[Preliminary: Please do not cite.]

Increase in Cash Holdings: Pervasive or Sector-Specific?

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[This Version: April 2009]

Abstract:

This paper finds that the average cash holdings of U.S. firms in high-tech sector tripled from 1980 to 2006, whereas the average cash holdings of firms in non-high-tech sector remained quite flat until early this decade. Furthermore, this paper demonstrates that the discrepancy in the trends between high-tech and non-high-tech sectors was driven by different determinants. Before 2000, the discrepancy was primarily driven by new listings over 1980-2000 in high-tech sector, their changing firm characteristics inducing them to hold more cash. The pervasive increase in cash holdings after 2000 could be attributed to the precautionary action in response to adverse macroeconomic shocks.

Key Words: *cash holdings; high-tech; R&D; new listings;*
JEL Classification: ***G30, G32***

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1. Introduction

Corporate cash policy has triggered a lot of interest recently, reflecting the old saying that 'In a recession cash is king'. While many traditional firms, even the well-established firms such as General Electric, have been desperately seeking a cash cure by cutting dividend, suspending new projects, and/or closing subsidiaries, high-tech firms seem to be better-prepared for the current economic storm by holding such huge piles of cash that some firms, such as IBM, Oracle and Intel, can even afford to initiate or increase their dividends, and firms like Oracle, Merck, and Pfizer can take acquisitions partially financed by cash.[1] Besides, checking business news over the past few years, an intriguing phenomenon widely documented is the gradual stockpiling of cash by large U.S. firms in the aftermath of the economic downturn in the early 2000s.[2] Among them, high-tech firms attract additional interest due to their more rapid speed of accumulating cash despite the 'growth' nature of their business.[3]

While much attention has recently been put on the aforementioned discrepancies in the cash holdings of *large* firms from high-tech and non-high-tech sectors, a little is known about the differences in the cash holdings of 'typical' firms from these two sectors over a longer period. Investigating their potential disparity is important since high-tech sector has grown rapidly over the past three decades due to new listings. Besides, literature has long identified that high-tech firms are exposed to more severe capital market frictions due to the high information asymmetry about their uncertain growth opportunities and the lack of collateral (Myers, 1984; Hall, 2005). Hence, holding cash is more important for these high-tech firms, particularly the immature ones, since keeping innovative by intensive and steady research and development is crucial for their survival and growth.

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1 "Desperately seeking a cash cure", the Economist, November 20, 2008; "GE Joins Parade of Deep Dividend Cuts", Paul Glader, Eleanor Laise and E.S. Browning, the Wall Street Journal, February 28, 2009; "Technology firms sitting on mountains of cash", Dan Gallagher, MarketWatch, February 13, 2009; "Oracle Foretells the Technology Sector's Future for Payouts", Martin Peers, 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%", Wall Street Journal, March 21, 2008; "Buying time", the Economist, January 29th 2009; "Merck's manoeuvres", the Economist, March 12, 2009.

2 "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, 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

3 "Too much cash, too little innovation", Business Week, July 18, 2005; "The tech sector is hogging the green blanket", Jesse Eisinger, The Wall Street Journal, April 05, 2006.

Using two general schemes of industry classification– the Fama-French classification and the Global Industry Classification Standard (GICS) – to subdivide the 1980-2006 sample of U.S. industrial firms, I find that only firms from research-intensive industries (such as software, hardware and pharmaceuticals) on average exhibit an upward trend in cash holdings. When a more rigorous standard designed by the U.S. Department of Commerce is used to divide the sample into high-tech and non-high-tech sectors, I find that the average cash-to-total assets ratio of high-tech sector tripled over the sample period (from 12.8% in 1980 to 39.5% in 2006); at the same time, the average cash holdings of non-high-tech firms remained relatively flat at around 11% over the period 1980-2000, and then started to increase after 2000, reaching 14.2% in 2005. This remarkable difference in the changing cash holdings between high-tech and non-high-tech firms has not received much attention.

What caused this difference? According to the literature on corporate cash holdings, the level of a firm's cash holdings is a function of its fundamental characteristics that are related to the costs and benefits of holding cash (Kim, et al., 1998; Opler et al., 1999). Meanwhile, the literature on R&D financing implies that the cash policy of high-tech firms may differ from non-high-tech firms since external financing is more costly for research-intensive firms while proper financial hedging instruments are unavailable (Hall, 2002; Carpenter and Petersen, 2002; Passov, 2003). Due to equity market development, many firms with weaker fundamentals went public in the 1980s and 1990s (Fama and French, 2004; Brown and Kapadia, 2007). Although both high-tech and non-high-tech sectors have embraced new firms, the cash policies of these new firms are not the same due to the different nature of their investment and operation. By dividing firms into different cohorts according to their IPO years, it becomes evident that new listings from later cohorts in high-tech sector have much higher cash ratios than their predecessors, whereas this new listing effect is not obvious in non-high-tech sector. Moreover, increase in cash has become pervasive across all cohorts in both sectors after 2000, reaching a peak around 2005.

A detailed comparison of firm characteristics related to cash policy across IPO cohorts shows that the 1980s and 1990s new listings in high-tech sector are distinct from both non-high-tech firms and earlier high-tech firms, in terms of the nature of their investment and financial policies. In order to access how changing firm characteristics can explain the different trends in cash holdings across high-tech and non-high-tech sectors, I follow Bates et al. (2009) approach in estimating a modified model of cash holdings using data over 1980-1989. The out-of-sample

predictions of annual cash holdings for each firm were calculated for each year during the period 1990-2006. To a large extent, the annual average of predicted cash ratios captures the trends of actual cash holdings in the whole sample and two sectors, although it overpredicts the cash holdings in non-high-tech sector and underpredicts the cash holdings in high-tech sector, especially the high-tech new listings. Moreover, the underprediction has strengthened in 2000s across all cohorts in high-tech sector, indicating that changing firm characteristics cannot explain the pervasive increase in cash holding during the post-2000 period. This paper interprets this post-2000 pervasive pattern as a common response, based on precautionary motive, to adverse economic shocks.

This paper contributes to the literature from the following four perspectives. First, it contributes to the analysis of the increase in cash holdings of U.S. industrials. Bates et al. (2009) focus on the trend in the annual average for the overall sample and attribute the increase to the changes in three major firm characteristics. This paper extends Bates et al. (2009) by comparing the trends of high-tech and non-high-tech sectors. This extension is important not only because the industry composition of public firms has changed due to new listings, but also because cash reserves are more important for the weaker new listings with high R&D intensity. Moreover, this paper also extends Bates et al. by demonstrating that the driving forces behind the increasing cash holdings during the pre- and post-2000 periods are different.

Second, 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 high-tech and non-high-tech sectors. Existing studies usually focus on the pervasiveness of the impact of new listings, understating cross-industry difference. This paper shows that the difference between high-tech and non-high-tech new listings is important for analyzing cash policy.

Furthermore, this paper provides a link to the literature on R&D financing. This literature argues that R&D-intensive firms, particularly immature ones, are more likely to suffer from capital market frictions and are lack of proper financial hedging instruments due the nature of their operation and investment (Hall, 2002, 2005; Carpenter and Petersen, 2002; Passov, 2003). This implies that cash holdings of high-tech firms, especially those new listings in high-tech sector, may differ from non-high-tech ones. This implication is supported by this paper.

Finally, this paper is indirectly linked to the recent literature that investigates the increasing conservatism in corporate debt policy (Strebulaev and Yang, 2007; Byoun, et al. 2008). This paper shows that new listings in high-tech sector tend to hold a larger proportion of their book assets in the form of cash, whilst they seldom issue debt; which implies 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 increase in debt conservatism.

The remainder of the paper is organized as follows. Section 2 reviews the current literature on corporate cash policy, new listings, and R&D financing. Section 3 provides the evidence that rising cash holdings was a phenomenon unique to high-tech sector until the year 2000, and it has become pervasive to all industries only thereafter. Section 4 provides some potential explanations for the observed difference in the cash holdings between high-tech and non-high-tech sectors during the pre- and post-2000 periods, and Section 5 concludes.

2. Literature Review

In this section, I motivate the empirical study of this paper by discussing existing research in three areas: corporate cash holdings, new listing effects, and R&D financing.

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). Hence, maintaining zero cash would be the optimal choice for any firm. The existence of capital market frictions provides the rationale for firms to hold cash. Keynes (1936) points out two major motives to justify cash holdings. First, holding cash can help a firm avoid the transaction costs associated with either converting a non-cash asset or using external financing to make cash payments. A second reason is a precautionary motive, i.e. the desire to hold cash as a cushion to hedge the risk of future cash shortfalls, caused by adverse business shocks or new investment opportunities.

Based on Keynes' insight, recent empirical studies on corporate cash holdings by Kim et al. (1998) and Opler et al. (1999) categorize the previous theories into the benefits and costs of holding one more dollar of cash. They found that some relevant firm characteristics, such as business risk, growth opportunity, and firm size among others, help explain the observed level of cash holdings. Firms with more growth opportunities and higher business risk usually hold more

cash; whereas larger firms, firms with higher net working capital, and highly levered firms usually hold less cash. This empirical model has been accepted as the building block for most recent empirical studies.[4] A recent study by Bates et al. (2009) find that the average cash-to-assets ratio of U.S. industrials more than doubled from 1980 to 2006 and this change can be attributed to the change in the firm characteristics analyzed in cash holding literature.

Over the last three decades, the increasing importance of Nasdaq and the growth of mutual funds have triggered downward shift of the supply curve of equity finance. This shift lowered the cost of equity capital, which allowed many firms with weaker fundamentals to enter into market. Fama and French (2004) show that 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 also have higher idiosyncratic volatilities. Moreover, high-tech industries have become more important due to the disproportional growth of new listings in this sector. As a result, American industrials have experienced a remarkable change, moving from a relatively stable capital-intensive business society to a more innovative but unstable knowledge-based one. The building-blocks of this knowledge-based business society, i.e. the high-tech firms, have a much stronger incentive to hold cash due to the nature of their investment.

Hall (2002, 2005) summarizes that the R&D investment has two distinct features: 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, especially at an early stage. These features imply that the impact of capital market imperfections will be more serious for R&D investment as compared to an ordinary investment. Building on Akerlof (1970), Myers and Majluf (1984) show that equity financing will suffer from undervaluation by the market (the Lemon premium), if investors are less informed than insiders about the value of the firm's assets. The information asymmetry is more important for an R&D investment, since by nature its value and its likelihood of success are hard to estimate by outsider investors. Moreover, the information gap cannot be reduced by voluntary disclosure due to strategic concerns on the danger of imitation of the innovative ideas by rivals. Hence, high information asymmetry exists

[4] An incomplete list of papers includes Dittmar et al.(2003), Pinkowitz et al. (2006), Foley et al. (2007), Faulkender and Wang (2006), Dittmar and Mahrt-Smith (2007), Harford et al. (2008), Bates et al. (2009), Acharya et al. (2007), Duchin (2008), and Dittmar (2008).

and persists for R&D investment, which implies higher Lemon premium when using external financing.

