

PERSISTENT OPERATING LOSSES AND CORPORATE FINANCIAL POLICIES*

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Abstract

Among U.S. firms, operating losses have become substantially more prevalent, persistent, and greater in magnitude since 1970. Loss firms now comprise over 30% of the Compustat universe and such losses continue for a median of four years. We find that firms with negative operating cash flows account for more than half of the rise in average cash balances over the sample period, with average cash holdings increasing by 615% for negative cash flow firms vs. 95% for positive cash flow firms. Further, firms exhibiting operating losses now comprise the majority of equity issuers. These issuers stockpile most of the funds raised in the issue and use these funds to cover subsequent operating losses. We conclude that the immediate and expected ongoing liquidity needs of firms with persistent operating losses have substantially altered corporate financial policies.

1. Introduction

A growing body of research reports secular changes in the composition of publicly traded U.S. companies. As reported in Kahle and Stulz (2016), U.S. companies have evolved over the past several decades from being manufacturing entities to being more service and high-tech oriented. Coincident with this shift, U.S. companies spend less on capital expenditures and more on research and development (R&D) so that intangible capital now comprises more than 50% of net assets for the average company (Falato, Kadyrzhanova, and Sim (2013)). Cash flows have also become more volatile and Bates, Kahle, and Stulz (2009) tie this increase in volatility to secular increases in average corporate cash holdings.

In this study, we explore the evolution of profitability among U.S. firms and show that not only have cash flows become riskier; they are now much lower for a considerable subset of U.S. firms. In the 1950's about 2% of public firms listed in Compustat reported operating losses (defined as negative cash flow from operations on the firm's Statement of Cash Flow). In contrast, the period since 1980 has been characterized by an explosion in the percentage of public firms with negative cash flow (CF), rising from 9% in 1979 to over 30% in several recent years. Moreover, similar patterns exist even if we measure operating cash flow before R&D expenditures have been deducted. Thus these patterns are not due exclusively to rising R&D expenditures over time.

We further show that for most firms in recent years, operating losses are not a transitory phenomenon. Firms that lose money on operations this period are likely to lose money next period as well. For example, fewer than 14% of the firms that reported negative CF in 2014 subsequently reported positive CF in 2015 and the median 'run' of negative cash flow is four years. This persistence in operating losses is also a recent phenomenon; up until approximately

1990, firms that reported an operating loss in one year had a greater than 50% chance of reporting positive operating earnings in the following year. Moreover the magnitude of operating losses has grown substantially over time as well. In the 1970s, operating cash flow for firms in the bottom decile of operating cash flow exhibited losses equal to 11% of assets, on average. In the 2000s, these average losses for firms in the bottom decile have ballooned to 58% of assets.

Persistent operating losses create immediate and ongoing liquidity needs that must be met by existing internal resources or external finance (or both). We show that firms expecting such losses behave differently than firms with positive cash flow on several dimensions of corporate financial policy such as cash holdings, equity issuance frequency, and cash savings from issuance. For example, between 1970 and 2015, average cash holdings as a percentage of total assets increase by 91% for firms exhibiting positive cash flow. More strikingly, however, average cash holdings increase by 615% for firms with negative operating cash flow. Firms with negative cash flow account for more than half of the increase in average cash balances of U.S. firms reported in Bates, Kahle, and Stulz (2009).

Traditionally, the precautionary demand for cash has been framed within a context focused on the second moment of the distribution of cash flow. According to the precautionary savings theory of Keynes (1936), firms stockpile cash to protect themselves against adverse cash flow shocks because these shocks could lead to underinvestment. However, when the first moment of the cash flow distribution is negative, first moment considerations are likely to dominate second moment considerations. In such situations, the demand for cash stems more from the expected level of cash flow than from its volatility. Consistent with this view, we show that neither changes in cash flow volatility nor increases in R&D expenditures (two traditional

proxies for the demand for precautionary cash) are sufficient to capture the additional amount of cash held by negative cash flow firms. For example, among the subsample of firms that comprise the top two deciles of R&D spending, we find that the cash holdings of high cash flow firms have grown by 54% over our sample period, while cash holdings of low cash flow firms have grown by nearly 900%.

Because an increasing number of firms exhibit persistent operational deficits, cash stockpiling for these firms is less about guarding against the possibility of a shock to financing needs or costs, and more about the fact that cash flow is negative *right now* and is likely to remain that way. In other words, the stockpile is not solely a precaution against the possibility of underinvestment induced by unexpected financing needs. It is a deliberate plan to finance near term operational needs under an expectation of negative cash flows.

To explore the source of cash stockpiles in firms with negative operating flows, we analyze debt and equity issuance activity and find that the relative proportions of each have reversed over time. In the 1970's, high CF firms mostly issued equity and low CF firms relied predominantly on debt. By contrast, in the most recent period (2010-2015), low CF firms raise 15 times more equity capital than debt capital. Consistent with Ritter and Welch's (2002) and Fama and French's (2004) evidence on new lists, we find that over the past four decades, negative cash flow firms represent an increasing proportion of firm-initiated equity issuances (IPOs, SEOs, and private placements).¹ In every year but one since 1989, the majority of firms issuing equity report negative operating cash flows (CF). In the last year of our sample, 2015, negative CF issuers outnumber positive CF issuers by a factor of 2 to 1.

¹ Firm-initiated equity issues are defined as stock issuances that exceed 3% of market equity. This definition captures the vast majority of IPOs, SEOs, and private placements while excluding most employee-initiated issuances such as ESPPs and the exercise of stock options (McKeon, 2015).

Firm-initiated equity issues typically represent a substantial cash inflow to the firm and McLean (2011) argues that cash savings from equity issuance has been increasing over time. Additionally, Huang and Ritter (2016) find that immediate cash needs are an important determinant of equity issues and that firms save 65% of the proceeds from equity issues in cash at year end, on average.

During our sample period, over 1/3 of firms initiating equity issues hold all of the proceeds as cash at year end. We illustrate the importance of operating losses by scaling each equity issuer's post-issue cash balances by the magnitude of the company's cash burn rate.² This scaled measure, commonly called "runway" within the venture capital industry, represents an estimate of how many months a firm with negative cash flows can continue to operate at the same rate without an infusion of external capital. *Ceteris paribus*, equity issuers could increase runway by increasing issuance size and stockpiling cash. However, we find that the median runway after issuance has stayed within the same range for decades, typically between 6 and 18 months, and, most notably, exhibits no time trend over the past two decades, a period during which average cash balances have exploded. In other words, cash savings from issuance have increased substantially, but burn rates have also risen concomitantly. The takeaway is that for equity issuers with negative cash flows, the increase in cash holdings is driven in large part by elevated operating needs in the sense that the number of months of operations covered by cash on hand has not changed substantially over time. Large cash holdings to cover commensurately large burn rates are not excess cash holdings; rather, they represent an expansion of the operating component.

² We define monthly burn rate as $-\text{[Operating CF-Dividends-Capital Expenditures]}$ divided by twelve. For example, a firm that reports negative CF of \$100MM and capital expenditures of \$20MM annually has a monthly burn rate of \$10MM. Firms generating positive free cash flows do not have a burn rate.

Our study contributes to three related strands of the literature. The first seeks to understand the magnitude of cash balances among U.S. firms and why average balances have grown so dramatically in recent years. Our findings complement and extend those from studies that ascribe a role for increased precautionary demands due to uncertainty in future financing needs, and for increased costs of repatriating foreign earnings in explaining high cash balances. We show that, in addition to these factors, an increased demand for operational cash to fund predictable, immediate, and ongoing liquidity needs is an important determinant of observed cash balances. Our findings also provide a potential explanation for the finding in Pinkowitz, Stulz, and Williamson (2016) that differences in average cash balances between U.S. firms and their foreign counterparts are driven by a small set of U.S. firms with very high R&D expenditures. We show that high cash balances of high R&D firms are concentrated among those firms with persistent operating losses.

Second, our findings extend those of Kim and Weisbach (2008), DeAngelo, DeAngelo, and Stulz (2010) and McLean (2011) on the motives for equity issuance. Kim and Weisbach (2008) report that additions to cash holdings are the primary use of equity issue proceeds in a large international sample of IPOs and SEOs. Moreover, McLean (2011) reports that the percentage of equity issue proceeds held as cash at the end of the year of issuance has increased substantially over time. These studies imply that cash stockpiling is an important motive for equity issuance. DeAngelo, DeAngelo, and Stulz (2010) report that most SEO issuers would have been unable to fund current operating plans in the absence of the equity issue. They thus attribute the issuance decision to the need to fund near-term investment. Our findings imply that equity issues are motivated simultaneously by both cash stockpiling and the funding of near-term investment. Equity issuers in recent years are increasingly characterized by ongoing operating

losses and, therefore, high cash burn rates. Thus, they not only have immediate funding needs, but also a need to stockpile cash to fund anticipated near-term future funding shortfalls.

Finally, our findings have implications for the empirical literature that models cash balances as a linear function of firm, country and institutional characteristics. These studies typically include contemporaneous cash flow among the set of variables that capture the firm's sources and uses of funds and, therefore, its operating cash needs. Our findings imply that such models have become increasingly misspecified in recent years as the distribution of firms has shifted towards firms with persistent operating losses. Because these firms exhibit unusually high cash balances, existing models that ignore this nonlinearity systematically underestimate 'normal' cash holdings for firms with persistent negative cash flows.

The rest of the study progresses as follows: Section 2 documents the rise in operating loss firms. Section 3 reports results explaining how the rise in corporate cash holdings is related to operating losses. Section 4 reports results on the relation between operating loss firms and cash savings from equity issuance. Section 5 discusses implications of our findings, and Section 6 concludes.

2. Descriptive evidence on operating losses

The main sample consists of all U.S firms with total assets greater than \$5 million (in 2015 dollars) between 1970 and 2015. The data are obtained from the Compustat database, Industrial Annual file. Historically regulated firms such as financial firms (SIC codes 6000 – 6999) and utilities (SIC codes 4900 – 4999) are excluded, as are firms missing data necessary for the calculation of cash ratios. Within this sample, we identify firm-initiated equity issues such as IPOs, SEOs, and private placements, using the method detailed in McKeon (2015), specifically,

those issues in which proceeds from common stock issuance are greater than 3% of market equity.

We begin by documenting the prevalence of operating losses over time. We define an operating loss as a negative cash flow from operations as reported on the statement of cash flows. Prior to 1987, firms were not mandated to report cash flow from operations. When this figure is missing, we calculate an approximation as described in the Appendix. Figure 1 plots the percentage of the sample that reports negative operating cash flows each year since 1960. The rise is striking. In the early part of the sample, negative operating cash flows are almost non-existent. Despite four recessions between 1960 and 1980 (as defined by the National Bureau of Economic Research (NBER)), the percentage of firms with negative cash flow only exceeds 10% three times. Since 1990, however, it has rarely been less than 25%.³ In 2015, the final year in the sample, nearly 1/3 of the sample firms report negative operating cash flows.

One firm characteristic that has changed substantially over time is R&D expenditures (Brown et al., 2009). To investigate whether the rise in negative cash flow firms is driven primarily by high R&D expenditures, we measure OCFRD, which is operating cash flow with R&D added back. As it turns out, there is more to the story than R&D. The proportion of firms with negative OCFRD has also experienced a substantial rise over the same period and by 2015 nearly 1 in 4 firms reported negative operating cash flows *even before subtracting R&D expense*.

