

# Increase in Cash Holdings: Pervasive or Sector-Specific?

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## Abstract:

This paper examines the difference in cash holdings between high-tech and non-high-tech firms over the period from 1974 to 2007. In contrast to the average cash-to-assets ratio of non-high-tech firms, which remained stable at a level close to that of the 1970s, the average cash ratio of high-tech firms more than tripled from 1980 to 2007. By expanding the regression model of cash holdings developed by Opler et al. (1999), and estimating it for the high-tech and non-high-tech sectors separately, I find that this difference can be explained by changing firm characteristics across these two sectors. This is a consequence of high-tech new listings, whose changing nature and increasing proportion in the sector over the past three decades are responsible for causing population characteristics in the high-tech sector to tilt toward those typical of firms that hold more cash.

**Key Words:** *cash holdings; new listings; high-tech; R&D*

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## 1. Introduction

Corporate cash policy has become a topic of significant interest recently, likely motivated in part by the old saying that ‘In a recession cash is king’. While many firms in traditional sectors, even well-established ones like General Electric, have been desperately seeking solutions to their cash poor problems by cutting dividends, suspending new projects, and/or closing subsidiaries, high-tech firms seem to be better prepared for recession conditions because they hold large reserves of cash. Some firms, for example IBM, Oracle, and Intel, can even afford to initiate or increase their dividends, while others, like Oracle, Merck, and Pfizer, can partially finance acquisitions using cash.<sup>1</sup> Furthermore, an intriguing phenomenon, widely documented in the business press over the past few years, is the gradual stockpiling of cash by large U.S. firms in the aftermath of the economic downturn in the early 2000s.<sup>2</sup> High-tech firms attracted special attention due to a more rapid speed of cash accumulation despite the ‘growth’ nature of their business.<sup>3</sup>

In this paper, I examine the trends in corporate cash holdings from 1974 to 2007, with a focus on the difference in cash holdings between firms in high-tech and non-high-tech sectors. From practical point of view, this topic is interesting due to the aforementioned puzzling observations of large firms in these two sectors, as well as the rapid growth of high-tech sector in the universe of publicly listed U.S. firms. From academic perspective, the distinction between high-tech and non-high-tech firms is important because it is well-known that high-tech firms are exposed to more severe capital market frictions due to high information asymmetry about their uncertain growth opportunities and a lack of collateral (Myers, 1984; Hall, 2002). Hence, holding cash is more important for high-tech firms, particularly the younger firms, since remaining innovative through intensive and steady research and development (R&D) is crucial for their survival and growth.

Like Bates et al. (2009), I investigate trends in cash holdings, measured by the average cash-to-assets ratio, over time and find that U.S. firms on average have increased their cash holdings since 1980. Using the official definition of high-tech industries offered by the U.S. Department of Commerce to split the sample of publicly listed firms into the high-tech and non-high-tech sectors, I find that the average cash-to-assets ratio has become increasingly different across the two sectors since 1980. The average cash-to-assets ratio for the high-tech sector more than

tripled, increasing from 11.2% in 1980 to 39.1% by 2007; over the same period, the average cash-to-assets ratio of non-high-tech firms remained relatively flat at around 11%, similar to their level during the 1970s, and only slightly increased during the 2000s. This difference in the trends in cash holdings between the high-tech and non-high-tech sectors is robust to alternative industry classification methodologies, such as the Fama-French classification and the Global Industry Classification Standard (GICS).

What is the cause of this difference? The literature on corporate cash holdings shows that the level of a firm's cash holdings is a function of fundamental characteristics that are related to the costs and benefits of holding cash (Kim, et al., 1998; Opler et al., 1999). Although it is easy to justify the fact that high-tech firms usually have higher cash-to-assets ratios than non-high-tech firms, the growing difference in the cash trends between these two sectors over the past three decades is puzzling. A clue to deciphering this puzzle is the new listings effect. As equity markets developed, many firms with weaker fundamentals went public in the 1980s and 1990s (Fama and French, 2004; Brown and Kapadia, 2007). However, the nature and impact of new listings are different between the high-tech and non-high-tech sectors. The high-tech sector has experienced a rapid expansion due to the new listings in the 1980s and 1990s. Moreover, these new listings are different from those firms that listed earlier. The combined effect of these two aspects has led the population of public firms in the high-tech sector to shift gradually toward the characteristics that, according to the literature on corporate cash holdings, are typical of firms that hold more cash. On the other hand, the population characteristics of the non-high-tech sector were less affected by new listings since they were more similar to those existing firms.

In order to test whether the difference in changing firm characteristics can help explain the difference in cash trends, I follow the framework proposed by Fama and French (2001). After estimating a regression model of corporate cash holdings using the first ten years of available data, I subsequently calculate the out-of-sample forecasts using observed firm characteristics and the estimates from the regression model. The regression model of corporate cash holdings is based on the one developed in Opler et al. (1999), but augmented with additional variables to take into account firms' external debt and equity financing, a potential non-linear impact of R&D, and macroeconomic factors. These modifications are based on recent findings in the literature and improve the explanatory power of the regression model. As emphasized by the literature on R&D financing (recently reviewed by Hall (2002)), the nature of investment and operation of

firms in the high-tech sector is distinct from that in the non-high-tech sector, so it is expected that the impact of various firm characteristics on corporate cash holdings may differ between these two sectors. To address the potential differences, the modified cash model is estimated separately for the high-tech and non-high-tech sectors in the estimation period. The out-of-sample forecasts on average justify the observed difference in cash trends across the high-tech and non-high-tech sectors over time.

Besides improving our understanding of the evolution of corporate cash holdings over the past three decades and the determinants of corporate cash holdings, this paper is closely linked to several other branches in the literature. First, this paper contributes to the literature on new listings and equity market development (Fama and French, 2004; Brown and Kapadia, 2007). This is the first paper to provide a detailed comparison of a wide range of firm characteristics of new listings in the high-tech and non-high-tech sectors. Existing studies usually focus on the pervasiveness of the impact of new listings, understating the cross-industry difference. This paper shows that the difference between high-tech and non-high-tech new listings is important for analyzing cash holdings.

Furthermore, this paper is indirectly linked to recent literature that investigates an increasing conservatism in corporate debt policy (Strebulaev and Yang, 2007; Byoun, et al. 2008) and a growing preference for financial flexibility (Graham and Harvey, 2001; DeAngelo and DeAngelo, 2007). This paper shows that the new listings in the high-tech sector tend to hold a larger proportion of their book assets in the form of cash whilst they seldom issue debt, hence implying a negative net leverage. Given the increasing proportion of high-tech firms in the overall sample of public firms, the high-tech new listings may have contributed to the observed conservatism in debt and preference for financial flexibility.

Finally, this paper provides a link to the literature on R&D financing. This literature argues that R&D-intensive firms, particularly the immature ones, are more likely to suffer from capital market frictions; and they also lack proper financial hedging instruments due to the nature of their operations and investment (Hall, 2002; Carpenter and Petersen, 2002; Passov, 2003). This implies that cash holdings of high-tech firms, especially for new listings, are different from non-high-tech ones. This implication is directly supported by this paper.

The remainder of the paper is organized as follows. Section 2 reviews current studies on corporate cash policy, new listings, and R&D financing. Section 3 provides the evidence on the

difference in cash trends between the high-tech and non-high-tech sectors. Section 4 provides the explanation for this difference, and Section 5 concludes.

## **2. Literature Review**

The empirical study of this paper is closely linked to existing research in three areas: corporate cash holdings, new listing effects, and R&D financing. In what follows, I provide a brief discussion of the related studies.

If capital markets were perfect, i.e. external financing was frictionless, holding cash and cash equivalents would be irrelevant, since firms could always raise external financing at no cost when internal funds were insufficient (Modigliani and Miller, 1958). Thus, maintaining zero cash would be the optimal choice for any firm. The existence of frictions in capital markets provides the rationale for firms to hold cash. As Keynes (1936) pointed out there are two primary motives to justify firms' cash holdings. First, holding cash can help a firm avoid the transaction costs associated with either liquidating a non-cash asset or using external financing to make cash payments. The second is a precautionary motive: the desire to hold cash as a cushion to hedge the risk of future cash shortfalls, which may be caused by either adverse business shocks or new investment opportunities.

Building on Keynes' insights, recent empirical studies on corporate cash holdings by Kim et al. (1998) and Opler et al. (1999) group the theories into benefits and costs of holding one more dollar of cash. They find that some relevant firm characteristics, such as business risk, growth opportunities, and size among others, can help explain the observed levels of cash held by firms. More specifically, firms with more growth opportunities and higher business risk usually hold larger cash reserves as a percentage of their total assets, whereas larger firms, firms with higher net working capital, and highly levered firms tend to hold less cash.<sup>4</sup> This empirical model has been used in many recent empirical studies, either to explore additional determinants of corporate cash holdings or to compute the 'optimal' level of cash that a firm should hold given its characteristics.<sup>5</sup>

Over the past three decades, the development of equity markets and the growth of mutual funds have led to a reduction in the cost of equity capital, which allowed many firms with weaker fundamentals to enter into market (Fama and French, 2004). Ritter and Welch (2002) show that the proportion of IPOs with negative earnings in the year before listing has increased

over the period from 1980 to 2001. Fama and French (2004) find that the new listings in the 1980s and 1990s are less profitable, have more growth opportunities, and have lower survival rates. Brown and Kapadia (2007) find that these new listings are riskier and shift the overall characteristics of the population, thus being a fundamental cause of the ‘increasing idiosyncratic risk’ puzzle. Fama and French (2001) discover that the shift caused by the new listings partly contributes to the steady decline in the percentage of dividend payers among public firms since 1978. Bates et al. (2009) find that changing firm characteristics can explain the phenomenon of rising cash holdings.

However, only a few papers in this literature have considered the differences in the evolutionary paths of firms in different industries. Fama and French (2004) briefly compare the distribution of profitability and growth opportunities (measured by changes in total assets) across five industries over the years, but understate these cross-industry differences due to their focus on the universe of public firms. Brown and Kapadia (2007) find that tech-intensive industries have higher idiosyncratic risk due to the new listings effect, but do not investigate this result in detail. However, the evolution of the cross-sectional differences in cash-relevant firm characteristics in the high-tech and non-high-tech sectors may play an important role in deciphering the different trends in their cash holdings. Although many firms went public in these two sectors, the impact of these listings on the two populations of firms may be different.

It is widely accepted that the central feature of high-tech firms is their intensive investment in research and development (R&D). Hall (2002) summarizes the two distinct features of R&D: first, the major portion of R&D spending is on human capital, which requires smooth investment and generates intangible assets; second, the output of the R&D investment is uncertain, particularly at the early stage.

These features imply that high-tech firms suffer more from capital market imperfections. On the one hand, it is hard for them to get debt financing since their intangible assets can barely be used as collateral. Bradley et al. (1984) identify R&D intensity being inversely related to leverage. Carpenter and Petersen (2002) find that debt financing is rarely used by small high-tech firms. On the other hand, information asymmetry is severe for R&D projects, because it is difficult for outside investors to assess the value and likelihood of success for these projects. Further, this information gap cannot be easily reduced by voluntary disclosure due to strategic concerns. High information asymmetry leads to costly equity financing according to the pecking

order theory (Myers and Majluf, 1984) or a greater tendency to time the market (Baker et al., 2004). In practice, Brown et al. (2009) find that internal funds and external equity are the two major sources of finance for high-tech firms. Hence, high-tech firms may typically be more likely to time the market to issue equity and then spend the proceeds on R&D gradually over time. Brown and Petersen (2009) find that R&D-positive firms, particularly financially-constrained ones, tend to use their cash reserves to smooth their R&D investment.

From a different but related perspective, high-tech firms are more inclined to use cash holdings for hedging. Froot, et al. (1993) point out that the hedging instrument used by a firm depends on the nature of its investment and financing opportunities. Richard Passov, the treasurer of Pfizer, argues that in practice R&D is usually regarded as a liability for high-tech firms since the inability to consistently fund R&D could trigger financial distress (Passov, 2003). R&D liabilities, coupled with the low correlation of R&D investment with a company's internal cash flow, as well as costly external financing, indicate a strong hedging motive for high-tech firms. However, the unique risks associated with R&D cannot be hedged in financial markets, making cash the preferable hedging tool chosen by high-tech firms (Passov, 2003). Acharya, et al. (2007) formalize the idea of using cash as a hedging tool, and find that a larger cash reserve is more preferable than lower debt when a firm's hedging need is higher.

The above literature review leads to the testing hypothesis to explain the difference in cash trends. Compared to the non-high-tech sector, the population of the publicly traded firms in the high-tech sector has tilted toward the characteristics typical of firms that hold more cash. The source of the tilt is the new lists: they dominate high-tech sector by number and they differ notably from the senior firms. With a proper regression model of corporate cash holding, and adjusting for the potential differences in the impact of various firm characteristics on corporate cash holdings across these two sectors, the differences in the changing firm characteristics across these two sectors can adequately explain the observed difference in their cash trends.

### **3. Time Trends in Corporate Cash Holdings: 1974-2007**

The base sample of my study contains all U.S. publicly traded firms in the CRSP-Compustat merged database (Fundamental Annual) for the period 1974-2007. The sample starts in 1974 because CRSP expanded to include NASDAQ firms in 1973 and U.S. GAAP was changed in 1974 to require firms to immediately expense their R&D expenditures (Statement of Financial

Accounting Standards, SFAS, No. 2, 1974). Firms that incorporate outside the United States are excluded. Financial firms (SIC codes 6000-6999) are excluded since they need to hold cash and marketable securities in order to meet statutory capital requirements. I also exclude utility firms (SIC codes 4900-4999) as their cash policy can be a by-product of regulation.

For a firm to be included in the sample in a given year, it must have equity traded on the NYSE, AMEX, or NASDAQ with a share code of 10 or 11 (ordinary common shares). Furthermore, firms in a given year are excluded if their assets or sales were non-positive or if their cash and marketable securities were negative. The screening leaves an unbalanced panel of 138,193 observations for 14,948 unique firms during the period from 1974 to 2007.

