# The Evolution of Corporate Cash*

John R. Graham

Fuqua School of Business, Duke University and NBER

Mark T. Leary

Olin School of Business, Washington University and NBER

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**Abstract**

We study how corporate cash holdings evolved from 1920 to 2012. The well-documented increase in average cash holdings in recent decades is not unique, but in fact is similar in magnitude and rate of change to cash dynamics that occurred nearly a century ago. Despite similarities in the mean, the cross-section of cash holdings has evolved quite differently in recent years relative to earlier periods. Large increases in average cash holdings from 1920 – 1945 and large decreases from 1945 – 1970 were broad-based, occurring at all points in the distribution of firms, among companies of all sizes, and among both new and existing firms. In contrast, modern average cash trends are dominated by new Nasdaq firms in the technology and healthcare sectors entering the sample. For most of the recent sample period, within-firm changes in cash are negative or flat.

We examine the ability of standard models of cash holdings to explain these shifts in the nature of cash policies and find little change in the dynamics of cash management over time, but some evidence that the determinants of cash targets have changed. Surprisingly, relations thought to support precautionary and transaction motives for holding cash are weaker or disappear earlier in the century, when financial frictions were arguably more severe. Finally, we show that cash targets based solely on firm characteristics have little ability to explain the large time-series changes in average or aggregate cash through the century. Including macroeconomic variables such as productivity and GDP growth improves the model's ability to capture the time series evolution of corporate cash.

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## 1. Introduction

How do firms allocate their financial resources? Much has been written about this fundamental issue in recent years, both in the academic literature and in the popular press, documenting that firms increasingly hold corporate resources as cash and marketable securities. This rapid increase in corporate cash balances has potentially important implications for corporate profitability, risk, and economic growth. For example, the February 19, 2011 *Wall Street Journal* states: "Politicians have been carping about the more than $2 trillion in cash sitting idle in corporate coffers even as unemployment remains high" (The *Wall Street Journal*, February 19, 2011, Jason Zweig).

In this paper, we use a unique data source extending back to the 1920s to ask whether this recent trend represents a shift in the nature of corporate cash policies and, if so, what is different about cash management today relative to the past. We first document that the recent increase in average cash balances is not, in fact, unusual by historical standards. The average ratio of cash to assets has gone through long periods of increase (1920 – 1945) and decrease (1945 – 1970) that are similar in magnitude and rate of change to what has occurred since 1980. Further, the increase in *aggregate* cash holdings from 1920 to 1945 and the decrease from 1945 to 1970 were considerably greater than that in recent decades.

Despite similarities in mean cash dynamics over the past century, we show that the nature of the recent cash trend is markedly different from historic dynamics. Previous fluctuations in average cash holdings were broad-based, occurring across industries and among firms of all sizes. Newly public firms had cash holdings similar to those of established firms. By contrast, the modern increase in average cash is concentrated in two sectors – technology and healthcare – and, at least until the early 2000s, almost entirely driven by new Nasdaq firms. The secular rise

in mean cash holdings in recent decades largely reflects a broadening of the distribution as high cash (relative to assets) firms enter the sample, rather than firms increasing their cash holdings over time. Since 1980, within-firm changes in cash ratios are for the most part flat or negative except during the early 2000s.

We explore the underlying causes of the changes observed in the distribution of cash holdings. In particular, we ask three questions. First, do firms appear to focus more (or less) closely on cash targets today than they have historically? Second, have cash targets changed through time in a way that explains the pronounced time-series variation in average cash holdings? And third, as the severity of market frictions has changed over the century, have the determinants of cash targets changed in a manner that helps explain the changing nature of cash policies?

Our results provide several insights. First, the dynamics of cash management are quite stable over time. The estimated speed of adjustment (SOA) towards cash targets is 27% per year in the pre-WW II era, compared to 20% per year since 1980. With the exception of the 1940s, the SOA stays within a range from 21% to 38% in every decade since the 1920s. Thus, to the extent that firms adhere to a target cash ratio, these targets have historically been somewhat loose, and remain so today.

Second, estimated cash targets based on a standard set of firm characteristics explain cross-sectional patterns in cash holdings but struggle to explain time series variation over a long horizon. Firm-characteristic-based targets account for 50% of the increase in average cash ratios since 1980, but very little of the large shifts in cash levels over the century. However, including variables that proxy for macroeconomic conditions as determinants of cash targets significantly improves the model's ability to explain time series variation in average cash balances. Among

others, the macroeconomic variables we study include a measure of productivity, GDP growth, and the opportunity cost of holding cash (Bates et al., 2009; Azar et al., 2015). The productivity and GDP growth macro variables in particular are significantly related to the time-series behavior of aggregate cash. These results suggest that cash policies respond to changes in the economic environment, or growth expectations, in a way that is not fully captured by firm-specific measures.

Third, while the relations between cash holdings and some firm characteristics are quite stable over time, we find some evidence that the determinants of cash targets are different today. For example, consistent with Bates, Kahle, and Stulz (2009) and others, we find that cash targets are higher for firms with more volatile cash flows and lower for larger and dividend-paying firms in the modern data. However, these relations become statistically and economically weaker (or flip sign) as we go further back in time. This is surprising, since these relations are typically interpreted as supporting the transaction costs or precautionary savings motives for cash holdings, which are predicated on the costs of external finance or on costs of converting non-cash assets to cash. As financial frictions were likely larger early in the 20th century, we would expect these relations to be more pronounced historically. These results suggest caution in interpreting the coefficients on standard proxies.

Our study relates to a large literature on the determinants of corporate cash holdings[2] as well as a growing recent literature exploring the drivers of the recent trend in average cash holdings.[3] Our primary contributions relative to prior work are, first, to document how the recent experience compares to past variation in cash policies. This serves both to put the current trends

[2] See, for example, Vogel and Maddala (1967), Kim, Mauer and Sherman (1998), Opler, Pinkowitz, Stulz, and Williamson (1999), Duchin (2010), Dittmar and Duchin (2010), and Gao, Harford, and Li (2013).
[3] See, for example, Bates, Kahle, and Stulz (2009), Falato, Kadyrzhanova, and Sim (2013), Azar, Kagy, and Schmalz (2014), and Nikolov and Whited (2014).

in historical perspective and also to highlight key changes in corporate behavior that candidate explanations must confront. Second, our unique data allow us to examine the ability of standard models of cash holdings as well as macroeconomic variables to explain time series patterns over long horizons. Finally, examining the older data allows us to study certain theoretical predictions (such as transactions and precautionary motives) in an era for which these motives should have been particularly acute. The historic data also have the advantage that certain modern explanations are less relevant historically, such as tax repatriation (Foley et al. 2006), allowing us to focus on the other theories.

While the long panel of data provides several advantages, there are also disadvantages. First, data limitations over the long sample limit the variables that can be included in the analysis. For example, we do not have statement of cash flows data, R&D, or many governance variables in the early part of the sample. Fortunately, not being able to include these variables does not appear to be a major problem, in the sense that the estimated coefficients for the variables that we do include do not appear to be significantly affected by the exclusion of variables with missing data. Second, like in any paper that relies on a long time-series of data, one needs to be cautious extrapolating results based on the past to explain recent financial activity. Nonetheless, our hope is that lessons learned studying nearly a century of cash provide helpful insights into interpreting modern cash trends.

The remainder of the paper proceeds as follows. In Section 2 we discuss the data and sample selection. In Section 3, we study trends in corporate cash policy over the last century at the aggregate, industry, and firm levels. In Section 4, we briefly discuss theories of liquidity management in the context of our analysis. Section 5 studies how the determination of cash policies has changed through time and explores the ability of firm characteristics and

macroeconomic variables to account for changes in corporate cash holdings. Section 6 concludes and discusses remaining unanswered issues.

## 2. Sample selection and summary statistics

To form our sample, we begin with all firms listed in the Center for Research in Security Prices (CRSP) monthly stock files. This includes all New York Stock Exchange (NYSE) firms since December 1925, all firms listed on the American Stock Exchange (Amex) since 1962, and all firms listed on Nasdaq since 1972. For these firms, stock market data come from CRSP. Accounting data are obtained from two sources: Standard and Poor's (S&P) Compustat database, and for CRSP firms not on Compustat, data hand-collected from Moody's Industrial Manuals.[4] The end result is an unbalanced firm-year panel beginning in 1920 and ending in 2012. In a few cases, we also replace variables with missing Compustat data with Moody's data.

Because of differing institutional environments, for the most part we exclude firms that are regulated (utilities, railroads, and telecommunications) or financial and focus our attention on unregulated (all other industries). These exclusions allow us to avoid the effects of industry-specific regulatory environments affecting our analyses, and of course align us with the vast majority of empirical corporate finance research.

Once per decade (in years ending in "8"), we also gather company-specific stock market and financial statement data on every public, unregulated nonfinancial firm in the Moody's universe. This extended sample includes data from regional exchanges, which to some extent

[4] All of the data before 1950 are from Moodys. In the 1950s, Compustat suffers from a well-known back-fill problem (Opler et al., 1999), namely that Compustat was initially formed by starting with a list of public companies that existed in the early 1960s, and data from the 1950s were back-filled for these firms. Our data entry process enters data for CRSP firms that existed in the 1950s that are excluded by Compustat (because the firms did not still exist in public form in the early 1960s). Our data entry process also adds data to supplement the Compustat sample in the 1960s and later, though the number of added observations gradually declines.

played the role of Amex and Nasdaq in early part of the 20th century. These data allow us to examine very small firms throughout the century. In addition, we also gather data from Statistics of Income (SOI), which has data on all the firms in the U.S. economy, including private and regulated companies. The SOI data are from the IRS and therefore are not company-specific but rather are aggregated by industry and/or company size.

Table 1 presents summary statistics for the main sample (unregulated CRSP firms). Panel A presents statistics for the firm-year panel. Panel B presents average firm characteristics by decade. In addition to their descriptive value, these results provide a context for subsequent analysis.

## 3. Trends in cash holdings

Figure 1 presents the aggregate (dashed line) and average (solid line) cash-to-assets ratio from 1920 to 2012. The rise in average cash that started around 1980 and has garnered much recent attention is evident, as are several other important trends. First, the growth in aggregate cash is much less pronounced than in the average, indicating that the recent growth in the average is driven by large cash balances in small firms (see also Bates et al., 2009). Similar to this relative stability in aggregate cash in the full sample, average and aggregate cash holdings for NYSE firms have been stable since 1970, with a modest increase only in the most recent decade. We show below that the full-sample average is driven upward since 1980 primarily by the entry into the sample of very high cash balances at new, unprofitable companies. These IPO firms rapidly burn cash for several years but other than this, within-firm cash balances are roughly constant for most firms in recent years. This IPO trend affected average cash holdings

but peaked in 2000. Starting in about 2000, larger firms have accumulated cash, as reflected in a moderate increase in aggregate (and NYSE) cash holdings.

Second, Figure 1 indicates that the average cash holdings were as high in the 1940s as they are in modern times – about 25% of assets (see also Graham, Leary, and Roberts, JFE forthcoming). There appear to be four eras in cash holdings over the past century. Cash-to-assets 1) increased dramatically from the 1920s until the mid-1940s, then 2) gradually declined through 1980. From 1980 to 2000, 3) average cash holdings increased dramatically but aggregate cash was flat. Finally, 4) starting in about 2000, average cash plateaued while aggregate cash holdings began to increase, then flattened out somewhat starting in 2010.

The literature has primarily measured cash holdings as cash-to-assets, without substantial justification for why this is more appropriate than, say, cash-to-sales. Given that

Cash/Assets = Cash/Sales * Sales/Assets,

one can consider two components to cash-to-assets: cash-to-sales (dollars of cash required to generate a dollar of sales), which measures the inverse of cash management efficiency; and sales-to-assets (i.e., asset turnover), which is a measure of asset productivity.

Aggregate cash-to-sales (shown in the upper left panel of Figure 2) is somewhat volatile in the early years of the sample but does not trend, with the volatility stemming from low sales during the early 1920's recession and the deep depression of the 1930s. After rising in the early 1940s, cash-to-sales and cash-to-assets follow fairly similar patterns, one that suggests the possibility of improving efficiency in the management of cash through about 1980. Both cash-to-assets and cash-to-sales increase starting in 1980. Average cash-to-sales (upper right panel) quadruples from 1980 to 2000, which we will show later is the result of new, low-sales firms

entering the sample in the past few decades. The lower panel of Fig. 2 shows that sales-to-assets increased dramatically from 1920 to 1945, mirroring the rapid rise in cash-to-assets, which is consistent with an increase in productivity over that period that largely flattened out after 1945.

Henceforth, we use cash-to-assets as our measure of cash holdings, keeping in mind that the variable captures largely offsetting time-trends from cash-to-sales and sales-to-assets. This analysis also suggests that cash management efficiency and productivity may play roles in explaining trends in cash holdings.

The evidence so far indicates that the change in average cash balances since 1980, while dramatic, is not unusual relative to the changes from 1920 – 1945 and from 1945 – 1970. Further, the change in the aggregate cash ratio in recent years is modest by historical standards. However, as we discuss below, the cross-sectional distribution of cash holdings has evolved quite differently in the modern era relative to these earlier periods. First, note from Figure 1 that aggregate cash holdings are very similar to average cash holdings before 1980, indicating that cash holdings at small and large firms were very similar and moved in tandem in earlier eras. This intuition is confirmed in Figure 3. The upper panels plot the quartile breakpoints of the cross-sectional distribution each year. From 1920 until 1980 the entire distribution moves together. However, a sharp break in this behavior occurs post 1980. In recent decades, the upper quartile has increased dramatically, while the lower quartile has been fairly stable. Similar patterns are observed for the NYSE sample, though to a lesser degree. Most of the increase in NYSE cash from 2000 to 2010 occurred in the upper half of the distribution.

The lower left panel of Figure 3 removes the impact of changing sample composition by plotting mean cash holdings for the 69 firms for which we have at least 80 years of data. The figure shows that, over the entire sample, these firms behave very similarly to the aggregate

holdings shown in Figure 1. Finally, the bottom right panel plots the aggregate cash-to-assets ratio using data from the *Statistics of Income* (SOI) compiled by the IRS from all U.S. corporate tax returns, including private firms. The patterns in the figure imply that including private firms does not change aggregate trends (so our focusing on public firms seems unlikely to affect our inferences). The figure also shows that the time-series pattern for regulated firms exhibits similar time-series behavior, though at a lower level and with less pronounced variation than for unregulated firms. The overall implication is that the patterns in cash behavior documented in Figure 1 apply broadly across firms from the early part of the century until 1980. Since 1980, though, there has been a marked widening of the distribution, particularly among newer, non-NYSE firms.

In Figure 4 we investigate further the causes of the heterogeneous post-1980 cash behavior. Panel A shows mean cash balances for both NYSE and non-NYSE ("Nasdaq") firms. Interestingly, the level and pattern of average cash holdings was similar for NYSE and non-NYSE in the 1960s and 1970s. The rapid increase in average cash since 1980, though, is clearly attributable to Nasdaq firms, with NYSE firms not exhibiting a rise until 2000. Panel B breaks down the data by tech and health care industries versus all other sectors of the economy, as defined by the Fama-French 12-industry categorization. Health/tech (which in this graph combines firms on both Nasdaq and NYSE) demonstrates a dramatic rise in average cash-to-assets starting in 1980. Non-NYSE firms in industries other than health and tech show an increase after 1980 but it is concentrated after 2000. Non-health/tech NYSE mean cash holdings do not increase until after 2000.