Figure 1 shows that negative cash flows are pervasive; however, a related question is whether negative cash flows are transitory. We find that it is increasingly the case that firms are experiencing persistent negative cash flows rather than negative cash flows that occur due to a temporary shock. Figure 2 illustrates a strong time trend in the persistence of negative cash

³ Kahle and Stulz (2016) also report a decline in average profitability among U.S. firms, but do not investigate its persistence or its connection with corporate financial policies.

flows. Panel A illustrates that in the 1970's and 80's most firms that experienced negative cash flows returned to positive cash flows in the following year. By contrast, less than ¼ of firms that reported negative cash flow in 2014 followed up with positive cash flow in 2015. Panel B reports the average number of years, including the current year, of consecutive negative cash flows. By construction, the lower bound of 1.0 represents a situation in which every firm reporting negative cash flow in a given year had positive cash flow in the prior year. Consistent with panel A, this measure exhibits a strong time trend, peaking in the last year of the sample at nearly four years. This implies that the occurrence of negative cash flows is not likely to be surprising or unexpected for most firms in recent years. Rather, they are operating with the intention and expectation of extended cash flow deficits. A likely consequence of this expectation is that corporate policies for such firms, such as cash holdings, will be driven at least as much by a plan to manage expected operating deficits as by factors that induce excess holdings such as precaution against the possibility of a negative shock.

The final characteristic to note is that the magnitude of negative cash flow has grown substantially over time. Table 1, panel A reports average CF/assets for the ten deciles during four subperiods: 1970-1979, 1980-1989, 1990-1999, and 2000-2015. All deciles report lower cash flows over time, but within the lowest decile the change is most dramatic. In the 1970's the average firm in the lowest decile reported cash flow equal to -9% of assets. During the 2000-2015 subperiod, the average was -55% of assets. Put another way, firms in this decile burn an average of almost 5% of assets *per month* even before accounting for capital expenditures.

Taken together, Figures 1 and 2, and Table 1 highlight three stylized facts about the evolution of firms reporting negative cash flows: Negative cash flows are vastly more prevalent, more persistent, and the magnitude of average negative cash flows within the lowest decile has

grown fivefold. These findings motivate the inquiry into implications of these transformative shifts in the distribution of cash flows for corporate policy.

In light of the drastic change in the distribution of cash flows, a related question is: whether other characteristics of negative cash flow firms have changed. Table 2 reports summary statistics on a variety of firm level variables for firms with negative cash flows. Surprisingly, firm age, measured as number of years as a public firm in Compustat, has increased. The average age of negative cash flow firms in the 1970's is 6.5 years, rising to 11 years in the 2000's. Thus, the shift in the distribution of cash flow is not due simply to the characteristics of newly listed firms.⁴ In terms of size, loss firms have become smaller over time at the median in term of total assets, but larger in terms of market capitalization. It follows that the market-to-book ratio is substantially higher in recent years, averaging 1.16 in the 1970's versus 2.70 in the 2000's. Leverage has fallen sharply, whether measured as book or market leverage, and R&D expenditures as a percentage of assets have increased substantially. Growth patterns have also changed. In the 70's, firms with negative cash flows exhibit signs of distress, with declining revenues and declining headcount, on average. In the 1990's and 2000's the opposite is true; negative cash flow firms are growing rapidly on average, both in terms of revenues and employee growth. Overall, these statistics suggest that as negative cash flows have become more prevalent, persistent and larger, the characteristics of these firms have changed as well. In recent years, firms with negative cash flows are more commonly highly valued, growth firms.⁵

⁴ Fama and French (2004) report that the profitability of newly listed firms has become increasingly left-skewed.

⁵ The industry concentration of negative cash flow firms has also changed over time. In the 2000's, four industries (Drugs, Business Services, Chips, Medical Eq) account for over 50% of the observations of negative cash flow. By contrast, the top four industries in the 1970's (Wholesale, Retail, Business Services, Machinery) account for only 26% of the observations.

3. Operating losses and cash holdings

Numerous studies have documented and offered explanations for the rise of corporate cash holdings. Bates, Kahle, and Stulz (2009) measure the rise in cash holdings from 1980 to 2006 and attribute the increase to precautionary motives rather than agency explanations. Specifically, they point to changing firm characteristics including declines in working capital and capital expenditures, and increases in cash flow volatility and R&D. Younger firms exhibit these characteristics more strongly, and as they enter the economy, the optimal level of cash rises. In Table 2 of their study, they report that the rise in cash holdings for firms with negative earnings has been particularly large. However, it is not obvious a priori that negative cash flows will be associated empirically with higher excess cash. For example, Opler et al. (1999) find that operating losses are the primary explanation for large *decreases* in excess cash for their sample firm over the period 1971-1994. Taken together, these findings motivate a closer examination of the relation between cash and cash flow.

As the prevalence, persistence, and magnitude of negative earnings has increased, cash holdings have grown dramatically. As Table 3 reports, the most dramatic increase is within the lowest deciles of operating cash flow, and the point of divergence in the mid 1980's roughly corresponds with the beginning of rapid growth of negative earnings firms in general in Figure 1. In 1970, cash holdings across the cash flow continuum are similar, and even slightly lower for low cash flow firms. The lowest decile held 6.5% of assets in cash, while the highest 8 deciles held an average of 8.4% of assets in cash. During the final year of the sample, 2015, average cash holdings within the lowest decile has grown to over 63% of assets, an increase of 878% over 1970 levels. Cash holdings within the highest eight deciles has also grown, but much more

modestly, increasing by 101% over the sample period. Overall, these figures are consistent with Bates et al. (2009), who document a tripling of cash ratios for negative net income firms over 1980-2006. The results in Table 3 indicate that the growth has not retreated in the years since 2006. The takeaway is that in order to understand the rise in average cash holdings generally, more attention needs to be paid to the left side of the cash flow distribution where the rise is most evident.

Figure 3 plots the rise in cash holdings. The middle (grey) curve reports the average observed values for the entire sample and shows that average cash holdings have grown by 208% over the sample period. However, once the sample is split into positive cash flow firms (dotted curve) and negative cash flow firms (bottom black curve), it is clear that negative cash flow firms are responsible for the majority of the overall growth in cash holdings observed within the full sample. If negative cash flow firms are removed from the sample, the growth in cash holdings over 1970-2015 is less than half as large as the growth in cash holdings for the full sample (95% vs 208% increase). The growth in cash balances among negative cash flow firms is a striking 615%.

Three traditional explanations for holding excess cash include repatriation taxes, agency problems, and precautionary motives. While the uptick on the right end of the cash flow distribution could be caused by tax considerations, the massive rise on the left is within firms that are not likely to be subject to an offshore cash holdup due to repatriation taxes, because (i) they have negative earnings to offset the tax burden, and (ii) only 8.5% of our sample firms that report operating losses also report foreign income. Similarly, firms on the left side of the distribution are less prone to agency problems. In their study of the effect of agency problems on cash holdings, Nikolev and Whited (2014) cite three factors commonly associated with agency

concerns: size, perquisite consumption, and limited managerial ownership. Negative cash flow firms are the least susceptible on all three counts. They are, on average, the smallest firms in the economy, they are subject to equity capital raising on a regular basis (as we later show), and are monitored more closely than mature high cash flow firms. Finally, in unreported analysis we find that negative cash flow firms have the highest levels of managerial ownership.

Since tax motives and agency concerns are mitigated for firms with negative cash flows, we are left solely with precaution as an explanation for the 615% rise in cash holdings between 1970 and 2015. In recent years, there has been an increased focus on R&D expenditures in the literature. In addition to the Bates, Kahle, and Stulz (2009) study cited earlier, Falato and Sim (2015) use state-level changes in R&D tax credits to show that firms increase their cash-to-asset ratios when their home state increases R&D tax credits. Begeau and Palazzo (2016) link the rise in cross-sectional cash holdings with the propensity of newly public firms to hold more cash at entry, particularly those with high R&D intensity. Pinkowitz, Stulz, and Williamson (2016) find that differences in average cash balances between U.S. firms and their foreign counterparts are driven by a small set of U.S. firms with very high R&D expenditures,

High R&D intensity could impact cash holdings through two (not mutually exclusive) mechanisms. First, disrupting R&D programs is particularly costly (Brown and Peterson, 2011), so the firm may hold extra cash as a precaution. Second, however, many R&D intensive firms also report negative cash flow. R&D represents a cash expense that needs to be covered regardless of the fact that it is R&D, and resultant cash holdings intended to cover near term operations are more accurately described as a response to the first moment of cash flow rather than the second moment.

To determine whether the operating cash flow effect is simply an overlap with R&D intensive firms, we analyze R&D and cash flow jointly in Table 4. Panel A reports the joint distribution by decile for each measure. Not surprisingly, the largest mass is in the lowest cash flow decile and highest R&D decile, but it only represents 5.5% of the sample. Extending to the three lowest deciles of Cash Flow and the three highest deciles of R&D only comprises 15.9% of the sample. Thus, although there is some overlap, it does not appear that the cash flow effect we study is simply a proxy for the R&D effect studied by others.

Panel B takes a step further to examine cash holdings at high R&D firms, defined as those within the top two deciles. The results indicate that growth in cash holdings for high R&D firms is heavily dependent on the firm's cash flow position. Specifically, for high R&D firms in cash flow deciles 3-10, where cash flow is typically positive, cash holdings have grown an average of 52%. In contrast, average cash holdings for high R&D firms in the lowest cash flow decile have grown 828%.

Figure 4 plots the relation between cash holdings and operating cash flow in each of four subperiods. Similar to Figure 3, the most striking increase is observed within firms at the low end of cash flow. However, Figure 4 reveals a more interesting observation, which is that the relation between cash holdings and cash flow deciles has become increasingly nonlinear over time. While the relation between cash holdings and cash flow was roughly flat in the 1970's, each subsequent decade has increased in convexity.

Standard models of cash holdings, in which cash is specified as a linear function of cash flow (and other characteristics), obscure this effect. Misspecification due to incorrect functional form of the cash flow variable results in systematic prediction error. We discuss these implications in greater detail in Section 5.2.

4. Equity Issuance, Cash Savings, and Runway

Anecdotal evidence suggests it has become easier for negative cash flow firms to raise equity capital in recent years.⁶ In Table 5, we investigate three mechanisms that firms can utilize to generate cash: equity issues, debt issues, and the sale of fixed assets. We measure each of these sources, scaled by total assets, and compare the average values within each cash flow decile at the beginning of the sample and the end of the sample.

In the 1970's, low cash flow firms raised little equity relative to high cash flow firms. On average, a firm in the highest decile of cash flow raised over 10 times as much equity as a percentage of assets compared to a firm in the lowest cash flow decile. For debt, the story is different. Very low cash flow firms raised, on average, twice as much debt capital compared to equity and firms in all deciles other than the highest raised more debt than equity on average. The highest cash flow firms raise four times more equity capital than debt in the 1970's. Additionally, sale of fixed assets appears to be an important source of cash in the 70's for firms with very low cash flow. In the lowest decile of cash flow, sale of fixed assets is the largest source of cash, generating 33% more cash than debt issues and about 3 times as much cash as equity issues.

Almost the exact opposite is true in recent years. Over the past decade, low cash flow firms raise far more cash through equity than through either debt issues or the sale of fixed assets. Relative to assets, equity issues raise, on average, 14 times the proceeds of debt issues and 162 times the proceeds from the sale of fixed assets in the lowest decile of cash flow.