[Insert Table 1 here]

Table 1 reports the composition of the sample. For each year, Table 1 reports the number of firms in the whole sample, as well as in the high-tech and non-high-tech sectors respectively. Despite general agreement on the characteristics of high-tech firms, there is less consensus on precisely which industries should be classified as ‘high-tech’. Here, I follow Brown et al. (2009) and use the official definition of high-tech industries offered by the United States Department of Commerce.<sup>6</sup> More specifically, the high-tech sector consists of firms from the following seven industries defined by 3-digit SIC codes: drugs (SIC 283), office and computing equipment (SIC 357), communications equipment (SIC 366), electronic components (SIC 367), scientific instruments (SIC 382), medical instruments (SIC 384), and software (SIC 737). The remaining firms in the sample are classified as non-high-tech. There was a rapid increase in the number of firms in the high-tech sector during the 1980s and 1990s, and a decline in the 2000s. The proportion of firms belonging to the high-tech sector increased from 12.82% in 1974 to 38.1% in 2000, and remained around this level henceforth, despite the decrease in the number of firms.<sup>7</sup> Hence, over the sample period, the high-tech sector has become increasingly important in the universe of publicly listed US firms.

[Insert Figure 1 here]

Figure 1 tracks the time trends in the cash-to-assets ratio and net leverage ratio of the whole sample, as well as for the high-tech and non-high-tech sectors respectively, measured by the annual mean, median, and value-weighted average. For each firm-year observation, the cash-to-assets ratio is measured by cash and marketable securities divided by total assets; the net

leverage ratio is defined as total debt minus cash and marketable securities, and then divided by total assets.

The trends in cash holdings and net leverage for the whole sample are plotted as scatter points in Figure 1. The annual mean cash ratio increased from 7.5% in 1974 to 9.8% in 1980 and then to 23% in 2007, reaching a peak of 23.7% in 2004.<sup>8</sup> The value-weighted average of the cash ratio, as well as the median cash ratio, also exhibit upward trends, but less steep than the trend of the annual mean. The annual mean (median) net leverage ratio decreased from 20.2% (21.4%) in 1974 to 16.6% (18.5%) in 1980 and then to -2.8% (0.7%) in 2007, implying that the average firm could almost repay its debts with its own cash holdings by the end of the sample period. The trends over the 1980-2006 period are close to those reported in Bates et al (2009).

When the differences between the two sectors are examined, the results are more dramatic. The cash holdings of these two sectors are very similar over the 1974 –1979 period. However, in 1980, the average cash ratio in the high-tech sector started to increase; between 1980 and 2007, it has more than tripled, from 11.2% to 39.1% (all in annual mean). In contrast, the average cash ratio of non-high-tech firms remained stable at a level similar to that of the 1970s, and increased only slightly in the 2000s. For the net leverage ratio, the annual average of high-tech firms became negative in the early 1990s and continued to fall, while non-high-tech firms on average are always net debtors.

To show that the difference in the cash trends for these two sectors from 1980 to 2007 is not due to the specific definition used by the U.S. Department of Commerce, I use two alternative definitions: the Fama-French industry classification and the Global Industry Classification Standard (GICS).<sup>9</sup> More specifically, the whole sample is split independently into industry groups according to the Fama-French 12-industry classification and the GICS 10 economic sectors to facilitate comparison.<sup>10</sup> Besides providing two alternative categorization schemes, these two classifications also provide a more detailed look on the component industries in the high-tech and non-high-tech sectors.

[Insert Table 2 here]

After calculating the mean and median cash ratio, as well as the value-weighted average cash ratio, for each industry group every year from 1980 to 2007, I investigate the significance of the time trend in the average cash ratios for each industry by applying a linear trend model, i.e. regressing the average cash ratio on a constant and a time index measured in years. Results for

the industry groups based on the Fama-French and the GICS schemes are reported in Table 2. Regardless of the measure used to capture the industry average, the upward trend in cash holdings is economically and statistically more significant for two industry groups: Business Equipment (BusEq, including firms in computers, software, and electronic equipment) and Healthcare (Hlth, including firms in drugs, medical equipment, and healthcare) by the Fama-French standard; or Information Technology (including software, hardware, and electronic equipment) and Health Care (including health care equipment and services, pharmaceuticals, biotech and life sciences) by the GICS scheme.<sup>11</sup> Although the Telecom group (Telcm, including firms in telephone and television transmission) also exhibits a statistically significant upward trend, its economic size is much smaller. The trend in the cash holdings for the other industry groups is either statistically insignificant or even downward (e.g. Energy). Since Business Equipment (or Information Technology by the GICS) and Healthcare industries are generally regarded to be research-intensive, results in Table 2 verify the aforementioned differences in the cash trends between the high-tech and non-high-tech sectors.

[Insert Figure 2 here]

In Figure 1, it is also worth pointing out that the trend in the cash holdings of high-tech firms has several peaks and these peaks coincide with periods of hot IPO markets. The annual number of IPO firms over the 1974-2007 period is plotted in Figure 2.<sup>12</sup> Following a moderate increase in the 1970s, stock markets experienced a surge of new listings in the 1980s and 1990s, before cooling down in the 2000s. When the IPO firms are decomposed into the high-tech and non-high-tech sectors, it is obvious that both sectors experienced the same hot and cold markets. Nevertheless, there are always a larger number of firms going public in the non-high-tech sector each year, except during the Internet bubble period in 1999 and 2000.

[Insert Figure 3 here]

Welch (1989, 1996) finds that firms usually make sequential seasoned equity offerings (SEO) or issue debt right after their IPO. Figure 3 depicts the cash holdings of newly IPO firms and seasoned firms in the two sectors, with newly IPO firms being defined as those within five years after their IPO dates and seasoned firms being defined as those that have been listed for more than five years. Several aspects of these plots deserve special attention. First of all, the peaks in the annual mean and median cash holdings only exist for the newly IPO high-tech firms, indicating that newly IPO firms tend to save the proceeds from the IPO (or the follow-up SEOs

and debt financing). Hence, external financing has a large impact on high-tech firms' cash holdings, especially for the newly IPO firms. Second, even though non-high-tech firms exhibit a slight rise in their cash holdings only after 2000, the upward trend exists in the cash holdings of high-tech firms over the entire sample period for both seasoned and newly IPO firms. The latter finding is important since it clearly shows that it is not the higher proportion of the newly IPO firms in the high-tech sector that drives the results. Moreover, it also shows that when the newly IPO firms in the high-tech sector become seasoned, they still hold more cash, on average, than those firms that went public earlier in the sample period. Hence, these findings indicate that, relative to the non-high-tech sector, some fundamental changes have taken place in the high-tech sector. In the next section, I will examine this in more detail.

#### **4. Explaining the Different Trends in Corporate Cash Holdings**

Why is the trend in cash holdings so different between the high-tech and non-high-tech sectors? In this section, I first examine the determinants of the cash ratio in a pooled sample, that is, across all sectors, as well as in the high-tech and non-high-tech sectors separately, over the entire sample period. I propose a modified version of the cash holding model by including several variables identified recently in related literature. I also examine the consistency of my results with that of previous studies and test whether the factors that affect the cash ratio differ across the two sectors. Subsequently, I examine the evolution of the firm characteristics in the two sectors to establish whether the population of the firms in the high-tech sector, compared to the non-high-tech sector, drifted more toward those firms tending to hold more cash. The contribution of the later listing cohorts to the evolution of the firm characteristics across the two sectors is investigated separately. Finally, I directly test, using the basic framework proposed in Fama and French (2001), whether the difference in the changing firm characteristics can provide an adequate explanation for the observed difference in the cash trends.

##### **4.1 The Determinants of Cash Holdings**

Previous studies use the cash holdings model proposed by Opler et al. (1999). This model attempts to explain firms' cash holdings using a number of important determinants, including firm size, profitability, net working capital, growth opportunities (as measured by market to book

ratio, capital expenditure, and R&D expense), risk (as measured by industry cash flow volatility), and leverage, as well as a dividend dummy.

Nevertheless, the findings of several recent studies on financial constraints, cash, and investment policy demonstrate the potential need to revise the cash model. In this paper, I extend the cash model by adding five more variables: net debt issuance, net equity issuance, R&D squared, and two macroeconomic variables (T-bill yield and default spread).<sup>13</sup>

Net Debt issuance and net equity issuance are two channels of external financing, whose impact on cash holding follows from restating the cash flow identity

$$OCF + NetDiss + NetEiss - Investments - Dividend - \Delta NWC = \Delta Cash \quad (1)$$

The first three terms on the left hand side of equation (1) are internal and external sources of funds: operating cash flow (OCF), net debt issuance (NetDiss), and net equity issuance (NetEiss). The remaining three terms are three major uses of funds. Funds are primarily used for investment activities, paying dividends, and building up non-cash working capital (such as inventory). What remains from these activities during a given fiscal year is reflected in the change in corporate cash holdings. Several recent studies find that firms save the proceeds from their external financing as cash, especially when firms take advantage of potential mispricing or have strong precautionary motives (Hertzel and Li, 2009; McLean, 2009). Moreover, it is noticeable in Figure 1 and Figure 2 that the peaks in the annual average cash ratio coincide with hot IPO markets. Further decomposition in Figure 3 shows that these peaks are caused by firms that went public within the past five years. Hence, it is necessary to add net equity issuance and net debt issuance to the regression model to account for the impact of external financing on firms' cash holdings.

Brown and Petersen (2009) find that firms, especially financially-constrained firms, tend to use their cash reserves to smooth their R&D investment. According to the regression model of Opler et al. (1999), the relationship between cash holdings and R&D intensity (measured by the R&D-to-sales ratio) is positive and linear, indicating that firms tend to hold more cash if their growth opportunities are based on R&D. However, given the findings of Brown and Petersen (2009), it is possible that increasing R&D expense leads to an increase in cash holdings but is limited by a certain threshold value. Hence, a potential non-linear relationship between R&D

intensity and cash holdings is modeled by including the squared term of R&D intensity as an additional variable.

Cash holding models are usually estimated with year dummies to control for the potential impact of common trends or business cycle effects since cash is held as a reserve against these cyclical events. Because I will use changing firm characteristics to explain the difference in the cash trends across the high-tech and non-high-tech sectors by using out-of-sample forecast, accounting for common trends or business cycles with year dummies is not feasible. Instead, I use the T-bill yield and the default spread. The risk-free rate represents the opportunity cost of cash; a decrease in the risk-free rate will decrease the opportunity cost of cash, making it cheaper to hold larger quantities of cash. The T-bill yield can be considered as a proxy for the risk-free rate, and is expected to have a negative impact on corporate cash holdings. The default spread, defined as the average yield on Baa less Aaa Moody's rated corporate bonds with a maturity of approximately 20-25 years, usually increases when macroeconomic conditions deteriorate and default risk intensifies. In such conditions, firms usually increase their cash reserves due to precautionary motives. Hence, it is expected that corporate cash holdings and the default spread are positively correlated.

The modified version of the regression model of corporate cash holdings is as follows:

$$\begin{aligned} \frac{Cash_{it}}{TA_{it}} = & \beta_0 + \beta_1 \cdot Size_{it} + \beta_2 \cdot \frac{NWC_{it}}{TA_{it}} + \beta_3 \cdot (IndustrySigma)_{it} + \beta_4 \cdot \frac{CF_{it}}{TA_{it}} + \beta_5 \cdot MB_{it} + \beta_6 \cdot \frac{CAPEX_{it}}{TA_{it}} \\ & + \beta_7 \cdot \frac{R \& D_{it}}{Sales_{it}} + \beta_8 \cdot \left( \frac{R \& D_{it}}{Sales_{it}} \right)^2 + \beta_9 \cdot Leverage_{it} + \beta_{10} \cdot DivDummy_{it} + \beta_{11} \cdot \frac{ACQN_{it}}{TA_{it}} \\ & + \beta_{12} \cdot NetDiss_{it} + \beta_{13} \cdot NetEiss_{it} + \beta_{14} \cdot TbillYield_t + \beta_{15} \cdot DefaultSpread_t + \varepsilon_{it} \end{aligned} \quad (2)$$

where the variable IndustrySigma stands for the industry cash flow volatility, used as a measure of business risk. The details on how the variables are constructed are provided in the Appendix.

[Insert Table 3 here]

Panel A of Table 3 presents the results of regressions estimated over the entire period of 1974 - 2007.

There are 138,193 firm-year observations in the dataset. Requiring complete data for the explanatory variables reduces the sample to 117,240 firm-year observations. The standard errors are adjusted for firm-level clustering, assuming errors are independent across firms but not

across time (Petersen, 2009). The first column in Table 3 reports the coefficient estimates for the basic regression model developed by Opler et al. (1999). The results are consistent with previous studies: small firms with high growth opportunities and low net working capital in industries with high cash flow volatility tend to hold more cash; while stable firms, such as those with dividend payments or higher leverage, usually hold less cash. Moreover, higher levels of capital expenditures and acquisitions are associated with lower cash holdings. The OLS estimates for the parameters of the modified model are reported in column (2). The estimated slope of R&D-to-sales has increased more than threefold, and the coefficient of R&D squared is found to be negative and statistically significant at the 1% level. These jointly indicate a concave relationship between cash holdings and R&D intensity. The cash-to-assets ratio increases more directly with R&D, but they are limited to the relationship imposed by the firm's level of sales. The coefficients on net equity issuance and net debt issuance are both statistically significant, consistent with the argument that firms leave some of the proceeds from their external financing in the form of cash. The coefficients on the T-bill yield and the default spread have the correct signs, that is, they are negative and positive respectively. The estimated coefficients of the remaining variables are generally consistent with the findings of the basic model in column (1). A major difference is that the coefficient on the acquisitions variable doubles, indicating that it is closely related to two new external financing variables. The modified model provides a better explanation of the variation in cash holding as the adjusted R-squared increases by almost 6% to reach 58.1% compared to 51.9% for the basic model.

To examine whether the T-bill yield and the default spread properly capture the common trend related to macroeconomic events, I replace these two variables with year dummies. The coefficient estimates reported in column (3) are almost the same as those in column (2), and the adjusted R-squared increases only by 0.3%. Therefore, using the T-bill yield and the default spread gives results that are similar to those year dummy variables. Results are similar if the model is estimated with year and industry fixed effects (Column 4). Finally, I use the Fama and MacBeth (1973) method, estimating the coefficients in the cross-sectional regression each year and reporting the time series averages of the annual estimates. The results obtained (Column (5)) are consistent with previous findings.

Since the business environment is different for firms in the high-tech versus non-high-tech sectors, I expect that the impact of firm characteristics on corporate cash holdings should be

different between these two sectors. To test whether there is difference, I estimate the modified model of corporate cash holdings for the high-tech and non-high-tech sectors separately over the period from 1974 to 2007. The results are reported in columns (6) and (7) of Table 3. Moreover, column (8) tests whether the differences in the estimated coefficients for the two sectors are statistically significant or not. Although all the coefficients have the same sign across the two sectors, the t-tests indicate that most of the coefficients are significantly different. Except for the market-to-book ratio, the R&D-to-sales ratio and its squared term, net equity issuance, and the default spread, coefficient estimates of all the other eleven explanatory variables for high-tech firms, in absolute terms, are statistically and economically larger than those of non-high-tech firms. Furthermore, the adjusted R-squared is higher for the high-tech sector (61% versus 43%), indicating that the modified cash model provides a better fit for high-tech firms. In general, there exists preliminary evidence in support of estimating the cash model for the two sectors separately.