We now link the post-1980 increase in mean cash-to-assets to the change in holdings among small non-NYSE firms. Figure 5 displays the time series of mean cash-to-asset ratios for

portfolios of firms based on size (book assets). Panel A focuses on the NYSE sample and shows a rise in cash holdings among small NYSE firms in recent decades. However, the increase in the mean is relatively small for these firms. For NYSE firms of all sizes, the recent increase in cash holdings was concentrated after 2000. One could worry that the apparently unique post-1980 contribution of non-NYSE firms (particularly in health/tech; see Figure 4) to mean cash holdings is affected by our main sample being composed of only NYSE firms before 1962 (CRSP began coverage of Amex firms in 1962 and Nasdaq firms in 1972). Therefore, in Panel B of Figure 5 we examine cash holdings once per decade (in years ending in "8") for all firms in the union of Moody's Industrial manual and Compustat. This extended sample includes many small, regional stock exchange firms. Importantly, for the extended sample, across the century there is a fairly stable definition of "small" firms as measured by the average real book assets. The plots indicate that small firms held the same amount of cash as large firms (even less in the pre-WW II era) until about 1980. That is, in contrast to the modern trends, the behavior of small non-NYSE firms mirrored that of large NYSE firms until the 1980s. This again stands in contrast to the diverging trends since 1980 when cash holdings at non-NYSE firms of all sizes, and especially small firms, increased sharply relative to NYSE firms.

Figure 6 shows that this modern increase is largely driven by new entrants into the sample. The solid line displays the average cash/assets ratio in each year *t* for all firms in the database as of year *t-1* (that is, firms that have been in the sample at least two years). The short- and long-dashed lines show the average cash/assets of firms new to the sample in each year *t*. Between 1925 and 1980, new firms came into the sample with similar cash balances as existing firms, with the exception of the 1930s, when new firms had somewhat higher average cash balances. New and existing NYSE firms continued to have similar cash balances between 1980

and 2010. By contrast, newly public Nasdaq firms over this modern period had dramatically higher average cash ratios than existing firms.[5]

Table 2 documents the extent to which the trends in average cash balances are driven by changing sample composition. In the first three columns of Panel A, we estimate panel regressions of the cash-to-assets ratio on a time trend, separately over each of the three sample periods, 1920 – 1950, 1951 – 1980, and 1981 – 2012. Consistent with Figure 1, the coefficients indicate a significantly positive trend over the first and third eras and a negative trend in the middle period. In columns (4) through (6) we add firm fixed effects, so the time-trend variables measure the average within-firm changes in cash over each period. For the first two periods, the within-firm trends are very similar in both sign and magnitudes to those in columns (1) and (2). However, since 1980 the average within-firm change in cash is negative, suggesting that all of the increase in average cash over that period is due to firms entering the sample with higher cash balances. Those firms already in the sample actually decrease cash over time.

In column (7), we follow Bates et al. (2009) and remove the first 4 years of data for each firm. The positive estimated trend indicates that the bulk of the within-firm decline in cash balances since 1980 occurs among new firms over their first 4 years. We also note, though, that even though the time-trend coefficient is positive after removing these years, its magnitude is small. The magnitude indicates a within-firm trend of 0.066 percentage points per year, which translates to an increase of just over two percentage points over the entire period from 1981 to 2012. Further, comparing the adjusted R-squares indicates that the time trend explains much less of the within-firm movements in cash in the modern era relative to the earlier periods.

[5] This finding is consistent with Bates et al. (2009), who show increasing cash balances among more recent IPO cohorts. See also McLean (2011) and Bouwman and Lowry (2012).

Finally, the results in column (8) indicate that the positive within-firm trend in column (7) is attributable entirely to the years after 2000. Within-firm trends were negative in the 1980s and 1990s, even after excluding each firm's first four years. Further, when we look at the average within-firm change in cash by year (untabulated), we find that it is positive only in 2001, 2002, 2003 and 2009. In sum, the information in Figure 6 and Table 2 indicates that other than IPO firms (which enter the sample with large cash-to-assets), there has not been much of an upward trend in cash holdings in the past few decades, with the exception of a few years since 2000.

*Summary of cash policy trends*

Analysis of corporate cash from 1920 through 2012 reveals the following stylized facts:

1. Aggregate and average cash were 8% of assets in 1920, rose rapidly to 25% of assets by 1945, then gradually fell back to less than 10% of assets by 1970. Cash holdings for both small and large firms followed these patterns.
2. Starting in about 1980, the average cash ratio began to grow rapidly for two decades, while aggregate cash remained fairly stable. The growth in the average came mainly from new Nasdaq firms entering the sample with large cash balances upon IPO. Within-firm changes in cash are negative; in particular, in the first few years after IPO, cash balances fall rapidly.
3. As a result, relative to the previous 60 years, there has been a dramatic widening of the distribution of cash holdings since 1980.
4. Starting in about 2000, cash balances began to accumulate in non-Nasdaq firms. Cash balances at Nasdaq firms plateaued but remained at more than twice the level of cash at other firms.
5. Much of the increase in cash in recent decades occurred in health and tech firms.
6. Regulated firms hold about half as much cash as unregulated firms but the time-series trends in cash balances are very similar.

What factors underlie these changes in corporate cash holdings through time? Do the recent changes in the level and dispersion of cash holdings represent a shift in the nature of cash policies? Or can extant empirical models of cash holdings and changing firm characteristics account for the trends we observe? In the remainder of our study, we attempt to provide answers to these and related questions.

## 4. Literature Review

Before beginning the empirical analysis, we briefly review the existing theories of corporate cash holdings and the related evidence. If capital markets were perfect, cash policy would be irrelevant for firm value. Investing excess cash in liquid assets would earn zero NPV and firms could costlessly meet any cash shortfalls by raising external finance, converting illiquid financial or real assets into cash, or reducing payout. In the presence of market frictions, though, these activities are not costless. In this case, a firm will manage cash so that the marginal benefit of holding the last dollar of cash just equals the marginal cost.

The benefits of holding cash typically result from financing frictions. Under a transactions motive (Keynes, 1936; Miller and Orr, 1966), firms hold sufficiently high cash balances to avoid the costs of selling non-cash assets when facing an unexpected mismatch between cash inflows and outflows. To the extent that there are economies of scale in cash management, this view predicts that larger firms will have lower cash targets. This model would further predict a decline in optimal cash holdings over time as transaction costs in financial markets decline. Under a precautionary motive (Opler et al. 1999), the benefit of cash is avoiding external finance costs when investment opportunities may unexpectedly exceed internal resources. Under this view, cash holdings should be optimally higher for firms with more

valuable investment opportunities, lower expected cash flows, and greater uncertainty, as well as for more financially constrained firms. As discussed by Myers and Majluf (1984), the precautionary motive may also imply that, since there is value to financial slack, firms will retain cash flows (thereby increasing cash holdings) when they exceed current investment opportunities and draw down cash balances in the opposite situation.[6] In such a financing hierarchy, cash holdings may be positlvely (negatively) correlated with past realizations of cash flow(investment), even if firms do not manage toward an explicit cash target.[7]

Theories of corporate cash point to three main costs of holding cash and liquid assets. The first is the lower returns earned on liquid assets (relative to more productive but less liquid assets) that occur because of the ease with which liquid assets can be converted into cash, as well as the yield foregone by holding cash in non-interest bearing accounts. Second, there may be a tax cost to holding cash, as interest earned on liquid assets is taxed at both the corporate and personal levels. Third, there may be a cost of managerial discretion (Jensen, 1986). If managerial incentives are not aligned with those of shareholders, managers may use excess cash to increase their private benefits at the expense of shareholder wealth. These sources of costs lead to the prediction that cash holdings are optimally lower when the liquidity premium increases, for firms facing higher corporate tax rates (relative to their investors' tax rates), and for firms with weaker governance, respectively.

Prior literature has found some degree of support for each of these theoretical predictions. While earlier studies find mixed support for the expected negative relation between firm size and

[6] Bolton, Chen, and Wang (2011) derive a dynamic S,s model that also leads to pecking-order like behavior. All else equal, high cash firms pay out to reduce the carrying cost of holding cash, medium-level cash firms maintain their cash balances, and low cash firms scale back investment or raise external funds to increase cash holdings.

[7] Riddick and Whited (2009) show that cash holdings can be negatively related to cash flow in a dynamic model. For example, a positive productivity shock may lead to increased cash flows as well more investment (and hence a reduction in cash holdings).

cash ratios, Opler et al. (1999) and Bates et al. (2009) confirm this relation in modern data. Several studies find a positive relation between cash holdings and proxies for investment opportunities and external finance costs, such as the market-to-book ratio, R&D spending, volatility and asset intangibility (e.g., Kim, Mauer and Sherman, 1998; Opler et al., 1999; Bates et al., 2009; Riddick and Whited, 2009; Falato, Kadyrzhanova, and Sim, 2013; Begenau and Palazzo, 2015). On the cost side, Kim et al. (1998) and Azar, Kagy, and Schmalz (2015) provide evidence that cash holdings are negatively related with, respectively, a measures of the liquidity premium and the cost of carry. Several studies provide evidence consistent with the agency costs of cash holdings. Harford (1999) and Harford, Mansi and Maxwell (2008) show that firms with more anti-takeover provisions hold less cash and make value-destroying acquisitions. Dittmar, Mahrt-Smith, and Servaes (2003) find that corporate cash holdings are greater in countries with weaker investor protections. Gao, Harford, and Li (2013) provide evidence that private firms (which are thought to be subject to fewer agency costs) hold half as much cash as public firms, and that poorly governed public firms quickly spend excess cash on excess investment. Nikolov and Whited (2014) use a dynamic structural model to show that cash holdings can be explained by agency costs such as managers' private benefits from excess perquisite consumption.

Finally, we note that corporate taxes can play a role in cash holdings for a second reason, related to retained cash from foreign profits left overseas to avoid repatriation taxes faced by U.S. multinational firms when they return profits home. For example, profits earned in Ireland and taxed at 12% would in general be assessed an additional tax of 23% when they are returned to the U.S., given the 35% US corporate income tax rate. Rather than pay repatriation taxes, many U.S. companies leave these foreign profits overseas, and they often appear as cash on corporate balance sheets. Foley, Hartzell, Titman, and Twite (2007) argue that in recent years

these repatriation taxes led to increased cash balances that are trapped overseas. The early part of our sample offers an advantage in that few US firms had significant multinational operations, so any effects of the repatriation tax motive to hold cash would have been minimal. Moreover, we note that foreign profit repatriation only leads to additional U.S. tax obligations when the U.S. tax rate is greater than foreign tax rates. Given that the mean tax rate for OECD countries was greater than the U.S. corporate income tax rate until the late 1990s (http://www.oecd.org/tax/tax-policy/tax-database.htm), we would not expect trapped cash to be a significant cause of increased cash holdings before then.

## 5. Empirically explaining corporate cash

In this section we examine the ability of empirical models of cash holdings to explain the data, in particular the patterns documented in Section 3. We examine both static and dynamic models of cash. Within the context of the latter, we explore the extent to which firms appear to target cash holdings, what determines the cash target, whether the target changes through time, and how quickly firms move to a new target. We demonstrate that firm characteristics are helpful in explaining cash targets across firms; however, for the most part we find that macro variables and variables that measure deviations from targets are needed to explain time-trends in aggregate cash.

### *5.1. Static model of cash holdings*

Bates et al. (2009) (BKS) develop an empirical model to explore cash behavior from 1980 to 2006. We begin by benchmarking our data to BKS before extending the estimation to the historical data. The primary BKS model uses panel data and regresses cash-to-assets as dependent variable on a collection of right-hand-side variables:

$$\frac{Cash}{A}_{it} = \alpha + \beta X_{it} + \theta_i + \phi_t + \varepsilon_{it} \quad (1)$$

where *X* includes firm-specific characteristics, including cash flow volatility, market-to-book assets, firm size (log of real assets), cash flow, capital expenditures, the ratio of R&D expense to sales, an indicator for dividend paying firms, acquisition expenditures, the net working capital to assets ratio, and leverage (total debt to assets). $\gamma_i$ and $\delta_t$, respectively, are firm and year fixed effects.

This model can be interpreted as estimating a target or expected amount of cash, given firm characteristics and other variables. Column 1 of Table 3 presents our estimation of the Bates et al. model over their 1980 – 2006 sample period. In the second column, we modify the specification slightly so that it only includes variables for which we have data over our entire sample frame. There are three key differences in our estimation relative to the published Bates et al. specification. First, our long sample does not have access to the statement of cash flows throughout; consequently, we define cash flows as net income before extraordinary items minus expected dividends. Expected dividends are defined as dividends per share in the previous fiscal year times shares outstanding in year *t*. This definitional difference affects both our cash-flow-to-assets and volatility of cash flows variables. Second, again due to the lack of a statement of cash flows in the older data, we define capital spending as the change in net PP&E scaled by lagged book assets. Third, our long sample does not include variables measuring R&D spending or acquisitions.

Comparison of columns 1 and 2 of Table 3 indicates that these differences have little impact on the estimated coefficient signs and significance. Both sets of results are similar to those reported by BKS. Consistent with the precautionary savings motive, cash holdings have a

positive association with cash flow volatility, market to book, and R&D expense. The positive coefficient on firm size does not appear to be consistent with a transactions motive if there are economies of scale in converting noncash assets into cash, nor consistent with a precautionary motive if larger firms face fewer frictions when accessing external finance. (Note that BKS report a negative coefficient on size when firm fixed effects are excluded.) The positive (negative) coefficient on Cash Flow (CapEx) is generally interpreted as capturing the accumulation (use) of cash when firms are profitable (invest). The negative coefficient on net working capital indicates some degree of substitution between cash and other short-term assets.

The net working capital and debt variables are among the more significant in the first two columns and deserve further attention; in particular, net working capital is of particular interest because BKS conclude that the run-up in cash in the early 2000s was affected greatly by substitution away from inventory and accounts receivable and into cash. Similarly, Kulchania and Thomas (2014) attribute a portion of this recent increase to firms saving cash out of capital freed up by inventory reductions. To further explore these relations, in column 3 we decompose net working capital into the following components: noncash current assets (Oth CA, primarily AR and Inventory), short term debt (STD)[8], and other current liabilities (Oth CL).

If other relatively liquid assets serve as substitutes for cash and marketable securities, we expect a negative relation between cash holdings and other current assets. Consistent with substitution on the asset side, we find a negative and highly significant relation. For the other two components of net working capital, we expect a positive relation if firms hold cash to offset anticipated near-term liabilities. However, we find a weak negative relation between cash and other current liabilities during the 1980-2012 period studied in column 3. Short-term and long-

[8] To our understanding, the BKS specification includes short-term debt in two places: net working capital and as part of leverage. We include short-term debt as a single variable in the context of replacing leverage (D) with separate variables for short-term and long-term debt (LTD) to assets.

term debt both have negative and similar magnitude coefficients. Thus, the negative relation between cash and net working capital in the first two columns appears to be driven by current assets as opposed to liabilities. We do not find evidence of firms stockpiling cash in order to pay off debt obligations coming due. Finally, one other change in column 3 is that firm size becomes negative and significant, consistent with large firms enjoying economies of scale in cash management or large firms facing fewer external financing frictions.

In column 4, we take an initial look at how the determinants of cash holdings have changed over time by estimating the column 3 specification over the period from 1926 to 1980. Most of the relations are the same sign and magnitude as in the modern data. There are two exceptions. First, cash flow volatility loses significance, although the magnitude of the coefficient is only moderately smaller. Second, the coefficient on other current liabilities flips sign and becomes significantly positive. This suggests that in the earlier part of the century, offsetting near-term liabilities may have been an important motive for holding cash balances, although the coefficient on short-term debt remains negative. For example, special tax levies were made on corporations around World War II that appear on year-end financial statements as tax reserves for pending tax payments (which are therefore part of Oth CL) and might also have led firms to hold additional cash at fiscal year-end in anticipation of making the pending tax payments. Column 5 estimates the same model over the entire sample period, with similar results.

In columns 6 and 7, we explore the impact of lagging the independent variables. If we are to interpret the model as describing cash targets, we want to include only variables that would be in the manager's information set during year *t*. Thus, we measure all stock variables (e.g., market-to-book, size, current assets, current liabilities, debt) as of the beginning of year *t* and

flow variables (e.g., cash flow, capital expenditures) over year *t*. In column 6, the dependent variable remains the level of cash-to-assets at the end of year t. The results are quite similar to those in column 5. The magnitude and significance of the negative coefficient on other current assets declines by almost half, but it remains negative and highly significant.

