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Why Do U.S. Firms Hold So Much More Cash than They Used To?

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ABSTRACT

The average cash-to-assets ratio for U.S. industrial firms more than doubles from 1980 to 2006. A measure of the economic importance of this increase is that at the end of the sample period, the average firm can retire all debt obligations with its cash holdings. Cash ratios increase because firms' cash flows become riskier. In addition, firms change: They hold fewer inventories and receivables and are increasingly R&D intensive. While the precautionary motive for cash holdings plays an important role in explaining the increase in cash ratios, we find no consistent evidence that agency conflicts contribute to the increase.

CONSIDERABLE MEDIA ATTENTION has been devoted to the increase in cash holdings of U.S. firms. For instance, a recent article in *The Wall Street Journal* states that "The piles of cash and stockpile of repurchased shares at [big U.S. companies] have hit record levels."[1] In this paper, we investigate how the cash holdings of U.S. firms have evolved since 1980 and whether this evolution can be explained by changes in known determinants of cash holdings. We document a secular increase in the cash holdings of the typical firm from 1980 to 2006. In a regression of the average cash-to-assets ratio on a constant and time, time has a significantly positive coefficient, implying that the average cash-to-assets ratio (the cash ratio) has increased by 0.46% per year. Another way to see this evolution is that the average cash ratio more than doubles over our sample period, from 10.5% in 1980 to 23.2% in 2006.

Everything else equal, following Jensen (1986), we would expect firms with agency problems to accumulate cash if they do not have good investment opportunities and their management does not want to return cash to shareholders. In the absence of agency problems, improvements in information and financial

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[1] Ian McDonald, "Capital Pains: Big Cash Hoards," *The Wall Street Journal*, July 21, 2006, p.C1.

technology since the early 1980s should have led to a reduction in corporate cash holdings. For example, firms can hedge more effectively as more types of derivatives have become available, so the precautionary demand for cash should be lower than 20 years ago. It is therefore important to investigate whether the dramatic increase in cash holdings results from agency problems, represents an anomaly that challenges existing theories of the determinants of corporate cash holdings, or results from changes in firm characteristics and their business environment.

The increase in cash holdings that we document has important implications for our understanding of the leverage of U.S. firms. Much of the finance literature measures leverage as the ratio of debt to assets or debt to equity. Using these definitions, there is little evidence of a decrease in average leverage for the firms in our sample. However, the net debt ratio (defined as debt minus cash, divided by book assets), a common measure of leverage for practitioners, exhibits a sharp secular decrease. Most of this decrease in net debt is explained by the increase in cash holdings. The fall in net debt is so dramatic that the average net debt for U.S. firms is negative in 2004, 2005, and 2006. Consequently, using net debt leads us to dramatically different conclusions about both the current level of leverage in U.S. firms and the evolution of leverage over the last 25 years.

After documenting the increase in cash holdings and decrease in net debt, we investigate why the increase in cash holdings has occurred. We first examine the evolution of cash holdings for different subsamples of firms. Much attention has been paid to the cash hoards of large firms such as Microsoft and Exxon, both of which held in excess of $30 billion in mid-2006.[2] However, we find that the increase in the average cash ratio is not explained by the evolution of cash holdings in large firms or in recent years. While large firms have experienced a substantial recent cash buildup, the average cash ratio has a significantly positive time trend for all size quintiles. Foley, Hartzell, Titman, and Twite (2007) show that one reason for the cash buildup is that U.S. firms had foreign profits that would have been taxed had they been repatriated. In our sample, we find that firms with no foreign income also experience a secular increase in the cash ratio.

The increase in cash holdings is closely related to the disappearing dividends and new listings phenomena documented by Fama and French (2001, 2004). At the beginning of our sample period, firms that do not pay common dividends have essentially the same average cash ratio as firms that pay dividends. While there is a clear time trend in cash holdings and in net debt for firms that do not pay dividends, there is no time trend in these variables for dividend payers. By the end of the sample period, the mean cash ratio of the firms that do not pay dividends has more than doubled and the median has more than tripled. Over the sample period, the average net debt ratio for nondividend payers falls from 19.3% to −5.0%, and the median ratio falls from 21.4% to −5.7%.

[2] See Ian McDonald, "Cash Dilemma: How to Spend It," *The Wall Street Journal*, May 24, 2006, p. C3; Jesse Eisenger, "Long & Short: The Tech Sector Is Hogging the Green Blanket," *The Wall Street Journal*, April 5, 2006, p. C1; and Simon London, "A Surplus of Cash Invariably Leads to a Shortage of Sense," *Financial Times*, November 30, 2005, "Business Life," p. 13.

A plausible explanation for the secular increase in cash holdings for nondividend payers is provided by the precautionary demand for cash theory. Under this theory, firms hold cash as a buffer to protect themselves against adverse cash flow shocks. It is well known that idiosyncratic risk increased over much of our sample period (see Campbell, Lettau, Malkiel, and Xu (2001)). When we divide the industries in our sample into quintiles sorted by idiosyncratic cash flow volatility, we find that the average cash ratio increases by less than 50% for firms in the industries that experience the smallest increase in risk but by almost 300% for firms in the industries that experience the greatest increase in risk. Brown and Kapadia (2007) provide evidence that idiosyncratic stock return risk is higher for firms in more recent IPO listing cohorts. We show that firms in more recent listing cohorts hold more cash. Brandt, Brav, Graham, and Kumar (2009) find that the increase in idiosyncratic risk has partially reversed in recent years. We find that cash ratios have also fallen slightly in recent years.

We next investigate whether the increase in cash holdings results from changes in firm characteristics, changes in the correlations between cash holdings and firm characteristics, or shifts in the demand for cash that are unrelated to firm characteristics. In other words, we identify whether cash holdings changed because firms moved along the demand curve for cash or because the demand curve shifted. For this exercise, we use regression models similar to those in Opler, Pinkowitz, Stulz, and Williamson (1999) (henceforth OPSW), which were derived before the recent run-up in cash holdings. We investigate whether allowing the intercepts and slopes of the estimated regressions to change in the 1990s and 2000s helps explain the cross section of cash holdings. Notably, the intercept falls over time, suggesting that the increase in the cash ratio cannot be explained by a shift in the demand for cash that is unrelated to characteristics known to be correlated with the cash ratio. Furthermore, while there is evidence of changes in slopes and intercepts, the importance of these changes is limited in that a regression that does not allow for these changes explains roughly as much of the variation in cash holdings as a regression that allows for such changes.

We estimate a model of cash holdings using data from the 1980s and use it to predict the determinants of cash holdings in the 1990s and the 2000s. The parameters of this model help explain why cash holdings have increased in recent years. We use the model to assess how changes in firm characteristics explain the increase in cash holdings. Four variables are particularly important. First, firms hold less working capital (net of cash), and in particular fewer inventories and accounts receivable. The noncash components of working capital and cash are substitutes in that these components can be converted into cash relatively quickly. Second, cash flow volatility increases substantially. Since cash holdings are positively related to risk, the increase in risk has a substantial impact on cash holdings. Third, capital expenditures decline, and cash is negatively correlated with capital expenditures. Fourth, R&D expenditures increase, and firms with higher R&D expenditures hold more cash.

Cash holdings do not increase for older, established firms that pay dividends, but firms that do not pay dividends increase their cash holdings dramatically.

Jensen (1986) argues that entrenched managers in firms with high free cash flow are reluctant to pay out cash to shareholders; thus, agency conflicts provide a plausible explanation for this difference. However, we also find that the firms whose cash holdings increase the most have low cash flow and high Tobin's q, characteristics not typically associated with serious free cash flow problems. We conduct three more formal analyses to assess whether agency problems can systematically explain the increase in cash holdings. First, we investigate whether the increase in the cash ratio is correlated with the GIM index of Gompers, Ishii, and Metrick (2003), an often-used proxy for managerial entrenchment. We find that the firms in the highest quintile of the GIM index, the firms in which managers are presumably most entrenched, experience the smallest increase in cash holdings from 1990 through 2006. Second, we consider whether cash has become less valuable as cash holdings have increased. If so, it is plausible that agency problems explain the increase in cash holdings. We find no evidence of a decrease in the value of cash. Finally, given an established line of research on the agency costs of "excess" cash, we examine whether modeled residuals can explain the future growth in cash balances. Our results indicate that there is a negative relation between excess cash and the future growth in cash holdings. Overall, the evidence is inconsistent with the notion that the increase in cash holdings over time can be systematically ascribed to agency problems in firms.

The paper proceeds as follows. In Section I, we briefly review the theoretical determinants of cash holdings and the existing evidence. We describe our sample construction and document secular trends in cash holdings and net debt for our sample in Section II. We examine subsamples to understand whether these trends are driven by certain types of firms in Section III. In Section IV, we estimate regression models of the cash ratio and investigate whether the intercepts and slopes of these models change in the 1990s and 2000s. In Section V, we estimate a model of cash holdings for the 1980s and use it to identify the changes in firm characteristics that explain the increase in cash. We explore the agency explanation for the increase in cash holdings in Section VI. Section VII concludes.

I. Why Firms Hold Cash

The economics and finance literature have identified four motives for firms to hold cash. We review the theory and evidence on these motives briefly.

1. *The transaction motive.* Classic models in finance (e.g., Baumol (1952), Miller and Orr (1966)) derive the optimal demand for cash when a firm incurs transaction costs associated with converting a noncash financial asset into cash and uses cash for payments. Since there are economies of scale with the transaction motive, large firms hold less cash. There is much evidence supporting the existence of these economies of scale (see, for instance, Mulligan (1997)).
2. *The precautionary motive.* Firms hold cash to better cope with adverse shocks when access to capital markets is costly. Consistent with this

perspective, OPSW find that firms with riskier cash flows and poor access to external capital hold more cash. The precautionary motive also suggests that firms with better investment opportunities hold more cash because adverse shocks and financial distress are more costly for them. OPSW also find support for this prediction using market-to-book ratios and R&D spending as proxies for investment opportunities. Almeida, Campello, and Weisbach (2004) model the precautionary demand for cash and find that financially constrained firms invest in cash out of cash flow, while unconstrained firms do not. Han and Qiu (2007) extend this model to allow for a continuous distribution of cash flow. They show theoretically that an increase in the volatility of cash flow increases cash holdings for firms that are financially constrained, but has no determinate effect on other firms. Empirical evidence in Han and Qiu suggests that from 1998 to 2002, the cash holdings of constrained firms increase with cash flow volatility. Riddick and Whited (2009) question existing results on firms' propensities to invest in cash out of cash flow because the literature does not adjust for measurement error in q; nonetheless, their model shows a positive relation between a firm's risk and its level of cash. Finally, Acharya, Almeida, and Campello (2007) develop a model showing that firms accumulate cash instead of reducing debt when the correlation between operating income and investment opportunities is low. In their model, firms that issue debt and hoard cash transfer income from high cash flow states of the world in order to fund investment in all states, including those with low cash flow.

3. *The tax motive.* Foley, Hartzell, Titman, and Twite (2007) find that U.S. corporations that would incur tax consequences associated with repatriating foreign earnings hold higher levels of cash. This is particularly true for affiliates for which the implied tax consequences of repatriation are the highest. Consequently, multinational firms are more likely to accumulate cash.
4. *The agency motive.* As argued by Jensen (1986), entrenched managers would rather retain cash than increase payouts to shareholders when the firm has poor investment opportunities. These discretionary cash holdings are typically estimated as the excess cash holdings derived from models controlling for the transaction and precautionary motives for holding cash. Dittmar, Mahrt-Smith, and Servaes (2003) find cross-country evidence suggesting that firms hold more cash in countries with greater agency problems. Dittmar and Mahrt-Smith (2007) and Pinkowitz, Stulz, and Williamson (2006) show that cash is worth less when agency problems between insiders and outside shareholders are greater. Dittmar and Mahrt-Smith (2007) and Harford, Mansi, and Maxwell (2008) provide evidence suggesting that entrenched managers are more likely to build excess cash balances, but spend excess cash quickly.

These four motives for holding cash have different implications for the causes and consequences of the secular increase in cash for U.S. firms. We expect that firms and financial intermediaries have become more efficient in handling transactions, thus reducing transactions-based requirements for cash holdings.

