Corporate Investments, Cash Flows and Cash Holdings: Evidence from the Oil Industry before and after the Financial Crisis

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Abstract

This paper studies corporate investments with internal funds when firms face real investment friction such as high adjustment cost and investment planning lag using a sample of U.S. oil companies from 2003 to 2011 before and after the 2008 financial crisis. We show that firms' capital expenditures are more sensitive to their lagged cash holdings than to their contemporaneous cash flows. By making investments with realized cash holdings, firms can avoid the investment adjustment costs that are incurred when investing with uncertain cash flows. We also show that cash flow policies are affected by liquidity constraints following the 2008 financial crisis: firms build up more cash reserves from cash flows, cut back payouts and raise more debt to maintain cash holdings.

Keywords: Corporate investments, Cash flows, Cash holdings, Oil price

1. Introduction

Modigliani and Miller (1958) argue that, when there is no financing friction, firms can fund all positive net present value (NPV) projects regardless of the availability of internal funds. Once financial market friction is introduced, the investment decisions of firms will depend on both investment opportunities (i.e., access to positive NPV projects) and internal fund availability because external funds are more expensive than internal funds. Following this intuition, Fazzari, Hubbard and Petersen (1988) developed an empirical approach to examine the impact of financing friction on the relation between investments and internal funds. Their key results are that, after controlling for a firm's investment opportunities as proxied for by Tobin's *Q*, internal funds (cash flows) have a significant positive impact on investment activities. This positive impact is interpreted as evidence for the presence of financing friction (Hubbard 1998; Stein 2003). Although it is important to consider external financing friction when analyzing the investment behaviors of firms, the key results of Fazzari, Hubbard and Petersen (1988) are also based on the assumption that real investment friction is not present, i.e., investments are reversible and have smooth adjustment costs (e.g. Hayashi 1982). If this assumption does not hold, then the effects of cash flows on investments are subject to missing variable bias because Tobin's *Q* is a poor proxy for investment opportunities when investment adjustment costs are not smooth. (Note 1) The captured effects of cash flows on investments may reflect the influence of investment opportunities on investments.

The extant literature has shown that real investment decisions are often subject to investment friction because investments can be indivisible and lumpy (e.g. Whited 2006), irreversible (e.g. Cooper and Haltiwanger 2006) with investment time lags and long investment horizons (e.g. Lamont 2000, Tsyplakov 2008, Tserlukevich 2008). The lumpiness of investment suggests that investments will be persistent, have inter-temporal features and have potentially high adjustment costs, especially if investment projects are irreversible. The time lag between when decisions to invest are made and when cash flows occur will also prevent firms from immediately adjusting investments when there are changes in cash flows. This is because cash flow levels for the coming year are uncertain when investment decisions are made, whereas required investment expenditures are clear because of investment persistence. Therefore, if the investment of capital expenditures is contingent on contemporaneous cash flows, it may result in investment projects to be frequently halted and restarted, which can be costly. In addition to cash flows, firms can rely on current cash holdings as alternative sources of internal funds. Cash holdings can be particularly useful for firms facing real investment friction because cash holdings are a realized value at the time of investment decision making for the coming year. By making investments with cash holdings, firms can avoid potential adjustment costs associated with investing based on uncertain cash flows.

The purpose of this paper is to examine corporate investments with internal funds (i.e., cash flows and cash holdings) and related cash flow policies when firms face investment friction such as high adjustment costs and investment time lags. To this end, we investigate a sample of U.S. oil companies from 2003 to 2011. Extant empirical studies (e.g. Tsyplakov 2008) have used the oil industry to examine the effect of investment friction because of the high adjustment costs and irreversible nature of investments in this industry, such as expensive geological surveys, long-term land leases, and drilling and exploration activities. Therefore, the oil industry represents an ideal context to study the investment decisions of firms facing real investment friction. In addition, due to the 2008 financial crisis, the sample period from 2003 to 2011 includes two periods with opposite cash flow patterns: the cash flow windfall period from 2003 to 2007, during which oil prices grew by 25% per year on average, and the cash flow downfall period from 2009 to 2011, when the demand for oil declined due to the recession that took place after the 2008 financial crisis. (Note 2) The financial crisis therefore serves as an exogenous shock to the financial status of oil companies and allows us to examine their investments with internal funds as well as their cash flow policies in response to positive and negative changes in cash flows.

We begin our analysis by investigating the impact of internal sources of funds (e.g., cash flows and cash holdings) on the investments of oil companies during the pre-crisis sample period. From 2003 to 2007, U.S. oil companies obtained significant cash inflows due to increasing oil prices. The boom in oil prices can be attributed to factors such as an increase in demand from emerging economies. On the supply side, oil output has been stable over time due to the "Peak Oil" effect. (Note 3) For example, in 2007, Exxon extracted approximately 4.4 million barrels of oil and natural gas a day, which is roughly the same output as in 2000. This scenario provides us with an identifying strategy to isolate shocks to a firm's cash flows from shocks to its investment opportunities in that cash flow changes are not correlated with changes in investment opportunities. On one hand, the cash flow windfalls experienced by U.S. oil companies are procyclical and time variant, following crude oil price increases driven by demand mostly from outside the U.S. On the other hand, changes in the investment opportunities available to these companies are rather time invariant because of the limited conventional oil resources available at the time. One common criticism of the Fazzari, Hubbard and Petersen (1988) approach is that the Tobin's *Q* might not fully capture investment opportunities because of measurement errors. Investment-cash flow sensitivity reflects the relationship between investments and investment opportunities due to missing variable bias because investment opportunities are not well accounted for. (Note 4) The uncorrelated cash flows and investment opportunities in the pre-crisis sample can help mitigate the endogenous concern between cash flows and investments and produce less biased results.

Using an augmented regression model including capital expenditures, cash flows, Tobin's *Q*, firm size, leverage, lagged cash holdings and lagged capital expenditures, we find that the capital expenditures of oil companies are not sensitive to their cash flow levels in different regression specifications. In contrast, we find that the lagged cash holdings of firms have a significant impact on capital expenditures in different model specifications. The results suggest that the investments of firms are determined or planned based on realized cash holdings at the beginning of the year. Because firms are reluctant to change their investment plans due to adjustment costs, investments do not fluctuate with contemporaneous cash flows. In addition, lagged capital expenditures have a positive impact on current capital expenditures, suggesting that there is investment persistence in capital expenditures. The positive impact of lagged cash holdings on investments is in line with the notion that investment friction, such as investment time lags and lumpy investments, will affect firms' choices relating to internal funds for investments. When firms make inter-temporal investment decisions, they will prefer to invest with realized cash holdings rather than uncertain contemporaneous cash flows. This allows firms to avoid potential investment adjustment costs that could be incurred when investing with uncertain cash flows from the coming year.

However, because of the existence of financing friction such as financial constraints, the insignificant investment-cash flow sensitivity that we find in our baseline model could be driven by two possibilities: first, most firms in our sample are not financially constrained; second, cash flow windfalls during the pre-crisis sample period could have eased financing friction for oil companies. To address the first alternative explanation, we follow a common practice in the extant empirical literature by splitting the pre-crisis sample into financially constrained and unconstrained firms based on firm size, bond ratings and commercial paper ratings. (Note 5) Large firms with access to external capital markets are usually considered to be less financially constrained. We find that investment-cash flow sensitivities remain statistically and economically insignificant, whereas investment-cash holding sensitivities are positive and significant regardless of the financial constraint status of firms. Moreover, the coefficients of cash holdings on investments are larger in magnitude for constrained firms than for unconstrained firms, suggesting that the investments of constrained firms rely more on cash holdings than those of unconstrained firms because unconstrained firms can easily build up cash reserves with external funds.

To address the second alternative explanation, we estimate the baseline model with the post-crisis sample. Credit rationing by financial institutions after the financial crisis generated additional barriers for accessing external funds and therefore exacerbated financing friction for all firms. Because the presence of financing friction for investments is more about being able to raise external funds when facing cash flow downfalls than it is about allocating surpluses when facing cash flow windfalls, we can mitigate the concern that the pre-crisis results are driven by cash flow surpluses by examining the investments of oil companies during the post-crisis period. We find that investment-cash flow sensitivities are insignificant, whereas investment-cash holding sensitivities are positive and significant regardless of the financial constraint status of firms in the post-crisis period. In addition, the coefficients of cash holdings on investments are larger for both constrained and unconstrained firms relative to the coefficients of cash holdings on investments in the pre-crisis period. The results suggest that the investments of oil companies are more dependent on cash holdings after the financial crisis.

The empirical results thus far have shown that investments do not represent an important outlay of contemporaneous cash flows and firms rely on cash holdings rather than cash flows for investments when they make inter-temporal investment decisions. Because firms accumulate cash holdings from cash flows, we next turn to the cash flow policies of oil companies to examine how firms allocate their cash flows among cash holdings and other cash-flow-related corporate policies during periods of cash flow windfalls and downfalls.

