Cyclicality of Growth Opportunities and the Value of Cash Holdings

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Abstract

This paper shows that business cycle dynamics and, in particular, the cyclicality of a firm's growth opportunities, are important determinants of the value of corporate cash holdings. We find that cash is more valuable for firms with relatively more attractive growth opportunities in bad states of the business cycle. Cash holdings provide the financial flexibility to invest even in times when capital supply is relatively scarce. This valuation effect is strongest for firms with low financial leverage and high R&D spending. For firms, where changes in cash holdings exert a stronger effect on stock returns, cash holdings also have a stronger relation with net investment and operating performance.

Keywords: Business cycle, cash holdings, value of cash, growth opportunities

JEL Classification Codes: G30, G32

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This paper shows that business cycle dynamics and, in particular, the cyclicality of a firm's growth opportunities, are important determinants of the value of corporate cash holdings. We find that cash is more valuable for firms with relatively more attractive growth opportunities in bad states of the business cycle. Cash holdings provide the financial flexibility to invest even in times when capital supply is relatively scarce. This valuation effect is strongest for firms with low financial leverage and high R&D spending. For firms, where changes in cash holdings exert a stronger effect on stock returns, cash holdings also have a stronger relation with net investment and operating performance.

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1. Introduction

Business cycle downturns are associated with worsening economic conditions for firms such as a drop in sales and restrictions in the supply of external capital. The recent financial crisis is an example of this relation (Duchin, Ozbas, and Sensoy, 2010; Kahle and Stulz, 2013). Already earlier periods of economic contraction came along with difficulties to raise external funds, even for firms with attractive growth opportunities during crisis times (Bernanke and Blinder, 1988; Bernanke, Lown, and Friedman, 1991; Campello, Graham, and Harvey, 2010; Eisfeldt and Muir, 2015). To attenuate these supply-side financial constraints, managers may accumulate cash and hedge for the risk of future cash shortfalls, particularly during economic downturns. Another argument is that high cash holdings are manifestations of agency problems in firms where managers use cash for perquisite consumption and undertake value-decreasing acquisitions (Jensen, 1986; Harford, 1999; Harford, Mansi, and Maxwell, 2008). Opposing this “agency costs” motive, Kim, Mauer, and Shermann (1998), Opler et al. (1999), and Mikkelson and Partch (2003) find that cash holdings are not harmful to firm performance if they are used to reduce a firm’s underinvestment problems and to fully exploit its growth opportunities. Almeida, Campello, and Weisbach (2004) analyze the use of cash to mitigate dependence on external finance and find that, unlike unconstrained firms, constrained firms tend to save a larger fraction of internal cash flow during recessions. Han and Qiu (2007) show that it is optimal for constrained firms to hold higher cash reserves in response to an increase in cash flow volatility in order to enhance the firm’s ability to undertake future investment. Therefore, the “precautionary” motive of holding cash suggests that cash is a valuable source of investment funding, and this should all the more be the case if firms have attractive growth opportunities during times with worsening economic conditions.

In this study, we contribute a business cycle-related perspective to the debate about the effect cash holdings have on firm valuation and investment decisions, thereby enhancing our understanding about why cash is valued differently across firms. We document that business cycle dynamics and, in particular, the cyclicality of a firm's growth opportunities are important determinants of how valuable cash holdings are for firms. Cash holdings create a higher value for firms with relatively more attractive growth opportunities in bad states of the economy because external financing becomes more costly during crisis times. This benefit of cash holdings for firms with less cyclical growth opportunities creates a novel motive for precautionary savings that is incremental to those already identified in prior studies. In addition, we find that higher cash holdings in firms with less cyclical growth opportunities are associated with higher investment activities and better operating performance.

Figure 1 illustrates our economic intuition. Assume that, under the presence of market frictions, the cost of external finance is time varying (Eisfeldt and Muir, 2015). In particular, the cost of external finance is high in bad times, and low in good times. Firm A exhibits a low cyclicality of growth opportunities and needs cash in bad states, exactly when raising external funds is costly. Firm B is the opposite; it has a high cyclicality of growth opportunities and requires financing in good states when it either has sufficient cash flow or the cost of external finance is low. Thus, compared to firm B, cash holdings should be more valuable in firm A. Moreover, investment and operating performance should be more sensitive to cash holdings in firm A than in firm B. Our results support these predictions.