The growth in derivative markets and improvements in forecasting and control suggest, all else equal, a lower precautionary demand for cash holdings. However, there has been a secular increase in idiosyncratic risk (Campbell, Lettau, Malkiel, and Xu (2001)). Irvine and Pontiff (2008) show that the increase in idiosyncratic risk mirrors an increase in cash flow volatility. These changes suggest a higher volatility in unhedgeable risks and hence a greater precautionary demand for cash holdings. As shown in Fama and French (2004), the composition of firms has changed because of an influx of newly listed firms with weak track records. Brown and Kapadia (2007) demonstrate that newly listed firms have permanently higher idiosyncratic risk, so the market-wide increase in idiosyncratic risk is due to a change in the composition of listed firms over time. We therefore expect cash holdings to be higher for newly listed firms in general, and for firms that go public later in the sample.

As discussed in Foley et al. (2007), during our sample period, U.S. multinationals elected to defer the taxes associated with repatriated foreign earnings, suggesting that firms with foreign operating subsidiaries are more likely to hold higher cash balances. The 2004 Jobs Creation Act allowed firms to repatriate these foreign cash balances in 2004 and 2005 at a substantially lower marginal rate. We use firms with nonmissing foreign pretax income to identify firms for which avoidance of taxation on foreign income might lead to higher cash holdings.

If the increase in the average cash ratio is explained by Jensen's (1986) free cash flow theory, then the bulk of the increase in cash holdings would occur in firms that generate free cash flow and have entrenched management that faces little pressure to pay out accumulated cash holdings. Firms generating strong free cash flow are firms with weak growth opportunities and hence low Tobin's q. Using the Gompers, Ishii, and Metric (2003) entrenchment index, we expect that firms with more entrenched management will experience a greater increase in the cash ratio.

A number of papers (Pinkowitz and Williamson (2004), Faulkender and Wang (2006), Pinkowitz, Stulz, and Williamson (2006), and Dittmar and Mahrt-Smith (2007)) estimate the value of cash holdings. For example, Dittmar and Mahrt-Smith (2007) find that the value of cash is lower for U.S. firms with poor governance. Pinkowitz, Stulz, and Williamson (2006) find a similar result internationally. If there is an agency explanation for the increase in cash holdings, the value of cash should fall over our sample period.

II. The Increase in Cash Holdings and the Decrease in Net Debt

We construct our sample from the WRDS merged CRSP/Compustat files for the period 1980 to 2006. These data include surviving and nonsurviving firms that appear on Compustat at any time in the sample period. We require that firms have positive assets (Compustat data item #6) and positive sales (data item #12) to be included in a given year. We exclude financial firms (SIC codes 6000-6999) because they may carry cash to meet capital requirements rather than for the economic reasons studied here. We also exclude utilities (SIC codes 4900-4999) because their cash holdings can be subject to regulatory supervision.

Table I

Average and Median Cash and Leverage Ratios from 1980 to 2006

The sample includes all Compustat firm-year observations from 1980 to 2006 with positive values for the book value of total assets and sales revenue for firms incorporated in the United States. Financial firms (SIC code 6000-6999) and utilities (SIC codes 4900-4999) are excluded from the sample, yielding a panel of 117,438 observations for 13,599 unique firms. Variable definitions are provided in the Appendix.

Year	*N*	Aggregate Cash Ratio	Average Cash Ratio	Median Cash Ratio	Average Leverage	Median Leverage	Average Net Leverage	Median Net Leverage
1980	3,519	0.063	0.105	0.055	0.269	0.243	0.164	0.178
1981	3,748	0.057	0.121	0.058	0.253	0.228	0.133	0.160
1982	3,752	0.061	0.121	0.064	0.261	0.232	0.140	0.158
1983	4,120	0.076	0.159	0.087	0.246	0.204	0.087	0.111
1984	4,172	0.070	0.140	0.069	0.254	0.218	0.114	0.141
1985	4,127	0.069	0.142	0.070	0.270	0.230	0.128	0.151
1986	4,261	0.076	0.157	0.081	0.273	0.236	0.116	0.143
1987	4,407	0.077	0.156	0.077	0.273	0.241	0.116	0.153
1988	4,237	0.062	0.141	0.068	0.280	0.244	0.139	0.163
1989	4,095	0.055	0.138	0.063	0.286	0.253	0.148	0.173
1990	4,042	0.051	0.134	0.062	0.282	0.244	0.147	0.168
1991	4,137	0.055	0.155	0.072	0.259	0.215	0.104	0.129
1992	4,307	0.057	0.163	0.079	0.245	0.193	0.082	0.111
1993	4,713	0.060	0.171	0.083	0.225	0.179	0.053	0.091
1994	4,985	0.058	0.155	0.070	0.230	0.187	0.075	0.106
1995	5,165	0.060	0.171	0.072	0.230	0.187	0.059	0.105
1996	5,568	0.066	0.193	0.088	0.222	0.170	0.029	0.077
1997	5,605	0.068	0.191	0.089	0.236	0.180	0.046	0.085
1998	5,263	0.065	0.178	0.075	0.289	0.205	0.110	0.119
1999	4,971	0.075	0.194	0.077	0.247	0.198	0.053	0.104
2000	4,947	0.074	0.208	0.088	0.242	0.173	0.034	0.075
2001	4,540	0.080	0.214	0.107	0.268	0.173	0.054	0.062
2002	4,233	0.091	0.214	0.114	0.258	0.172	0.045	0.054
2003	3,992	0.101	0.227	0.133	0.235	0.160	0.008	0.016
2004	3,693	0.109	0.240	0.147	0.225	0.145	−0.015	−0.003
2005	3,549	0.105	0.237	0.148	0.219	0.136	−0.020	−0.005
2006	3,297	0.103	0.232	0.133	0.221	0.146	−0.010	0.015

Finally, we restrict our sample to firms that are incorporated in the United States.

The second column of Table I reports the number of sample firms in each year. We measure the cash ratio as cash and marketable securities (data item #1) divided by total assets (data item #6). The third column of Table I summarizes the aggregate cash ratio for the sample firms, which is the sum of cash divided by the sum of assets for all sample firms. This ratio is 6.3% in 1980 and increases to 10.3% by 2006, reaching a peak of 10.9% in 2004. The next column reproduces the average cash ratio for the sample firms by year. This ratio increases from 10.5% in 1980 to 23.2% in 2006, peaking in 2004. The same trend is conveyed by the median cash ratio, which is reported in column 5. The median cash ratio in 2006 is 242% of the median cash ratio in 1980, while the mean is 221% of its value in 1980.

To assess whether there was a statistically significant trend in the cash ratio, we estimate regressions of the cash ratio on a constant and time measured in years (not reported in a table). The coefficient on the time trend for the average cash ratio corresponds to a yearly increase of 0.46% and has a p-value below 0.01. The R^2 of the regression is 89%. For the median, the slope coefficient represents a 0.27% yearly increase. It also has a p-value below 0.01. The R^2 is 64%. This evidence is consistent with a positive time trend in cash holdings over the sample period. We note, however, that such regressions are only useful to characterize the evolution of the cash holdings during the sample period, and it would not make sense to extrapolate the in-sample trend to future years.

We now turn to the implications of the increase in the cash ratio for the measurement of leverage. Column 6 of Table I reports average debt for our sample firms by year. We measure debt as long-term debt (data item #9) plus debt in current liabilities (data item #34), divided by book assets. While average leverage falls from 2001 to 2005, average leverage in 2004 is almost the same as it was 10 years earlier. Median leverage, reported in column 7, is low in the first half of the 1990s, and then increases before falling from 1998 to 2005. When we consider the average net leverage ratio, which subtracts cash from debt, we obtain a dramatically different perspective regarding the time trend in leverage for U.S. firms. The average net debt ratio is 16.4% in 1980. It falls during 15 years and becomes negative in the last 3 years of the sample. In a regression of the average net debt ratio on a constant and time, the coefficient on time represents a decrease of -0.60% per year and has a p-value of less than 0.01. The last column of the table shows the median net debt ratio. This ratio also falls from 17.8% in 1980 to 1.5% in 2006; median net debt is negative in 2004 and 2005.

III. How Pervasive Is the Increase in Cash Holdings?

The evidence summarized in Section II illustrates a secular increase in the average cash ratio and a corresponding decrease in net debt. The decrease in net debt occurs because firms hold more cash rather than because they have less debt. To assess whether the increase in cash is related to firm size, we divide the sample firms into quintiles each year according to the book value of their assets at the end of the prior year. The results are similar if we use the market value of equity.

Figure 1 illustrates the average cash ratios for the firm size quintiles over our sample period. The average cash ratio increases across each size quintile, but the increase is more pronounced for smaller firms. The increase in the average cash ratio for the largest firms is especially strong in the later years of our sample, although not in the most recent years.[3] From 1980 to their peak, average cash holdings more than double for the second and third quintiles

[3] Though not reported, the average cash ratio of S&P 500 firms roughly doubles from 1998 to 2006.

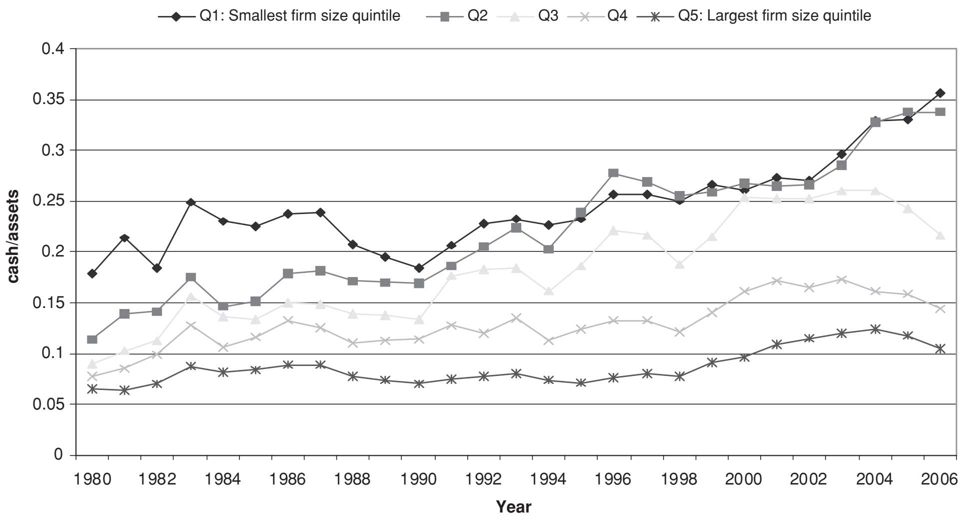

Figure 1. Average cash ratios by firm size quintile from 1980 to 2006. The sample includes all Compustat firm-year observations from 1980 to 2006 with positive values for the book value of total assets and sales revenue for firms incorporated in the United States. Financial firms (SIC code 6000-6999) and utilities (SIC codes 4900-4999) are also excluded from the sample, yielding a panel of 117,438 observations for 13,599 unique firms. The cash ratio is measured as the ratio of cash and marketable securities to the book value of total assets. Firms are sorted into quintiles based on the book value of sample firm assets in the prior fiscal year. The first quintile (Q1) comprises the smallest firms in the sample, while the fifth quintile (Q5) comprises the largest firms in the sample.

and almost double for all other quintiles. We again regress the cash ratio on a constant and time (measured in years) for each size quintile and find a positive and significant slope coefficient for each. Given this evidence, we conclude that the secular increase in cash ratios is not driven by the largest firms in our sample, and is markedly more pronounced in smaller firms.

While not shown in the figure, average net debt falls sharply for the firms in the first three quintiles (the smallest firms), but shows little decrease for the largest firms. Notably, firms in the largest quintile have higher leverage in 2006 than in 1980, so the increase in leverage partly offsets the impact of the increase in cash holdings on net debt. All other size quintiles experience a decrease in leverage. The decrease in average leverage is small except for the second quintile. Median leverage, in contrast, falls substantially for the three smallest quintiles but increases for the largest firms.

The 1990s witnessed a surge in IPO activity. IPO firms could have more cash because of the IPO and because they often issue seasoned equity within several years of the IPO. In columns 2 and 3 of Table II, we report average cash ratios for firms that, respectively, did and did not go public within the last 5 years.[4] The average cash ratio more than doubles (from 9.9% to 21.8%) for non-IPO firms

[4] We use Thomson's SDC New Issues database to determine IPO dates, when available, and CRSP listing dates for firms not in SDC.