In column 7, we add lagged cash to the explanatory variables in column 6 and first difference the dependent variable. Column 7 thus models the change in the cash-to-assets ratio as a function of lagged target determinants and the lagged level of cash. This specification thus has a dynamic interpretation: "How much does cash change this year, given its starting value (lagged cash) and target cash determinants (the other explanatory variables)?" The sign and significance of most variables are again unchanged, with the exception of the working capital components. The coefficient on other current assets switches sign, while that on current liabilities becomes insignificant.

This collection of results allows for a nuanced interpretation of the relation between cash and net working capital. While cash holdings are contemporaneously negatively correlated with other current assets (in column 6), holding lagged cash fixed higher levels of current assets do not *predict* a reduction in cash holdings (in column 7). This raises the possibility that the negative relation in other columns between cash and net working capital (or Oth CA) could be somewhat mechanical rather than representing a determinant of firms' cash targets. For example, current assets by definition are those assets expected to be converted into cash in the near term. Unless this cash is immediately distributed or otherwise redeployed, a reduction in current assets will correspond to an increase in cash. On the other hand, if firms target an overall liquidity ratio and alter cash holdings as an inverse response to changes in the level of inventories or accounts receivable, then higher levels of these other current assets, all else equal, should predict lower

changes in cash. We do not, however, find such a negative relation in column 7. We explore more fully these implications in a dynamic model of cash in the next section.

*5.2 Dynamic target-adjustment model of cash*

A target-adjustment model similar to that in column (7) of Table 3 has several advantages in our setting. First, it allows us ask whether the changing nature of cash holdings through time is associated with a change in the importance of cash targets for firms. Additionally, it allows us to separately model the determinants of cash targets from temporary deviations around these targets. This will allow us to extract estimates of target cash balances in order to examine whether fluctuations in these targets can account for the substantial time series variation in cash holdings documented in Section 2. It also enables us to isolate the elements that need to be part of the target in order to explain these time series patterns.

For example, in the previous section we interpreted a positive (negative) relation between cash-to-assets and cash flow (capital spending) as an indication of a potentially passive accumulation of profits (use of cash).[9] While this may be a reasonable interpretation of the net effect of these variables, it may mask two potentially offsetting effects for each variable. For cash flow, because there is a cost to holding cash, all else equal cash balances might be lower in firms that expect near-term cash flows to be higher; while more mechanically, cash balances should be higher when current-period cash flows accumulate. For capital expenditures, because there is a cost to not being able to pursue good investment projects, all else equal cash balances should be higher in firms that expect near-term investment to be higher; and more mechanically, cash balances should be lower when cash is used to invest. In each case, the first effect can be interpreted as being consistent with a precautionary motive to holding cash. While these

[9] As noted earlier, such behavior could be consistent with a financing hierarchy view in which firms retain cash flow in anticipation of future investment needs to avoid external finance costs.

offsetting effects are difficult to disentangle using a static model, they can be separately estimated in a dynamic adjustment model. Thus, in the specification that follows, we include in the "determinants of the cash target" vector *X* proxies for expected cash flow and investment measured as the average value of these values over years t-3 through t-1, and we include contemporaneous cash flow and investment in the "temporary deviations from target" vector *Z*:

$$\Delta \frac{\boldsymbol{Cash}}{\boldsymbol{A}}_{\boldsymbol{it}} = \boldsymbol{\gamma}\left(\boldsymbol{C}^{*}_{\boldsymbol{it}} - \boldsymbol{C}_{\boldsymbol{i,t-1}}\right) + \boldsymbol{\delta Z_{it}} + \boldsymbol{\varepsilon_{it}} \text{ , where} \qquad (2)$$

$$C^{*}_{it} = \alpha + \beta X_{it-1} + \theta_i + \phi_t.$$

In equation (2), $C^{*}_{it}$ represents target cash holdings and $\gamma$ is the speed of adjustment toward that target.

*5.2.1 Have cash policies changed through time?*

Table 4 displays results from estimating equation (2) over the entire sample period and three separate eras: 1920 – 1950, 1951 – 1980, and 1981 – 2012. It is well known that estimating dynamic panel models in the presence of unobserved firm effects can produce biased results, especially with persistent variables and short time series (Flannery and Hankins, 2010). To address this concern, we estimate model (2) using the "system GMM" procedure of Blundell and Bond (1988). Coefficient estimates are scaled by the standard deviation of each independent variable within each period to ease comparison of magnitudes across variables and eras.

There are several notable results. First, the estimated speed of adjustment, while slightly higher in the middle of the century, has been fairly stable over time. It also suggests relatively slow reversion to targets. In the early part of the century, firms closed on average 27% of the gap

between actual and target cash holdings annually and 20% per year in the modern era.[10] Thus, it takes 2.5 to over 3 years to close just half of the gap between actual and target cash. Despite large changes in average cash levels over time, the dynamics of cash management do not seem to have changed much. To the extent that firms manage toward a cash target, these targets continue to be somewhat loose.

Second, separating expected from contemporaneous cash flow and investment is empirically relevant. For example, firms with higher expected cash flow tend to have lower cash targets, consistent with a precautionary savings explanation. Moreover, considering the third variable from the bottom, higher cash flow during year t (controlling for target determinants) is associated with a higher change in cash holdings during year t, consistent with passive accumulation of cash, at least in the short term. Similarly, contemporaneous investment is strongly negatively correlated with changes in cash (second variable from bottom of Table 4), consistent with firms using internal resources to fund investment. However, we find little evidence that our proxy for expected investment is a significant determinant of cash targets. We note, however, that the market-to-book ratio, an alternate proxy for investment opportunities, is robustly positively associated with cash targets, consistent with the precautionary motive.[11]

Third, we find some evidence that the determinants of cash targets have changed over the century, though not always in expected directions. Bates et al. (2009) argue that increasing cash

[10] We note that our estimates over the modern period are slightly lower than, but in line with, those of Dittmar and Duchin (2010).

[11] Lutz (1945) examines cash holdings from 1914-1943 for small select samples of U.S. firms. Without conducting statistical tests, he argues that these firms followed a hierarchy in which profitable firms used internal profits to fund operations and investment. Excess profits were then accumulated to increase cash balances, except when a firm had debt outstanding, in which case excess cash was first used to reduce debt principle. These effects are all captured by our model, the last being captured in our specification by the last variable in Table 4 (CF x D/A, which can be interpreted as follows: when firms have debt outstanding, they use excess cash flows to pay down debt). Our results find some support for this effect during 1951-1980.

flow volatility is one of the key drivers of the increase in average cash ratios in recent decades. Our results indicate that cash flow volatility is most significantly associated with higher cash targets in this modern era. A similar pattern is found in Table 5, which estimates the model separately for each decade. If we interpret a positive relation with volatility as consistent with a precautionary savings motive, the lack of or weak historic significance is surprising. One would expect financial frictions to be more severe in the early part of the century than they are today, which would suggest the precautionary motive should have been stronger historically.

Similarly, the relation between cash targets and firm size remains negative throughout our sample, but becomes economically smaller as we go further back in time and is statistically insignificant in the earliest period. A similar pattern is found in the regressions grouped by decade in Table 5. Finding that firm size is negatively correlated with cash holdings is frequently interpreted as evidence in favor of a transactions motive (economies of scale in converting noncash assets to cash) or precautionary motive (small firms face more borrowing frictions, so hold more cash). One would expect these motives to be stronger in earlier eras, when asset and financial markets were less developed.

A potential concern with this finding is that there is simply more variation in firm size in the modern data due to expanded coverage of CRSP since 1970. To address this concern, Table 6 reports results for an abbreviated regression that includes the firm-specific variables available for the extended sample (that includes firms on regional stock exchanges). In this case, the coefficient on firm size monotonically grows less negative and less significant in each preceding decade, a pattern that is again opposite from what one would expect if transaction or precautionary motives were stronger in the more distant past. Figure 7 presents the relation between size for each decile of the extended sample for each 8-year in the sample. These charts

reveal virtually no relation between size and cash holdings until 1968, when the smallest firms began to hold modestly more cash than larger firms. Only in 1998 and later do we see much evidence that larger firms hold less cash than the median-sized firm. Overall, these patterns are not overly supportive of size-based implications providing evidence in favor of transactions or precautionary motives to hold more cash.

In a similar vein, in Table 4 the indicator for dividend payers has a significant negative coefficient in the most recent period. This is again consistent with a precautionary motive, if dividend payment proxies for low financing constraints, or with a transactions model if dividend payers tend to be more stable and thus better able to forecast cash needs. However, the coefficient becomes smaller in magnitude over 1951-80 and switches to positive in the pre-1950 period.[12]

Overall, the changes in cash target determinants through time affect how we interpret coefficients associated with several common proxies. While cash flow volatility, firm size, and dividend payment are significant determinants of cash targets in recent years, the fact that these relations weaken or switch sign earlier in the century suggests caution in interpreting them as supportive of models predicated on financing frictions. On the other hand, the market-to-book ratio is significantly positively associated with cash holdings in each period (and in every decade in Table 5), which is consistent with a precautionary motive. We also note that the leverage variables are robustly negatively associated with cash targets, though this relation is harder to interpret in the context of cash management theories. This negative relation is potentially

[12] For dividend-paying status, and perhaps some of the other explanatory variables, it is important to keep sample composition in mind as we interpret. For example, the early part of the main sample is composed entirely of NYSE firms, much different than the modern sample. Panels B of Tables 4 and 5, however, indicate that for a subsample of NYSE firms, most of the results are consistent with those for the full sample. Another interpretation consideration is that dividend-paying status may have had different implications in earlier eras.

consistent with a precautionary motive to the extent that higher leverage reflects lower cost access to credit markets.

*5.2.2 Do firm characteristics explain time series variation?*

We now examine the extent to which the substantial variation in average cash holdings through the century can be explained by changes in cash targets over time. To do so, we extract the estimated cash target for each firm-year from equation (2) as $\hat{\alpha} + \hat{\beta} X_{it-1}$.[13] We then average these estimated targets across firms each year. Given the evidence above that the determinants of cash targets may have changed over time, to estimate the targets we estimate equation (2) over the full sample as well as separately for the 1926 – 1980 and the post-1980 periods.

The left panel of Panel A in Figure 8 displays the time series of average estimated cash targets and average actual cash ratios over the 1926 – 1980 period. Despite dramatic variation in average cash holdings, the average estimated target changes very little over this more than 50 year period. This suggests that cash targets, as a function of firm characteristics alone, have limited ability to account for changes in average cash holdings over time. The right plot of Panel A repeats the exercise over the modern era from 1981 – 2012. In contrast to the earlier period, estimated cash targets are better (though not completely) able to explain the increase in cash in recent decades. The increase in average estimated target from 1981 through 2004 accounts for over 60% of the increase in average cash ratios over that time span. After 2004, both average estimated targets and actual ratios level off, declining by 3% and 2%, respectively. However, the model misses the steepest part of the run-up in average cash ratios that occurs starting in 2000.

[13] For this exercise, we estimate equation (2) without the year fixed effects to allow changing firm characteristics to capture time-series changes in average cash holdings. Results are qualitatively similar when year fixed effects are included in the estimation.

The relative improvement of the model on modern data is consistent with the evidence in Section 3 that much of the recent trend in cash is associated with changing sample composition. The model to some extent can separate from existing firms the new, small, tech and health Nasdaq firms entering the sample with high cash ratios. Given that there is a time-series component to when these firms enter the sample, the model is able to capture time-series behavior since 1980 fairly well. However, these same characteristics associated with high cash ratios today do not explain variation in cash holdings in the older data, as reflected in the left-hand plot of Panel A as well as in the evidence from Table 4 discussed above.

### *5.3 Changes in the macroeconomic environment*

The dynamic adjustment model analyzed in the previous section is based on a cash target derived from firm-specific characteristics. The model produces several economically intuitive cross-sectional results; however, its ability to explain time-series behavior is limited, especially prior to 1980. This suggests that either there are important excluded firm characteristics or that changes in the macroeconomic environment, rather than firm-specific characteristics, are important for explaining changes in cash holdings through time. In this section, we introduce macroeconomic variables in an attempt to capture economy-wide forces that change through time in a manner that affects corporate cash holdings in aggregate.

In Table 7, we add a number of macroeconomic variables to the determinants of cash targets in equation (2). As discussed by Kim et al. (1998), the yield differential between liquid assets and the illiquid assets in which a firm can invest represents an opportunity cost of holding cash and marketable securities. To capture this cost, we include the spread between AAA rated corporate bond yields and 10-year Treasury yields, which we refer to as *Liquidity Premium*. Azar et al. (2015) argue that because many firms hold a portion of their liquid assets in noninterest

bearing accounts, the cost of carry is also an important component of the cost of cash holdings. Therefore, we include the 3-month Treasury-bill rate as a proxy for this carry cost as well as a measure of economic conditions. Additionally, higher inflation may discourage cash holdings, to the extent that these are held in non-interest bearing accounts or at fixed nominal yields. Market volatility, measured as the standard deviation of daily market returns over the previous year, is included as a proxy for aggregate uncertainty, which should be positively related to cash holdings under a precautionary savings motive. GDP growth is included as an indicator for expected investment opportunities. Finally, we also include the aggregate output-to-capital ratio as a measure of productivity. Under a transactions model, a higher flow of output for a given asset base would lead to higher optimal cash holdings.

The coefficient estimates reported in Table 7 indicate that several of these variables are significantly related to target cash holdings. Over the 1926 – 1980 period (column 1), cash targets are positively associated with market volatility, GDP growth, and productivity, all consistent with precautionary or transactions motives. The signs of these coefficients are similar in the full sample, though due to countervailing effects in the modern era, their magnitudes and statistical significance generally decline. On the other hand, the interest rate and inflation measures have insignificant or counter-intuitive coefficient estimates, with the exception of the T-bill rate over the full sample.

Panel B of Figure 8 demonstrates the impact of including macro variables on the average estimated targets. Over the 1926 – 1980 period, we see that the macroeconomic indicators substantially improve the ability of the model to explain time-series variation in average cash holdings, relative to the targets based on firm characteristics alone. In particular, the average estimated targets now capture to some degree the rapid increase in cash holdings in the 1930s

and 1940s and the subsequent decrease in the post-war era. The right plot in Panel B shows that macro variables also help explain time-series patterns in the modern era. While firm characteristics alone captured more than half of the increase in average cash holdings over this period, the macro variables help the model capture most of the change in level, as well as the run-up in cash in the early 2000s. In this right panel, the mean absolute percent difference between average estimated targets and actual cash ratios declines from 15% (panel A) to 9% (panel B, when macro variables are included), a reduction of over 40%.

One potential concern with the analysis above is that macro variables may be better able than firm characteristics to explain time series variation in a panel model because by definition the macro variables only vary in the time series dimension and thus the model does not need to try to fit cross-sectional relations with these variables. An alternative way of comparing the role of firm-specific and macro factors that addresses this concern is to estimate a time-series model for the determinants of aggregate cash holdings. To accomplish this, we first collapse our data down to one observation per year by forming aggregate ratios (i.e., asset-weighted averages). We then estimate regressions of the following form:

$$\left(\frac{Cash}{A}\right)_t = \boldsymbol{\alpha} + \boldsymbol{\beta_1 X_t} + \boldsymbol{\beta_2 M_t} + \boldsymbol{\varepsilon_t}, \qquad (3)$$

where $X_t$ represents aggregate firm characteristics and $M_t$ represents macroeconomic variables. As before, stock variables in *X* are measured at the beginning of year *t* and flow variables over year *t*. We then estimate equation (3) in first difference form to prevent results being driven by a common trend.

Table 8 presents the results from this aggregate, first-difference specification. As expected, though the firm-specific variables perform well in the cross-section (e.g., Table 4),

they are largely insignificant with respect to explaining time-series behavior of aggregate cash. The firm characteristics we use as target determinants collectively explain only 8% of the time series variation in aggregate cash over the 1926 – 2012 period (column 1 of Panel A). Columns (2) and (3) highlight variables that have more explanatory power. First, contemporaneous cash flow and investment are much more strongly related to changes in aggregate cash holdings than are changes in the determinants of cash targets. Adding these two variables raises the adjusted r-squared from 8% to 45%. Column (3) indicates that the macroeconomic variables also have some ability to explain changes in aggregate cash, collectively accounting for 26% of the time-series variation. Consistent with the dynamic panel results in Table 7, aggregate cash holdings are significantly positively associated with both GDP growth and aggregate productivity. This latter relation makes particular sense in the historic period when one might expect the transactions motive for cash to be important.[14] Inflation is significantly negatively related to cash holdings, as expected, though this relation becomes insignificant once we control for the full set of firm characteristics (column 4).