⁶ For example, Jay Ritter notes that "In the early Eighties, the major underwriters insisted on three years of profitability. Then it was one year, then it was a quarter. By the time of the Internet bubble, they were not even requiring profitability in the foreseeable future." (*Rolling Stone*, April 5, 2010).

Meanwhile, firms in the highest cash flow decile are now repurchasing both debt and equity, on average. These stylized facts have had a marked impact on capital structure for negative cash flow firms, consistent with the leverage summary statistics in Table 2.

Figure 5 illustrates that over the same time period as the rise in cash holdings and overall prevalence of operating loss firms, the characteristics of equity issuers have changed, particularly with regards to cash flow. In the 1970's and 1980's, firms issuing equity are cash flow positive on average, but in every year since 1989, the average equity issuer is burning cash. These results are consistent with the evidence on earnings in Fama and French (2004) showing that earnings become progressively left skewed through time for newly listed firms, and that as these firms integrate into the economy overall profitability becomes left skewed as well.

To further analyze the relation between cash flow and equity issuance frequencies, we calculate the mean number of firm-initiated issuances per year for each cash flow decile based on quarterly data. Table 5 reports the results of this analysis. While Figure 5 suggests that a large portion of equity issuances are conducted by low cash flow firms, Table 6 demonstrates the inverse: a large portion of low cash flow firms are equity issuers. In fact, between 2010 and 2015 the lowest decile of cash flow recorded 0.89 firm-initiated issuances *per firm per year*. The high frequency of issuance activity suggests that the observed high rate of savings from equity issuance in recent years could be driven by near term operating needs in addition to precautionary motives related to uncertainty.

One of the primary features of precautionary cash savings from equity issuance is the stockpiling of issue proceeds for future use. Following McLean (2011), we measure cash minus issuance (CMI) as cash holdings at the end of the fiscal year minus total proceeds from equity issuances during the year, where we define equity issuance as all firm-initiated equity issues.

When this variable carries a positive sign (CMI+), it indicates that the firm stockpiled all the equity proceeds from issues it initiated in a given year. In Figure 6, we plot the time series of CMI+ proportions for equity issuers. Interestingly, it does not display the strong time trend that characterizes average cash holdings. Over the sample period, the percentage of issuers that hold all the proceeds in cash typically varies between 30% and 50% with a mean of 39%. The 1970's and 2000's are in the higher segment of the range while the 1980's and 90's are in the lower portion of the range. Although several studies report that precautionary motives driven by the volatility of cash flows have risen greatly through the sample period, Figure 6 fails to detect a meaningful trend in cash stockpiling behavior from equity issuance. We therefore posit that it must be the case that there are additional factors influencing cash savings from equity issuance beyond these standard notions of precaution. One such factor is the first moment of the cash flow distribution, i.e., expected negative operating cash flows.

To investigate the size of the cash stockpile relative to the needs of the firm, we borrow a metric from the venture capital industry, where negative cash flows for portfolio firms are commonplace. Within venture-backed firms, a figure that often underlies decisions about cash holdings and equity issuance is the monthly “burn rate,” which we define as operating cash flow minus dividends and capital expenditures, divided by 12. Table 7 reports the median burn rate as a percentage of total assets over time for equity issuers with negative cash flow. It is monotonically increasing, rising from about 8% in the 1970's to over 25% in the most recent period. In the 1970's, the median level of cash holdings for negative cash flow equity issuers was less than 5% of assets at year end. At 2015 burn rates, a stockpile of that size would be depleted before the ides of March.

Cash holdings divided by the monthly burn rate is often referred to as “runway,” or in other words, how many months a company could sustain current operations without an infusion of external capital. Investors can limit runway by staging investment to mitigate overinvestment problems. Hertz et al. (2012) find that public market staging is particularly strong for firms with high R&D and intangible assets. Additionally, they report that the median length of time before returning to the capital market is 12 months. We extend their findings by analyzing runway length over time to detect whether it has changed in ways similar to average cash holdings. Figure 7 plots the median runway at the time of issuance for negative earnings firms over the sample period, and shows that it has stayed within the same range for the last 30 years: between 6 and 18 months. Many other firm characteristics have changed, such as those associated with precautionary cash balances (e.g., R&D intensity and cash flow volatility), but these factors have not altered the median runway of equity issuers in meaningful ways. For negative cash flow firms, having about a year’s supply of cash is the norm. These firms aren’t saving more relative to their needs; their operational needs have grown.

In a contemporaneous study, McLean and Palazzo (2016) analyze the timing and size of equity issues and report evidence that firms issue not only to cover short term liquidity squeezes, but also to stockpile the proceeds as a precaution against adverse future market conditions. In light of their finding that precautionary considerations can influence issuance size, it seems likely that such considerations contribute to the time-series variation in the median runway we observe after issuance in Figure 7. Nonetheless, the fact that runway exhibits virtually no time trend over recent decades, while the average cash balances of issuers has exploded, points to operating needs, rather than precaution, as the first order factor influencing the time series of cash balances.

5. Other Implications and Discussion

In this section, we discuss other implications of the findings presented in this study, including (i) motivations for equity issuance, (ii) misspecification in models of cash holdings, and (iii) the cash flow sensitivity of cash.

5.1 Motivations for Equity Issuance

Our findings have implications for the literature on motivations for equity issuance. Kim and Weisbach (2008) show that cash holdings are the largest use of equity issuance proceeds for an international sample of over 30,000 IPOs and SEOs between 1990 and 2003. McLean (2011) extends this result by documenting that the percentage of equity issuance proceeds held as cash at the end of the year of issuance has increased over time. Specifically, he reports that in the 1970's firms retained an average of \$0.23 in cash for each dollar of issuance, but that this figure rises to \$0.60 for the period 2000-2007. In a separate study, DeAngelo, DeAngelo and Stulz (2010) report that 62% of the SEO issuers in their sample would run out of cash by the end of the following year without the issuance. They attribute SEO decisions primarily to a "lifecycle theory that predicts young firms with high market-to-book (M/B) ratios and low operating cash flows sell stock to fund investment." Overall, our findings suggest that cash savings and lifecycle motives are not mutually exclusive.

For example, under the lifecycle explanation we should observe a disproportionate number of equity issuances at the low end of the cash flow spectrum, and this is exactly what we see in recent years. Table 8 reports the distribution of firm-initiated equity issues for the first ten years and the last ten years of the sample period to compare how the joint distribution of equity

issues and cash flow has changed over time. In the first ten years of the sample, equity issuance frequency is skewed towards high cash flow firms. However, during the most recent period, from 2006-2015, equity issuances are dominated by negative CF firms: the lowest decile of CF accounts for 32% of all equity issues and the lowest two deciles comprise 52% of all equity issues. Consistent with the lifecycle theory, these two deciles have the youngest average age and high average M/B ratios.

These results, coupled with the results on burn rates, reconcile the findings in previous studies. For firms with positive burn rates, which make up the majority of equity issuers in recent years, it is possible to observe both a high savings rate in the year of issuance (as in McLean (2011)), as well as a full depletion of pre-issuance cash (as in DeAngelo, DeAngelo, and Stulz (2010)) during the following year. The issuances are topping up the stockpile on a regular basis, but the firms are burning through the stockpile rapidly. A portion of the stockpile is undoubtedly related to volatility-induced precaution, but the savings from issuance are also driven by near term operating needs.

5.2 Models of Cash Holdings

Nonlinearity in the association between cash holdings and cash flow implies that models of cash holdings that estimate such holdings as a linear function of cash flow are increasingly misspecified. One econometric option to deal with convexity is to add a squared term to the specification. However, it is primarily nonlinearity on the left side of the cash flow distribution that is the focus of this study. For this reason, we employ an indicator for negative values of cash flow, and an interaction term between this indicator and the value of cash flow/assets to

capture the magnitude of the losses. These variables allow for inference of differential effects for negative and positive cash flow firms.

Table 9 reports results from OLS regressions of cash holdings on standard determinants used in the literature (equation 1) plus the new variables we describe above to capture the effects of negative cash flow on cash policy (equation 2). Specifically,

$$\begin{aligned} \frac{Cash}{Assets_{i,j,t}} = & \alpha + \beta_1 \frac{CF}{Assets_{i,t}} + \beta_2 \ln(ME)_{i,t} + \beta_3 \overline{CF Vol}_{j,t} \\ & + \beta_4 I(R\&D Intense)_{i,t} + \beta_5 \frac{M}{B}_{i,t} + \beta_6 \frac{CapEx}{Assets_{i,t}} + \beta_7 \frac{Debt}{Assets_{i,t}} \\ & + \varepsilon_{i,t} \end{aligned} \quad (1)$$

$$\begin{aligned} \frac{Cash}{Assets_{i,j,t}} = & \alpha + \beta_1 \frac{CF}{Assets_{i,t}} + \beta_2 I(CF < 0)_{i,t} + \beta_3 \left[I(CF < 0) * \frac{CF}{Assets} \right]_{i,t} \\ & + \beta_4 \ln(ME)_{i,t} + \beta_5 \overline{CF Vol}_{j,t} + \beta_6 I(R\&D Intense)_{i,t} + \beta_7 \frac{M}{B}_{i,t} \\ & + \beta_8 \frac{CapEx}{Assets_{i,t}} + \beta_9 \frac{Debt}{Assets_{i,t}} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

Both specifications control for factors related to precaution. Specifically, *Size* to capture financing constraints, *Industry Cash Flow Volatility* to capture probability of a negative shock to cash flow, an indicator of *high R&D intensity* and *market-to-book* ratio, both of which are related to growth opportunities. To isolate the effect of precaution related to R&D from the cash flow effect of R&D, we control for the existence of an R&D intensive investment agenda, but not the level of R&D, which is an operating expense.

In column 1 of Table 9, *Cash Flow* carries a large negative coefficient, consistent with several prior studies, but challenging to interpret in light of the nonlinearity between cash flow and cash. Column 2 reveals the importance of including variables that capture operating needs. Both the negative earnings indicator and the interaction term are highly significant determinants of corporate cash holdings. Moreover, after controlling for operating losses, the coefficient on *Cash Flow* reverses and is highly significant in the opposite direction. One implication is that the model with the negative earnings variables should also improve model fit on the right side of the cash flow distribution, where large positive cash flows are otherwise penalized in predictions of cash holdings if cash flow is forced into a linear specification where it carries a negative coefficient.

A common variation of Equation (1) adds fixed effects to capture variation through time and/or across industries. Columns 3 and 4 add year fixed effects to the models and columns 5 and 6 add year and industry fixed effects. Neither fixed effects specification picks up the impact of negative cash flow firms. In both cases, the sign of the coefficient on *Cash Flow* in the linear specification is negative and significant, whereas the specification with indicators for negative cash flow flips the sign on the *Cash Flow* variable, implying that the relation between cash flow and cash holdings depends greatly on the sign of the cash flows.

In Figures 8A and 8B we detail the effects of functional form misspecification on prediction error. Figure 8A compares average prediction error within each decile in the full sample panel regressions. The comparison is between the standard model and the model that captures nonlinearity by adding the negative indicator and interaction term as in (2). The improvement is most evident in the tails of the distribution, which is not surprising due to the convex relation. Overall, improvement is noted in seven of the ten deciles. These results are

consistent with the finding in Table 9 that the linear specification does not do a good job of characterizing the relation between cash and cash flow.

Figure 8B compares three prediction models designed to account for time varying changes in cash holdings. The first is the standard model with year fixed effects added, the second adds both year and industry fixed effects. The third is the nonlinear model estimated in annual cross-sections for each year of the sample to allow the coefficients to vary through time, similar to the technique used in Harford et al. (2009) to predict leverage targets.