Table II

Average Cash Ratios from 1980 to 2006 Delineated by New Issue Status, the Payment of Dividends, and Accounting Performance

The sample includes all Compustat firm-year observations from 1980 to 2006 with positive values for the book value of total assets and sales revenue for firms incorporated in the United States. Financial firms (SIC code 6000-6999) and utilities (SIC codes 4900-4999) are excluded from the sample, yielding a panel of 117,438 observations for 13,599 unique firms. Firms are assigned to the IPO subsample if they have gone public within the prior 5 calendar years, and to the non-IPO subsample otherwise. A firm is classified as a dividend payer if it paid common dividends in that year. Firms with accounting losses at the fiscal end of the designated year are assigned to the negative net income subsample. Differences in the average cash ratio between the new issues, dividend status, and accounting performance subsamples are statistically different from zero at better than the 1% level for each reported year with the exception of differences in accounting performance for 1982. Variable definitions are provided in the Appendix.

	New Issues		Dividend Status		Accounting Performance	
Year	IPO Firms	Non-IPO Firms	Dividend Payer	Nondividend Payer	Negative Net Income	Nonnegative Net Income
1980	0.211	0.099	0.086	0.130	0.122	0.101
1981	0.231	0.109	0.092	0.151	0.140	0.115
1982	0.209	0.110	0.103	0.138	0.119	0.122
1983	0.275	0.131	0.118	0.189	0.173	0.153
1984	0.214	0.117	0.101	0.165	0.159	0.132
1985	0.206	0.120	0.106	0.164	0.150	0.138
1986	0.225	0.132	0.111	0.181	0.169	0.151
1987	0.209	0.134	0.109	0.178	0.182	0.143
1988	0.187	0.126	0.103	0.159	0.165	0.129
1989	0.181	0.125	0.098	0.156	0.147	0.132
1990	0.187	0.120	0.097	0.151	0.145	0.128
1991	0.245	0.132	0.103	0.177	0.172	0.144
1992	0.262	0.135	0.104	0.188	0.193	0.146
1993	0.265	0.136	0.105	0.198	0.214	0.148
1994	0.222	0.125	0.092	0.179	0.206	0.132
1995	0.248	0.131	0.096	0.198	0.207	0.152
1996	0.276	0.143	0.097	0.224	0.262	0.154
1997	0.263	0.149	0.102	0.218	0.252	0.154
1998	0.251	0.143	0.088	0.205	0.235	0.140
1999	0.302	0.146	0.084	0.225	0.265	0.145
2000	0.327	0.157	0.079	0.239	0.280	0.144
2001	0.345	0.175	0.090	0.243	0.273	0.147
2002	0.362	0.180	0.099	0.241	0.266	0.160
2003	0.380	0.200	0.126	0.256	0.289	0.182
2004	0.402	0.217	0.131	0.276	0.337	0.189
2005	0.324	0.227	0.131	0.276	0.332	0.188
2006	0.326	0.218	0.120	0.277	0.351	0.176

during our sample period. The average cash ratio for IPO firms is 21.1% in 1980. It peaks to 40.2% in 2004, but falls to 32.6% in 2006. Though not reproduced in the table, the median cash ratio for IPO firms triples over the sample period. When we estimate the time trend, the mean and median are significant for both

IPO and non-IPO firms. This evidence shows that the increase in cash holdings we document is not due to the capital raising activities of the IPO firms in our sample.

We next turn to the role of dividends. Fama and French (2001) show that firms have become less likely to pay dividends during our sample period. Jensen's (1986) free cash flow theory suggests that nondividend payers with poor growth opportunities will accumulate more cash. In columns 4 and 5 of Table II, we reproduce the time series of the average cash ratio for dividend payers and nondividend payers. The average cash ratio of dividend payers in a sample year is the average cash ratio of firms that pay a common dividend that year. There is a dramatic increase in the cash ratio among the nondividend payers, but not among the dividend payers. For example, the average cash ratio of dividend payers is about the same in 2000 as in 1980. In contrast, the average (median) cash ratio of nondividend payers is 113% (211%) higher in 2006 than in 1980. Many papers consider nondividend paying firms to be financially constrained (for instance, Almeida, Campello, and Weisbach (2004)), suggesting that the increase in cash holdings occurred in financially constrained firms. In light of the model of Han and Qiu (2007), our evidence on the cash holding increases of nondividend paying firms supports the precautionary motive.

Firms with negative net income are more likely to be financially constrained than firms with positive net income. The existing literature shows that the cash flow sensitivity of corporate investment in cash differs for financially constrained firms. We therefore divide the sample into firms with negative net income and other firms. We report average cash ratios for these subsamples in the last two columns of Table II. The firms with negative net income exhibit a dramatic increase in cash holdings. The average cash ratio of these firms almost triples over the sample period. Firms with nonnegative net income also exhibit an increase in cash holdings, but the time trend is markedly lower.

The precautionary motive for cash holdings predicts that firms in industries that experience a large increase in idiosyncratic risk should have a greater increase in cash holdings than firms in industries that experience a small increase in idiosyncratic risk. To examine this, we divide the two-digit SIC code industries in our sample into industry quintiles according to their increase in cash flow volatility over our sample period. We measure cash flow risk as the standard deviation of industry cash flow to assets, computed as follows. For each firm-year, we compute the standard deviation of cash flow to assets for the previous 10 years. We require at least three observations. We then average the firm cash flow standard deviations each year across each two-digit SIC code. Strikingly, in recent years, more than half of the firms in the sample are in the industries in the top quintile of the increase in idiosyncratic volatility. Figure 2 shows the evolution of the average cash ratio for the five quintiles sorted according to the increase in idiosyncratic volatility. The firms in the highest quintile of the increase in volatility experience the most dramatic increase in cash holdings. The average cash ratio of these firms is 12.9% in 1980 and increases to 39.0% in 2006. The clear evidence from the figure is that the increase

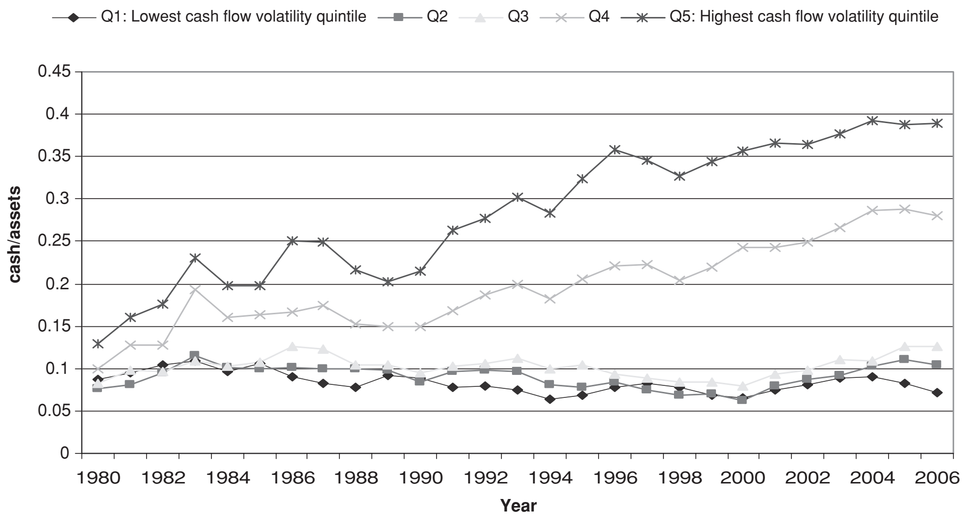

Figure 2. Average cash ratios by idiosyncratic risk. The figure summarizes the average cash-to-assets ratio for quintiles of industries sorted by increases in idiosyncratic risk. We first divide the two-digit SIC code industries in our sample into industry quintiles according to the increase in idiosyncratic cash flow volatility over our sample period. We measure cash flow risk as the standard deviation of industry cash flow computed as follows. For each firm, we compute cash flow standard deviation for the previous 10 years. We require at least three observations for the standard deviation to be calculated. We then take the average across the two-digit SIC code of the firm cash flow standard deviations. The sample includes all Compustat firm-year observations from 1980 to 2006 with positive values for the book value of total assets and sales revenue for firms incorporated in the United States. Financial firms (SIC code 6000-6999) and utilities (SIC codes 4900-4999) are excluded from the sample, yielding a panel of 117,438 observations for 13,599 unique firms. The cash ratio is measured as the ratio of cash and marketable securities to the book value of total assets.

in cash ratios is concentrated in industries that experience a large increase in cash flow volatility.

The evidence that nondividend paying firms increase their cash ratio more than dividend paying firms is consistent with the evidence in Brown and Kapadia (2007) that the idiosyncratic risk of newly listed firms, which are less likely to pay dividends, has increased over time. We investigate this possibility directly by examining whether cash ratios are related to the period in which a firm went public. Following Brown and Kapadia, we construct cohorts of firms according to their listing date. The 1960s cohort includes all firms that have a listing prior to 1970. The 1970 cohort includes all firms that list from 1970 to 1975. We continue in this manner, constructing cohorts of firms that list within a 5-year period. We track the cash holdings of the cohorts from the 6th year following the listing year, to ensure that the cash accumulated at the IPO has been used. The results shown in Figure 3 are striking. First, each successive cohort, with the exception of the 1980s cohort, has a higher average cash ratio than the previous cohort in the early years of its existence (in the 2000s, the 1985, 1990, and 1995 cohorts become similar). Second, while cash ratios of

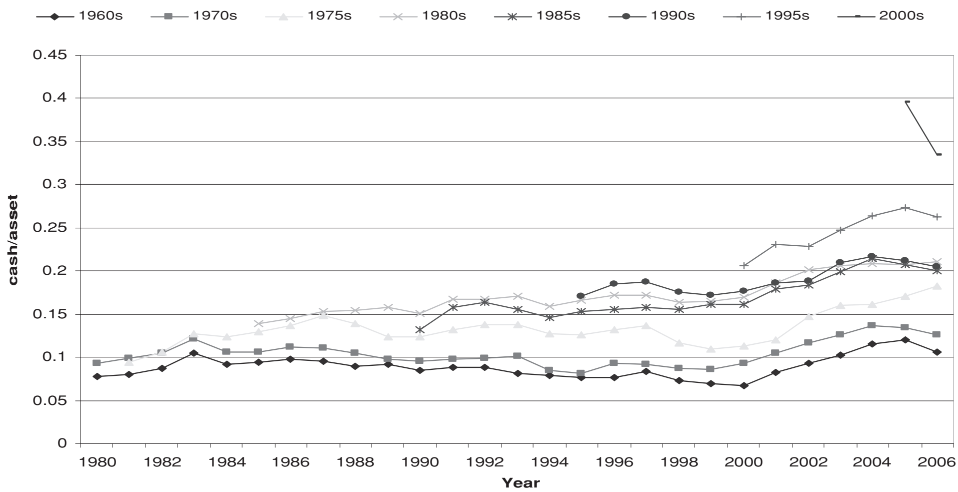

Figure 3. Average cash ratios by an IPO cohort. The figure summarizes the average cash-to-assets ratio for cohorts of firms constructed by listing date. The 1960s cohort includes all firms that have a listing prior to 1970. The 1970s cohort includes all firms that list from 1970 to 1975. We then construct cohorts of firms that list within a 5-year period. Cash holdings for each firm in each cohort are estimated beginning in the 6th year after the listing date. The sample includes all Compustat firm-year observations from 1980 to 2006 with nonmissing data for the book value of total assets and sales revenue for firms incorporated in the United States. Financial firms (SIC code 6000-6999) and utilities (SIC codes 4900-4999) are excluded from the sample, yielding a panel of 117,438 observations for 13,599 unique firms. The cash ratio is measured as the ratio of cash and marketable securities to the book value of total assets.

the pre-1980 cohorts first decrease before experiencing a sharp increase at the end of the sample period, the cash ratios of the other cohorts mostly increase. The later cohorts do not see a reduction in cash ratios as they mature (except for the last 2 sample years), so that they hold more cash than firms in earlier cohorts at the same stage of their lifecycles. Thus, a substantial part of the increase in cash holdings can be attributed to the changing nature of newly listed firms over time. This result is the cash counterpart of the disappearing dividend result of Fama and French (2001).