Bates et al. (2009) find that U.S. firms hold much more cash now than they did in the past in order to hedge against liquidity risks. Acharya et al. (2007) show that the impact of cash flows on cash holdings should be jointly determined with debt levels because cash can be readily used to repay debts. In addition, payout policies such as those related to dividends and stock repurchases also represent important cash outlays. Moreover, as suggested by Almeida et al. (2004), Acharya et al. (2007) and others, a firm's cash flow policies toward cash holdings, debts and payouts will vary based on its potential financial constraint level. Therefore, we estimate a system of joint determination among cash flows, cash holdings, net debt issuance, dividends and stock repurchases based on partitioning the potential financial constraint status of oil companies to investigate cash flow sensitivities on cash holdings, net debt issuances, dividends and share repurchases.

We next highlight the cash flow policies of oil companies during the pre-crisis sample period. For constrained firms, we find that cash flows have a significant positive impact on cash holdings, suggesting that constrained firms build up cash reserves with cash windfalls. Regarding to dividends, share repurchases and debt issuances, cash flow sensitivities are neither statistically nor economically significant for constrained firms. The results suggest that cash holdings are a major outlay of cash flows for constrained firms. For unconstrained firms, we find that net debt issuance is negatively related to cash flows and share repurchases are positively related to cash flows. Cash flows have no significant impact on dividends or cash holdings. The results suggest that unconstrained firms use cash flows to repay debts and repurchase shares during cash windfall periods. The overall results indicate that financing friction plays an important role in the cash flow policies of oil companies and there seems to be a "pecking order" with regard to the uses of cash flows (Myers 1984, Myers and Majluf 1984). The priority for constrained firms is building up cash reserves and a large portion of cash flows goes to cash holdings for future investment purpose. These results are similar to those of other empirical studies, such as Almeida et al. (2004) and Acharya et al. (2007). For unconstrained firms, building up cash reserves is not the priority use of cash flows because easy access to low-cost external funding can usually help them maintain their cash holdings at a desired level. When there are cash flow windfalls, unconstrained firms will choose to repay their debts and buy back shares to reduce debt overhang costs (Myers 1977) and agency costs from free cash flows (Jensen 1986). Unconstrained firms thereby use cash flow surpluses in the current period to increase their financing capacity in case cash flows decline in the future. (Note 6)

The systematic liquidity supply shocks after the 2008 financial crisis exacerbates the already present financing friction. Together with cash flow downfalls during the post-crisis period, the use of cash flows by oil companies for cash holdings, net debt issuances and payouts is also affected relative to the pre-crisis period. To highlight differences with the pre-crisis period results, unconstrained firms also save cash from cash flows and do not buy back shares during the post-crisis period. These results suggest that unconstrained firms build up cash reserves from cash flows and cut back on payouts to accommodate declines in cash flow and liquidity constraints after the crisis. Debt and dividend policies remain qualitatively unchanged. Cash flows have no significant impact on changes to dividends. The insensitivity of dividend changes toward cash flows in periods of cash windfalls and downfalls is consistent with the notion that firms usually smooth dividends to maintain stable dividends payouts regardless of cash flow conditions (Allen and Michaely 2003). Cash flows are negatively related to debt issuance in unconstrained firms but there is no such effect for constrained firms. The results suggest that unconstrained firms will raise debt to supplement declining cash flows and retain cash holding levels during the post-crisis period. The rationing of the

liquidity supply after the crisis limits the ability of constrained firms to raise debt even though they experienced negative cash flow shocks. The results relating to the post-crisis cash flow policies of oil companies are also consistent with the notion of a "perking order" in the use of cash flows. When there are positive cash flow shocks, firms use cash flows to accumulate cash holdings, repay debts and make payouts to shareholders. When there are negative cash flow shocks, firms accumulate cash, raise more debt and cut back on payouts to retain cash holdings.

A recent study by Gatchev et al. (2010) also investigates the impact of investment adjustment costs on the relation between investments and cash flows as well as related cash flow policies by examining cash flow sensitivities to investments and various cash flow outlays. After adding lagged investments as an explanatory variable, they show that cash flows virtually have no impact on investments and that lagged investments can explain a significant amount of current investments. They attribute the results to high investment adjustment costs and investment persistence. They also argue that the significant investment-cash flow sensitivities identified in previous studies are driven by missing variable bias because the inter-temporal nature of investment decisions is not accounted for. Our paper differs from their study in that we focus on investigating how firms invest with internal funds when investment persistence and adjustment costs are present by introducing lagged cash holdings as a new explanatory variable in the investment equation. We show that investments are highly sensitive to lagged cash holdings after considering investment persistence. Our results are intuitive in the context of investment planning time lags and investment persistence, showing that realized cash holdings are a more reliable internal source of funds for investment than uncertain cash flows when the investment decisions of firms are affected by real investment friction.

This paper is also related to empirical works that study cash flow windfalls. For example, Blanchard et al. (1994) investigate what happened to 11 firms when they won lawsuits or received cash settlements during the early 1980s. The authors find that cash flow windfalls were squandered by managers through unsuccessful diversification, debt-raising or compensation to ensure their self-interest and independence of firms with themselves at the helm. They attribute the empirical results to the agency cost of free cash flows (Jensen 1986). Apparently, the results of this study are not consistent with the managerial entrenchment of the free cash flows hypothesis. Instead, the findings are rather consistent with the financing resources irrelevance theory of Modigliani and Miller (1958) when financing friction is present, i.e., if there is a cash flow surplus, unconstrained firms will use cash flow windfalls to repay debts and make payouts to shareholders, whereas constrained firms will use cash flow windfalls to build up cash reserves and increase their financial flexibility.

The remainder of this paper is organized as follows. We describe the sample construction and the variable summary statistics in Section 2. Section 3 presents the empirical methodology and results. Section 4 concludes.

2. Sample Construction and Variables

2.1 Sample Construction

Starting in the early 2000s, especially after 2003, there was impressive increase in global crude oil prices due to strong demand from emerging economies in developing countries. Before the 2008 financial crisis, oil prices increased by approximately 25% per year from 2003 to 2007. Oil prices peaked in mid-2008, right before the financial crisis, and plummeted quickly to roughly $40 per barrel at the end of 2008. In the post-crisis period from 2009 to 2011, oil prices bounced back with stock markets because of various stimulus plans from major economies around the world. Figure 1 presents monthly crude oil prices (West Texas Light Grade) from 2003 to 2011.

To empirically test how cash flows affect an oil company's investments and other corporate financial policies, we choose U.S. oil companies with a two-digit SIC code of "13" in the Compustat North American universe database. This category includes crude petroleum and natural gas production and drilling as well as exploration services for gas wells and oil and gas fields. Many oil companies, such as Chevron, are listed under SIC code "2911", which stands for petroleum refining, even though their core businesses are crude oil production. Therefore, we also include these firms in our sample. Following extant empirical studies (e.g. Almeida and Campello 2007), we exclude firms with capital stocks (net amount of property, plant and equipment) of less than $5 million. This eliminates very small firms to avoid the small denominator problem because linear investment models are likely to be inadequate for those firms (Gilchrist and Himmelberg 1995). Our final sample consists of 233 U.S. oil companies from 2003-2011 (excluding 2008).

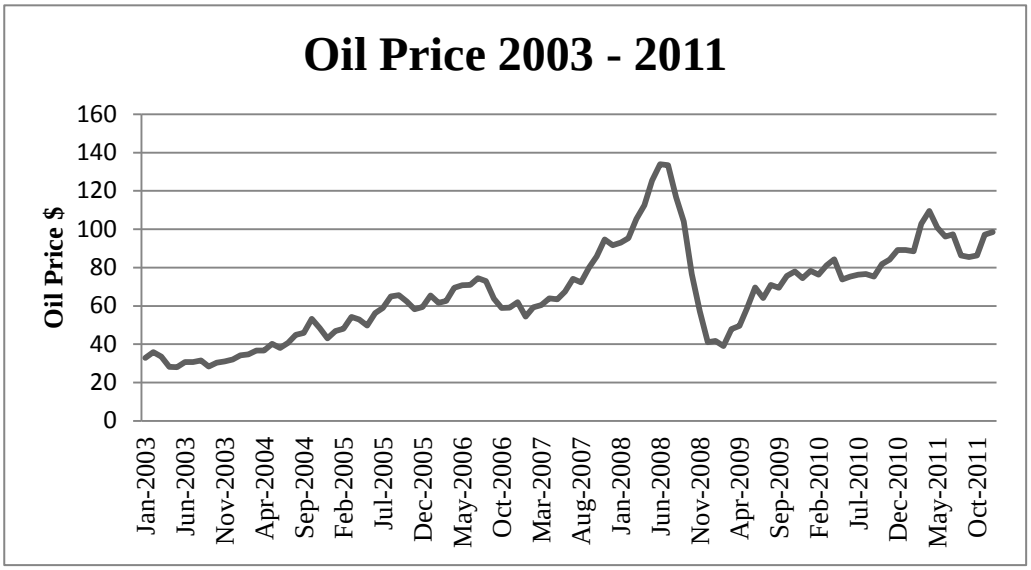

Figure 1. Crude Oil Price 2003-2011

2.2 Variables

The main variables of interest are cash flows, cash holdings and investments. Following the extant empirical literature, cash flows (CF_t / K_{t-1}) are defined as earnings before extraordinary items plus depreciation deflated by the capital stock at the beginning of the period (net amount of property, plant and equipment). Cash holdings (CH_{t-1} / K_{t-1}) are defined as cash and short-term investments at the beginning of the period deflated by the capital stock at the beginning of the period. Investments (I_t / K_{t-1}) are defined as capital expenditures deflated by the capital stock at the beginning of the period. To control for investment persistence, we also include lagged investment (I_{t-1} / K_{t-2}) as an explanatory variable. Other variables examined in this paper include firm size, Tobin's *Q*, and leverage, among others. Please refer to the appendix for a full description and definition of the variables used in this paper.