Although the signs and statistical significance of the coefficients from the above regressions are consistent with expectations, the results do not provide clear guidance on which determinants are relatively more important in explaining corporate cash holdings.<sup>14</sup> To examine the relative importance of these explanatory variables, I apply a method proposed by Grömping (2007), which provides estimates of the proportion of the variation of the dependant variable explained by the variation of each of the explanatory variables by taking into account the pair-wise correlation among the independent variables. Two values are reported for each determinant: the percentage of the variation in the dependant variable that it explains (absolute value) and the percentage of the variation explained within the regression model that it contributes (standardized value). A higher absolute or standardized value indicates a more important variable.

The results based on the OLS regressions of the modified cash model for the whole sample and for the high-tech and non-high-tech sectors respectively are reported in Panel B of Table 3.<sup>15</sup> According to the standardized values, the top five contributors to the overall variation in the predicted cash holdings, for the pooled sample as well as for two separate sectors, are leverage, R&D (including R&D and R&D squared), net working capital, size, and net equity issuance. In total, they contribute to more than 80% of the total explanatory power of the model, irrespective of whether it is for the whole sample or for the two separate sectors. However, the explanatory power of R&D and net working capital is much stronger for high-tech than for non-high-tech firms. R&D and net working capital jointly contribute to 50% of the total explanatory power of

the model for the high-tech sector, but only 22% for the non-high-tech sector. Overall the modified cash model explains 61.3% of the variation in the cash holdings of high-tech firms, but just 43.3% for non-high-tech firms. Hence, the absolute explanatory power of R&D and net working capital is even higher in the high-tech sector. Moreover, the contribution from the industry-level cash flow volatility (IndustrySigma) is relatively small, just around 4% of the total variation for the whole sample and even smaller for the two separate sectors. This does not necessarily shake its role as a key proxy for the precautionary motive to hold cash, since this industry-level measure has less cross-sectional variation than those firm-level variables.

## **4.2 Changing Firm Characteristics in Two Sectors**

Previous studies establish that the characteristics of firms that went public during the 1980s and 1990s are different from those that went public earlier, in terms of lower profitability and more growth opportunities (Fama and French, 2004). The shift in the characteristics of the population of public firms, caused by these new listings, has been used to explain the puzzling phenomena of disappearing dividends, increasing idiosyncratic risk, and increasing cash holdings (Fama and French, 2001; Brown and Kapadia, 2007; Bates et al., 2009).

However, less is known about the differences in the attributes of new listings in the high-tech versus non-high-tech sectors. According to Figure 3, there are many new listings in both sectors, especially in the 1980s and 1990s. The analysis in the previous section identifies a set of firm characteristics that are correlated with the cross-sectional variation in corporate cash holdings. Furthermore, it is evident that five core variables contribute to more than 80% of the total explanatory power of the model, for the whole sample as well as for the two sectors separately. In this section, I investigate a) whether these cash-related characteristics of the listed firms in the two sectors have changed over time, b) how the changes of these characteristics are different between high-tech firms and non-high-tech firms, and c) to what extent the new listings have contributed to these changes.

[Insert Table 4 here]

Table 4 reports the summary statistics of the cash-related characteristics of the listed firms in the high-tech and non-high-tech sectors in sub-periods defined according to calendar decades, with the 1980s and 1990s being the two sub-periods with huge increase in new listings.

The equally-weighted averages of each characteristic for the high-tech and non-high-tech sectors during a given sub-period are reported respectively in Panel A. This presents a general picture of the evolution of the characteristics of a typical firm in each sector over time. Since the difference in the cash trends started at the beginning of the 1980s, I use the 1970s characteristics as the benchmark for comparison purposes, and thus focus on changes in subsequent decades.

During the 1980-2007 period, both sectors experienced an increase in firm size, business risk (measured by industry cash flow volatility), and R&D intensity, and a decrease in net working capital, capital expenditure, leverage, and the proportion of dividend payers. Based on the findings described in the previous section that the cash ratio increases with business risk and R&D intensity, and decreases with size, net working capital, capital expenditure, leverage, and dividend dummy, changes in these firm characteristics, except firm size, are all in the direction of increasing cash holdings.

More importantly, the extent of changes is quite different across the two sectors. The high-tech sector has gone through more significant changes relative to the non-high-tech sector. To facilitate the comparison, I follow Brown and Kapadia (2007) to directly test the time trends in the aforementioned firm characteristics of the two sectors over 1980-2007, by regressing each firm characteristic on a constant and a time index measured in years. Slope coefficients and their p-values are reported in Panel A of Table 5. Subsequently, I compare the estimates of the slope coefficient between the high-tech and non-high-tech sectors, with the focus on the five core characteristics.

The *Leverage* of high-tech firms declined much faster, at a rate of 0.4% per year (compared to 0.1% per year for non-high-tech firms). The average leverage of high-tech firms in the 2000s is 12.4%, only half of the level during the 1970s benchmark period. Compared with the 1970s, *R&D intensity* has increased considerably in both sectors, but with a remarkable difference in their rates. R&D/Sales of non-high-tech firms followed an upward trend with a slope equal to 0.1%, but the time trend is much steeper in the high-tech sector, increasing from 23.8% in 1980s to 66.8% in 2000s with an annual rate of 2.4%. The ratio of *net working capital to assets* has decreased in both sectors. Starting with a higher level of 29.1% (compared to 20.4% in non-high-tech), NWC/TA of the high-tech firms, on average, ends up at a much lower level of 1.5% in the 2000s (compared to 7.6% for the non-high-tech sector), since the rate of decrease in the high-tech sector is three times faster than that in the non-high-tech sector. For both sectors, *net*

*equity issuance* has become more common after the 1970s and experienced an inverted-U shape change with its peak in the 1990s. However, high-tech firms generally use much more equity financing than firms in the non-high-tech sector and are more dependent on equity financing than on debt financing. This is consistent with the findings of previous studies on the R&D financing literature (Hall, 2002). Finally, compared to 1970s, the average **size** of firms in both sectors has dropped in the 1980s and 1990s due to new listings. Over the entire period from 1980 to 2007, the average size has increased gradually, but high-tech firms are usually much smaller than non-high-tech firms.

Besides these five core factors, Panel A also shows that the changes in several other factors are also stronger in the high-tech sector. Business risk, measured by Industry Sigma, has increased much faster in the high-tech sector, a result consistent with the findings on idiosyncratic volatility in Brown and Kapadia (2007). The ratios of cash flow to assets are similar in both sectors in the 1970s but drop afterwards, consistent with previous findings that new listings in the 1980s and 1990s are less profitable (Fama and French, 2004). However, over 1980-2007, the ratio of cash flow to assets gradually rises in the non-high-tech sector, but continues to decline and becomes negative for the high-tech sector. The latter is consistent with the finding in Ritter and Welch (2002) that over the past three decades the portion of technology IPOs and the percentage of IPOs with negative earnings are positively correlated. Comparing the trends in CF/TA, the source of internal funds, with the trends in the two channels of external financing, it seems that on average high-tech firms have become more and more dependent on external financing, especially equity, to fund their investments.

Panel A also shows that growth opportunities, as measured by the market-to-book ratio, are higher in the high-tech sector. Furthermore, a difference deserving more attention is that the growth opportunities in the high-tech sector are based on R&D expenditures, while the non-high-tech sector's growth is built mostly on capital expenditure.<sup>16</sup> This is important since capital expenditures help build a firm's tangible assets, whereas R&D expenditures, treated as an expense, generate intangible assets that are not reflected on the balance sheet. This partly explains the difference in the market-to-book ratio across the two sectors. However, what is more important is that growth opportunities based on R&D are more uncertain compared to those based on capital expenditures, and hence they trigger a stronger precautionary motive for holding cash.

Panel A provides evidence that the high-tech sector has shifted more significantly towards a set of firms with characteristics consistent with higher and increasing cash holdings. In Panel B, I decompose the firms in each sub-period according to the year they went IPO and investigate whether the changes are driven by new listings or not.<sup>17</sup>

When compared to the non-high-tech sector, the high-tech sector has been progressively dominated by new listings. During the 1980s, the 1980 IPO cohort constitutes 54% of the observations in the high-tech sector, compared to 34% in the non-high-tech sector. During the 1990s, the 1980 and 1990 cohorts jointly contribute to 84% of the sample observations in the high-tech sector, while the ratio is 70% for the non-high-tech sector. Even after the burst of the Internet bubble, 79% of the observations in the 2000s are from the 1980s and 1990s cohorts in the high-tech sector, whereas the ratio is 63% in the non-high-tech sector.

Moreover, firms in the later cohorts are different from those in the earlier cohorts, and these differences are more significant in the high-tech as compared to the non-high-tech sector. In the high-tech sector, although the firms that survived in each cohort have on average decreased their leverage over time, a more important phenomenon is that the leverage of firms from the later cohorts is always lower than that in an earlier cohort. A similar pattern is not obvious in the non-high-tech sector. In both sectors, later cohorts have higher R&D intensity, but the increase takes place much faster in the high-tech sector. The R&D-to-sales ratio of the Pre-1980 IPO cohorts is around 10% in all the sub-periods, while the R&D-to-sales ratio of the 1980s cohort is between 35% and 38% over time, and the ratio of the 1990s cohort is even higher at 74%. Hence, the higher R&D intensity of new listings has contributed to the increase in the average R&D intensity in the high-tech sector. A similar analysis can be applied to other characteristics, for example net working capital and net equity issuance.

In sum, the results tabulated in Table 4 show that when compared to the non-high-tech sector, the population of publicly traded firms in the high-tech sector has tilted more towards characteristics typical of firms that hold more cash. The source of this tilt is new listings: they dominate the high-tech sector by number and they differ from more senior firms. What remains to be answered is whether these differences in firm characteristics can explain the observed difference in cash trends across the two sectors since the early 1980s.

### 4.3 Can Changing Characteristics Explain the Difference in Cash Holdings?

To test whether changing firm characteristics can explain the difference in the observed cash trends across the two sectors, I follow the basic empirical strategy proposed in Fama and French (2001). First, I estimate the modified regression model of corporate cash holdings over the 1974-1983 period (estimation period). This provides a model of how cash holdings depend on firm characteristics identified earlier. I then use this estimated model of corporate cash holdings to predict the cash that firms should hold over the 1984-2007 period. By fixing the coefficients based on the 1974-1983 period but allowing for changes in firm characteristics, the predictions capture the change in cash holdings explained by changing firm characteristics.

Although the difference in the cash trends starts around 1980, I expand the estimation period to 1983 for two reasons: a) to increase the number of available observations for estimating the model coefficients, and b) to include the impact of the recessions of the early 1980s and the subsequent hot IPO markets. By doing so, the estimation period contains adequate variation in the external financing variables and the macroeconomic variables to ensure a proper estimate of their impact on cash policy.<sup>18</sup>

[Insert Table 5 here]

Table 5 reports the coefficient estimates of the modified model of cash holdings during the estimation period of 1974-1983, for the pooled sample (both sectors) and for the high-tech and non-high-tech sectors respectively. Setting aside the dividend dummy, the estimated slopes for the estimation period confirm our inferences about the roles of firm characteristics in cash holdings as documented in Table 3.

Given these model estimates from the estimation period, I can assess the cash-to-assets ratio a *typical* firm in the high-tech (non-high-tech) sector would have maintained had the firm chosen its cash policy in the same way as during the estimation period. The expected cash ratios are computed by applying the regression coefficients from the estimation period (documented in Table 5) to the values of the explanatory variables for each firm-year during the forecast period of 1984-2007. Due to the missing values for some explanatory variables, I can only calculate the expected cash holdings for 88,236 firm-year observations during the forecast period (28,091 observations in the high-tech sector and 60,145 observations in the non-high-tech sector). Differences between actual and expected values represent the variations in cash holdings that cannot be explained by changes in firm characteristics.

[Insert Table 6 here]

Table 6 reports the annual mean of actual and expected cash holdings, in the high-tech sector (Panel A) and in the non-high-tech sector (Panel B), with the coefficients being estimated from both the pooled regression and the separate regressions during the estimation period. Although the predicted cash holdings in the high-tech sector on average track the upward trend, the results based on the coefficients from the separate regression are much better, as evidenced from the lower deviation from the annual means of actual values. More specifically, if I ignore the difference between the two sectors by using the coefficients from the pooled regression in the estimation period, the inference on the out-of-sample forecast would be that high-tech firms on average hold more cash than needed for most years and the excess cash increases faster over time, staying above 10% in the 2000s. Since the predicted level of cash is already taking into account the various motives of holding cash, persistently holding excess cash at such a high level would be considered as a puzzle. Nevertheless, the results based on the coefficients from the separate regression for the high-tech sector tells a different story: high-tech firms on average seem to hold more cash than needed over the past 10 years, but the excess cash is always below 4% of total assets. Compared to the remarkable differences between the results from different estimation methods in the high-tech sector, the out-of-sample predictions in the non-high-tech sector, as documented in Panel B, are only slightly affected, and the expected cash holdings are closer to the actual values.

Overall, the analysis in this section shows that the modified model of corporate cash holdings tracks differences in cash trends across the high-tech and non-high-tech sectors by incorporating changes in cash-related firm characteristics. However, the distinct results in the high-tech sector when using coefficient estimates from the separate versus the pooled regressions imply that researchers should properly account for the cross-sector differences before concluding that high-tech firms on average hold too much ‘excess’ cash.

## **5. Conclusion**

Corporate cash policy has triggered a lot of interest recently, but most of the attention has been focused on the difference in cash holdings of large firms from the high-tech and non-high-tech sectors. This paper studies the difference in the cash holdings of ‘typical’ firms from these two sectors over a longer period and attempts to provide an explanation for the difference.

Since 1980, the average cash holdings of publicly listed U.S. firms in the high-tech and non-high-tech sectors have become more and more different. In contrast to the average cash-to-assets ratio of non-high-tech firms that remained stable around 11%, which is similar to its level during the 1970s, the average cash ratio in the high-tech sector has increased significantly, rising gradually from 11.2% in 1980 to 39.1% in 2007. This upward trend in the cash holdings of the high-tech sector, along with its growing weight in the universe of publicly listed U.S. firms, contributed to the phenomenon of increasing cash holdings for the entire sample of firms, as documented in Bates et al. (2009).