During the 1990s, an increasing proportion of newly public firms came from high-tech industries. If technology firms are more reliant on precautionary cash holdings, then the above results may be due to an increase in the proportion of high-tech firms in our sample. We use the definitions in Loughran and Ritter (2004) to categorize technology firms, and define "old-economy" manufacturing firms as firms with SIC codes 2000-3999 that are not high technology firms.[5] In 1980, the proportion of firms classified as high-tech was 28%. By 2000 this proportion had increased to 45%. We find (but do not tabulate) that in every year the average cash ratio of high-tech firms is greater than the average cash

[5] Results are quantitatively similar if we use the Department of Commerce definitions of high-tech industries.

ratio of manufacturing firms. In the first 5 years (1980 to 1984), the average cash ratio of high-tech firms exceeds the average cash ratio of manufacturing firms by 54%; in the last 5 years, it does so by 45%. Throughout the sample period, the cash ratios of both types of firms increase. The average cash ratio increases slightly less for high-tech firms than for manufacturing firms; from the first 5 years to the last 5 years, the increase is 90% for high-tech firms and 101% for manufacturing firms. There is a positive and significant time trend for the average and median cash ratios for both groups of firms, and both groups exhibit a negative trend in net leverage. Consequently, while the increase in cash holdings and the decrease in net leverage can be ascribed to a change in the composition of listed firms over time, this effect cannot be attributed specifically to an increase in the proportion of technology firms in our sample.

Foley et al. (2007) note that during our sample period multinationals benefited from retaining the cash they earned abroad, given that earning repatriation would often have negative tax consequences. Toward the end of our sample period, firms were allowed to repatriate cash held in foreign countries at a lower tax rate. We use nonmissing foreign pretax income to identify firms for which avoidance of taxes on foreign income might lead to higher cash holdings. There is no evidence that cash holdings increase more for firms with foreign pretax income in our sample period. In particular, while the average cash ratio of firms without foreign taxable income increases from 14.3% in 1990 to 25.3% in 2006, the cash ratio of firms with foreign taxable income is 10.8% in 1990 and increases to 20.2% in 2006.

Agency theory predicts that cash holdings will increase for firms with high free cash flow. Our evidence on the changes in cash holdings for subsamples of firms is largely inconsistent with the agency explanation. In particular, we find that cash holdings increase more in firms that are financially constrained, as proxied by negative net income, than in other firms. Further, larger, more established firms are more likely to have agency problems of free cash flow that could lead to an increase in cash holdings. However, the increase in cash holdings is much more significant for smaller and recently listed firms. We further investigate the agency explanation for the increase in cash ratios in Section VI.

IV. Did the Demand Function for Cash Holdings Change?

In this section, we examine whether the increase in cash holdings can be explained by firm characteristics and whether the relation between firm characteristics and the cash ratio changes over time. We start from regressions that relate the cash ratio to firm characteristics and investigate whether such regressions can explain the increase in cash ratios through changes in firm characteristics. This approach attempts to identify whether there was a regime shift in how firms determine their cash holdings.

The literature employs several alternative definitions of the cash ratio, including (1) cash to assets, (2) cash to net assets (where net assets equals book assets minus cash), (3) log of cash to net assets, and (4) cash to sales. Although cash to assets is the most traditional measure, OPSW use the cash-to-net assets ratio. The cash-to-net assets ratio generates extreme outliers for firms with most of their assets in cash. This problem is significant for our sample. Foley et al. (2007) use the logarithm of the cash-to-net assets ratio. Their measure reduces the magnitude of the problem of extreme outliers but does not eliminate it in our sample, which includes firms with assets less than $100 million. Thus, we focus primarily on regressions using cash to assets as the dependent variable, but reproduce regressions using the log of cash to net assets. Using cash to sales does not affect our results in a material way.

The explanatory variables that we use follow OPSW and are motivated by the transaction and precautionary explanations for corporate cash holdings discussed in Section I. We incorporate the ratio of a firm's acquisition expenses to assets as an additional variable in the model since acquisitions and capital expenditures would seem to be substitutes.

The variables used (Compustat annual data items in parentheses) are as follows:

1. *Market-to-book ratio*. Firms with better investment opportunities value cash more since it is costly for these firms to be financially constrained. We use the book value of assets (#6) minus the book value of equity (#60) plus the market value of equity (#199 $*$ #25) as the numerator of the ratio and the book value of assets (#6) as the denominator.
2. *Firm size.* There are economies of scale to holding cash. We use as our size measure the logarithm of book assets (#6) in 2004 dollars.
3. *Cash flow to assets.* We measure cash flow as earnings after interest, dividends, and taxes but before depreciation divided by book assets ((#13 – #15 – #16 – #21) / #6). Firms with higher cash flow accumulate more cash, all else equal. Such firms might have better investment opportunities, but we control for these through other variables.
4. *Net working capital to assets.* Net working capital (NWC) consists of assets that substitute for cash. We thus expect a negative relation between NWC and cash holdings. We subtract cash (#1) from NWC (#179), so our NWC measure is net of cash.
5. *Capital expenditures to assets.* We measure capital expenditures as the ratio of capital expenditures (#128) to book assets (#6). If capital expenditures create assets that can be used as collateral, capital expenditures could increase debt capacity and reduce the demand for cash. Further, as shown by Riddick and Whited (2009), a productivity shock that increases investment can lead firms to temporarily invest more and save less cash, which would lead to a lower level of cash. At the same time, capital expenditures could proxy for financial distress costs and/or investment opportunities, in which case they would be positively related to cash.
6. *Leverage.* We measure leverage as long-term debt (#9) plus debt in current liabilities (#34) divided by book assets (#6). If debt is sufficiently constraining, firms will use cash to reduce leverage, resulting in a negative relation between cash holdings and leverage. The hedging argument

of Acharya, Almeida, and Campello (2007), however, is consistent with a positive relation between leverage and cash holdings.

7. *Industry cash flow risk.* We expect firms with greater cash flow risk (measured as discussed in Section III) to hold more precautionary cash.
8. *Dividend payout dummy.* We define a dummy variable equal to one in years in which a firm pays a common dividend (#21). Otherwise, the dummy equals zero. Firms that pay dividends are likely to be less risky and have greater access to capital markets, so the precautionary motive for cash holdings is weaker for them.
9. *R&D to sales*. This variable also measures growth opportunities. Firms with greater R&D are assumed to have greater costs of financial distress. R&D expenditures consume cash, but R&D's role as a proxy for growth opportunities and financial distress could lead to a positive relation between the cash ratio and R&D spending. R&D is measured as R&D (#46) / sales (#12), and is set equal to zero when R&D (#46) is missing. Results are similar if we use R&D/assets.
10. *Acquisitions to assets*. Acquisition activity is defined as acquisitions (#129) / book assets (#6), where acquisition expenditures reflect only the cash outflows associated with acquisitions. We would expect the sign on this coefficient to be the same as the sign for capital expenditures.

Data requirements limit the size of our sample. For example, the unrestricted sample has 3,297 observations in 2006, but only 2,735 observations have sufficient data to estimate the OPSW regressions. The sample that meets the data requirements has an increase in the average cash ratio of 112.0% over the sample period, close to the increase of 121.3% for the unrestricted sample. Outliers in firm-year explanatory variables are winsorized as follows: Leverage is winsorized so that it is between zero and one. R&D/assets, R&D/sales, acquisitions/assets, cash flow volatility, and capital expenditures/assets are winsorized at the 1% level. The bottom tails of NWC/assets and cash flow/assets are winsorized at the 1% level, and the top tail of the market-to-book ratio is winsorized at the 1% level.

We report our initial regression results in Panel A of Table III. Our standard errors allow for clustering by firm and by year, using the procedure in Cameron, Gelbach, and Miller (2006). Model 1 of Panel A shows the estimates for the regression using all sample years. Given our data restrictions, the panel consists of 100,414 firm-year observations for 12,792 unique firms. We do not use dummy variables for years or for industries in this regression. Market to book and cash flow risk (industry sigma) have positive and significant coefficients. The sign and significance of the coefficients on size, NWC, leverage, R&D, and the dividend dummy are also similar to those documented in OPSW (whose sample ends in 1994). Capital and acquisition expenditures both have negative and significant coefficients.

The sign on capital expenditures is sensitive to whether the dependent variable is the ratio of cash to assets or the log of the ratio of cash to net assets. Model 2 of Table III re-estimates Model 1 using the log of cash to net assets. In this

Table III

Regressions Estimating the Determinants of Cash Holdings

The sample includes all Compustat firm-year observations from 1980 to 2006 with positive values for the book value of total assets and sales revenue for firms incorporated in the United States. Financial firms (SIC code 6000-6999) and utilities (SIC codes 4900-4999) are excluded from the sample, yielding a panel of 117,438 observations for 13,599 unique firms. Missing explanatory values reduce the panel used here to 100,414 firm-year observations for 12,792 unique firms for the OLS regressions. The calculation of differences further reduces the sample for the changes regressions to 75,064 firm-year observations. The fixed effects regression excludes firms that have gone public in the past 5 years and has 65,183 firm-year observations. The models in Panel B include separate slopes and intercepts for firm-year observations from the 1990s to the end of the sample period, and for 2000 through 2006. p-values based on standard errors robust to clustering by firm and year are reported in parentheses for the OLS regressions. p-values in the Fama-MacBeth regressions use Newey and West (1987) standard errors to control for autocorrelation. For the fixed effects regression in column 9, we report within R^2. Variable definitions are provided in the Appendix.

Panel A

Model	1 OLS	2 OLS	3 Changes	4 OLS	5 OLS	6 Changes	7 F-M (1980s)	8 F-M (1990s)	9 FE
Dependent Variable	Cash/Assets	Log (Cash/ Net Assets)	Cash/Assets	Cash/Assets	Log (Cash/ Net Assets)	Cash/Assets	Cash/Assets	Cash/Assets	Cash/Assets
Intercept	0.258	−2.305	0.014	0.261	−2.238	0.010	0.301	0.225	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
Lag dcash			−0.095			−0.095			
			(0.000)			(0.000)			
Lag cash			−0.135			−0.140			
			(0.000)			(0.000)			
Industry sigma	0.370	0.455	0.078	0.481	0.427	0.078	0.193	0.475	0.090
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.016)
Market to book	0.016	0.173	0.003	0.016	0.177	0.003	0.011	0.018	0.008
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Real size	−0.006	−0.065	0.033	−0.004	−0.068	0.033	−0.009	−0.003	0.004
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.013)	(0.059)
Cash flow/ assets	−0.001	−0.334	0.035	−0.002	−0.328	0.034	0.023	−0.004	0.029
	(0.954)	(0.000)	(0.000)	(0.863)	(0.000)	(0.000)	(0.067)	(0.768)	(0.000)

(*continued*)

Table III—*Continued*

Panel A

Model	1 OLS	2 OLS	3 Changes	4 OLS	5 OLS	6 Changes	7 F-M (1980s)	8 F-M (1990s)	9 FE
Dependent Variable	Cash/Assets	Log (Cash/ Net Assets)	Cash/Assets	Cash/Assets	Log (Cash/ Net Assets)	Cash/Assets	Cash/Assets	Cash/Assets	Cash/Assets
NWC/ assets	−0.195	−0.552	−0.140	−0.200	−0.533	−0.139	−0.206	−0.202	−0.180
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capex	−0.291	1.353	−0.179	−0.308	1.380	−0.179	−0.263	−0.380	−0.243
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	−0.364	−1.395	−0.188	−0.366	−1.395	−0.186	−0.364	−0.361	−0.234
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D/ sales	0.066	0.305	0.010	0.065	0.308	0.010	0.059	0.064	0.019
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dividend dummy	−0.040	−0.270	0.006	−0.045	−0.274	0.005	−0.032	−0.054	0.001
	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.683)
Acquisition activity	−0.171	−0.486	−0.133	−0.170	−0.446	−0.132	−0.093	−0.215	−0.130
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
1990s dummy				−0.028	−0.178	−0.000			
				(0.000)	(0.000)	(0.006)			
2000s dummy				−0.008	0.261	0.015			
				(0.000)	(0.000)	(0.000)			
Year dummies									Yes
Adjusted R^2	0.455	0.248	0.199	0.459	0.251	0.203	0.357	0.488	0.154