Table 1. Summary Statistics

Panel A (Full Sample)	Mean	Std. Dev.	5th	50th	95th
Cash Flow	0.152	0.378	-0.485	0.176	0.657
Capital Expenditure	0.398	0.489	0.025	0.263	1.225
Tobin's Q	1.828	1.336	0.785	1.472	3.830
Cash Holding	0.184	0.429	0.012	0.046	0.834
Leverage	0.292	0.234	0	0.257	0.739
Size	6.178	2.147	2.586	6.234	7.583
Panel B (Pre-crisis)					
Cash Flow	0.193	0.397	-0.509	0.218	0.718
Capital Expenditure	0.458	0.532	0.032	0.310	1.361
Q	1.973	1.340	0.933	1.606	4.497
Cash Holding	0.196	0.442	0.014	0.048	0.908
Leverage	0.284	0.224	0	0.255	0.703
Size	5.933	2.113	2.515	5.973	9.687
Panel C (Post-crisis)					
Cash Flow	0.088	0.338	-0.439	0.124	0.534
Capital Expenditure	0.305	0.398	0.021	0.197	0.955
Q	1.612	1.302	0.683	1.271	3.463
Cash Holding	0.165	0.408	0.008	0.034	0.700
Leverage	0.304	0.248	0	0.262	0.773
Size	6.566	2.146	2.696	6.665	7.913
Panel D	Mean Comparison (pre- vs. post-crisis)				
Cash Flow	0.104***				
Capital Expenditure	0.153***				
Cash Holding	0.031**				
Leverage	0.020**				

This table presents the mean and standard deviation for some key variables used in this study. Full sample includes calendar years from 2003 to 2011 excluding 2008. Pre-crisis sample includes calendar years from 2003 to 2007. Post-crisis sample includes calendar years from 2009 to 2011. The definitions of variables are presented in Appendix. Cash flows, capital expenditures and cash holdings are scaled by the beginning of period capital stock (K) as in net amount of property, plant and equipment. *, **, *** represent statistical significance at 10%, 5% and 1% respectively.

Table 2. Correlation Matrix

Variables	Cash Flow	Capital Expenditure	Tobin's Q	Cash Holding	Leverage	Size
Cash Flow	1					
Capital Expenditure	0.046	1				
Tobin's Q	-0.051	0.039	1			
Cash Holding	0.075	0.108	0.009	1		
Leverage	-0.08	-0.037	0.072	-0.002	1	
Size	0.423	0.422	-0.367	0.376	-0.368	1

This table presents the correlation matrix of the key variables in this study from 2003 to 2011 excluding 2008. The definitions of variables are presented in Appendix. Cash flows, capital expenditures and cash holdings are scaled by the beginning of period capital stock as in net amount of property, plant and equipment.

Table 1 presents the summary statistics for the key variables in this study. We deflate all series to 2003 dollars using the Consumer Price Index. All variables are winsorized at 1% and 99%. We report summary statistics for all the sample years from 2003 to 2011 except 2008 (Panel A), the pre-crisis period from 2003 to 2007 (Panel B), the post-crisis period from 2009 to 2011 (Panel C) and a mean comparison of key variables between the pre- and post-crisis samples (Panel D). Several points in the summary statistics are noteworthy. After the financial crisis, cash flows, capital expenditures and cash holdings all decline to a certain degree. However, the extent of this varies. Average cash flows decrease significantly from 0.193 to 0.088 after the financial crisis, a drop of over 50%. Average capital expenditures also decrease from 0.458 to 0.305, representing a much more moderate drop of 30%. Average cash holdings decrease from 0.196 to 0.166; this 15% drop makes this factor the least affected of the three. In contrast, average leverage increases from 0.284 to 0.304 after the financial crisis. The results of the summary statistics imply that after the financial crisis, oil companies raised more debt to compensate for declining cash flows. Based on the untabulated results, we also find that the correlation between cash holdings and investments is much higher than the correlation between cash flows and investments for both the pre- and post-crisis samples. The correlations between cash flows and investments are -0.005 and -0.035 for the pre- and post-crisis periods, respectively, whereas the correlations between cash holdings and investments are 0.298 and 0.368 for the pre- and post-crisis periods, respectively. This implies that investments are more closely related to cash holdings than cash flows; this relationship becomes even stronger after the financial crisis. Table 2 presents the correlation matrix of the key variables in this study. The results show that the key variables such as cash flows, capital expenditure, cash holdings and Tobin's Q are not highly correlated. Thus, it mitigates the concerns of multicollinearity among the key variables. Next, we turn to the multivariate analysis to present the main results of this paper.

3. Methodologies and Results

3.1 Investments, Cash Flows and Cash Holdings from 2003 to 2007

A widely used empirical model to test the impact of cash flows on investment is a reduced form regression between investments and cash flows after controlling for a firm's set of investment opportunities (proxied for by Tobin's *Q*) as developed by Fazzari, Hubbard and Petersen (1988). To consider the effect of cash holdings, leverage and investment persistence on investments, we estimate an augmented regression model among capital expenditures, cash flows, cash holdings, firm size, leverage, lagged capital expenditures and Tobin's *Q* in the Equation (1) below to examine the investment behaviors of oil companies.

$$I_{i,t} / K_{i,t-1} = \alpha + \beta_1 \times CF_{i,t} / K_{i,t-1} + \beta_2 \times CH_{i,t-1} / K_{i,t-1} + \beta_3 \times Q_{i,t-1} + \beta_4 \times Size_{i,t-1} + \beta_5 \times Leverage_{i,t-1} + \beta_6 \times I_{i,t-1} / K_{i,t-2} + \sum firm_i + \sum year_t + \varepsilon_{i,t} \quad (1)$$

where $I_{i,t} / K_{i,t-1}$ is defined as a firm's capital expenditures in fiscal year *t* deflated by the capital stock at the beginning of year *t*. $CF_{i,t} / K_{i,t-1}$ is defined as a firm's cash flows in fiscal year *t* deflated by the capital stock at the beginning of year *t*, where cash flows are defined as earnings before extraordinary items plus depreciation. $CH_{i,t-1} / K_{i,t-1}$ is a firm's cash in the beginning of year *t* and short-term investments scaled by capital stock. $Q_{i,t-1}$ is Tobin's *Q* at the beginning of year *t*, which is defined as the market value of assets divided by the book value of assets. $Size_{i,t-1}$ is the natural logarithm of a firm's total assets at the beginning of year *t*. $Leverage_{i,t-1}$ is a firm's leverage at the beginning of year *t* and is defined as long-term debt and current liabilities divided by total assets. $I_{i,t-1} / K_{i,t-2}$ is defined as a firm's capital expenditures in fiscal year *t-1* deflated by the capital stock at the beginning of year *t-1*. Firm and year capture firm

and year fixed effects, respectively. The OLS results of Equation (1) with different specifications are reported in Table 3, and standard errors are clustered at the firm level.

Table 3. Cash flows, cash holdings and investments from 2003 to 2007

	(1)	(2)	(3)	(4)	(5)
CFt / Kt-1	0.132	0.074	0.058	0.031	0.029
	(0.87)	(0.73)	(0.60)	(0.32)	(0.36)
Q t-1	0.152***	0.115**	0.109**	0.116**	0.118**
	(3.40)	(2.11)	(2.15)	(2.24)	(2.36)
CH_{t-1} / Kt-1		0.461***	0.498***	0.499***	0.487***
		(2.72)	(2.77)	(2.73)	(2.63)
Size t-1			-0.206**	-0.245***	-0.226***
			(-2.52)	(-2.88)	(-2.79)
$Leverage_{t-1}$				-0.431**	-0.429**
				(-2.38)	(-2.46)
I_{t-1} / K_{t-2}					0.436**
					(2.28)
Year Effect	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes
R-square	0.64	0.73	0.74	0.74	0.75
N	891	891	891	891	891

This table presents OLS regression results of Equation (1) for U.S. oil companies from 2003 to 2007 with different specifications. The dependent variables are I_t / K_{t-1}, which is defined as a firm's capital expenditures of year t deflated by year beginning capital stock (net amount of property, plant and equipment). Q_{t-1} is the year beginning Tobin's *Q*. Tobin's *Q* is defined as (market value of equity + book value of debt) / total asset. CF_t/K_{t-1} is defined as a firm's cash flows of year t deflated by year beginning capital stock. $Size_{t-1}$ is the beginning of period firm total asset in natural logarithm. CH_{t-1}/K_{t-1} is defined as a firm's cash and short term investment of year t-1 scaled by capital stock. $Leverage_{t-1}$ is defined as total liability divided by total assets. I_{t-1} / K_{t-2} is defined as a firm's capital expenditures of year t-1 deflated by year t-2 capital stock. Heteroskesdasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

