Debt C	Debt U	KZ C	KZ U
CFL	0.033*** [0.005]	-0.005 [0.018]	0.244*** [0.064]	0.016* [0.008]	0.369*** [0.051]	0.054*** [0.014]	0.040*** [0.010]	0.012 [0.026]	0.046*** [0.009]
Q	0.004*** [0.001]	0.002 [0.002]	0.002 [0.002]	0.003*** [0.001]	-0.007*** [0.001]	0.005*** [0.001]	0.005*** [0.002]	0.006*** [0.001]	0.006*** [0.001]
Size	0.002*** [0.000]	0.009** [0.004]	-0.002*** [0.000]	0.006** [0.003]	-0.004*** [0.001]	0.001 [0.002]	0 [0.001]	-0.002*** [0.001]	0.001 [0.001]
Capxr	-0.461*** [0.024]	-0.607*** [0.109]	-0.409*** [0.040]	-0.573*** [0.051]	-0.429*** [0.034]	-0.640*** [0.056]	-0.397*** [0.043]	-0.414*** [0.048]	-0.437*** [0.047]
Aqcr	-0.508*** [0.020]	-0.569*** [0.153]	-0.348*** [0.025]	-0.486*** [0.086]	-0.396*** [0.023]	-0.955*** [0.045]	-0.343*** [0.026]	-0.750*** [0.045]	-0.338*** [0.028]
Dncwcr	-0.104*** [0.012]	-0.039* [0.021]	-0.394*** [0.035]	-0.059*** [0.013]	-0.423*** [0.040]	-0.230*** [0.027]	-0.068*** [0.015]	-0.346*** [0.031]	-0.079*** [0.014]
Dstdr	-0.028*** [0.010]	-0.078*** [0.020]	0.092*** [0.028]	-0.050*** [0.012]	0.119*** [0.022]	-0.183*** [0.046]	0.001 [0.012]	-0.109* [0.062]	-0.011 [0.011]
Constant	0.013*** [0.002]	-0.018 [0.021]	0.024*** [0.004]	0.001 [0.008]	0.048*** [0.005]	0.026*** [0.007]	0.018*** [0.005]	0.046*** [0.005]	0.011* [0.006]
# of Obs.	22541	1452	6607	6768	6768	6768	6768	6768	6768
R-sq.	0.09	0.06	0.17	0.06	0.07	0.14	0.05	0.16	0.02

Note: Robust standard errors in brackets.

*significant at 10%; ** significant at 5%; *** significant at 1%.

Further, from Table 3 we also find that Q is a significant and positive contributor to cash holdings in either of the sub-periods, regardless the financial status of the firm (with one exception). Firm size is significant and positive in overall sample in both periods, but its impact seems more pronounced in the recent time period and with mixed impacts on constrained and unconstrained firms.

As expected, capital expenditure, acquisition, and change of working capitals all have significant and negative coefficients in both periods. This result is consistent with that of Almeida *et al.* (2004) who state that firms' investment and financing decisions also influence their cash holdings. Though we find the significant impacts of all three variables on cash holdings, our empirical result seems to suggest a larger impact of acquisition on cash holdings but weaker impact from capital expenditure and change of working capital in recent years than in the early period. Further, it seems the pattern is very much stable and consistent for both financially constrained and unconstrained firms. Interestingly, the change of short term debt seems not a significant contributor to cash holdings in the early period, but our results of the recent period show a significant and negative coefficient in the overall sample, which indicates when firms borrow more short-term loans, their cash holdings do not increase but decrease. Further, financially constrained firms seem to have very different pattern than unconstrained firms. Financially unconstrained firms have positive and significant coefficients of short-term debt, but constrained firms have consistently significant and negative coefficients. Our results seem to indicate borrowing short-term debt does not help the cash build up for financially constrained firms.

One more point is that the augmented regressions have significantly higher R squares compared to the basic regressions. This further shows that the cash holdings of firms are impacted by many factors other than just cash flows. The lower explaining power of the basic equation also leads to the conclusion that cash flow's impact to cash flow seems to decrease over years.