[Insert Figure 1 here]

The analysis is based on the hypothesis that, when external financing becomes extremely costly, cash is no longer merely "negative debt" for firms that have valuable growth opportunities in bad states of the economy. For example, firms that can finance their investments internally may attempt to gain additional market share by increasing investment expenditures at times when changes in industry conditions force their rivals to underinvest. Bolton and Scharfstein (1990), Froot, Scharfstein, and Stein (1993), and Haushalter, Klasa, and Maxwell (2007) analyze cash holdings as a means to avoid "predation risk", i.e., the risk of underinvestment leading to a loss of investment opportunities and market share to (entering) product rivals.[1] Froot (1992) reports that the pile of cash in Intel's war chest had grown so much in the 1990s that the company could have easily funded its investment plans for the next two years only with cash. Intel's management defended this cash policy by emphasizing the important role of cash as a source of financial flexibility to successfully compete in the product markets, and that this financial flexibility was particularly valuable during bad times.

Cash should be particularly important as a source of funding for investments that require persistence and are smoothed over a long time horizon, but for which external finance is difficult to obtain, such as R&D expenditure (Brown, Fazzari, and Petersen, 2009; Brown and Petersen, 2011).[2] Bates, Kahle, and Stulz (2009) and Falato, Kadyrzhanova, and Sim (2013) show that both high-tech and R&D-intensive firms hold more cash than "old-economy" manufacturing firms, thus explaining a large part of the secular increase in cash holdings.[3] In line with these empirical patterns, the positive valuation effect for cash holdings we find for firms with low cyclicality of growth opportunities is most pronounced for the subsample of firms with high R&D expenses.

In our empirical analysis, we study the relation between the value of cash, the business cycle, and the cyclicality of growth opportunities using a sample of U.S. firms at the intersection of Compustat and CRSP between 1968 and 2012. To analyze how the business cycle dependence of a firm's growth opportunities affects the value of its cash holding, we build on Arnold, Hackbarth, and Puhan (2014). They proxy for the degree of cyclicality of a firm's growth opportunities by correlating the

[1] Froot, Scharfstein, and Stein (1993) show that corporate derivatives usage can protect firms from underinvestment during industry- or market-wide downturns (see also Adam, Dasgupta, and Titman, 2007). Our findings refine the argument in Opler et al. (1999), Mikkelson and Partch (2003), Almeida, Campello, and Weisbach (2004), and Acharya, Almeida, and Campello (2007) that cash holdings provide firms with similar benefits.

[2] Foley et al. (2007) suggest an alternative explanation for high R&D firms to hold more cash. U.S. multinationals, many of which are R&D intensive, have a strong incentive to retain cash in foreign subsidiaries because of the tax costs associated with repatriating foreign income. Recently, Pinkowitz, Stulz, and Williamson (2012) challenge this view.

[3] Azar, Kagy, and Schmalz (2015) suggest that the current U.S. corporate cash holdings are not abnormal in a historical comparison but can be explained by the secular decrease in the "cost of carry" (defined as the spread between the Treasury Bill rate and the return on the corporate sector's liquid assets portfolio).

firm's individual Tobin's Q over a five-year rolling window with aggregate sales growth across all firms in their sample. Tobin's Q captures a firm's individual growth opportunities, while aggregate sales growth reflects the state of the business cycle (Opler and Titman, 1994; Carvalho and Grassi, 2015). The intuition for our correlation measure is that a relatively lower (higher) correlation indicates that the firm's growth opportunities are relatively less (more) cyclical.

Following the methodology in Faulkender and Wang (2006), we regress firms' excess stock returns on changes in cash (and other variables) and find that for firms with less cyclical growth opportunities (or low correlation firms) changes in cash holdings are associated with higher excess stock returns. This valuation effect is most pronounced for low correlation firms when coupled with lower leverage, smaller size, and higher R&D spending. In addition, the association between the cyclicality of a firm's growth opportunities and the value-enhancing effect of cash holdings is stronger in bad business cycle states. This valuation effect in bad economic states is not driven by firms in financial distress. Moreover, we find that for firms with a stronger relation between changes in cash holdings and stock returns, higher cash holdings have a stronger positive effect on net investment and operating performance. One of our robustness tests reveals that shareholders in firms with poor corporate governance extract negative value from holding cash due to higher agency costs, but this effect is at least partially resolved in bad business cycle states, when cash becomes more valuable even for these firms. However, corporate governance does not play a pivotal role in our analysis of the relation between the cyclicality of growth opportunities and the value of cash.