Column 1 of Table 3 reports the typical reduced form regression results with cash flows and *Q* as independent variables on capital expenditures. At 0.132, the coefficient of CF_t /K_{t-1} is statistically insignificant, whereas the coefficient of Q_{t-1} is 0.152 and significant at the 1% level, suggesting that cash flows do not have a significant impact on investments and that investments are more related to investment opportunities, as proxied for by *Q*. Columns 2 through 5 report augmented regression results with different specifications. Similar to the reduced form in Column 1, the coefficients of $CF_{i,t}$ / $K_{i,t-1}$ remain insignificant in different regression specifications and decrease to only 0.029 when we add more control variables into the specifications. However, we find significant and positive coefficients of $CH_{i,t-1}/K_{i,t-1}$, ranging from 0.461 to 0.499, in the different regression specifications, suggesting that the capital expenditures of oil companies are more sensitive to their cash holdings at the beginning of the period than their contemporaneous cash flows. In addition, the coefficient of $I_{i,t-1}$ / $K_{i,t-2}$ is 0.436 and statistically significant, suggesting that lagged investments also have a great impact on current investments and that investment decisions are inter-temporal and persistent. The results are consistent with the notion that investment friction affects firm choices regarding internal funds for investments. If investments are persistent and have high adjustment costs, firms will rely on their cash holdings at the beginning of the year instead of on contemporaneous cash flows for investments because realized cash holdings are a more reliable source of internal funds than the uncertain cash flows of the coming year.

3.2 Investments, Cash Flows, Cash Holdings and Financial Constraints from 2003 to 2007

Whereas the results from the previous section have indicated the importance of investment friction in firms' investment decisions regarding cash flows and cash holdings, we need to acknowledge that the oil companies in our sample may also encounter financing friction, such as financial constraints. If investment-cash flow sensitivity is a valid measure of a firm's financial constraint status, then our baseline results could be driven by the possibility that most of the firms in our sample are financially unconstrained. To rule out this alternative explanation, we follow the extant empirical literature (e.g. Kaplan and Zingales 1997, Almeida et al. 2004) and partition the pre-crisis sample into financially constrained and unconstrained firms based on firm size, long-term bond ratings and short-term commercial paper ratings. Large firms with access to external capital markets are less financially constrained than small firms without access to external capital markets. We then estimate Equation (1) with the pre-crisis sample for both constrained and unconstrained firms. The results are reported in Table 4.

Table 4. Investments and financial constraint from 2003 to 2007

	Firm Size		Bond Rating		Commercial Paper Rating	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
	(1)	(2)	(3)	(4)	(5)	(6)
CF_t / K_{t-1}	-0.086	0.041	-0.053	0.069	0.026	0.066
	(-0.90)	(0.58)	(-0.57)	(0.97)	(0.26)	(0.81)
Q_{t-1}	0.105	0.073**	0.114	0.132*	0.116	0.097**
	(0.94)	(2.02)	(1.06)	(1.87)	(1.21)	(2.28)
CH_{t-1} / K_{t-1}	0.514**	0.165**	0.497**	0.310*	0.505**	0.176**
	(2.56)	(2.30)	(2.59)	(1.73)	(2.37)	(2.16)
$Size_{t-1}$	-0.295**	-0.259***	-0.265**	-0.175**	-0.247***	-0.292**
	(-2.05)	(-3.53)	(-2.28)	(-2.26)	(-2.86)	(-2.21)
$Leverage_{t-1}$	-0.510*	-0.240**	-0.519*	-0.478**	-0.429**	-0.438**
	(-1.82)	(-2.15)	(-1.89)	(-2.19)	(-2.31)	(-2.01)
I_{t-1} / K_{t-2}	0.426**	0.440**	0.416**	0.452**	0.408**	0.467**
	(2.46)	(2.38)	(2.26)	(2.35)	(2.18)	(2.47)
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.69	0.88	0.65	0.84	0.68	0.85
N	225	234	543	348	652	239

This table presents OLS regression results of Equation (1) for U.S. oil companies from 2003 to 2007 by partition of financial constraint status based on firm size, bond ratings and commercial paper ratings. The dependent variables are I_t / K_{t-1}, which is defined as a firm's capital expenditures of year t deflated by year beginning capital stock (net amount of property, plant and equipment). Q_{t-1} is the year beginning Tobin's *Q*. Tobin's *Q* is defined as (market value of equity + book value of debt) / total asset. CF_t/K_{t-1} is defined as a firm's cash flows of year t deflated by year beginning capital stock. $Size_{t-1}$ is the beginning of period firm total asset in natural logarithm. CH_{t-1}/K_{t-1} is defined as a firm's cash and short term investment of year t-1 scaled by capital stock. $Leverage_{t-1}$ is defined as total liability divided by total assets. I_{t-1} / K_{t-2} is defined as a firm's capital expenditures of year t-1 deflated by year t-2 capital stock.

Heteroskesdasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

Columns 1 through 6 of Table 4 report the OLS results of Equation (1) with the pre-crisis sample by partitioning firms based on their financial constraint status based on firm size, bond ratings and commercial paper ratings. A firm is financially constrained if its total assets are in the bottom quartile and it has no bond or commercial paper ratings. A firm is financially unconstrained if its total assets are in the top quartile and it has commercial paper or bond ratings. The coefficients of cash flows on capital expenditures are statistically and economically insignificant regardless of the financial constraint status based on different partition criteria, suggesting that investments are not sensitive to cash flows even among financially constrained firms. As in the baseline results, the coefficients of CH_{t-1} / K_{t-1} are positive and significant in all specifications, suggesting that investments are positively related to lagged cash holdings. In addition, the coefficients of CH_{t-1} / K_{t-1} for constrained firms are larger in magnitude than those of unconstrained firms (differences range from 0.187 to 0.349, with p-value<0.01), suggesting that investments made by constrained firms are more sensitive to cash holdings than those of unconstrained firms. The difference in investment-cash holding sensitivities between constrained and unconstrained firms suggest that cash holdings are more important to constrained firms because they allow for these firms to have sufficient internal funds for their investments.

3.3 Cash Holdings, Debt Issuance and Payouts from 2003 to 2007

If oil companies prefer cash holdings to cash flows as internal funds for investments when facing investment persistence and adjustment costs, then how oil companies allocate their cash flows to maintain an ideal cash holdings level will be the next research question to be explored. To this end, we examine the cash flow policies of oil companies with regard to cash holdings and other cash flow outlays, as suggested by the extant literature. For example, Almeida et al. (2004) and Han and Qiu (2007) model the corporate demand for precautionary cash holdings, showing that cash flows are positively related to cash holdings for financially constrained firms and that firms increase cash holdings as cash flows become riskier. In addition, Acharya et al. (2007) show that the impact of cash flows on cash holdings should be jointly determined with debt levels because cash can be readily used to redeem debt. Moreover, as shown by Gatchev et al. (2010) and Dasgupta et al. (2011), payout policies, such as those related to dividends and stock repurchases, should also be considered in joint determination because payouts to shareholders represent another important outlay of cash flows. To mitigate possible endogeneity among cash, debt and payout policies due to joint determination, we estimate a system of four simultaneous equations, similar to the specification in Acharya et al. (2007), to examine cash flow policies toward cash holdings and other outlays such as debt, dividends and share repurchases. (Note 7) The system of equations is as follows:

$$\Delta CH_{i,t} = \alpha_0 + \alpha_1 \times CF_{i,t} + \alpha_2 \times Q_{i,t} + \alpha_3 \times Size_{i,t} + \alpha_4 \times CH_{i,t-1} + \alpha_5 \times \Delta Dividend_{i,t} + \alpha_6 \times \Delta Repurchase_{i,t} + \alpha_7 \times \Delta Debt_{i,t} + \sum firm_i + \sum year_t + \varepsilon^c_{i,t} \quad (2)$$

$$\Delta Debt_{i,t} = \beta_0 + \beta_1 \times CF_{i,t} + \beta_2 \times Q_{i,t} + \beta_3 \times Size_{i,t} + \beta_4 \times Leverage_{i,t-1} + \beta_5 \times \Delta CH_{i,t} + \beta_6 \times \Delta Dividend_{i,t} + \beta_7 \times \Delta Repurchase_{i,t} + \sum firm_i + \sum year_t + \varepsilon^d_{i,t} \quad (3)$$

$$\Delta Dividend_{i,t} = \gamma_0 + \gamma_1 \times CF_{i,t} + \gamma_2 \times Q_{i,t} + \gamma_3 \times Size_{i,t} + \gamma_4 \times Dividend_{i,t-1} + \gamma_5 \times \Delta CH_{i,t} + \gamma_6 \times \Delta Debti,t + \gamma_7 \times \Delta Repurchasei,t + \sum firm_i + \sum year_t + \varepsilon^v_{i,t} \quad (4)$$

$$\Delta Repurchase_{i,t} = \delta_0 + \delta_1 \times CF_{i,t} + \delta_2 \times Q_{i,t} + \delta_3 \times Size_{i,t} + \delta_4 \times Repurchase_{i,t-1} + \delta_5 \times \Delta CH_{i,t} + \delta_6 \times \Delta Debt_{i,t} + \delta_7 \times \Delta Dividend_{i,t} + \sum firm_i + \sum year_t + \varepsilon^r_{i,t} \quad (5)$$

where the dependent variables $\Delta CH_{i,t}$, $\Delta Debt_{i,}t$, $\Delta Dividend_{i,t}$ and $\Delta Repurchase_{i,t}$ are changes in cash holdings, net long-term debt issuance (difference between long-term debt issuance and long term-debt reduction), dividends and stock repurchases scaled by the capital stock, respectively. $CH_{i,t-1}$ is the cash holding at the beginning of year *t* scaled by the capital stock. $Leverage_{i,t-1}$ is the leverage at the beginning of year *t*. $Dividend_{i,t-1}$ is the dividend paid to common stockholders at the beginning period of year *t* scaled by the capital stock and $Repurchase_{i,t-1}$ is the net stock repurchase at the beginning of year *t* scaled by the capital stock.

