Macroeconomic Determinants of Cash Holding

Uncertainty, Inflation, and Trends

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Abstract

Using a panel for United States firms over 1960-2007, this paper documents several empirical features of cash holdings by firms. We show that cash holdings as a share of total assets, after a period of decline, have been increasing considerably since the 1980s. While there is important heterogeneity in the amount of cash holdings, the increase in the cash-to-assets ratio has been a robust feature of all firms irrespective of their size, industry, level of idiosyncratic risk faced, etc. Our data analysis shows that idiosyncratic risk, measured by the standard deviation of real sales growth, is an important determinant of cash holdings by firms. We then document that changes in inflation are a central driver of the time-series changes in cash holdings: periods of price-level increase dictates a shift away from holding assets imperfectly hedged against inflation. Finally, we present a model where firms have an incentive to hold liquid assets to formally explain the features of the empirical analysis and identify the impacts of cash holdings on real variables and inflation on real variables via firm level cash holdings.

JEL Classification: E23; E32; G32.

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1 Introduction

Why are firms accumulating cash? Since the early 1980s, the levels of liquid asset holdings by US based firm has steadily increased and is now higher than any time since the 1960s. Given that firm level resources are continually channeled towards holding liquid assets in the face of sluggish output and employment growth, the importance of understanding why firms have been accumulating cash is clear. The goal of this paper is to contribute to this understanding.

We aim to account for the broad features of liquid asset holding over time as depicted in Figure 1. The most striking feature of liquid asset holdings is that the cash ratio - the ratio of firm level cash and marketable security holdings to total assets - has a V-shape over time. The cash ratio in the US declined significantly in the 60s and 70s and then started to rise 1980s onwards. In this paper we account for this V-shape; we explore a common explanation for the decline in cash ratio in the 60s and 70s and the rise thereafter. Methodologically, we empirically isolate the main drivers of cash holdings and then build a model where firms have an incentive to hold liquid assets to formally explain the features found in our empirical analysis.

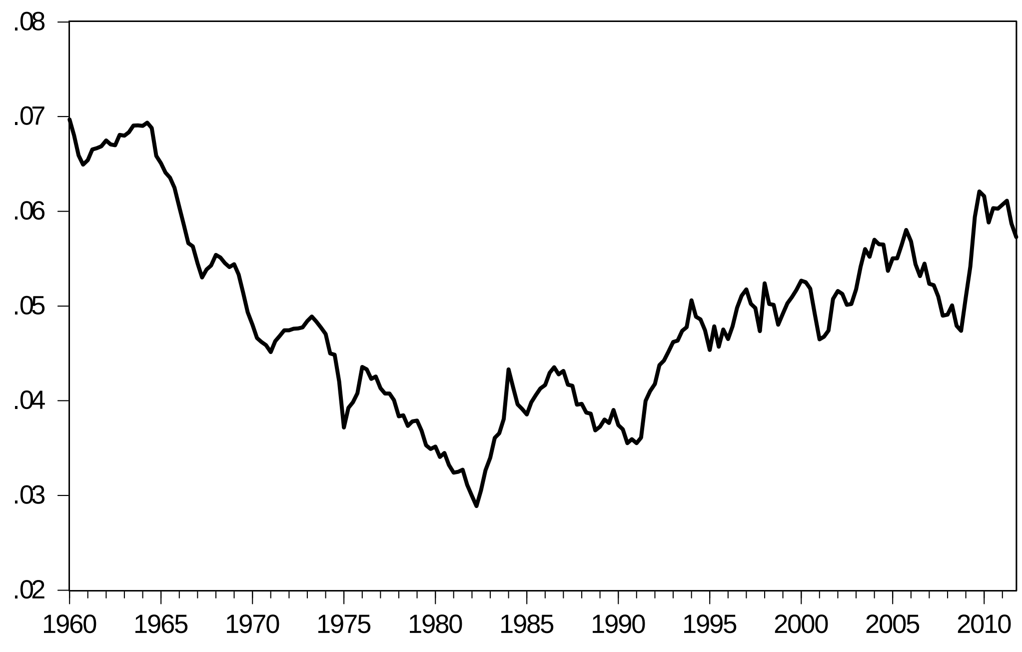

Figure 1: Cash Ratio 1960-2011. Data is from the Flow-of-Funds compiled by the US Federal Reserve Bank. Cash ratio is the ratio of firm-level cash, marketable securities, and other financial securities with less than 1 year maturity to total assets. Data is quarterly.

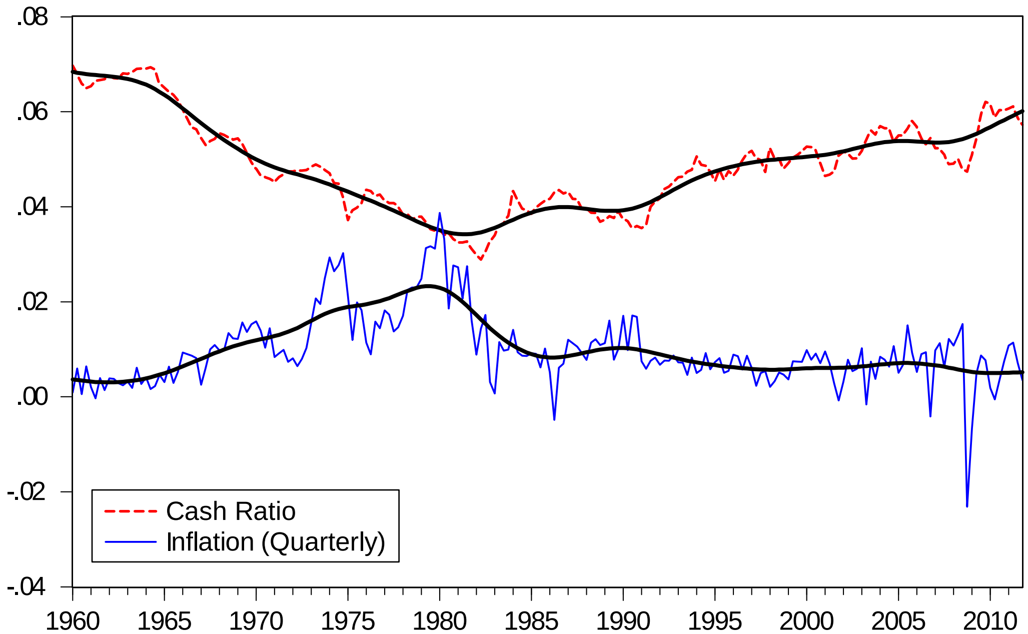

Figure 2: CASH RATIO AND QUARTERLY INFLATION 1960-2011. Data on Cash ratio is from the Flow-of-Funds compiled by the US Federal Reserve Bank. Cash ratio is the ratio of firm-level cash, marketable securities, and other financial securities with less than 1 year maturity to total assets. Inflation is computed quarterly accessed from the Federal Reserve Bank of St. Louis FRED Database. Trends are the Hodrick-Prescott filtered trend with smoothing parameter $\lambda = 1600$.

Using firm-level panel data, we establish two key facts. First we find that cash holdings are increasing in uncertainty of revenue flows. Firms hold cash due to a precautionary saving motive against adverse income streams, particularly when access to capital markets is poor. Second, we show that inflation is a central driver of changes in the time trend of cash holdings over time. All else equal, the real value of nominal assets erodes with inflation. Periods of price-level increase dictate a shift away from holding assets imperfectly hedged against inflation. Visually, Figure 2 captures this relationship. It displays the cash ratio and quarterly inflation along with their Hodrick Prescott trend. In short, our data indicates firms hold cash as a precaution against adverse revenue streams. Inflation impacts the level of the cash holdings by altering the marginal cost of holding these liquid nominal assets.

Our theoretical framework identifies a complementarity between liquid asset holding and capital and labor. We feature a cost to short-term borrowing in the spirit of the costly state verification framework in Bernanke and Gertler (1989). Uncertainty in revenue flows can lead to a situation where a firm does not have enough liquidity to cover its liabilities. In this case, they issue costly short-term debt to cover their obligations. Firms thus have incentive to accumulate liquid assets as a precaution against such states. A firm with a high level of liquidity is more easily able to cover higher levels of factor input expenses without issuing costly debt in periods of low revenue flow. In this way, higher liquidity leads to higher demand for capital and labor.

From a policy perspective, our model framework identifies a unique channel in which inflationary monetary policy adversely impacts real output: price level increases erode the value of nominal liquid assets which, in turn, reduces firm demand for productive capital and labor.

Our empirical analysis utilizes a firm-level panel from Compustat to investigate the determinants of cash holdings by firms similar to Opler et al. (1999) and Bates et al. (2009). We also identify the precautionary motive as a strong motive for firms' cash holdings. In contrast to these papers, we focus not only on firm-level explanations of the change in cash holdings but also on the impact of aggregate factors. We argue that aggregate inflation is a crucial factor in explaining the changing structure of the balance sheets. Recent work by Armenter and Hnatkovska (2012) shows that firms hold financial assets for precautionary reasons. They use a quantitative model to explain how firms can become net lenders. The relationship between cash holdings and macroeconomic uncertainty is explored in Baum et al. (2008) who find a relationship between cash holdings and macroeconomic uncertainty. Tax based explanations of liquid asset holding includes Stokey (2012) who argues that firms store liquid assets and cut investment until tax uncertainty is resolved. Foley et al. (2007) find that US multinationals hold cash because of the high cost of income repatriation associated with US corporate tax burdens. On the other hand, Pinkowitz et al. (2012) contend that high R&D expenditures by multinationals are a stronger factor for cash holdings than the tax related factors. To the best of our knowledge, our is the first to link inflation to firm-level cash holdings.

Our model is closely related to the costly debt frameworks developed by Carlstrom and Fuerst (1997), Bernanke and Gertler (1989), Bernanke et al. (1989) (henceforth BGG). The two main differences between our framework and the BGG model is that: (1) we model firm liquid asset holding decisions whereas BGG model the wealth decision of an entrepreneur; (2) we explicitly model the firms' dividend payment decision in our model which allows us to analyze the tradeoff between liquid asset holdings and payments to shareholders. In addition, our model is also able to explain firm level asset holdings vis-a-vis uncertainty and thus is also closely related to the financial markets and uncertainty shock literature (for example Christiano et al. (2009) and Gertler et al. (2010)).