Taken together, firms with a low cyclicality of growth opportunities benefit and extract an additional amount of value from cash holdings due to their higher financial flexibility to invest and exploit their growth opportunities, particularly in times with scarce external supply of capital. While all firms are affected by a supply-side financing shock, their ability to extract value from cash evolves differently over the business cycle, depending on the cyclicality of a firm's growth opportunities. This valuation effect is strongest for firms with high R&D spending due to higher adjustment costs compared to physical investment.

Prior studies such as Kim, Mauer, and Shermann (1998), Opler et al. (1999), Faulkender and Wang (2006), and Han and Qiu (2007) examine determinants and valuation implications of the cross-sectional variation of cash holdings.[4] Our paper contributes a business cycle-related perspective to the debate about 1) which firms and 2) why some firms value cash more. The study of Acharya, Almeida, and Campello (2007) is closest to our work. In their model, a firm can choose between higher cash holdings and higher debt capacity to be able to undertake investment opportunities. However, with uncertainty about future cash flows, cash and (negative) debt have different functions in the optimization of financially constrained firms' investment. Acharya, Almeida, and Campello (2007) find that constrained firms with high hedging needs (i.e., investment opportunities arise when cash flows are low) save cash rather than pay down debt since cash balances allow them to transfer resources into states with low cash flows. Constrained firms with a high correlation between the presence of investment opportunities and high cash flows (and low hedging needs) pay down debt rather than save cash.

In contrast to Acharya, Almeida, and Campello (2007), our analysis does not focus on a firm's choice between higher cash holdings and lower debt. We are interested in the impact of the business cycle and difficulties in the supply of external capital on the value of cash and, in particular, in the relation between different degrees of cyclicality of growth opportunities and the value of cash. While there is no systematic relation between hedging needs and either of the two (cash vs. debt) cash flow sensitivities for unconstrained firms in Acharya, Almeida, and Campello (2007)'s study, our valuation effects of cash holdings are independent of the firm's financial status and hold for both constrained and unconstrained firms. For either group of firms, a higher debt capacity does not help increase funding capacity in bad business cycle states. In contrast, cash balances transfer financial resources into

[4] See Denis (2011) for a comprehensive overview on the literature on corporate cash holdings.

bad business cycle states with supply-side financial frictions. Cash is more valuable for all firms with hedging needs that emanate from a low correlation between the firm's growth opportunities and the aggregate business cycle and thus represent systematic risk.

Our study is also related to Palazzo (2012). In his model, managers can finance investment with retained earnings or equity but face a source of aggregate risk. The optimal cash holding policy solves a trade-off between the choice to distribute dividends in the current period or to save cash and thus avoid costly external financing in the future. Riskier firms (i.e., firms with a high correlation between cash flow and the aggregate shock) have the highest hedging needs because they are more likely to experience a cash flow shortfall in those states in which they need external financing the most. Rather than measuring the value of cash for firms with different hedging needs, he analyzes the asset pricing implications of cash holdings and systematic risk, i.e., the relation between the firm's precautionary savings, its correlation between cash flows and an aggregate source of risk, and equity risk premia. Most important, he finds a positive correlation between cash holdings and expected equity returns.[5]

Another study that is akin to our analysis is Denis and Sibilkov (2010). They show that cash is relatively more valuable in market terms for constrained firms since it enables them to undertake profitable investments, which they might not be able to undertake otherwise due to restricted or excessively costly access to capital markets. Conditional on the extent of interdependence with rivals, Haushalter, Klasa, and Maxwell (2007) show that a firm's investment behavior depends on its cash holdings and the predation risks it faces. Therefore, our study complements both Denis and Sibilkov's (2010) and Haushalter, Klasa, and Maxwell's (2007) findings by highlighting the impact of the cyclicality of a firm's growth opportunities on the value that the firm can extract from its cash holdings.

[5] In a related study, Simutin (2010) also finds that firms with high excess cash holdings are more exposed to systematic risk and earn a significant excess return over firms with low excess cash holdings.