Similar implications are found in the variance decomposition in Panel B, which shows the percent of explained variation coming from each variable (based on the specification in column (4) of Table 8, Panel A). Contemporaneous investment and cash flow, GDP growth, and aggregate productivity combine to account for nearly 80% of the variation explained by the model.

Figure 9 provides a graphical depiction of the model's ability to account for variation in aggregate cash holdings through time. Recall that the model is estimated in first differences. To construct these plots, we cumulate the predicted changes in the aggregate cash ratio (dashed line)

[14] Recall that we previously documented a strong relation between sales-to-assets (a proxy for productivity) and the run-up in cash-to-assets through the mid-40s (see Figure 2)

and compare that series to the cumulated changes in the actual aggregate cash ratio (solid line). As in the panel model (Figure 8), firm characteristics alone predict little change in the aggregate cash ratio over the entire sample period (upper left plot of Figure 9). The upper right and lower plots show that adding cash flow and investment, along with also adding macroeconomic variables, results in the model being able to reasonably capture changes in aggregate cash holdings through the century.

While it is encouraging that the target from the model with macro variables appears to predict observed behavior, recall that we argued in Section 3 that during the 1980s most of the increase in mean cash holdings was attributable to new Nasdaq firms entering the sample. For the macro variables to provide an economic explanation for the post-1980 run up in average cash, it would therefore be necessary that the macro variables differentially affect these new, Nasdaq firms. In a similar vein, from 1970 to the end of the sample, aggregate cash only increased in the last dozen years. Therefore, for macro variables to explain the modern increase in aggregate cash, the macro effects would need to be strongest in these most recent years.

## 6. Conclusions and directions for future research

We use a unique data source to study the evolution of corporate cash policies through time. We first document a number of new stylized facts that help put the recent increase in average cash balances in perspective. The aggregate cash ratio in the 1920-1930s is similar to today, despite large fluctuations in between. While average cash to assets has risen dramatically since 1980, it is no higher today than in the 1940s. Further, average cash balances have undergone several pronounced shifts through the century of similar magnitude to what we have seen in recent decades.

Despite these similarities, we also show that the cross-section of cash holdings has evolved quite differently in recent years relative to earlier periods. Large changes in the average level of cash holdings from 1920 – 1945 and from 1945 – 1970 were broad-based, occurring at all points in the distribution, among firms of all sizes, and among both new and existing firms. By contrast, the modern average cash trends are dominated by new Nasdaq firms in the technology and healthcare sectors entering the sample. Within-firm changes in cash are negative or flat in most years.

We examine the ability of standard models of cash holdings to explain these shifts in the nature of cash policies through time. We find first that the dynamics of cash management have changed little over time. Cash targets have been loose historically and remain so today. Second, we find some evidence that the determinants of cash targets have changed over time. Somewhat puzzlingly, relations thought to support precautionary and transaction motives for holding cash are actually weaker or disappear earlier in the century, when financial frictions were arguably more severe.

Finally, we show that cash targets based solely on firm characteristics have little ability to explain the large shifts in average cash through the century. On the other hand, introducing macroeconomic variables improves the model's ability to capture time series patterns in the data. However, caution is warranted before attributing the recent run-up in cash balances to changes in macro variables. First, the signs on key macro variables vary between the old and modern eras, clouding interpretation. Second, one must reconcile the role of macro factors with fact that recent trends are dramatically different for established NYSE firms and new Nasdaq firms. A complete economic explanation for the significance of the macro factors would require the cash policies of

these groups of firms to have different sensitivities to macroeconomic conditions. This issue requires further exploration.

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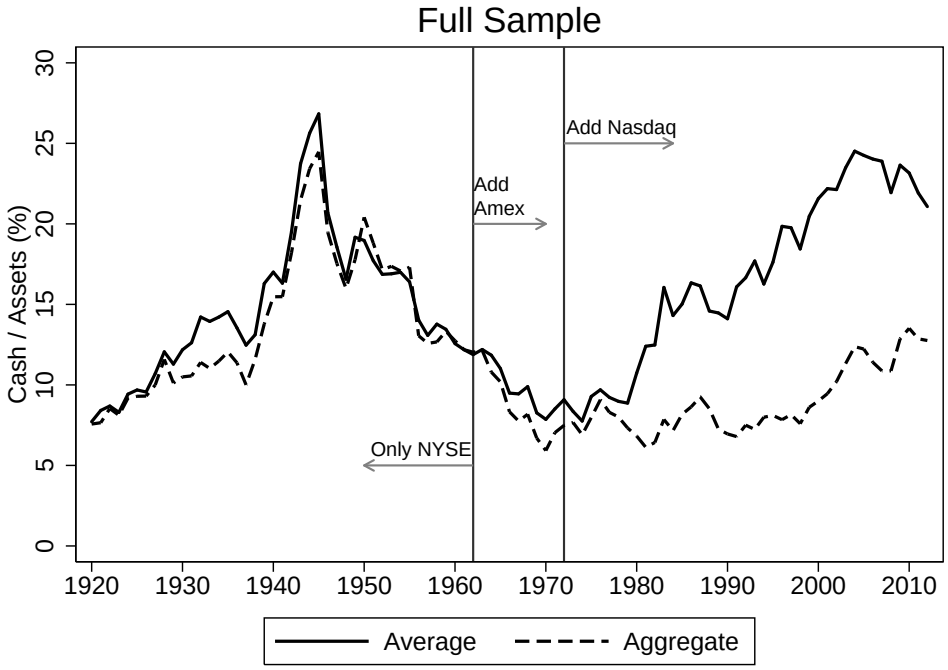
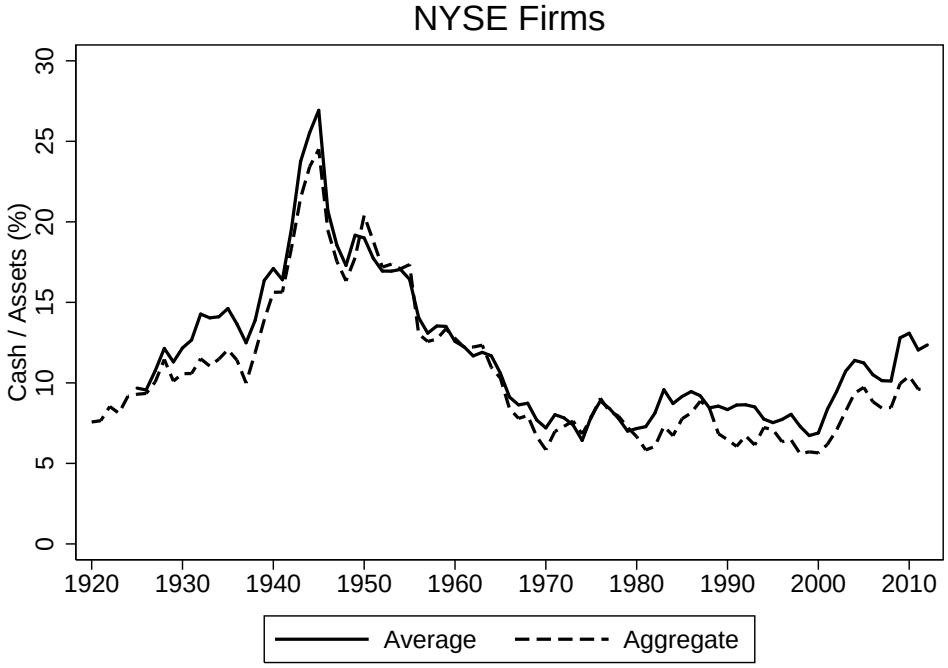
**Figure 1**
**Average and Aggregate Cash Ratios Through Time**

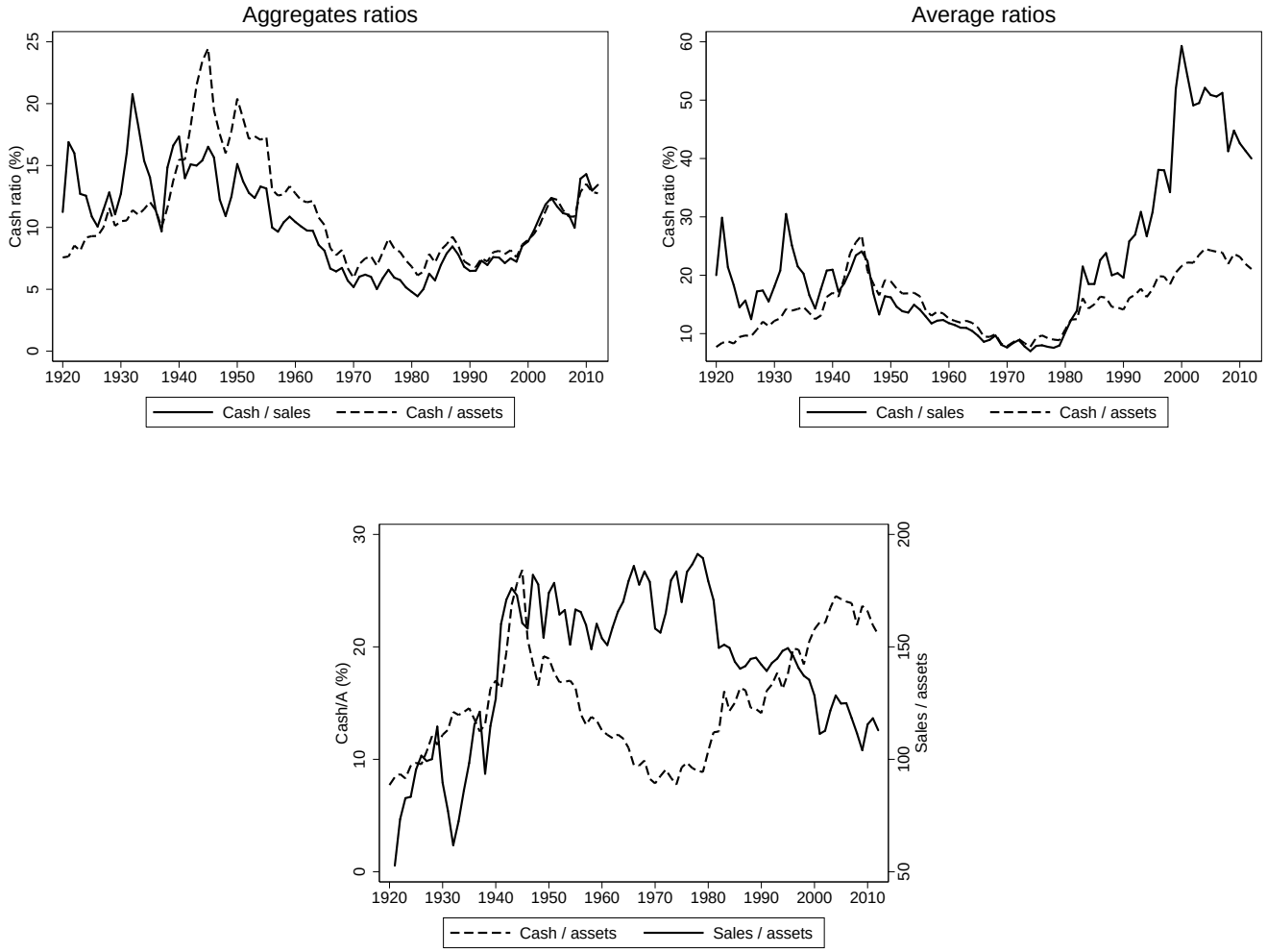
The solid (dashed) line presents the annual average (aggregate) ratio of cash and short-term investments to total assets. Aggregate cash-to-assets is defined each year as the cross-sectional sum of total cash and short-term investments divided by the sum of total book assets. The sample includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded.



## Figure 2
## Cash and Sales

Cash is defined as cash and short-term investments. Panel A plots aggregate ratios, formed as the cross-sectional sum of cash scaled by the cross-sectional sum of total sales (solid line) or book assets (dashed line). All lines in Panels B and C represent annual cross-sectional averages of the cash-to-assets ratio (dashed line), cash-to-sales (solid line Panel B) or sales to assets (solid line Panel C) ratio. The sample includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded.



## Figure 3
## Distribution of cash holdings

The sample in Panels A, B and C includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. Panels A and B display the annual quartile breakpoints of the distribution of the ratio of cash and short-term investments to total book assets. Panel C presents the average cash-to-assets ratio each year for firms in our sample with at least 80 years of non-missing data for both cash and short-term investments and total assets. Panel D presents aggregate cash (excluding short-term investments) to assets from the IRS Statistics of Income. Regulated firms include those in the utilities, railroads and telecommunications industries. Unregulated firms include all other non-financial industries.

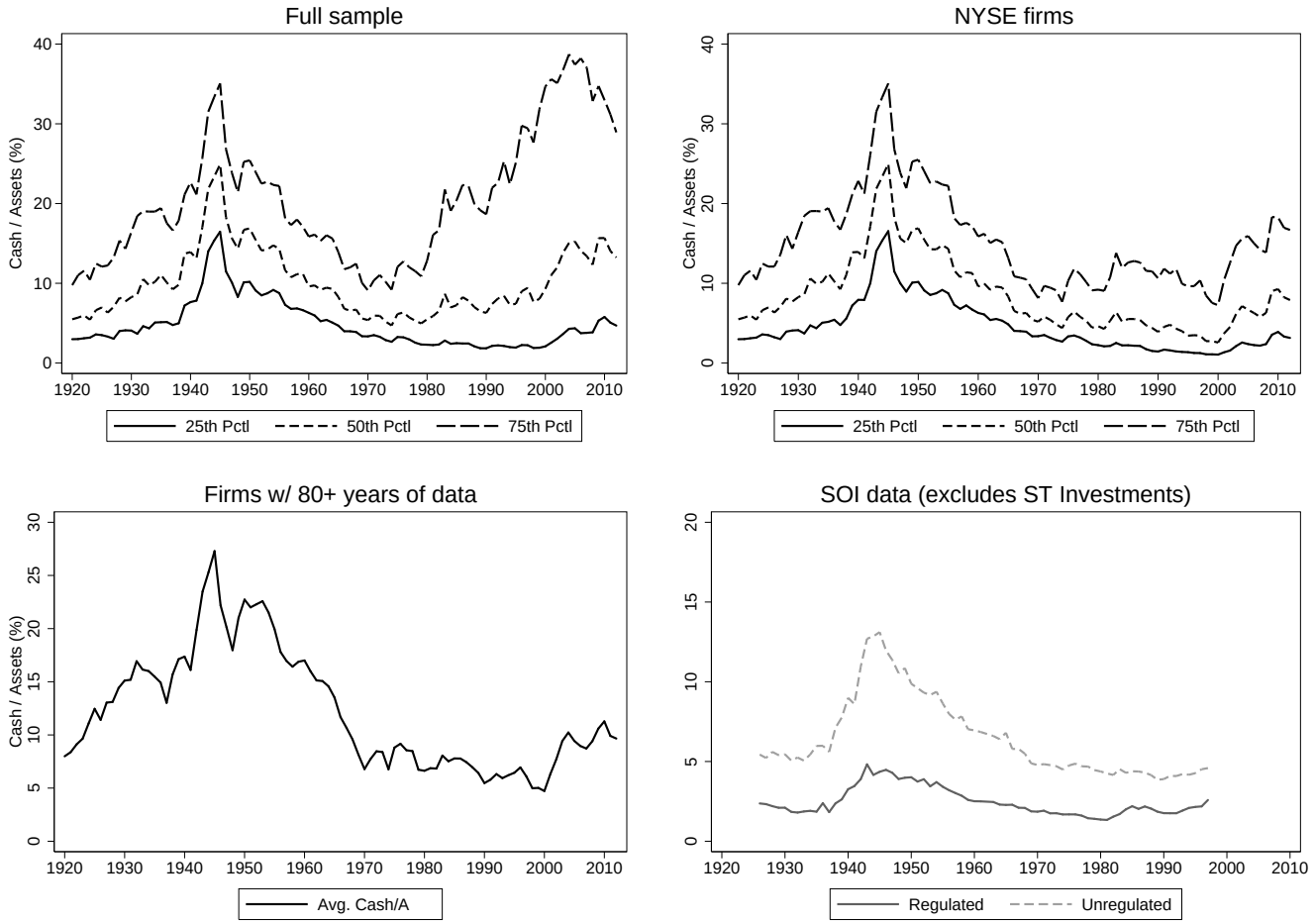
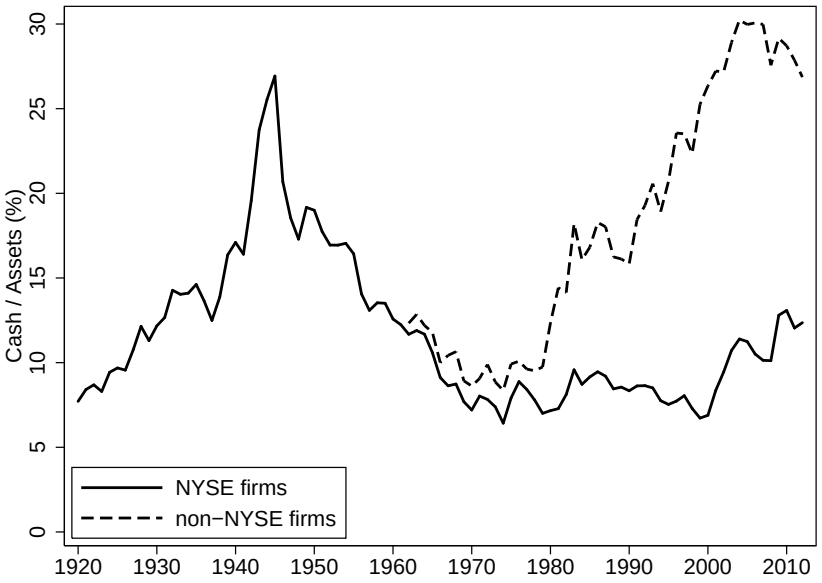


**Figure 4**
**Cash Trends by Exchange and Industry**

The sample includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. Non-NYSE firms include Amex listed firms starting in 1962 and Nasdaq firms starting in 1972. Technology and healthcare firms are defined using the Fama and French 12-industry definitions.