Regression Results with Macroeconomic Variables

The purpose of this study is to investigate whether the sensitivity of cash flow to cash holding is time varying. When separate the overall time period of our sample into the first period a 1993 to 2000, and a recent period of 2001-2011, our intention is to compare the cash flow sensitivity to cash in the most recent time period when economic condition is much more volatile than that of the first period. To capture the different economic conditions and the impacts to firms' behaviours, we include macroeconomic variables in the regression. Our method is consistent with that adopted by Almeida *et al.* (2004), but different in details.

Table 4 reports the extended regressions with macroeconomic variables (Equation 3). The macroeconomic condition proxy used is the growth rate in GDP (GDPgr). The table reports the regression results of two sub-periods of 1993 to 2000 in Panel A and of 2001 to 2011 in Panel B respectively. From our results in Panel A, we can clearly see that GDP growth significantly and negatively impacts the cash holding, indicating that firms try to hold more cash in the negative economic environment in the first time period. Further, we find that in the first period, GDP growth impacts the cash holding in the same pattern (coefficients are negative or zero, though most are not significant) regardless of financial constraints.

Interestingly, when checking the recent time period results in Panel B, we find that GDP growth rate has no impact to the overall cash holdings of firms. Nevertheless, in recent period, all financially constrained firms regardless of the grouping criterion used show significant and positive coefficients, indicating that constrained firms tend to increase their cash holdings under the favourable economic conditions. This evidence seems to support the findings in Riddick and Whited (2009) where firms save more cash for the precautionary motive. However, we also find that financially unconstrained firms receive no impact or negative impacts from GDP change to their cash holdings.

Table 4. Extended regression with macroeconomic variables (GDP growth rate)
Panel A: 1993 – 2000

	All (C&U)	Div C	Div U	Financial Constrained (C) or Unconstrained (U)					
				Size C	Size U	Debt C	Debt U	KZ C	KZ U
CFL	0.068*** [0.012]	0.054 [0.034]	0.102 [0.085]	0.049*** [0.014]	-0.029 [0.046]	0.065** [0.028]	0.094*** [0.020]	0.023 [0.037]	0.076*** [0.016]
Q	0.005*** [0.001]	0.006** [0.002]	0.005*** [0.002]	0.005*** [0.001]	0.003** [0.002]	0.005*** [0.001]	0.012*** [0.003]	0.006*** [0.001]	0.008*** [0.002]
Size	0.003*** [0.001]	0.007 [0.008]	-0.001 [0.001]	0.007 [0.005]	-0.001 [0.001]	0.007* [0.004]	0 [0.001]	-0.001 [0.001]	0.004** [0.002]
Capxr	-0.494*** [0.031]	-0.819*** [0.123]	-0.299*** [0.056]	-0.587*** [0.068]	-0.237*** [0.044]	-0.858*** [0.068]	-0.207*** [0.050]	-0.718*** [0.078]	-0.306*** [0.056]
Aqcr	-0.319*** [0.025]	-0.631*** [0.149]	-0.257*** [0.034]	-0.493*** [0.096]	-0.191*** [0.028]	-0.605*** [0.094]	-0.201*** [0.031]	-0.497*** [0.069]	-0.212*** [0.035]
Dncwcr	-0.186*** [0.021]	-0.130*** [0.036]	-0.308*** [0.051]	-0.150*** [0.024]	-0.224*** [0.032]	-0.266*** [0.046]	-0.142*** [0.028]	-0.287*** [0.063]	-0.146*** [0.025]
Dstdr	-0.222*** [0.024]	-0.102** [0.047]	-0.279*** [0.042]	-0.201*** [0.034]	-0.245*** [0.036]	-0.592*** [0.087]	-0.128*** [0.028]	-0.497*** [0.088]	-0.150*** [0.030]
Gdpgr	-0.003** [0.002]	-0.009 [0.009]	0 [0.002]	-0.001 [0.004]	-0.002 [0.002]	-0.003 [0.004]	-0.003 [0.002]	-0.003 [0.003]	-0.002 [0.003]
Constant	0.016** [0.007]	0.042 [0.043]	0.011 [0.008]	-0.006 [0.019]	0.027*** [0.009]	0.014 [0.018]	0.006 [0.009]	0.060*** [0.014]	-0.008 [0.011]
# of Obs.	8999	706	2835	2703	2703	2703	2703	2703	2703
R-sq.	0.13	0.14	0.17	0.13	0.11	0.18	0.05	0.16	0.1