The identified difference in the cash trends between the high-tech and non-high-tech sectors coincides with a growing difference in the cash-relevant firm characteristics across the two sectors. When compared to the non-high-tech sector, the population of public firms in the high-tech sector has tilted toward attaining the characteristics typical of firms that hold more cash. This tilt is caused by the new listings: the high-tech sector has expanded considerably by the new listings in the 1980s and 1990s, whose nature differ notably from existing firms. On the other hand, the new listings in the non-high-tech sector are similar to existing ones and thus less change is seen in the characteristics of the population.

In order to test whether the differences in changing firm characteristics provide an adequate explanation for the observed difference in the cash trends across these two sectors, I expand the basic regression model of corporate cash holdings developed in Opler et al. (1999) by adding several variables to control for the impact of external financing, non-linearity of R&D, and macroeconomic events, and I employ the basic framework proposed in Fama and French (2001). The out-of-sample forecasts, based on coefficients estimated separately for the two sectors in the early sub-period and changing firm characteristics in the forecast period, on average, adequately justify the observed difference in cash trends across the high-tech and non-high-tech sectors over time.

Furthermore, for the high-tech sector, the average excess cash holdings is reduced to only 4% of the total assets when the coefficients from the separate estimation per sector are used compared to an average of above 10% of the total assets, when the coefficients from a pooled estimation are used. This result should generate some skepticism towards a “one-size-for-all” cash holding model, as it may generate false claims that the high-tech sector holds too much cash.

Over the past three decades, the high-tech sector has become more important among the publicly listed US firms due to the disproportional influx of new listings into this sector. Moreover, high-tech firms are different from traditional firms in terms of operation, investment, and financial policies. The results in this paper document this difference and highlight the importance of developing theoretical and empirical models to examine the high-tech sector in particular, instead of relying on a generic model for all industries.

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**Table 1**  
**The Distribution of Firms**

This table reports the number of firms in the whole sample and in the high-tech and non-high-tech sectors separately each year during the period from 1974 to 2007. The sample includes U.S. firms documented on the Compustat-CRSP merged database (fundamental annual) that have positive total assets and sales and nonnegative cash and marketable securities, and have common shares traded on the NYSE, AMEX, or Nasdaq. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 138,193 observations for 14,948 unique firms. The high-tech and non-high-tech sectors are defined according to the U.S. Department of Commerce. The proportions (in percentage) of the high-tech and non-high-tech sectors in annual sample are reported respectively.

| Year | Whole Sample | High-Tech |         | Non-High-Tech |         |
|------|--------------|-----------|---------|---------------|---------|
|      | Number       | Number    | Percent | Number        | Percent |
| 1974 | 3400         | 434       | 12.8%   | 2966          | 87.2%   |
| 1975 | 3337         | 434       | 13.0%   | 2903          | 87.0%   |
| 1976 | 3328         | 442       | 13.3%   | 2886          | 86.7%   |
| 1977 | 3255         | 438       | 13.5%   | 2817          | 86.5%   |
| 1978 | 3202         | 447       | 14.0%   | 2755          | 86.0%   |
| 1979 | 3286         | 501       | 15.2%   | 2785          | 84.8%   |
| 1980 | 3318         | 526       | 15.9%   | 2792          | 84.1%   |
| 1981 | 3558         | 613       | 17.2%   | 2945          | 82.8%   |
| 1982 | 3668         | 677       | 18.5%   | 2991          | 81.5%   |
| 1983 | 3883         | 816       | 21.0%   | 3067          | 79.0%   |
| 1984 | 4127         | 960       | 23.3%   | 3167          | 76.7%   |
| 1985 | 4055         | 972       | 24.0%   | 3083          | 76.0%   |
| 1986 | 4116         | 1038      | 25.2%   | 3078          | 74.8%   |
| 1987 | 4301         | 1128      | 26.2%   | 3173          | 73.8%   |
| 1988 | 4211         | 1111      | 26.4%   | 3100          | 73.6%   |
| 1989 | 4043         | 1087      | 26.9%   | 2956          | 73.1%   |
| 1990 | 3998         | 1075      | 26.9%   | 2923          | 73.1%   |
| 1991 | 4025         | 1104      | 27.4%   | 2921          | 72.6%   |
| 1992 | 4216         | 1193      | 28.3%   | 3023          | 71.7%   |
| 1993 | 4586         | 1309      | 28.5%   | 3277          | 71.5%   |
| 1994 | 4888         | 1356      | 27.7%   | 3532          | 72.3%   |
| 1995 | 5097         | 1495      | 29.3%   | 3602          | 70.7%   |
| 1996 | 5535         | 1742      | 31.5%   | 3793          | 68.5%   |
| 1997 | 5614         | 1857      | 33.1%   | 3757          | 66.9%   |
| 1998 | 5304         | 1789      | 33.7%   | 3515          | 66.3%   |
| 1999 | 5036         | 1785      | 35.4%   | 3251          | 64.6%   |
| 2000 | 4874         | 1855      | 38.1%   | 3019          | 61.9%   |
| 2001 | 4328         | 1661      | 38.4%   | 2667          | 61.6%   |
| 2002 | 3954         | 1508      | 38.1%   | 2446          | 61.9%   |
| 2003 | 3655         | 1342      | 36.7%   | 2313          | 63.3%   |
| 2004 | 3628         | 1356      | 37.4%   | 2272          | 62.6%   |
| 2005 | 3548         | 1322      | 37.3%   | 2226          | 62.7%   |
| 2006 | 3455         | 1266      | 36.6%   | 2189          | 63.4%   |
| 2007 | 3364         | 1230      | 36.6%   | 2134          | 63.4%   |
|      | 138193       | 37869     |         | 100324        |         |

**Table 2****Trends in Cash Holdings: Fama-French Industries and GICS Economic Sectors**

This table reports the trends in cash holdings of industry groups defined by the Fama-French 12 industry classification (Panel A) and the Global Industry Classification Standard (GICS) (Panel B) over the period from 1980 to 2007. The sample includes U.S. firms documented on the Compustat-CRSP merged database (fundamental annual) that have positive total assets and sales and nonnegative cash and marketable securities, and have common shares traded on the NYSE, AMEX, or Nasdaq. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 138,193 observations for 14,948 unique firms. The cash-to-assets ratio (Cash/TA) is measured as cash plus marketable securities (DATA 1), divided by book value of total assets (DATA 6). The annual mean, median, and value-weighted average (based on annual book assets) of Cash/TA in each subsample are regressed separately on a constant and a year index. Estimates of the slope coefficient, p-value, and R-squared are reported for each industry group separately.

**Panel A: the Fama-French 12 Industry Groups**

| Description<br>(FF 12 industries) | Cash/TA_Mean |        |      | Cash/TA_Median |        |      | Cash/TA_VW |        |      |
|-----------------------------------|--------------|--------|------|----------------|--------|------|------------|--------|------|
|                                   | slope        | Pvalue | R-Sq | slope          | Pvalue | R-Sq | slope      | Pvalue | R-Sq |
| BusEq                             | 0.85%        | <.0001 | 0.88 | 1.03%          | <.0001 | 0.88 | 0.72%      | <.0001 | 0.86 |
| Chems                             | 0.06%        | 0.144  | 0.08 | -0.04%         | 0.191  | 0.06 | 0.03%      | 0.298  | 0.04 |
| Durbl                             | 0.05%        | 0.218  | 0.06 | 0.03%          | 0.502  | 0.02 | 0.00%      | 0.992  | 0.00 |
| Enrgy                             | -0.23%       | <.0001 | 0.57 | -0.13%         | 0.000  | 0.42 | -0.03%     | 0.453  | 0.02 |
| HLth                              | 0.92%        | <.0001 | 0.88 | 1.11%          | <.0001 | 0.86 | 0.29%      | <.0001 | 0.53 |
| Manuf                             | 0.09%        | 0.002  | 0.31 | 0.04%          | 0.233  | 0.05 | 0.03%      | 0.313  | 0.04 |
| NoDur                             | -0.01%       | 0.842  | 0.00 | -0.02%         | 0.362  | 0.03 | -0.05%     | 0.031  | 0.17 |
| Shops                             | 0.03%        | 0.356  | 0.03 | -0.02%         | 0.506  | 0.02 | 0.08%      | 0.020  | 0.19 |
| Telcm                             | 0.20%        | <.0001 | 0.45 | 0.15%          | <.0001 | 0.57 | 0.09%      | <.0001 | 0.51 |
| other                             | 0.15%        | 0.000  | 0.44 | 0.07%          | 0.027  | 0.17 | 0.01%      | 0.876  | 0.00 |

**Panel B: the GICS Economic Sectors**

| Description<br>(GICS Economic Sector) | Cash/TA_Mean |        |      | Cash/TA_Median |        |      | Cash/TA_VW |        |      |
|---------------------------------------|--------------|--------|------|----------------|--------|------|------------|--------|------|
|                                       | slope        | Pvalue | R-sq | slope          | Pvalue | R-sq | slope      | Pvalue | R-sq |
| Energy (10)                           | -0.18%       | 0.000  | 0.42 | -0.10%         | 0.005  | 0.26 | -0.02%     | 0.648  | 0.01 |
| Materials (15)                        | -0.09%       | 0.004  | 0.28 | -0.06%         | 0.016  | 0.20 | 0.03%      | 0.286  | 0.04 |
| Industrial (20)                       | 0.02%        | 0.573  | 0.01 | -0.01%         | 0.739  | 0.00 | -0.09%     | 0.002  | 0.31 |
| Consumer discretionary (25)           | 0.08%        | 0.006  | 0.26 | 0.04%          | 0.181  | 0.07 | -0.01%     | 0.830  | 0.00 |
| Consumer staples (30)                 | -0.06%       | 0.071  | 0.12 | -0.06%         | 0.011  | 0.23 | -0.08%     | 0.005  | 0.26 |
| Health care (35)                      | 0.82%        | <.0001 | 0.85 | 0.92%          | <.0001 | 0.86 | 0.25%      | <.0001 | 0.52 |
| Financials (40)                       | 0.04%        | 0.648  | 0.01 | 0.24%          | 0.006  | 0.25 | -0.57%     | 0.118  | 0.09 |
| Information technology (45)           | 0.86%        | <.0001 | 0.89 | 1.05%          | <.0001 | 0.90 | 0.80%      | <.0001 | 0.89 |
| Telecommunications (50)               | 0.40%        | <.0001 | 0.72 | 0.31%          | <.0001 | 0.75 | 0.13%      | <.0001 | 0.51 |
| Utilities (55)                        | -0.07%       | 0.575  | 0.01 | -0.09%         | 0.439  | 0.02 | 0.13%      | 0.150  | 0.08 |

**Table 3****Determinants of Corporate Cash Holdings: 1974-2007**

This table analyzes the impact of firm characteristics on firms' cash holdings over the period from 1974 to 2007. The sample includes U.S. firms documented on the Compustat-CRSP merged database (fundamental annual) that have positive total assets and sales and nonnegative cash and marketable securities, and have common shares traded on the NYSE, AMEX, or Nasdaq. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 138,193 observations for 14,948 unique firms. The regression equation is:

$$\begin{aligned} \frac{Cash_{it}}{TA_{it}} = & \beta_0 + \beta_1 \cdot Size_{it} + \beta_2 \cdot \frac{NWC_{it}}{TA_{it}} + \beta_3 \cdot (IndustrySigma)_{it} + \beta_4 \cdot \frac{CF_{it}}{TA_{it}} + \beta_5 \cdot MB_{it} + \beta_6 \cdot \frac{CAPEX_{it}}{TA_{it}} \\ & + \beta_7 \cdot \frac{R \& D_{it}}{Sales_{it}} + \beta_8 \cdot \left( \frac{R \& D_{it}}{Sales_{it}} \right)^2 + \beta_9 \cdot Leverage_{it} + \beta_{10} \cdot DivDummy_{it} + \beta_{11} \cdot \frac{ACQN_{it}}{TA_{it}} \\ & + \beta_{12} \cdot NetDiss_{it} + \beta_{13} \cdot NetEiss_{it} + \beta_{14} \cdot TbillYield_t + \beta_{15} \cdot DefaultSpread_t + \varepsilon_{it} \end{aligned} \quad (2)$$

Size is the logarithm of net assets. NWC is net working capital, equal to current assets minus current liabilities minus cash. IndustrySigma is the mean of cash flow standard deviations of firms in the same industry, defined by 2-digit SIC code. CF is operating income before depreciation, less interest and taxes. M/B is market value of equity plus total assets minus book value of equity, and then divided by total assets. CAPEX is capital expenditure. R&D/Sales is R&D expenditure to sales, where missing value of R&D expenditure is replaced by zero. Leverage is the ratio of long-term debt plus debt in current liabilities to total assets. DivDummy is dividend dummy, set to one if common dividend is positive. ACQN is acquisition expenditures. NetDiss is equal to long-term debt issuance minus long-term debt reduction, scaled by total assets. NetEiss is equal to the sale of common and preferred stock minus the purchase of common and preferred stock, scaled by total assets. TbillYield is the average annual three-month rates published by the Federal Reserve. DefaultSpread is the average yield on Baa less Aaa Moody's rated corporate bonds with maturity of approximately 20-25 years. Missing explanatory values reduce the panel data used here to 117,240 firm-year observations for 14,242 unique firms. Panel A reports the estimating results. Column (1)-(5) are based on the pooled sample (with all firms). Column (1) uses OLS regression to estimate the basic model designed by Opler et al. (1999). Column (2), (3) and (4) uses OLS regressions to estimate the modified model, in equation (2), without/with dummy variables for industry and year. In Column (5), the coefficients and standard errors are estimated using the Fama-MacBeth method (1973). Industries are defined according to the 2-digit SIC. Column (6) and (7) are separate regressions for the high-tech and non-high-tech sectors. Column (8) tests whether the coefficients estimates for the high-tech sector are different from the non-high-tech sector. P-values are reported. For each regression, adjusted  $R^2$  is reported. The standard errors are adjusted for clustering on firms. They are computed assuming observations are independent across firms, but not across time. t-statistics are reported in the parentheses. \*, \*\*, and \*\*\* indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Panel B reports the relative importance of the explanatory variables in the regression with the pooled sample (Column (2) of Panel A), as well as the regressions with non-high-tech firms (Column (6) of Panel A) and high-tech firms (Column (7) of Panel A) respectively. Relative importance is obtained by means of variance decomposition as proposed by Grömping (2007). For each determinant two values are reported: the percentage of the variation of the dependant variable that it explains (absolute value) and the percentage of the variation explained within the regression model (standardized value).