Furthermore, debt financing is more difficult for the R&D intensive firms, since their key assets are intangible. These intangible assets are firm-specific, hence they have low 're-deployable' value, in the Williamson (1988) sense, thus they cannot be used as collateral. The lack of collateral and the highly volatile returns make it forbiddingly expensive for R&D intensive firms, especially the small ones, to use debt financing, particularly in the absence of positive cash flows (Carpenter and Petersen, 2002). Consistent with their reasoning, they find that debt financing is rarely used by small high-tech firms. Brown, Fazzari, and Petersen (2009) show that internal funding and external equity financing are the two major sources to fund R&D investment. Moreover, R&D cycle in 1990s and 2000s was driven by the financial market development.

Froot, Scharfstein and Stein (1993) justify firms' hedging motive when external financing is more costly than internal financing and pointed out that the hedging instrument depends on the nature of the firm's 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 the R&D investment with the company's cash flow, and the high cost of external financing, imply that the hedging demands of high-tech firms are much stronger than those of non-high-tech firms. However, despite the growth of financial hedging tools, Passov (2003) points out that the risk associated with R&D investment cannot be hedged in financial markets, making cash holdings the hedging instrument chosen by most high-tech firms. Acharya, Almeida, and Campello (2007) formalize the idea of using cash holdings as a hedging instrument, and show that higher cash holdings are more preferable than lower debt when a firm's hedging need is higher. This is consistent with the empirical evidence that high-tech firms, even the largest and most successful ones such as Microsoft, Pfizer, etc, consistently hold significant cash positions and have very low leverage.

3. Time Trends in Cash Holdings: 1980-2006[5]

Taking all US publicly traded firms documented in the CRSP-Compustat Merged database (Industrial Annual) for the period 1980-2006 as the base sample, I follow the method described in Bates et al. (2009) to screen the sample. This involves excluding financial firms (SIC codes 6000-6999) due to difficulties in assessing their liquidity, and utilities (SIC codes 4900-4999) since their liquidity might be driven by regulatory requirements. 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. This screening leaves an unbalanced panel of 118,289 observations for 13,893 unique firms.

3.1 Trends in Cash Holdings: Whole Sample

[Insert Table 1 here]

For each firm-year observation, the cash holding is measured by the sum of cash and marketable securities divided by total assets. The trends in cash holdings for the whole sample, as tabulated in Table 1, are close to Bates et al (2009). The book-value weighted average of cash ratio (called VW-cash ratio) rises from 6.2% in 1980 to 10.3% in 2006, reaching a peak of 11.2% in 2004, whereas the equally-weighted average of cash ratio (called EW-cash ratio) rises from 10.4% in 1980 to 23.1% in 2006, reaching peak around 2005 with 23.5%.[6] The annual median cash ratio also exhibits an upward trend. Considering that cash holdings and debt, to some extent, can be regarded as two sides of the same coin, the net leverage ratio, defined as total debt minus cash and marketable securities and divided by book assets, is used to compare their relative scale. The annual EW-net leverage (median net leverage) decreases from 16% (17.9%) in 1980 to -2.5% (1.4%) in 2006, implying that an average firm can almost repay all its debts with its own cash holdings by the end of the sample period.

[5] The trends in cash holdings are examined according to fiscal year. The results are robust to using the calendar year of the fiscal year-end.

[6] 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 EW-cash ratio is equivalent to the average cash ratio in Bates et al. (2009). Similar relations apply for leverage and net leverage.

3.2 Trends in Cash Holdings: Industry Analysis

After confirming the increase in the average cash ratio for U.S. industrials, a natural question is whether this increase is a pervasive trend or an industry-specific phenomenon.

Two independent schemes of industry categorization are considered in this paper: the Fama-French industry classification and the Global Industry Classification Standard (GICS).[7] The former scheme is favored by academic scholars, while the latter, developed by Standard & Poor's (S&P) and Morgan Stanley Capital International (MSCI), is popular among financial practitioners. 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 for the ease of comparison.[8]

For each fiscal year, I calculate the equally- and value-weighted average cash ratio, as well as the median cash ratio, for each industry group. Then, I investigate the significance of the time trend for the average and median cash ratios of each industry by applying a linear trend model, regressing them on a constant and a time index measured in years. The results for industry groups based on the Fama-French and the GICS schemes are reported in Panels A and B of Table 2 respectively. The results based on all firms, reported in the first row of Table 2, exhibit an upward trend. For the EW-cash ratio, the coefficient estimate of the time trend indicates an annual increase of 0.45%, with an R-squared equal to 89%. The upward trends of the median cash ratio and the VW-cash ratio are less steep, but still remain statistically significant.

[Insert Table 2 here]

7 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) 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 Compustat PDE (price, earnings, and dividends) 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, Lee, and Oler (2003) and Chan, Lakonishok, and Swaminathan (2007) compare the GICS with the Fama-French classification in capital market research.

8 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 547 firm-year observations from the financials (40) sector and 111 firm-year observations from 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, which is included in the manufacturing industry according to the Fama-French 12-industry classification.

A more interesting finding is the pronounced cross-industry difference. Regardless of the measure used to capture 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. Although *Telecom* (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 of other industries is either statistically insignificant or even downward (e.g. Energy). Apparently, the overall increase in the cash ratios over 1980-2006 is largely driven by the extraordinary upward trend in the cash holdings of *Business Equipment* (or *Information Technology* by the GICS) and *Healthcare* industries.[9] In order to check the robustness of the results to the proxy used for a firm's cash holdings, I also follow Opler et al. (1999) method in measuring the cash holdings with the ratio of cash-to-net assets, where net assets are calculated as the total assets net of cash and marketable securities. The results on the relative significance of the trends across industry groups, although not tabulated here, remain unchanged.

Among the industries classified by the Fama-French and the GICS schemes, firms in *Business Equipment* (*Information Technology*) and *Healthcare* industry groups are usually regarded as more research-intensive (Fama and French, 2004; Brown and Kapadia, 2007). Hence, the prior findings provide a preliminary insight, indicating that high-tech firms are the ones that have increased their cash holdings over time. For further investigation, I follow Brown, Fazzari, and Petersen (2009) to use the official definition of high-tech industries offered by the United States Department of Commerce.[10] The detailed comparison between the Fama-French *Business Equipment* and *Healthcare* industry groups and the Dept. of Commerce definition of high-tech industries in Appendix A clearly shows that the latter classification is much stricter. Moreover,

[9] The R^2 of the linear trend model for these two industry groups are also much larger than others.

[10] "An Assessment of United States Competitiveness in High-Technology Industries," United States Department of Commerce, February 1983. The largest three-digit high-tech industries include 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).

Panel C of Table 2 examines the overall mean and median cash ratios, as well as the trends in annual mean and median cash ratios, across these industry classifications. The average cash ratio of high-tech firms defined by the Dept. of Commerce has increased by 0.97% per year. In contrast, those non-high-tech firms, locating in the Fama-French *Business Equipment* and *Healthcare* industries or not, generally hold much less cash and have not increased their cash holdings over time. These findings further confirm that it is the high-tech firms that hold more cash and have increased their cash holdings over the sample period. Hence, the U.S. Dept. of Commerce classification of high-tech industries will be used in the remainder of this paper.

[Insert Figure 1 here]

Figure 1 tracks the time trends, measured by annual mean, median, and value-weighted average, in the cash-to-total assets, leverage, and net leverage ratios of high-tech and non-high-tech sectors, respectively, in the period 1980-2006. The plots clearly show that: (i) on average, high-tech firms increased their cash holdings and the increase became more pronounced after 1990; (ii) the cash holdings of non-high-tech firms were quite stable over 1980-2000, but exhibited a slight upward trend since 2001, peaking around 2005; (iii) the leverage ratio of high-tech firms decreased dramatically after 1990 and stayed lower than the cash-to-total assets ratio, indicating negative net debt holdings; however, leverage ratios were, on average, higher than the cash-to-total assets ratios for non-high-tech firms.

In sum, the above analysis shows that the increase in cash holdings over the entire 1980-2006 period is a phenomenon specific to high-tech firms. The cash holdings of non-high-tech firms only increased slightly in the 2000s.[11]

3.3 Changing Industry Composition

Over this period, the overall industry composition of U.S. public firms has changed dramatically, as technology-intensive firms have become increasingly important largely due to

[11] Some studies in the literature use other classifications to define high-tech industry. Loughran and Ritter (2004) give detailed description of the SICs used to define internet and technology firms in their study. Their definition does not include biotech/pharmaceutical industries. However, some studies (Cliff and Denis, 2004; Lowry et al., 2009) consider biotech/pharmaceutical firms as high-tech firms.

the disproportionate growth in their new listings (Fama and French, 2004; Bennett and Sias, 2006; Brown and Kapadia, 2007).

[Insert Table 3 here]

Panels A and B of Table 3 present the industry composition of the sample, according to the number of firms and their aggregate book assets respectively, for four selected years (1980, 1990, 2000, and 2006). In terms of the number of firms, the high-tech sector experienced a cycle over this period, increasing in the 1980s and 1990s and declining after 2000.[12] Furthermore, the proportion of firms in the high-tech sector relative to the total number of firms increased from 15.92% in 1980 to 37.84% in 2000, and stayed around this level henceforth, despite the decrease in the number of firms.[13] Panel B reports the aggregate book assets for the high-tech sector and the non-high-tech sector in 2006 dollars so as to allow for inter-temporal comparisons. The high-tech sector increased much faster than the non-high-tech sector. More specifically, the aggregate book assets of high-tech sector have more than quintupled from 1980 to 2006, while the aggregate book assets of non-high-tech sector only doubled over the same period. In terms of the relative weight, the high-tech sector rose from 8.23% of the total assets of U.S. industrials in 1980 to 18.53% in 2000, and henceforth remained around this level.

To summarize, above analysis shows that the observed increase in the average cash holdings of U.S. industrials in the 1980s and 1990s can be attributed to the increased average cash holdings within the high-tech sector, as well as the disproportionate growth of the high-tech sector. The increase in cash holdings in the 2000s seems to be a common trend in both high-tech and non-high-tech sectors.

4. Explaining the Difference in Cash Holdings Trends

Section 3 establishes the evidence that the upward trend in cash holdings over the entire sample period can only be identified for high-tech firms; while the average cash holdings of non-

[12] The finding is also consistent with the tech bubble formed in the late 1990s and its bursting afterwards.

[13] A more detailed check through the Fama-French 12 industry groups, unreported in the table, shows that some industries in the non-high-tech sector, such as Durables, Manufacturing, and Non-Durables, have gradually shrunk over time.

high-tech firms remained stable and only increased after 2000. The question remains as to what causes this difference.