Finally, since the valuation effects on cash attributable to the cyclicality of growth opportunities are most pronounced for firms with high R&D spending, our findings are also consistent with the idea that cash has a strategic role (rather than only a precautionary one). There is an evolving literature on the importance of cash in innovative industries with high product market competition, suggesting that cash is a "commitment device" for the implementation of successful innovation (Schroth and Szalay, 2010; Frèsard, 2010; Ma, Mello, and Wu, 2014; Lyandres and Pallazzo, 2014).

The remainder of our study is structured as follows: Section II describes the data and presents univariate analyses to motivate our hypotheses. Section III shows our main empirical results. We start by estimating the relation between the cyclicality of a firm's growth opportunities and the value of its cash holdings. We proceed by analyzing the effect of cash holdings on investment activities and operating performance. Section IV contains robustness tests, such as an analysis of the sensitivity of annual stock returns to cash holdings. Section V concludes and discusses further directions of research.

2. Data and univariate analyses

2.1. Sample and descriptive statistics

The sample we use for our analyses comes from CRSP North America merged with the Compustat annual files and includes the years 1968 to 2012. Following Faulkender and Wang (2006), all data are measured in 2001 USD terms using the consumer price index (CPI). We exclude financial (SIC codes 6000–6999) and utility (SIC codes 4910–4939) firms as well as firm-years with negative values in net assets, market equity, or dividends. These data cleaning steps result in a sample of 131,855 firm-year observations, which can vary over different subsamples. All variables are winsorized at the 1% and 99% level.

Table 1 provides summary statistics of our sample. Panel A shows all variables used in the value of cash regressions following the Faulkender and Wang (2006) specification. The dependent variable in this model is excess stock return. Excess stock return is computed as a firm's annual stock return (over the fiscal year) minus the return on a benchmark portfolio. Benchmark portfolios are the twenty-five Fama-French value-weighted portfolios. Changes in independent variables are the differences in value from the previous to the current year. Most important, cash is cash and short term equivalents. The change in cash has a slightly positive mean of 0.44%, and a median of 0%. These small values indicate a relatively symmetric distribution of cash changes.

Earnings are calculated as earnings before extraordinary items plus interest, deferred income taxes and investment tax credit. Net assets are total assets minus cash and short term equivalents. Leverage is defined as the market debt ratio, calculated as total debt over the sum of total debt and the market value of equity. Net financing is measured as total equity issuance minus repurchases plus debt issuance minus debt redemption. Investments in research and development are set to zero if missing in the sample. Additional variables included are common dividends and interest expense. All variables are scaled by lagged market equity (except leverage).

[Insert Table 1 here]

Panel B of Table I summarizes the variables used in our investment regressions, which are based on Kim, Mauer, and Shermann (1998) and Denis and Sibilkov's (2010) multi-equation specification. Net investment is calculated as capital expenditures and investments in research and development minus depreciation scaled by total assets; it has a mean of 5.47%, and a lower median of only 3.24%. Cash is defined as the level of cash and short-term equivalents scaled by total assets; the cash to total assets ratio shows a right-skewed distribution with a mean of 14.39%, and a median of 7.43%. Cash flow is the operating cash flow, calculated as earnings before interest, taxes, depreciation, and amortization divided by sales. Mean and median cash flow do not differ considerably with values of 11.85% and 11.14%, respectively. Market-to-book is the ratio of market equity to book equity. The prior change in sales is calculated as the log of the change in sales over the previous two years. Book leverage is total long-term debt and debt in current liabilities scaled by total assets. Firm size is the logarithm of total assets. Industry cash flow volatility is measured as the median of the firm-level standard deviation of the first differences in earnings before interest, taxes, depreciation, and amortization over the prior twenty years. The cash cycle duration is calculated as the average inventory age plus average collection period minus average payment period. The Z-score is based on Altman (1968). The return spread is earnings before interest and taxes scaled by total assets minus the annualized T-bill return over the fiscal year. Finally, the change in industry production is calculated as the logarithm of sales growth over the previous year on SIC2-industry level.