Note: Robust standard errors in brackets.
 *significant at 10%; **significant at 5%; ***significant at 1%.

Panel B: 2001 – 2011

	All (C&U)	Div C	Div U	Financial Constrained (C) or Unconstrained (U)				KZ C	KZ U
				Size C	Size U	Debt C	Debt U		
CFL	0.029*** [0.005]	-0.01 [0.018]	0.272*** [0.065]	0.013 [0.009]	0.376*** [0.050]	0.049*** [0.013]	0.036*** [0.010]	0.008 [0.026]	0.042*** [0.009]
Q	0.004*** [0.001]	0.001 [0.002]	0.001 [0.002]	0.002** [0.001]	-0.007*** [0.001]	0.004*** [0.001]	0.005*** [0.002]	0.006*** [0.001]	0.006*** [0.001]
Size	0.002*** [0.000]	0.010** [0.005]	-0.002*** [0.000]	0.007** [0.003]	-0.004*** [0.001]	0.001 [0.002]	0 [0.001]	-0.002*** [0.001]	0.001 [0.001]
Capxr	-0.464*** [0.024]	-0.602*** [0.108]	-0.415*** [0.041]	-0.584*** [0.051]	-0.428*** [0.034]	-0.645*** [0.055]	-0.404*** [0.043]	-0.411*** [0.048]	-0.444*** [0.046]
Aqcr	-0.512*** [0.020]	-0.574*** [0.154]	-0.345*** [0.025]	-0.501*** [0.085]	-0.394*** [0.023]	-0.962*** [0.045]	-0.346*** [0.025]	-0.753*** [0.045]	-0.340*** [0.027]
Dncnwr	-0.085*** [0.010]	-0.033* [0.019]	-0.374*** [0.032]	-0.050*** [0.012]	-0.381*** [0.036]	-0.195*** [0.024]	-0.048*** [0.012]	-0.322*** [0.033]	-0.062*** [0.012]
Dstdr	-0.117*** [0.013]	-0.114*** [0.025]	-0.307*** [0.030]	-0.103*** [0.016]	-0.288*** [0.040]	-0.378*** [0.048]	-0.050*** [0.015]	-0.428*** [0.064]	-0.076*** [0.015]
Gdpgr	0 [0.000]	0.006** [0.002]	-0.002*** [0.000]	0.005*** [0.001]	-0.002*** [0.000]	0.002** [0.001]	0 [0.001]	0.001* [0.001]	0 [0.001]
Constant	0.011*** [0.002]	-0.033 [0.022]	0.026*** [0.004]	-0.009 [0.010]	0.055*** [0.006]	0.022*** [0.008]	0.017*** [0.005]	0.044*** [0.005]	0.008 [0.007]
# of Obs.	22541	1452	6607	6768	6768	6768	6768	6768	6768
R-sq.	0.09	0.06	0.15	0.06	0.06	0.14	0.05	0.16	0.03

Note: Robust standard errors in brackets.
*significant at 10%; **significant at 5%; ***significant at 1%.

The results indicate unconstrained firms can better handle the fluctuating economic conditions in the recent time period. The results based on dividend payout and size seem to suggest that when GDP grows, unconstrained firms reduce their cash holding to invest more or to lower their liabilities, and when GDP decreases, these firms would increase cash holding out of precautionary purpose. Alternatively when using debt ratio and KZ index to proxy for financial constraints, we see that cash holdings of unconstrained firms are independent to the fluctuating economic conditions. In addition to GDP growth rate, we use an alternative variable in Equation 3 to be the proxy of the macroeconomic conditions. The results are reported in Table 5.