Panel B

Model	1 Cash/Assets			2 Cash/Assets			3 Log (Cash/Net Assets)		
Dependent Variable	Estimate	Interaction 1990s	Interaction 2000s	Estimate	Interaction 1990s	Interaction 2000s	Estimate	Interaction 1990s	Interaction 2000s
Intercept	0.306	−0.073	−0.034	0.284	−0.068	−0.016	−1.990	−0.092	−0.251
	(0.000)	(0.000)	(0.010)	(0.000)	(0.000)	(0.203)	(0.000)	(0.378)	(0.058)
Industry sigma	0.142	0.340	0.022	0.222	0.272	−0.019	0.151	0.238	0.127
	(0.057)	(0.000)	(0.721)	(0.000)	(0.000)	(0.753)	(0.010)	(0.004)	(0.095)
Market to book	0.011	0.007	0.000	0.005	0.006	0.004	0.088	0.084	0.020
	(0.000)	(0.000)	(0.983)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.239)
Real size	−0.009	0.005	0.005	−0.009	0.005	0.003	−0.076	−0.034	0.062
	(0.000)	(0.000)	(0.009)	(0.000)	(0.000)	(0.030)	(0.000)	(0.015)	(0.000)
Cash flow/ assets	0.024	−0.018	−0.041	0.066	0.014	−0.073	−0.377	0.094	−0.057
	(0.062)	(0.272)	(0.025)	(0.000)	(0.499)	(0.002)	(0.000)	(0.245)	(0.369)
NWC/ assets	−0.204	−0.006	0.034	−0.236	0.016	0.040	−0.466	−0.295	0.134
	(0.000)	(0.660)	(0.048)	(0.000)	(0.330)	(0.024)	(0.000)	(0.015)	(0.277)
Capex	−0.255	−0.071	−0.079	−0.378	−0.067	−0.043	0.870	0.338	−0.048
	(0.000)	(0.004)	(0.123)	(0.000)	(0.044)	(0.407)	(0.000)	(0066)	(0.932)
Leverage	−0.370	0.001	0.013	−0.370	0.001	0.013	−1.443	−0.164	0.527
	(0.000)	(0.965)	(0.449)	(0.000)	(0.965)	(0.449)	(0.000)	(0.293)	(0.000)
R&D/sales	0.061	0.003	0.001	0.052	0.004	0.005	0.277	0.023	−0.018
	(0.000)	(0.585)	(0.834)	(0.000)	(0.364)	(0.083)	(0.000)	(0.533)	(0.593)
Dividend dummy	−0.035	−0.013	−0.015	−0.016	−0.016	−0.023	−0.054	−0.230	−0.271
	(0.000)	(0.016)	(0.007)	(0.000)	(0.003)	(0.000)	(0.413)	(0.001)	(0.000)

(continued)

Table III—*Continued*

Panel B

Model	1 Cash/Assets			2 Cash/Assets			3 Log (Cash/Net Assets)		
Dependent Variable	Estimate	Interaction 1990s	Interaction 2000s	Estimate	Interaction 1990s	Interaction 2000s	Estimate	Interaction 1990s	Interaction 2000s
Acquisition activity	−0.076	−0.105	−0.081	−0.219	−0.149	0.020	−0.335	−0.754	0.546
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.572)	(0.031)	(0.000)	(0.050)
Net equity issuance				0.129	0.022	−0.080	0.260	0.000	−0.518
				(0.000)	(0.252)	(0.050)	(0.007)	(1.000)	(0.052)
Net debt issuance				0.173	0.023	−0.070	0.298	−0.023	−0.260
				(0.000)	(0.460)	(0.028)	(0.024)	(0.898)	(0.076)
Loss dummy				0.002			−0.213		
				(0.684)			(0.000)		
T-bill				−0.000			−0.035		
				(0.776)			(0.001)		
Credit spread				0.009			0.145		
				(0.087)			(0.056)		
IPO1				0.080			0.736		
				(0.000)			(0.000)		
IPO2				0.065			0.328		
				(0.000)			(0.000)		
IPO3				0.042			0.246		
				(0.000)			(0.000)		
IPO4				0.027			0.189		
				(0.000)			(0.006)		
IPO5				0.026			0.171		
				(0.000)			(0.003)		
Adjusted R^2	0.462			0.506			0.274		

specification, the coefficient on capital expenditures switches signs but remains significant. Model 2 has a substantially lower R^2 than Model 1, indicating that Model 1 explains variation in cash holdings much better. Similar variation is observed in the literature, including Haushalter, Klasa, and Maxwell (2007) and Harford, Mansi, and Maxwell (2008). The coefficient on capital expenditures is insignificant in the Fama-MacBeth regressions in OPSW, but positive and significant in their pooled regressions, which do not control for clustering like we do.

Model 3 re-estimates Model 1 using changes in the variables rather than levels. This approach eliminates the impact of constant unobservable firm characteristics on cash holdings. In this specification, we include the lagged change in cash and the lagged level of cash to allow for partial adjustment of the cash ratio to the equilibrium level. The coefficients on the modeled factors yield slightly different results in sign and significance in comparison to those obtained in Model 1, including positive and significant coefficients on firm size, cash flow, and the dividend dummy. These factors are either negative or insignificant in Model 1. These differences may be due to changes in the influence of firm characteristics on cash holdings over time. We consider this when discussing the results in Panel B of Table III.

We next investigate whether the intercepts of the models change over time, identifying an increase in the cash ratio not explained by changes in modeled firm characteristics. We add two indicator variables to the models allowing for intercept shifts in the 1990s and the 2000s. In Model 4 both dummy variables have negative and significant coefficients, suggesting that changes in firm characteristics lead to higher cash ratios than those actually observed in the 1990s and 2000s. Model 5 re-estimates Model 2 with the dummy variables. In this specification, the dummy variable for the 1990s is significantly negative but the dummy variable for the 2000s is significantly positive. The intercept for the 2000s is higher than for the 1980s or the 1990s. This evidence is consistent with an increase in cash holdings in the 2000s that cannot be explained by changes in firm characteristics. Model 6 re-estimates Model 3 with the dummy variables and leads to the same conclusion as Model 5.

It is possible that the intercepts do not change over time but the slopes do, as would be the case if the relation between firm characteristics and the cash ratio changes over time. To consider this possibility, we estimate Fama-MacBeth regressions for two different subperiods—the 1980s and the remainder of our sample period. These regressions are summarized in Models 7 and 8, respectively. The coefficient estimates for both periods are consistent with those of the pooled regression of Model 1. Further, the intercept is higher in the 1980s relative to the latter half of the sample period.

Finally, we consider specifications with fixed effects. First, we estimate Model 1 with industry fixed effects. With industry fixed effects, the coefficient on the industry risk measure is 0.374 and significant at the 1% level (regression not reported). Second, we examine a regression specification using firm and year fixed effects. In this specification (not reported), industry risk has a negative and significant coefficient, a result attributable to firms in the sample that recently went public. If we require each firm to have been public for 5 years, industry risk has a positive and significant coefficient, as shown in Model 9, but the magnitude of the coefficient is smaller than in the comparable Model 1. We report the R^2 computed for changes within firms.

Though we do not report the results in the table, we also explore the sensitivity of our results to alternate measures of risk. First, we use (1) an industry-level measure estimated over 5 years, (2) a value-weighted average measure, and (3) a median measure, and find similar results to those reported in Table III. We then use a firm-level measure. With the firm-level measure, we have fewer observations since we require that the firm exists for 5 years to estimate this risk measure. We again find similar results, but the coefficient on cash flow risk is 0.10, substantially lower than the coefficient on industry risk in Model 1. This result is not unexpected since industry cash flow risk is estimated more precisely than firm cash flow risk, and because requiring 5 years of firm-level data tilts our sample toward more established firms.

We perform a series of additional analyses that are unreported in Panel A of Table III. First, we are concerned that normalizing NWC by total assets might lead to biases in our regressions since a firm with more cash than another, otherwise identical, firm would have a lower cash ratio yielding a negative coefficient in the regression. Thus, we re-estimate our regressions using NWC divided by net total assets, that is, total assets minus cash. Our results are unchanged using this alternative measure of NWC. To check whether foreign income can explain the increase in the cash ratio, we add the ratio foreign income to total assets to our regressions. The coefficient on foreign income is significantly negative, but this result is caused by large outliers. When we winsorize foreign income to total assets at the 1% level, the coefficient on foreign income is not significantly different from zero. A concern is that leverage and NWC respond to the same variables as cash holdings. We re-estimate regression (1) excluding leverage and NWC. When we do so, the coefficient on idiosyncratic risk almost doubles. It could also be the case that firms substituted lines of credit for cash holdings. To investigate whether this possibility could help explain our results, we use a sample of firms for which lines of credit data are available and re-estimate regression (1) adding a firm's lines of credit as an explanatory variable.[6] As expected, the lines of credit variable has a significant negative coefficient. However, the other coefficients in the regression are not affected. Finally, data on goodwill are available from Compustat beginning in 1988. We investigate whether normalizing by tangible assets rather than total assets affects our results. We obtain coefficient estimates that are closer to Model 8, the Fama-McBeth regression for the sample after 1990, than to Model 1. This is not surprising since the sample for the regression with assets net of goodwill starts in 1988.

In summary, Panel A of Table III shows that the relation between cash holdings and firm characteristics is generally consistent across the models we estimate, with the exception of the coefficient on capital expenditures which varies with the construction of the cash ratio. We incorporate indicator variables

[6] We thank Amir Sufi for allowing us to use his data on corporate lines of credit.

allowing the intercept to change in the 1990s and the 2000s, and find no increase in the intercept in the 1990s. The intercept in the 2000s is no greater than in the 1980s for Model 4, but it is for Models 5 and 6. Consequently, Models 5 and 6 do not allow us to exclude the possibility that a regime shift explains the higher cash holdings of the 2000s.

Differences in the intercepts could result from changes in the relation between cash holdings and firm characteristics. To evaluate whether this is the case, we estimate models in Panel B of Table III that allow for changes in both the intercept and slope coefficients. Model 1 of Panel B replicates Model 1 of Panel A, but with indicator variables for the 1990s and 2000s that interact with all independent variables. Adding these indicator variables increases the adjusted R^2 by less than 1%. In general, the absolute value of a coefficient increases over time (i.e., the interactions are of the same sign as the coefficient for the whole sample period). When the absolute value of a coefficient does not increase, the changes are typically small. For all but two variables, the sign of the coefficient is the same for each subperiod. The exceptions are the coefficients on cash flow and size. In Model 1 of Panel A, the coefficient on cash flow is insignificant. In Model 1 of Panel B, the coefficient is positive and significant in the 1980s, but switches to negative and significant in the 2000s (p-value from an F-test $= 0.000$). For size, the coefficient is negative and significant in the 1980s and 1990s, but becomes trivially positive in the 2000s (p-value from an F-test $= 0.551$). The negative relation between cash holdings and firm size is consistent with models of a transaction demand for cash. This relation appears to disappear in the 2000s. A possible explanation is that the cash holdings in the 2000s reflect agency problems, so that large firms hold cash that is not justified by transaction models. We explore the agency explanation in detail in Section VI. In general, the sign on the relation between cash holdings and firm characteristics does not change during our sample period, but the strength of the relation does change for some variables. The most striking change is the increase in the coefficient on cash flow risk in the 1990s.

We introduce several additional control variables in Model 2 of Panel B that were not incorporated in the OPSW model. We control for equity and debt issues, as well as proximity to an IPO. Since capital raising tends to be lumpy, firms should have more cash immediately after raising capital and cash should decrease as they spend the capital raised. We define net debt issuance as debt issuance (data item #111) minus debt retirement (data item #114), divided by book assets (data item #6). Net equity issuance is calculated as equity sales (data item #108) minus equity purchases (data item #115), divided by book assets. Since Section III shows that firms with negative net income have more cash, we also add a dummy variable equal to one for firms reporting a loss. Finally, we add the T-bill yield and a credit spread measure. The T-bill yield is the average annual 3-month rate published by the Federal Reserve. The credit spread is the difference between the AAA and BBB yields, also reported by the Federal Reserve. In models of the transaction demand for cash, a decrease in the risk-free rate decreases the opportunity cost of cash, so that we would expect a positive coefficient on the T-bill yield. An increase in credit spread would imply an increase in default risk and in the precautionary demand for cash. Adding all of these variables increases the adjusted R^2 by roughly 5 percentage points. As expected, IPO firms hold more cash and the cash ratio falls as the IPO gets more distant.[7] Also, firms that issue more equity or more debt have more cash, while the coefficient on the accounting loss indicator variable is insignificant. Taking into account these additional firm-specific variables has no meaningful impact on the intercepts for the 1990s and 2000s; they remain negative and significant. T-bill yields are uncorrelated with cash holdings, but the credit spread variable is positive and significant at the 10% level. Our conclusions about changes over time in the other coefficients discussed in relation to Model 1 of Panel B are unchanged.