4.1 IPO Effect

Bates et al. (2009) find that firms tend to hold more cash during the first few years after their IPOs. Kecskes (2008) shows that these cash holdings are usually above the level that can be explained by the corporate cash holding model, i.e. firms tend to hold positive excess cash during the first few years after the IPO. Figure 2 shows that on average firms in the sample tend to hold their highest level of cash right after the IPO and then decrease the cash level gradually over time. A more interesting finding is that a typical firm in the high-tech sector persistently has higher cash ratios than a typical non-high-tech firm, in terms of both mean and median.

[Insert Figure 2 here]

Table 3 presents the evidence that whereas high-tech sector was a small proportion of public listed firms in 1980, it has subsequently experienced rapid growth. This implies a relatively larger proportion of new IPO firms (those within the first five years after IPOs) in the high-tech sector each year. Combined with the above finding that high-tech firms on average have much higher cash ratios than non-high-tech firms in the earlier years after going public, this may explain the difference in the trends of cash holdings across these two sectors. To validate this explanation, Figure 3 plots the cash holdings of IPO firms and seasoned firms in two sectors, where seasoned firms are defined as those that have been listed for more than five years.

[Insert Figure 3 here]

Two remarks can be pointed out: (1) within any particular year, new IPO firms tend to hold more cash than already established firms; (2) the upward trend over the entire sample period only exists in high-tech sector, for both seasoned and new IPO firms; non-high-tech firms exhibit a small upward trend in their cash holdings only after 2000. The latter finding is important since it clearly shows that it is not the higher proportion of recently IPO firms in high-tech sector that drives the results. Moreover, this plot also shows that when IPO firms in high-tech sector become seasoned, on average they still hold more cash than those firms that went public earlier.

Hence, these findings imply some fundamental changes in high-tech sector that require further analysis.

4.2 New Listings and Trends in Cash Holdings

Fama and French (2004) find that cross-sectional distribution of public firms have changed due to the flood of unprofitable new listings with high growth opportunities. Bates et al (2009) show that the new listing effect, i.e. firms that went public in the 1980s and 1990s on average hold more cash than those got listed in early period, helps explain the increase in cash holdings of the overall sample. Since both high-tech and non-high-tech sectors contain new publicly-listed firms over the sample period and holding cash is more important for R&D-intensive high-tech firms, the new listing effect may be more pronounced in high-tech sector.

[Insert Figure 4 here]

In this section, I examine the trends in cash holdings of high-tech and non-high-tech firms based on listing cohorts. The listing date is defined according to Jay Ritter's database of IPO dates. If the IPO date of a stock is unavailable from Ritter, the first trading date documented on the CRSP file is used instead. According to their listing years, firms are sorted into the following groups: pre-1960 (listed before 1960), 1960s (listed from 1960 to 1969), 1970s (listed from 1970 to 1979), 1980s (listed from 1980 to 1989), 1990s (listed from 1990 to 2000), and 2000s (listed from 2001 to 2006).[14]

Panel A and Panel B of Figure 4 track the annual mean and median of cash-to-total assets ratio for each cohort in the high-tech and the non-high-tech sectors. Cash holdings of a firm during the first five fiscal years following its IPO are excluded to avoid the impact of cash received from its IPO.[15] In the high-tech sector, firms in the 1980s and 1990s cohorts hold on average much more cash than earlier cohorts; moreover, the 1990s cohort tend to hold even more cash compared to the 1980s cohort. These indicate that the newly listed IPOs drive up the cash holdings in the high-tech sector. However, this new listing effect does not hold for the non-high-

[14] I also split the sample according to five-year cohorts and get similar results.

[15] Welch (1989, 1996) provides another potential explanation for excluding these observations. Firms usually take seasoned offerings (SEO) following their IPOs, but the purposes of these sequential SEOs are generally different from regular SEOs. The probability of these sequential SEOs usually drops sharply four years after the IPO.

tech sector, i.e. the non-high-tech firms that went public after 1980 have, on average, similar cash ratios as their predecessors. These findings are consistent with the stable cash holdings for non-high-tech firms as depicted in Figure 1.

Another interesting finding from Figure 4 is that accumulating cash became a pervasive phenomenon across all cohorts in both sectors after 2000, reaching a peak around 2005. This post-2000 pervasive pattern may reflect a common response to macroeconomic events, such as the burst of internet bubble and the recession around 2001, which added to the uncertainty in the economy and increased credit constraints. A detailed analysis will be undertaken in section 4.5.

4.3 Cash Holdings Model

Opler et al. (1999) argue that a firm holds a certain amount of cash in order to support its operations and growth. Hence, a normal level of cash holdings has to be a function of firm characteristics, such as growth opportunities, business risk, profitability, net working capital, and size, etc. As advocated by Bates et al. (2009), the cash-to-total assets ratio is used as the measure of corporate cash holdings and the explanatory variables are also standardized by total assets.

The main regression specification is as follows:

$$\frac{Cash_{it}}{TA_{it}} = \beta_0 + \beta_1 \cdot (IndustrySigma)_{it} + \beta_2 \cdot MB_{it} + \beta_3 \cdot size_{it} + \beta_4 \cdot \frac{CF_{it}}{TA_{it}} + \beta_5 \cdot \frac{NWC_{it}}{TA_{it}} + \\ + \beta_6 \cdot \frac{CAPEX_{it}}{TA_{it}} + \beta_7 \cdot Leverage_{it} + \beta_8 \cdot \frac{R\&D_{it}}{Sales_{it}} + \beta_9 \cdot DivDummy_{it} + \beta_{10} \cdot \frac{ACQN_{it}}{TA_{it}} \\ + YearDummies + IndustryDummies + \varepsilon_{it}$$

The definitions of the explanatory variables with Compustat data items are provided in Appendix B. The Fama-French 49 industry categories are used for industry dummies.[16] Year dummies are included to deal with the secular trend due to macroeconomic events.

[16] The Fama-French industries are defined on Ken French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/datalibrary.html). Using a two-digit SIC classification as Opler et al. (1999) and Foley et al. (2007) does not change the inferences.

The model is estimated with pooled sample, i.e. using firms from both high-tech and non high-tech sectors. Such an approach suggests that firm characteristics should have the same impact across all firms.

[Insert Table 4 here]

The coefficient estimates obtained by ordinary least squares (OLS) regression, with/without year and industry fixed-effect, are reported in Table 4. The coefficient estimates are similar to those reported in the existing literature. Cash holdings is a positive function of a firm's growth opportunities (proxied by the R&D-to-sales ratio and the market-to-book ratio), its risk, and its profitability; and a negative function of the firm's size, its leverage, its net working capital, its capital expenditure, its acquisition expenditure, and whether it pays dividends or not. Notice that the inclusion of industry and year dummies leads only to a slight increase in the model's explanatory power as measured by the R-squared, from 45.3% to 47.8%.

In order to examine the robustness of these results to the existence of outliers and potential skewness, a median regression estimation procedure, based on minimizing the sum of absolute residuals, is also employed. The results reported in specification [3] of Table 4 are similar to the ones obtained using OLS. Finally, I also use the method designed in Fama and MacBeth (1973), where a cross-sectional regression is estimated for each year and the time series average of coefficient estimates is reported. The results from the Fama-MacBeth method are similar to OLS regression with industry and year dummies, except that the coefficient estimate of the industry sigma becomes insignificant.

Although the signs and significance of coefficients from the above regressions are consistent with literature, the results do not provide clear guidance on which determinants are relatively more important in explaining corporate cash holdings.[17] 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. For each determinant two values are reported: the percentage of the

[17] 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.

variation of the dependant variable that it explains (absolute value) and the percentage of the variation explained within the regression model (standardized value). A higher standardized or absolute value will indicate a more important variable.

The results, based on the basic regression without any dummy variable, are reported in Specification [5] of Table 4.[18] According to the standardized values, the largest contributors to the overall variation in the predicted cash holdings are leverage (around 34%), R&D intensity (around 29%), net working capital (around 12%), and market-to-book ratio (around 11%). The contribution from Industry-level cash flow volatility (IndustrySigma) is relatively small, just around 4%. However, this does not necessarily shake its role as a key proxy for precautionary motive to hold cash since the industry-level measure in general has less cross-sectional variation than those firm-level variables.

4.4 Changing Firms Characteristics in High-Tech and Non-High-Tech Sectors

A potential explanation for the increasing difference in cash holdings between high-tech and non-high-tech sectors is that the population of firms in high-tech sector, as triggered by new listings, has drifted towards a higher proportion of firms with characteristics such that holding more cash is desirable, whereas non-high-tech sector experienced a relatively modest shift. This section investigates the evolution of those fundamental characteristics related to cash policy.

Since the focus of analysis is how firm characteristics of the 1980s, 1990s, and 2000s cohorts differ from the earlier ones, firms that went public before 1980 are pooled together as a 'Pre-1980' cohort in each sector for the clarity of comparison. Furthermore, since corporate cash reserve may be piled up due to excess proceeds from lumpy equity and debt issues, which are more frequent right after an IPO, I further divide the observations in each cohort into seasoned firms (defined as those firms listed for more than five years) and recent IPOs (those within the first five years following IPOs). Table 5 reports the characteristics of the average firm from different cohorts in high-tech and non-high-tech sectors. The summary statistics are reported respectively for seasoned firms (Panel A) and recent IPOs (Panel B).[19]

[18] The relative importance results are obtained using the R package *relaimpo*, discussed in Grömping (2006).

[19] The table on seasoned firms does not include the 2000s cohorts since only those firms went public in 2001 and survived until 2006 can satisfy the requirement and the sample is very small. The table about Newly IPOs does not

[Insert Table 5 here]

In both high-tech and non-high-tech sectors, firms that went public in 1980-2006 are much smaller and hold more cash compared to firms in the Pre-1980 cohort. Moreover, recent IPOs are smaller and hold more cash than those seasoned firms within the same cohort. Bates et al. (2009) argue that increasing cash flow volatility is a major driving force for the observed trend in cash holdings. The analysis here shows that cash flow volatilities are always higher in high-tech sector than in non-high-tech sector, and they increase more quickly among the recent listing cohorts in high-tech sector.

Regarding the nature of investment policies, high-tech firms invest more in R&D than capital expenditures, whereas non-high-tech firms always behave in an opposite way[20]. Moreover, in both sectors, firms in the 1980s and 1990s cohorts experienced a decrease in their capital expenditures and an increase into their R&D spending compared to the pre-1980 cohort. These changes are particularly remarkable for high-tech sector. More specifically, although the high-tech pre-1980s cohort's spending on R&D was comparable to capital expenditures, average R&D spending of the 1990s cohort in high-tech sector has increased to almost four times the size of capital expenditures (mean R&D/TA=0.157 vs. mean CapEx/TA=0.038). Clearly, the importance of R&D has risen considerably in high-tech sector due to new listings in later cohorts.