2.2. Measuring the cyclicality of growth opportunities

To measure the cyclicality of growth opportunities, we follow Arnold, Hackbarth, and Puhan (2014). They analyze the interaction of the cyclicality of growth opportunities with a firm's decision to use asset sales instead of equity to fund their investment activities. In our context, we compute a correlation measure by estimating five-year rolling window correlations between a firm's Tobin's Q and the lagged aggregate sales growth across all firms in our sample. Tobin's Q is defined as the sum of long-term debt, short-term debt, and market equity divided by total assets. To control for industry effects, we scale firm-level Q by the SIC3-industry average Tobin's Q.

The intuition for this novel correlation measure is that it captures whether a firm's growth opportunities move in line with the aggregate business cycle. A relatively low or even negative correlation of a firm's growth opportunities (Tobin's Q) with the business cycle (measured as aggregate sales growth) indicates that this firm exhibits less cyclical growth opportunities and benefits from relatively more valuable investment opportunities in bad economic states (i.e., a relatively high Tobin's Q accompanied by low aggregate sales growth) compared to other firms.[6] On the contrary, firms with a high correlation of their growth opportunities with aggregate sales growth tend to be more cyclical in their investment behavior.

Figure 2 illustrates the distribution of our correlation measure, denoted as *Corr*. Most important, it includes a large number of firms with a low cyclicality of growth opportunities (low correlation firms as opposed to high correlation firms). Table 1 confirms the wide-spread distribution of our correlation measure, with the values of *Corr* ranging from –0.98 to +0.99. The mean (median) correlation is 0.05 (0.06), i.e., both values are close to zero.

[Insert Figure 2 here]

2.3. Univariate analysis: Theory

Next, we examine differences in firm characteristics between firms with different degrees of cyclicality of their growth opportunities. Our choice of firm characteristics is based on Acharya, Almeida, and Campello (2007). In particular, we use leverage, cash holdings, Tobin's Q, Altman's (1968) Z-score, and cash flow. In a first step, we sort all firms according to our correlation variable, i.e., the correlation of a firm's growth opportunities with aggregate sales growth. In a second step, we assign all firms into buckets of correlation measure values of size 0.4, resulting in five groups for correlation measures between +1 and –1, and compare firm characteristics across these buckets (or groups of firms). This approach is implemented for the full sample and for subsamples of firms, based on firm characteristics that are likely to be related to the cyclicality of growth opportunities and thus to potential explanations why some firms consider cash holdings more valuable.

[6] Opler and Titman (1994) and Carvalho and Grassi (2015) also use aggregate sales growth as a proxy for the business cycle.

Our first variable of interest is leverage. Based on Faulkender and Wang (2006), we expect that firms, for which cash is extremely valuable, have lower leverage. In highly leveraged firms, a small increase in cash goes largely to increasing debt value, not equity value. This ‘option theory’ (Merton, 1973) also predicts that the value of an additional dollar of cash to equity holders increases as leverage declines. Firms with low leverage tend to share similar characteristics. For example, as shown in Frank and Goyal (2009), they are likely to be younger and smaller, operate in innovative industries (such as high tech), or entail more intangible assets (such as R&D). Hall (2002) and Brown, Fazzari, and Petersen (2009) also show that firms with high R&D investments have lower leverage. Their high cash flow volatility increases the opaqueness of R&D investments, thereby aggravating the problems from adverse selection and moral hazard in industries with high R&D-intensity, such as the high tech industry (Stiglitz and Weiss, 1981; Stiglitz, 1985; Brown, Fazzari, and Petersen, 2009). Accordingly, these firms suffer from severe external financing constraints. Another related problem of raising debt finance for firms with high R&D expenditures is that their market value strongly depends on expected future growth, but, due to high cash flow volatility, these firms slip more easily into problems of financial distress (Cornell and Shapiro, 1988).

Another attribute of R&D investments is that they are associated with higher adjustment costs than physical investment. They grow persistently over time and are smoothed over the business cycle (Brown, Fazzari, and Petersen, 2009), and thus we expect that high R&D firms exhibit a low level of cyclicality in their growth opportunities. Furthermore, Brown and Petersen (2011) show that particularly young, high tech firms turn to internal equity (cash reserves) to buffer R&D activities against temporary negative finance (or supply-side) shocks. If firms with a low cyclicality of growth opportunities are more dependent on cash and assign a higher value on the marginal dollar of cash to avoid underinvestment problems during bad states, this effect should also be reflected in a higher level of cash holdings.