The paper is organized as follows. In Section 2 we present the empirical facts underlying our study. Section 3 presents a model where firms have an incentive to hold liquid assets consistent with our empirical observations. We conclude with Section 4.

2 Data

This section documents the primary reasons firms hold liquid assets and identifies the main factors underlying the change in firms' cash holdings over time. First, we describe our firm-level panel data and present the broad time-series features of the sample. Empirically, we show that a key reason firms hold liquid assets is as a precaution against uncertain revenue flows. Finally, we document that changes in inflation are a main factor in accounting for the changes in cash holdings over time: price-level increases make it more costly to hold liquid assets if they are imperfectly hedged against inflation.

2.1 Description of the Data

We use Compustat annual industrial data from 1955-2011 for our empirical analysis.[1] The data contains observations for publically traded firms that represent 99 percent of total domestic market capitalization. We restrict our sample to US based firms and include all firms that appear in Compustat at any time. Firm year observations that have either negative log assets or firms with negative sales are additionally excluded. Financial firms and utilities (SIC Codes 6000-6999 and 4900-4999, respectively) are also omitted because their cash holdings may be the result of capital requirements or government regulation. Firms are required to be in the sample for at least 9 years and the observations are drawn from 1960-2007, this is due to the firm-specific uncertainty measure we use (see below). Our primary sample contains 8,904 firms for 103,550 firm-year observations.

Table 1 presents the main variables used in the study along with summary statistics. Our main variable of interest, the cash ratio, is measured as the ratio of liquid assets to total assets.[2] Liquid assets in this definition include cash, saving deposits, treasuries, short-term bonds, commercial paper, money market mutual funds, equities, and other marketable securities with less than 1 year to maturity. The average cash ratio for our sample is 13 percent.[3]

We measure firm-level uncertainty as the variability of real sales growth. Under the precautionary motive, theory would predict that cash holdings would be higher the more volatile the sales and thus revenue flows. We use two measures of uncertainty, the first is a centered 9-year rolling window of real sales growth. Real sales are obtained by deflating

[1]Quarterly data from Compustat exists from 1975–2011. Since our primary focus is on the long trends in cash holdings, we sacrifice the frequency provided by the quarterly data to gain a longer sample.

[2]The literature and the popular press call this measure of liquidity the "cash ratio," which we follow.

[3]This average cash ratio is slightly higher than the aggregate cash ratio in the Flow of Funds data, but, as discussed below, the time series of the Compustat data follows the trends of the Flow of Funds data.

nominal sales by the GDP deflator.[4] We additionally experiment with other window sizes and backward looking measures of the standard deviation of sales growth. Our second measure of uncertainty is a centered 9-year rolling window of firm-level coefficient of variation of real sales. We interpret this as the measured risk per dollar in sales.

We document four alternative uses of cash. *(i) Reduce debt/deleverage.* Leverage is defined as debt divided by assets. As firms become excessively leveraged they may use liquid assets to pay down their debt. *(ii) Investment.* Capital expenditures as a share of assets measure a contemporaneous tradeoff with cash (*CapX/Assets*). *(iii) Dividend payments* We construct a dividend dummy variable that equals 1 in years in which firms pay dividends and 0 otherwise. The data shows that firms pay dividends in nearly 50 percent of the observations. *(iv) Takeovers and mergers.* We measure the expenditures on the acquisitions of other firms (*Acquisitions/Assets*) to capture liquid asset use for such takeovers. Acquisitions data does not begin until 1970 and 73 percent of the observations for this variable are 0.

Finally, firm size is measured as the log of real assets *log(Assets/GDP Deflator)*). Also, we measure the expectation of profitable future investment opportunities as the *market-to-book ratio*, the market price of the firm (using annual closing share prices) divided by the book value of assets. As this ratio rises, we may expect that the firm has an expectation of future growth which may impact the use of resources today.

Figure 3 presents various decompositions of the mean and median cash ratio. Panel A shows the familiar V-shape trend similar to the flow of funds data for both the average and median cash ratio. In Panel B we break up the sample into the average cash ratio of manufacturing and non-manufacturing firms to visually inspect whether the trends are being driven by economic structural transformation following the relative rise of the service sector in the latter half of the sample. The levels follow each other closely and the manufacturing sector actually holds more cash relative to the other sectors.

Given that cash holdings may be related to poor access to credit markets, it may be expected that smaller firms would rely on holding more cash than large firms. Smaller firms are generally thought to have more difficulty accessing credit markets. Panel C displays the mean cash ratio by asset quintiles. It is interesting to note that although the media has paid special attention to cash holdings by large firms such as Apple, Google, and Microsoft. In the data smaller firms have been the largest holders of cash relative to their size. Additionally, the cash ratio time series of all firms, regardless of size, have followed the same, general V-shape trend.

In Panel D, we decompose the mean cash ratio by the standard deviation of sales growth quintiles. In the figure, for example, the 5th quintile represents the cash ratio of firms that

[4] Real sales growth is defined as $\frac{\text{Real Sales}_t - \text{Real Sales}_{t-1}}{\frac{1}{2}(\text{Real Sales}_t - \text{Real Sales}_{t-1})}$.

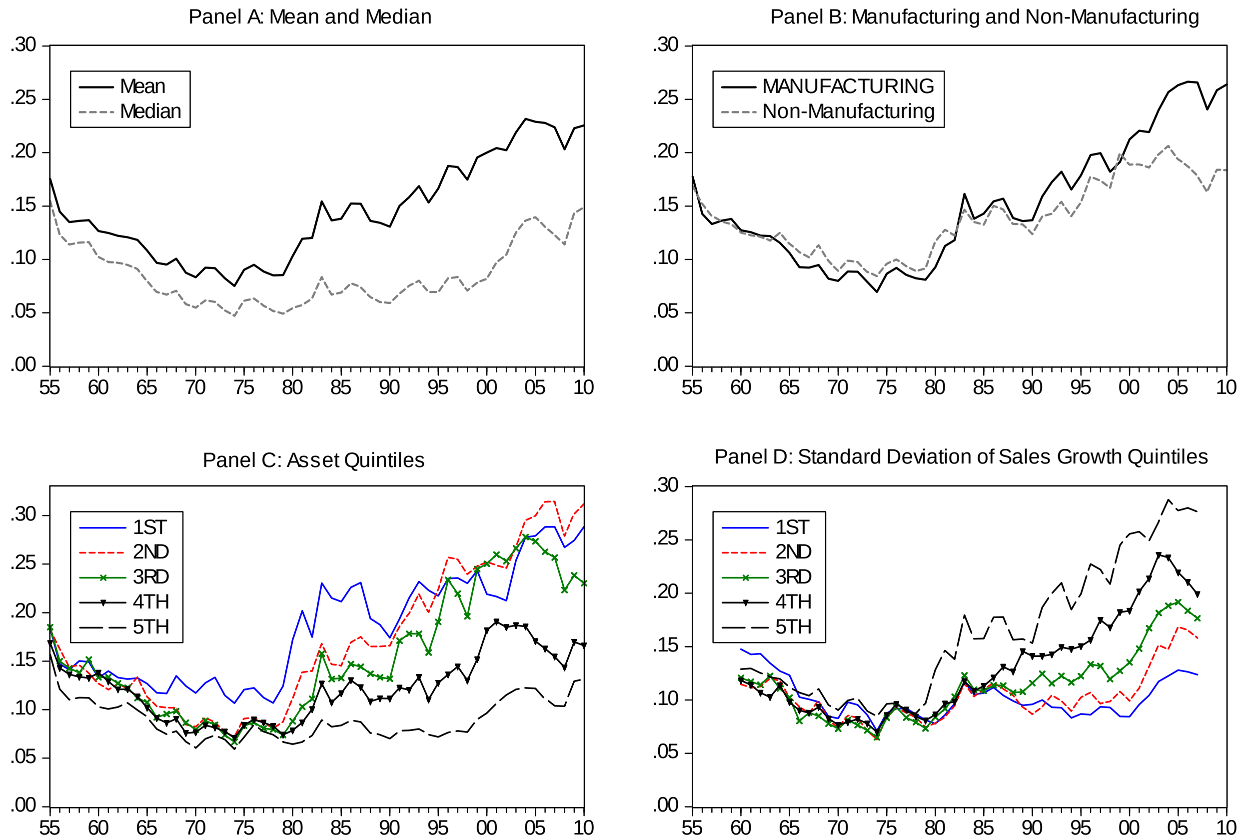

Figure 3: Mean Cash Ratio1955-2010. Data are means for each group from the Compustat data. Panel A shows the mean and median cash ratio. Manufacturing is defined as SIC classification codes 20-39.

face the most volatile sales. Firms with the largest volatility in sales growth are also the largest holders of cash. Again, it is interesting to see that regardless of volatility group, the general trends of cash holdings remain similar to each other.

Throughout our sample period, the standard deviation of sales growth has continuously increased (see Figure 4). As seen from Panel A and documented by Comin and Philippon (2006), firm-level sales growth volatility has been increasing. Panel B confirms this trend by showing the mean standard deviation of sales growth by standard deviation of sales growth quintiles. This panel shows that volatility of sales growth has been increasing for all groups including the most volatile and the least volatile. Quantitatively, the mean standard deviation for the most volatile group (quintile 5) has risen 2.5 times from 1960 to 2007. In turn, although difficult to see due to the scaling, the mean standard deviation for the least volatile group has in fact risen 50 percent.