Extant studies have also shown that the precautionary cash saving motive varies cross-sectionally according to the financial constraint status of firms. For example, Almeida et al. (2004) show that constrained firms will systematically save cash from cash flows, whereas unconstrained firms do not display this tendency. Similarly, payout policies, such as those related to share repurchases, are also closely related a firm's financial constraint status. Share repurchasers spend cash flows or raise more debt when buying back shares (Dittmar 2000; Stephens and Weisbach 1998). Therefore, the repurchase of shares by constrained firms may decrease equity value because of the decline in corporate liquidity and the increase of financial distress risk (Chen and Wang 2012). To address the

cross-sectional differences among cash flow policies according to the financial constraint status of firms, we estimate Equations (2) through (5) across partitions based on the financial constraint status of firms with similar classifications as those used in Section 3.2. The regression results are reported in Table 5.

Table 5. Cash holding, debt and payout policy from 2003 to 2007

Panel A	Firm Size		Commercial Paper Rating		Bond Rating	
Δ CH_t	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	0.063***	-0.030	0.183**	-0.049	0.160**	0.039
	(2.61)	(-0.35)	(2.44)	(-0.01)	(2.41)	(0.51)
Q_t	0.006	0.003	-0.002	0.038	0.008	-0.003
	(0.93	(0.44)	(-0.14)	(0.11)	(0.65)	(-0.29)
$Size_t$	0.025	-0.001	-0.058	0.008	0.058	-0.002
	(0.52)	(-0.22)	(-0.44)	(0.08)	(0.43)	(-0.58)
CH_{t-1}	-0.308***	-0.261***	-0.205**	-0.567***	-0.350	-0.252***
	(-2.70)	(-4.19)	(-2.05)	(-2.62)	(-1.48)	(-5.74)
Δ $Debt_t$	-0.458	-0.195	-0.449	-0.268	-0.216	-0.216*
	(-0.89)	(-1.20)	(-0.39)	(-0.10)	(-0.49)	(-1.91)
Δ Div_t	0.01	-0.241	-0.085	-0.099	-0.872	0.918
	(0.68)	(-0.29)	(-0.41)	(-0.05)	(-0.46)	(0.47)
Δ $Repurchase_t$	-0.092	0.039	-0.515	0.344	0.295	-0.020
	(-0.36)	(0.54)	(-0.43)	(0.05)	(0.38)	(-0.18)
R-square	0.11	0.12	0.15	0.14	0.17	0.16
Panel B	Firm Size		Commercial Paper Rating		Bond Rating	
Δ $Debt_t$	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	-0.024**	-0.407***	-0.031**	-0.780**	-0.036***	-0.665***
	(-2.02)	(-3.83)	(-2.56)	(-2.58)	(-3.03)	(-3.38)
Q_t	0.001	-0.015	0.001	0.140	0.001	0.039
	(0.62)	(-1.37)	(0.66)	(0.88)	(0.46)	(1.34)
$Size_t$	0.013	-0.012*	0.010	-0.048	0.013***	-0.011
	(1.53)	(-1.65)	(1.42)	(-0.43)	(2.69)	(-1.38)
$Leverage_{t-1}$	0.013	-0.110**	-0.030**	-0.028**	0.006	-0.364***
	(1.00)	(-2.41)	(-2.31)	(-2.19)	(0.64)	(-3.30)
Δ CH_t	0.034	-0.168	-0.043	-0.116	-0.057	-0.224
	(0.34)	(-1.09)	(-0.44)	(-0.11)	(-0.58)	(-0.50)
Δ Div_t	0.815	-0.833**	-0.274	0.096	-0.339	-0.127*
	(1.22)	(-2.08)	(-1.07)	(0.46)	(-1.38)	(-1.74)
Δ $Repurchase_t$	-0.014	0.010	0.086	0.038	0.073	0.308
	(-0.20)	(0.06)	(1.51)	(0.44)	(1.31)	(1.20)
R-square	0.14	0.15	0.15	0.13	0.14	0.17

Panel C	Firm Size		Commercial Paper Rating		Bond Rating	
Δ Div_t	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	0.001	0.014	0.011	0.038	0.002	0.019
	(0.06)	(0.59)	(0.14)	(0.98)	(0.41)	(1.09)
Q_t	0.001	0.006***	0.001	-0.002	0.001	0.005**
	(0.41)	(2.77)	(0.07)	(-0.66)	(0.53)	(2.13)
$Size_t$	0.002	0.004***	-0.002	0.001	0.001	0.002**
	(0.24)	(2.73)	(-0.11)	(0.57)	(0.04)	(2.60)
Div_{t-1}	-0.473***	-0.328***	-0.367**	-0.307**	-0.214***	-0.151**
	(-4.94)	(-4.95)	(-2.21)	(-2.14)	(-3.20)	(-2.48)
Δ CH_t	-0.010	0.057	-0.021	-0.003	-0.007	0.037
	(-1.59)	(0.90)	(-0.15)	(-0.19)	(-0.61)	(1.18)
Δ $Debt_t$	-0.027	0.064	0.277	0.020*	0.034	0.072**
	(-0.42)	(1.12)	(0.13)	(1.65)	(0.26)	(2.47)
Δ $Repurchase_t$	0.004	-0.037*	-0.042	-0.027	-0.010	-0.041
	(0.93)	(-1.89)	(-0.15)	(-0.16)	(-0.85)	(-1.51)
R-square	0.16	0.18	0.14	0.19	0.12	0.17
Panel D	Firm Size		Commercial Paper Rating		Bond Rating	
Δ $Repurchase_t$	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	0.010	0.443**	-0.078	0.774*	0.068	0.178**
	(0.074)	(2.24)	(-0.10)	(1.77)	(0.53)	(2.48)
Q_t	-0.007	-0.008	-0.005	-0.052	-0.010**	-0.054
	(-1.29)	(-0.51)	(-0.13)	(-0.91)	(-2.07)	(-1.48)
$Size_t$	-0.034	-0.008	0.230	0.015	-0.033	-0.007
	(-0.94)	(-0.76)	(0.10)	(0.73)	(-0.80)	(-0.52)
$Repurchase_{t-1}$	-0.478***	-0.487***	-0.667**	-0.648**	-0.459***	-0.534***
	(-5.24)	(-5.60)	(-2.14)	(-2.56)	(-3.43)	(-2.76)
Δ CH_t	0.077	-0.680	-0.087	-0.032	-0.055	-0.026*
	(0.27)	(-1.13)	(-0.09)	(-0.08)	(-0.18)	(-1.72)
Δ $Debt_t$	-0.019	-0.328	-0.337	0.404	0.358	-0.807
	(-0.39)	(-0.64)	(-1.00)	(1.03)	(0.39)	(-1.40)
Δ Div_t	0.391	0.912**	0.564	0.985	0.881**	0.850
	(1.30)	(2.16)	(1.08)	(1.03)	(2.50)	(1.41)
R-square	0.11	0.14	0.15	0.12	0.17	0.19
N	225	234	543	348	652	239

Panels A through D of this table present 3SLS regression results of Equations (2) through (5) respectively for U.S. oil companies from 2003 to 2007. The dependent variables of Panel A through Paned D are $\Delta CH_{i,t}$, $\Delta Debt_{i,}t$, $\Delta Div_{i,t}$ and $\Delta Repurchase_{i,t}$ respectively. $\Delta CH_{i,t}$, $\Delta Debt_{i,}t$, $\Delta Div_{i,t}$ and $\Delta Repurchase_{i,t}$ are defined as the change of cash holding, net long term debt issuance (difference between long term debt issuance and long term debt reduction), the change of dividend and the change of stock repurchase scaled by capital stock respectively. *CF* is defined as the firm cash flow deflated by capital stock. *Leverage* is defined as a firm's beginning period long term debt and debt in current liability scaled by its total assets. *CH* is defined as the firm's beginning period cash and short term

investment deflated by capital stock. *Q* is defined as (market value of equity + book value of debt) / total asset. *Size* is the natural logarithm of total assets. *Div* is defined as the beginning period dollar amount of common share dividend scaled by capital stock and *Repurchase* is defined as the beginning period dollar amount of stock repurchase net of stock issuance scaled by capital stock. Sample is partitioned by a firm's total assets, commercial paper ratings and bond ratings. A firm is considered to be financially constrained if the firm's total asset is in the bottom quartile and unconstrained if the total asset is in the top quartile. A firm is considered to be financially constrained if the firm does not have commercial paper rating or bond rating. A firm is considered to be unconstrained if the firm has commercial paper rating or bond rating. Firm and year effects dummy are also included. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

Panels A through D of Table 5 report the regression results of Equations (2) through (5), respectively. The dependent variables in Panels A through D are Δ*CH*, Δ*Debt*, Δ*Dividend* and Δ*Repurchase*, respectively. Columns 1 through 6 of each panel report the regression results of each equation according to the partition of the pre-crisis sample based on potential financial constraint levels, firm size, commercial paper ratings and bond ratings. A firm is financially constrained if its total assets are in the bottom quartile and it has no bond or commercial paper ratings. A firm is financially unconstrained if its total assets are in the top quartile and it has bond or commercial paper ratings.