Panel A: Exchange listings




Panel B: Industry comparison

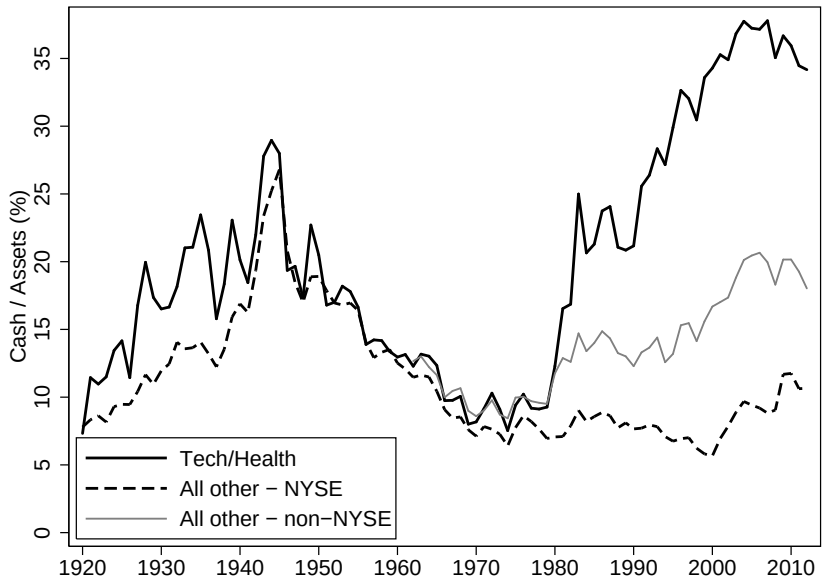
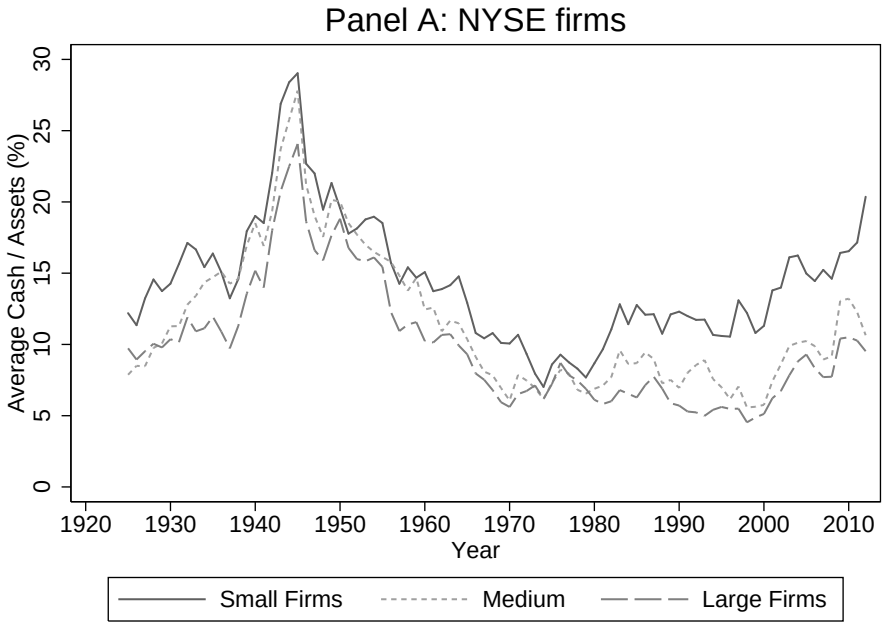


**Figure 5**
**Cash Trends by Firm Size**

The sample in Panel A includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. The sample in Panel B includes all firms (excluding financial firms, utilities and railroads) covered by the Moody's Industrial manuals in each year ending in "8." In Panel A, NYSE firms are sorted into terciles each year by total book assets and the average ratio of cash and short-term investments is calculated within each portfolio. In Panel B, large and small non-NYSE firms are based on firms above and below median book assets each year among all non-NYSE firms.



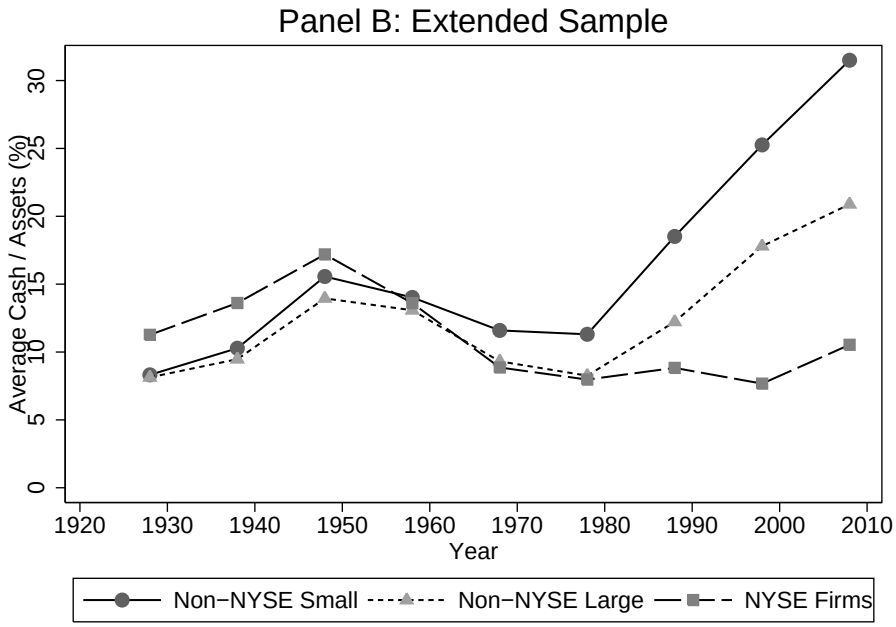
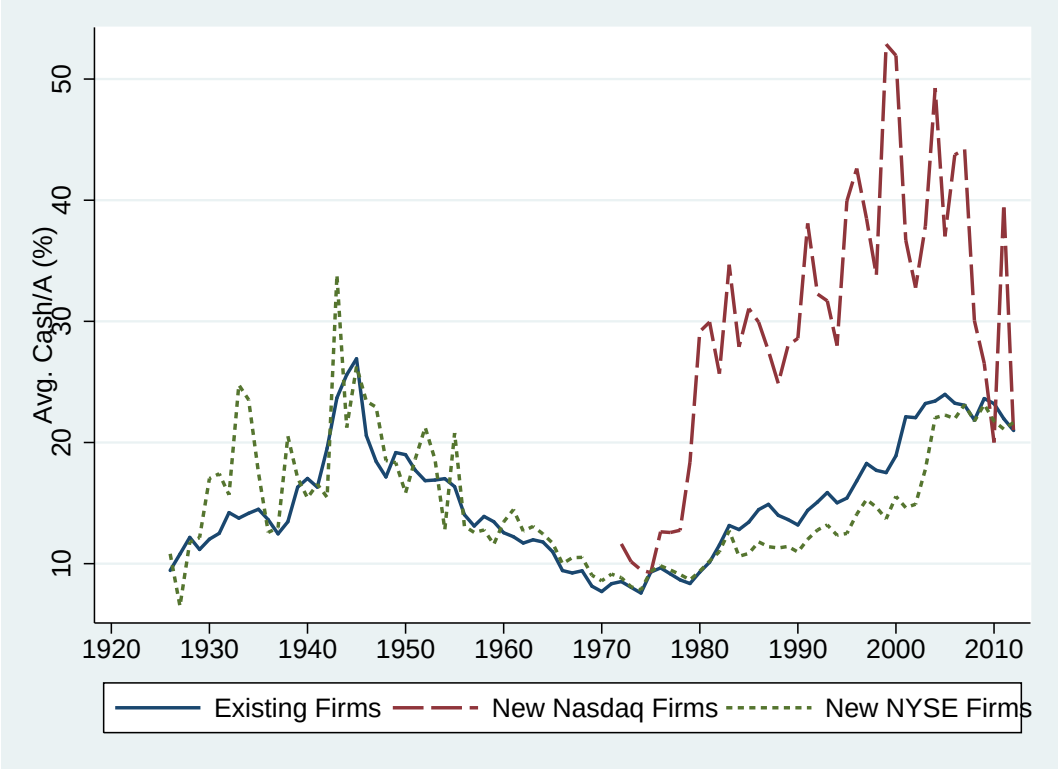



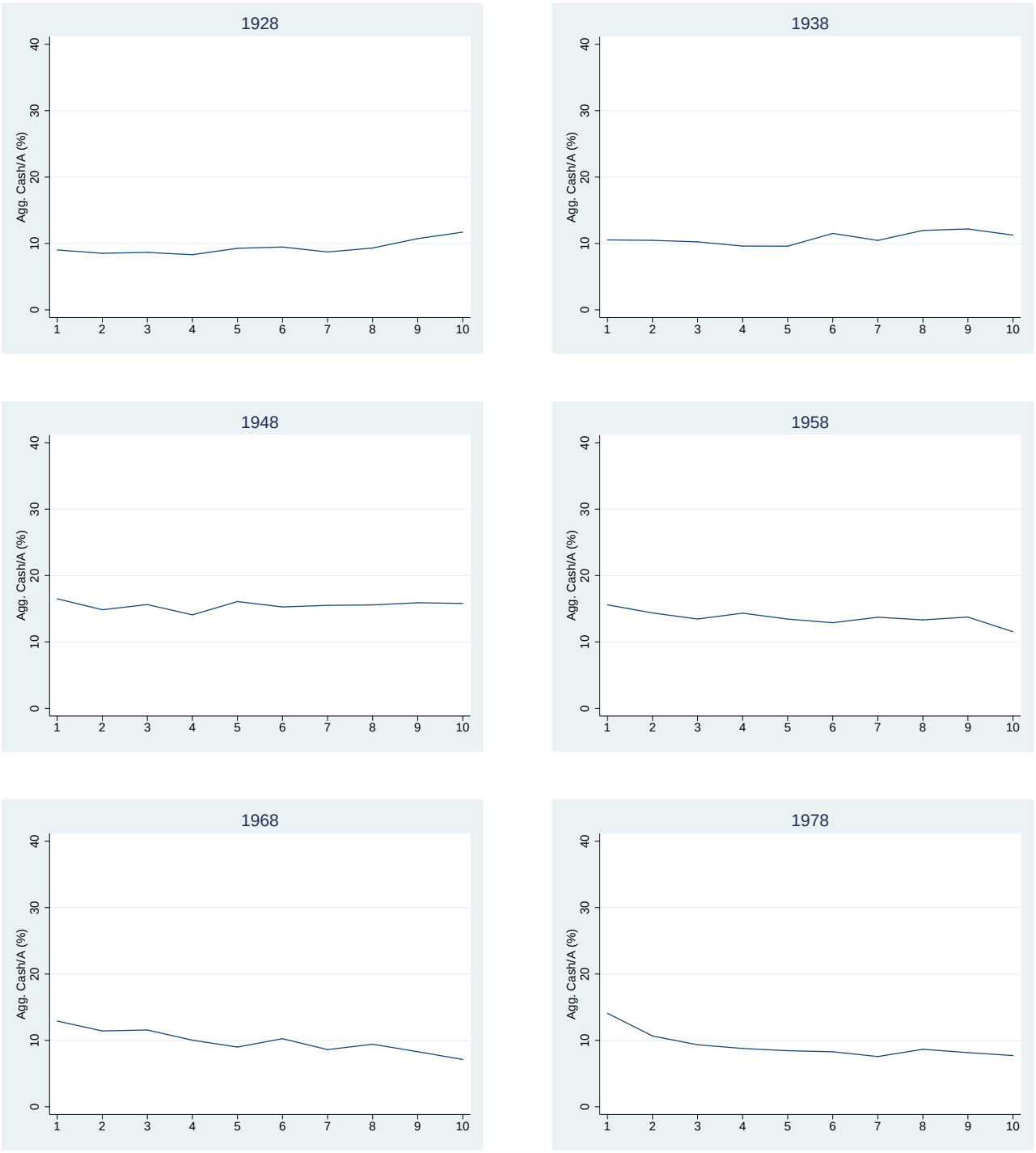
**Figure 6**
**Impact of New Entrants**

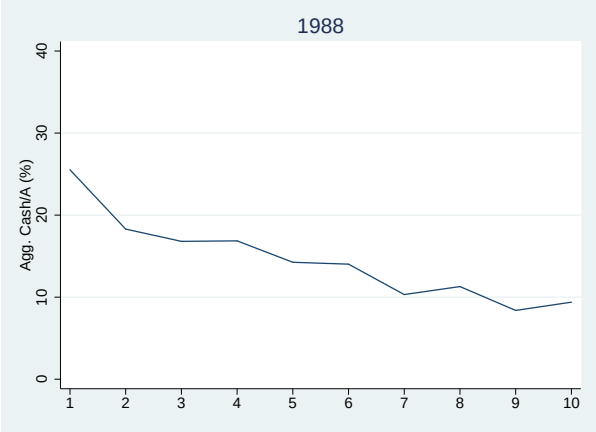
The sample includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. New firms are those firms that appear in the sample for the first time in each year $t$. Existing firms are those that were in the sample in both years $t-1$ and $t$. Each line represents the average ratio of cash and short-term investments to total book assets.

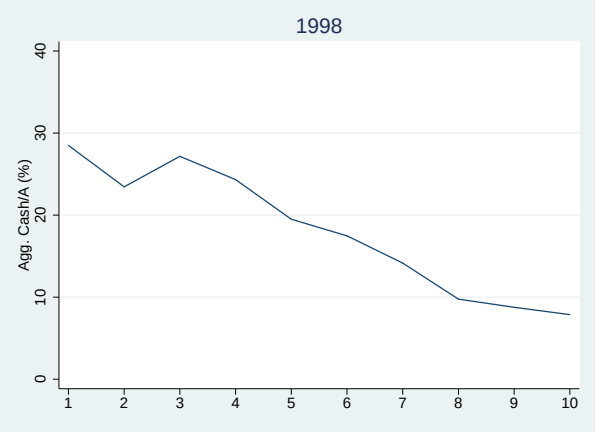


## Figure 7
## Cash Holdings by firm size

The sample includes all firms (excluding financial firms, utilities and railroads) covered by the Moody's Industrial manuals. Firms are sorted into deciles each year by total book assets and the average ratio of cash and short-term investments is calculated within each portfolio.