Both fixed effects models create larger prediction errors in most deciles, again particularly in the tails. In the case of year fixed effects, the annual cross sections perform better in 8 of the 10 deciles, and when compared to the model with year and industry fixed effects the annual cross sections perform better in every decile. The reason is intuitive: the lion's share of the increase in cash holdings has occurred in the tails of cash flow, but year fixed effects impact the predicted value uniformly across the distribution. Overall, the results support the use of the indicator and interaction terms and suggest caution in estimating fixed effects models in which movement in the dependent variable is driven in part by an unspecified nonlinear component of one of the explanatory variables.

Finally, in Table 10, we use the augmented cash holdings model to provide a 'back of the envelope' estimate of the relative contribution of cash flow levels versus cash flow volatility to predicted cash holdings for negative cash flow firms. The first two columns report coefficients from estimating Equation (2) over five-year subperiods at the beginning (1970-1974) and end (2011-2015) of the sample period: The third and fourth columns report the subperiod median values of each variable for firms that report negative operating cash flow. The predicted

contribution to cash holdings, reported in the final two columns, is the product of the coefficients and median observed values.

The effect of cash flow levels on predicted cash holdings is revealed by the cash flow variables. In this example, the level variables contribute over twice as much to the increase in predicted cash as the volatility variable. Thirty percent the increase in predicted cash/assets is attributable to cash flow levels, while 13% of the increase is attributable to cash flow volatility.

5.3. Cash Flow Sensitivity of Cash

Our findings speak primarily to cash *levels*, but a related facet of corporate policy is how cash *changes* with cash flow. Almeida, et al. (2004) measure the cash flow sensitivity of cash holdings using a sample of manufacturing firms over 1971-2000. They find that cash is sensitive to cash flow for financially constrained firms, but not for financially unconstrained firms. Such findings are consistent with constrained firms saving cash out of cash flow in high cash flow states and drawing down cash holdings when cash flow is negative.⁷

Our evidence implies, however, that in recent years, an increasing proportion of firms exhibit negative cash flows and *increase* their cash holdings by stockpiling a portion of the funds raised through equity issues. Such behavior will attenuate the positive cash flow sensitivity of cash documented in earlier periods and failing to control for the different sensitivity of negative cash flow firms could have a material impact on measured cash-cash flow sensitivities.⁸

To investigate this possibility, Table 11 reports the results of tests in which we estimate the cash flow sensitivity of cash over the first ten years of our sample period (1970-1979) and the

⁷ Also consistent with this view, Opler et al. (1999) find that operating losses are the primary explanation for large *decreases* in excess cash for their sample firm over the period 1971-1994.

⁸ This possibility is recognized by Almeida et al. (2004) and they show that the sensitivity they document is robust to exclusion of negative cash flow firms.

last ten years of the sample period (2006-2015). In columns (1) and (3), we constrain the cash flow sensitivity of cash to be the same for firms with positive and negative cash flow, while in Columns (2) and (4) we allow the sensitivity to differ. During the 1970-1979 subperiod, negative cash flow firms are less common (Figure 1). Not surprisingly, therefore, we find in Column (2) that allowing sensitivities to differ for negative earnings firms has only a modest impact on the estimated cash-cash flow sensitivities of positive cash flow firms. In other words, pooling positive and negative cash flow firms has little impact on inferences.

By contrast, Column 4 reveals that sensitivities for positive cash flow firms are substantially higher once cash flow sensitivities are allowed to differ for positive and negative cash flow firms in the 2006-2015 subperiod. The reason for this is clear. Negative cash flow firms account for an increased proportion of the sample and these firms do not exhibit the same positive sensitivity of cash to cash flow.

6. Conclusion

The population of U.S. firms is increasingly comprised of firms with persistent, large negative cash flows. Such characteristics create ongoing liquidity needs that are directly tied to current and near-term operations. Correspondingly, we find that cash balances have increased much more substantially in recent decades for these firms than for the rest of the population. Perhaps most strikingly, we find that over the past four decades, average cash holdings have risen by over 615% for firms with negative cash flow, as compared with 95% for firms with positive cash flow. Our evidence thus supports the view that the recent growth in cash balances among U.S. firms is not solely a reflection of increased precautionary demands due to cash flow volatility, increased disincentives to repatriate foreign earnings, or increased agency problems.

Rather, for an increasing proportion of firms, higher cash balances reflect near-term operational needs under an expectation of negative cash flows.

Additionally, we find that equity issuance activity is increasingly dominated by firms with negative cash flows. Although firms are saving a substantial proportion of equity issuance proceeds in cash, they are also burning cash at an unprecedented rate. As a result, there is virtually no time trend in estimates of cash runway over the last 25 years. Our findings on equity issuance raise additional questions that we are currently pursuing. First, given potentially large fixed costs of issuing equity, why do negative cash flow firms issue as often as they do? An alternative approach would be for firms to issue less frequently and stockpile the proceeds. The fact that they do not follow such a policy suggests either a supply-driven public market staging of finance of the type studied in Hertz et al. (2012) or the possibility that these firms are issuing equity in a more low-cost manner. These and other questions await further analysis.

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Appendix A: Variable Descriptions

Cash Holdings	CHE/AT
EBITDA	EBITDA/AT
EBITDARD	[EBITDA+XRD]/AT. XRD is coded to 0 if missing.
Operating Cash Flow	OANCF. If missing, replaced by NI+DPC+TXDC+ESUBC+SPPIV+FOPO+FSRCO+WCAPC+APALCH+INVCH+RECCH
I(CF<0)	Indicator that takes a value of 1 when Cash Flow<0, and 0 otherwise
Cash Flow x I(CF<0)	Interaction that takes the value of Cash Flow when Cash Flow<0, and 0 otherwise
Size	Natural Log of AT
Industry CF Vol	Standard deviation of cash flows is measured for each firm over up to 10 years (minimum 3). Values are averaged based on Fama French 48 industries annually.
I(R&D Intense)	Indicator that takes a value of 1 when [XRD/AT]>0.02, and 0 otherwise
M/B	(AT+MKTVAL-SEQ)/AT. MKTVAL is replaced by CSHO*PRCC_C if missing.
Capital Expenditures	CAPX. Coded to 0 if missing.
Leverage	[DLTT+DLC]/AT
Firm-initiated	
Equity Issuance	SSTK when [SSTK/MKTVAL]>0.03
Employee-initiated	
Equity Issuance	SSTK when [SSTK/MKTVAL]<0.02
Net Equity Issuance	SSTK-PRSTK
Net Debt Issuance	[DLTT+DLC] _t -[DLTT+DLC] _{t-1}
Burn Rate	-[Operating Cash Flow-DVC-CAPX]. Divided by 12 for monthly burn rate.
Runway	CHE/Monthly Burn Rate

All variable mnemonics are from Compustat, Industrial Annual File
All ratios are winsorized at the 1st and 99th percentiles.

Table 1
Evolution of cash flow by decile

This table reports mean values of CF/assets for deciles formed annually. The full sample is 227,745 firm year observations over the period 1970-2015. Values are averaged over all firm year observations within the decile during the specified subperiod.

CF decile	1970-79	1980-89	1990-99	2000-15
1	(0.09)	(0.25)	(0.38)	(0.55)
2	0.04	(0.02)	(0.10)	(0.14)
3	0.08	0.04	(0.02)	(0.03)
4	0.10	0.08	0.02	0.02
5	0.12	0.11	0.04	0.05
6	0.14	0.13	0.07	0.07
7	0.16	0.16	0.09	0.10
8	0.19	0.20	0.12	0.12
9	0.23	0.25	0.16	0.16
10	0.35	0.43	0.24	0.25

Table 2
Summary statistics for negative cash flow firms

This table reports mean (*median*) values for firms with negative cash flow. All variables are defined in the appendix. The full sample is 227,745 firm year observations over the period 1970-2015.

	1970's	1980's	1990's	2000's
N	2,847	8,247	15,819	19,352
Firm Age	6.5	7.7	7.7	11.0
	6	5	5	8
Total Assets (2015\$)	430	274	247	462
	109	33	42	54
Mkt Cap (2015\$)	103	118	290	359
	32	25	55	69
M/B	1.16	1.86	2.73	2.70
	0.92	1.23	1.73	1.70
Book Leverage	0.386	0.348	0.248	0.224
	0.382	0.328	0.180	0.095
Mkt Leverage	0.387	0.273	0.170	0.139
	0.403	0.246	0.093	0.047
R&D/TA	0.015	0.041	0.092	0.146
	0.000	0.000	0.007	0.061
Revenue Growth	-1.7%	15.9%	35.1%	29.4%
	-3.8%	-1.3%	10.4%	3.0%
Employee Growth	-5.7%	0.7%	18.9%	7.7%
	-6.7%	-4.6%	5.3%	0.0%

Table 3**Evolution of average cash holdings by cash flow decile**

This table reports mean values of cash/assets for cash flow deciles formed annually. The full sample is 227,745 firm year observations over the period 1970-2015. Values are averaged over all firm year observations within each decile each year.

	Deciles		
	1	2	3-10
1970	0.065	0.062	0.084
1971	0.068	0.072	0.093
1972	0.070	0.067	0.093
1973	0.065	0.064	0.083
1974	0.054	0.061	0.075
1975	0.061	0.059	0.095
1976	0.061	0.065	0.100
1977	0.061	0.062	0.093
1978	0.056	0.055	0.089
1979	0.057	0.062	0.082
1980	0.061	0.059	0.099
1981	0.065	0.061	0.111
1982	0.081	0.077	0.114
1983	0.085	0.108	0.149
1984	0.138	0.124	0.116
1985	0.146	0.110	0.123
1986	0.148	0.155	0.135
1987	0.189	0.134	0.130
1988	0.174	0.101	0.122
1989	0.180	0.104	0.122
1990	0.211	0.110	0.116
1991	0.272	0.148	0.130
1992	0.322	0.156	0.134
1993	0.384	0.192	0.139
1994	0.343	0.155	0.129
1995	0.343	0.186	0.142
1996	0.415	0.278	0.151
1997	0.404	0.244	0.153
1998	0.385	0.236	0.140
1999	0.430	0.321	0.152
2000	0.420	0.345	0.161
2001	0.449	0.347	0.161
2002	0.446	0.337	0.165
2003	0.499	0.299	0.184
2004	0.517	0.327	0.194
2005	0.517	0.307	0.194
2006	0.522	0.323	0.191
2007	0.554	0.312	0.191
2008	0.499	0.272	0.174
2009	0.489	0.274	0.190
2010	0.551	0.254	0.191
2011	0.558	0.255	0.177
2012	0.546	0.270	0.172
2013	0.573	0.369	0.177
2014	0.610	0.436	0.175
2015	0.637	0.479	0.169
Growth: 1970 to 2015	878%	676%	101%

Table 4
Cash Flow and R&D

Panel A reports the joint distribution of cash flow and R&D deciles over the sample period. The full sample is 227,745 firm year observations over the period 1970-2015. Panel B reports average cash holdings by cash flow decile for the top two deciles of R&D.