Regarding financing policies, the cash flow of high-tech firms decreased over time since many firms with negative earnings went public in the 1980s and 1990s; meanwhile, cash flow of non-high-tech firms remains relatively stable. Concerning the sources of external financing, although new listings in both sectors prefer issuing equity than debt, equity financing plays a dominant role in high-tech sector, especially for those post-1980s cohorts. Moreover, when compared to seasoned firms within the same cohort, new IPOs tend to issue more equity than debt.

Table 5 also compares dividend policy and capital structure across different cohorts. In both sectors, more recent cohorts became less likely to pay dividends, which is consistent with the disappearing dividend phenomenon documented by Fama and French (2001). However, this

include Pre-1980s cohorts since only those firms that went public between 1976 and 1979 were still Newly IPOs at the beginning of sample period. Again the sample size is very small.

[20] R&D expense is scaled by total assets so as to facilitate the comparison with capital expenditure.

reluctance to pay dividends was much stronger in high-tech sector. Although book leverage stayed quite stable across different cohorts in non-high-tech sector, high-tech sector has experienced a decrease in leverage. Along with the increase in cash holdings from earlier cohorts to more recent cohorts, average net leverage have become negative in those post-1980 cohorts of high-tech sector. This is consistent with the plots in Figure 1, which shows that starting from 1990 a typical high-tech firm can repay all its debt with its cash reserve. Although the literature on cash policy tends to treat capital structure and dividend policies as the determinants of cash holdings, DeAngelo and DeAngelo (2007) propose a framework that these three policies are jointly determined so as to maintain investment flexibility in the face of uncertainty. Hence, the findings that more recent listing cohorts in high-tech sector have lower leverage, become less likely to pay dividends, and keep a higher level of cash holdings are consistent with each other.

4.5 Explaining the Difference in Cash Trends by Changing Firm Characteristics

The previous section shows that the characteristics of an average firm from high-tech sector have changed notably over the sample period, primarily due to those newly listed companies in the 1980s and 1990s. Following Bates et al. (2009) in assuming that the propensity to hold cash does not change over time and subsample, the question becomes whether the changing firm characteristics can explain the difference in cash holdings between high-tech and non-high-tech sectors. Moreover, can the changes in firm characteristics explain the difference in cash holdings across different cohorts in high-tech sector as depicted in Figure 4?

Following Bates et al. (2009), I first estimate a modified version of the cash holding model using the first ten years of data, i.e. the observations over the period from 1980 to 1989. Besides those determinants considered in Opler et al. (1999), the modified cash model includes net equity issuance and net debt issuance, since the proceedings of external financing tend to remain on the balance sheet for some time. The Fama and MacBeth (1973) procedure is applied for the estimation: a cross-sectional OLS regression is estimated year-by-year and the reported coefficients are the time series averages of annual estimates. The out-of-sample predictions of annual cash holdings for each firm are calculated for each year in 1990-2006. The deviation of actual cash holdings from predicted cash holdings by the modified model is also calculated.

[Insert Table 6 here]

Table 6 shows the predicted value, as well as the difference between actual and predicted cash holdings, for the whole sample, high-tech and non-high-tech sectors, and for different cohorts of seasoned firms in high-tech sector. The results for the whole sample, reported in Panel A, are close to Bates et al. (2009)'s findings: the modified cash model predicts the upward trends in the average cash-to-total assets ratio. Also similar to their finding, it overpredicts cash holdings in the 1990s and underpredicts in the 2000s.

The sample is then divided into high-tech and non-high-tech sectors according to the U.S. Dept. of Commerce definition. The predicted average cash holdings exhibit the upward trend for high-tech sector and the flat pattern for non-high-tech sector. However, the cash model persistently overpredicts the average cash holdings of non-high-tech firms by about 3% each year. Meanwhile, the model underpredicts the average cash holdings of high-tech firms and the level of underprediction increases over time, from 1.8% in 1991 to 9.4% in 2006. This increase might be attributed to the fact that a higher proportion of high-tech sample comes from new listings in the 1990s. Since firms tend to hold more cash over the first few years after IPO, the larger proportion of new IPOs may cause the underprediction.

Panel B reports the predicted cash ratios and their deviations from actual values for the seasoned firms from different cohorts in high-tech sector. It is evident that the modified cash model adequately predicts the relative levels of cash holdings across different cohorts documented in Figure 4, with the 1990s cohort holding more cash than the 1980s cohort, which in turn holds more cash than the Pre-1980 cohorts. A more interesting finding comes from the difference between actual and predicted cash ratios. In the 1990s, the cash model overpredicts cash ratios for the seasoned high-tech firms in the pre-1980 cohort but underpredicts cash ratios for the 1980s and 1990s cohorts. In the 2000s, the underprediction has become pervasive across all these listing cohorts, and the extents of underprediction increase with the chronological order of listing cohorts.

4.6 What Drove the Post-2000 Increase in Cash Holdings?

Figure 4 clearly shows that the increase in cash holdings has become a pervasive phenomenon across all listing cohorts in both high-tech and non-high-tech sectors. Especially, the fact that even those firms that went public before 1980 have increased their cash holdings in

the 2000s is quite intriguing. Table 5 shows that these firms have reached a mature stage in their life cycle, since they are large firms that generate positive and stable cash flows, possess positive retained earnings, and are more likely to pay dividends. This provides an initial insight that the driving force for the increase in cash holdings in the 2000s is different from the early period.

Furthermore, the analysis in Table 6 suggests that the increase in cash reserves in the 2000s cannot be completely explained by changes in firm characteristics triggered by new listings. Even in the whole sample, the cash model starts to underpredict cash holdings from 2001. Although this underprediction can be partially attributed to the newly listed firms from high-tech sector, a further check shows that the underprediction of the cash model for the seasoned high-tech firms, regardless of the listing cohorts, has become economically and statistically significant after 2000.

A potential explanation for this pervasive increase in cash holdings in the 2000s is the common response to a number of adverse macroeconomic shocks, such as a) the Nasdaq Composite Index falling sharply after reaching its peak in March 2000; b) the recession in 2001 and the 9/11 terrorist attach spreading the uncertainty across the whole economy. Bloom (2009) shows uncertainty seems to jump up after major economic and political shocks and higher uncertainty usually causes firms to "temporarily pause their investment and hiring".[21] Linking this to cash holding literature, Keynes (1936) argues that a precautionary motive, defined as the desire to hold cash as a cushion to hedge the risk of future cash shortfalls, influences a firm's cash policy to a great extent. Hence, these exogenous shocks have triggered firms, regardless of their maturity and affiliated industry, to protect and even increase their cash reserves for precautionary concerns. This explanation is also consistent with media coverage on the intriguing increase in cash holdings among S&P 500 firms since 2000.

In fact, the current economic crisis provides another natural experiment that has generated many examples in support of this precautionary motive of cash holding in the face of adverse macroeconomic shock. Firms have been taking different ways, such as cutting or suspending dividend payments, firing employees, and reducing or stopping capital expenditures and/or R&D spending, in order to preserve their cash reserve, and this is a pervasive phenomenon.

[21] The Federal Open Market Committee (FOMC) stated in October 2001 that "the events of September 11 produced a marked increase in uncertainty [...] depressing investment by fostering an increasingly widespread wait-and-see attitude" (cited from Bloom (2009)).

5 Conclusion

Following the finding in Bates, Kahle, and Stulz (2009) that the average cash holdings for U.S. industrial firms more than doubled from 1980 to 2006, this paper examines it in detail to establish whether the phenomenon is pervasive across all firms or just sector specific.

Using two industry-classification schemes – the Fama-French classification scheme and the Global Industry Classification Standard (GICS) – to subdivide the sample, I find that only firms from R&D-intensive industries on average exhibit an upward trend in their cash holdings. When a more rigorous standard designed by the U.S. Department of Commerce is taken to classify the sample into high-tech and non-high-tech sectors and a more detailed analysis is conducted, it is clear that the increase in cash holdings over the entire period occurred solely among firms in high-tech sector, whereas the average cash holdings of firms in non-high-tech sector remained quite flat until 2000.

This paper moves further to provide some potential explanations for the identified difference in the trends in cash holdings between high-tech and non-high-tech sectors. Before 2000, the difference was primarily driven by high-tech firms that went public later in the sample period. Compared to high-tech firms that went public before 1980 and those firms in non-high-tech sector, new listings in high-tech sector have very different operating and financial characteristics, which entail them to hold more cash. Since 2000, the increase in cash holdings has become a pervasive phenomenon across all the cohorts in both sectors. This phenomenon can barely be explained by changing firm characteristics. A rising precautionary motive in response to adverse macroeconomic shocks, i.e. dot-com bubble burst, the 9/11 terrorist attack, and 2001 recession, better address the pervasiveness of increasing cash holdings during post-2000 period.

In sum, the increase in cash holdings of U.S. industrials seems to be a reflection of the changing industry composition of U.S. public firms towards a knowledge-based economy, as well as the response to some market turbulence along this transformation.

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Table 1

Annual average and median cash and leverage ratios across all sample firms: 1980-2006

For each year, the table includes U.S. firms documented on the Compustat-CRSP merged database that have positive total assets and sales and have nonnegative cash and marketable securities. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 118,289 observations for 13,893 unique firms. The cash ratio is measured as the ratio of cash plus marketable securities (DATA 1), divided by the book value of total assets (DATA 6). Leverage is defined as the ratio of long-term debt (DATA 9) plus debt in current liabilities (DATA 34), divided by the book value of total assets. Net leverage is calculated as long-term debt plus debt in current liabilities minus cash and market securities, divided by total assets. Annual averages, including the book-value weighted average (VW-) and the equally-weighted average (EW-), and annual median of cash ratio, leverage, and net leverage across all firms are reported separately each year.