1988
Agg. Cash/A (%)
0
10
20
30
40
1
2
3
4
5
6
7
8
9
10


1998
Agg. Cash/A (%)
0
10
20
30
40
1
2
3
4
5
6
7
8
9
10

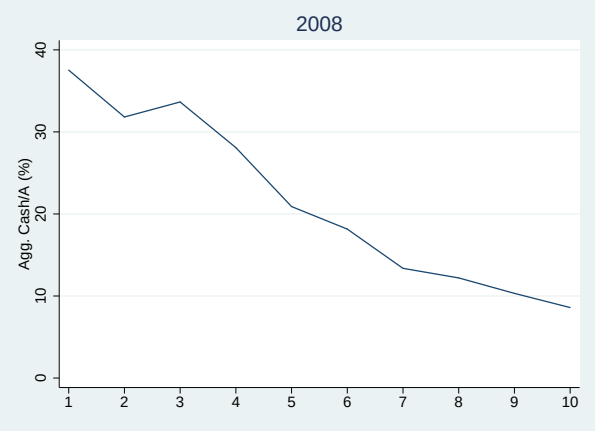
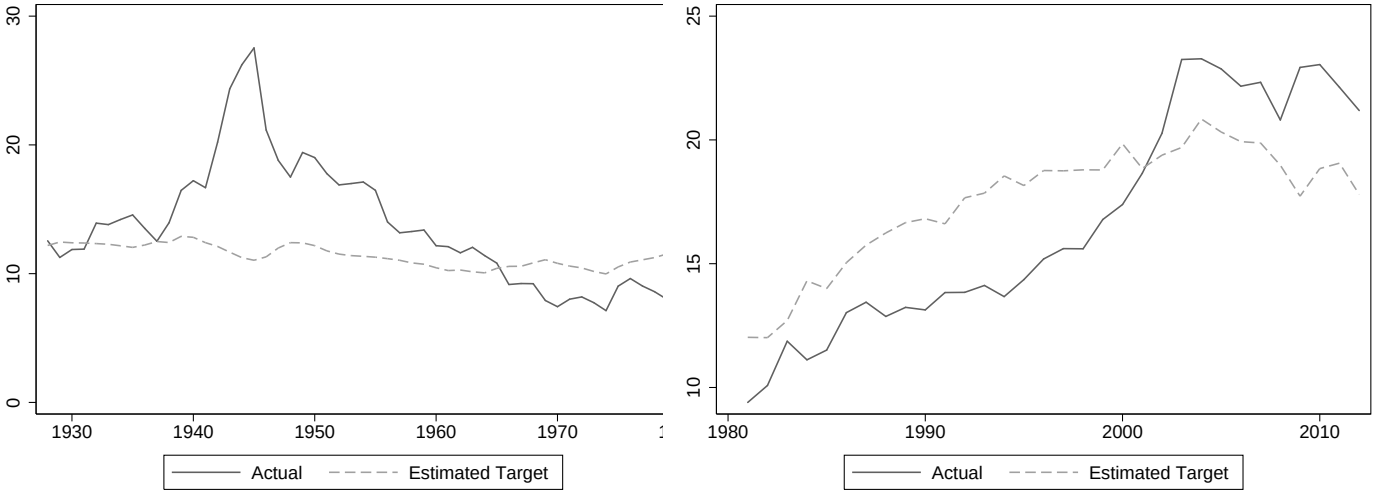

2008
Agg. Cash/A (%)
0
10
20
30
40
1
2
3
4
5
6
7
8
9
10

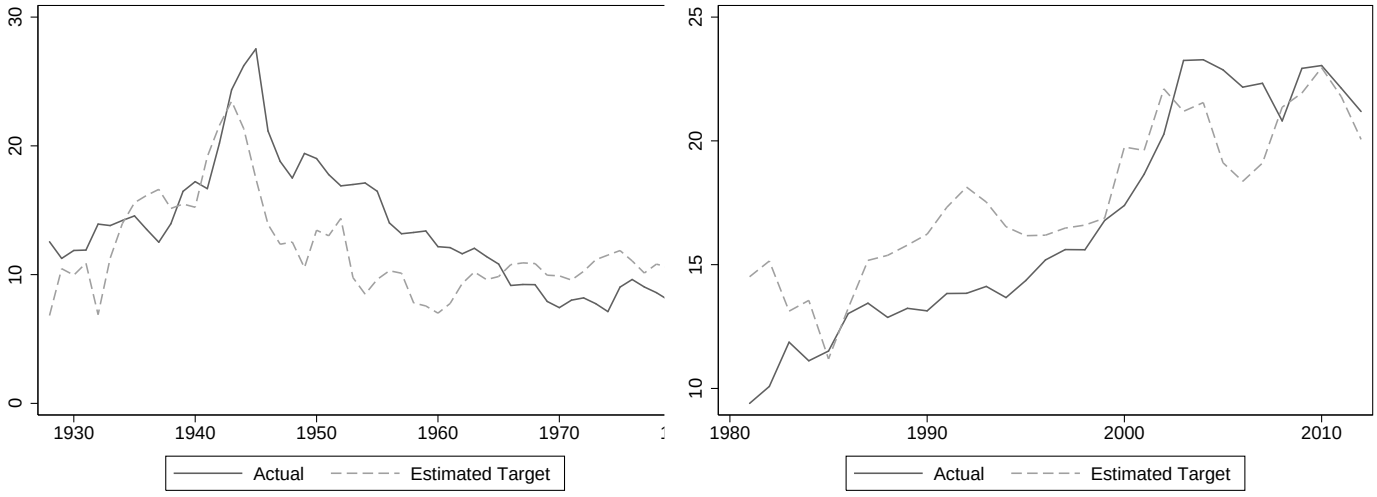
**Figure 8**
**Average Cash Ratio: Fitted vs. Actual**

The sample includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals from 1925 - 2012. Financial firms, utilities and railroads are excluded. The solid line presents the annual cross sectional average of the ratio of cash and short-term investments to total assets. The dashed lines display the average estimated target from the partial adjustment model in equation (2). In Panel A, the target determinants include only the firm characteristics shown in Table 4. In Panel B, we add the macroeconomic variables from Table 7. In the left (right) plot of Panels A and B, equation (2) is estimated over the period 1926 - 1980 (1981 - 2012). In Panel C, the model is estimated over the entire sample period.

Panel A: Firm characteristics




Panel B: Firm characteristics and Macro variables



Panel C: Full sample estimation

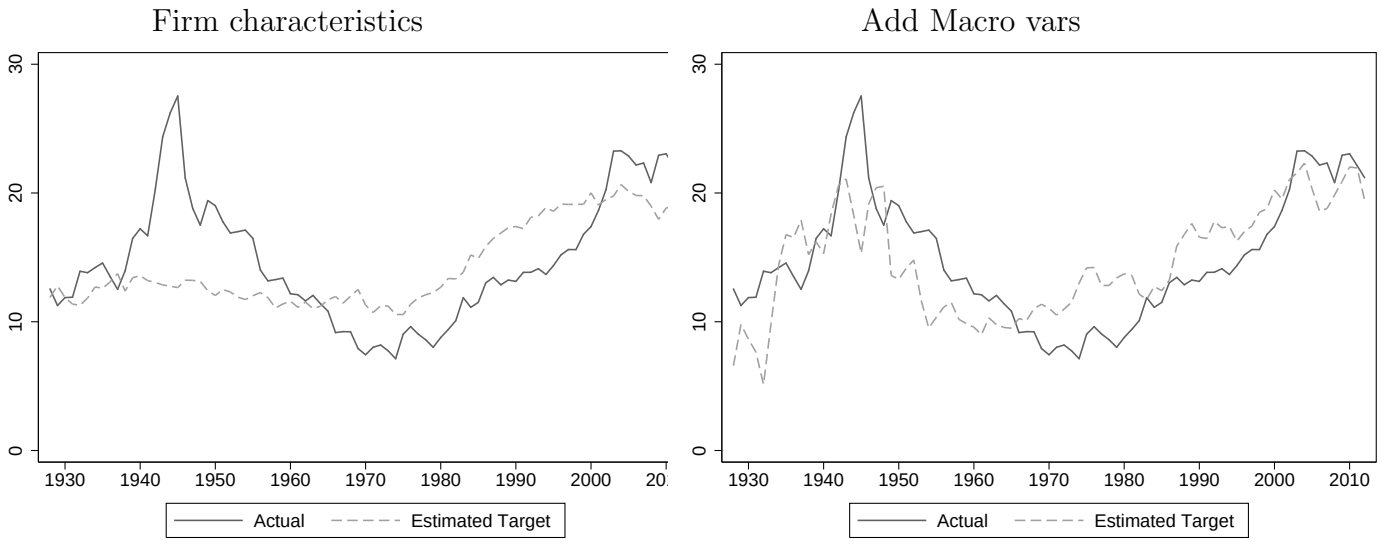


**Figure 9**

**Cumulative changes in aggregate cash ratio: fitted vs. actual**

The sample includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals from 1925 - 2012. Financial firms, utilities and railroads are excluded. The solid line presents cumulative annual changes in the aggregate ratio of cash and short-term investments to total assets. The dashed lines display cumulative predicted changes from estimating equation (3) in first difference form. In Panel A, the estimation includes only the firm-specific target determinants in column (1) of Table 8; in Panel B, we add contemporaneous cash flow and investment; in Panel C, we add the macroeconomic variables in columns (3) and (4) of Table 8.

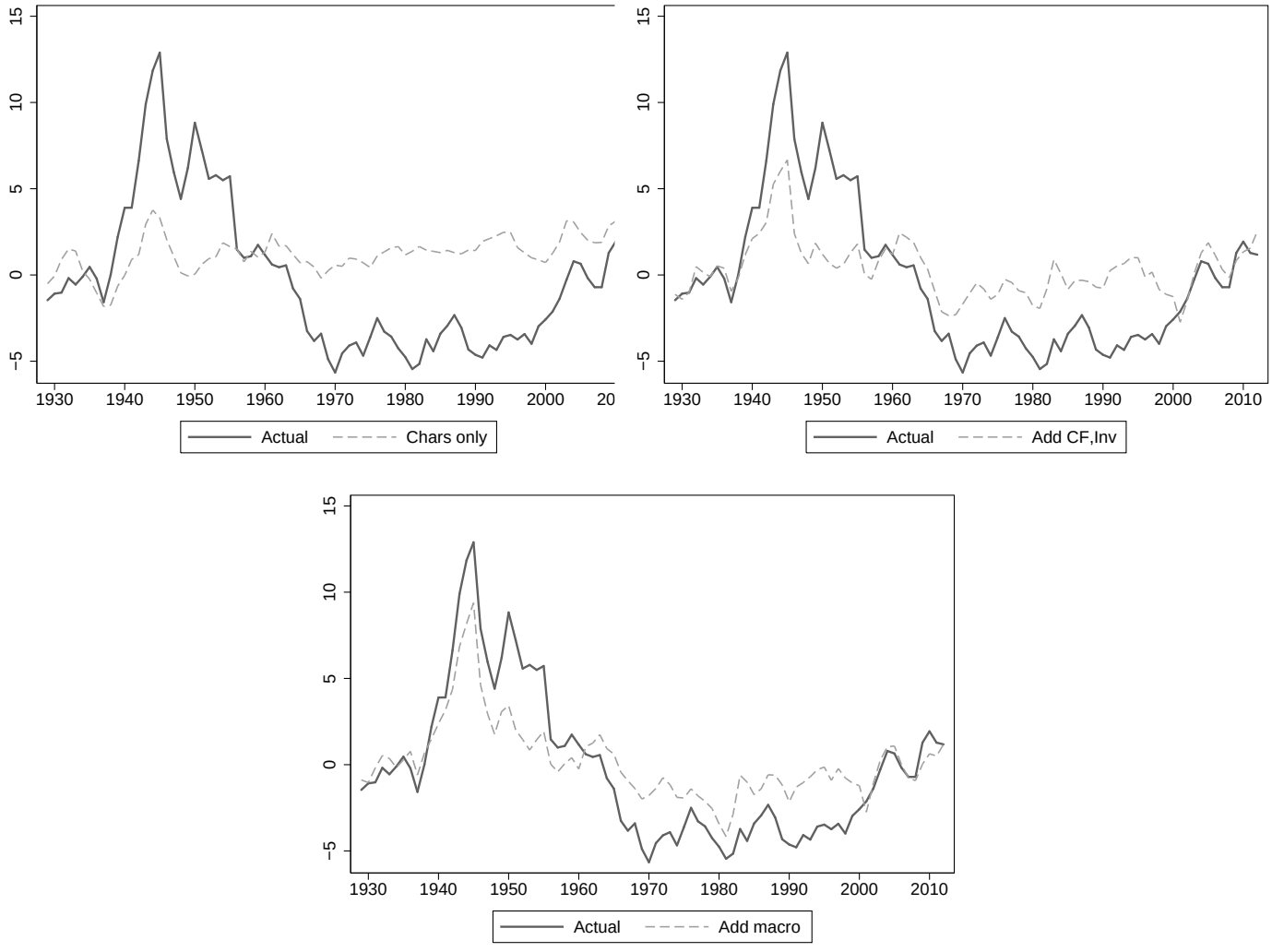


**Table 1**

Summary Statistics

The sample covers the period 1920 - 2010 and includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. All variables are expressed as percentages, with the exception of market-to-book assets and average book assets.

Panel A: Panel Data Summary Statistics

| | mean | sd | min | max |
|---|---|---|---|---|
| Cash / Assets (%) | 15.60 | 18.53 | 0.04 | 88.28 |
| Cash / Sales (%) | 24.97 | 68.59 | 0.04 | 558.20 |
| Cash flow volatility | 0.08 | 0.06 | 0.00 | 0.77 |
| Mkt assets / Book assets | 1.72 | 1.51 | 0.07 | 10.74 |
| ln(Real book assets) | 5.24 | 1.95 | -3.10 | 12.54 |
| (Curr. Assets - Cash) / A (%) | 39.25 | 21.89 | 1.16 | 86.84 |
| Other Curr. Liab. / A (%) | 19.89 | 11.78 | 1.79 | 65.83 |
| ST Debt / A (%) | 5.30 | 8.86 | 0.00 | 50.52 |
| LT Debt / A (%) | 16.13 | 16.92 | 0.00 | 76.38 |
| Dividend payer | 0.45 | 0.50 | 0.00 | 1.00 |
| Sales / A (%) | 147.06 | 101.21 | 0.35 | 572.25 |
| Cash Flow / A (%) | -0.05 | 0.72 | -173.26 | 55.78 |
| Investment / A (%) | 3.58 | 11.14 | -23.41 | 65.25 |

Panel B: Averages by Decade

The sample includes firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. Averages are calculated as the equal-weighted mean of all firm-year observations within each decade.

| | Obs. | Cash/ A | Cash/ S | CF vol | MA/ BA | ln(Real assets) | Curr. A/ A | Oth. Curr. Liab./A | ST D/ A | LT D/ A | Div. Pay. | Sales/ A | CF/ A | Invest./ A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1921–1930 | 1,937 | 11.38 | 18.09 | 0.05 | 1.18 | 5.84 | 29.29 | 6.49 | 2.24 | 8.16 | 0.75 | 96.39 | 0.03 | 3.11 |
| 1931–1940 | 4,993 | 14.18 | 20.67 | 0.06 | 1.03 | 5.68 | 29.25 | 7.61 | 1.83 | 7.98 | 0.62 | 98.46 | 0.00 | -0.64 |
| 1941–1950 | 6,232 | 20.68 | 18.90 | 0.04 | 1.06 | 5.77 | 39.87 | 18.85 | 2.07 | 6.77 | 0.95 | 168.60 | 0.05 | 2.72 |
| 1951–1960 | 6,609 | 15.13 | 12.93 | 0.03 | 1.16 | 6.19 | 43.08 | 17.66 | 3.26 | 11.40 | 0.92 | 160.97 | 0.03 | 3.23 |
| 1961–1970 | 11,645 | 9.76 | 8.91 | 0.02 | 1.58 | 6.03 | 47.44 | 18.00 | 5.44 | 16.40 | 0.79 | 171.07 | 0.03 | 4.84 |
| 1971–1980 | 27,005 | 8.67 | 7.54 | 0.03 | 1.22 | 5.33 | 49.44 | 20.64 | 6.54 | 19.13 | 0.65 | 181.65 | 0.04 | 4.69 |
| 1981–1990 | 35,016 | 13.30 | 17.55 | 0.07 | 1.72 | 4.53 | 42.38 | 20.68 | 7.35 | 17.90 | 0.40 | 149.69 | -0.05 | 4.20 |
| 1991–2000 | 42,081 | 16.83 | 30.80 | 0.11 | 2.10 | 4.83 | 37.42 | 21.14 | 5.63 | 16.55 | 0.26 | 142.72 | -0.09 | 4.29 |
| 2001–2012 | 37,335 | 22.85 | 47.13 | 0.13 | 2.01 | 5.68 | 29.54 | 20.69 | 3.60 | 15.64 | 0.27 | 117.46 | -0.11 | 1.81 |

**Table 2**

Time trends in cash holdings

The sample includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. The dependent variable is the ratio of cash and short-term investments to total assets. The first three columns capture time trends in average cash holdings. Columns (4) - (6) include firm fixed effects and therefore measure average within-firm changes in cash ratios. Columns (7) and (8) measure within-firm changes in cash excluding the first four years after each firm's IPO, proxied by the first year the firm appears in our database. $t-$statistics are in parentheses. Statistical significance at the 1%, 5% and 10% levels is indicated by ***, **, and *, respectively. Standard errors are adjusted for clustering at the firm level.