In Panel A of the cash holding regression, the coefficients of *CF* are all positive and significant for the constrained firms, suggesting that financially constrained firms tend to accumulate cash reserves from cash flows. For unconstrained firms, the coefficients of *CF* are much smaller and statistically insignificant with different signs, suggesting that those firms do not systematically save cash from cash flows. The results are similar to the findings in Acharya et al. (2007), Almeida et al. (2004) and others, suggesting that constrained firms need to build up cash reserves from cash flows for investment purposes because of the higher costs associated with external funds. The insignificant cash holding-cash flow sensitivity for unconstrained firms suggests that saving cash from cash flows is not a priority for unconstrained firms. These firms usually have a desired level of cash holdings based on their investment needs. If cash reserves are below the desired level, firms can increase their balance by raising external funds. Therefore, when there are positive cash flow shocks, it is not necessary for unconstrained firms to build up extra cash holdings if they have already reached their target cash holding threshold because holding extra cash can be costly as well (e.g., agency cost of free cash flows). For constrained firms, saving cash is crucial. By building up cash holdings in the current period, when there are positive cash flow shocks, firms can also transfer current high cash flows to possible periods of low cash flows in the future to minimize the effect of cash flow fluctuations.

In Panel B of the debt capacity regression, the coefficients of *CF* are negative and significant for unconstrained firms, suggesting that these firms use cash flows for debt repayment. For constrained firms, the coefficients of *CF* are also negative, although there are economically negligible compared to unconstrained firms. The results from Panel B suggest that debt repayment is a major cash flow outlay for unconstrained firms. Because unconstrained firms face less financing friction than constrained firms, they can easily build up cash holdings through external funds when facing cash shortages. Therefore, when there are positive cash flow shocks, unconstrained firms will choose to repay their debts if they have already reached their desired cash holdings level. These results are consistent with debt overhang cost theory. When a firm experiences a positive cash flow shock, it may choose to optimally reduce debt overhang costs associated with future investments by decreasing its debt in the current period in order to increase investment in subsequent periods.

Panel C reports the impact of cash flows on dividend payouts. None of the coefficients of *CF* are significant either statistically or in magnitude regardless of the financial constraint status of firms. These results suggest that changes in dividends are not sensitive to cash flows during the sample period, consistent with the findings of Dasgupta et al. (2011). The results are consistent with the notion that dividends tend to be "sticky" and that firms will usually smooth dividends to keep them stable regardless of cash flow conditions (Allen and Michaely 2003).

Panel D reports the effect of cash flows on share repurchases. Our results show that only unconstrained firms will make repurchases, whereas constrained firms will not buy back shares. These results suggest that when there are positive cash flow shocks, unconstrained firms will make payouts to shareholders if there have cash flow surpluses beyond their financing needs (e.g., cash holdings, debt). Repurchases can thereby reduce free cash flow problems and mitigate conflicts of interest between shareholders and management. Constrained firms will not repurchase because building up cash holdings should be their primary use for cash flows.

In sum, this section presents the cash flow policies of oil companies with regard to cash holdings, debt issuances and payouts during the pre-crisis sample period. Together with the results of Sections 3.1 and 3.2, we show that there seems to be a "pecking order" with regard to the use of cash flows. Constrained firms need to accumulate cash

holdings from cash flows for investment purposes because external funds are costly. Therefore, whenever there are positive cash flow shocks, their first priority will be to build up cash reserves. The easy access of unconstrained firms to external funds implies that they can usually maintain a desired cash holdings level based on their investment needs. When there are cash flow surpluses, unconstrained firms will repay their debts to increase their future financing capacity and make payouts to shareholders through share repurchases.

In reality, the cash flow policies of oil companies are also intuitive. After several years of oil price growth due to factors such as demand from emerging economies, the war in Iraq and Hurricane Katrina, oil companies expected oil prices to become more volatile in the future because of market speculation, slowing demand and the development of alternative fuels. In fact, oil prices dropped by over 60% during the 2008 financial crisis. Meanwhile, with the declining supply of conventional sources of oil, oil companies are waiting for the next technological and economically viable investment in the energy supply, either alternative fuels such as solar power or unconventional oil resources. By saving cash and decreasing debt when there are positive cash flow shocks, oil companies will be in a better financial position if oil prices become volatile in the future. The 2008 financial crisis acted as an exogenous shock to the cash flows of oil companies and exacerbated liquidity constraints for all firms. Next, we investigate how these exogenous shocks influenced the investments of oil companies with internal funds and the use of cash flows during the post-crisis period.

3.4 Investments, Cash Flows and Cash Holdings from 2009 to 2011

During the 2008 financial crisis, oil prices decreased from their peak of approximately $130 per barrel in mid-2008, to their lowest point of roughly $40 per barrel at the end of 2008. Because of stimulus plans from major world economies to cope with the financial crisis, oil prices started to rise along with stock markets and commodity prices during the post-crisis period from 2009 to 2011, as shown in Figure 1. However, oil companies still suffered significant declines in cash flows because of reduced demand due to the recession that took place after the crisis. In addition, liquidity constraints and rationing after the financial crisis systematically exacerbated financing friction across all firms (Campello et al. 2010). Therefore, it will be interesting to investigate how oil companies invest with internal funds when there are negative cash flow shocks. In addition, by examining the investment financing behavior of oil companies when there are negative cash flow shocks and additional financing friction, we can also rule out the alternative explanation to the baseline results in the pre-crisis sample that cash flow windfalls ease financing friction for all firms and that this causes the insignificant investment-cash flow sensitivity. To this end, we first estimate Equation (1) with the post-crisis sample from 2009 to 2011. The results are reported in Table 6.

Table 6. Investments, cash flows, cash holdings from 2009 to 20011

	(1)	(2)	(3)	(4)	(5)
CF_t / K_{t-1}	0.086	0.072	0.062	0.059	0.046
	(0.60)	(0.43)	(0.33)	(0.21)	(0.24)
Q_{t-1}	0.132**	0.140**	0.114**	0.101**	0.109**
	(2.40)	(2.50)	(2.46)	(2.28)	(2.34)
CH_{t-1} /K_{t-1}		0.672***	0.699***	0.702***	0.692***
		(7.39)	(7.08)	(7.35)	(7.26)
$Size_{t-1}$			-0.142**	-0.121*	-0.130*
			(-2.27)	(-1.88)	(-1.90)
$Leverage_{t-1}$				-0.198**	-0.201**
				(-1.96)	(-2.01)
I_{t-1} / K_{t-2}					0.387**
					(2.36)
Year Effect	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes
R-square	0.74	0.78	0.79	0.80	0.82
N	531	531	531	531	531

This table presents OLS regression results of Equation (1) for U.S. oil companies with post-crisis sample from 2009 to 2011. The dependent variables are I_t / K_{t-1}, which is defined as a firm's capital expenditures of year t deflated by

year beginning capital stock (net amount of property, plant and equipment). Q_{t-1} is the year beginning Tobin's *Q*. Tobin's *Q* is defined as (market value of equity + book value of debt) / total asset. CF_t/K_{t-1} is defined as a firm's cash flows of year t deflated by year beginning capital stock. $Size_{t-1}$ is the beginning of period firm total asset in natural logarithm. CH_{t-1}/K_{t-1} is defined as a firm's cash and short term investment of year t-1 scaled by capital stock. $Leverage_{t-1}$ is defined as total liability divided by total assets. I_{t-1} / K_{t-2} is defined as a firm's capital expenditures of year t-1 deflated by year t-2 capital stock. Heteroskesdasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

Columns 1 through 5 of Table 6 report the regression results for Equation (1) with different specifications with the post-crisis sample. The overall results are similar to those of the pre-crisis period. Investments are not sensitive to cash flows in different specifications, whereas capital expenditures are positively and significantly related to cash holding levels. Compared to the results from the pre-crisis period, we also find that the coefficients of lagged cash holdings are larger in magnitude after the crisis. The coefficients of cash holdings range from 0.672 to 0.702 in the post-crisis sample compared to a range of 0.461 to 0.499 in the pre-crisis sample. Coefficient differences range from 0.201 to 0.211 (with p-value<0.01), suggesting that oil companies are more dependent on their cash holdings for investments after the financial crisis than they were before the financial crisis.