The third model reported in Panel B uses the log of the ratio of cash to net assets as the dependent variable. In Model 5 of Panel A, the coefficient on the intercept for the 2000s was positive, suggesting an upward shift in the demand for cash not explained by changes in firm characteristics. This result no longer holds when we allow for shifts in slopes. Both indicator variables are negative, but neither is significant at the 5% level. One noticeable difference between Model 3 and Model 2 of Panel B is that the T-bill rate has a negative and significant coefficient in Model 3 but is not significant in Model 2.[8]

In an unreported regression, we replicate Model 3 of Panel A (the changes regression) with dummy variables for the 1990s and 2000s and their corresponding interaction terms. The model has six additional variables compared to the models reported in Panel B, namely the lagged change in the cash ratio, the lagged level of the cash ratio, and their respective interaction terms. The results from this model are consistent with the results in Model 6 of Panel A. The intercept decreases in the 1990s and then increases in the 2000s, so that in the 2000s it is the same as in the 1980s. Consequently, an increase in the intercept cannot explain the high cash ratios in the 2000s compared to the 1980s.

There are several important findings from the regressions in Table III. First, the models in Panel B suggest that cash holdings were lower than expected in the 1990s. None of the evidence in Panel B indicates that, given their characteristics, firms had higher than expected cash holdings in the 2000s since the interactions for the intercepts are negative. Second, allowing for time variation in the coefficients adds little to the explanatory power of the regressions. Third, the negative relation between cash holdings and firm size breaks down in the 2000s.

We perform an additional evaluation of changes in intercepts and slopes that is not reproduced in Table III. We estimate Model 1 of Panel A cross-sectionally for each year. This approach confirms the results of the regressions in Table III. In particular, the intercept of the regression falls over time. Interestingly, the explanatory variables explain more of the cross-sectional distribution of cash

[7] In unreported specifications we find that the correlation between cash and a firm's temporal distance from the IPO year is insignificant beyond the sixth year.

[8] In addition, the loss indicator variable is negative and significant in this specification. This surprising result is due to the high negative correlation of the loss dummy with size and with cash flow to assets. If these two variables are removed from the regression, the loss indicator variable has a positive and significant coefficient.

holdings in recent years. The evolution of two coefficients is particularly interesting: The cash flow risk coefficient tends to be insignificant in the early years of the sample, while the firm size coefficient switches from negative and significant in the 1980s and 1990s to positive and significant in the early 2000s. The latter result most likely reflects the increase in cash holdings of large firms starting in 2000.

V. Why Did the Cash Ratio Increase?

Section IV shows that changes in firm characteristics are the major reason why cash holdings increase. In this section, we attribute the increase in cash holdings to changes in specific firm characteristics. We proceed in three steps. First, we estimate a modified version of the OPSW model for the 1980s using Fama-MacBeth regressions, the coefficients of which are the average coefficients from annual cross-sectional regressions estimated over the period 1980 to 1989. In contrast to the models estimated in Panel A of Table III, this model (reported in the legend of Table IV) takes into account net equity and net debt issues. Second, we compute how actual cash holdings in the 1990s and 2000s differ from cash holdings predicted by that model. Finally, we attribute the increase in predicted cash holdings to changes in firm characteristics.

Column 2 of Table IV reports the predicted cash ratios for the whole sample. The difference between the actual and predicted cash ratios is shown in column 3 and the *t*-statistic for the difference is shown in column 4. The actual average cash ratios are not reproduced but are equal to the sum of columns 2 and 3. For example, in 2004, the difference between the predicted and actual cash ratios is 0.7% with a *t*-statistic of 2.27. The model consistently overpredicts cash holdings in the 1990s. For the 2000s, the difference between actual and predicted cash holdings is significantly greater than zero in the last 3 years of the sample; however, the differences are proportionately small. The highest difference is in 2006, when the model underpredicts cash holdings by 4.8%, or roughly 1% of assets.

The next three columns of Table IV examine firms in the S&P 500 index. The cash holdings model estimated in the 1980s overpredicts cash holdings of S&P 500 firms in the 1990s and 2000s. The unexpected cash holdings are not significantly different from zero in 2002 through 2004, but actual holdings are less than predicted in 2005 and 2006. The unexpected cash holdings of the S&P 500 subsample average to −1.3% of assets over the last 3 years of our sample, compared to 1.1% for non-S&P 500 firms.

Columns 8 and 11 of Table IV show the predicted average cash ratios for firms that do and do not pay a common dividend, respectively, while columns 9 and 12 show the difference between actual and predicted. The model predicts an increase in the average cash ratio of 42.6% from 1990 to 2006 for nondividend payers, but an increase of only 24.3% for dividend payers. The actual increase in the cash ratio for dividend payers is less than predicted throughout the sample period. In contrast, the increase in cash holdings for nondividend payers is higher than predicted in the latter half of the sample period. The maximum error of the model for this subsample is 2.4% of assets in absolute value.

Table IV

Predicted Cash Ratios and Their Deviations from Actual Cash Holdings over Time

This table summarizes the predicted cash ratios of sample firms from 1990 through 2006, and deviations of the actual cash ratios from those predicted by an out-of-sample model. Predicted cash holdings for each year are derived from a Fama-MacBeth model predicting cash ratios, the coefficients of which are the average coefficients from annual cross-sectional regressions estimated over the period 1980 to 1989. Estimates from this regression are as follows: Cash ratio = 0.307 + 0.230 Industry cash flow volatility + 0.006 Market to book – 0.009 Log size + 0.077 Cash-flow/Assets – 0.238 Net working capital/Assets – 0.372 Capital expenditures/Assets – 0.360 Leverage + 0.048 R&D/Sales – 0.024 Dividend dummy – 0.233 Acquisitions/Assets + 0.158 Net equity/Assets + 0.190 Net debt/Assets. The table summarizes differences between actual and predicted cash ratios, by year, for the whole sample (n = 64,068 firm-year observations), for firms in the S&P 500 index (n = 5,031), and for firms paying and not paying common dividends (n = 16,206 and 47,862, respectively) during a particular year. t-statistics summarize the statistical significance of differences between predicted and actual cash ratios for the whole sample and each of the observed subsamples independently. Variable definitions are provided in the Appendix.

	Whole Sample			S&P 500 Firms			Firms Paying a Dividend			Firms Not Paying a Dividend		
Year	Predicted	Actual – Predicted	t-statistic	Predicted	Actual – Predicted	t-Statistic	Predicted	Actual – Predicted	t-Statistic	Actual – Predicted	Predicted	t-Statistic
1990	0.149	−0.015	−6.14	0.098	−0.023	−4.80	0.109	−0.011	−3.45	0.168	−0.016	−5.16
1991	0.170	−0.015	−6.18	0.109	−0.034	−8.78	0.120	−0.016	−4.90	0.192	−0.015	−4.61
1992	0.175	−0.015	−6.26	0.115	−0.039	−9.16	0.127	−0.022	−7.25	0.197	−0.012	−3.73
1993	0.185	−0.015	−6.49	0.120	−0.045	−10.54	0.133	−0.025	−8.08	0.206	−0.011	−3.67
1994	0.176	−0.024	−11.28	0.117	−0.049	−11.95	0.125	−0.035	−12.69	0.195	−0.021	−7.39
1995	0.180	−0.018	−7.97	0.117	−0.047	−10.58	0.122	−0.031	−10.44	0.200	−0.013	−4.64
1996	0.192	−0.008	−3.47	0.119	−0.047	−10.18	0.124	−0.030	−10.36	0.214	0.000	−0.11
1997	0.185	−0.004	−1.60	0.120	−0.048	−10.81	0.127	−0.025	−7.48	0.203	0.003	0.97
1998	0.170	−0.004	−1.54	0.117	−0.045	−9.42	0.114	−0.029	−8.93	0.188	0.004	1.41
1999	0.189	−0.010	−4.05	0.125	−0.042	−7.42	0.114	−0.031	−8.83	0.211	−0.004	−1.39
2000	0.201	−0.008	−3.10	0.136	−0.034	−5.46	0.117	−0.038	−11.10	0.223	−0.001	−0.24
2001	0.200	−0.002	−0.72	0.144	−0.020	−2.97	0.122	−0.034	−8.92	0.219	0.006	1.62
2002	0.200	−0.002	−0.59	0.147	−0.005	−0.72	0.131	−0.036	−9.10	0.217	0.007	1.85
2003	0.212	0.001	0.38	0.153	−0.003	−0.39	0.142	−0.023	−5.65	0.232	0.008	2.26
2004	0.222	0.007	2.27	0.155	−0.006	−0.77	0.144	−0.021	−5.08	0.247	0.016	4.20
2005	0.217	0.009	2.81	0.153	−0.013	−1.74	0.145	−0.021	−5.14	0.244	0.020	4.94
2006	0.209	0.010	3.21	0.144	−0.022	−3.56	0.135	−0.023	−6.27	0.239	0.024	5.72

Though we do not report the results in the table, we compare the predicted cash ratio to the actual cash ratio for high-tech firms versus manufacturing firms, and for firms that had an IPO within the past 5 years versus non-IPO firms. Except for 1990, the model underpredicts the cash holdings of high-tech firms every year. The difference between actual and predicted is low in the first half of the 1990s, but over the last 5 years of the sample period, the underprediction averages 5.1% of assets. For recent IPO firms, the prediction errors are positive in every year; although, the errors average only 2.2% of assets in the 1990s, they exceed 8% of assets in 2002, 2003, and 2004. As a result, the model substantially underpredicts the cash ratios of firms that have recently gone public and overpredicts the cash holdings of the other firms.

The model predicts a 40.3% increase in the average cash ratio from 1990 to 2006 for the whole sample. How can such a large increase be explained? To answer this question, we investigate how firm characteristics change over time and how this change affects cash ratios. Consider a firm that has the sample average industry cash flow volatility in the 1980s, which is 7.0%. The coefficient on industry cash flow volatility in the Fama-MacBeth regression is 0.230, so we expect a cash ratio of 1.6% due to industry cash flow volatility ($0.230 * 7.0\%$) for this firm in the 1980s. Average industry cash flow volatility increases during our sample period. For example, average cash flow volatility in 2006 is 16.3%. In 2006, a cash ratio of 3.7% could be attributed to average cash flow volatility, and holding all other variable constant, we infer that the average cash ratio increased by 2.1 percentage points from the 1980s to 2006 because of the increase in cash flow volatility. The various models we estimate in Table III generally lead to a similar impact of the increase in cash flow volatility on the cash ratio, except for the changes model and the fixed effects model, where the effect is also positive but lower.

Table V attributes the increase in the predicted cash ratio to changes in the determinants of that ratio. The increase in the cash ratio is the difference between the average from 2000 to 2006 and the average for the 1980s. For each estimate, we calculate standard errors based on the Delta method discussed in Greene (2008). The first column of Table V shows the decomposition for the whole sample. Most of the change in predicted cash holdings is explained by four variables. In order of importance, these variables are the change in NWC net of cash, the change in cash flow risk, the change in capital expenditures, and the change in R&D.

NWC falls by more than 10% of assets from the 1980s to the 2000s. The largest contributor to that fall is the decrease in inventories. In the 1980s, inventories average 19.9% of assets. In contrast, in the 2000s, the average is 12.3%. The decrease in inventories is more dramatic when we look at the median (not reported), which averages 18.3% in the 1980s, but only 7.4% in the 2000s. In addition to the decrease in inventories, a decrease in accounts receivable also contributes substantially to the fall in NWC. In the 1980s, accounts receivable averages 20.3% of assets. In contrast, the average of accounts receivable is 15.3% in the 2000s.