In Table 5, the proxy used is the default spread of BBB and AAA rated bond yields. From the results, the default spread seems to have no significant impact on firms' cash holdings in early time period but significant and negative impacts on cash holdings in the recent time period. Since higher default spread is found in recession, the negative coefficients indicate firms tend to save more cash holding from cash when the economy is in recession. In the recent time period, we observe significant and negative coefficients in all constrained firms (not significant in dividend group). In two cases (dividend payout and size) of unconstrained firms, the coefficients are positive while the other two are just zero. This result is similar to that when GDP growth is used as the proxy. Using default spread, our results seem to suggest again that in recent time period the precautionary motive to save more cash seems dominate.

Table 5: Extended regression with macroeconomic variables (default spread)
Panel A: 1993 – 2000

	All (C&U)	Financial Constrained (C) or Unconstrained (U)							
		Div C	Div U	Size C	Size U	Debt C	Debt U	KZ C	KZ U
CFL	0.068*** [0.012]	0.056* [0.033]	0.103 [0.085]	0.049*** [0.014]	-0.031 [0.047]	0.066** [0.028]	0.095*** [0.020]	0.024 [0.037]	0.078*** [0.015]
Q	0.005*** [0.001]	0.006*** [0.002]	0.005*** [0.002]	0.005*** [0.001]	0.003** [0.002]	0.005*** [0.001]	0.012*** [0.003]	0.006*** [0.001]	0.008*** [0.002]
Size	0.003*** [0.001]	0.007 [0.008]	-0.001 [0.001]	0.007 [0.005]	-0.001 [0.001]	0.007* [0.004]	0 [0.001]	-0.001 [0.001]	0.003* [0.002]
Capxr	-0.493*** [0.031]	-0.820*** [0.124]	-0.301*** [0.056]	-0.584*** [0.067]	-0.232*** [0.044]	-0.858*** [0.068]	-0.208*** [0.050]	-0.718*** [0.078]	-0.303*** [0.056]
Aqcr	-0.321*** [0.025]	-0.636*** [0.151]	-0.257*** [0.034]	-0.492*** [0.096]	-0.192*** [0.028]	-0.606*** [0.094]	-0.202*** [0.031]	-0.499*** [0.069]	-0.212*** [0.035]
Dncnwr	-0.186*** [0.021]	-0.131*** [0.035]	-0.309*** [0.052]	-0.151*** [0.024]	-0.222*** [0.032]	-0.267*** [0.046]	-0.143*** [0.028]	-0.288*** [0.063]	-0.148*** [0.025]
Dstdr	-0.222*** [0.024]	-0.102** [0.047]	-0.280*** [0.042]	-0.201*** [0.034]	-0.242*** [0.036]	-0.592*** [0.087]	-0.128*** [0.028]	-0.497*** [0.088]	-0.151*** [0.030]
DSpread	-0.002 [0.016]	-0.039 [0.076]	-0.007 [0.018]	0.025 [0.040]	0.016 [0.017]	-0.016 [0.037]	0.007 [0.025]	0.002 [0.032]	0.024 [0.031]
Constant	0.005 [0.011]	0.033 [0.060]	0.018 [0.013]	-0.025 [0.029]	0.009 [0.013]	0.015 [0.027]	-0.01 [0.017]	0.049** [0.023]	-0.033 [0.021]
# of Obs.	8999	706	2835	2703	2703	2703	2703	2703	2703
R-sq.	0.13	0.14	0.17	0.13	0.11	0.18	0.05	0.16	0.1

Note: Robust standard errors in brackets
 * significant at 10%; ** significant at 5%; *** significant at 1%