Panel A: Joint Distribution of Cash Flow and R&D Deciles

	Lowest CF										Highest CF
	1	2	3	4	5	6	7	8	9	10	
<i>R&D</i>	1	0.5%	0.8%	1.1%	1.2%	1.3%	1.3%	1.1%	1.1%	0.9%	0.7%
	2	0.4%	0.8%	0.9%	1.1%	1.3%	1.3%	1.3%	1.2%	1.0%	0.7%
	3	0.5%	0.8%	0.9%	1.0%	1.1%	1.3%	1.3%	1.3%	1.1%	0.8%
	4	0.6%	0.9%	1.0%	1.0%	1.0%	1.2%	1.2%	1.2%	1.0%	0.9%
	5	0.7%	0.9%	1.0%	1.0%	0.9%	1.1%	1.1%	1.1%	1.1%	1.0%
	6	0.8%	1.1%	1.1%	0.9%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%
	7	1.0%	1.2%	1.0%	0.9%	0.9%	0.9%	1.0%	0.9%	1.1%	1.2%
	8	1.3%	1.5%	1.0%	0.8%	0.8%	0.8%	0.8%	0.9%	1.0%	1.1%
	9	2.6%	1.6%	0.9%	0.6%	0.6%	0.6%	0.6%	0.6%	0.8%	1.1%
	10	5.5%	1.0%	0.5%	0.3%	0.3%	0.3%	0.3%	0.4%	0.5%	0.8%

Panel B: Average Cash Holdings for High R&D Firms

	1970-1979	2006-2015	Growth	
<i>Cash Flow</i>	1	0.06	0.59	828%
	2	0.07	0.29	344%
	3	0.07	0.18	164%
	4	0.07	0.13	88%
	5	0.07	0.12	62%
	6	0.08	0.11	34%
	7	0.09	0.12	39%
	8	0.10	0.13	28%
	9	0.11	0.15	33%
	10	0.14	0.22	52%

Table 5**Proceeds from the Sale of Debt, Equity and PPE**

This table reports the average annual proceeds from equity issuance, debt issuance, and the sale of fixed assets, scaled by total assets, for firms in each cash flow decile. The full sample is 227,745 firm year observations over the period 1970-2015. The first ten years and last ten years of the sample are reported for comparison.

	1970-79			2006-15			
	Net Equity	Net Debt	Sale of PPE	Net Equity	Net Debt	Sale of PPE	
	/Assets	/Assets	/Assets	/Assets	/Assets	/Assets	
	1	0.004	0.011	0.015	0.371	0.023	0.002
	2	0.001	0.024	0.011	0.137	0.023	0.003
	3	0.003	0.024	0.009	0.054	0.024	0.003
	4	0.002	0.023	0.009	0.025	0.027	0.003
<i>Cash Flow</i>	5	0.003	0.026	0.009	0.011	0.022	0.003
<i>Decile</i>	6	0.004	0.023	0.009	0.007	0.015	0.003
	7	0.006	0.020	0.009	0.000	0.011	0.003
	8	0.008	0.020	0.009	(0.005)	0.006	0.004
	9	0.012	0.023	0.009	(0.015)	0.001	0.004
	10	0.036	0.013	0.011	(0.026)	(0.014)	0.004

Table 6
Equity Issuance Frequency

This table reports the average number of firm-initiated equity issuances per firm per year, compiled from quarterly data. Quarterly issuance data is available over the period 1985-2015.

	1985-1989	1990-1999	2000-2009	2010-2015	
	1	0.35	0.74	0.70	0.89
	2	0.25	0.48	0.38	0.54
	3	0.22	0.33	0.23	0.24
	4	0.20	0.27	0.18	0.15
<i>Cash Flow</i>	5	0.19	0.23	0.14	0.12
<i>Decile</i>	6	0.18	0.18	0.12	0.12
	7	0.16	0.15	0.10	0.08
	8	0.18	0.13	0.09	0.07
	9	0.23	0.12	0.08	0.06
	10	0.30	0.13	0.08	0.06

Table 7

Annual Burn Rate for Equity Issuers

This table reports the percentage of assets depleted annually by equity issuers with positive burn rates. Burn rate is defined as

$[-\text{Operating Cash Flow} + \text{dividends} + \text{capital expenditures}]$. The full sample is 227,745 firm year observations over the period 1970-2015.

Period	% burned
1971-75	8.2%
1976-80	7.7%
1981-85	13.1%
1986-90	12.5%
1991-95	13.5%
1996-2000	18.8%
2001-05	21.5%
2006-10	23.2%
2011-15	25.9%

Table 8**Distribution and Characteristics of Firm-initiated Equity Issues by Cash Flow decile**

This table reports the distribution of equity issuers by cash flow decile over the period 1971-1980 and 2006-2015. Mean market-to-book asset ratios and mean firm age is reported for the period 2006-15.

Year	N	Lowest CF								Highest CF	
		1	2	3	4	5	6	7	8	9	10
1971-1980 Eq Iss Distribution	3,428	9%	7%	8%	9%	9%	8%	9%	10%	11%	21%
Cumulative		9%	16%	24%	32%	41%	49%	58%	68%	79%	100%
2006-2015 Eq Iss Distribution	6,864	32%	20%	11%	8%	6%	5%	5%	4%	4%	4%
Cumulative		32%	52%	63%	72%	78%	83%	88%	92%	96%	100%
Mean M/B		3.84	2.32	1.69	1.48	1.48	1.56	1.68	1.87	2.21	3.03
Mean Age		11.5	14.4	17.4	21.1	22.6	23.7	24.2	24.0	22.8	18.8

Table 9
Determinants of cash holdings

This table reports results from OLS regressions of cash holdings (cash/assets) on various determinants. The full sample is 227,745 firm year observations over the period 1970-2015. Columns 1, 3, and 5 use a linear specification for cash flow while columns 2, 4, and 6 allow for non-linearity when earnings are negative by adding an indicator of negative earnings and an interaction that takes the value of CF/assets when it is negative and zero otherwise. Variables are defined in the appendix. Standard errors are clustered by firm and year. *, **, and *** indicate significance at the 10%, 5% and 1% levels respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Cash Flow	-0.134 *** (<i><0.001</i>)	0.117 *** (<i><0.001</i>)	-0.131 *** (<i><0.001</i>)	0.132 *** (<i><0.001</i>)	-0.116 *** (<i><0.001</i>)	0.122 *** (<i><0.001</i>)
I(CF<0)		0.040 *** (<i><0.001</i>)		0.039 *** (<i><0.001</i>)		0.036 *** (<i><0.001</i>)
CF x I(CF<0)		-0.331 *** (<i><0.001</i>)		-0.343 *** (<i><0.001</i>)		-0.311 *** (<i><0.001</i>)
Size	-0.007 *** (<i><0.001</i>)	-0.004 *** (<i><0.001</i>)	-0.007 *** (<i><0.001</i>)	-0.005 *** (<i><0.001</i>)	-0.008 *** (<i><0.001</i>)	-0.006 *** (<i><0.001</i>)
Industry CF Vol	0.545 *** (<i><0.001</i>)	0.529 *** (<i><0.001</i>)	0.553 *** (<i><0.001</i>)	0.516 *** (<i><0.001</i>)	0.224 *** (<i><0.001</i>)	0.208 *** (<i><0.001</i>)
I(R&D Intense)	0.070 *** (<i><0.001</i>)	0.065 *** (<i><0.001</i>)	0.068 *** (<i><0.001</i>)	0.064 *** (<i><0.001</i>)	0.064 *** (<i><0.001</i>)	0.061 *** (<i><0.001</i>)
M/B	0.031 *** (<i><0.001</i>)	0.027 *** (<i><0.001</i>)	0.031 *** (<i><0.001</i>)	0.027 *** (<i><0.001</i>)	0.028 *** (<i><0.001</i>)	0.024 *** (<i><0.001</i>)
Cap Ex	-0.201 *** (<i><0.001</i>)	-0.244 *** (<i><0.001</i>)	-0.197 *** (<i><0.001</i>)	-0.233 *** (<i><0.001</i>)	-0.231 *** (<i><0.001</i>)	-0.264 *** (<i><0.001</i>)
Leverage	-0.270 *** (<i><0.001</i>)	-0.263 *** (<i><0.001</i>)	-0.272 *** (<i><0.001</i>)	-0.264 *** (<i><0.001</i>)	-0.274 *** (<i><0.001</i>)	-0.267 *** (<i><0.001</i>)
Constant	0.154 *** (<i><0.001</i>)	0.116 *** (<i><0.001</i>)	0.156 *** (<i><0.001</i>)	0.121 *** (<i><0.001</i>)	0.167 *** (<i><0.001</i>)	0.149 *** (<i><0.001</i>)
Fixed Effects	<i>None</i>	<i>None</i>	<i>Year</i>	<i>Year</i>	<i>Year, Industry</i>	<i>Year, Industry</i>
N	175,407	175,407	175,407	175,407	175,407	175,407
R2	0.408	0.421	0.412	0.425	0.443	0.453

Table 10**Numerical example: What drives growth in cash holdings in low cash flow firms?**

This table reports predicted cash holdings for the median firm characteristics from the lowest decile of CF/assets during the periods (i) 1970-74 and (ii) 2011-2015 using coefficients from OLS regressions of cash holdings (cash/assets) on various determinants defined in the appendix. The full sample is 227,745 firm year observations over the period 1970-2015. Predicted cash is the product of the coefficients and median values for each respective subperiod.

	Coefficients		Median Values		Predicted Cash		Increase	%
	1970-1974	2011-2015	CF<0	CF<0	(1)	(2)		
	1970-1974	2011-2015	1970-1974	2011-2015				
Cash Flow	0.118	0.322	-0.061	-0.159	(0.007)	(0.051)		
I(CF<0)	0.013	0.084	1	1	0.013	0.084		
Cash Flow x I(CF<0)	-0.160	-0.386	-0.061	-0.159	0.010	0.062		
Industry CF Vol	0.295	0.274	0.029	0.157	0.009	0.043		
Size	-0.004	-0.001	2.153	4.340	(0.009)	(0.006)		
R&D	-0.363	0.640	0.000	0.080	-	0.051		
M/B	0.023	0.022	0.926	1.900	0.021	0.042		
Cap Ex	-0.078	-0.457	0.042	0.014	(0.003)	(0.006)		
Leverage	-0.142	-0.243	0.397	0.085	(0.056)	(0.021)		
Constant	0.088	0.130			0.088	0.130		
Predicted cash					0.064	0.327	0.263	
Contribution from level of cash flow					0.015	0.094	0.079	30%
Contribution from cash flow volatility					0.009	0.043	0.034	13%

Table 11
Cash Flow Sensitivity of Cash

This table reports results from OLS regressions estimated over the 1st 10 years and last 10 years of the sample (1970-79 and 2006-2015). Columns 1 and 3 report change in cash/assets regressed on cash flow and a constant. Columns 2 and 4 allow for non-linearity when cash flow are negative by adding an indicator of negative earnings and an interaction that takes the value of CF/assets when it is negative and zero otherwise. Columns 5 and 6 constrain the sample to the lowest three deciles of size (constrained firms) and estimate the model separately for positive and negative cash flow firms. Variables are defined in the appendix. Standard errors are clustered by firm and year. *, **, and *** indicate significance at the 10%, 5% and 1% levels respectively.