**Panel A:**

|                         | Pooled Sample ( All Firms ) |                       |                       |                       |                       | High-Tech             | Non-High-Tech         | Diff (P-value) |
|-------------------------|-----------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
|                         | (1)                         | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)            |
| Size                    | -0.020***<br>(-34.21)       | -0.018***<br>(-31.54) | -0.019***<br>(-32.32) | -0.020***<br>(-32.96) | -0.020***<br>(-24.64) | -0.023***<br>(-17.94) | -0.017***<br>(-27.03) | 0.000          |
| NWC/TA                  | -0.265***<br>(-50.04)       | -0.282***<br>(-53.94) | -0.280***<br>(-53.50) | -0.294***<br>(-50.22) | -0.277***<br>(-38.36) | -0.428***<br>(-38.08) | -0.225***<br>(-37.99) | 0.000          |
| Industry Sigma          | 0.651***<br>(20.06)         | 0.502***<br>(16.30)   | 0.507***<br>(14.37)   | 0.489***<br>(10.40)   | 0.286***<br>(7.26)    | 0.367***<br>(4.65)    | 0.131***<br>(4.01)    | 0.006          |
| CF/TA                   | 0.060***<br>(11.44)         | 0.174***<br>(32.66)   | 0.177***<br>(33.25)   | 0.181***<br>(33.72)   | 0.169***<br>(17.60)   | 0.243***<br>(30.42)   | 0.112***<br>(15.86)   | 0.000          |
| MB                      | 0.016***<br>(25.86)         | 0.007***<br>(11.92)   | 0.007***<br>(11.70)   | 0.007***<br>(10.92)   | 0.008***<br>(7.43)    | 0.005***<br>(6.53)    | 0.007***<br>(8.20)    | 0.134          |
| Capex/TA                | -0.396***<br>(-37.59)       | -0.525***<br>(-49.08) | -0.519***<br>(-48.15) | -0.482***<br>(-43.70) | -0.521***<br>(-26.34) | -0.632***<br>(-26.30) | -0.422***<br>(-35.20) | 0.000          |
| RD/Sales                | 0.068***<br>(42.57)         | 0.242***<br>(41.46)   | 0.240***<br>(41.05)   | 0.235***<br>(39.53)   | 0.196***<br>(15.76)   | 0.213***<br>(30.87)   | 0.214***<br>(15.42)   | 0.944          |
| (RD/Sales) <sup>2</sup> |                             | -0.032***<br>(-33.65) | -0.032***<br>(-33.40) | -0.031***<br>(-32.34) | -0.011<br>(-0.44)     | -0.027***<br>(-25.52) | -0.029***<br>(-11.81) | 0.448          |
| Leverage                | -0.342***<br>(-66.66)       | -0.333***<br>(-63.72) | -0.328***<br>(-62.53) | -0.330***<br>(-61.71) | -0.308***<br>(-35.89) | -0.456***<br>(-36.56) | -0.273***<br>(-47.39) | 0.000          |
| DivDummy                | -0.008***<br>(-4.03)        | -0.006***<br>(-3.20)  | -0.006***<br>(-2.80)  | -0.005**<br>(-2.32)   | -0.006**<br>(-2.28)   | -0.016***<br>(-2.96)  | 0.003<br>(1.26)       | 0.001          |
| ACQN/TA                 | -0.221***<br>(-27.67)       | -0.419***<br>(-47.87) | -0.423***<br>(-47.57) | -0.416***<br>(-46.53) | -0.378***<br>(-19.26) | -0.584***<br>(-30.32) | -0.339***<br>(-36.77) | 0.000          |
| NetDiss                 |                             | 0.295***<br>(46.44)   | 0.289***<br>(45.60)   | 0.285***<br>(45.36)   | 0.269***<br>(24.31)   | 0.362***<br>(24.89)   | 0.247***<br>(36.02)   | 0.000          |
| NetEiss                 |                             | 0.194***<br>(49.69)   | 0.197***<br>(50.29)   | 0.196***<br>(50.00)   | 0.177***<br>(13.24)   | 0.170***<br>(30.34)   | 0.208***<br>(38.28)   | 0.000          |
| TbillYield              |                             | -0.140***<br>(-6.61)  |                       |                       |                       | -0.370***<br>(-6.55)  | -0.084***<br>(-3.89)  | 0.000          |
| Default Spread          |                             | 1.720***<br>(13.99)   |                       |                       |                       | 1.805***<br>(5.19)    | 1.253***<br>(10.56)   | 0.133          |
| Constant                | 0.320***<br>(62.14)         | 0.313***<br>(54.18)   | 0.346***<br>(53.16)   | 0.334***<br>(55.13)   | 0.330***<br>(40.50)   | 0.436***<br>(31.67)   | 0.289***<br>(44.33)   | 0.000          |
| Observations            | 117240                      | 117240                | 117240                | 117240                | 117240                | 32583                 | 84657                 |                |
| Adj. R-squared          | 0.519                       | 0.581                 | 0.584                 | 0.590                 | 0.532                 | 0.613                 | 0.433                 |                |
| Industry FE             | No                          | No                    | No                    | Yes                   | No                    | No                    | No                    |                |
| Year FE                 | No                          | No                    | Yes                   | Yes                   | No                    | No                    | No                    |                |

**Panel B: Relative Importance of Determinants**

|                               | Absolute values |           |               | Standardized values |           |               |
|-------------------------------|-----------------|-----------|---------------|---------------------|-----------|---------------|
|                               | Pooled          | High-Tech | Non-High-Tech | Pooled              | High-Tech | Non-High-Tech |
| <b>Size</b>                   | 6.23%           | 3.31%     | 7.81%         | 10.71%              | 5.41%     | 18.06%        |
| <b>NWC/TA</b>                 | 6.35%           | 14.72%    | 5.35%         | 10.92%              | 24.02%    | 12.36%        |
| <b>Industry Sigma</b>         | 2.43%           | 0.60%     | 0.07%         | 4.18%               | 0.98%     | 0.15%         |
| <b>CF/TA</b>                  | 1.39%           | 2.05%     | 0.71%         | 2.40%               | 3.35%     | 1.65%         |
| <b>MB</b>                     | 1.00%           | 0.38%     | 0.85%         | 1.71%               | 0.63%     | 1.97%         |
| <b>Capex/TA</b>               | 2.09%           | 2.05%     | 1.97%         | 3.60%               | 3.35%     | 4.56%         |
| <b>RD/Sales</b>               | 10.67%          | 10.59%    | 2.87%         | 18.35%              | 17.28%    | 6.64%         |
| <b>(RD/Sales)<sup>2</sup></b> | 5.00%           | 5.08%     | 1.33%         | 8.60%               | 8.30%     | 3.08%         |
| <b>Leverage</b>               | 15.36%          | 15.31%    | 14.00%        | 26.43%              | 24.97%    | 32.35%        |
| <b>DivDummy</b>               | 0.03%           | 0.07%     | 0.01%         | 0.06%               | 0.12%     | 0.01%         |
| <b>ACQN/TA</b>                | 0.73%           | 1.04%     | 0.83%         | 1.25%               | 1.70%     | 1.93%         |
| <b>NetDiss</b>                | 0.95%           | 1.06%     | 1.11%         | 1.64%               | 1.72%     | 2.57%         |
| <b>NetEiss</b>                | 5.81%           | 4.76%     | 6.27%         | 9.99%               | 7.76%     | 14.48%        |
| <b>TbillYield</b>             | 0.03%           | 0.21%     | 0.02%         | 0.06%               | 0.35%     | 0.04%         |
| <b>Default Spread</b>         | 0.07%           | 0.04%     | 0.07%         | 0.12%               | 0.07%     | 0.15%         |
| <b>Total Variation</b>        | 58.13%          | 61.29%    | 43.26%        | 100%                | 100%      | 100%          |

## Table 4

### Changes in Firm Characteristics

This table compares the characteristics of firms over the period from 1974 to 2007. The sample includes U.S. firms documented on the Compustat-CRSP merged database (fundamental annual) that have positive total assets and sales and nonnegative cash and marketable securities, and have common shares traded on the NYSE, AMEX, or Nasdaq. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 138,193 observations for 14,948 unique firms. Size is the logarithm of net assets. NWC is net working capital, equal to current assets minus current liabilities minus cash. IndustrySigma is the mean of cash flow standard deviations of firms in the same industry, defined by 2-digit SIC code. CF is operating income before depreciation, less interest and taxes. M/B is market value of equity plus total assets minus book value of equity, and then divided by total assets. CAPEX is capital expenditure. R&D/Sales is R&D expenditure to sales, where missing value of R&D expenditure is replaced by zero. Leverage is the ratio of long-term debt plus debt in current liabilities to total assets. DivDummy is dividend dummy, set to one if common dividend is positive. ACQN is acquisition expenditures. NetDiss is equal to long-term debt issuance minus long-term debt reduction, scaled by total assets. NetEiss is equal to the sale of common and preferred stock minus the purchase of common and preferred stock, scaled by total assets. In Panel A, the total sample is split into four sub-periods for two sectors. Obs is the total number of observations of a given sector in the indicated sub-period. The results for each period are simple averages over all firm-year observations locating in a given sub-sample. Firm characteristic of high-tech firms and non-high-tech firms over 1980-2007 are regressed separately on a constant and a year index. Estimates of the slope coefficient are reported in the row titled Time Trends [1980, 2007]. P-values are also reported. In Panel B, the observations in each sub-period are further divided according to listing cohorts. Based on the year of going public, firms are sorted into the following cohorts: pre-1980 IPO (listed before 1980), 1980s IPO (listed from 1980 to 1989), 1990s IPO (listed from 1990 to 2000), and 2000s IPO (listed from 2001 to 2006). IPO dates are identified first by using Jay Ritter's proprietary database of IPO dates. If the IPO date of a stock is unavailable from Ritter, the first trading date on the CRSP is identified as the IPO date. Obs is the total number of observations of a given listing cohorts in a given sector in the indicated sub-period. The results for each period are simple averages over all firm-year observations locating in a given sub-sample defined according to listing cohort and sub-period.

# Panel A: Sub-Periods

| Sector            | Sub-Period                 | Obs   | Cash/TA | Size   | NWC/TA | Industry<br>Sigma | CF/TA  | MB     | Capex<br>/TA | R&D<br>/TA | R&D<br>/Sales | Leverage | Div<br>Dummy | ACQN/TA | NetDiss | NetEiss |
|-------------------|----------------------------|-------|---------|--------|--------|-------------------|--------|--------|--------------|------------|---------------|----------|--------------|---------|---------|---------|
| Non-<br>High-Tech | [1974, 1979]               | 17112 | 0.086   | 5.220  | 0.204  | 0.034             | 0.078  | 1.072  | 0.079        | 0.009      | 0.009         | 0.267    | 0.658        | 0.007   | 0.014   | 0.004   |
|                   | [1980, 1989]               | 30352 | 0.118   | 4.667  | 0.133  | 0.056             | 0.029  | 1.615  | 0.090        | 0.012      | 0.034         | 0.277    | 0.466        | 0.017   | 0.017   | 0.051   |
|                   | [1990, 2000]               | 36613 | 0.112   | 5.025  | 0.107  | 0.070             | 0.036  | 1.788  | 0.076        | 0.014      | 0.045         | 0.273    | 0.323        | 0.026   | 0.015   | 0.064   |
|                   | [2001, 2007]               | 16247 | 0.132   | 5.867  | 0.076  | 0.077             | 0.051  | 1.813  | 0.061        | 0.016      | 0.059         | 0.247    | 0.339        | 0.024   | 0.007   | 0.025   |
|                   | Time trend<br>[1980, 2007] |       | 0.001   | 0.053  | -0.003 | 0.001             | 0.001  | 0.013  | -0.001       |            | 0.001         | -0.001   |              | 0.001   | 0.000   | -0.001  |
|                   | p-value                    |       | <.0001  | <.0001 | <.0001 | <.0001            | <.0001 | <.0001 | <.0001       |            | <.0001        | <.0001   |              | <.0001  | 0.129   | <.0001  |
|                   |                            |       |         |        |        |                   |        |        |              |            |               |          |              |         |         |         |
| High-Tech         | [1974, 1979]               | 2696  | 0.096   | 4.262  | 0.291  | 0.043             | 0.079  | 1.497  | 0.080        | 0.055      | 0.050         | 0.250    | 0.414        | 0.005   | 0.017   | 0.023   |
|                   | [1980, 1989]               | 8928  | 0.205   | 3.591  | 0.198  | 0.074             | -0.031 | 2.382  | 0.078        | 0.089      | 0.238         | 0.199    | 0.220        | 0.011   | 0.013   | 0.117   |
|                   | [1990, 2000]               | 16560 | 0.308   | 3.765  | 0.103  | 0.106             | -0.064 | 3.029  | 0.056        | 0.131      | 0.502         | 0.141    | 0.115        | 0.018   | 0.007   | 0.172   |
|                   | [2001, 2007]               | 9685  | 0.384   | 4.332  | 0.015  | 0.131             | -0.097 | 2.683  | 0.035        | 0.141      | 0.668         | 0.124    | 0.091        | 0.024   | 0.008   | 0.104   |
|                   | Time trend<br>[1980, 2007] |       | 0.010   | 0.038  | -0.010 | 0.003             | -0.004 | 0.027  | -0.002       |            | 0.024         | -0.004   |              | 0.001   | 0.000   | 0.000   |
|                   | p-value                    |       | <.0001  | <.0001 | <.0001 | <.0001            | <.0001 | <.0001 | <.0001       |            | <.0001        | <.0001   |              | <.0001  | 0.676   | 0.119   |
|                   |                            |       |         |        |        |                   |        |        |              |            |               |          |              |         |         |         |