THE TIME-VARYING CASH FLOW SENSITIVITY OF CASH

Panel B: 2001 – 2011

	All (C&U)	Financial Constrained (C) or Unconstrained (U)							
		Div C	Div U	Size C	Size U	Debt C	Debt U	KZ C	KZ U
CFL	0.029*** [0.005]	-0.011 [0.018]	0.273*** [0.065]	0.013 [0.009]	0.375*** [0.050]	0.049*** [0.013]	0.036*** [0.010]	0.008 [0.026]	0.042*** [0.009]
Q	0.003*** [0.001]	0.001 [0.002]	0.001 [0.002]	0.002** [0.001]	-0.007*** [0.001]	0.004*** [0.001]	0.005*** [0.002]	0.006*** [0.001]	0.006*** [0.001]
Size	0.002*** [0.000]	0.010** [0.005]	-0.002*** [0.000]	0.007** [0.003]	-0.004*** [0.001]	0.001 [0.002]	0 [0.001]	-0.002*** [0.001]	0.001 [0.001]
Capxr	-0.464*** [0.024]	-0.598*** [0.108]	-0.416*** [0.041]	-0.583*** [0.051]	-0.429*** [0.034]	-0.645*** [0.055]	-0.404*** [0.043]	-0.411*** [0.048]	-0.444*** [0.046]
Aqcr	-0.512*** [0.020]	-0.580*** [0.154]	-0.346*** [0.025]	-0.503*** [0.085]	-0.395*** [0.023]	-0.963*** [0.045]	-0.346*** [0.026]	-0.754*** [0.045]	-0.340*** [0.027]
Dncnwr	-0.085*** [0.010]	-0.033* [0.019]	-0.376*** [0.032]	-0.050*** [0.012]	-0.384*** [0.036]	-0.194*** [0.024]	-0.048*** [0.012]	-0.322*** [0.033]	-0.062*** [0.012]
Dstdr	-0.117*** [0.013]	-0.113*** [0.025]	-0.309*** [0.031]	-0.103*** [0.016]	-0.291*** [0.041]	-0.378*** [0.048]	-0.050*** [0.015]	-0.428*** [0.064]	-0.076*** [0.015]
DSpread	-0.004** [0.002]	-0.038*** [0.011]	0.005** [0.002]	-0.024*** [0.005]	0.008*** [0.002]	-0.010** [0.004]	0.002 [0.003]	-0.007** [0.003]	0.001 [0.004]
Constant	0.016*** [0.003]	0.018 [0.021]	0.017*** [0.005]	0.026*** [0.009]	0.041*** [0.006]	0.036*** [0.007]	0.015** [0.006]	0.054*** [0.006]	0.007 [0.007]
# of Obs.	22541	1452	6607	6768	6768	6768	6768	6768	6768
R-sq.	0.09	0.06	0.15	0.07	0.05	0.14	0.05	0.16	0.03

Note: Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Robustness Check - Positive versus Negative Cash Flow

Bao *et al.* (2012) state that results of Almeida *et al.* (2004) seem driven by the signs of cash flows. They contend that the cash flow sensitivity of cash is asymmetric to cash flow, and the cash flow sensitivity of cash asymmetry holds regardless of the financial constraints. They further conclude that firms have different levels of responses to their cash holdings when facing positive and negative cash flows. In this study, we regroup our samples by the sign of cash flow as well to investigate the asymmetry in the cash flow sensitivity of cash. We redo all the above basic and extended regression tests at each time period and with positive cash flows separately from those with negative cash flows. Some of the most interesting results are shown in Table 6.

As we find in Table 6, in the basic regression results, firms with negative cash flows and non-negative cash flows seem not distinguishable from each other. In the first time period, we observe positive and significant sensitivity of cash flow to cash regardless of the sign of cash flows. Further, financially constrained and unconstrained firms behave similarly. In the recent period, the positive and significant coefficients are also observed for firms with either negative or non-negative cash flows. However, we do find that the magnitude of the coefficients is very different. During 2001-2011, when firms have negative cash flows, the coefficient of cash flow to cash is 0.010 for all firms, while in the non-negative cash flow scenario, the coefficient is 16 times the size (0.160).