Year N	N	VW-Cash Ratio	EW-Cash Ratio	Median Cash Ratio	EW-Leverage	Median Leverage	EW-Net Leverage	Median Net Leverage
1980	3517	0.062	0.104	0.054	0.265	0.243	0.160	0.179
1981	3757	0.056	0.120	0.058	0.250	0.228	0.130	0.162
1982	3758	0.060	0.120	0.064	0.259	0.233	0.139	0.159
1983	4130	0.076	0.158	0.086	0.239	0.204	0.080	0.112
1984	4197	0.070	0.139	0.068	0.251	0.218	0.112	0.142
1985	4155	0.070	0.141	0.069	0.265	0.231	0.124	0.152
1986	4290	0.077	0.156	0.080	0.269	0.238	0.113	0.145
1987	4445	0.078	0.155	0.075	0.271	0.242	0.116	0.155
1988	4276	0.063	0.140	0.067	0.277	0.245	0.137	0.166
1989	4125	0.056	0.136	0.062	0.282	0.254	0.146	0.175
1990	4077	0.053	0.132	0.060	0.277	0.245	0.144	0.170
1991	4171	0.057	0.152	0.070	0.255	0.216	0.102	0.132
1992	4352	0.060	0.160	0.077	0.237	0.195	0.077	0.116
1993	4757	0.059	0.169	0.081	0.222	0.182	0.053	0.096
1994	5016	0.058	0.154	0.069	0.225	0.188	0.071	0.108
1995	5216	0.060	0.168	0.071	0.226	0.189	0.058	0.110
1996	5630	0.065	0.189	0.084	0.218	0.172	0.029	0.082
1997	5647	0.067	0.188	0.087	0.230	0.182	0.042	0.089
1998	5311	0.066	0.176	0.072	0.252	0.207	0.077	0.122
1999	5083	0.075	0.197	0.077	0.241	0.197	0.045	0.104
2000	4968	0.073	0.205	0.085	0.232	0.176	0.027	0.078
2001	4510	0.079	0.212	0.106	0.235	0.173	0.024	0.064
2002	4163	0.090	0.212	0.114	0.228	0.172	0.018	0.055
2003	3900	0.103	0.226	0.133	0.213	0.160	-0.011	0.016
2004	3839	0.112	0.235	0.144	0.199	0.145	-0.035	0.000
2005	3724	0.110	0.235	0.147	0.199	0.137	-0.035	-0.003
2006	3275	0.103	0.231	0.133	0.203	0.144	-0.025	0.014

Table 2

Trends in Cash Holdings: Industry Analysis

This table reports the trends in cash holdings of industry groups defined independently by the Fama-French 12 industry classification (Panel A), the Global Industry Classification Standard (GICS) (Panel B), and the U.S. Department of Commerce definitions of high-tech sector (Panel C). The sample includes U.S. firms documented on the Compustat-CRSP merged database that have positive total assets and sales and have nonnegative cash and marketable securities. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 118,289 observations for 13,893 unique firms. Firms are independently split into industry groups according to different classification criteria. The detailed comparison between the Fama-French Business Equipment and Healthcare industry groups and the U.S. Dept. of Commerce definition of high-tech industries is in Appendix A. The cash-to-total assets ratio (Cash/TA) is measured as cash plus marketable securities (DATA 1), divided by book value of total assets (DATA 6). Annual median, equally-weighted average, 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 the whole sample and for each industry group separately.

Panel A: the Fama-French 12 Industry Groups

	Cash/TA_EW			Cash/TA_Median			Cash/TA_VW		
	slope	Pvalue	R-Sq	slope	Pvalue	R-Sq	slope	Pvalue	R-Sq
All	0.45%	<.0001	0.89	0.27%	<.0001	0.64	0.14%	<0.001	0.43
BusEq	**0.87%**	**<.0001**	**0.88**	**1.05%**	**<.0001**	**0.89**	**0.74%**	**<.0001**	**0.85**
Chems	0.03%	0.499	0.02	-0.07%	0.066	0.13	0.02%	0.408	0.03
Durbl	0.04%	0.344	0.04	0.01%	0.727	0.00	0.05%	0.511	0.02
Enrgy	-0.22%	<.0001	0.51	-0.10%	0.001	0.36	-0.05%	0.237	0.06
Hlth	**0.90%**	**<.0001**	**0.85**	**1.06%**	**<.0001**	**0.83**	**0.28%**	**<.0001**	**0.49**
Manuf	0.07%	0.024	0.19	0.01%	0.673	0.01	0.01%	0.643	0.01
NoDur	0.01%	0.789	0.00	-0.02%	0.572	0.01	-0.06%	0.025	0.18
Shops	0.02%	0.590	0.01	-0.02%	0.461	0.02	0.08%	0.026	0.18
Telcm	0.21%	0.000	0.40	0.17%	<.0001	0.63	0.08%	<.0001	0.48
other	0.12%	0.001	0.35	0.05%	0.166	0.08	-0.06%	0.121	0.09

Panel B: the GICS Economic Sectors

Description	Cash/TA_EW			Cash/TA_Median			Cash/TA_VW		
(GICS Economic Sector)	slope	Pvalue	R-sq	slope	Pvalue	R-sq	slope	Pvalue	R-sq
Energy (10)	-0.21%	<.0001	0.52	-0.10%	0.001	0.36	-0.05%	0.247	0.05
Materials (15)	-0.09%	0.009	0.24	-0.07%	0.014	0.22	0.02%	0.375	0.03
Industrial (20)	0.02%	0.619	0.01	-0.01%	0.700	0.01	-0.10%	0.001	0.35
Consumer discretionary (25)	0.08%	0.010	0.24	0.04%	0.232	0.06	0.02%	0.525	0.02
Consumer staples (30)	-0.06%	0.108	0.10	-0.05%	0.054	0.14	-0.08%	0.006	0.26
Health care (35)	**0.79%**	**<.0001**	**0.81**	**0.90%**	**<.0001**	**0.81**	**0.24%**	**<.0001**	**0.48**
Financials (40)	0.02%	0.874	0.00	0.14%	0.182	0.07	-0.65%	0.090	0.11
Information technology (45)	**0.86%**	**<.0001**	**0.88**	**1.05%**	**<.0001**	**0.89**	**0.80%**	**<.0001**	**0.88**
Telecommunications (50)	0.33%	<.0001	0.60	0.33%	<.0001	0.77	0.13%	<.0001	0.52
Utilities (55)	-0.05%	0.473	0.02	-0.11%	0.163	0.08	0.09%	0.233	0.06

Panel C: BusEq and Hlth (by Fama-French) vs. High-Tech Sector (by U.S. Dept. of Commerce)

BusEq and Hlth a la FF12	High-Tech a la US Dept. of Commerce	No of Obs.	Cash/TA		Trends in Cash Holdings			
					Cash/TA_Mean		Cash/TA_Median	
			Mean	Median	slope	p-value	slope	p-value
no	no	79305	0.116	0.052	0.05%	0.043	0.01%	0.688
yes	no	4123	0.153	0.078	0.02%	0.696	-0.01%	0.898
yes	yes	34861	**0.300**	**0.235**	**0.97%**	**<.0001**	**1.16%**	**<.0001**

Table 3

Changing Industry Composition

This table reports the annual number of firms (Panel A) and aggregate book assets (Panel B) in high-tech and non-high-tech sectors in four selected years – 1980, 1990, 2000, and 2006. The sample includes U.S. firms documented on the Compustat-CRSP merged database that have positive total assets and sales and have nonnegative cash and marketable securities. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 118,289 observations for 13,893 unique firms. High-tech and non-high-tech sectors are defined according to the U.S. Department of Commerce. Annual numbers of firms of subgroups are reported in Panel A. Panel B reports the aggregate book assets (in 2006 dollars; reported in billions of dollars) of all firms by subgroup. The proportions (in percentage) of high-tech sector in annual sample are reported respectively.

Panel A: Annual number of firms

	1980	1990	2000	2006
Non-High-Tech	2957	2997	3088	2080
High-Tech	560	1080	1880	1195
Total	3517	4077	4968	3275
High-Tech (%)	15.92%	26.49%	37.84%	36.49%

Panel B: Annual Aggregate book assets (in 2006 dollars; reported in billions of dollars)

	1980	1990	2000	2006
Non-High-Tech	3833.7	4943.6	7953.2	8343.2
High-Tech	343.7	627.7	1808.4	1839
Total	4177.4	5571.3	9761.6	10182.3
High-Tech (%)	8.23%	11.27%	18.53%	18.06%

Table 4

Regression Models Predicting the Normal Cash Holdings

This table reports the estimates of a model of corporate cash holdings. The sample includes nonfinancial and nonutility U.S. firms documented on the Compustat-CRSP merged database that have positive total assets and sales and have nonnegative cash and marketable securities. Missing explanatory values reduce the panel data used here to 100,894 firm-year observations for 13,063 unique firms. Specifications [1] and [2] use OLS regression to estimate coefficients, without/with dummy variables for industry and year. Standard errors are clustered by firm. Adjusted R^2 is reported. Specification [3] uses median regression with dummy variables for industry and year. Pseudo- R^2 is reported. In Specification [4], the coefficients and standard errors are estimated using the Fama-MacBeth method (1973). Industries are defined according to the Fama-French 49 industries. T-statistics are reported in specifications [1]-[4]. Specification [5] reports the relative importance of the different firm characteristics in the linear model of corporate cash holdings (without industry or year dummy). The relative importance of the explanatory variables 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).

$$\frac{Cash_{it}}{TA_{it}} = \beta_0 + \beta_1 \cdot (IndustrySigma)_{it} + \beta_2 \cdot MB_{it} + \beta_3 \cdot size_{it} + \beta_4 \cdot \frac{CF_{it}}{TA_{it}} + \beta_5 \cdot \frac{NWC_{it}}{TA_{it}} +$$
$$+\beta_6 \cdot \frac{CAPEX_{it}}{TA_{it}} + \beta_7 \cdot Leverage_{it} + \beta_8 \cdot \frac{R\&D_{it}}{Sales_{it}} + \beta_9 \cdot DivDummy_{it} + \beta_{10} \cdot \frac{ACQN_{it}}{TA_{it}}$$
$$+YearDummies + IndustryDummies + \varepsilon_{it}$$

	[1]		[2]		[3]		[4]		[5]	
	OLS Regressions without dummy variables for industry or year		OLS Regressions with dummy variables for industry and year		Median Regression with dummy variables for industry and year		Fama-MacBeth Regression with dummy variables for industry		Relative Importance of explanatory variables (without dummies)	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Absolute	Standardized
IndustrySigma	0.345	15.47	0.154	5.61	0.121	11.25	0.051	1.22	2%	4%
MB	0.018	27.57	0.015	22.64	0.019	87.62	0.013	14.13	5%	11%
Size	-0.006	-9.33	-0.005	-8.35	-0.005	-20.35	-0.007	-7.98	1%	1%
CF/TA	0.009	1.79	0.02	3.77	0.014	6.77	0.026	4.76	0%	0%
NWC/TA	-0.217	-39.34	-0.235	-37.77	-0.145	-70.49	-0.235	-34.22	5%	12%
Capex/TA	-0.356	-31.43	-0.309	-26.62	-0.173	-33.85	-0.338	-18.92	2%	4%
Leverage	-0.361	-62.62	-0.348	-59.65	-0.227	-126.82	-0.345	-49	15%	34%
R&D/Sales	0.061	39.34	0.052	31.08	0.072	147.86	0.05	39.56	13%	29%
DivDummy	-0.042	-17.44	-0.034	-13.87	-0.017	-18.82	-0.034	-15.5	2%	4%
ACQN/TA	-0.222	-27.45	-0.216	-26.28	-0.094	-15.52	-0.215	-11.15	0%	1%
Constant	0.268	50.06								
Obs.	100894		100894		100894		100894			
Adj R-squared	0.4532		0.4781		0.2456		0.4754		0.4532	

Table 5

Firm Characteristics by Listing Cohorts

This table reports the characteristics of firms in different listing cohorts in high-tech and non-high-tech sectors. Based on the year of going public, firms are sorted into the following groups: pre-1980 (listed before 1980), 1980s (listed from 1980 to 1989), 1990s (listed from 1990 to 2000), and 2000s (listed from 2001 to 2006). Panel A compares the seasoned firms (listed at least five years) in 1980s and 1990s cohorts with Pre-1980 listings. Panel B compares characteristics of newly IPOs (during the first five years after IPO) in 1980s, 1990s, and 2000s cohorts. Details on variable construction are given in Appendix B.