In addition, we examine firms' investments with internal funds with regard to different financial constraint statuses when cash flows decline during the post-crisis period. To this end, we apply a similar approach as that in Section 3.2 by estimating Equation (1) with the post-crisis sample of financial constraint status partitioning based on firm size, bond ratings and commercial paper ratings. The results are reported in Table 7. The overall results are generally as expected. Cash flows do not have a significant impact on investments regardless of the financial constraint status of firms and capital expenditures are positively related to lagged cash holdings for all firms. Moreover, as in the pre-crisis sample results, we find that the coefficients of lagged cash holdings are much higher for constrained firms than for unconstrained firms. Coefficient differences between constrained and unconstrained firms range from 0.483 to 0.537 (with p-value<0.01), suggesting that constrained firms rely on cash holdings for investments to a greater extent than unconstrained firms. Together with Sections 3.1 and 3.2, the overall results show that firms prefer to use cash holdings as internal funds for investments over cash flows to avoid adjustment costs when they encounter investment friction, such as investment persistence and investment time lags. Constrained firms rely on cash holdings for investments to a greater extent than unconstrained firms, and the relationship between investments and cash holdings is strengthened when cash flows decline.

Table 7. Investments and financial constraints from 2009 to 2011

	Firm Size		Bond Rating		Commercial Paper Rating	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
	(1)	(2)	(3)	(4)	(5)	(6)
CF_t / K_{t-1}	0.092	-0.060	0.078	-0.033	0.062	-0.072
	(0.32)	(-1.14)	(0.21)	(-0.78)	(0.24)	(-0.40)
Q_{t-1}	0.094**	0.198**	0.085**	0.187**	0.099***	0.044
	(1.98)	(2.30)	(2.20)	(2.50)	(2.97)	(0.74)
CH_{t-1} / K_{t-1}	0.753***	0.216**	0.721***	0.205**	0.719***	0.236***
	(7.85)	(2.56)	(7.66)	(2.44)	(7.63)	(2.69)
$Size_{t-1}$	-0.255**	-0.077	-0.262**	-0.090	-0.139**	-0.206
	(-2.12)	(-1.61)	(-2.53)	(-1.50)	(-2.01)	(-1.30)
$Leverage_{t-1}$	-0.382	-0.578***	-0.292	-0.626***	-0.187	-0.382**
	(-1.17)	(-2.85)	(-0.93)	(-3.18)	(-0.87)	(-2.22)
I_{t-1} / K_{t-2}	0.354**	0.397**	0.402**	0.357**	0.336**	0.380**
	(2.12)	(2.26)	(2.38)	(2.21)	(2.41)	(2.19)
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.86	0.86	0.81	0.84	0.80	0.85
N	129	148	291	240	349	182

This table presents OLS regression results of Equation (1) for U.S. oil companies from 2009 to 2011 by partition of financial constraint status based on firm size, bond ratings and commercial paper ratings. The dependent variables are I_t / K_{t-1}, which is defined as a firm's capital expenditures of year t deflated by year beginning capital stock (net amount of property, plant and equipment). Q_{t-1} is the year beginning Tobin's *Q*. Tobin's *Q* is defined as (market value of equity + book value of debt) / total asset. CF_t/K_{t-1} is defined as a firm's cash flows of year t deflated by year beginning capital stock. $Size_{t-1}$ is the beginning of period firm total asset in natural logarithm. CH_{t-1}/K_{t-1} is defined as a firm's cash and short term investment of year t-1 scaled by capital stock. $Leverage_{t-1}$ is defined as total liability divided by total assets. I_{t-1} / K_{t-2} is defined as a firm's capital expenditures of year t-1 deflated by year t-2 capital stock. Heteroskesdasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

3.5 Cash Holdings, Debt Issuance and Payouts from 2009 to 2011

The previous section (Section 3.3) has shown that there seems to be a "pecking order" with regard to cash flow outlays for oil companies during the pre-crisis period: firms will accumulate cash reserves from cash flows if they are financially constrained. Unconstrained firms will use cash flows to repay debts and repurchase shares. The 2008 financial crisis caused not only declines in the cash flows of oil companies but also the deterioration of financing friction for all firms. In this section, we examine the cash flow policies of oil companies during the post-crisis period. To this end, we employ a similar empirical approach as that used in Section 3.3 with a system of equations consisting of Equations (2) through (5) with post-crisis sample through a similar partitioning of firms based on their financial constraint status. The regression results are reported in Table 8. Panels A through D of Table VII report the regression results of Equations (2) through (5), respectively, with the post-crisis sample. The dependent variables in Panels A through D are ΔCH, $\Delta Debt$, $\Delta Dividend$ and $\Delta Repurchase$, respectively. Columns 1 through 6 of each panel

report the regression results of each equation by the partitioning of the post-crisis sample based on a firm's potential financial constraint level based on firm size, commercial paper ratings and bond ratings.

Table 8. Cash holding, debt and payout policy from 2009 to 2011

Panel A	Firm Size		Commercial Paper Rating		Bond Rating	
Δ CH_t	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	0.474**	0.118**	0.234***	0.067*	0.357**	0.126**
	(2.51)	(2.35)	(2.68)	(1.82)	(2.45)	(2.25)
Q_t	-0.196	0.001	-0.007	-0.046	-0.010	0.010
	(-0.20)	(0.02)	(-0.80)	(-1.15)	(-0.69)	(0.41)
$Size_t$	0.856	-0.001	-0.011	0.026	-0.009	-0.006
	(0.92)	(-0.12)	(-0.77)	(0.09)	(-0.58)	(-0.66)
CH_{t-1}	-0.307**	-0.100**	-0.101**	-0.646*	-0.139**	-0.677**
	(-2.35)	(-2.46)	(-2.57)	(-1.86)	(-2.00)	(-2.36)
Δ $Debt_t$	-0.154	-0.294*	-0.908	-0.794	-0.189	-0.229
	(-0.166)	(-1.79)	(-0.50)	(-0.46)	(-0.51)	(-0.35)
Δ Div_t	0.091	0.120	0.253	-0.866	0.199	-0.120
	(0.97)	(1.30)	(0.73)	(-0.23)	(0.60)	(-0.76)
Δ $Repurchase_t$	-0.212	-0.133	-0.404	-0.223	-0.527	0.224
	(-0.23)	(0.74)	(-0.64)	(-0.37)	(-0.57)	(0.99)
R-square	0.12	0.13	0.17	0.15	0.16	0.14

Panel B	Firm Size		Commercial Paper Rating		Bond Rating	
Δ $Debt_t$	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	-0.030*	-0.682**	-0.031	-0.656**	-0.040*	-0.392**
	(-1.72)	(-2.30)	(-0.80)	(-2.51)	(-1.72)	(-2.57)
Q_t	0.001	-0.067	0.007	-0.016	0.003	0.032*
	(0.81)	(-0.23)	(1.39)	(-0.22)	(1.35)	(1.76)
$Size_t$	-0.005	-0.004	0.010	0.046	0.003	0.003
	(-1.10)	(-0.07)	(1.57)	(0.17)	(0.70)	(0.05)
$Leverage_{t-1}$	-0.016	-0.202*	-0.010	-0.195**	-0.006	-0.087*
	(-0.14)	(-1.86)	(-0.32)	(-2.39)	(-0.38)	(-1.82)
Δ CH_t	0.095	-0.608	0.443	0.243	0.182	0.565
	(0.58)	(-0.28)	(1.04)	(0.32)	(0.84)	(0.86)
Δ Div_t	-0.586	-0.581	-0.241	0.177	-0.095*	0.083
	(-1.38)	(-0.29)	(-1.23)	(1.42)	(-1.80)	(1.37)
Δ $Repurchase_t$	0.141	-0.145	0.397	-0.476	0.251*	0.212
	(0.58)	(-0.25)	(1.56)	(-0.50)	(1.90)	(1.30)
R-square	0.13	0.12	0.13	0.11	0.17	0.19