Tobin's Q serves as our proxy for investment opportunities. We include it to examine whether firms with less cyclical growth opportunities (low correlation firms), on average, have better investment opportunities than high correlation firms. We further add Altman's (1968) Z-score to assure that firms with low cyclicality of growth opportunities, such as high R&D firms, are not financially distressed. Financially distressed firms have different incentives with respect to cash holdings and investment behavior than financially healthy firms, and thus it is important to verify that financial distress does not affect our results. Finally, we include cash flow. However, among firms with different cyclicality of growth opportunities, there should be no specific reason for cash flows to vary.

2.4. Univariate analysis: Results

Table 2 summarizes the results of our univariate tests. Using *t*-tests for differences in means, full sample results in panel A indicate that the means for leverage, cash holdings, and Tobin's Q in the first bin (lowest correlation measure) are significantly different from the means in the fifth bin (highest correlation measure). However, the patterns are not always clear across the other bins. The tests support our notion that firms with different degrees of cyclicality have indiscernible cash flows; the corresponding *t*-statistic is insignificant. Univariate tests further indicate that financial distress is not a driver of our results. Just the opposite, low correlation firms have a significantly higher Z-score than high correlation firms.

Panels B-E in Table 2 summarize the results for different subsamples. First, we sort firms according to their R&D investments. Subsample 1 in panel B includes firms with high R&D expenses (top 25% of R&D expenses to total assets ratio), while subsample 2 contains all other firms (bottom 75% of R&D expenses to total assets ratio). First, high R&D firms exhibit a significantly lower level of cyclicality in their growth opportunities than other firms; the mean (median) correlations are 0.038 (0.033) and 0.046 (0.062), respectively (not shown in panel B). These univariate differences are statistically significant at the 10% (5%) level. Second, confirming earlier results of Hall (2002) and Brown, Fazzari, and Petersen (2009), high R&D firms have significantly lower leverage than low R&D firms, as indicated by a *t*-test for differences in means across groups. In addition, in both subsamples, low correlation firms exhibit lower leverage than high correlation firms, indicating that low correlation firms with their relatively attractive growth opportunities throughout all business cycle states finance investments with equity rather than debt. Third, high R&D firms hold higher levels of cash than low R&D firms. In both subsamples, the mean difference for the extreme bins (low minus high correlation firms) is not statistically significant. Across all bins, the relation between cyclicality and the level of cash holdings shows no clear pattern.[7] Fourth, Tobin's Q across subsamples and correlation buckets shows two effects. On the one hand, among high R&D firms, low correlation firms exhibit a higher Tobin's Q than high correlation firms. On the other hand, high R&D firms generally feature a higher Tobin's Q than low R&D firms. Finally, the mean-comparison tests for the Z-score indicate that low correlation firms are financially healthier (with a higher Z-score) than high correlation firms in both subsamples of high and low R&D firms. Comparing Z-scores across subsamples, there is a tendency of a higher Z-score for high R&D firms than for lower R&D firms. The test statistic is not significant, however, indicating that the level of financial distress does not play a significant role for our results.

[Insert Table 2 here]

In panel C, we focus on young firms versus old firms. Following Brown, Fazzari, and Petersen (2009), we classify young firms as fourteen years old or younger, and old firms as fifteen years old or older. As already shown, firms with a low correlation measure tend to be high R&D and low leverage firms. Young firms with a low correlation measure have lower leverage than high correlation firms, but the reverse is true for old firms. However, leverage is generally higher among young firms. These

[7] The theoretical predictions are ambiguous. On the one hand, firms with a relatively low cyclicality of growth opportunities need liquidity to fund their investments when the business cycle is in a bad state and external funding is hard to obtain. Hoarding cash is one way to avoid underinvestment problems during bad states. On the other hand, less cyclical growth opportunities could result in lower cash holdings. These firms may not be able to pile up cash because they (have to) spend it on growth opportunities in lack of external financing opportunities. As a result, both effects are possible.

findings indicate that our results should not only be driven by young firms, but to a large extent are also influenced by old firms. We further observe that among both old and young firms low correlation firms are the ones with a higher Tobin's Q, while young firms in general have a higher Tobin's Q compared to old firms. Finally, the results for the Z-score indicate that young firms have higher Z-scores than old firms, and that low correlation firms have higher Z-scores than high correlation firms. The mean-comparison tests are not statistically significant, again supporting our notion that financial distress is not an important correlate for firms with less cyclical growth opportunities.