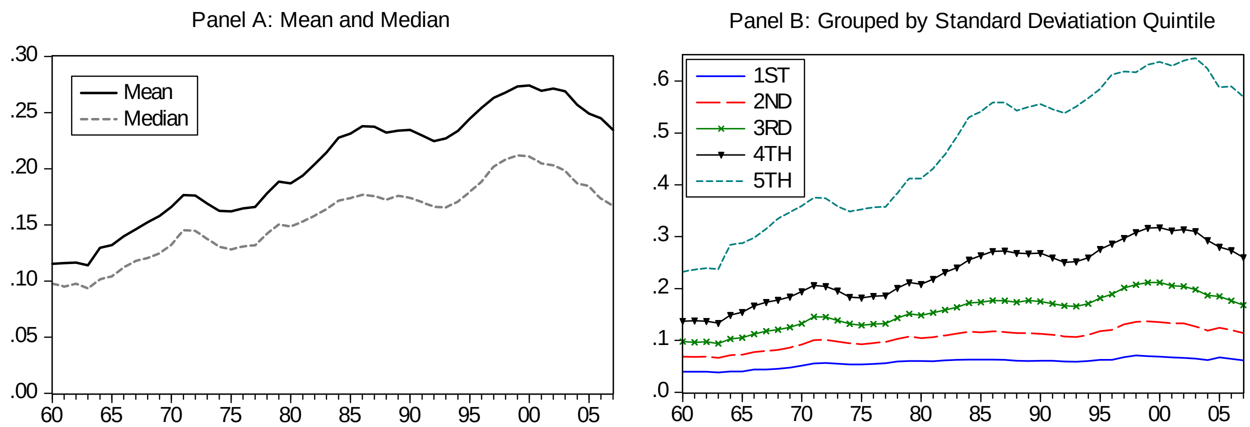

Figure 4: STANDARD DEVIATION OF REAL SALES GROWTH MEANS 1955-2010. Data are means for each group from the Compustat data. Panel A shows the mean and median cash ratio.

2.2 What Determines Firm-Level Cash Holding?

We aim to understand the factors behind the change in cash holdings over time. Empirically, the first stage in addressing this issue is to establish the key determinant of cash holdings at the firm-level. Table 2 presents panel regressions predicting the determinants of the cash ratio from 1960-2007. The explanatory variables are those described in Section 2.1. The regressions include SIC 2 digit and year dummy variables and we cluster the standard errors by year. The regression specifications are similar to Opler et al. (1999) and Bates et al. (2009).

Column 1 reports our main specification, hereby referred to as *Model 1.* The coefficient on the standard deviation of real sales growth (*SD Real Sales Growth*), our primary measure of the precautionary motive, is positive and statistically significant. As a simple illustration of its economic significance, multiplying the mean *SD Real Sales Growth* by the regression coefficient accounts for 34 percent of the mean cash ratio.[5] Alternatively, it indicates that moving from the 1^{st} to the 5^{th} quintile of *SD Sales Growth* raises the cash ratio by 8.9 percentage points.

Confirming the visual relationship seen in Figure 3, the coefficient on *Log Assets* is negative and statistically significant. For example, moving from the 5^{th} to the 1^{st} quintile in asset size reduces the cash ratio by 3.9 percentage points. The coefficient on the *Market-to-Book Ratio* is positive. If firms have optimistic growth prospects, Opler et al. (1999) suggest that they may hold liquid assets because it is costly for such firms to be credit constrained.

[5]This is calculated as $\frac{MeanSDRealSalesGrowth^{*}\beta_{SDRealSalesGrowth}}{MeanCashRatio} = \frac{0.217^{*}0.205}{0.130} = 0.342$.

Some of the most important aspects of understanding firms' cash holdings are the direct tradeoffs of holding an additional dollar in liquid assets. These tradeoffs are displayed in the coefficients for *Leverage*, *CapX/Assets*, and the *Dividend Dummy*, which are all negative. Only the *Dividend Dummy* is not statistically significant. For instance, a one standard deviation increase in *Capx/Assets* suggests a 1.4 percentage point decrease in the cash ratio. The results indicate that cash accumulation requires resources that could be used for other productive uses.

In columns (2)-(4) we present three alternative measures of the precautionary motive. The first is the backward looking, rolling 9 year window of *SD Real Sales Growth*. Due to its backward looking nature, the sample is able to include observations from the Great Recession. We additionally experiment with window sizes of 5 years and 13 years (both centered and backward looking) of *SD Real Sales Growth* (results not shown) with similar magnitudes of economic significance as those shown here. These estimates are robust to alternative specification of the window size and direction of this uncertainty measure. The marginal effects of the *Coefficient of Variation* in column (3) and 2 digit SIC industry mean of *SD Real Sales Growth* in column (4) similarly have positive and statistically significant coefficients. However, the magnitudes on the industry standard deviation coefficient are larger than the other measures of uncertainty. We feel the variability in firm-level sales is a more precise gauge of the uncertainty firms face.

Firms may hold liquid assets with specific future uses in mind rather than as a precautionary motive, so we include additional regressors in specifications (5) and (6). If firms hold liquidity for known future expenditures, the coefficient on the percent change in real cash holdings one year in advance would be expected to be positive because firms would save for future use. Column (5) shows the sign of this coefficient is negative and thus implies persistence in cash spending and accumulation. We include acquisition expenditures in column (6) because firms may accumulate cash to aid in acquisition expenditures. For firms that have positive expenditures on acquisitions in a year, a one standard deviation increase in *Acquisitions/Assets* implies a 2.3 percentage point decrease in the cash ratio. Given that our primary objective is to understand the long run trends in cash holdings, we do not include *Acquisitions/Assets* in the main specification because data only begins in 1970, cutting the sample by 10 years.

Looking across the regression tables, the results remain robust to alternative specifications. Firm-level uncertainty is a key factor in understanding the cash ratio. This result mirrors the observations by Opler et al. (1999) and Bates et al. (2009).

We present 4 alternative specifications in Table 3 to further examine the robustness of the results. In column (1), we trim the sample by the smallest 5 percent firms by asset size.

Column (2) omits per-period decisions that may be near substitutes to cash holdings. We do this to avoid any potential collinearity problems that may arise from including simultaneous tradeoffs between holding liquid assets and other uses. The coefficients remain robust in the statistical and economic sense under both specifications.

To determine if the changes in the relationship between firm characteristics and the cash ratio has changed over time, we divide the sample into two intervals: the period of declining mean cash ratio and the period of rising cash ratio. We use the Quandt Likelihood Statistic (QLR statistic) with one unknown structural break in the mean cash ratio series.[6] The QLR statistic signifies the break date is 1978. Columns (3) and (4) display the regression estimates over these two sample periods. Over the later portion of the sample, it is clear that the main change has been the increasing importance of the cash flow uncertainty on cash holdings. We also ran a regression including an interaction term with each explanatory variable and a dummy if the year is post 1978 (results omitted) and find the marginal effects of each variable are very close to the coefficients in the split sample.

We reestimate the regression models from Tables 2 and 3 with full firm-level fixed effects. These are presented in Tables 4 and 5. From here on, we refer to the results in column (1), Table 4 as *Model 1 Fixed Effects*. The adjusted R^2 in these regressions are more than twice as high because we including the firm-specific controls. The regression coefficients remain quantitatively similar to the previous regressions with two main exceptions. First, the dividend dummy is positive and statistically significant throughout which may indicate that firms that have ample cash (a stock) are the ones who pay dividends (a flow). Second, the magnitudes of the *SD Real Sales Growth* variables are dampened but still exhibit the same statistically significant sign. The exception is the industry standard deviation coefficient which is statistically not different from zero. We hypothesize the firm-specific controls soak up variation from this regressor because of the 8,904 firms in the sample, 56 percent have 10 observations or less due to the entrance and exit from the sample.

2.2.1 The Precautionary Motive

Our regression results show that the most economically significant determinant of the cash ratio is *SD Real Sales Growth*. We would expect the strength of the precautionary motive to be decreasing with ease to capital market access. Under the premise that firm size is a proxy for capital market access, a widely used measure of credit frictions in the economics literature, we ran an alternative regression with the interaction of SD Sales Growth and a dummy variable for asset quintile size (results are omitted for brevity). We find that the interaction terms monotonically decrease in asset size.

[6] We use 19 percent trimming (9 years) in our QLR statistic estimations.

We run an additional check to further investigate the existence of the precautionary motive in the sample. Under the theory, firms hold liquid assets to protect against adverse shocks. We would then expect to see firms accumulate liquid assets in periods of high revenue and spend the liquid assets in times of distress. Table 5 presents regression results on the percent change in cash holdings on a list of controls. The last two columns include firm-level fixed effects regressions. Our primary coefficient of interest is on *Real Sales Growth*. Across all sets of estimates, there is a consistent positive relationship between sales and the growth in cash holdings. Of course, in times of high revenue firms may have more income to spend on all uses, including cash, but the behavior is consistent with the precautionary motive.

This section empirically documented the main factors explaining the demand for liquidity holding. We established that the precautionary motive is a key determinant for firms' liquid asset holding. However, to what extent can these factors account for the aggregate changes in the cash ratio over time? We next turn to answering this question.

2.3 Why Have Firms' Cash Holdings Changed Over Time?

In this section we first show that changes in firm specific attributes cannot adequately explain the fall in the mean cash ratio in the 1960s and 1970s or the steady rise thereafter. We then document that the change in the cash ratio is due to aggregate factors impacting all firms symmetrically. Finally we identify inflation as that key aggregate factor.

2.3.1 Determinants of Cash Holding Variability

To visually inspect the impact of select firm attributes on the change in the cash ratio, we plot the predicted time series effects on the cash ratio for select variables using the coefficient estimates from *Model 1* (see Figure 5). We omit many of the variables for visual ease because their cumulative effects are small but we do quantify their effects later in the paper. The solid black line is the average cash ratio. The other three lines are predictions of the cash ratio using the regression coefficients from *Model 1* and fixing all other variable other than the variable of interest at their sample mean. The annual dummy coefficients are the coefficient for each individual year. Changes in *Leverage* follow a slight U-shape but the magnitudes are minute. Changes in *SD Sales Growth* predicts an increase in the cash ratio, of 2.5 percentage points from 1960-2007. The annual dummy variable coefficients, which are simply an annual level change, appear to follow the main features of the cash ratio including the inflections and time-series trends. We interpret the annual dummy variable coefficients as capturing the aggregate time-series factors that symmetrically impact on all firms. We provide some explanations for this assumption in Section 2.3.2.