	1970-79		2006-2015			
	1 All	2 All	3 All	4 All	5 Size Dec<=3 CF<0	6 Size Dec<=3 CF>0
Cash Flow	0.085 *** <i>0.000</i>	0.124 *** <i>0.000</i>	0.082 *** <i>0.000</i>	0.186 *** <i>0.000</i>	0.056 *** <i>0.000</i>	0.278 *** <i>0.000</i>
I(CF<0)		0.005 *** <i>(0.002)</i>		-0.004 <i>(0.122)</i>		
CF x I(CF<0)		-0.140 *** <i>0.000</i>		-0.147 *** <i>0.000</i>		
M/B	-0.004 *** <i>(0.010)</i>	-0.005 *** <i>(0.003)</i>	0.001 <i>(0.140)</i>	-0.001 <i>(0.334)</i>	0.004 *** <i>(0.001)</i>	-0.001 <i>(0.487)</i>
ln(Assets)	0.000 <i>(0.554)</i>	0.001 <i>(0.144)</i>	-0.002 *** <i>0.000</i>	-0.002 *** <i>0.000</i>	0.004 ** <i>(0.020)</i>	(0.008) *** <i>0.000</i>
Constant	-0.01 ** <i>(0.041)</i>	-0.019 *** <i>0.000</i>	0.002 <i>(0.731)</i>	-0.004 <i>(0.399)</i>	-0.035 *** <i>0.000</i>	0.013 <i>(0.108)</i>
N	26,870	26,870	32,729	32,729	5,195	4,060
R2	0.038	0.049	0.029	0.037	0.017	0.071

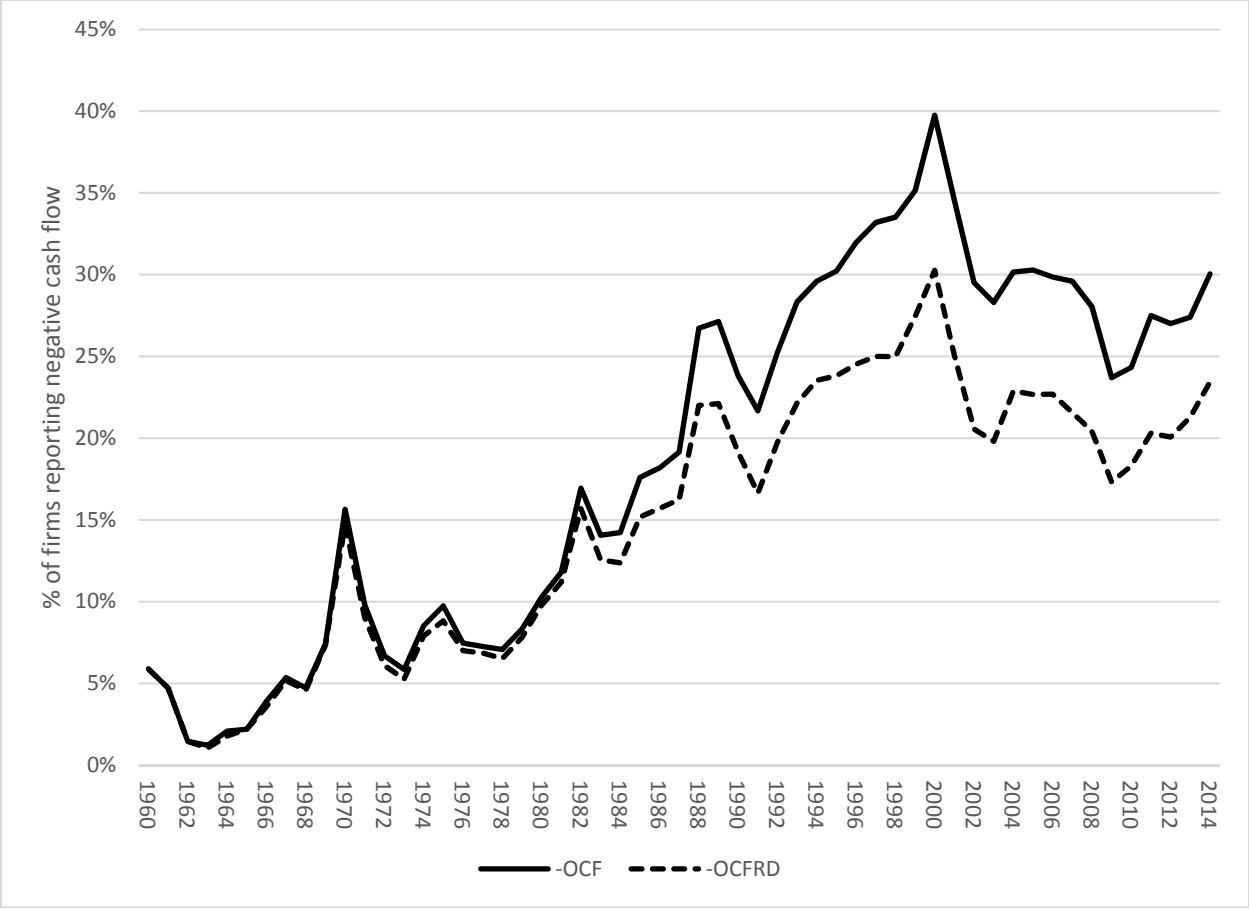


Figure 1. Prevalence of Negative Cash Flow. This chart reports the percentage of Compustat listed firms that report negative operating cash flow. -OCF is negative operating cash flow, -OCFRD is negative operating cash flow after adding back R&D expense. Detailed variable descriptions are available in the appendix.

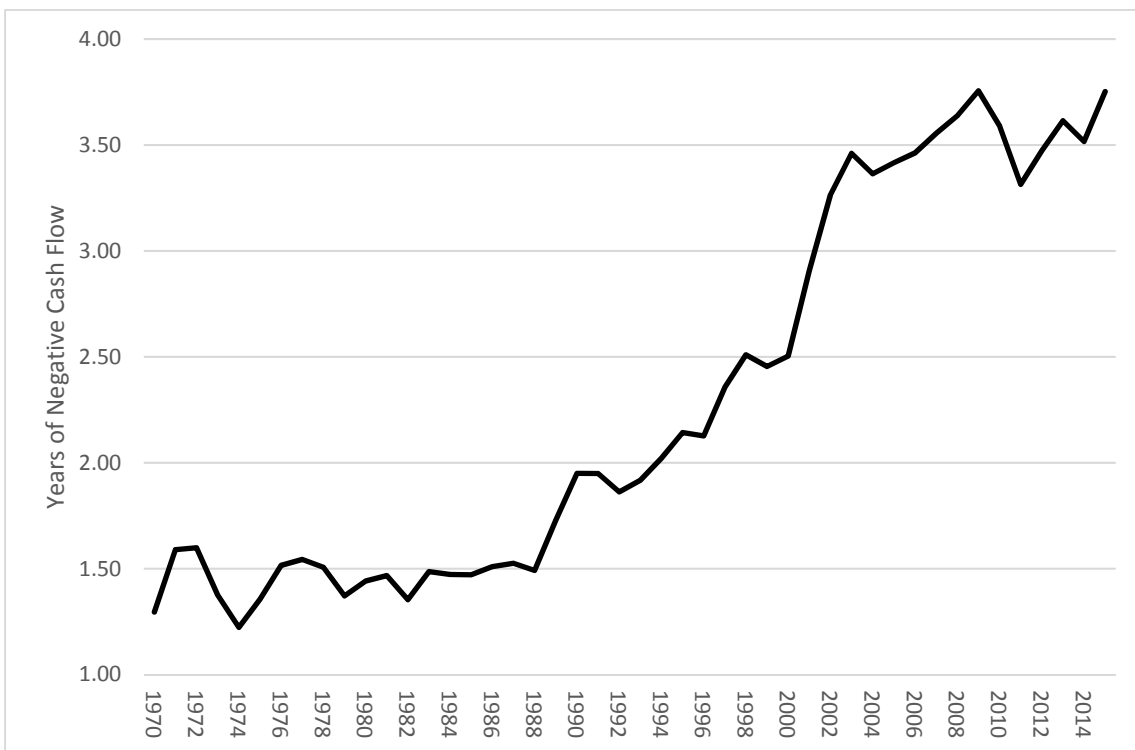
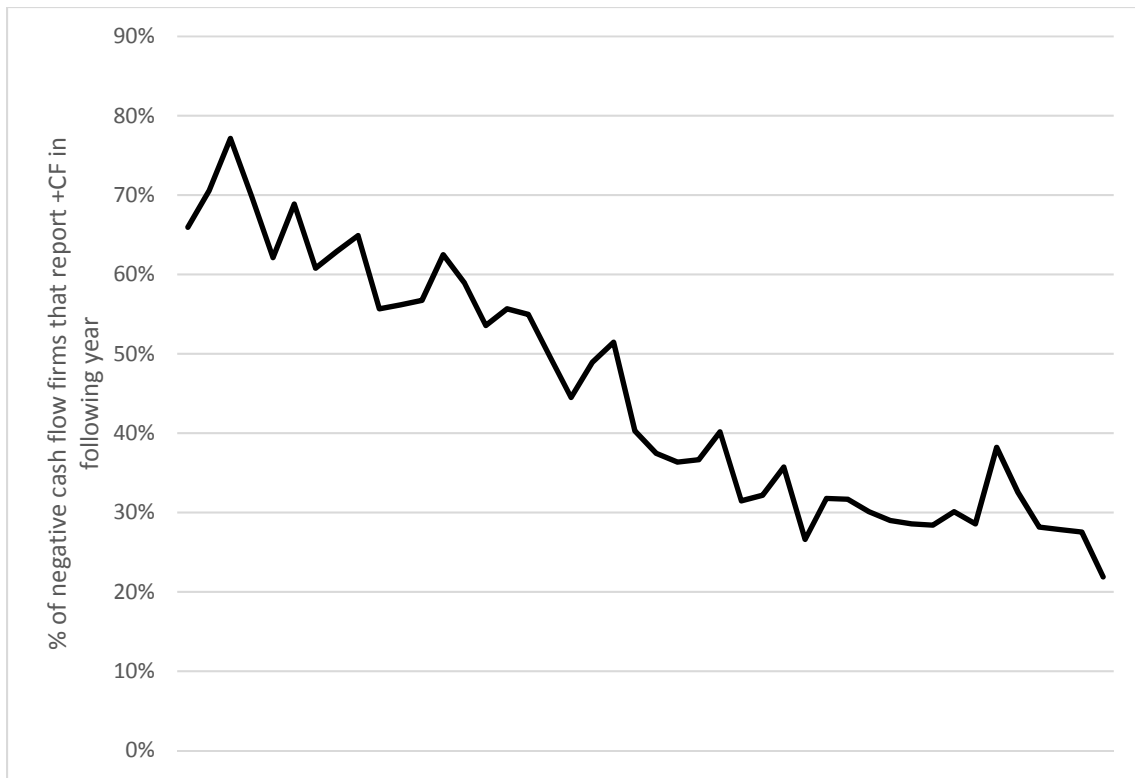


Figure 2. Persistence of Negative Cash Flow. Panel A: Proportion of Negative cash flow firms that report positive cash flow in the following year. Panel B: Average number of consecutive years of negative cash flow for firms that report negative cash flow.