Panel A: Full Sample

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | 1920-50 | 1951-80 | 1981-2012 | 1920-50 | 1951-80 | 1981-2012 | 1981-2012 | 1981-2012 |
| | | | | | | | Excl. first 4 years | |
| Time trend | 0.455*** | -0.242*** | 0.386*** | 0.423*** | -0.357*** | -0.119*** | 0.066*** | |
| | (23.47) | (-18.13) | (23.67) | (17.81) | (-25.22) | (-7.55) | (3.93) | |
| Time trend x 1980s | | | | | | | | -0.108*** |
| | | | | | | | | (-2.98) |
| Time trend x 1990s | | | | | | | | -0.091** |
| | | | | | | | | (-2.13) |
| Time trend x 2000s | | | | | | | | 0.148*** |
| | | | | | | | | (3.34) |
| Firm FE | | | | Yes | Yes | Yes | Yes | Yes |
| Adj. $R^2$ | 0.097 | 0.034 | 0.022 | 0.112 | 0.083 | 0.003 | 0.001 | 0.009 |
| N | 17,793 | 54,894 | 132,071 | 17,793 | 54,894 | 132,071 | 86,040 | 86,040 |

Panel B: NYSE Firms

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | 1920-50 | 1951-80 | 1981-2012 | 1920-50 | 1951-80 | 1981-2012 | 1981-2012 | 1981-2012 |
| | | | | | | | Excl. first 4 years | |
| Time trend | 0.476*** | -0.366*** | 0.117*** | 0.412*** | -0.413*** | 0.100*** | 0.102*** | |
| | (18.90) | (-23.61) | (7.74) | (14.59) | (-23.63) | (5.41) | (5.20) | |
| Time trend x 1980s | | | | | | | | 0.003 |
| | | | | | | | | (0.07) |
| Time trend x 1990s | | | | | | | | -0.117** |
| | | | | | | | | (-2.49) |
| Time trend x 2000s | | | | | | | | 0.312*** |
| | | | | | | | | (6.79) |
| Firm FE | | | | Yes | Yes | Yes | Yes | Yes |
| Adj. $R^2$ | 0.076 | 0.116 | 0.009 | 0.085 | 0.170 | 0.007 | 0.008 | 0.026 |
| N | 14,909 | 26,816 | 34,856 | 14,909 | 26,816 | 34,856 | 29,010 | 29,010 |

**Table 3**

Determinants of cash holdings

The sample in columns (1) through (3) cover the period 1980 - 2012 and include all firms in the intersection of CRSP and Compustat, excluding financial firms, utilities and railroads. The sample in column (4) through (7) covers the period 1926 - 2012 and includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. The first four years of data for each firm are excluded. The dependent variable in columns (1) through (6) is the ratio of cash and short-term investments to total assets. Column (7) models the annual change in this cash ratio. All models include firm and year fixed effects. $t-$statistics are in parentheses. Statistical significance at the 1%, 5% and 10% levels is indicated by ***, **, and *, respectively. Standard errors are adjusted for clustering at the firm level.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | 1980-2006 | 1980-2006 | 1980-2012 | 1926-80 | 1926-2012 | 1926-2012 | 1926-2012 |
| Ind. CF vol. | 0.088** | 0.047* | 0.057*** | 0.041 | 0.066*** | 0.061*** | 0.023* |
| | (2.26) | (1.88) | (2.59) | (0.65) | (3.10) | (2.80) | (1.83) |
| MA/BA | 0.010*** | 0.009*** | 0.011*** | 0.016*** | 0.012*** | 0.012*** | 0.006*** |
| | (10.23) | (10.21) | (13.66) | (8.09) | (15.46) | (14.53) | (10.84) |
| Real size | 0.003* | 0.003 | -0.021*** | -0.007** | -0.014*** | -0.018*** | -0.010*** |
| | (1.72) | (1.41) | (-11.65) | (-2.41) | (-9.45) | (-12.11) | (-12.83) |
| Cash flow / A | 0.042*** | 0.025*** | 0.006* | 0.063* | 0.008** | 0.011** | 0.010** |
| | (5.40) | (4.28) | (1.66) | (1.82) | (2.06) | (2.32) | (2.06) |
| CapEx / A | -0.283*** | -0.069*** | -0.093*** | -0.104*** | -0.093*** | -0.138*** | -0.178*** |
| | (-20.79) | (-12.99) | (-19.16) | (-15.86) | (-23.35) | (-27.50) | (-36.41) |
| R&D / Sales | 0.036*** | | | | | | |
| | (6.95) | | | | | | |
| Div. payer | 0.003 | 0.001 | 0.005* | 0.020*** | 0.010*** | 0.006*** | 0.001 |
| | (1.16) | (0.19) | (1.95) | (7.97) | (5.50) | (3.08) | (0.48) |
| Acquisitions | -0.173*** | | | | | | |
| | (-19.83) | | | | | | |
| NWC / A | -0.231*** | -0.242*** | | | | | |
| | (-29.00) | (-29.38) | | | | | |
| D / A | -0.250*** | -0.257*** | | | | | |
| | (-31.94) | (-33.00) | | | | | |
| Oth CA/A | | | -0.529*** | -0.436*** | -0.472*** | -0.253*** | 0.028*** |
| | | | (-46.46) | (-31.76) | (-49.95) | (-29.20) | (5.62) |
| Oth CL/A | | | -0.022* | 0.243*** | 0.045*** | 0.041*** | 0.007 |
| | | | (-1.78) | (15.46) | (4.37) | (3.98) | (1.14) |
| STD / A | | | -0.207*** | -0.054*** | -0.183*** | -0.150*** | -0.049*** |
| | | | (-22.10) | (-4.13) | (-23.77) | (-19.01) | (-8.93) |
| LTD / A | | | -0.186*** | -0.118*** | -0.178*** | -0.145*** | -0.039*** |
| | | | (-26.97) | (-10.83) | (-30.43) | (-24.50) | (-11.93) |
| Cash(t-1) | | | | | | | -0.404*** |
| | | | | | | | (-58.19) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adj. $R^2$ | 0.176 | 0.157 | 0.298 | 0.444 | 0.327 | 0.186 | 0.257 |
| N | 64,647 | 70,542 | 84,474 | 44,713 | 126,953 | 117,855 | 117,855 |

**Table 4**

Cash Determinants by Period

The table presents results from estimating equation (2) via the system-GMM procedure of Blundell and Bond (1998). The sample covers the period 1920 - 2012 and includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. The dependent variable is the ratio of cash and short-term investments to total assets. All models include year fixed effects. $t-$statistics are in parentheses. Statistical significance at the 1%, 5% and 10% levels is indicated by ***, **, and *, respectively. Standard errors are adjusted for clustering at the firm level.

Panel A: Full Sample

| | 1926-50 | 1951-80 | 1981-2012 | 1926 - 2012 |
|---|---|---|---|---|
| SOA | 0.21*** | 0.30*** | 0.19*** | 0.20*** |
| | (6.37) | (11.61) | (9.71) | (15.52) |
| *Cash target determinants* | | | | |
| CF vol. | 0.52 | 0.06 | 3.87*** | 3.63*** |
| | (1.28) | (0.44) | (14.07) | (14.89) |
| MA/BA | 2.92*** | 1.40*** | 4.34*** | 3.84*** |
| | (4.64) | (6.81) | (11.66) | (14.09) |
| Real Assets | -0.21 | -1.08*** | -2.65*** | -2.20*** |
| | (-0.49) | (-8.09) | (-8.93) | (-9.99) |
| E[CF] | -1.07 | -0.45* | -1.31* | -1.25* |
| | (-1.47) | (-1.71) | (-1.83) | (-1.93) |
| E[Investment] | -0.27 | 0.09 | 0.41 | 0.43** |
| | (-0.67) | (0.48) | (1.24) | (2.04) |
| Div. payer | 1.33*** | -0.32** | -0.80*** | -0.65*** |
| | (3.51) | (-2.30) | (-4.12) | (-4.31) |
| Curr. Assets / A | 3.29*** | -0.55* | 2.52** | 1.69*** |
| | (2.81) | (-1.69) | (2.38) | (2.94) |
| Oth. Curr. Liab / A | -0.88 | -0.13 | 1.35*** | 0.88*** |
| | (-0.99) | (-0.58) | (4.22) | (3.89) |
| ST Debt / A | -1.79*** | -0.57*** | -1.76*** | -1.57*** |
| | (-4.37) | (-4.14) | (-6.80) | (-8.67) |
| LT Debt / A | -2.03*** | -1.11*** | -1.74*** | -1.75*** |
| | (-5.60) | (-6.98) | (-4.33) | (-7.50) |
| *Deviations from target* | | | | |
| CF | 0.83** | 1.35*** | 0.46 | 0.33 |
| | (2.50) | (7.22) | (0.98) | (1.00) |
| Investment | -1.26*** | -1.08*** | -1.86*** | -1.63*** |
| | (-10.92) | (-19.02) | (-31.67) | (-35.71) |
| CF x D/A | 0.20 | -1.07*** | 0.05 | 0.05 |
| | (1.15) | (-3.62) | (0.21) | (0.29) |
| Year FE | Yes | Yes | Yes | Yes |
| N | 11,044 | 37,766 | 95,511 | 144,321 |

Panel B: NYSE Sample

| | 1926-50 | 1951-80 | 1981-2012 | 1926 - 2012 |
|---|---|---|---|---|
| SOA | 0.21*** | 0.31*** | 0.30*** | 0.23*** |
| | (6.37) | (10.62) | (11.58) | (15.10) |
| *Cash target determinants* | | | | |
| CF vol. | 0.52 | 0.23* | 1.15*** | 1.10*** |
| | (1.28) | (1.86) | (6.93) | (6.67) |
| MA/BA | 2.92*** | 1.21*** | 1.59*** | 1.99*** |
| | (4.64) | (6.58) | (8.29) | (10.72) |
| Real Assets | -0.21 | -0.88*** | -1.25*** | -1.05*** |
| | (-0.49) | (-5.85) | (-5.93) | (-5.85) |
| E[CF] | -1.07 | -0.76*** | -0.45 | -0.52 |
| | (-1.47) | (-3.04) | (-0.56) | (-0.74) |
| E[Investment] | -0.27 | -0.06 | 0.00 | 0.38** |
| | (-0.67) | (-0.30) | (0.01) | (2.11) |
| Div. payer | 1.33*** | 0.07 | -1.07*** | -0.57*** |
| | (3.51) | (0.53) | (-6.42) | (-4.17) |
| Curr. Assets / A | 3.29*** | -1.14*** | -0.23 | 0.53 |
| | (2.81) | (-3.86) | (-0.66) | (1.59) |
| Oth. Curr. Liab / A | -0.88 | 0.64*** | 0.60** | 0.27 |
| | (-0.99) | (3.11) | (2.57) | (1.21) |
| ST Debt / A | -1.79*** | -0.01 | -0.86*** | -0.87*** |
| | (-4.37) | (-0.06) | (-5.12) | (-5.95) |
| LT Debt / A | -2.03*** | -0.33** | -1.74*** | -1.25*** |
| | (-5.60) | (-1.98) | (-8.89) | (-7.36) |
| *Deviations from target* | | | | |
| CF | 0.83** | 0.88*** | 0.45*** | 0.41*** |
| | (2.50) | (8.36) | (4.33) | (5.43) |
| Investment | -1.26*** | -0.98*** | -1.22*** | -1.13*** |
| | (-10.92) | (-13.95) | (-19.16) | (-22.98) |
| CF x D/A | 0.20 | -0.32*** | -0.11 | -0.05 |
| | (1.15) | (-3.42) | (-0.99) | (-0.58) |
| Year FE | Yes | Yes | Yes | Yes |
| N | 11,044 | 23,185 | 29,144 | 63,373 |

**Table 5**

Cash Determinants by Decade

The table presents results from estimating equation (2) via the system-GMM procedure of Blundell and Bond (1998). The sample covers the period 1920 - 2012 and includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. The dependent variable is the ratio of cash and short-term investments to total assets. All models include year fixed effects. $t-$statistics are in parentheses. Statistical significance at the 1%, 5% and 10% levels is indicated by ***, **, and *, respectively. Standard errors are adjusted for clustering at the firm level.