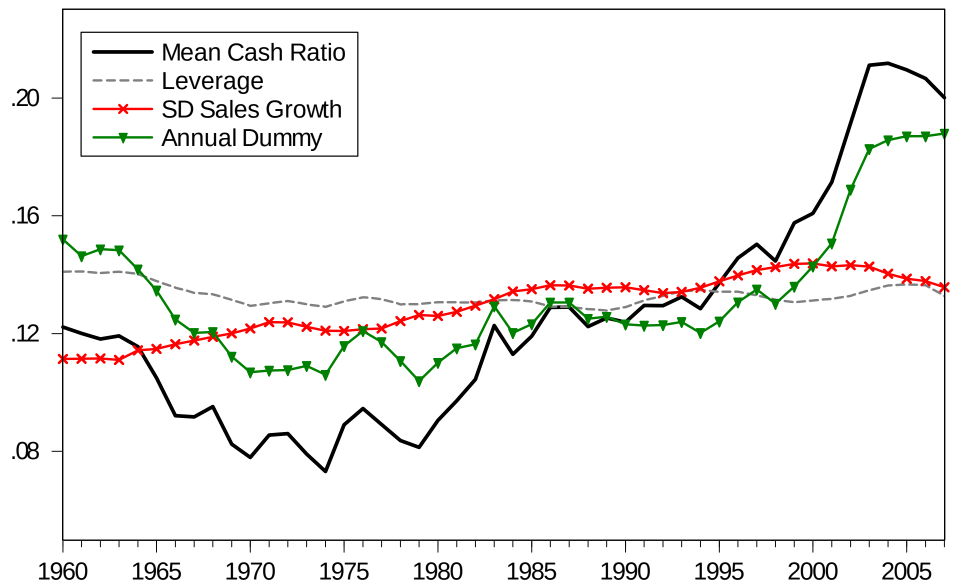

Figure 5: Predicted Impacts of Leverage, SD Real Sales Growth, and annual dummy coefficients on the Cash Ratio 1960-2007. Mean cash ratio shown as the solid black line. The other series are obtained by holding all variables constant at their mean level except the variable in question. Predictions come from the regression coefficients obtained in Model 1.

We next assess the measured impact on cash ratio changes for each variable in Model 1. We then divide the sample into intervals 1960-1978, representing the period of falling cash ratio, and 1978-2007 when the cash ratio trended upwards as informed by our QLR statistic in Section 2.2. We finally examine the contribution of each variable on the change in the cash ratio during each interval.

To estimate the predicted percentage point contribution of each variable on the change in the cash ratio over the two intervals, we first multiply the variables' mean by its regression coefficient from *Model 1* for 1960, 1978, and 2007. We then find the difference of the predicted effects on the cash ratio for each variable for each time interval. Panel A of Table 7 summarizes the mean of each variable for each year. The numbers in Panel B are the predicted changes in the cash ratio from the mean changes in each variable for each sub-period holding all other variables constant.

From 1960-1978 the mean cash ratio declined 3.9 percentage points. The increase in *Leverage* accounted for 1 percentage point of this fall while *SD Real Sales Growth* increase impacted the cash ratio in the opposite way by a similar magnitude. The annual dummy coefficients are the largest single factor predicting the decline in the cash ratio.

For the 1978-2007 period, the cash ratio rose 11.7 percentage points. In this sample period, 1.2 percentage points is attributable to the increase in sales volatility. However, once again the dummy variable accounts for 2/3 of the observed rise in cash ratio, or 7.7 percentage points of the 11.7 percentage point increase.

For robustness, we tested whether cash ratio changes over time arise from time-series variation in the relationship between firm characteristics and cash holdings. In turn, we identified the contributions of each variable derived from a regression that includes an interaction with each variable and a dummy if the year is post 1978 (results not shown). The predicted percentage point contributions for each variable on cash ratio changes are quantitatively similar to the results shown in Table 7 with the annual dummy variable coefficients displaying the most explanatory power. The change in the cash ratio is neither adequately accounted for by changes in firm-specific characteristics nor changes in the relationship with firm-specific attributes and cash holdings over time.

We established that firm-specific attributes captured in the regressions, particularly sales growth volatility, are important in understanding why firms hold cash in Section 2.2. However, the results here demonstrate that these firm-level attributes are unsatisfactory in explaining the *change* in the cash ratio over time. Rather, the most important elements are aggregate factors. We next identify these aggregate factors.

2.3.2 Impact of Aggregate Variables on Cash Holdings

To begin, we summarize possible candidates for the aggregate factors impacting the changes in firm-level cash holdings into 3 main categories.

Inflation and Inflation Related Variables Inflation may reduce the holding of liquid assets such as cash, short-term bonds, equities, and other marketable securities of short terms if these are not perfectly protected against inflation. Specifically, the value of assets held in nominal denominations erodes as inflation increases. All else equal, in periods of price-level increase holding assets imperfectly hedged against inflation dictates a shift away from holding these assets. As a simple exercise to examine the protection of liquid assets from inflation, we calculate the quarterly contemporaneous correlations from 1960Q1 to 2012Q4 of inflation with real T-bill rates and real stock market returns.[7] The correlation coefficient of inflation with real T-bill rates is -0.50 and with real stock market returns is -0.15. Both are statistically significant at the 5 percent level.

[7] Real T-Bill rates are quarterly, inflation adjusted returns on a 3 month US T-bill. Market returns are inflation adjusted quarterly value-weighted returns to a portfolio of the largest 20 percent of firms by stock market capitalization. Data for this is from the CRSP database and accessed from Kenneth French's website at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Our measures of inflation and inflation related variables are annual inflation; expected inflation as measured by the mean 1 year ahead December forecasts from the Livingston Survey;[8] the nominal interest rate on the 3 month T-bill; and the real interest rate on the 3 month T-bill.[9] We classify the interest rates as inflation related because, by the Taylor Rule and Fisher Equation, these are a function of inflation.[10]

Yield Curve The yield curve is a measure of the differential in expected returns between long and short-term investments. To the extent that US Treasuries are an approximation for total returns, we may expect that when long-term rates increase relative to short-term rates, firms may move assets out of short-term liquid assets into long-term assets. We measure this as the difference between the 10 year and 3 month annual rates on US Treasuries.

Real GDP Growth Real GDP growth may represent information about the expected future states of the economy not captured in our firm-level regressions. However, we believe this effect may already be captured in the firm-level sales growth.

We regress the annual dummy variable coefficients from *Model 1* on the described aggregate variables. We interpret these regressions as the impact of aggregate variables on the cash ratio. Table 8 summarizes the results. Columns (1)-(7) use the annual dummy variable coefficients from Model 1 as a dependent variable and columns (8) and (9) use the coefficients from the *Model 1 Fixed Effects* regression. Inflation displays a large negative and statistically significant effect on the annual dummy coefficients. This implies a negative relationship between inflation and level shifts in the cash ratio. Column (2) repeats the regression but includes unique dummy variables for each recession. The coefficients on inflation remain similar to that on the nominal interest rate which is unsurprising given they are highly correlated (correlation is 0.75). The real interest rate, yield curve, and GDP growth are statistically not different from zero and have very low explanatory power (adjusted $R^2 < 0$). Although the magnitudes are slightly smaller the inflation variables in columns (8) and (9) remain robust.

It is important to note that these regressions represent correlations and do not imply causality. Given that the annual dummy coefficients represent aggregate factors affecting cash holdings of all firms, the interpretation of these regressions is that inflation and nominal interest rates have a strong (negative) association with this aggregate relationship.

We omit variables related to taxes in these regressions. Tax rates and tax rate uncertainty

[8] Data accessed through the Federal Reserve Bank of Philadelphia's website at http://www.phil.frb.org/research-and-data/real-time-center/livingston-survey/.

[9] The real interest rate is adjusted by each year's mean inflation forecast through the Livingston Survey.

[10] Real interest rates are a function of inflation to the extent changes in inflation are unexpected.

has certainly moved in the limelight with Apple holding $145 billion in liquid assets (as of April 2013). Recent literature points taxes and tax uncertainty as a contributing factor (see Section 1 for literature on this.). We find merit in these arguments but believe if taxes are the main source of corporate cash holding variation, over the 47 years of our sample the liquid assets would have been distributed to shareholders at some point. These effects may be important to understanding cash holdings during sub-intervals in our sample.

2.3.3 Impact of Inflation on Cash Holdings

To illustrate the explanatory effect of aggregate inflation on cash holdings, we reestimate the regressions from *Model 1* with the modification of including inflation directly in the regressions. Collinearity with inflation prohibits the use of the annual dummy variables in this regression. The results are presented in Table 9. Columns (1) and (3) reproduce the regression results from Section 2.2. The right two columns include firm-level fixed effects. Including inflation in the regressions yield similar results as using the annual dummy variables which is unsurprising given the high correlation between the two. Comparing the remaining coefficients between columns (1) and (2) and between (3) and (4) illustrate that including inflation changes the results very little. The adjusted R^2 is just 0.016 smaller than in *Model 1* and the changes from the *Model 1 Fixed Effects* are negligible. Column (2) indicates that a 10 percentage point decrease in inflation – the change in the inflation rate between 1980 and 2007 – yields a 4.8 percentage point rise in the cash ratio, or nearly 50 percent of the observed change over the 1980-2007 interval.

To briefly examine if the negative relationship between liquid asset holdings and inflation holds at the aggregate level, we next run a simple regression of the cash ratio from the flow of funds data on inflation expressed as an annual rate from 1960-2007 at quarterly frequency. The results are presented in column (1) in Table 10. These should be interpreted as mere correlations, but the association between cash holdings and inflation is strongly negative using the alternative Flow of Funds data as well. Column (2) repeats the exercise but includes unique dummy variables for each recession. For comparison, we repeat the regressions using the annual mean and median cash ratio from the Compustat data as left-hand side variables in columns (3)-(6). Across the alternative measures of the cash ratio, inflation continually exhibits a strong negative impact on cash holdings.