## Panel B: Listing Cohorts in Each Sub-Period

| Sector                   | IPO Cohort   | Obs   | Cash/TA | Size  | NWC/TA | CF/TA  | MB    | Capex/TA | R&D/TA | R&D/Sales | Leverage | Div<br>Dummy | ACQN/TA | NetDiss | NetEiss |
|--------------------------|--------------|-------|---------|-------|--------|--------|-------|----------|--------|-----------|----------|--------------|---------|---------|---------|
| Sub-Period: [1980, 1989] |              |       |         |       |        |        |       |          |        |           |          |              |         |         |         |
| Non-High-Tech            | Overall      | 30352 | 0.118   | 4.667 | 0.133  | 0.029  | 1.615 | 0.090    | 0.012  | 0.034     | 0.277    | 0.466        | 0.017   | 0.017   | 0.051   |
|                          | Pre-1980 IPO | 20059 | 0.098   | 5.287 | 0.164  | 0.057  | 1.361 | 0.079    | 0.010  | 0.012     | 0.271    | 0.622        | 0.014   | 0.012   | 0.011   |
|                          | 1980s IPO    | 10293 | 0.157   | 3.459 | 0.073  | -0.026 | 2.111 | 0.113    | 0.017  | 0.079     | 0.287    | 0.161        | 0.022   | 0.027   | 0.128   |
| High-Tech                | Overall      | 8928  | 0.205   | 3.591 | 0.198  | -0.031 | 2.382 | 0.078    | 0.089  | 0.238     | 0.199    | 0.220        | 0.011   | 0.013   | 0.117   |
|                          | Pre-1980 IPO | 4099  | 0.133   | 4.488 | 0.245  | 0.047  | 1.875 | 0.077    | 0.067  | 0.072     | 0.217    | 0.402        | 0.010   | 0.012   | 0.036   |
|                          | 1980s IPO    | 4829  | 0.267   | 2.829 | 0.159  | -0.097 | 2.812 | 0.078    | 0.108  | 0.379     | 0.183    | 0.065        | 0.011   | 0.013   | 0.188   |
| Sub-Period: [1990, 2000] |              |       |         |       |        |        |       |          |        |           |          |              |         |         |         |
| Non-High-Tech            | Overall      | 36613 | 0.112   | 5.025 | 0.107  | 0.036  | 1.788 | 0.076    | 0.014  | 0.045     | 0.273    | 0.323        | 0.026   | 0.015   | 0.064   |
|                          | Pre-1980 IPO | 11143 | 0.083   | 6.031 | 0.137  | 0.075  | 1.514 | 0.065    | 0.011  | 0.011     | 0.260    | 0.627        | 0.019   | 0.007   | 0.000   |
|                          | 1980s IPO    | 10708 | 0.109   | 4.505 | 0.109  | 0.034  | 1.731 | 0.074    | 0.015  | 0.039     | 0.280    | 0.256        | 0.019   | 0.012   | 0.036   |
|                          | 1990s IPO    | 14762 | 0.137   | 4.642 | 0.082  | 0.008  | 2.038 | 0.086    | 0.016  | 0.075     | 0.278    | 0.142        | 0.036   | 0.023   | 0.133   |
| High-Tech                | Overall      | 16560 | 0.308   | 3.765 | 0.103  | -0.064 | 3.029 | 0.056    | 0.131  | 0.502     | 0.141    | 0.115        | 0.018   | 0.007   | 0.172   |
|                          | Pre-1980 IPO | 2626  | 0.135   | 5.183 | 0.193  | 0.067  | 1.974 | 0.055    | 0.076  | 0.080     | 0.196    | 0.383        | 0.019   | 0.004   | 0.017   |
|                          | 1980s IPO    | 5535  | 0.248   | 3.640 | 0.133  | -0.026 | 2.738 | 0.055    | 0.125  | 0.348     | 0.160    | 0.106        | 0.015   | 0.008   | 0.084   |
|                          | 1990s IPO    | 8399  | 0.402   | 3.404 | 0.055  | -0.129 | 3.551 | 0.058    | 0.151  | 0.735     | 0.112    | 0.036        | 0.020   | 0.008   | 0.276   |
| Sub-Period: [2001, 2007] |              |       |         |       |        |        |       |          |        |           |          |              |         |         |         |
| Non-High-Tech            | Overall      | 16247 | 0.132   | 5.867 | 0.076  | 0.051  | 1.813 | 0.061    | 0.016  | 0.059     | 0.247    | 0.339        | 0.024   | 0.007   | 0.025   |
|                          | Pre-1980 IPO | 4001  | 0.093   | 6.753 | 0.108  | 0.085  | 1.605 | 0.053    | 0.010  | 0.014     | 0.241    | 0.664        | 0.022   | 0.001   | -0.005  |
|                          | 1980s IPO    | 2586  | 0.122   | 5.548 | 0.115  | 0.060  | 1.725 | 0.058    | 0.017  | 0.039     | 0.234    | 0.383        | 0.020   | 0.005   | 0.010   |
|                          | 1990s IPO    | 7627  | 0.146   | 5.562 | 0.060  | 0.037  | 1.814 | 0.061    | 0.019  | 0.083     | 0.251    | 0.190        | 0.024   | 0.009   | 0.022   |
|                          | 2000s IPO    | 2033  | 0.164   | 5.669 | 0.027  | 0.026  | 2.329 | 0.079    | 0.013  | 0.086     | 0.259    | 0.207        | 0.036   | 0.012   | 0.112   |
| High-Tech                | Overall      | 9685  | 0.384   | 4.332 | 0.015  | -0.097 | 2.683 | 0.035    | 0.141  | 0.668     | 0.124    | 0.091        | 0.024   | 0.008   | 0.104   |
|                          | Pre-1980 IPO | 903   | 0.227   | 6.116 | 0.129  | 0.067  | 2.040 | 0.036    | 0.069  | 0.120     | 0.145    | 0.430        | 0.024   | 0.006   | 0.003   |
|                          | 1980s IPO    | 1646  | 0.316   | 4.542 | 0.076  | -0.027 | 2.491 | 0.034    | 0.116  | 0.382     | 0.133    | 0.140        | 0.023   | 0.004   | 0.051   |
|                          | 1990s IPO    | 5971  | 0.407   | 4.102 | -0.014 | -0.129 | 2.691 | 0.035    | 0.155  | 0.744     | 0.125    | 0.038        | 0.023   | 0.010   | 0.098   |
|                          | 2000s IPO    | 1165  | 0.484   | 3.829 | -0.010 | -0.161 | 3.415 | 0.035    | 0.161  | 1.108     | 0.093    | 0.035        | 0.028   | 0.006   | 0.281   |

**Table 5****Determinants of Corporate Cash Holdings: Estimation Period**

This table presents the results of coefficient estimates for the high-tech and non-high-tech sectors, jointly and separately, during the estimation period from 1974 to 1983. The sample includes U.S. firms documented on the Compustat-CRSP merged database (fundamental annual) that have positive total assets and sales and nonnegative cash and marketable securities, and have common shares traded on the NYSE, AMEX, or Nasdaq. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 34,235 observations during the period from 1974 to 1983. The regression equation is:

$$\begin{aligned} \frac{Cash_{it}}{TA_{it}} = & \beta_0 + \beta_1 \cdot Size_{it} + \beta_2 \cdot \frac{NWC_{it}}{TA_{it}} + \beta_3 \cdot (IndustrySigma)_{it} + \beta_4 \cdot \frac{CF_{it}}{TA_{it}} + \beta_5 \cdot MB_{it} + \beta_6 \cdot \frac{CAPEX_{it}}{TA_{it}} \\ & + \beta_7 \cdot \frac{R \& D_{it}}{Sales_{it}} + \beta_8 \cdot \left( \frac{R \& D_{it}}{Sales_{it}} \right)^2 + \beta_9 \cdot Leverage_{it} + \beta_{10} \cdot DivDummy_{it} + \beta_{11} \cdot \frac{ACQN_{it}}{TA_{it}} \\ & + \beta_{12} \cdot NetDiss_{it} + \beta_{13} \cdot NetEiss_{it} + \beta_{14} \cdot TbillYield_t + \beta_{15} \cdot DefaultSpread_t + \varepsilon_{it} \end{aligned} \quad (2)$$

Size is the logarithm of net assets. NWC is net working capital, equal to current assets minus current liabilities minus cash. IndustrySigma is the mean of cash flow standard deviations of firms in the same industry, defined by 2-digit SIC code. CF is operating income before depreciation, less interest and taxes. M/B is market value of equity plus total assets minus book value of equity, and then divided by total assets. CAPEX is capital expenditure. R&D/Sales is R&D expenditure to sales, where missing value of R&D expenditure is replaced by zero. Leverage is the ratio of long-term debt plus debt in current liabilities to total assets. DivDummy is dividend dummy, set to one if common dividend is positive. ACQN is acquisition expenditures. NetDiss is equal to long-term debt issuance minus long-term debt reduction, scaled by total assets. NetEiss is equal to the sale of common and preferred stock minus the purchase of common and preferred stock, scaled by total assets. TbillYield is the average annual three-month rates published by the Federal Reserve. DefaultSpread is the average yield on Baa less Aaa Moody's rated corporate bonds with maturity of approximately 20-25 years. Missing explanatory values reduce the panel data used here to 29,004 firm-year observations for 5,235 unique firms. Results from OLS regression without industry and year dummies are reported for the pooled sample (Column (1)), for high-tech firms (Column (2)), and for non-high-tech firms (Column (3)). The standard errors are adjusted for clustering on firms. They are computed assuming observations are independent across firms, but not across time. t-statistics are reported in the parentheses. \*, \*\*, and \*\*\* indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

|                         | [1]<br>Pooled Sample  | [2]<br>High-Tech      | [3]<br>Non-High-Tech  |
|-------------------------|-----------------------|-----------------------|-----------------------|
| Size                    | -0.016***<br>(-21.83) | -0.014***<br>(-7.38)  | -0.016***<br>(-20.86) |
| NWC/TA                  | -0.261***<br>(-32.40) | -0.438***<br>(-20.23) | -0.236***<br>(-27.15) |
| Industry Sigma          | 0.338***<br>(3.92)    | 0.640**<br>(2.16)     | 0.268***<br>(2.96)    |
| CF/TA                   | 0.143***<br>(11.07)   | 0.245***<br>(10.71)   | 0.103***<br>(6.81)    |
| MB                      | 0.004***<br>(3.05)    | 0.002<br>(0.93)       | 0.004***<br>(2.59)    |
| Capex/TA                | -0.445***<br>(-26.06) | -0.615***<br>(-14.81) | -0.403***<br>(-21.47) |
| RD/Sales                | 0.144***<br>(6.87)    | 0.130***<br>(4.62)    | 0.157***<br>(4.94)    |
| (RD/Sales) <sup>2</sup> | -0.019***<br>(-5.23)  | -0.017***<br>(-3.53)  | -0.021***<br>(-3.85)  |
| Leverage                | -0.267***<br>(-33.24) | -0.346***<br>(-15.62) | -0.256***<br>(-29.84) |
| DivDummy                | 0.009***<br>(3.85)    | 0.001<br>(0.12)       | 0.011***<br>(4.46)    |
| ACQN/TA                 | -0.376***<br>(-17.66) | -0.537***<br>(-9.06)  | -0.347***<br>(-15.42) |
| NetDiss                 | 0.243***<br>(21.29)   | 0.339***<br>(12.52)   | 0.225***<br>(17.93)   |
| NetEiss                 | 0.274***<br>(26.47)   | 0.282***<br>(16.51)   | 0.259***<br>(19.85)   |
| TbillYield              | -0.082***<br>(-4.28)  | -0.128**<br>(-2.20)   | -0.074***<br>(-3.66)  |
| Default Spread          | 0.425***<br>(4.40)    | 1.041***<br>(3.88)    | 0.280***<br>(2.74)    |
| Constant                | 0.294***<br>(39.83)   | 0.352***<br>(15.63)   | 0.288***<br>(36.46)   |
| Observations            | 29004                 | 4492                  | 24512                 |
| Adj. R-squared          | 0.469                 | 0.602                 | 0.426                 |

## Table 6

### Actual and Predicted Cash Holdings: Forecast Period

This table reports the predicted cash ratios and the difference between actual and predicted cash ratios in the high-tech sector (Panel A) and in the non-high-tech sector (Panel B) during the forecast period from 1984 to 2007. The sample includes U.S. firms documented on the Compustat-CRSP merged database (fundamental annual) that have positive total assets and sales and nonnegative cash and marketable securities, and have common shares traded on the NYSE, AMEX, or Nasdaq. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 103,958 observations during the period from 1984 to 2007, including 32,541 observations in the high-tech sector and 71,417 observations in the non-high-tech sector. Due to missing explanatory values, I can calculate expected cash holdings for 28,091 observations in the high-tech sector and 60,145 observations in the non-high-tech sector. Predicted cash holdings are calculated for each firm-year observation by fitting the firm characteristics in forecasting period into the cash holding model estimated in the estimating period. Panel A reports the findings for the high-tech sector, where coefficients estimates during the estimation period come from separate regression on high-tech firms in the estimation period (Column [6]) and from the joint estimation with pooled sample (Column [2]). Panel B reports the findings for the non-high-tech sector, where coefficients estimates during the estimation period come from separate regression on high-tech firms in the estimation period (Column [7]) and from the joint estimation with pooled sample (Column [2]). Annual mean of actual cash, predicted cash, as well as the deviations of the actual cash ratios from predicted cash holdings, are reported for two sectors separately. T-statistics summarize the statistical significance of the deviations of the actual cash ratios from expected cash holdings in each year.