Panel C	Firm Size		Commercial Paper Rating		Bond Rating	
Δ Div_t	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	-0.002	0.008	0.004	0.032	0.010	0.006
	(-0.12)	(1.33)	(0.24)	(0.70)	(0.21)	(1.07)
Q_t	0.001	0.004	-0.001	0.001	-0.001	-0.002
	(0.68)	(0.34)	(-0.06)	(0.10)	(-0.08)	(-0.87)
$Size_t$	-0.002	-0.001	-0.002	-0.006	0.001	-0.001
	(-0.12)	(-0.02)	(-0.10)	(-0.71)	(0.05)	(-0.12)
Div_{t-1}	-0.078	-0.023	-0.104	-0.041	-0.279*	-0.069
	(-0.26)	(-0.49)	(-0.30)	(-0.45)	(-1.81)	(-1.38)
Δ CH_t	0.013	0.045	0.014	-0.004	0.011	0.111*
	(0.66)	(1.09)	(0.46)	(-0.12)	(0.25)	(1.73)
Δ $Debt_t$	-0.062	0.038	0.097	0.041	0.201	-0.015
	(-0.15)	(0.86)	(0.22)	(1.64)	(0.20)	(-0.26)
Δ $Repurchase_t$	0.012	0.006	-0.008	0.011	-0.021	0.006
	(0.27)	(0.35)	(-0.10)	(0.35)	(-0.13)	(0.29)
R-square	0.15	0.16	0.15	0.17	0.14	0.16
Panel D	Firm Size		Commercial Paper Rating		Bond Rating	
Δ $Repurchase_t$	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	-0.083	0.135	-0.012	0.287	0.031	0.153*
	(-0.04)	(0.49)	(-0.05)	(0.14)	(0.27)	(1.67)
Q_t	0.004	-0.063*	0.014	-0.049	-0.002	-0.055
	(0.04)	(-1.83)	(0.15)	(-0.08)	(-0.16)	(-1.51)
$Size_t$	-0.065	0.021*	0.025	-0.118	-0.013**	0.005
	(-0.10)	(1.94)	(0.17)	(-0.14)	(-2.02)	(0.85)
$Repurchase_{t-1}$	-0.974**	-0.700**	-0.522	-0.281**	-0.600	-0.584**
	(-2.15)	(-2.56)	(-0.34)	(-2.16)	(-1.07)	(-2.15)
Δ CH_t	0.149	-0.109	0.171	0.462	0.363	0.433
	(0.10)	(-0.84)	(0.19)	(0.09)	(0.36)	(0.83)
Δ $Debt_t$	-0.65	-0.978*	-0.304	0.839	-0.841	0.052
	(-0.07)	(-1.94)	(-0.19)	(0.14)	(-0.19)	(0.13)
Δ Div_t	-0.341	0.602	-0.513	0.176	-0.223	-0.608
	(-0.49)	(0.23)	(-0.16)	(0.14)	(-0.06)	(-1.10)
R-square	0.12	0.13	0.17	0.14	0.16	0.21
N	129	148	349	182	291	240

Panels A through D of this table present 3SLS regression results of Equations (2) through (5) respectively for U.S. oil companies from 2009 to 2011. The dependent variables of Panel A through Paned D are $\Delta CH_{i,t}$, $\Delta Debt_i t$, $\Delta Div_{i,t}$ and $\Delta Repurchase_{i,t}$ respectively. $\Delta CH_{i,t}$, $\Delta Debt_i t$, $\Delta Div_{i,t}$ and $\Delta Repurchase_{i,t}$ are defined as the change of cash holding, net long term debt issuance (difference between long term debt issuance and long term debt reduction), the change of dividend and the change of stock repurchase scaled by capital stock respectively. *CF* is defined as the firm

cash flow deflated by capital stock. *Leverage* is defined as a firm's beginning period long term debt and debt in current liability scaled by its total assets. *CH* is defined as the firm's beginning period cash and short term investment deflated by capital stock. *Q* is defined as (market value of equity + book value of debt) / total asset. *Size* is the natural logarithm of total assets. *Div* is defined as the beginning period dollar amount of common share dividend scaled by capital stock and *Repurchase* is defined as the beginning period dollar amount of stock repurchase net of stock issuance scaled by capital stock. Sample is partitioned by a firm's total asset, commercial paper ratings and bond ratings. A firm is considered to be financially constrained if the firm total asset is in the bottom quartile, without bond rating or commercial paper rating. A firm is considered to be financially unconstrained if the total asset is in the top quartile, with commercial paper rating or bond rating. Firm and year effects dummy are also included. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

We next highlight the results that differ from those of the pre-crisis sample. First, unconstrained firms also save cash from cash flows during the post-crisis period. Two out of three coefficients of cash flows on cash holdings are positive and significant at 5% for unconstrained firms, suggesting that these firms will try to build up cash reserves from cash flows to maintain their cash holding levels because of declines in cash flows and the exacerbation of financing friction for external funds after the financial crisis. Second, unconstrained firms do not buy back shares after the financial crisis. Only one coefficient of cash flows on share repurchases is marginally significant at 10%, suggesting that the decline in cash flows after the financial crisis prevented firms from making payouts to shareholders through share repurchases.

The debt and dividend policies remain qualitatively the same as during the pre-crisis period. Cash flows are negatively related to net debt issuance for unconstrained firms, suggesting that they will try to raise more debt when cash flows decrease. For constrained firms, the relation between cash flows and net debt issuance is not economically or statistically significant, suggesting that constrained firms have difficulty accessing external funds after the financial crisis. As in the pre-crisis period, dividend policies are not sensitive to cash flow changes, which is consistent with the "sticky" nature of dividends.

The overall results from this section suggest that the cash flow policies of oil companies with regard to cash reserves and share repurchases are affected by the financial crisis during the post-crisis period. The results are also consistent with the "pecking order" theory. When cash flows decrease, unconstrained firms will save cash from cash flows and cut back on payouts to shareholders. Whereas unconstrained firms can still raise debt from external sources, the access of constrained firms to external funds is limited because of liquidity constraints imposed after the crisis.

4. Conclusions

In this paper, we study firms' investments with internal funds using a sample of U.S. oil companies before and after the 2008 financial crisis. We show that firms will prefer to use cash holdings for their investments over cash flows if they face real investment friction, such as investment plan time lags and high adjustment costs. By making investments with cash holdings at the beginning of the year instead of on contemporaneous cash flows, oil companies can avoid costly investment adjustments when cash flows fluctuate. We also investigate the cash flow policies of oil companies with regard to cash reserves, net debt issuance and payouts to shareholders. We show that there seems to be a "pecking order" with regard to the uses of cash flows. For constrained firms, the priority use of cash flows is for accumulating cash reserves. For unconstrained firms, cash flows will be used to repay debts and buy back shares when there are positive cash flow shocks.

The declines in cash flows and the imposition of liquidity constraints after the 2008 financial crisis affect the investments of oil companies based on internal funds as well as their cash flow policies. During the post-crisis period, capital expenditures become more sensitive to cash holdings than they were prior to the crisis. In addition, unconstrained firms save cash holdings from cash flows, raise debt and cut back on share repurchases to compensate for declines in cash flow after the crisis. In sum, this paper contributes to our understanding of how firms invest with internal funds when they face real investment friction and how they use cash flows in response to exogenous cash flow changes.

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Notes

Note 1. A more accurate measure of investment opportunities is marginal *q*, which is defined as the market value of new *additional* investments divided by their replacement costs. Because marginal *q* is unobservable, empirical studies instead use average *q* (Tobin's *Q*, the ratio of the market value of *existing* capital to its replacement costs) to proxy for investment opportunities according to certain assumptions, i.e., frictionless capital markets and smooth adjustment costs. If these assumptions do not hold, average *q* will be a poor proxy for marginal *q*.

Note 2. We exclude 2008 from our sample because of significant oil price volatility during this year ($92.97 in January, $133.88 in June and $41.12 in December). The inclusion of 2008 could lead to potentially biased results. We therefore split the sample into a pre-crisis sample period (2003-2007) and a post-crisis sample period (2009-2011). The average annual growth rate of oil prices is calculated based on the average monthly price of West Texas Intermediate grade for that year.

Note 3. The peak oil effect refers to the phenomenon that when the maximum rate of petroleum extraction is reached, the rate of production is expected to enter terminal decline. The concept was introduced by M. King Hubbert in the 1950s. The peak oil effect mostly refers to the depletion of *conventional* oil resources because *unconventional* oil resources such as oil shales and heavy oil were not economically and technically viable at the time. With an increase in oil prices and technological innovation, however, there is an ongoing debate within the industry regarding when the "Peak Oil" point actually is. Before 2008, global crude oil output reached its peak in 2005 (U.S. Energy Information Administration).

Note 4. For example, see Erickson and Whited (2000), Gomes (2001) and Alti (2003).

Note 5. Following common practices, we use the term "constrained" and "unconstrained" to describe a firm's financial constraint status, i.e., the cost wedge between internal funds and external funds will be greater for "constrained" firms and smaller for "unconstrained" firms. However, the terms "more constrained" or "less constrained" would be more appropriate because it is difficult to argue that a certain group of firms is completely constrained or unconstrained.

Note 6. Share repurchase is defined as stock repurchase net of sales of common and preferred stock. Therefore, we consider share repurchases to be a financing policy because they reflect net equity financing effects.

Note 7. Acharya et al. (2007) show that it is important to consider that cash flow outlay policies are not orthogonal to each other and that spurious inferences could be drawn if endogeneity among cash flow outlay policies is not corrected for.

Appendix A: Variable Definitions

Variable	Definition
Cash (CH)	Cash and short term investment
Tobin's Q (Q)	Market value of assets divided by the book value of assets, or [total assets + market value of equity – book value of equity – deferred taxes] / total assets.
Leverage	The sum of long term debt and debt in current liabilities scaled by total assets
Size	The natural log of total assets in $M.
Cash Flow (CF)	Income before extraordinary items plus depreciation
Investment (I)	Capital expenditure
Net debt change (Δ Debt)	Issuance of long term debt net of long term debt reduction
Dividend	Dividend paid to common shares
Capital stock (K)	Net amount of property, plant and equipment)
Repurchase	Stock repurchase net of sales of common and preferred stock