3 Partial Equilibrium Model

Our empirical analysis established two important results. First, we showed that the standard deviation of sales growth, a measure of the precautionary motive, is a main contributing factor to firm-level cash holdings. Second, we conclude that inflation is a key driver of the changes in the level of cash holdings from 1960-2007. Combining these two facts, theory suggests that the marginal benefit of holding an additional dollar of liquid assets as a precaution against adverse shocks should equal the marginal cost of foregone dividend payments and investment as well as inflation. Inflation raises the marginal cost when short-term and other liquid assets are imperfectly protected against inflation.

We now construct a model where firms have an incentive to hold on to liquid assets that is consistent with the empirical observations. The goal of the theoretical model is to understand the channels through which inflation impacts firms' decisions to hold liquid assets and to capture how inflation impacts real variables. In the model uncertain cash flows stem from variability in demand. Variability in demand can lead to a situation where a firm does not have enough liquidity to cover its current liabilities. A firm that is unable to cover its current liabilities has to issue costly short-term debt to cover any shortfall in liquidity. In turn, because short-term debt is costly, firms will hold liquid assets to protect against cases where income from sales is unable to cover its costs.

3.1 The Firm's Problem

Consider a continuum of firms indexed by i that hire labor, $L_{i,t}$, and use this labor in conjunction with capital stock, $K_{i,t}$, and aggregate technology, A_t, to produce output using a standard Cobb-Douglas production process:

$$Y_{i,t} = A_t K_{i,t}^{\alpha} L_{i,t}^{1-\alpha}$$

where $1 - \alpha$ is the labor share in production.

The firm uses part of the output it produces to augment its own capital stock and sells what remains as a consumption good. The resulting supply of consumption goods is given by:

$$C_{i,t}^{S} = Y_{i,t} + (1 - \delta) K_{i,t} - K_{i,t+1} \tag{1}$$

where δ is the depreciation rate of capital.

In addition, the firm faces uncertain demand in the form of an idiosyncratic demand shock, $D_{i,t}$, where $D_{i,t}$ is drawn from a distribution fully summarized by mean $\bar{D}$ and variance σ_D. Proceeds from these sales along with their liquid assets constitute the firms period revenue stream:

$$Revenue = p_t D_{i,t} C_{i,t}^{S} + B_{i,t}$$

where p_t is the economy-wide price and $B_{i,t}$ is the firm-specific liquid asset/cash holdings.

On the other hand the firm's short term liabilities include the wage payments it has to make to its labor:

$$\textit{Short-Term Liabilities} = w_t L_{i,t}$$

where w_t is the economy-wide wage rate.

The timing of decisions is important. In the model, as in the real world, the firm chooses the level of "investment" in capital, $K_{i,t+1}$, and the amount of labor to hire, $L_{i,t}$, after seeing the aggregate technology, A_t, and prices schedules p_t, w_t, but simultaneously with the realization of its individual demand shock, $D_{i,t}$. In such an environment depending on the firm-specific realization of $D_{i,t}$, its revenues may or may not be able to cover its short-term liabilities. In the case where the firm is unable to cover its liabilities it must issue debt at an interest rate of R_{t+1}. We assume issuing such debt is costly and all firms who take on such debt in addition must pay a fixed cost μ. This is similar to the costly state verification framework in Bernanke and Gertler (1989). The firm's period net revenue balance can now be written as:[11]

$$\begin{aligned} \textit{Revenue/DebtBalance} &= p_t D_{i,t} C^S_{i,t} - w_t L_{i,t} + B_{i,t} - \mu I_{p_t D_{i,t} C^S_{i,t} + (1+R_t) B_{i,t}} < w_t L_{i,t} \\ &= p_t D_{i,t} C^S_{i,t} - w_t L_{i,t} + B_{i,t} - \mu I_{D_{i,t} < \frac{w_t L_{i,t} + B_{i,t}}{p_t C^S_{i,t}}} \end{aligned}$$

The firm's problem can thus be summarized as follows:

$$\max_{K_{i,t+1}, L_{i,t}} \sum_{t=0}^{\infty} \beta^t \mathbb{E}_t \left[\mathbb{E}_D \left[p_t D_{i,t} C^S_{i,t} - w_t L_{i,t} + B_{i,t} - \mu I_{D_{i,t} < D^*_{i,t}} \,\middle|\, \bar{D}_t, \sigma_t \right] \right]$$

s.t.

$$C^S_{i,t} \equiv A_t K^{\alpha}_{i,t} L^{1-\alpha}_{i,t} + (1-\delta) K_{i,t} - K_{i,t+1}$$

$$D^*_{i,t} \equiv \frac{w_t L_{i,t} - B_{i,t}}{p_{i,t} C^S_{i,t}}$$

where, $\mathbb{E}_D$ indicates that the labor and capital decisions every periods are made simultaneously with the realization of the stochastic variable D. Thus, the above optimization problem simplifies to:

[11] A positive number implies the firm generated net revenue and a negative number that it has a loan balance.

$$\max_{K_{i,t+1},L_{i,t}} \sum_{t=0}^{\infty} p_t \beta^t \mathbb{E}_t \left[\bar{D}_t C_{i,t}^S - w_t L_{i,t} + B_{i,t} - \mu \ Prob\left(D_{i,t} < D_{i,t}^* \mid \bar{D}_t, \sigma_{D,t} \right) \right]$$

s.t.

$$C_{i,t}^S \equiv A_t K_{i,t}^{\alpha} L_{i,t}^{1-\alpha} + (1-\delta) K_{i,t} - K_{i,t+1}$$

$$D_{i,t}^* \equiv \frac{w_t L_{i,t} - B_{i,t}}{p_{i,t} C_{i,t}^S}$$

The optimal labor choice, $L_{i,t}$, and capital choice, $K_{i,t+1}$, are given by the following first order conditions:

$$\begin{aligned} \beta p_{t+1} \bar{D}_{t+1} \left(\alpha \left(\frac{L_{i,t+1}}{K_{i,t+1}} \right)^{1-\alpha} + (1-\delta) \right) - \beta \mu \frac{\partial Prob\left(D_{i,t+1} < D_{i,t+1}^* \mid \bar{D}_{t+1}, \sigma_{D,t+1} \right)}{\partial K_{i,t+1}} \\ = p_t \bar{D}_t + \mu \frac{\partial prob\left(D_{i,t} < D_{i,t}^* \mid \bar{D}_t, \sigma_{D,t} \right)}{\partial K_{i,t+1}} \end{aligned} \tag{2}$$

$$p_t \bar{D}_t (1-\alpha) \left(\frac{K_{i,t}}{L_{i,t}} \right)^{\alpha} = w_t + \mu \frac{\partial prob\left(D_{i,t} < D_{i,t}^* \mid \bar{D}_t, \sigma_{D,t} \right)}{\partial L_t} \tag{3}$$

here,

$$\begin{aligned} \frac{\partial prob\left(D_{i,t+1} < D_{i,t+1}^* \mid \bar{D}_t, \sigma_{D,t} \right)}{\partial K_{i,t+1}} &= -\frac{D_{i,t+1}^*}{C_{i,t+1}^S} \left(\alpha \left(\frac{L_{i,t+1}}{K_{i,t+1}} \right)^{1-\alpha} + (1-\delta) \right) pdf_{i,t+1} < 0 \\ \frac{\partial prob\left(D_{i,t} < D_{i,t}^* \mid \bar{D}_t, \sigma_{D,t} \right)}{\partial K_{i,t+1}} &= \frac{D_{i,t}^*}{C_{i,t}^S} pdf_{i,t} > 0 \\ \frac{\partial prob\left(D_{i,t} < D_{i,t}^* \mid \bar{D}_t, \sigma_{D,t} \right)}{\partial L_{i,t}} &= \frac{w_t}{p_t C_{i,t}^S} pdf_{i,t} - \frac{D_{i,t}^*}{C_{i,t}^S} (1-\alpha) \left(\frac{K_{i,t}}{L_{i,t}} \right)^{\alpha} pdf_{i,t} \\ pdf_{i,t} &\equiv pdf\left(D_{i,t} = D_{i,t}^* \mid \bar{D}_t, \sigma_{D,t} \right) > 0 \end{aligned}$$

Also, by construction we assume that around a reasonably calibrated steady-state $\frac{\partial pdf_{i,t}}{\partial B_{i,t}} < 0$. Many standard distributions, including the normal distribution, are able to meet this criteria as long as steady state probability is less than 1/2.

Consider equation (2). The left-hand side of this equation gives the marginal benefit of "investing" in one more unit of capital. This marginal benefit can be broken up into two parts: the first term gives the additional revenue generated tomorrow by augmenting tomorrow's capital stock by a marginal unit of capital; the second term shows how the additional marginal revenue generated by the higher capital stock lowers the probability of having to issue costly debt.

The right-hand side of equation (2) formalizes this cost of investing in capital. Investing in capital reduces the production of consumption goods and thus lowers the revenue generated today. The first term captures the direct loss in revenue. The second term formalizes how the loss in revenue leads to a higher probability of having to issue costly debt because of lower revenue streams.

Equation (3) gives us the first order condition with respect to labor. The left-hand side of this equation gives the marginal revenue product of labor, i.e. the marginal benefit of labor. The first term on the right-side, the wage, gives us the marginal cost of hiring labor and the second term gives the marginal probability that the firm will have to issue costly debt as a result of hiring one additional unit of labor. The sign of this marginal probability term is undetermined. Hiring more labor both increases the revenue generated by the firm but also increases the short-term liabilities of the firm. The higher revenue reduces the probability of having to issue costly debt, while the higher short-term liabilities increase this probability. The first term and second term in the definition of this marginal probability give the effects of the increase in liabilities and revenue respectively.