**Panel A: High-Tech Sector**

| Year | Firms | Actual | From Separate Estimation |                   |       | From Joint Estimation |                   |       |
|------|-------|--------|--------------------------|-------------------|-------|-----------------------|-------------------|-------|
|      |       |        | Expected                 | Actual - Expected | t     | Expected              | Actual - Expected | t     |
| 1984 | 832   | 0.225  | 0.196                    | 0.029             | 5.87  | 0.187                 | 0.039             | 7.55  |
| 1985 | 824   | 0.206  | 0.184                    | 0.023             | 4.36  | 0.173                 | 0.033             | 6.18  |
| 1986 | 868   | 0.225  | 0.213                    | 0.013             | 2.45  | 0.194                 | 0.032             | 5.91  |
| 1987 | 917   | 0.242  | 0.232                    | 0.010             | 1.98  | 0.207                 | 0.035             | 6.40  |
| 1988 | 933   | 0.221  | 0.218                    | 0.003             | 0.63  | 0.192                 | 0.029             | 5.47  |
| 1989 | 931   | 0.205  | 0.221                    | -0.016            | -3.02 | 0.194                 | 0.011             | 2.14  |
| 1990 | 907   | 0.207  | 0.232                    | -0.025            | -4.80 | 0.200                 | 0.007             | 1.40  |
| 1991 | 947   | 0.252  | 0.275                    | -0.023            | -4.62 | 0.236                 | 0.016             | 3.10  |
| 1992 | 1035  | 0.270  | 0.290                    | -0.020            | -3.95 | 0.251                 | 0.019             | 3.73  |
| 1993 | 1135  | 0.297  | 0.299                    | -0.001            | -0.27 | 0.259                 | 0.038             | 7.45  |
| 1994 | 1178  | 0.287  | 0.287                    | 0.001             | 0.13  | 0.247                 | 0.040             | 7.83  |
| 1995 | 1276  | 0.309  | 0.308                    | 0.001             | 0.18  | 0.266                 | 0.043             | 9.03  |
| 1996 | 1474  | 0.347  | 0.335                    | 0.012             | 2.85  | 0.292                 | 0.055             | 12.59 |
| 1997 | 1603  | 0.346  | 0.316                    | 0.031             | 6.73  | 0.275                 | 0.071             | 15.16 |
| 1998 | 1532  | 0.327  | 0.304                    | 0.023             | 4.88  | 0.260                 | 0.066             | 13.96 |
| 1999 | 1508  | 0.347  | 0.333                    | 0.014             | 3.05  | 0.287                 | 0.060             | 13.24 |
| 2000 | 1547  | 0.377  | 0.358                    | 0.019             | 4.21  | 0.310                 | 0.068             | 14.63 |
| 2001 | 1417  | 0.381  | 0.332                    | 0.048             | 8.92  | 0.276                 | 0.105             | 19.38 |
| 2002 | 1334  | 0.374  | 0.344                    | 0.030             | 5.39  | 0.276                 | 0.098             | 17.60 |
| 2003 | 1194  | 0.398  | 0.373                    | 0.025             | 4.60  | 0.298                 | 0.101             | 18.37 |
| 2004 | 1222  | 0.409  | 0.381                    | 0.028             | 5.41  | 0.307                 | 0.102             | 19.37 |
| 2005 | 1205  | 0.404  | 0.361                    | 0.043             | 7.94  | 0.289                 | 0.115             | 21.27 |
| 2006 | 1145  | 0.400  | 0.360                    | 0.041             | 7.39  | 0.291                 | 0.110             | 20.05 |
| 2007 | 1127  | 0.399  | 0.359                    | 0.040             | 6.97  | 0.289                 | 0.110             | 19.28 |

**Panel B: Non-High-Tech Sector**

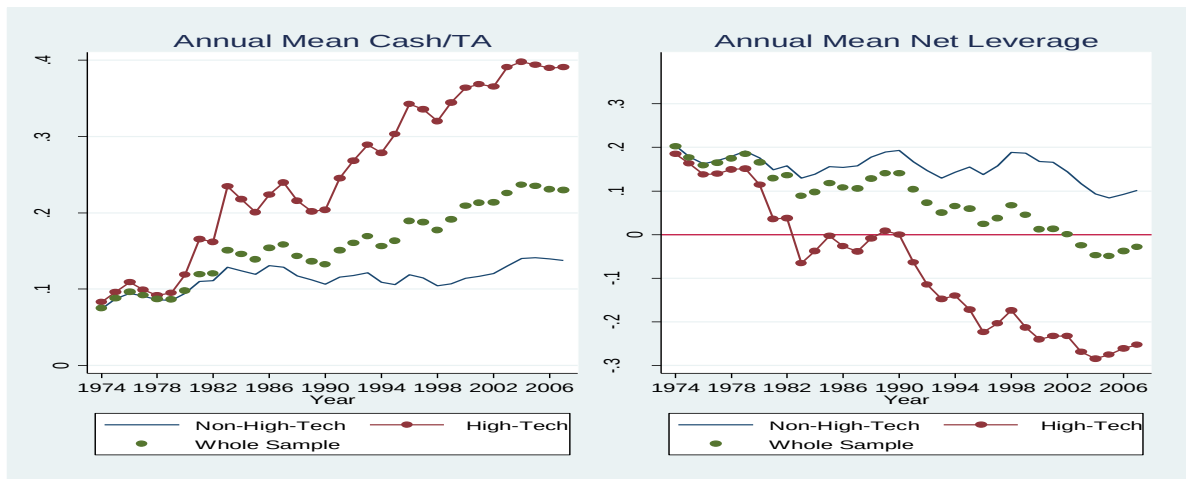
| Year | Firms | From Separate Estimation |          |                      |        | From Joint Estimation |                      |        |
|------|-------|--------------------------|----------|----------------------|--------|-----------------------|----------------------|--------|
|      |       | Actual                   | Expected | Actual -<br>Expected | t      | Expected              | Actual -<br>Expected | t      |
| 1984 | 2714  | 0.125                    | 0.124    | 0.001                | 0.23   | 0.126                 | -0.001               | -0.49  |
| 1985 | 2599  | 0.121                    | 0.121    | 0.000                | 0.10   | 0.122                 | -0.001               | -0.46  |
| 1986 | 2565  | 0.133                    | 0.129    | 0.004                | 1.56   | 0.131                 | 0.002                | 0.72   |
| 1987 | 2648  | 0.129                    | 0.131    | -0.002               | -0.81  | 0.134                 | -0.005               | -1.86  |
| 1988 | 2602  | 0.118                    | 0.122    | -0.004               | -1.66  | 0.124                 | -0.007               | -2.70  |
| 1989 | 2452  | 0.114                    | 0.123    | -0.009               | -3.42  | 0.125                 | -0.011               | -4.42  |
| 1990 | 2424  | 0.108                    | 0.124    | -0.016               | -6.27  | 0.127                 | -0.019               | -7.56  |
| 1991 | 2477  | 0.117                    | 0.137    | -0.019               | -7.80  | 0.141                 | -0.024               | -9.43  |
| 1992 | 2566  | 0.120                    | 0.143    | -0.023               | -9.72  | 0.148                 | -0.028               | -11.52 |
| 1993 | 2810  | 0.127                    | 0.148    | -0.022               | -9.63  | 0.153                 | -0.026               | -11.57 |
| 1994 | 3026  | 0.112                    | 0.139    | -0.027               | -12.89 | 0.143                 | -0.031               | -14.66 |
| 1995 | 3074  | 0.108                    | 0.133    | -0.025               | -12.17 | 0.137                 | -0.029               | -13.89 |
| 1996 | 3174  | 0.122                    | 0.140    | -0.018               | -8.59  | 0.144                 | -0.022               | -10.37 |
| 1997 | 3130  | 0.117                    | 0.128    | -0.010               | -4.78  | 0.131                 | -0.013               | -6.16  |
| 1998 | 2931  | 0.108                    | 0.114    | -0.006               | -2.88  | 0.117                 | -0.009               | -4.22  |
| 1999 | 2686  | 0.111                    | 0.120    | -0.009               | -3.89  | 0.123                 | -0.012               | -5.44  |
| 2000 | 2450  | 0.119                    | 0.125    | -0.006               | -2.46  | 0.129                 | -0.010               | -3.85  |
| 2001 | 2179  | 0.122                    | 0.125    | -0.004               | -1.38  | 0.130                 | -0.009               | -3.01  |
| 2002 | 2026  | 0.127                    | 0.132    | -0.004               | -1.53  | 0.138                 | -0.011               | -3.56  |
| 2003 | 1954  | 0.133                    | 0.136    | -0.003               | -1.08  | 0.143                 | -0.010               | -3.48  |
| 2004 | 1941  | 0.144                    | 0.141    | 0.003                | 0.98   | 0.148                 | -0.004               | -1.41  |
| 2005 | 1923  | 0.145                    | 0.139    | 0.006                | 2.12   | 0.146                 | -0.001               | -0.23  |
| 2006 | 1921  | 0.145                    | 0.134    | 0.011                | 3.94   | 0.140                 | 0.005                | 1.71   |
| 2007 | 1873  | 0.142                    | 0.131    | 0.011                | 3.83   | 0.137                 | 0.005                | 1.65   |

## Figure 1

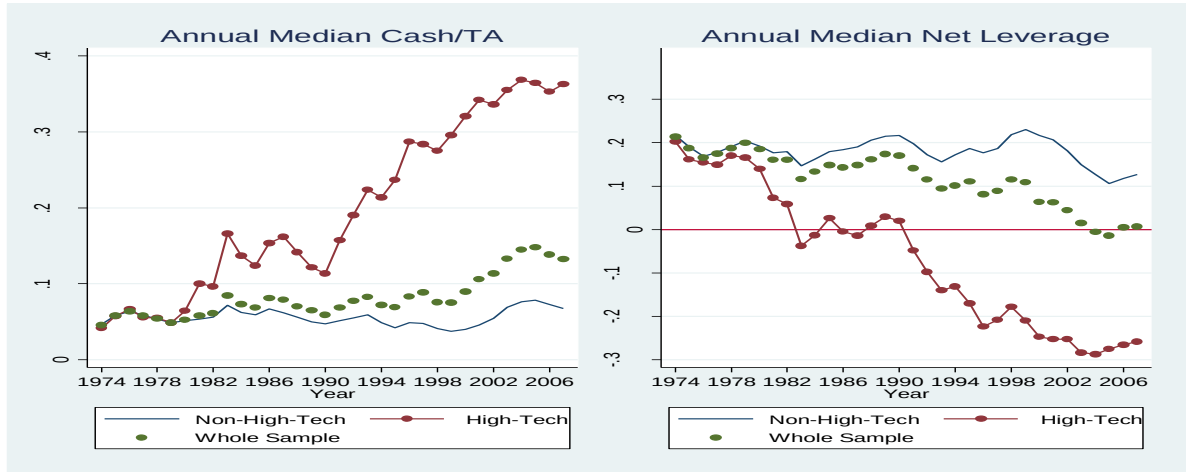
### Trends in Cash Holdings and Net Leverage: 1974-2007

These figures depict the annual mean, median, and value-weighted average (based on annual book assets) in the cash ratio and net leverage ratio of the whole sample and of the high-tech and non-high-tech sectors over the period 1974 to 2007. The sample includes U.S. firms documented on the Compustat-CRSP merged database (fundamental annual) that have positive total assets and sales and nonnegative cash and marketable securities, and have common shares traded on the NYSE, AMEX, or Nasdaq. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 138,193 observations for 14,948 unique firms. The high-tech and non-high-tech sectors are defined according to the U.S. Department of Commerce. The cash-to-assets ratio (Cash/TA) is measured as cash plus marketable securities (CHE), divided by book value of total assets (AT). Net leverage is calculated as long-term debt (DLTT) plus debt in current liabilities (DLC) minus cash and market securities, divided by book value of total assets. Figures in Panel A (B) depict the annual mean (median) of cash ratio and net leverage of firms in two sectors separately. Figures in Panel C are the annual value-weighted averages (based on annual book assets) in two sectors.

**Panel A: Annual Mean**



**Panel B: Annual Median**



**Panel C: Annual Value-Weighted Average**

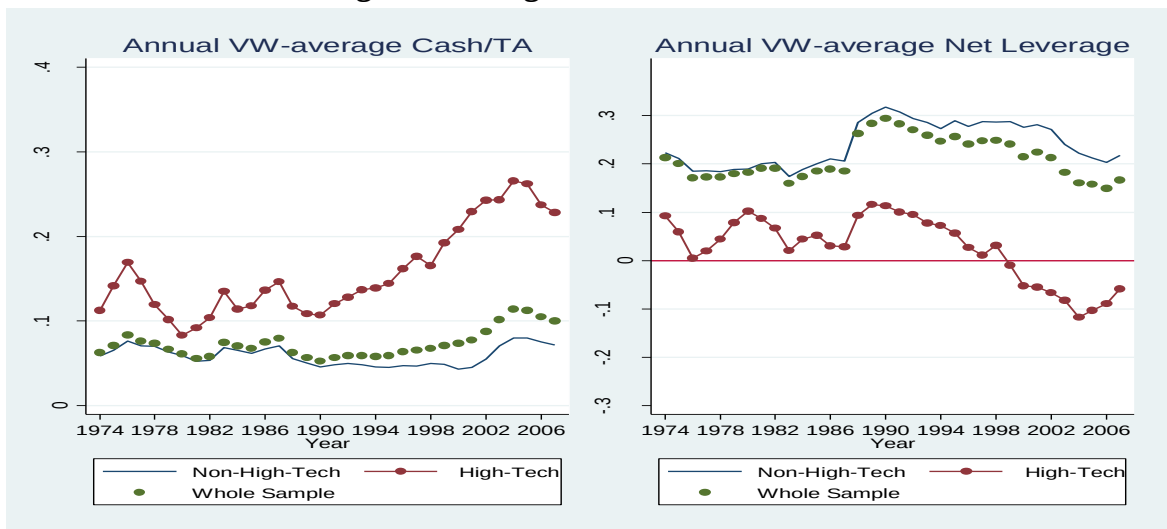


**Figure 2:**  
**Annual Number of IPOs**

This figure plots the number of IPOs each year over the period of 1974-2007, for the whole sample and for the high-tech and non-high-tech sectors respectively. IPO dates are identified first by using Jay Ritter's proprietary database of IPO dates (<http://bear.cba.ufl.edu/ritter/FoundingDates.htm>). If the IPO date of a stock is unavailable from Ritter, the first trading date on the CRSP is identified as the IPO date. The high-tech and non-high-tech sectors are defined according to the U.S. Department of Commerce.