Panel A: Seasoned Firms

		Non-High-Tech			High-Tech		
		Pre-1980s	1980s	1990s	Pre-1980s	1980s	1990s
Cash/TA	Mean	0.092	0.112	0.122	0.144	0.254	0.371
	Median	0.048	0.050	0.055	0.092	0.196	0.341
Total Assets	Mean	3188.9	1234.5	1339.5	2230.8	556.4	571.6
(2006$ million)	Median	308.3	116.6	278.7	120.8	50.5	85.6
MB	Mean	1.417	1.717	1.819	1.896	2.599	2.952
	Median	1.189	1.292	1.386	1.457	1.778	2.169
IndustrySigma	Mean	0.067	0.088	0.092	0.097	0.130	0.177
	Median	0.056	0.074	0.077	0.088	0.120	0.173
NWC_TA	Mean	0.146	0.092	0.062	0.208	0.119	0.005
	Median	0.143	0.087	0.057	0.217	0.131	0.008
R&D/sales	Mean	0.012	0.039	0.066	0.078	0.362	0.757
	Median	0	0	0	0.052	0.093	0.149
R&D/TA	Mean	0.010	0.015	0.016	0.070	0.125	0.157
	Median	0	0	0	0.056	0.091	0.113
CapEx/TA	Mean	0.070	0.072	0.065	0.062	0.050	0.038
	Median	0.052	0.045	0.040	0.048	0.036	0.024
ACQN/TA	Mean	0.016	0.019	0.024	0.015	0.016	0.021
	Median	0	0	0	0	0	0
CF/TA	Mean	0.049	0.029	0.031	0.045	-0.034	-0.125
	Median	0.064	0.064	0.069	0.074	0.055	0.008
NetEiss	Mean	0.004	0.027	0.020	0.020	0.062	0.082
	Median	0	0.000	0.001	0.001	0.005	0.010
NetDiss	Mean	0.006	0.008	0.012	0.005	0.005	0.012
	Median	-0.001	0	0	-0.001	0	0
DivDummy	Mean	0.624	0.282	0.183	0.396	0.116	0.041
	Median	1	0	0	0	0	0
Leverage	Mean	0.268	0.282	0.288	0.206	0.166	0.143
	Median	0.248	0.254	0.245	0.165	0.084	0.037
Net Leverage	Mean	0.176	0.169	0.166	0.062	-0.087	-0.225
	Median	0.190	0.192	0.183	0.069	-0.098	-0.249
RE/TA	Mean	0.171	-0.244	-0.396	0.021	-0.815	-1.912
	Median	0.280	0.102	0.071	0.264	0.013	-0.635
N		34346	13151	9027	7161	7467	5593

Panel B: Newly IPOs (1st through 5th year following IPO)

		Non-High-Tech			High-Tech		
		1980s	1990s	2000s	1980s	1990s	2000s
Cash/TA	Mean	0.153	0.150	0.155	0.277	0.424	0.495
	Median	0.070	0.061	0.069	0.213	0.416	0.514
Total Assets	Mean	388.6	751.2	2108.7	77.7	244.0	323.3
(2006$ million)	Median	37.5	119.7	445.5	21.1	60.3	104.0
MB	Mean	2.156	2.095	2.357	3.042	3.463	3.484
	Median	1.472	1.533	1.700	2.103	2.505	2.744
IndustrySigma	Mean	0.069	0.086	0.101	0.088	0.153	0.188
	Median	0.062	0.071	0.088	0.086	0.145	0.191
NWC_TA	Mean	0.068	0.068	0.024	0.144	0.027	-0.007
	Median	0.058	0.051	0.007	0.163	0.021	-0.012
RD/sales	Mean	0.091	0.100	0.101	0.459	0.824	1.222
	Median	0	0	0	0.088	0.167	0.178
RD/TA	Mean	0.017	0.020	0.012	0.115	0.158	0.160
	Median	0	0	0	0.080	0.116	0.109
CapEx/TA	Mean	0.110	0.086	0.081	0.077	0.056	0.038
	Median	0.067	0.052	0.044	0.054	0.038	0.023
ACQN/TA	Mean	0.021	0.035	0.038	0.011	0.019	0.025
	Median	0	0	0	0	0	0
CF/TA	Mean	-0.032	-0.010	0.016	-0.116	-0.163	-0.169
	Median	0.038	0.055	0.066	0.022	-0.035	-0.012
NetEiss	Mean	0.129	0.139	0.117	0.205	0.251	0.267
	Median	0.001	0.003	0.006	0.015	0.031	0.068
NetDiss	Mean	0.026	0.019	0.004	0.013	0.004	0.002
	Median	0	0	0	0	0	0
DivDummy	Mean	0.178	0.137	0.227	0.056	0.029	0.033
	Median	0	0	0	0	0	0
Leverage	Mean	0.288	0.274	0.266	0.181	0.110	0.090
	Median	0.261	0.240	0.231	0.107	0.022	0.010
Net Leverage	Mean	0.135	0.123	0.111	-0.096	-0.312	-0.403
	Median	0.170	0.169	0.151	-0.093	-0.362	-0.455
RE/TA	Mean	-0.247	-0.328	-0.345	-0.541	-1.175	-1.110
	Median	0.045	0.001	-0.006	-0.024	-0.365	-0.528
N		11017	13430	1520	4815	8667	806

Table 6

Predicted Cash Holdings due to Changing Characteristics

This table reports the predicted cash ratios and the difference between actual and predicted cash ratios in the whole sample and various subsamples over 1990-2006. Using all observations over the period 1980 to 1989, the coefficients of a cash holding model are estimated by Fama-MacBeth method, i.e. the average coefficients from annual cross-sectional regressions. With changing firm characteristics over 1990-2006, for each firm, predicted cash ratio = **0.317**-**0.325***ACQN/TA+**0.091***CF/TA-**0.449***CapEx/TA-**0.022*** DivDummy -**0.355***Leverage + **0.006***MB-**0.251*** NWC/TA+**0.249***NetDiss+ **0.190*** NetEiss+**0.045***RD/Sales +**0.170*** IndustrySigma -**0.009***size. Details on variable construction are given in Appendix B. In each year during 1990-2006 period, besides the out of sample prediction, Panel A reports the average deviations of the actual cash ratios from predicted cash holdings for the whole sample (N= 65392 firm-year observations), for high-tech sector (N= 20670 firm-year observations), and for non-high-tech sector (N= 44722 firm-year observations). Panel B reports the average predicted value and deviations of seasoned firms from different listing cohorts in high-tech sector, including pre-1980 cohort (N= 2882 firm-year observations), 1980s cohort (N= 5317 firm-year observations), and 1990s cohort (N= 4469 firm-year observations). T-statistics summarize the statistical significance of the deviations of the actual cash ratios from predicted cash holdings in each year for the whole sample and each of the subsamples respectively.

Panel A: Whole Sample, Non-High-Tech Sector, and High-Tech Sector

	Whole Sample			Non-High-Tech Sector			High-Tech Sector		
Year	predicted	Actual-predicted	t-statistic	predicted	Actual - predicted	t-statistic	predicted	Actual - predicted	t-statistic
1990	0.148	-0.016	-7.06	0.130	-0.025	-9.85	0.199	0.006	1.15
1991	0.170	-0.018	-7.81	0.145	-0.031	-12.88	0.233	0.018	3.48
1992	0.175	-0.017	-7.25	0.149	-0.033	-13.86	0.242	0.026	4.91
1993	0.183	-0.015	-6.50	0.155	-0.034	-15.06	0.256	0.036	6.78
1994	0.172	-0.023	-10.78	0.145	-0.042	-20.37	0.246	0.029	5.62
1995	0.178	-0.019	-8.65	0.143	-0.041	-19.38	0.265	0.037	7.43
1996	0.189	-0.009	-4.30	0.148	-0.035	-16.47	0.284	0.049	10.15
1997	0.178	0.000	0.16	0.136	-0.028	-12.86	0.269	0.061	11.92
1998	0.162	0.001	0.45	0.121	-0.025	-10.97	0.252	0.057	10.95
1999	0.183	-0.003	-1.13	0.131	-0.030	-12.79	0.288	0.052	10.00
2000	0.190	-0.001	-0.28	0.135	-0.032	-12.51	0.291	0.056	10.67
2001	0.183	0.012	4.08	0.137	-0.029	-10.83	0.266	0.086	14.35
2002	0.189	0.007	2.50	0.143	-0.032	-11.68	0.272	0.079	12.91
2003	0.204	0.008	2.79	0.153	-0.029	-10.16	0.296	0.075	12.75
2004	0.211	0.013	4.36	0.159	-0.025	-8.84	0.304	0.079	13.62
2005	0.206	0.016	5.53	0.157	-0.023	-8.17	0.293	0.087	14.56
2006	0.199	0.018	5.68	0.149	-0.022	-7.48	0.294	0.094	13.95

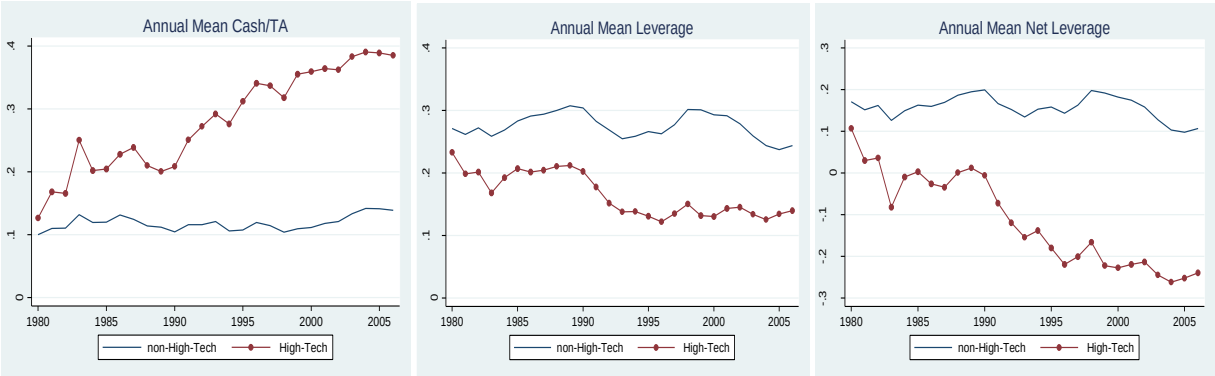
Panel B: Seasoned Firms from Different Cohorts in High-Tech Sector