3.2 Aggregation

For analytical tractability we assume perfect risk sharing by the firms. Firms in our setup share all of the end of period short-term debt and revenue they generate. This allows us to reduce the state space of our model economy from one that includes a distribution of capital and liquid asset holdings across the firms to one which is fully specified by the mean levels of capital and asset holdings. Each firm in our setup starts the period with the same level of capital and liquid assets.

Further, given the capital and labor decisions are made before the realization of the idiosyncratic demand shock $D_{i,t}$ and that the start of period level of capital and liquid assets are the same for all firms, the per period capital and labor decisions will be identical across the firms. As such we can drop the i subscript. Now, the total profits produced by each firm post risk-sharing is given by

$$
\begin{aligned}
Profits &= \int \left(p_t D_{i,t} C_t^S - w_t L_t + B_t - \mu I_{D_t < \frac{w_t L_t + B_t}{p_t C_t^S}} \right) di \\
&= p_t \bar{D}_t C_t^S - w_t L_t + B_t - \mu \; prob \left(D_t < D_t^* | \bar{D}_t, \sigma_{D,t} \right)
\end{aligned}
$$

where $L_t = L_{i,t}$ and $K_t = K_{i,t}$ are given by equations (2) and (3).

Next, the firms use these profits to pay out dividends, d_t, and retain the rest as liquid assets, B_{t+1}. This optimization problem is given by:

$$\max_{\{d_t\}_{t\in[0,\infty]}} \sum_{t=0}^{\infty} \beta \mathbb{E}_t d_t$$

where, [12]

$$d_t + \frac{B_{t+1}\pi_{t+1}}{1+R_{t+1}} = p_t \bar{D}_t C_t^S - w_t L_t + (1+R_t) B_t - \mu \ prob\left(D_t < D_t^* | \bar{D}_t, \sigma_{D,t}\right)$$

The optimal dividend versus liquid asset decision is given by the following equations

$$\beta - \beta\mu \frac{\partial prob\left(D_{t+1} < D_{t+1}^* | \bar{D}_{t+1}, \sigma_{D,t+1}\right)}{\partial B_{t+1}} = \frac{\pi_{t+1}}{1+R_{t+1}} \tag{4}$$

$$d_t = p_t \bar{D}_t C_t^S - w_t L_t + (1+R_t) B_t - \mu \ prob\left(D_t < D_t^* | \bar{D}_t, \sigma_{D,t}\right) - \frac{B_{t+1}\pi_{t+1}}{1+R_{t+1}} \tag{5}$$

with

$$\begin{aligned} \frac{\partial prob\left(D_{t+1} < D_{t+1}^* | \bullet\right)}{\partial B_{t+1}} &= -\frac{1}{p_{t+1} C_{t+1}^S} pdf_{t+1} < 0 \\ pdf_{t+1} &\equiv pdf\left(D_{t+1} = D_{t+1}^* | \bar{D}_{t+1}, \sigma_{D,t+1}\right) > 0 \end{aligned}$$

The left-hand side of equation (4) gives the benefit of holding liquid assets. It is the marginal probability of not having to obtain a loan as the amount of liquid assets increase. The right-hand sides gives the cost. Liquid assets are stored in nominal accounts and thus face depreciation due to inflation, ceteris paribus. However, higher interest rates induce firms to hold more interest bearing liquid assets.

Equation (5) simply gives the definition of dividends. Dividends here are profits net of liquid asset holdings. It is important to note that as the current level of liquid assets (B_t) rises, the probability of having to acquire costly short-term debt ($prob\left(D_t < D_t^* | \bar{D}_t, \sigma_{D,t}\right)$) falls and thus increases the level of dividends today. Whereas, if the firm decides to increase the level of liquid assets for tomorrow (B_{t+1}) then the dividends today fall. These two forces represent the tradeoff between holding liquid assets and paying out dividends in our model.

Equations (1)-(5) thus give us five equations in five unknowns: consumption supply C^S; capital K; labor L; liquid assets/bank balances B; and dividends d. These completely

[12] The term π_{t+1} indicates that the liquid assets are stored in nominal terms and B_t gives the real equivalent of these assets.

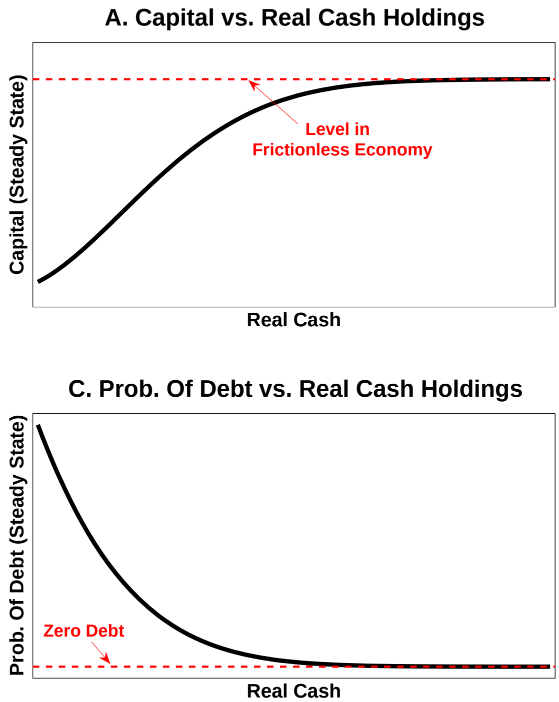

Figure 6: Partial Equilibrium Model Comparative Statics: Steady State Changes in Response to Changes in the Real Cash

summarize the choices of the firm in our model economy.

To close this partial equilibrium framework we additionally need to specify a labor supply equation and a price level. We normalize the price level to 1 and set the labor supply equation:

$$w_t = w_0 + w_1 L_t^{\gamma} \tag{6}$$

3.3 Comparative Statics

Our model gives us two sets of interesting results. First, liquid assets in our model are complementary to capital and labor in the production process. Panels A and B in figure 6 plot how the steady state levels of capital and labor increase as the amount of liquid assets increase in our economy. Demand for capital and labor rise as firms hold more liquidity: even in periods of low revenue flows, firms with high levels of liquid assets are still able to insure against issuing costly debt. Firms in our economy fearing having to issue costly debt hire less labor and invest in less capital than in an otherwise frictionless economy. Increasing the level of liquid assets reduces the probability of having to issue costly short-term debt (Panel C) and in turn induces the firms to increase capital and labor. In the extreme case when the level of liquid assets are enough to cover all possible short-term liabilities the probability of

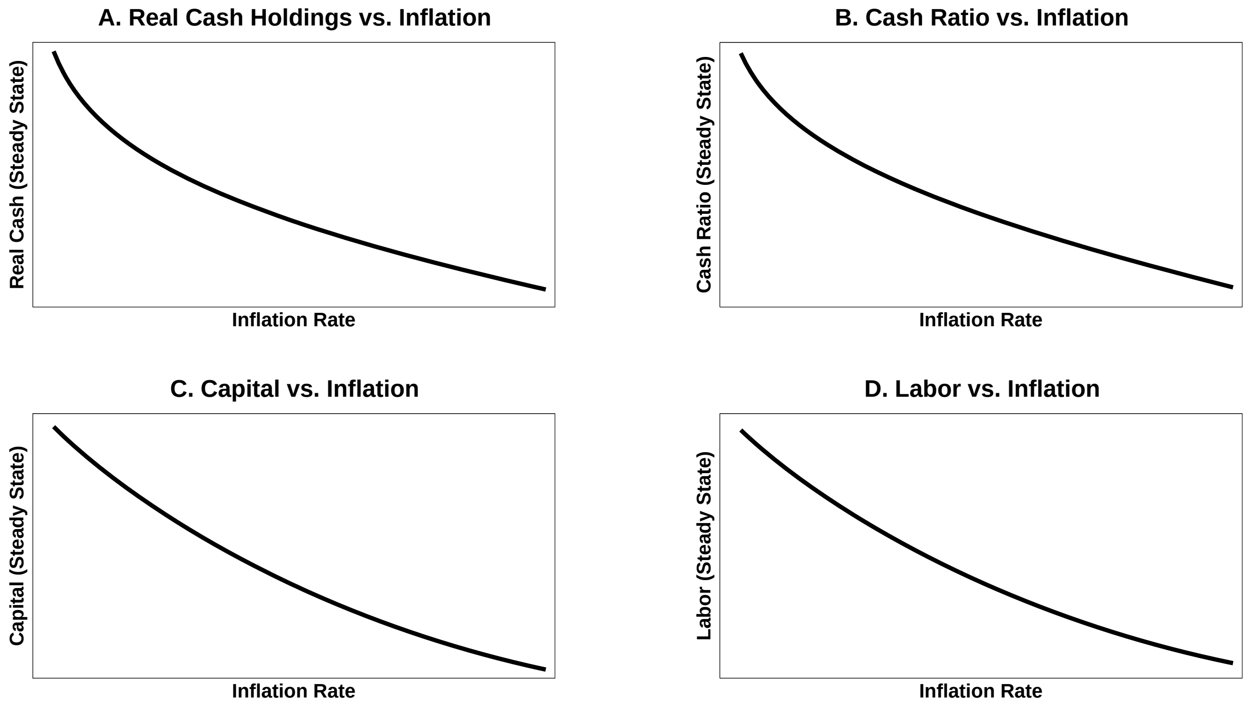

Figure 7: Partial Equilibrium Model Comparative Statics: Steady State Changes in Response to Changes in Inflation

having to issue short-term debt goes to 0 and the levels of capital and labor are at the same level as in a frictionless economy.

Second, as inflation in our economy increases the level of real cash holdings falls (panel A in Figure 7). This is consistent with what we witness in the data. Nominal liquid assets holdings are particularly exposed to inflation, and thus high inflation increases the marginal cost of holding these assets. Lower cash holdings also cause the level of capital and labor to fall (panels C & D). As mentioned above, this is because the probability of having to issue costly short-term debt rises as the level of liquid asset holdings fall. Finally, the level of liquid asset holdings fall more than the level of capital. This causes the cash ratio to fall as inflation rises (panel B). This final results helps us provide a coherent explanation of why the cash ratio in the data falls as inflation rises. In short, we introduce a novel channel by which inflation impacts real variables via firm-level cash holdings.