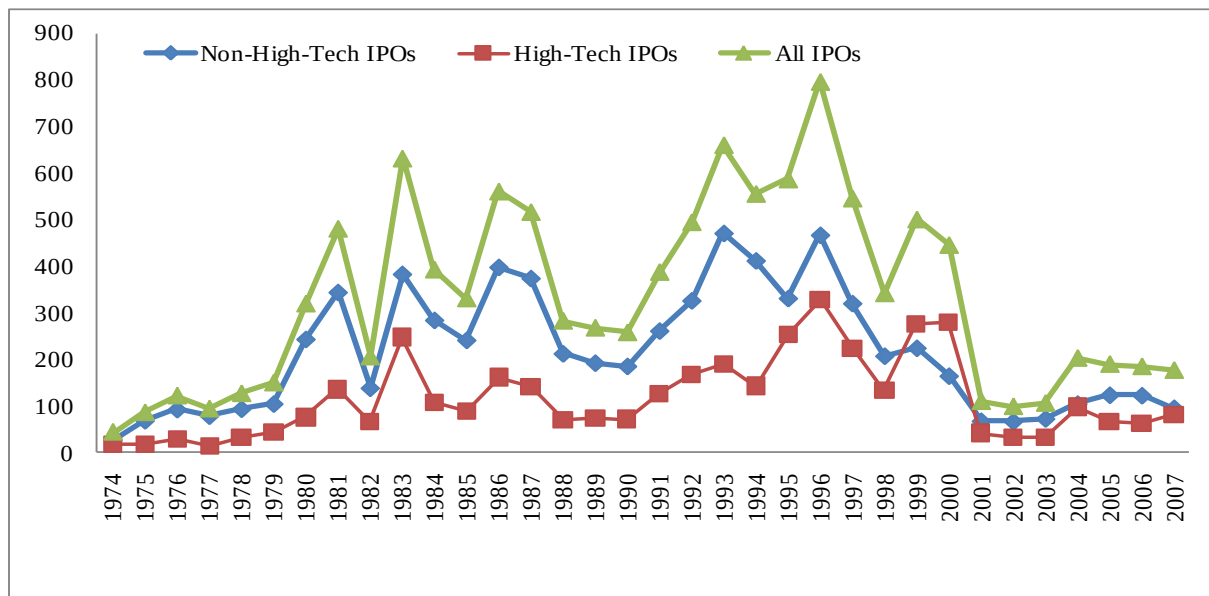
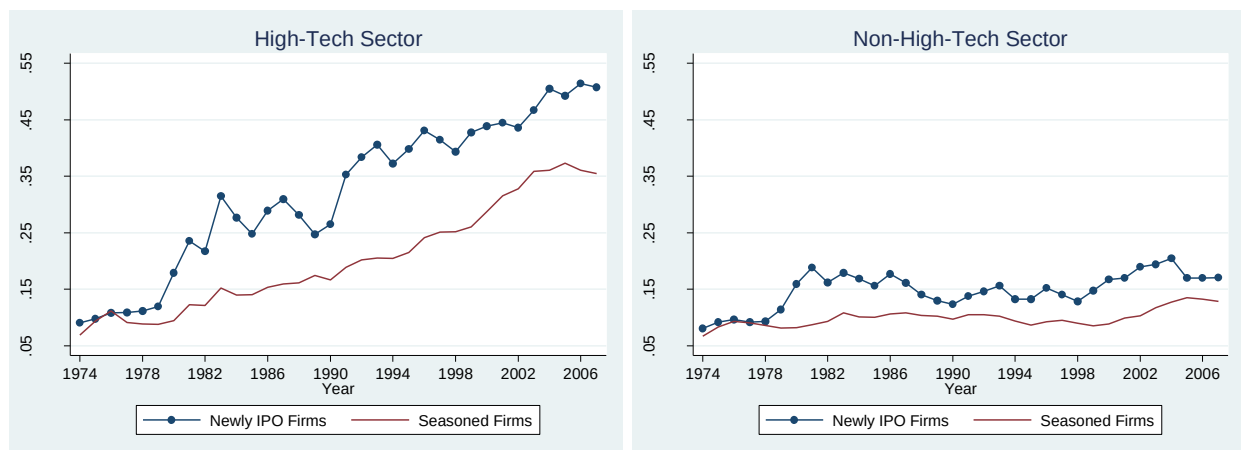


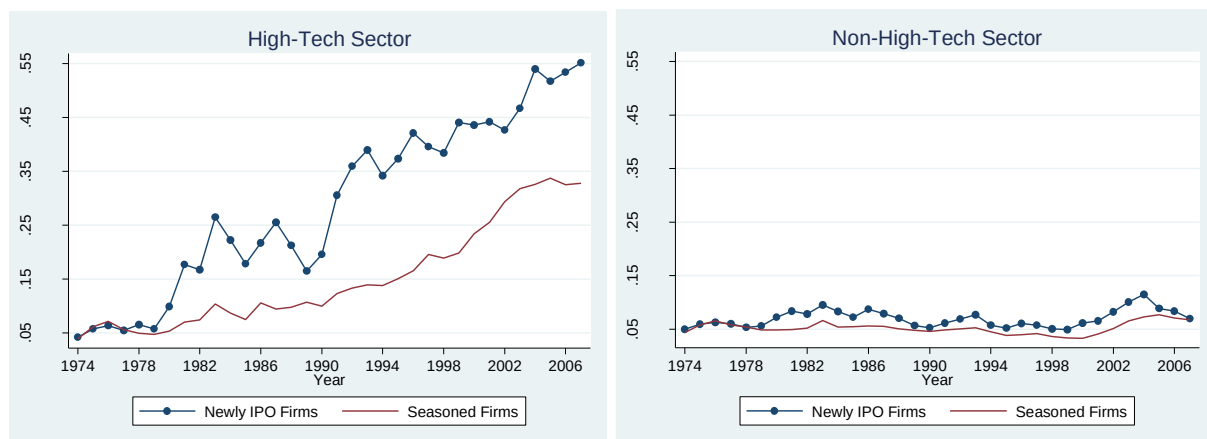
**Figure 3:**  
**Trends in Cash Holdings of Newly IPO Firms and Seasoned Firms**

This figure plots the trends in cash holdings, annual mean and median, of IPO firms and seasoned firms in the high-tech and non-high-tech sectors. The sample includes U.S. firms documented on the Compustat-CRSP merged database (fundamental annual) that have positive total assets and sales and nonnegative cash and marketable securities, and have common shares traded on the NYSE, AMEX, or Nasdaq. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 138,193 observations for 14,948 unique firms. The high-tech and non-high-tech sectors are defined according to the U.S. Department of Commerce. Observations of Newly IPO firms are those within five years after their IPO dates. Observations of seasoned firms are the ones beginning in the sixth year after the IPO dates. The cash-to-assets ratio (Cash/TA) is measured as cash plus marketable securities (DATA 1), divided by book value of total assets (DATA 6).

**Panel A: Annual Mean**



**Panel B: Annual Median**



## Appendix: Variable Construction

All names in parentheses refer to the Compustat (XPF version, Fundamental Annual) item names.

|                                               | Definition                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cash-to-assets (Cash/TA)                      | Cash-to-assets ratio (Cash/TA) is measured as cash plus marketable securities (CHE), divided by book value of total assets (AT).                                                                                                                                                                     |
| Net Leverage                                  | Net leverage is calculated as long-term debt (DLTT) plus debt in current liabilities (DLC) minus cash and market securities (CHE), divided by book value of total assets (AT).                                                                                                                       |
| Industry cash flow volatility (IndustrySigma) | For each firm-year, I compute the standard deviation of cash flow over assets for the previous 10 years if there are at least 3 observations. Industry sigma is calculated as the mean of cash flow standard deviations of firms in the same industry, defined by 2-digit SIC code.                  |
| Market-to-Book (MB)                           | MB is the ratio of market value of assets to book value of assets. The market value of assets is equal to total assets (AT) minus book value of common equity (CEQ) plus the market value of common equity (fiscal year end price (PRCC_F) times shares outstanding (CSHO)).                         |
| Size                                          | Size is measured with the logarithm of net assets (AT-CHE) that is converted to 2006 dollars using the Consumer Price Index.                                                                                                                                                                         |
| Cash flow over assets (CF/TA)                 | Cash flow is defined as operating income before depreciation (OIBDP), less interest (XINT) and taxes (TXT).                                                                                                                                                                                          |
| Net working Capital over assets (NWC/TA)      | NWC/NA is the ratio of working capital (ACT-LCT) minus cash and marketable securities (CHE) to total assets (AT).                                                                                                                                                                                    |
| Capital expenditures (Capex/TA)               | Capex/TA is the ratio of Capital expenditures (CAPX) to total assets (AT).                                                                                                                                                                                                                           |
| Leverage                                      | Leverage is the ratio of long-term debt (DLTT) plus debt in current liabilities (DLC) to total assets (AT).                                                                                                                                                                                          |
| R&D Expense (R&D/Sales)                       | R&D/Sales is the ratio of R&D expenditure (XRD) to Sales (SALE). If R&D expenditure (XRD) is missing, I follow the tradition to set the missing value to zero.                                                                                                                                       |
| Dividend payer (DivDummy)                     | Dividend payer dummy is set to one if a common dividend (DVC) is positive; else equal to zero.                                                                                                                                                                                                       |
| Acquisition (ACQN/ TA)                        | ACQN/NA is the ratio of Acquisitions (AQC) to total assets (AT).                                                                                                                                                                                                                                     |
| Net debt issuance (NetDiss)                   | Net debt issuance is equal to long-term debt issuance (DLTIS) minus long-term debt reduction (DLTR), scaled by total assets (AT).                                                                                                                                                                    |
| Net equity issuance (NetEiss)                 | Net equity issuance is equal to the sale of common and preferred stock (SSTK) minus the purchase of common and preferred stock (PRSTKC), scaled by total assets (AT).                                                                                                                                |
| T-bill yield                                  | The average annual three-month rates published by the Federal Reserve. Data are from <a href="http://research.stlouisfed.org/fred2/">http://research.stlouisfed.org/fred2/</a> .                                                                                                                     |
| Default spread                                | The average yield on Baa less Aaa Moody's rated corporate bonds with maturity of approximately 20-25 years. Data are from <a href="http://research.stlouisfed.org/fred2/">http://research.stlouisfed.org/fred2/</a> .                                                                                |
| IPO date                                      | Jay Ritter's proprietary database of IPO dates ( <a href="http://bear.cba.ufl.edu/ritter/FoundingDates.htm">http://bear.cba.ufl.edu/ritter/FoundingDates.htm</a> ) is used. If the IPO date of a stock is unavailable from Ritter, the first trading date on the CRSP is identified as the IPO date. |

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## Notes:

<sup>1</sup> “Desperately seeking a cash cure”, *The Economist*, November 20, 2008; “GE Joins Parade of Deep Dividend Cuts”, by Paul Glader, Eleanor Laise and E.S. Browning, *The Wall Street Journal*, February 28, 2009; “Technology firms sitting on mountains of cash”, by Dan Gallagher, *MarketWatch*, February 13, 2009; “Oracle Foretells the Technology Sector's Future for Payouts”, by Martin Peers, *The Wall Street Journal*, March 21, 2009; “IBM raises dividend, to buy back more shares”, *Reuters*, April 28, 2009; “Intel to Boost Its Dividend About 10%”, *The Wall Street Journal*, March 21, 2008; “Buying time”, *The Economist*, January 29th 2009; “Merck's manoeuvres”, *The Economist*, March 12, 2009.

<sup>2</sup> “Corporate cash balances and economic activity”, by Governor Kevin M Warsh of the US Federal Reserve, 18 July 2006; “Behind Those Stock Piles of Corporate Cash”, by Mark Hulbert, *The New York Times*, October 22, 2006; “Corporate America sits on its cash”, by Justin Baer, *Financial Times*, September 23 2008; “Corporates are driving the global saving glut”, by Jan Loeys, et al. JPMorgan Research, June 24, 2005

<sup>3</sup> “Too much cash, too little innovation”, *Business Week*, July 18, 2005; “The tech sector is hogging the green blanket”, by Jesse Eisinger, *The Wall Street Journal*, April 05, 2006.

<sup>4</sup> Dittmar (2008) provides a recent survey of this literature. Opler et al. (1999) and Bates et al. (2009) provide detailed descriptions on the theories and evidence that support the empirical model on cash holdings.

<sup>5</sup> An incomplete list of papers includes Harford (1999), Dittmar et al.(2003), Pinkowitz et al. (2006), Foley et al. (2007), Dittmar and Mahrt-Smith (2007), Harford et al. (2008), Kecskes (2008), Duchin (2008), Bates et al. (2009), and Duchin et al. (2009).

<sup>6</sup> “An Assessment of United States Competitiveness in High-Technology Industries,” United States Department of Commerce, February 1983.

<sup>7</sup> A detailed check on the Fama-French 12 industry groups, not reported in the paper, shows that some industries in the non-high-tech sector, such as Durables, Manufacturing, and Non-Durables, have gradually shrunk over time.

<sup>8</sup> The VW-cash ratio is equivalent to the aggregate cash ratio in Bates et al. (2009), which is defined as the sum of the cash and marketable securities divided by the sum of book assets for all sample firms. The annual mean is equivalent to the average cash ratio in Bates et al. (2009).

<sup>9</sup> The Fama-French industries are defined on Ken French’s website (<http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/datalibrary.html>). The Global Industry Classification Standard (GICS), developed by Standard & Poor’s (S&P) and Morgan Stanley Capital International (MSCI), categorizes a firm according to its operational characteristics as well as investors’ perceptions of its principal business activity. The GICS data can be retrieved from the CCM -- Fundamental Annual file. It contains 10 economic sectors (according to the first two digits of the GICS code), which can be further sub-divided into a hierarchy of 23 industry groups, 59 industries, and 123 sub-industries. Recent studies by Bhojraj et al. (2003) and Chan et al. (2007) compared the GICS with the Fama-French classification in capital market research.

<sup>10</sup> Since financials and utilities according to the SIC codes are excluded, only 10 of the Fama and French 12 industry groups are used in this study. According to the GICS, our sample contains small numbers of observations from the financials (40) sector and the utilities (55) sector. This is due to minor disagreement between the SIC and GICS schemes. For example, Potlatch Corporation (NPERMNO= 49744) is classified by the GICS in financial sector since it is traded as a real estate investment trust. However, due to its business in pulp, paperboard, and wood products, Potlatch is allocated in the paperboard mills industry according to the SIC, thus is included in the manufacturing industry according to the Fama-French 12-industry classification.

<sup>11</sup> The  $R^2$  of the linear trend model for these two industry groups are also much larger than others.

<sup>12</sup> The pattern on the whole sample (indicating by ‘All IPO’) over 1974-2001 is close to Fama and French (2004, Figure 2). The annual numbers of IPOs in my sample are always slightly smaller than those in Fama and French (2004) since my sample is narrower by excluding financials and utilities.

<sup>13</sup> Except for R&D squared, the other four variables are used in Bates et al. (2009) in their robustness checks.

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<sup>14</sup> Several recent studies in corporate finance discussed the relative importance of explanatory variables, such as Bekaert et al. (2008) on equity market segmentation, Frank and Goyal (2009) on capital structure decisions, and Lemmon et al. (2008) on persistence in capital structures.

<sup>15</sup> The relative importance results are obtained using the R package *relaimpo*, discussed in Grömping (2006).

<sup>16</sup> The R&D-to-assets ratio is reported here to facilitate the direct comparison with the capital expenditure-to-assets ratio.

<sup>17</sup> Industry Sigma is excluded from this table since it is an industry measure and hence impossible to decompose the contribution of each IPO cohort.

<sup>18</sup> If the estimation of a model takes place using only a segment of the available historical data, it is essential that the estimation interval is representative of the entire period. An important lesson learnt from the recent credit crunch is that including historical data on market crashes during the estimation period can improve forecasts for future crises.