Further, we find that cash flow is positive, significant, and with large coefficients in the recent time period with non-negative cash flow for both financially constrained and unconstrained firms. If we compare the coefficients of CF of the entire sample, we find that non negative groups have a larger coefficient in both early and recent time period. Over time, the non-negative CF group increases its coefficient (0.099 to 0.160) where the negative CF group decreases its coefficient (from 0.028 to 0.010).

**Table 6: Basic and extended regression with negative and non-negative cash flows
1993 - 2000**

	Financial Constrained (C) or Unconstrained (U) Negative Cash Flows								
	All (C&U)	Div C	Div U	Size C	Size U	Debt C	Debt U	KZ C	KZ U
Basic	0.028*** [0.006]	0.021* [0.013]	0.011 [0.030]	0.026*** [0.007]	0.014 [0.009]	0.037** [0.015]	0.022** [0.010]	0.033* [0.019]	0.021*** [0.007]
Obs.	3334	683	191	1743	263	1295	976	811	1334
Extended	0.040** [0.020]	0.054 [0.035]	-0.065 [0.077]	0.028* [0.016]	0 [0.004]	0.053 [0.048]	0.067*** [0.025]	0.146 [0.108]	0.056*** [0.017]
Obs.	3334	683	191	1743	263	1295	976	811	1334
Non Negative Cash Flows									
Basic	0.099*** [0.031]	0.825* [0.393]	0.102** [0.047]	0.197*** [0.063]	0.001 [0.057]	0.126** [0.057]	0.061 [0.058]	0.114** [0.055]	0.069 [0.051]
Obs.	5665	23	2644	960	2440	1408	1727	1892	1369
Extended	-0.079 [0.126]	0.432 [0.442]	0.330** [0.133]	-0.132 [0.237]	0.038 [0.132]	0.221 [0.220]	0.18 [0.153]	0.163 [0.160]	-0.05 [0.171]
Obs.	5665	23	2644	960	2440	1408	1727	1892	1369
2001-2011									
Negative Cash Flows									
Basic	0.010*** [0.003]	0.001 [0.005]	0.017 [0.030]	0.008*** [0.003]	0.023 [0.039]	0.011 [0.007]	0.007** [0.003]	-0.009 [0.021]	0.002 [0.003]
Obs.	8547	1374	627	4510	783	2970	2926	1778	3748
Extended	-0.007 [0.009]	-0.015 [0.017]	-0.024 [0.066]	0 [0.009]	0.17 [0.108]	0.013 [0.019]	0.01 [0.013]	-0.032 [0.053]	0.024** [0.011]
Obs.	8547	1374	627	4510	783	2970	2926	1778	3748
Non Negative Cash Flows									
Basic	0.160*** [0.018]	0.142 [0.213]	0.150*** [0.027]	0.213*** [0.037]	0.063*** [0.024]	0.217*** [0.034]	0.093*** [0.034]	0.184*** [0.032]	0.129*** [0.034]
Obs.	13994	78	5980	2258	5985	3798	3842	4990	3020
Extended	0.442*** [0.103]	0.051 [0.282]	0.472*** [0.111]	0.201 [0.180]	0.289*** [0.082]	0.453*** [0.136]	0.203 [0.132]	0.533*** [0.132]	0.315* [0.162]
Obs.	13994	78	5980	2258	5985	3798	3842	4990	3020

Note: Robust standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%.

This seems to suggest again that the sensitivity of cash flow to cash holding is time varying, and in recent time period, the observed overall weaker impact of cash flow to cash holding as found in Table 2 seems mainly driven by the negative cash flow firms. The non-negative cash flow firms show, on average, a larger sensitivity of cash flow to cash.