	Seasoned High-Tech Firms in pre-1980 cohort			Seasoned High-Tech Firms in 1980s cohort			Seasoned High-Tech Firms in 1990s cohort		
Year	predicted	actual-predicted	t-statistic	predicted	actual-predicted	t-statistic	predicted	actual-predicted	t-statistic
1990	0.140	-0.009	-1.21	0.193	-0.005	-0.57			
1991	0.152	-0.020	-2.78	0.216	0.011	1.42			
1992	0.156	-0.014	-1.69	0.220	0.012	1.62			
1993	0.160	-0.019	-2.18	0.224	0.016	1.95			
1994	0.163	-0.031	-3.61	0.222	0.015	1.86			
1995	0.163	-0.028	-3.41	0.235	0.014	1.79	0.274	0.025	0.94
1996	0.167	-0.023	-2.74	0.240	0.015	1.76	0.293	0.081	4.01
1997	0.160	-0.010	-1.12	0.225	0.025	2.67	0.266	0.053	3.88
1998	0.152	-0.014	-1.55	0.217	0.022	2.38	0.258	0.067	5.06
1999	0.163	-0.019	-2.07	0.232	0.027	2.64	0.266	0.054	4.20
2000	0.171	-0.013	-1.22	0.239	0.017	1.57	0.283	0.047	4.20
2001	0.167	0.022	1.91	0.230	0.040	3.12	0.283	0.069	6.58
2002	0.192	0.017	1.24	0.234	0.059	4.41	0.282	0.069	7.04
2003	0.204	0.019	1.42	0.249	0.054	4.16	0.311	0.070	7.67
2004	0.201	0.036	2.63	0.258	0.061	4.46	0.306	0.070	8.34
2005	0.203	0.056	3.99	0.250	0.070	4.79	0.299	0.089	11.14
2006	0.191	0.059	3.28	0.261	0.054	3.06	0.290	0.093	10.22

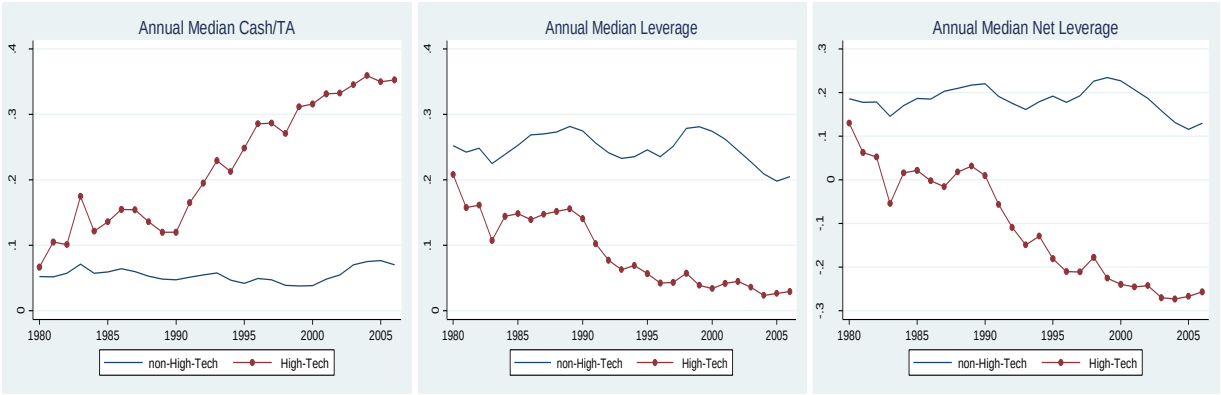
Figure 1
Trends in Cash Ratio, Leverage, and Net Leverage: High-Tech vs. Non-High-Tech Sectors

These figures depict the annual mean, median, and value-weighted average (based on annual book assets) in the cash ratio, leverage ratio, and net leverage ratio of high-tech and non-high-tech sectors. High-tech and non-high-tech sectors are defined according to the U.S. Department of Commerce. In each year, the sample includes nonfinancial and nonutility U.S. firms documented on the Compustat-CRSP merged database that have positive total assets and sales and have nonnegative cash and marketable securities. The cash-to-total assets ratio (Cash/TA) is measured as cash plus marketable securities (DATA 1), divided by book value of total assets (DATA 6). Leverage ratio is defined as the ratio of long-term debt (DATA 9) plus debt in current liabilities (DATA 34), divided by book value of total assets. Net leverage is calculated as long-term debt plus debt in current liabilities minus cash and market securities, divided by book value of total assets.

Panel A: Annual Mean



Panel B: Annual Median



Panel C: Annual Value-Weighted Average

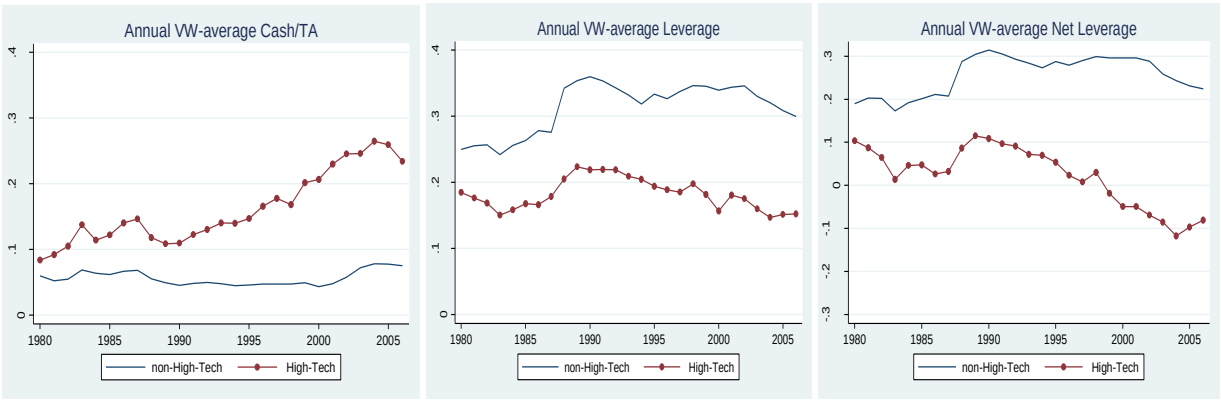
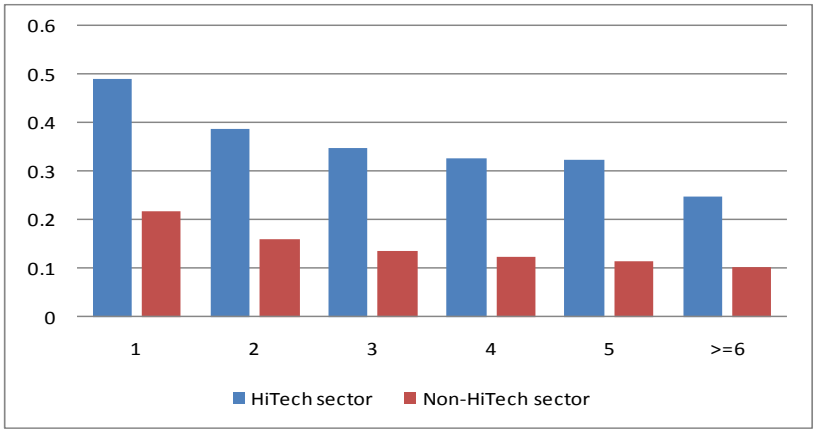


Figure 2

Mean and Median Cash Ratios over Years after IPO: High-Tech vs. Non-High-Tech Sectors

This figure depicts the change in average cash holdings over the years following IPOs in high-tech and non-high-tech sectors. The sample includes U.S. firms documented on the Compustat-CRSP merged database that have positive total assets and sales and have nonnegative cash and marketable securities. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 118,289 observations for 13,893 unique firms. High-tech and non-high-tech sectors are defined according to the U.S. Department of Commerce. Observations from high-tech and non-high-tech sectors are grouped respectively according to the fiscal years relative to their IPO dates. Jay Ritter's proprietary database of IPO dates 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. These figures depict the mean (Panel A) and median (Panel B) of cash-to-assets ratios of these subsamples. The cash-to-total assets ratio (Cash/TA) is measured as cash plus marketable securities (DATA 1), divided by book value of total assets (DATA 6).

Panel A: Mean Cash/TA



Panel B: Median Cash/TA

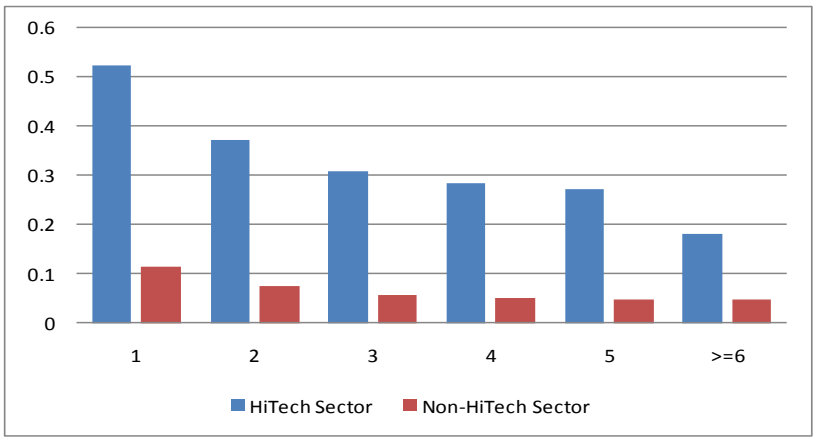


Figure 3

Trends in Cash Ratios of New IPO firms and Seasoned Firms: High-Tech vs. Non-High-Tech Sectors

This figure plots the trends in cash holdings, annual mean and median, of IPO firms and seasoned firms in high-tech and non-high-tech sectors. High-Tech firms are defined according to the U.S. Dept. of Commerce. Observations of 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-total assets ratio (Cash/TA) is measured as cash plus marketable securities (DATA 1), divided by book value of total assets (DATA 6). The sample includes U.S. firms documented on the Compustat-CRSP merged database that have positive total assets and sales and have nonnegative cash and marketable securities. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 118,289 observations for 13,893 unique firms.