4 Conclusion

This paper investigates the determinants of and the changes in liquid asset holding by domestic US firms from 1960-2007. Some of the most conspicuous aspects of firms-level cash holdings are the decline from 1960 until the late 1970s and the steady increase thereafter.

We employ a panel of US firms from Compustat data and show that cash holdings by firms have followed the same general trends irrespective of size, industry, idiosyncratic risk, etc.

We establish two main findings in our empirical analysis. First, we demonstrated that uncertainty, measured as the standard deviation of real sales growth, is an important determinant of firms' cash holdings. Our regression estimations predict that sales variability alone can account for over 1/3 of the observed cash holdings by firms. Second, we identified inflation as the main driver of changes in the time-series of cash holdings: inflation impacts the level of cash holdings by altering the marginal cost of holding nominal assets. To the best of our knowledge, this is the first study to investigate this channel.

We unify the observations from our empirical investigation and identify the channels nominal asset holdings impact real variables at the firm level. The central facet of our model is that if a firm's revenue falls short of its liabilities they must issue costly short-term debt to cover these liabilities. Consistent with our empirical findings, cash holdings are increasing in revenue uncertainty. Firms that hold more cash are thus more likely to demand more capital and labor inputs than liquidity depressed firms because even in periods of low revenue flows they are still able to meet their obligations without issuing costly debt.

The policy implications of the model open a new channel to explore the effects of nominal aggregates on real variables. We suggest that inflation, through the reduction of cash holdings by firms, reduces the demand for productive capital and labor inputs. Future work includes extending the model to a general equilibrium framework and isolating the impact of monetary policy on real variables via cash holdings by firms.

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Table 1: Summary Statistics

	N	Mean	SD	Median
Cash Ratio	103,550	0.130	0.163	0.070
SD Real Sales Growth	103,550	0.217	0.188	0.100
Coefficient of Variation	97,053	0.372	0.314	0.230
Real Sales Growth	103,550	0.060	0.283	0.050
Leverage	103,550	0.249	0.313	0.220
Market-to-book Ratio	103,550	1.261	3.268	0.730
CapX/Assets	103,550	0.070	0.071	0.050
Log Assets	103,550	5.329	2.046	5.260
Acquisitions/Assets	88,113	0.017	0.058	0.000
Dividend Dummy	103,550	0.497	0.500	0.000

The table summarizes firm year observations from 1960-2007 of US based publically traded firms from Compustat. Real variables are deflated using the annual GDP Deflator. Cash Ratio is the sum of cash and marketable securities as a share of total assets. SD Real Sales Growth is the centered 9 year rolling standard deviation of real sales growth for each firm. The coefficient of variation is the centered 9 year rolling window of real sales by its average sales in the corresponding timeframe. Leverage is debt/assets. The market-to-book ratio is the end of the year share price times the number of shares outstanding divided by the book value of assets. Log assets are inflation adjusted. The dividend dummy equals 1 if the firm paid dividends in that year and 0 otherwise.

Table 2: Regressions Predicting the Determinants of the Cash Ratio

	Dependent Variable: Cash Ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
SD Real Sales Growth	0.205***				0.199***	0.214***
	(0.015)				(0.015)	(0.015)
SD Real Sales Growth (Backward)		0.191***				
		(0.016)				
Coefficient of Variation			0.058***			
			(0.007)			
SD Real Sales Growth (2 Digit Industry Mean)				0.441***		
				(0.027)		
Log Assets	-0.007***	-0.008***	-0.010***	-0.011***	-0.007***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Real Sales Growth	-0.009*	-0.024***	-0.024***	-0.005	-0.006	0.000
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)
Market-to-Book Ratio	0.006**	0.006**	0.008*	0.007**	0.006**	0.006**
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Leverage	-0.119**	-0.108***	-0.109***	-0.111**	-0.118**	-0.113**
	(0.036)	(0.010)	(0.011)	(0.034)	(0.036)	(0.036)
CapX/Assets	-0.201***	-0.217***	-0.225***	-0.216***	-0.198***	-0.227***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.015)
Dividend Dummy	-0.006	0.002	-0.008*	-0.022***	-0.007	-0.007
	(0.005)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)
Change in Cash (Forward 1 Year)					-0.034***	
					(0.001)	
Acquisitions/Assets (Expenditure)						-0.253***
						(0.027)
Intercept	0.185***	0.172***	0.204***	0.199***	0.191***	0.152***
	(0.011)	(0.009)	(0.010)	(0.012)	(0.011)	(0.015)
Select Year Dummy Variables (with 1960 = 0)						
1970	-0.045***	-0.047***	-0.037***	-0.062***	-0.044***	
	(0.004)	(0.001)	(0.002)	(0.004)	(0.004)	
1980	-0.042***	-0.041***	-0.033***	-0.064***	-0.044***	
	(0.004)	(0.002)	(0.003)	(0.005)	(0.004)	
1990	-0.029***	-0.039***	-0.023***	-0.065***	-0.029***	
	(0.006)	(0.003)	(0.004)	(0.007)	(0.006)	
2000	-0.009	-0.018***	-0.008	-0.054***	-0.007	
	(0.005)	(0.003)	(0.004)	(0.006)	(0.005)	
2007	0.036***	0.029***	0.044***	0.003	0.031***	
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	
Annual Dummy	yes	yes	yes	yes	yes	yes
Sic 2 Digit dummy	yes	yes	yes	yes	yes	yes
N	103,550	107,176	97,053	103,550	103,321	88,113
$Adj.R^2$	0.280	0.267	0.233	0.252	0.303	0.291

Standard errors in parenthesis. **p<0.05 *** p<0.001. The dependent variable is the cash ratio. Regressions span 1960-2007. Data in (6) encompasses 1970-2007.

Table 3: Regressions Predicting the Determinants of the Cash Ratio

	Dependent Variable: Cash Ratio			
	Top 95^{th} by Size (Assets)	Omit Simultaneous Cash Decisions	1960-1978	1979-2007
	(1)	(2)	(3)	(4)
SD Real Sales Growth	0.219***	0.184***	0.068***	0.223***
	(0.017)	(0.018)	(0.011)	(0.015)
Log Assets	-0.006***	-0.009***	-0.006***	-0.006***
	(0.000)	(0.001)	(0.001)	(0.001)
Real Sales Growth	-0.024***	-0.010**	-0.015**	-0.010*
	(0.004)	(0.004)	(0.005)	(0.004)
Market-to-Book Ratio	0.020***	0.007**	0.021***	0.005**
	(0.004)	(0.002)	(0.003)	(0.002)
Leverage	-0.193***		-0.114**	-0.113*
	(0.013)		(0.032)	(0.042)
CapX/Assets	-0.218***		-0.186***	-0.216***
	(0.015)		(0.018)	(0.017)
Dividend Dummy	-0.017***		0.009**	-0.019***
	(0.003)		(0.003)	(0.005)
Intercept	0.183***	0.159***	0.135***	0.170***
	(0.011)	(0.013)	(0.008)	(0.018)
Select Year Dummy Variables (with 1960 = 0)				
1970	-0.037***	-0.055***		
	(0.001)	(0.001)		
1980	-0.032***	-0.054***		
	(0.002)	(0.002)		
1990	-0.018***	-0.036***		
	(0.003)	(0.004)		
2000	-0.013**	-0.011**		
	(0.004)	(0.004)		
2007	0.025***	0.037***		
	(0.003)	(0.003)		
Annual Dummy Variables	yes	yes	yes	yes
Sic 2 Digit dummy	yes	yes	yes	yes
N	95,631	105,522	41,057	62,493
$Adj.R^2$	0.349	0.221	0.225	0.287

Standard errors in parenthesis. **p<0.05 *** p<0.001. The dependent variable is the cash ratio. Regressions span 1960-2007 for (1) and (2). (3) and (4) are divided into sub-intervals. The interval timing is determined by the QLR statistic with 1 unknown structural break in the mean cash ratio.

Table 4: Fixed Effects Regressions Predicting the Determinants of the Cash Ratio

	Dependent Variable: Cash Ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
SD Real Sales Growth	0.070***				0.067***	0.078***
	(0.006)				(0.005)	(0.006)
SD Real Sales Growth (Backward)		0.069*** (0.006)				
Coefficient of Variation			0.019***			
			(0.002)			
SD Real Sales Growth (2 Digit Industry Mean)				0.024 (0.017)		
Log Assets	-0.008***	-0.011***	-0.009***	-0.009***	-0.012***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Real Sales Growth	-0.019***	-0.023***	-0.025***	-0.018***	-0.017***	-0.015***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Market-to-Book Ratio	0.004***	0.003***	0.005***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Leverage	-0.089***	-0.060***	-0.064***	-0.088***	-0.083***	-0.085***
	(0.009)	(0.005)	(0.005)	(0.009)	(0.009)	(0.009)
CapX/Assets	-0.171***	-0.165***	-0.165***	-0.172***	-0.168***	-0.181***
	(0.017)	(0.015)	(0.017)	(0.017)	(0.015)	(0.020)
Dividend Dummy	0.011***	0.015***	0.012***	0.010***	0.010***	0.012***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Change in Cash (Forward 1 Year)					-0.036*** (0.001)	
Acquisitions/Assets (Expenditure)						-0.140*** (0.013)
Intercept	0.213***	0.219***	0.215***	0.228***	0.230***	0.197***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.008)
Select Year Dummy Variables (with 1960 = 0)						
1970	-0.042***	-0.042***	-0.043***	-0.042***	-0.039***	
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
1980	-0.041***	-0.041***	-0.042***	-0.041***	-0.040***	
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	
1990	-0.040***	-0.041***	-0.041***	-0.040***	-0.037***	
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	
2000	-0.041***	-0.037***	-0.042***	-0.041***	-0.033***	
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	
2007	-0.018***	-0.010***	-0.021***	-0.020***	-0.016***	
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	
Annual Dummy	yes	yes	yes	yes	yes	yes
N	103550	107176	97053	103550	103321	88113
$Adj.R^2$	0.698	0.684	0.676	0.697	0.723	0.706

Standard errors in parenthesis. **p<0.05 *** p<0.001. The dependent variable is the cash ratio. Regressions use the fixed effects model. Regressions span 1960-2007. Data in (6) encompasses 1970-2007.