Table V

Determinants of Changes in Predicted Cash between 2000 and 2006

This table summarizes the determinants of the change in predicted cash ratios between 2000 and 2006, where the change in the cash ratio is measured as the difference between the average cash ratio from 2000 through 2006 and the average cash ratio from 1980 through 1989. The determinants of the cash ratio are modeled as Cash ratio = 0.307 + 0.230 Industry cash flow volatility + 0.006 Market to book – 0.009 Log size + 0.077 Cash-flow/Assets – 0.238 Net working capital/Assets – 0.372 Capital expenditures/Assets – 0.360 Leverage + 0.048 R&D/Sales – 0.024 Dividend – 0.233 Acquisitions/Assets + 0.158 Net equity/Assets + 0.190 Net debt/Assets. Estimated standard errors (in parentheses) are calculated based on the Delta method discussed in Greene (2008). Variable definitions are provided in the Appendix.

	Whole Sample	Nondividend Paying Firms	Dividend Paying Firms	Difference	Non-S&P 500 Firms	S&P 500 Firms	Difference
Industry sigma	0.020	0.021	0.014	0.007	0.021	0.018	0.003
	(0.0011)	(0.0012)	(0.0008)		(0.0011)	(0.0011)	
Market to book	0.002	0.002	0.002	−0.001	0.002	0.006	−0.004
	(0.0001)	(0.0001)	(0.0002)		(0.0001)	(0.0003)	
Real size	−0.008	−0.013	−0.009	−0.004	−0.009	−0.007	−0.002
	(0.0003)	(0.0004)	(0.0004)		(0.0003)	(0.0004)	
Cash flow/ assets	−0.002	−0.002	0.001	−0.002	−0.003	0.002	−0.005
	(0.0002)	(0.0002)	(0.0001)		(0.0002)	(0.0002)	
NWC/ assets	0.025	0.022	0.021	0.001	0.025	0.024	0.002
	(0.0006)	(0.0007)	(0.0007)		(0.0006)	(0.0010)	
Capex	0.013	0.0150	0.011	0.004	0.013	0.013	0.001
	(0.0003)	(0.0004)	(0.0004)		(0.0004)	(0.0005)	
Leverage	0.010	0.018	−0.004	0.022	0.011	−0.003	0.014
	(0.0007)	(0.0009)	(0.0010)		(0.0007)	(0.0015)	
R&D/ sales	0.010	0.012	0.000	0.012	0.011	0.002	0.010
	(0.0005)	(0.0006)	(0.0000)		(0.0005)	(0.0001)	
Dividend	0.004	0.000	0.000	0.000	0.004	0.005	−0.001
	(0.0002)	(0.0000)	(0.0000)		(0.0002)	(0.0004)	
Acquisition activity	−0.002	−0.001	−0.002	0.001	−0.002	−0.001	−0.001
	(0.0001)	(0.0002)	(0.0003)		(0.0001)	(0.0004)	
Net equity issuance	0.000	−0.003	−0.002	−0.001	0.001	−0.002	0.003
	(0.0003)	(0.0004)	(0.0002)		(0.0003)	(0.0003)	
Net debt issuance	−0.001	−0.001	−0.003	0.002	−0.001	−0.001	0.000
	(0.0002)	(0.0003)	(0.0003)		(0.0003)	(0.0004)	
TOTAL	0.072	0.071	0.030	0.040	0.073	0.055	0.018

In risk management theories, greater volatility of cash flow increases the present value of deadweight costs of financial distress.[9] One would expect firms with greater volatility of cash flow to hedge more, but if they have unhedgeable risks, they would hold more cash. It is therefore not surprising that firms hold more cash as cash flow risk increases. Average industry cash flow risk more than doubles during the sample period, from 7.0% in the 1980s to 15.9% in the 2000s.

In the 1980s, average capital expenditures as a percentage of assets are more than double average R&D expenditures as a percentage of assets (8.9% vs. 3.2%). In contrast, in the 2000s, R&D exceeds capital expenditures (6.7% vs. 5.4%). We would expect the increased importance of R&D relative to capital expenditures to have a significant effect on the cash ratio. The cash ratio is increasing in R&D. A plausible interpretation is that, given lower asset tangibility, R&D investment opportunities are costly to finance using external capital, so R&D intensive firms require a greater cash buffer against future shocks to internally generated cash flow. In contrast, capital expenditures are more likely to generate assets that can be used as collateral and hence are easier to finance. As a result, capital expenditures may mostly consume cash, which would be consistent with their negative relation with the cash ratio.

The next three columns of Table V illustrate the determinants of changes in predicted cash holdings for dividend payers and nondividend payers. For this decomposition, we use the change in the determinants of the cash ratio for subsamples. For instance, when we attribute the change in the predicted cash ratio for dividend-paying firms, we estimate the impact on the cash ratio of the change in the average value of the explanatory variables between the 1980s and the period from 2000 to 2006 for these firms. We first consider the decomposition for nondividend payers. We see that the increase in cash flow risk and the decrease in NWC explain an increase in the cash ratio of 2.1 percentage points and 2.2 percentage points, respectively. Further, a leverage decrease, a decrease in capital expenditures, and an increase in R&D together explain roughly a 4.5 percentage point increase in the cash ratio. When we turn to dividend payers, the contributions of the decrease in NWC and of the increase in cash flow risk stand out. The leverage of nondividend payers decreases relative to the leverage of the dividend payers, contributing to an increase in the cash ratio of nondividend payers relative to dividend payers of 2.2 percentage points. R&D expenses increase more for nondividend payers, which explains a differential of 1.2 percentage points in the cash flow ratio change. Finally, the cash flow risk of dividend payers increases less than the cash flow risk of nondividend payers.

In the last three columns of Table V, we examine why the average predicted cash ratio grew more for non-S&P 500 firms than for S&P 500 firms. The last column of Table V decomposes the difference in the change in the predicted cash ratio between the S&P 500 firms and the non-S&P 500 firms. For the

[9] See, for instance, Smith and Stulz (1985) and Froot, Scharfstein, and Stein (1993). Minton and Schrand (1999) examine cash flow volatility and its deadweight costs empirically.

non-S&P 500 firms, the change in NWC and the change in cash flow risk together explain an increase in the cash ratio of 4.6 percentage points. Other variables that contribute in excess of 1 percentage point are the changes in capital expenditures, R&D, and leverage. When we consider the S&P 500 firms, we again see that NWC, cash flow risk, and capital expenditures are important, but their contribution is slightly less than for the non-S&P 500 firms. From the average of the 1980s to the average of the 2000s, the difference in the increase in the predicted cash ratio between the non-S&P 500 and S&P 500 firms is 1.8 percentage points. As seen from the decomposition, the two largest components in absolute value are leverage and R&D. As illustrated in Table III, the cash ratio decreases with leverage and increases with R&D. Over our sample period, leverage falls slightly for the non-S&P 500 firms (from 26.1% in the 1980s to 23.1% in the 2000s) but stays roughly constant for the S&P 500 firms. More significantly, R&D increases more for the non-S&P 500 firms. In the 1980s, R&D as a percentage of assets was 3.3% for the non-S&P firms and 2.3% for the S&P firms. In the 2000s, these percentages are, respectively, 7% and 3.3%.

The evidence confirms the role of a precautionary motive for the growth in the cash ratio, and suggests that changes in firm characteristics largely explain secular trends in the demand for cash. If firms are holding cash because of the precautionary motive and their risk increases, we expect the volatility of cash holdings to increase as well. To consider this possibility, we proceed as follows. For each firm-year observation in our sample, we compute the standard deviation of cash holdings for the prior 5 years, requiring at least three observations. We then compute an equally weighted average of the standard deviation of cash holdings across firms in an industry. We expect (1) that the industry standard deviation of cash holdings increases over the sample period and (2) that there is a high correlation between the standard deviation of cash holdings and cash flow risk. We find that the mean and the median of the standard deviation of cash holdings increase over time. The average of the medians is 7.1% in the 1980s, 8.4% in the 1990s, and 9.3% in the 2000s. We also find that the correlation between the median standard deviation of cash holdings and the median cash flow volatility is 84%.

VI. Agency Problems and Growth in the Cash Ratio

The evidence summarized thus far indicates that empirical models of the demand for cash can explain the increase in cash holdings over time primarily through changes in firm characteristics. We rely on models that incorporate various proxies for a firm's demand for cash derived from transaction and precautionary motives for cash holdings. We have not, however, investigated directly whether variables that proxy for agency costs are related to changes in cash holdings. In this section we conduct three formal tests to evaluate whether agency problems provide a systematic explanation for the increasing cash holdings of firms in our sample.

First, we utilize the Gompers, Ishii, and Metric (2003) index (GIM index) as a measure of managerial entrenchment. The GIM index is a cumulative index of 24 antitakeover governance provisions obtained from the Investor

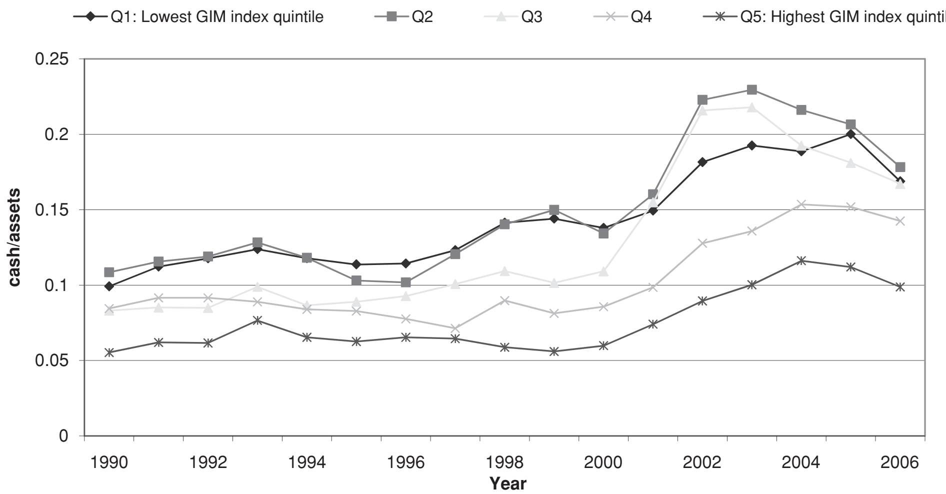

Figure 4. Average cash ratios sorted by quintiles of the GIM index from 1990 to 2006. The figure summarizes the average cash-to-assets ratio for quintiles of firms sorted by their GIM index. We split the firms for which we have the GIM index into quintiles in each year that IRCC publishes its information on takeover protections, using values of the GIM index as break points. We keep the assignment of firms the same in years in which no information is published by IRCC. The sample includes all Compustat firm-year observations from 1990 to 2006 with positive values for the book value of total assets and sales revenue for firms incorporated in the United States and for which we have IRRC data. Financial firms (SIC code 6000-6999) and utilities (SIC codes 4900-4999) are excluded from the sample, yielding a panel of 17,556 observations for 2,362 unique firms. The cash ratio is measured as the ratio of cash and marketable securities to the book value of total assets.

Responsibility Research Center (IRRC) volumes published periodically between 1990 and 2006. Firms that have a high value of the GIM index are thought to have more entrenched management. IRRC covers firms in the S&P 1500 and other major U.S. corporations, a subset of our initial sample. For instance, in 1990, 709 firms have a GIM index while our full sample has 4,042 firms. Following Gompers, Ishii, and Metrick, we assume that a firm's governance provisions remain in place from the publication year of an IRRC volume until the publication year of the next volume. We then sort firm-year observations with corresponding IRRC data into quintiles formed on values of the GIM index.

Figure 4 shows the evolution of cash holdings for each quintile of the GIM index from 1990 to 2006. We see that the average cash ratio increases for each quintile. If entrenched managers are more likely to retain free cash flow, we should see that the cash ratio of firms in the top quintile should increase more than the cash ratio of firms in the bottom quintile. There is no evidence of such an evolution. In 1990, the average cash ratio of the highest quintile is 55.73% of the average cash ratio of the lowest quintile. From 1991 to 2006, the average cash ratio of the highest quintile represents more than 55.73% of the average cash ratio of the lowest quintile in only 5 years. One might argue that the fact that 3 of these 5 years are the last years of the sample suggests that the most recent increase in cash holdings might be explained by agency problems.