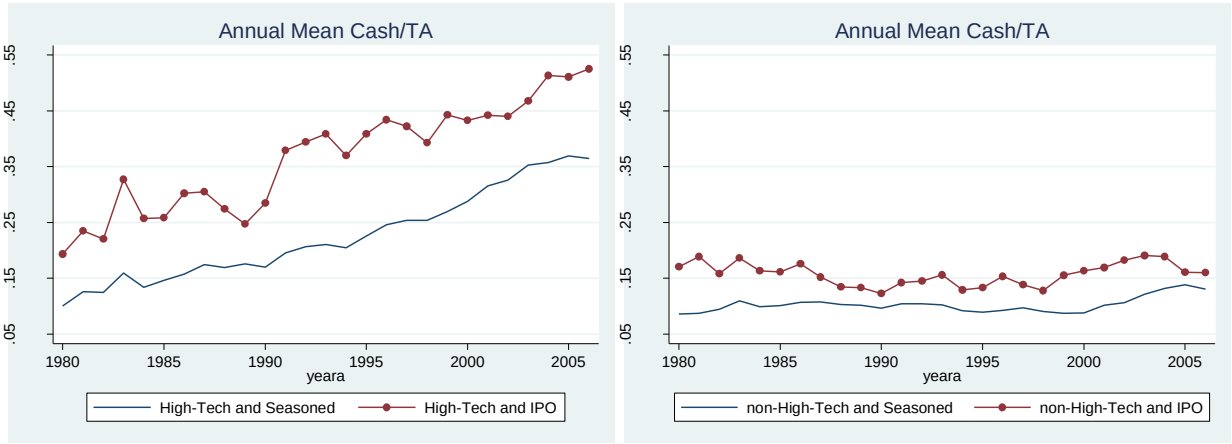
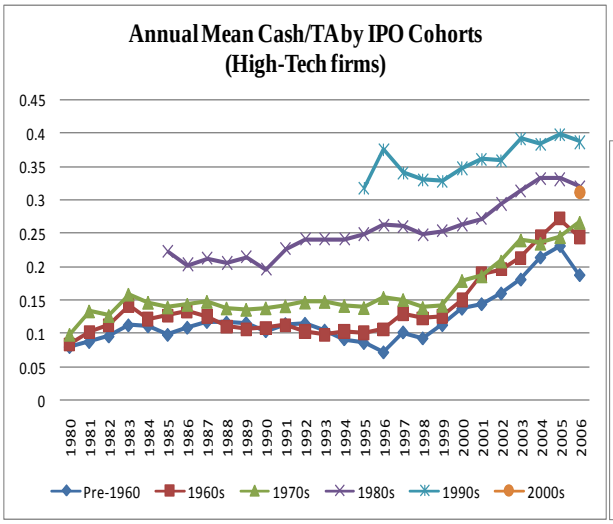


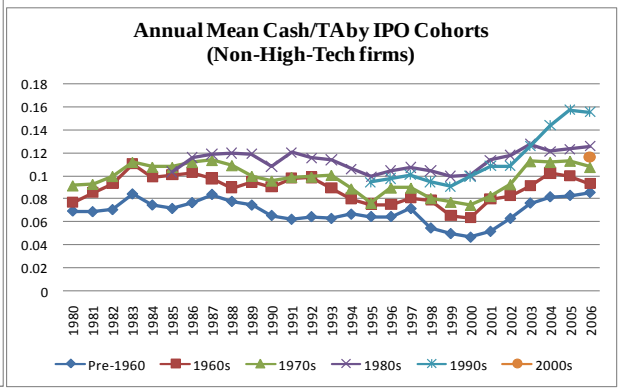
Figure 4

Trends in Average Cash Ratio by IPO cohorts: High-Tech vs. non-High-Tech Sectors

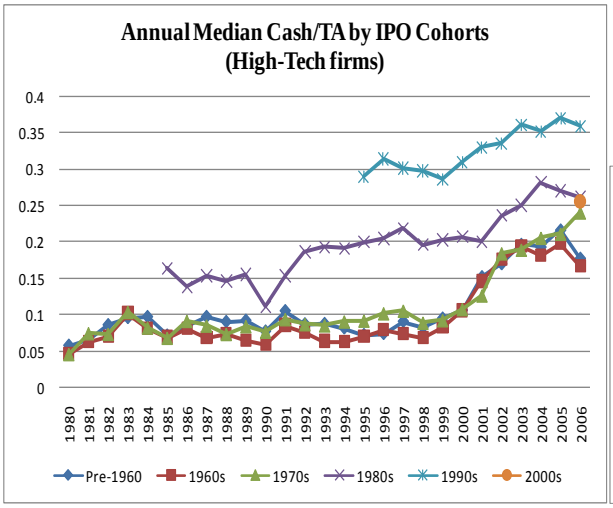
This figure depicts the annual average Cash/TA for seasoned firms sorted into cohorts based on their year of listing, i.e. pre-1960 (listed before 1960), 1960s (listed from 1960 to 1969), 1970s (listed from 1970 to 1979), 1980s (listed from 1980 to 1989), 1990s (listed from 1990 to 2000), and 2000s (listed from 2001 to 2006). The cash ratio of each firm is estimated beginning in the sixth year after the listing date. High-Tech firms are defined according to the U.S. Dept. of Commerce. Panel A reports the annual mean of Cash/TA for each cohort in high-tech and non-high-tech sectors respectively. Panel B reports the annual median of Cash/TA for each cohort in high-tech and non-high-tech sectors respectively. High-Tech firms are defined according to the U.S. Department of Commerce. The cash-to-total assets ratio (Cash/TA) is measured as cash plus marketable securities (DATA 1), divided by book value of total assets (DATA 6). The sample includes U.S. firms documented on the Compustat-CRSP merged database that have positive total assets and sales and have nonnegative cash and marketable securities. Financial firms (SIC code 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the sample, leaving an unbalanced panel of 118,289 observations for 13,893 unique firms.

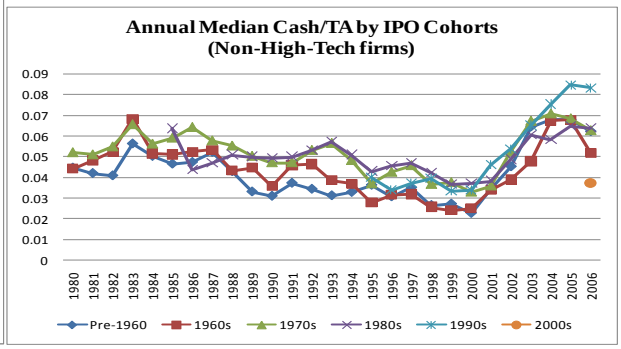
Panel A: Annual Mean





Panel B: Annual Median





Appendix A

Table A1 compares the Business Equipment and Healthcare industry groups by the Fama-French 12 industry classification with the high-tech industries categorized by the United States Department of Commerce criteria. Panel A shows the allocation of SIC codes according to these two standards. Obviously, besides the SIC codes contained in the high-tech industries according to the U.S. Dept. of Commerce criteria, the Fama-French classification includes several additional industries, such as miscellaneous electrical machinery (SIC 369), Ophthalmic Goods Manufacturing (SIC 385), Health Services (SIC 8000-8099) and etc. Some of these extra industries are less likely to be R&D intensive.

To investigate their R&D intensity, I sort the sample independently according to whether the firms locate in the Fama-French Business Equipment and Healthcare industries or whether they belong to high-tech industries defined by the U.S. Dept. of Commerce. Panel B shows that 34,861 firm-year observations belong to both the Dept. of Commerce high-tech industries and Business Equipment and Healthcare categories, while 4,123 firm-year observations belong to Business Equipment and Healthcare industries but do not belong to the Dept. of Commerce high-tech industries. Furthermore, the R&D intensity of these 4,123 firm-year observations is much lower than those of high-tech industries, regardless of the proxies for R&D intensity.

In sum, the comparison in Table A1 justifies the soundness of using high-tech industries defined by the U.S. Dept. of Commerce in this study.

Table A1

High-Tech industries: Fama-French vs. U.S. Department of Commerce

This table compares Business Equipment and Healthcare industry groups defined by the Fama-French industry classification and the high-tech industries categorized the U.S. Dept. of Commerce. Panel A shows the allocation of SIC codes according to these two standards. Panel B exhibits the distribution of sample observations according to these two classification methodologies, as well as the average R&D intensity of each group. Three measures of R&D intensity are applied for each firm-year observation: the ratios of R&D expenditure to total assets, the ratios of R&D expenditure to sales, and the ratios of R&D expenditure to net assets. Mean and median R&D intensity are reported for each sub-sample respectively.

Panel A: Definitions of BusEq and Hlth of the Fama-French 12 industry groups, and the High-Tech industries defined by the US Department of Commerce

Fama-French12 industry groups	SIC range
BusEq (Computers, Software, and Electronic Equipment)	3570-3579
	3660-3692
	3694-3699
	3810-3829
	7370-7379
Hlth (Healthcare, Medical Equipment, and Drugs)	2830-2839
	3693-3693
	3840-3859
	8000-8099

High-Tech industries – US Dept. of Commerce	3-digit SIC
office and computing equipment	357
communications equipment	366
electronic components	367
scientific instruments	382
software	737
drugs	283
medical instruments	384

Panel B: Sample Distribution and R&D Intensity according to Two Classification Methodologies

BusEq and Hlth a la FF 12	HiTech a la US Dept. of Commerce	No of obs	R&D/TA		R&D/Sales		R&D/NA	
			Mean	Median	Mean	Median	Mean	Median
no	no	79305	0.014	0	0.046	0	0.024	0
yes	no	4123	0.026	0	0.092	0	0.042	0
yes	yes	34861	0.126	0.087	0.513	0.096	0.293	0.123

Appendix B

Variable Definitions[22]

Size	Size is measured with the logarithm of book assets (DATA 6) that is converted to 2006 dollars using the Consumer Price Index.
Capital expenditures (Capex/TA)	Capex/TA is the ratio of Capital expenditures (DATA128) to total assets (DATA6).
R&D Expense (R&D/Sales)	R&D/Sales is the ratio of R&D expenditure (DATA 46) to Sales (DATA 12). If R&D expenditure (DATA 46) is missing, I follow the tradition to set the missing value to zero.
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 (DATA6) minus book value of common equity (DATA60) plus the market value of common equity (price (DATA199) times shares outstanding (DATA25)).
Acquisition (ACQN/ TA)	ACQN/NA is the ratio of Acquisitions (DATA129) to total assets (DATA6).
Cash flow over assets (CF/TA)	Cash flow is equal to operating income (DATA13) minus interest (DATA15), taxes (DATA16), and common dividends (DATA21), and then divided by total assets (DATA6).
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 median of cash flow standard deviations of firms in the same industry, defined by 2-digit SIC code.
Net working capital (NWC/ TA)	NWC/NA is the ratio of working capital (DATA4-DATA5) minus cash and marketable securities (DATA1) to total assets (DATA6).
Leverage	Leverage is the ratio of long-term debt (DATA9) plus debt in current liabilities (DATA34) to total assets (DATA6).
Dividend payer (DivDummy)	Dividend payer dummy is set to one if a common dividend (DATA21) is positive; else equal to zero.
Net equity issuance (NetEiss)	Net equity issuance is equal to the sale of common and preferred stock (data108) minus the purchase of common and preferred stock (data115), scaled by total assets (DATA6).
Net debt issuance (NetDiss)	Net debt issuance is equal to long-term debt issuance (data111) minus long-term debt reduction (data114), scaled by total assets (DATA6).
Retained earnings (RE/TA)	RE/TA is the ratio of retained earnings(36) to total assets(6).
IPO date	Jay Ritter's proprietary database of IPO dates (http://bear.cba.ufl.edu/ritter/ FoundingDates.htm) 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.

[22] Compustat Industrial Annual Data Items are provided in parentheses.