Panel A: Full Sample

| | 1925-30 | 1931-40 | 1941-50 | 1951-60 | 1961-70 | 1971-80 | 1981-90 | 1991-00 | 2001-2012 |
|---|---|---|---|---|---|---|---|---|---|
| SOA | 0.23 | 0.24*** | 0.42*** | 0.36*** | 0.26*** | 0.38*** | 0.30*** | 0.21*** | 0.25*** |
| | (1.14) | (3.42) | (5.72) | (4.46) | (4.41) | (7.91) | (8.01) | (5.52) | (7.32) |
| *Cash target determinants* | | | | | | | | | |
| CF vol. | 0.41 | 0.27 | 0.57* | -0.28 | 0.07 | 0.19 | 0.45* | 2.84*** | 5.47*** |
| | (0.59) | (0.45) | (1.69) | (-1.00) | (0.27) | (1.20) | (1.74) | (7.16) | (15.90) |
| MA/BA | 3.49** | 3.25*** | 2.83*** | 1.27*** | 1.56*** | 1.44*** | 3.03*** | 5.44*** | 4.32*** |
| | (2.02) | (5.20) | (6.32) | (2.78) | (4.61) | (5.80) | (7.26) | (8.35) | (10.19) |
| Real Assets | -0.52 | -0.34 | -0.57 | -0.81** | -1.34*** | -1.04*** | -2.29*** | -3.04*** | -3.23*** |
| | (-0.62) | (-0.76) | (-1.55) | (-2.16) | (-5.95) | (-6.64) | (-7.71) | (-7.05) | (-8.81) |
| E[(Earn - Div)/A] | -2.32 | -0.09 | -0.46 | -0.97* | -1.17* | 0.00 | 0.26 | -3.18*** | -1.19 |
| | (-0.63) | (-0.13) | (-0.87) | (-1.89) | (-1.81) | (0.01) | (0.45) | (-4.25) | (-1.57) |
| E[Δ PP&E/A] | 0.27 | -0.41 | -1.34*** | -0.41 | 0.02 | -0.24 | -0.73*** | 0.31 | -0.82** |
| | (0.13) | (-1.06) | (-3.04) | (-0.77) | (0.05) | (-1.15) | (-2.67) | (0.52) | (-2.17) |
| Div. payer | 1.68 | 2.05*** | 0.02 | 0.10 | 0.38 | -0.44*** | -0.71*** | -0.65* | -1.68*** |
| | (1.16) | (4.55) | (0.08) | (0.30) | (1.51) | (-2.69) | (-2.78) | (-1.79) | (-7.07) |
| Current assets / A | 1.03 | 1.52 | -0.37 | -1.25 | -0.02 | -1.19*** | -0.06 | 2.57 | -1.71 |
| | (0.29) | (1.42) | (-0.33) | (-1.26) | (-0.02) | (-3.14) | (-0.07) | (1.39) | (-1.59) |
| Current Liab./ A | -0.05 | 0.82 | 0.73 | 1.10* | -0.48 | 0.01 | 0.18 | 1.39** | 1.39*** |
| | (-0.04) | (1.28) | (0.94) | (1.76) | (-1.04) | (0.04) | (0.60) | (2.51) | (3.51) |
| ST Debt / A | 0.85 | -1.67** | -1.61*** | -0.49** | 0.07 | -0.89*** | -1.97*** | -1.31*** | -2.27*** |
| | (0.51) | (-2.56) | (-3.40) | (-2.04) | (0.27) | (-5.81) | (-7.11) | (-2.82) | (-7.77) |
| LT Debt / A | -2.56*** | -1.52*** | -2.68*** | -0.95*** | -0.20 | -1.42*** | -2.31*** | -1.29 | -3.31*** |
| | (-2.81) | (-3.44) | (-4.64) | (-2.78) | (-0.61) | (-7.71) | (-7.28) | (-1.51) | (-7.68) |
| *Deviations from target* | | | | | | | | | |
| (Earn - Div)/A | 0.89*** | 0.54*** | 0.33 | 1.25*** | 0.76*** | 1.52*** | 2.17** | 1.41*** | 0.15 |
| | (2.99) | (2.69) | (0.56) | (5.66) | (4.76) | (6.32) | (2.55) | (5.05) | (0.78) |
| Δ PP&E/A | -1.08*** | -0.98*** | -1.76*** | -1.37*** | -0.96*** | -1.17*** | -2.17*** | -1.98*** | -1.90*** |
| | (-4.71) | (-6.03) | (-10.97) | (-8.64) | (-10.02) | (-16.98) | (-20.91) | (-21.25) | (-21.33) |
| CF x D/A | -0.23 | 0.18 | 0.80** | -0.28* | -0.25* | -1.33*** | -1.52** | -0.65*** | 0.31** |
| | (-0.94) | (0.99) | (2.35) | (-1.71) | (-1.77) | (-5.00) | (-2.33) | (-3.23) | (2.04) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1,207 | 4,338 | 5,499 | 6,133 | 9,132 | 22,501 | 28,277 | 33,678 | 33,556 |

Panel B: NYSE Sample

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | 1925-30 | 1931-40 | 1941-50 | 1951-60 | 1961-70 | 1971-80 | 1981-90 | 1991-00 | 2001 - 2012 |
| SOA | 0.23 | 0.24*** | 0.42*** | 0.36*** | 0.25*** | 0.45*** | 0.25*** | 0.31*** | 0.37*** |
| *Cash target determinants* | (1.14) | (3.42) | (5.72) | (4.45) | (4.45) | (7.26) | (5.26) | (3.85) | (7.91) |
| CF vol. | 0.41 | 0.27 | 0.57* | -0.28 | 0.23 | 0.40** | 0.47 | 0.85*** | 1.81*** |
| | (0.59) | (0.45) | (1.69) | (-1.01) | (0.88) | (2.32) | (1.29) | (3.50) | (7.43) |
| MA/BA | 3.49** | 3.25*** | 2.83*** | 1.27*** | 2.05*** | 1.00*** | 1.06* | 1.24*** | 1.93*** |
| | (2.02) | (5.20) | (6.32) | (2.78) | (5.18) | (4.40) | (1.80) | (3.95) | (6.45) |
| Real Assets | -0.52 | -0.34 | -0.57 | -0.81** | -1.05*** | -0.73*** | -1.14*** | -1.47*** | -1.26*** |
| | (-0.62) | (-0.76) | (-1.55) | (-2.16) | (-4.85) | (-3.97) | (-2.88) | (-4.22) | (-4.30) |
| (Earn - Div)/A | -2.32 | -0.09 | -0.46 | -0.97* | -1.53*** | 0.01 | -1.10 | -1.73*** | 1.02** |
| | (-0.63) | (-0.13) | (-0.87) | (-1.89) | (-2.74) | (0.05) | (-1.57) | (-3.86) | (2.44) |
| E[Δ PP&E/A] | 0.27 | -0.41 | -1.34*** | -0.41 | 0.41 | -0.67*** | 0.16 | 0.28 | -0.35 |
| | (0.13) | (-1.06) | (-3.04) | (-0.77) | (0.91) | (-3.23) | (0.30) | (0.65) | (-1.45) |
| Div. payer | 1.68 | 2.05*** | 0.02 | 0.10 | 0.39 | -0.06 | -1.16*** | -0.86*** | -1.00*** |
| | (1.16) | (4.55) | (0.08) | (0.30) | (1.45) | (-0.42) | (-3.03) | (-2.98) | (-4.49) |
| Current assets / A | 1.03 | 1.52 | -0.37 | -1.25 | -0.57 | -1.75*** | 0.23 | -0.41 | 0.00 |
| | (0.29) | (1.42) | (-0.33) | (-1.26) | (-0.79) | (-5.33) | (0.29) | (-0.45) | (0.01) |
| Current Liab./ A | -0.05 | 0.82 | 0.73 | 1.11* | -0.17 | 0.85*** | 0.07 | 0.25 | 0.87** |
| | (-0.04) | (1.28) | (0.94) | (1.77) | (-0.37) | (3.32) | (0.15) | (0.55) | (2.36) |
| ST Debt / A | 0.85 | -1.67** | -1.61*** | -0.49** | 0.13 | -0.05 | -0.36 | -0.48 | -1.48*** |
| | (0.51) | (-2.56) | (-3.40) | (-2.02) | (0.48) | (-0.34) | (-0.87) | (-1.27) | (-6.67) |
| LT Debt / A | -2.56*** | -1.52*** | -2.68*** | -0.95*** | -0.12 | -0.40* | -1.60*** | -1.49*** | -2.31*** |
| | (-2.81) | (-3.44) | (-4.64) | (-2.79) | (-0.35) | (-1.77) | (-3.76) | (-2.67) | (-9.05) |
| *Deviations from target* | | | | | | | | | |
| (Earn - Div)/A | 0.89*** | 0.54*** | 0.33 | 1.25*** | 0.51*** | 0.95*** | 0.99*** | 0.82*** | 0.27 |
| | (2.99) | (2.69) | (0.56) | (5.67) | (3.02) | (3.79) | (4.17) | (7.67) | (1.48) |
| Δ PP&E/A | -1.08*** | -0.98*** | -1.76*** | -1.37*** | -0.87*** | -1.00*** | -1.65*** | -1.18*** | -1.29*** |
| | (-4.71) | (-6.03) | (-10.97) | (-8.64) | (-8.32) | (-11.22) | (-14.06) | (-11.76) | (-12.61) |
| CF x D/A | -0.23 | 0.18 | 0.80** | -0.28* | -0.17 | -0.36 | -0.49** | -0.25 | -0.05 |
| | (-0.94) | (0.99) | (2.35) | (-1.71) | (-1.32) | (-1.54) | (-2.38) | (-1.55) | (-0.41) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1,207 | 4,338 | 5,499 | 6,132 | 7,064 | 9,989 | 8,699 | 9,521 | 10,924 |

**Table 6**

Cross-sectional regressions: Eight-years

The sample includes all firms (excluding financial firms, utilities and railroads) covered by the Moody's Industrial manuals. Cross-sectional regressions are estimated each year. The dependent variable is the ratio of cash and short-term investments to total assets. $t-$statistics are in parentheses. Statistical significance at the 1%, 5% and 10% levels is indicated by ***, **, and *, respectively.

Panel A: Cross-sectional regression results

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | 1928 | 1938 | 1948 | 1958 | 1968 | 1978 | 1988 | 1998 | 2008 |
| ln(Real Assets) | 0.505 | 0.001 | -0.289 | -0.971 | -1.570 | -1.835 | -3.032 | -3.705 | -5.509 |
| | (1.28) | (0.00) | (-1.24) | (-4.91) | (-9.25) | (-11.59) | (-13.14) | (-15.32) | (-16.56) |
| CF | 1.966 | 1.441 | 0.465 | 1.134 | 1.118 | 0.612 | -1.009 | -2.339 | -3.328 |
| | (3.28) | (4.23) | (1.82) | (5.27) | (4.42) | (2.26) | (-2.71) | (-6.42) | (-7.40) |
| NWC / A | -2.655 | -2.366 | -3.988 | -3.228 | -3.567 | -3.771 | -4.234 | -6.642 | -6.552 |
| | (-6.71) | (-6.43) | (-15.35) | (-14.14) | (-15.66) | (-20.58) | (-16.30) | (-25.53) | (-19.81) |
| D / A | -3.111 | -4.202 | -3.484 | -3.502 | -3.055 | -4.501 | -7.660 | -10.027 | -9.144 |
| | (-8.22) | (-13.00) | (-15.31) | (-17.89) | (-13.83) | (-22.71) | (-27.56) | (-34.24) | (-24.49) |
| Adj. $R^2$ | 0.145 | 0.154 | 0.218 | 0.269 | 0.255 | 0.277 | 0.254 | 0.346 | 0.371 |
| N | 891 | 1,232 | 2,099 | 2,039 | 2,678 | 3,979 | 4,710 | 5,922 | 3,858 |

Panel B: Firm size distribution

| | p1 | p10 | p25 | p50 | p75 | p90 | p99 |
|---|---|---|---|---|---|---|---|
| 1928 | 1.06 | 3.32 | 7.62 | 21.56 | 64.88 | 159.99 | 900.23 |
| 1938 | 0.57 | 2.51 | 6.04 | 16.11 | 48.19 | 145.47 | 1016.37 |
| 1948 | 1.03 | 2.72 | 5.91 | 14.19 | 39.80 | 107.69 | 858.50 |
| 1958 | 1.47 | 4.34 | 9.76 | 25.14 | 74.74 | 234.72 | 1628.03 |
| 1968 | 2.66 | 7.05 | 14.66 | 37.03 | 119.38 | 433.27 | 2695.02 |
| 1978 | 0.53 | 2.57 | 7.21 | 24.21 | 88.05 | 357.44 | 2764.00 |
| 1988 | 0.24 | 0.85 | 2.84 | 12.72 | 63.15 | 326.52 | 3532.36 |
| 1998 | 0.57 | 2.32 | 6.56 | 24.31 | 111.16 | 457.32 | 5338.29 |
| 2008 | 0.76 | 4.26 | 14.22 | 61.62 | 288.34 | 1170.38 | 13259.52 |
| Total | 0.46 | 2.46 | 7.08 | 24.22 | 96.55 | 403.04 | 4751.88 |

**Table 7**

Cash Determinants: Macroeconomic variables

The sample covers the period 1926 - 2012 and includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. The dependent variable is the annual change in the ratio of cash and short-term investments to total assets. Parameters are estimated using the "System GMM" method of Blundell and Bond (1998). $t-$statistics are in parentheses. Statistical significance at the 1%, 5% and 10% levels is indicated by ***, **, and *, respectively. Standard errors are adjusted for clustering at the firm level.

| | 1926-80 | 1981-2012 | 1926-2012 |
|---|---|---|---|
| T-bill rate | -0.26 | -0.17 | -1.84*** |
| | (-0.79) | (-0.76) | (-9.64) |
| Inflation | 0.74** | 0.77*** | 0.14 |
| | (2.11) | (3.83) | (0.85) |
| Liq. Premium | 0.44** | 1.71*** | 0.10 |
| | (2.44) | (4.53) | (0.48) |
| Mkt Vol. | 2.66*** | 0.12 | 1.33*** |
| | (6.44) | (0.52) | (6.30) |
| GDP growth | 2.81*** | -0.75*** | 0.45*** |
| | (7.27) | (-3.29) | (3.10) |
| Productivity | 1.32*** | -0.40** | 0.16 |
| | (5.38) | (-2.35) | (1.21) |
| Firm characteristics | Yes | Yes | Yes |
| N | 48,485 | 95,511 | 143,996 |

**Table 8**

Aggregate cash (1st Differences)

The table presents from estimating equation (3) in first difference form. The sample covers the period 1926 - 2012 and includes all firms in the CRSP database that are also covered either in Compustat or Moody's Industrial Manuals. Financial firms, utilities and railroads are excluded. The dependent variable is the annual change in the aggregate ratio of cash and short-term investments to total assets. Newey-West (1987) standard errors assuming two non-zero lags are used to compute all $t$-statistics (in parentheses).

Panel A: Estimated Coefficients

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Firm Characteristics* | | | | |
| CF vol. | -0.301 | -0.409** | | -0.268 |
| | (-1.65) | (-2.53) | | (-1.65) |
| MA/BA | -0.318** | -0.183 | | -0.317** |
| | (-2.14) | (-1.27) | | (-2.30) |
| Firm size | 0.058 | -0.027 | | -0.057 |
| | (0.51) | (-0.27) | | (-0.52) |
| E(CF) | -0.199 | 0.116 | | 0.154 |
| | (-0.79) | (0.52) | | (0.89) |
| E(Invest) | -0.059 | -0.138 | | 0.053 |
| | (-0.33) | (-0.78) | | (0.28) |
| Curr. A/A | -0.400 | -0.439* | | -0.333* |
| | (-1.52) | (-1.84) | | (-1.69) |
| Other CL/A | 0.397 | 0.210 | | -0.012 |
| | (1.19) | (1.30) | | (-0.08) |
| STD/A | -0.098 | 0.021 | | -0.069 |
| | (-0.67) | (0.17) | | (-0.57) |
| LTD/A | 0.108 | -0.151 | | -0.199 |
| | (0.89) | (-1.11) | | (-1.41) |
| Div. Payers | 0.134 | 0.294** | | 0.137 |
| | (0.89) | (2.42) | | (0.90) |
| CF | | 0.861*** | | 0.832*** |
| | | (3.56) | | (3.00) |
| Invest | | -1.090*** | | -1.015*** |
| | | (-6.43) | | (-4.55) |
| *Macroeconomic Factors* | | | | |
| T-bill rate | | | -0.259 | 0.028 |
| | | | (-0.89) | (0.13) |
| Inflation | | | -0.964*** | -0.115 |
| | | | (-3.02) | (-0.48) |
| Liq. Premium | | | 0.137 | 0.075 |
| | | | (1.22) | (0.72) |
| sd(Mkt Ret.) | | | 0.046 | 0.241 |
| | | | (0.34) | (1.56) |
| GDP growth | | | 0.606** | 0.650*** |
| | | | (2.45) | (2.67) |
| Productivity | | | 0.330* | 0.504*** |
| | | | (1.76) | (3.50) |
| Adj. $R^2$ | 0.08 | 0.45 | 0.26 | 0.52 |
| N | 86 | 86 | 84 | 84 |

Panel B: Variance Decompositions

| | (1) |
|---|---|
| *Firm Characteristics* | |
| CF vol. | 4% |
| MA/BA | 7% |
| Real Assets | 0% |
| E[CF] | 1% |
| E[Invest] | 0% |
| Curr. A / A | 3% |
| Oth. CL/A | 0% |
| STD/A | 0% |
| LTD/A | 2% |
| Div. payer | 1% |
| CF | 23% |
| Invest | 33% |
| *Macroeconomic factors* | |
| T-bill | 0% |
| Inflation | 0% |
| Liq. Prem. | 0% |
| Mkt Vol | 2% |
| GDP growth | 12% |
| Productivity | 11% |