Table 5: Fixed Effects Regressions Predicting the Determinants of the Cash Ratio

	Dependent Variable: Cash Ratio			
	Top 95^{th} by Size (Assets)	Omit Simultaneous Cash Decisions	1960-1978	1979-2007
	(1)	(2)	(3)	(4)
SD Real Sales Growth	0.065***	0.060***	0.018*	0.087***
	(0.005)	(0.006)	(0.008)	(0.007)
Log Assets	-0.005***	-0.007***	-0.000	-0.008***
	(0.001)	(0.001)	(0.001)	(0.002)
Real Sales Growth	-0.021***	-0.020***	-0.012*	-0.022***
	(0.003)	(0.002)	(0.005)	(0.003)
Market-to-Book Ratio	0.007***	0.004***	0.013***	0.003***
	(0.002)	(0.001)	(0.002)	(0.001)
Leverage	-0.110***		-0.055*	-0.095***
	(0.007)		(0.021)	(0.008)
CapX/Assets	-0.196***		-0.173***	-0.177***
	(0.011)		(0.013)	(0.028)
Dividend Dummy	0.006***		0.009**	0.009***
	(0.001)		(0.003)	(0.002)
Intercept	0.209***	0.189***	0.136***	0.216***
	(0.006)	(0.005)	(0.006)	(0.012)
Select Year Dummy Variables (with 1960 = 0)				
1970	-0.043***	-0.051***		
	(0.001)	(0.001)		
1980	-0.043***	-0.048***		
	(0.001)	(0.002)		
1990	-0.040***	-0.048***		
	(0.002)	(0.002)		
2000	-0.049***	-0.047***		
	(0.003)	(0.003)		
2007	-0.032***	-0.020***		
	(0.003)	(0.003)		
Annual Dummy	yes	yes	yes	yes
N	95,631	105,522	41,057	62,493
$Adj.R^2$	0.718	0.681	0.613	0.726

Standard errors in parenthesis. **p<0.05 *** p<0.001. Regressions use the fixed effects model. The dependent variable is the cash ratio. Regressions span 1960-2007 for (1) and (2). (3) and (4) are divided into sub-intervals. The interval timing is determined by the QLR statistic with 1 unknown structural break in the mean cash ratio.

Table 6: Regressions Predicting the Changes in Cash

	Dependent Variable: Change in Cash			
	(1)	(2)	(3)	(4)
Real Sales Growth	0.255***	0.259***	0.224***	0.227***
	(0.021)	(0.019)	(0.021)	(0.019)
Market-to-book Ratio	0.007*	0.007*	0.015***	0.017***
	(0.003)	(0.003)	(0.003)	(0.003)
Leverage	-0.076*	-0.072	-0.171***	-0.165***
	(0.037)	(0.038)	(0.026)	(0.025)
ΔCapX	-0.022**	-0.013	-0.036***	-0.026**
	(0.008)	(0.008)	(0.007)	(0.008)
Log Assets	0.013***	0.017***	0.035***	0.049***
	(0.003)	(0.003)	(0.007)	(0.009)
Dividend Dummy	-0.034***	-0.033**	-0.068***	-0.074***
	(0.009)	(0.009)	(0.010)	(0.011)
Acquisitions/Assets		-0.877***		-1.055***
(Expenditure)		(0.078)		(0.085)
Intercept	0.003	-0.010	-0.176***	-0.229***
	(0.042)	(0.051)	(0.049)	(0.054)
SIC 2 Digit Dummy	yes	yes	no	no
Fixed Effects	no	no	yes	yes
Annual Dummy	yes	yes	yes	yes
N	101,995	87,145	101,995	87,145
$Adj.R^2$	0.020	0.023	-0.013	-0.016

Standard errors in parenthesis. **p<0.05 *** p<0.001. The dependent variable is the percent change in cash. Regressions span 1960-2007. Data in (4) encompasses 1970-2007. ΔCapX is the percent change in capital expenditures.

Table 7: Summary Statistics

Panel A

	Means		
	1960	1978	2007
Cash Ratio	0.122	0.084	0.200
SD Real Sales Growth	0.115	0.178	0.235
Real Sales Growth	0.038	0.084	0.072
Market-to-book Ratio	1.251	0.602	2.033
Leverage	0.175	0.268	0.244
CapX/Assets	0.075	0.086	0.055
Log Assets	6.449	5.281	5.932
Dividend Dummy	0.935	0.714	0.342
Annual Dummy	0.000	-0.041	0.036

Panel B

	Percentage Point Change in Cash Ratio	
	1960-1978	1978-2007
Predicted contributions by:		
SD Real Sales Growth	0.013	0.012
Real Sales Growth	0.000	0.000
Market-to-book Ratio	-0.004	0.009
Leverage	-0.011	0.003
CapX/Assets	-0.002	0.006
Log Assets	0.008	-0.005
Dividend Dummy	0.001	0.002
Annual Dummy	-0.041	0.077
Residual	-0.002	0.013
Total	**-0.039**	**0.117**

Panel A summarizes the mean of each variable in 1960, 1978, and 2007. Panel B shows the predicted percentage point change in cash ratio in time intervals 1960-1978 and 1978-2007 informed by the regression estimates from Model 1.

Table 8: Impact of Aggregate Variables on Annual Dummy Coefficients 1960-2007

Dependent Variable:	Annual Dummy Variable Coefficients								
Dependent Variable Source:	Model 1							Model 1 Fixed Effects	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inflation	-0.434***	-0.448**						-0.245***	-0.259***
	(0.101)	(0.157)						(0.056)	(0.091)
Expected Inflation			-0.510***						
			(0.112)						
Nominal Interest Rate				-0.517***					
				(0.104)					
Real Interest Rate					-0.281				
					(0.290)				
Yield Curve						0.221			
						(0.303)			
Real GDP Growth							-0.001		
							(0.170)		
Intercept	-0.002	-0.002	0.002	0.009	-0.020***	-0.023***	-0.020**	-0.019***	-0.020
	(0.005)	(0.006)	(0.006)	(0.006)	(0.004)	(0.005)	(0.007)	(0.003)	(0.004)
Recession Dummy	no	yes	no	no	no	no	no	no	yes
N	48	48	48	48	48	48	48	48	48
Adj. R^2	0.271	0.300	0.294	0.336	-0.013	-0.01	-0.022	0.252	0.308

Standard errors in parenthesis. **p<0.05 *** p<0.001. The dependent variable is Annual Dummy Coefficients from Model 1 in (1)-(7) and the Annual Dummy Coefficients from Model 1 Fixed Effects in (8)-(9). Regressions span 1960-2007. (2) and (9) contain recession dummy variables if that year witnessed a quarter in recession. Each recession has its own unique dummy variable.

Table 9: Regressions Predicting the Determinants of the Cash Ratio

	Dependent Variable: Cash Ratio			
	(1)	(2)	(3)	(4)
Inflation		-0.454***		-0.176**
		(0.088)		(0.053)
SD Real Sales Growth	0.205***	0.210***	0.070***	0.064***
	(0.015)	(0.015)	(0.006)	(0.006)
Log Assets	-0.007***	-0.005***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Real Sales Growth	-0.009*	-0.010*	-0.019***	-0.019***
	(0.004)	(0.005)	(0.002)	(0.002)
Market-to-Book Ratio	0.006**	0.007**	0.004***	0.004***
	(0.002)	(0.002)	(0.001)	(0.001)
Leverage	-0.119**	-0.122**	-0.089***	-0.091***
	(0.036)	(0.037)	(0.009)	(0.009)
CapX/Assets	-0.201***	-0.234***	-0.171***	-0.178***
	(0.013)	(0.018)	(0.017)	(0.017)
Dividend Dummy	-0.006	-0.014**	0.011***	0.013***
	(0.005)	(0.004)	(0.001)	(0.001)
Intercept	0.185***	0.175***	0.213***	0.192***
	(0.011)	(0.011)	(0.005)	(0.007)
Annual Dummy	yes	no	yes	no
SIC 2 Digit Dummy	yes	yes	no	no
Fixed Effects	no	no	yes	yes
N	103,550	103,550	103,550	103,550
Adj. R^2	0.280	0.266	0.698	0.694

Standard errors in parenthesis. **p<0.05 *** p<0.001. The dependent variable is the ratio. Regressions span 1960-2007. Columns (1) and (3) reproduce the regression estimates from Model 1 and Model 1 Fixed Effects, respectively. (2) and (4) include annual inflation directly in the regression model.

Table 10: Impact of Inflation on Cash Holding 1960-2007

Dependent Variable:	Cash Ratio					
Data Source:	Flow of Funds (Quarterly)		Compustat (Annual)			
Aggregation:	Aggregate		Mean		Median	
	(1)	(2)	(3)	(4)	(5)	(6)
Inflation	-0.236***	-0.265***	-0.694***	-0.724**	-0.401***	-0.414**
(Annual Rate)	(0.019)	(0.023)	(0.172)	(0.266)	(0.094)	(0.156)
Intercept	0.058***	0.059***	0.154***	0.155***	0.089***	0.089***
	(0.001)	(0.001)	(0.009)	(0.011)	(0.005)	(0.006)
Recession Dummy$^{\#}$	no	yes	no	yes	no	yes
N	208	208	48	48	48	48
$Adj.R^2$	0.425	0.523	0.246	0.277	0.267	0.233

Standard errors in parenthesis. **p<0.05 *** p<0.001. The dependent variable is the ratio. Regressions span 1960-2007. Columns (1) and (2) are quarterly data and inflation for each quarter is expressed at an annual rate. (2), (4) and (6) contain recession dummy variables if that time period was in a recession. Each recession has its own unique dummy variable.