The extended regression results demonstrate different pattern. In the first time period, only firms with negative cash flows show significant and positive sensitivity of cash flow to cash holding s, but not those firms with non-negative cash flows. In the recent time period, only firms with non-negative cash flows show strongly significant and positive sensitivity of cash flow to cash. Interestingly, these results seem to support the asymmetry in the sensitivity of cash flow to cash argued by Bao *et al.* (2012), though they find the coefficients are largely negative. In our results, the sensitivity seems consistently positive. Comparing two time periods, we find the same pattern repeats with regard to the time-varying sensitivity from early period to later period. Early in Table 4, we observe decreasing sensitivities from early to later period where the sensitivity is 0.068 in early period and 0.029 in later period (both are significant).

In Table 6, when we further decompose our samples into firms with negative versus non-negative cash flows, we find that the time-varying sensitivity is driven mainly by firms with negative cash flows where their sensitivity of cash flow to cash dropped sharply from 0.04 (significant) to -0.007 (not significant). Meanwhile, the firms with non-negative cash flows sharply increase their sensitivity of cash flow to cash from to 0.442 (significant). Further, financially constrained firms versus unconstrained firms seem not distinguishable in the extended regression results, indicating that financial constraints may not have a huge impact on the cash flow sensitivity to cash holdings when a different regression method is applied. This result seems to support Duchin *et al.* (2010).

CONCLUSIONS

Firms are observed saving cash from cash flows and exhibiting a consistent sensitivity of cash flow to cash holdings. Almeida *et al.* (2004) find the sensitivity depends on the financial constraints where financially constrained firms tend to save more from cash inflow while unconstrained firms'

propensity to save is indistinguishable from zero. Further, they argue that constrained firms increase their propensity to retain cash following negative macroeconomic shocks, while unconstrained firms do not. The later literature finds cash flow holdings of US firms have increased after 2000 (Bates *et al.*, 2009), the sensitivities are largely negative, and asymmetric to the sign of cash flows (Bao *et al.*, 2012).

In this study, we empirically revisit this issue and test US manufacturing companies during 1993 to 2011 period. We follow mainly the regressions in Almeida *et al.* (2004) and revise the macroeconomic proxies used in the regressions. Different from Almeida *et al.* (2004), we separate our samples into two time periods which is 1993-2000 and 2000-2011 to consider that with the observed increasing trend of cash holdings and the dramatic change of economic conditions in recent years, the sensitivity of cash flow to cash may exhibit time-varying pattern. Further, we test the sensitivity separately in scenarios where firms have negative cash flows and non-negative cash flows to address the potential asymmetry in the sensitivity. Our results document that the overall sample shows a clear time-varying sensitivity from early time period (1993-2000) to later period (2000-2011) in both the basic and extended regression results and the sensitivity becomes weaker in recent years though still positive and significant. Further, the changing pattern is also reflected in the fact that in recent year, financially unconstrained firms seems to behave similarly with the constrained firms. Therefore, our results support the conclusion of Riddick and Whited (2009) who argue that the sensitivity of cash flow to cash seems to be driven by too many factors and may not be used as indicator of the external financial constraints.

Our results also show that the asymmetric sensitivity of cash flow to cash may also be specific to the regression method used. In the results of basic regression of Almeida *et al.* (2004), we do not find asymmetry with regard to negative and non-negative cash flow. However, in the augmented regression (Equation 2), a clear asymmetric sensitivity with regard to sign of cash flow has been observed. However, our results are not consistent with that of Bao *et al.* (2011) in the sign of the sensitivity. We find that the positive sign holds even when firms are separated into negative and non-negative groups. Further, with this separation, we find that the driving force of the overall

weakening sensitivity of cash flow to cash is mainly the firms with negative cash flows. The firms with positive cash flows show stronger sensitivity, positive and significant, in recent years than in before. Further, the financially unconstrained companies show positive and significant sensitivity in recent years, inconsistent with the findings of Almeida *et al.* (2004).

With regard to the macroeconomic influences, we find that in the early time period, economic conditions negatively impact the sensitivity of cash flow to cash, but in recent years, the impact seems to be positive. Further, our result also suggest that financially unconstrained firms seem to have a higher capacity to handle bad economic conditions in the recent time period, while the sensitivity patterns of both financially constrained and unconstrained firms seem to suggest the precautionary motive to the cash saving.

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