However, in 2005, this percentage is 55.96%, roughly the same as in 1990. Since firms in low quintiles of the GIM index tend to be young, high growth firms, it is not surprising that they hold more cash. The fact that the firms with the most entrenched management hold the least amount of cash is inconsistent with the view that entrenchment leads managers to hoard cash. This evidence is consistent with the evidence in Pan (2007) that firms with a high GIM index are also more likely to pay dividends and have a higher payout ratio.

Second, we examine the value of cash holdings over time. A number of recent papers correlate agency costs of cash with the value of corporate cash holdings. We follow the approach in Pinkowitz and Williamson (2004), which uses a valuation regression developed by Fama and French (1998) and modifies it by introducing cash holdings as an independent variable. While this approach is ad hoc in that it does not specify a functional form that results directly from a theoretical model, it explains a substantial amount of the cross-sectional variation in firm values. Their basic regression specification is as follows:

$$\begin{aligned} V_{i,t} &= \alpha + \beta_1 E_{i,t} + \beta_2 dE_{i,t} + \beta_3 dE_{i,t+2} + \beta_4 dA_{i,t} + \beta_5 dA_{i,t+2} + \beta_6 RD_{i,t} \\ &\quad + \beta_7 dRD_{i,t} + \beta_8 dRD_{i,t+2} + \beta_9 I_{i,t} + \beta_{10} dI_{i,t} + \beta_{11} dI_{i,t+2} + \beta_{12} D_{i,t} \\ &\quad + \beta_{13} dD_{i,t} + \beta_{14} dD_{i,t+2} + \beta_{15} dV_{i,t+2} + \varepsilon_{i,t}, \end{aligned} \tag{1}$$

where X_t is the level of variable X in year t divided by the level of total assets in year t; dX_t is the change in the level of X from year $t-2$ to year t, $X_t - X_{t-2}$; dX_{t+2} is the change in the level of X from year t to year $t+2$, $X_{t+2} - X_t$; V is the market value of the firm calculated at fiscal year-end as the sum of the market value of equity, the book value of short-term debt, and the book value of long-term debt; E is earnings before extraordinary items plus interest, deferred tax credits, and investment tax credits; A is total assets; RD is the research and development (R&D) expense; I is the interest expense; and D is dividends defined as common dividend paid. When R&D is missing, we set it equal to zero. A straightforward way to estimate the relation between market value and cash holdings in the model is to split the change in assets into its cash and noncash components and estimate the following specification:

$$\begin{aligned} V_{i,t} &= \alpha + \beta_1 E_{i,t} + \beta_2 dE_{i,t} + \beta_3 dE_{i,t+2} + \beta_4 dNA_{i,t} + \beta_5 dNA_{i,t+2} + \beta_6 RD_{i,t} \\ &\quad + \beta_7 dRD_{i,t} + \beta_8 dRD_{i,t+2} + \beta_9 I_{i,t} + \beta_{10} dI_{i,t} + \beta_{11} dI_{i,t+2} + \beta_{12} D_{i,t} \\ &\quad + \beta_{13} dD_{i,t} + \beta_{14} dD_{i,t+2} + \beta_{15} dV_{i,t+2} + \beta_{16} L_{i,t} + \varepsilon_{i,t}, \end{aligned} \tag{2}$$

where NA is net assets defined as total assets minus cash and L corresponds to cash holdings. The coefficient on cash holdings measures the value of holding a dollar of cash. If the increase in cash holdings is a by-product of agency problems, the value of cash will fall over time. Dittmar and Mahrt-Smith (2007) estimate a regression similar to equation (2) for U.S. firms, and Pinkowitz, Stulz, and Williamson (2006) utilize a comparable specification for international firms using 1-year leads and lags.

Table VI reproduces estimates of the regression given by equation (2). Model 1 of Table VI includes all firms in our sample for which the data can be obtained to estimate the regression. We incorporate two interaction terms with cash to

Table VI

OLS Regression Results for the Market Value of the Firm

The dependent variable for the regressions is the market value of the firm in year t, M_t. For each independent variable X, X_t is the level in year t, divided by the level of total assets in year t; dX_t is the change in the level of X from year $t-2$ to year t, divided by total assets in year t $((X_t - X_{t-2})/A_t)$; dX_{t+2} is the change in the level of X from year $t+2$ to year t, divided by assets in year t $((X_{t+2} - X_t)/A_t)$. The first regression is for the full sample of firms that satisfy our prior data requirements, and for which we are able to calculate 2-year leads and lags, yielding a panel of 49,347 observations for 7,059 unique firms. The second regression imposes the additional requirement that assets exceed \$100 million in 2004, yielding a panel of 30,676 observations for 4,250 unique firms. p-values based on standard errors robust to clustering by firm and year are reported in parentheses. Variable definitions are provided in the Appendix.

Model	1	2
Variable		
Intercept	0.620	0.302
	(0.000)	(0.000)
E_t	−0.505	3.852
	(0.051)	(0.000)
dE_t	0.866	−0.392
	(0.000)	(0.016)
dE_{t+2}	0.238	1.428
	(0.018)	(0.000)
dNA_t	0.776	0.619
	(0.000)	(0.000)
dNA_{t+2}	0.421	0.224
	(0.000)	(0.000)
RD_t	3.012	3.468
	(0.000)	(0.000)
dRD_t	1.647	2.097
	(0.001)	(0.40)
dRD_{t+2}	3.953	4.463
	(0.000)	(0.000)
I_t	1.622	0.512
	(0.003)	(0.411)
dI_t	−4.079	−2.294
	(0.000)	(0.006)
dI_{t+2}	−2.743	−1.440
	(0.000)	(0.020)
D_t	9.180	6.592
	(0.000)	(0.000)
dD_t	11.000	11.041
	(0.000)	(0.000)
dD_{t+2}	15.538	12.113
	(0.000)	(0.000)
dV_{t+2}	−0.083	−0.067
	(0.001)	(0.076)
L_t	1.263	1.234
	(0.000)	(0.000)
$L_t * D90s$	0.475	0.777
	(0.032)	(0.000)
$L_t * D00s$	0.219	0.450
	(0.455)	(0.199)
$D90s$	0.195	0.331
	(0.000)	(0.000)
$D00s$	0.061	0.062
	(0.147)	(0.164)
Adjusted R^2	0.293	0.402

allow the value of cash to change from the 1980s to the 1990s and the 2000s. Coefficients on these interaction variables are positive, but only significantly different from zero for the 1990s, providing no evidence of a decrease in the value of cash. The estimated model yields sensible coefficients except for earnings, which has a negative coefficient. Fama and French (1998) point out that it could be inappropriate to estimate their model across all firms if there are large systematic differences in the cost of equity across subsamples. It is plausible that the cost of equity could be quite different for smaller firms. We therefore estimate Model 2, which employs an identical specification to Model 1 but uses only firms with assets in excess of $100 million in 2004. In this specification, earnings have the expected positive coefficient, but our conclusion about the trend in the value of cash remains unchanged.

We conduct one final investigation (but do not report the results in a table) to identify whether agency problems can explain the increase in cash holdings. In a given year, we expect firms with high excess cash, defined as firms with a high residual in the cross-sectional regression, to be more likely to have high agency problems. For agency problems to explain the growth in cash holdings, these firms should experience higher growth in cash holdings relative to firms with low excess cash. We investigate this possibility as follows. Every 5 years, we rank firms according to their excess cash using the residuals from the cross-sectional regression estimated using parameters from the modified OPSW model discussed in Section V. We then estimate the growth in cash holdings over the next 5 years for the average and median firms in each excess cash quintile. We find that for each quintile, there is a negative relation between the excess cash and the growth rate of the cash ratio. This result is inconsistent with an agency explanation for the increase in cash holdings over time.

VII. Conclusion

We document a dramatic increase from 1980 through 2006 in the average cash ratio for U.S. firms. We show that this increase is concentrated among firms that do not pay dividends, firms in more recent IPO listing cohorts, and firms in industries that experience the greatest increase in idiosyncratic volatility. After documenting the increase in cash ratios, we investigate the causes for that increase. We use a model for cash holdings developed by Opler, Pinkowitz, Stulz, and Williamson (1999), but recognize that the literature has not made enough progress to provide a model that dominates all others. We find that the main reasons for the increase in the cash ratio are that inventories have fallen, cash flow risk for firms has increased, capital expenditures have fallen, and R&D expenditures have increased. While the contribution of changes in these firm factors to the overall increase in cash holdings varies across alternative empirical models of cash holdings, our conclusions are generally robust.

The increase in cash flow risk is connected to the widely studied increase in idiosyncratic risk. Recent evidence of a decrease in idiosyncratic risk, if it persists, should lead firms to eventually reduce their cash holdings and may explain why the average cash ratio peaked in 2004 in our sample.[10] The decrease

[10] See Brandt, Brav, Graham, and Kumar (2009).

in inventories, however, is probably here to stay. Further, the greater importance of R&D relative to capital expenditures also has a permanent effect on the cash ratio. Becaues of lower asset tangibility, R&D investment opportunities are costlier to finance than capital using external capital expenditures. Consequently, greater R&D intensity relative to capital expenditures requires firms to hold a greater cash buffer against future shocks to internally generated cash flow.

Our evidence shows that the increase in cash ratios, while dramatic, can largely be explained by the change in firm characteristics over our sample period and, less significantly, by changes in the relation between firm characteristics and cash holdings. The data are consistent with existing evidence showing that the precautionary motive to hold cash is a critical determinant of the demand for cash. Though the market for derivatives has grown dramatically, our evidence suggests that firms face many risks that they cannot hedge or are reluctant to hedge with derivatives. There is, of course, substantial cross-sectional variation in cash holdings that is not explained by our model. Consequently, our results could be consistent with the hypothesis that some firms hold too much cash because of agency problems. However, agency problems do not appear capable of explaining our aggregate evidence. In particular, there is no evidence that cash ratios grow more for firms with more entrenched management or that the value of cash falls during our sample period.

We also document a dramatic decrease in net debt for U.S. firms over the sample period. If cash is simply negative debt, leverage should be measured using net debt. In this case, the standard measures of leverage used in the finance literature ignore a stunning evolution in the net debt of U.S. firms. By 2006, the average firm has no leverage when leverage is measured by net debt. Assuredly, cash enables firms to forestall distress and default. Thus, the growing importance of cash should be taken into account when evaluating the financial condition and assessing the capital structure decisions of firms.

Appendix: Variable Definitions

Variable	Definition
Acquisition activity	The ratio of expenditures on acquisitions relative to the book value of total assets
Capex	The ratio of capital expenditures to the book value of total assets
Cash flow	EBITDA − interest − taxes − common dividends
Cash ratio	The ratio of cash and marketable securities to the book value of total assets
Credit spread	The difference between the AAA and BBB yields published by the Federal Reserve
dcash	The cash ratio minus the lagged cash ratio
Dividend dummy	A dummy variable equal to one if the firm paid a common dividend in that year, and zero if it did not
Industry sigma	The mean of the standard deviations of cash flow/assets over 10 years for firms in the same industry, as defined by the two-digit SIC code

(*continued*)

Appendix—*Continued*

Variable	Definition
IPO1 through IPO5	Dummy variables equal to one if the firm went public 1, 2, 3, 4 or 5 years ago
Leverage	The ratio of total debt to the book value of total assets, where debt includes long-term debt plus debt in current liabilities
Loss	A dummy variable equal to one if net income is less than zero, and zero otherwise
Market to book	Measured as (book value of total assets – book value of equity + market value of equity)/book value of total assets
Net debt issuance	Calculated as annual total debt issuance minus debt retirement, divided by the book value of total assets
Net equity issuance	Calculated as equity sales minus equity purchases, divided by the book value of total assets
Net Leverage	Calculated as the difference between total debt and cash and marketable securities, divided by the book value of total assets
NWC	Calculated as net working capital minus cash and marketable securities
Real size	The natural log of the book value of total assets in 2004 dollars
R&D/sales	The ratio of research and development expense to sales
T-bill	The U.S. treasury bill yield measured as the average 3-month rate published by the Federal Reserve
C	Cash and marketable securities
D	Common dividends
E	Earnings, calculated as earnings before extraordinary items + interest + income statement deferred tax credits + investment tax credits
I	Interest expense
M	Market value of equity + short-term debt + long-term debt
NA	Net assets, calculated as book value of total assets – cash
RD	Research and development expense or zero when missing

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