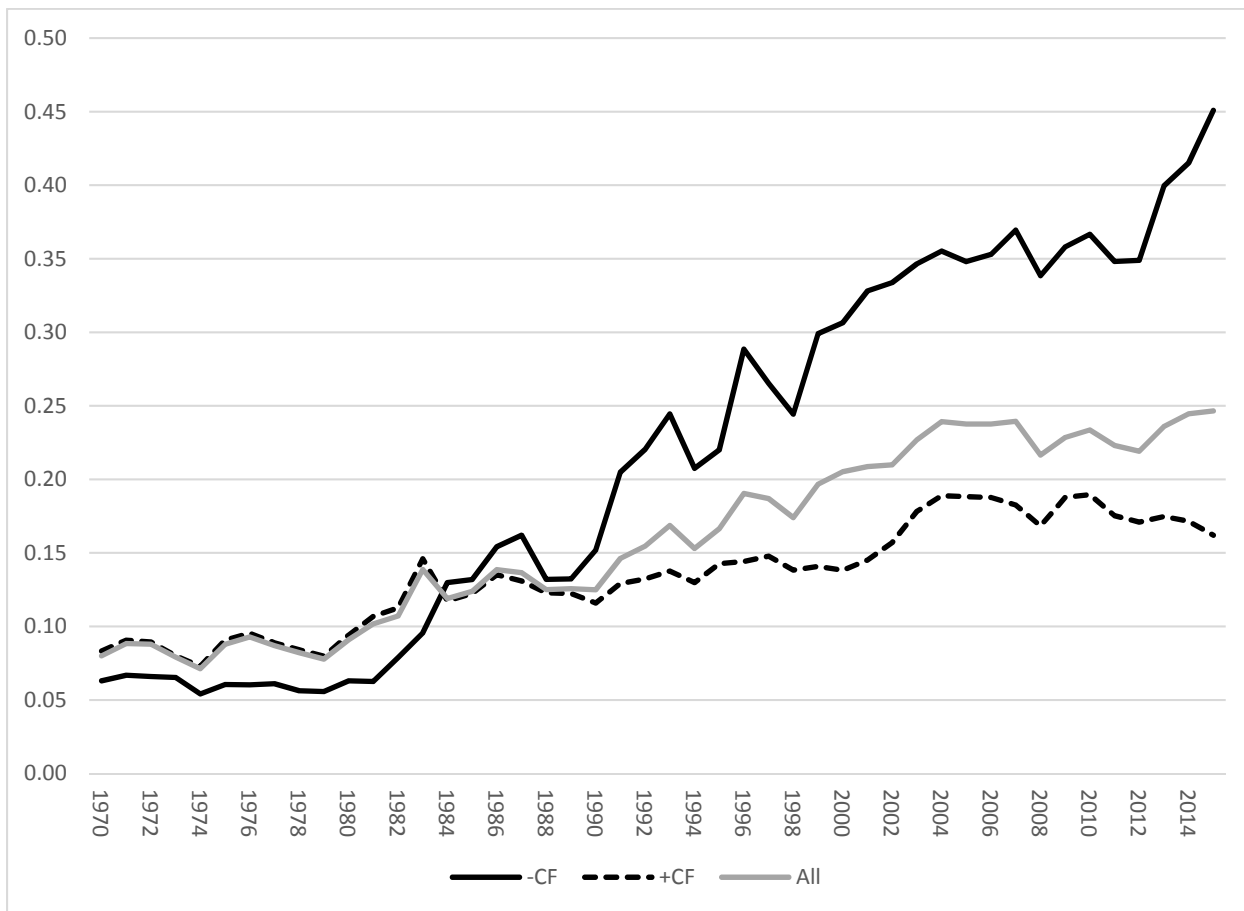


Figure 3. Evolution of Cash Holdings. This chart reports mean values of cash/total assets annually over 1970-2015 for the full sample (gray line) as well as two subsamples: positive cash flow firms (dotted line) and negative cash flow firms (solid black line).

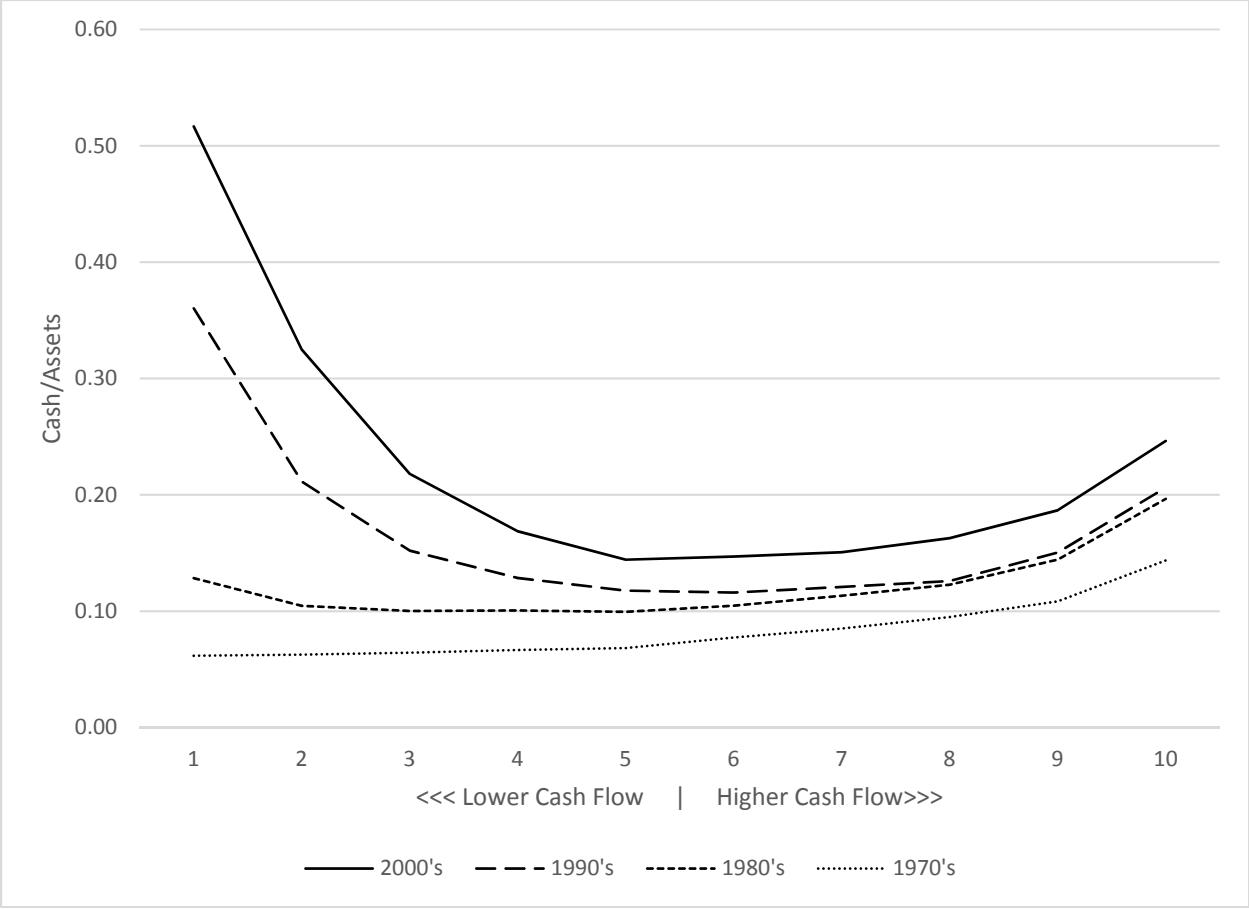


Figure 4. Convexity in the Relation Between Cash Holdings and Cash Flow Deciles. This chart reports mean values of cash/total assets for each decile of operating cash flow during four subperiods: (i) 1970-79, (ii) 1980-89, (iii) 1990-99, and (iv) 2000-2015.

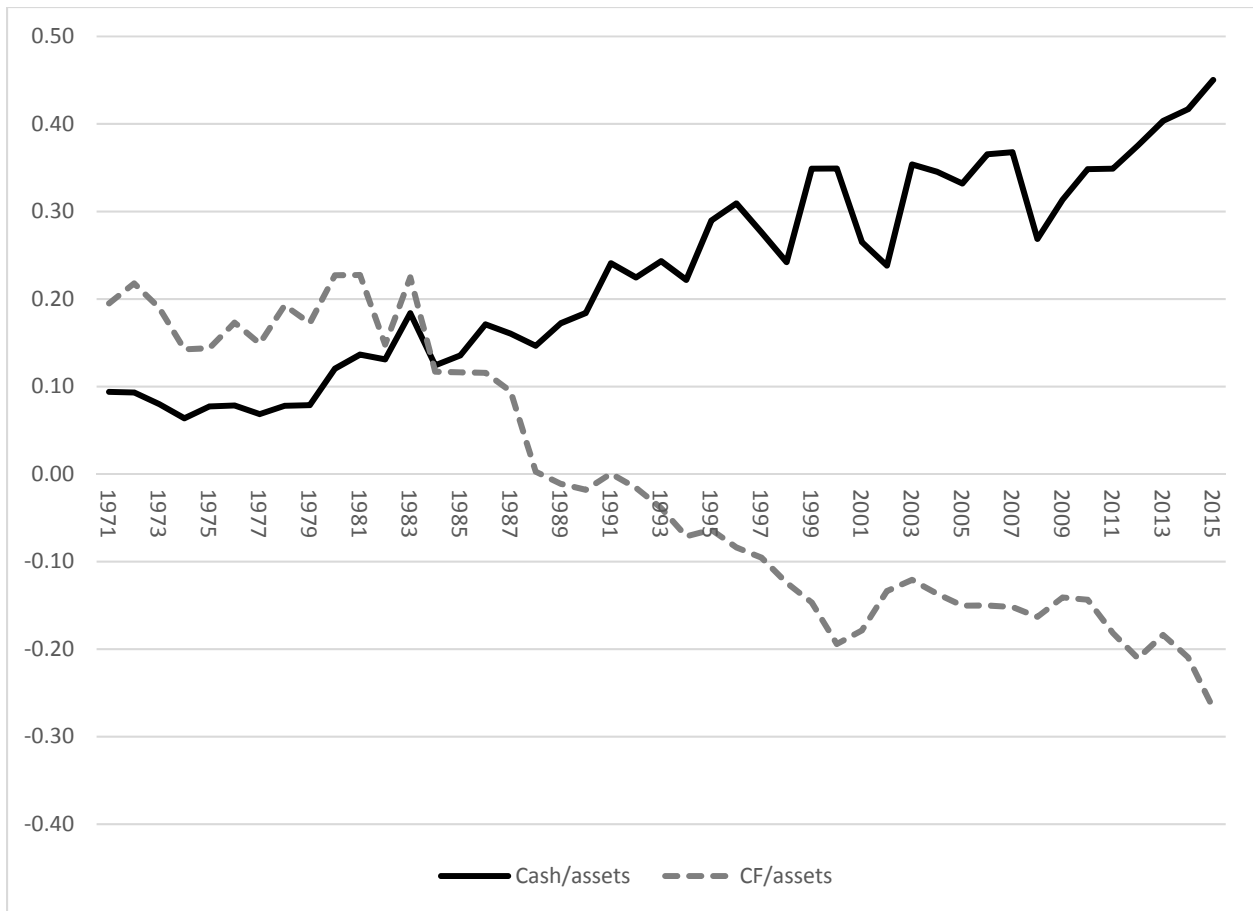


Figure 5. Equity Issuer Characteristics. This chart reports mean values of cash holdings and operating cash flow for all firms that initiate an equity issuance in a given year.

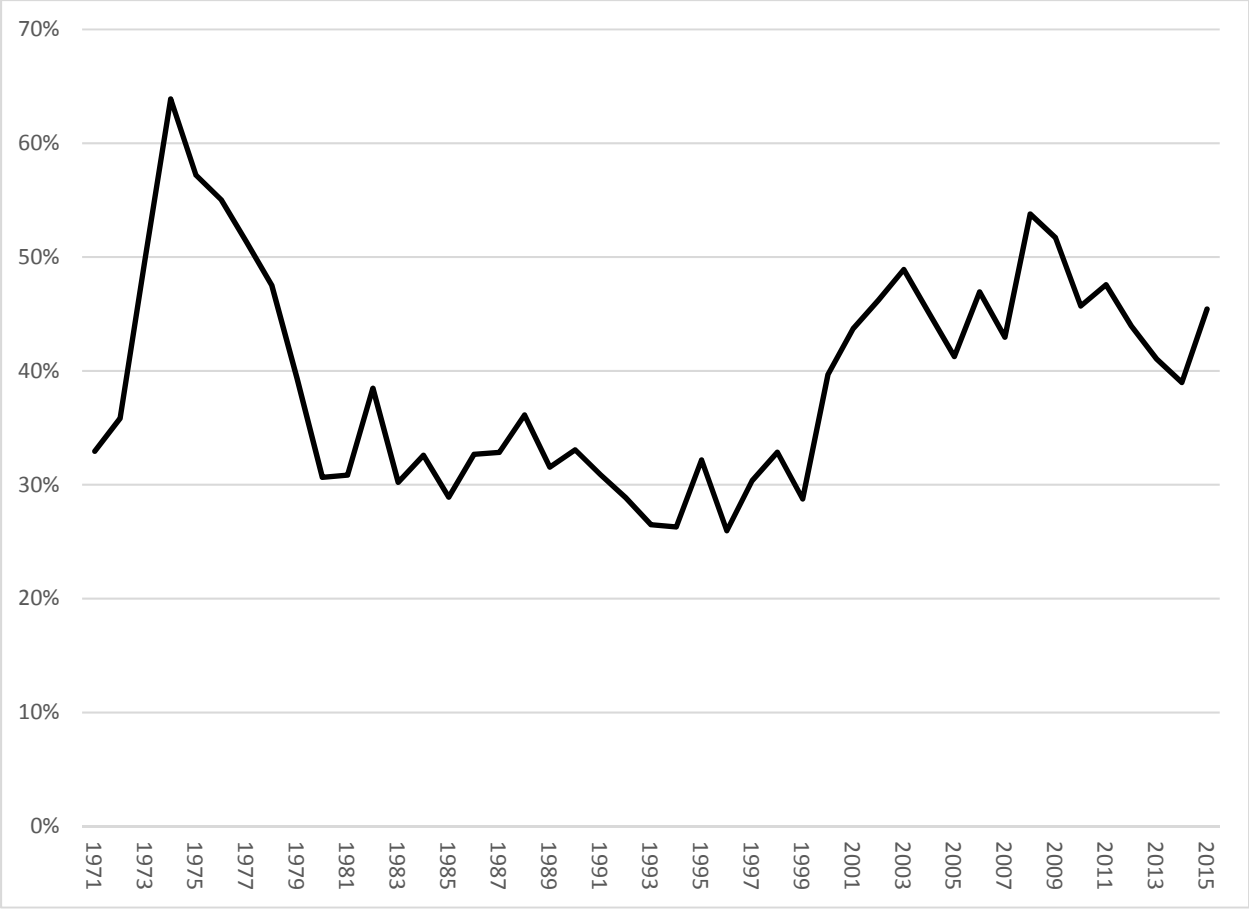


Figure 6. Cash Minus Issuance. This chart reports the proportion of equity issuers that held all proceeds in cash at the end of the year during which the issuance occurs.

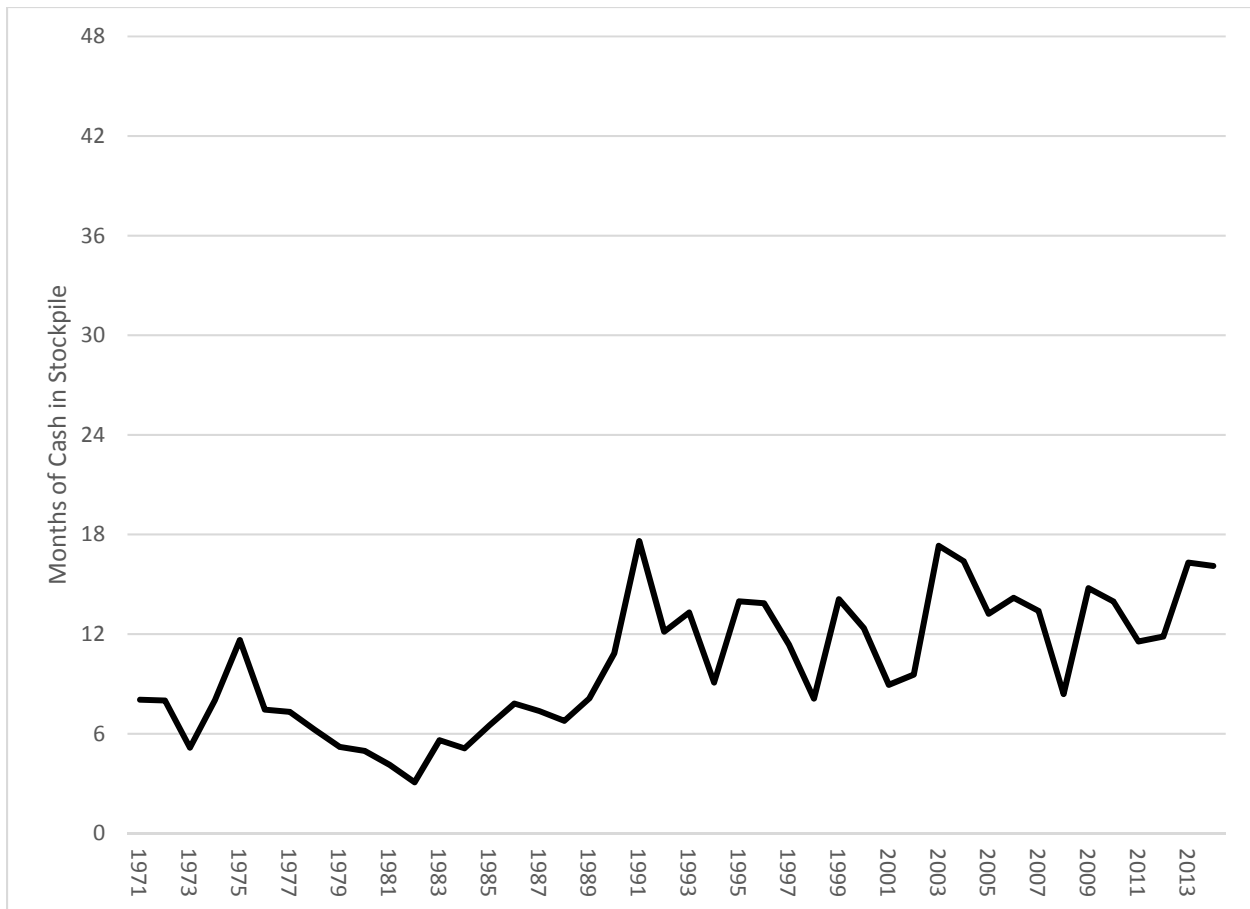


Figure 7. Median Runway for Equity Issuers with Negative Cash Flow. This chart reports the mean number of months of continued operations that could be sustained given current cash holdings. The sample includes all firms that both initiate an equity issuance and report negative cash flow in a given year.

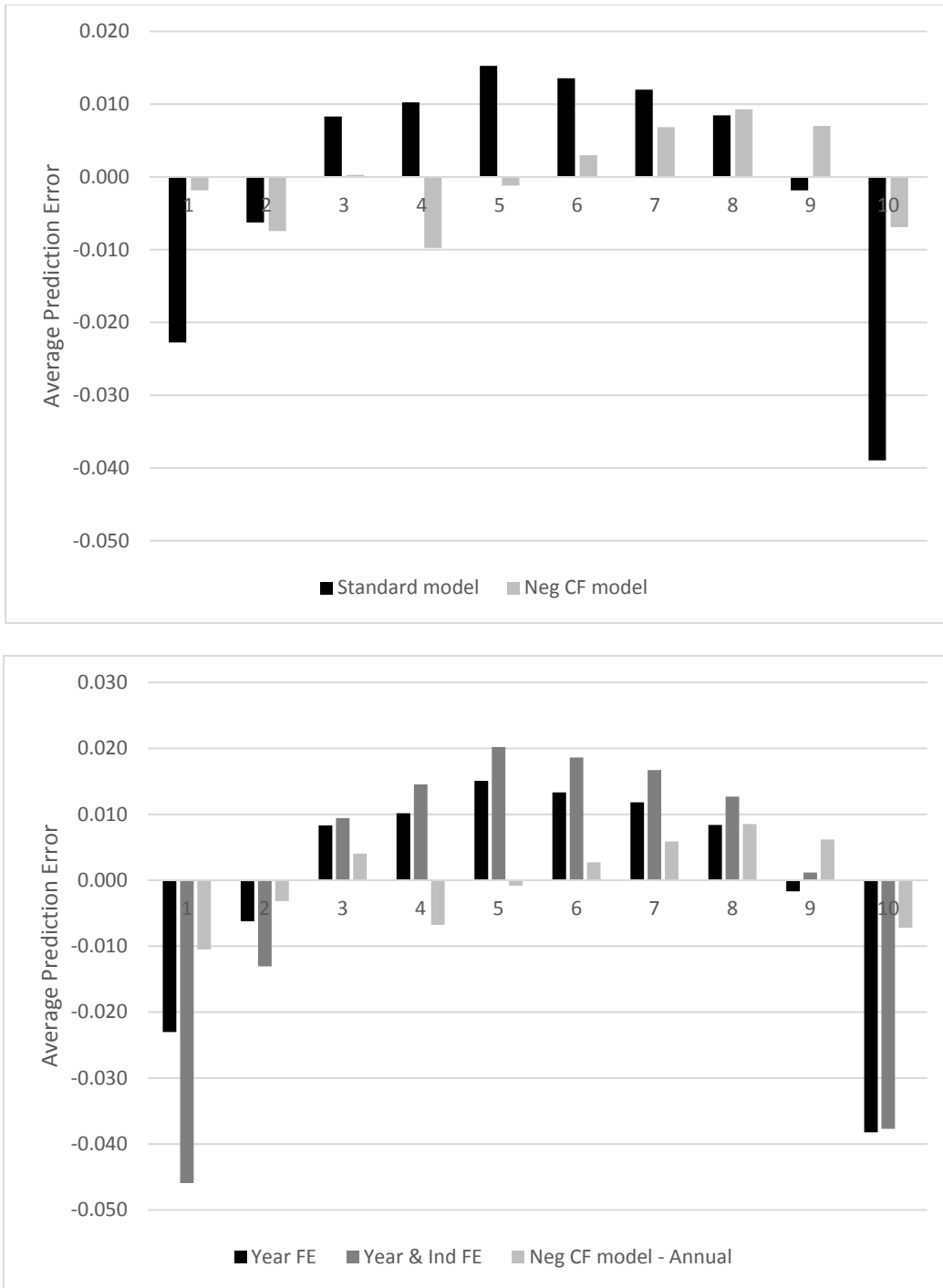


Figure 8. Prediction Error in Models of Cash Holdings. Panel A reports average prediction error from a standard model of cash/assets including cash flow, size, leverage, R&D intensity, industry cash flow volatility, capital expenditures and market-to-book ratio. The second series in panel A adds an indicator variable for negative cash flow and an interaction between negative cash flow and level of cash flow. Panel B reports prediction error from estimates using (i) the standard model with year fixed effects, (ii) year and industry fixed effects, and (iii) the negative earnings model from panel A estimated on annual cross sections. Both panels report average error sorted by cash flow decile where 1 is the lowest level of cash flow and 10 is the highest.