Size is another firm characteristic that could be systematically correlated with the cyclicality of firms' growth opportunities. According to Hennessy and Whited (2007), size is strongly related to the level of a firm's financial constraints. Based on earlier studies (Rajan and Zingales, 1995; Opler et al., 1999), we expect smaller firms to have lower leverage, higher cash holdings, and a higher Tobin's Q than larger firms. However, the pattern that low correlation firms exhibit lower leverage, higher cash holdings, and better investment opportunities than high correlation firms should hold for both small and large firms, and it should not be attributable to the degree of a firm's (demand-side) financial constraints. One way to capture financial constraints that are related to size and age is the size-age-index (SA-index).[8] Hadlock and Pierce (2010) show that the SA-index depends primarily on firm size (as measured by total assets). Based on the SA-index, we construct two subsamples in panel D. One subsample contains large firms (observations with an SA-index in the top 25% of its distribution), and the other subsample small firms (all other observations). As expected, whereas large firms have a higher leverage than small firms, small firms have higher cash holdings and a higher Tobin's Q than large firms. Most importantly, regardless of their size, low correlation firms still have lower leverage and higher Tobin's Q than high correlation firms. For cash holdings, the patterns across bins are not

[8] Following Hadlock and Pierce (2010), the SA-index is computed as: $-0.737\times Size + 0.043\times Size^2 - 0.040\times Age$. Other studies support the view that the variables from which the index is computed, size and age, capture the level of financial constraints (Hennessy and Whited, 2007; Fee, Hadlock, and Pierce, 2009). Firm size and age are also often viewed as proxy variables for information asymmetry measures (Leary and Roberts, 2010).

conclusive (although the difference between the two extreme bins is statistically significant for high SA-index firms). The test statistic for the Z-score indicates that low correlation firms are financially healthier than high correlation firms in both subsamples of large and small firms. Comparing the Z-scores across the two subsamples, the difference is insignificant.

In a final step, we split our sample into years with a good or a bad economic state. Our main prediction is that cyclicality matters, rather than the pure fact that the economy is in a good or a bad state. Therefore, we expect that the patterns documented so far do not change across states. In panel E, the first subsample includes all bad state observations (with mean sales growth in the lowest 25% of its distribution), and the second subsample contains all years in a good state (all years not categorized as bad state). We observe that low correlation firms have a significantly higher Tobin's Q than high correlation firms in good economic states. In bad economic states, the difference in Tobin's Q is insignificant, arguably because growth opportunities are generally scarce during crisis times. Leverage is again lower for low correlation firms in both states of the world. The patterns for cash holdings are again not conclusive. While the test statistic for the Z-score reveals that firms in bad states exhibit a lower Z-score, the overall level of the Z-score is relatively high in bad states. Most importantly, firms with relatively less cyclical growth opportunities still tend to be the ones with better financial health (higher Z-score) in both subsamples.

3. Main empirical results

Our univariate analysis suggests that R&D, leverage, size, and the state of the business cycle are potential determinants of the relationship between a firm's cyclicality of growth opportunities and the value of its cash holdings. In this section, we implement multivariate regression tests to analyze whether these factors have an impact on the value of cash and, in particular, to examine the relevance of the cyclicality of growth opportunities on the value that firms with these characteristics can extract from its cash holdings.

3.1. Cyclicality of growth and the value of cash: Empirical framework

We base our methodology on Faulkender and Wang (2006), who test how changes in a firm's cash level affect excess stock returns. Our dependent variable, excess stock return, is the stock return of firm *i* over the fiscal year minus firm *i*'s benchmark portfolio return over the fiscal year. To assign a benchmark portfolio return to firm *i* in year *t*, we use the twenty-five Fama and French benchmark portfolios and the corresponding size and book-to-market breakpoints from Kenneth French's web-site.[9] We regress the excess stock return on the change in cash during the year and other firm characteristics as control variables. Since all variables are scaled by lagged market equity, the estimate for the change in cash represents the change in a firm's market value resulting from a one dollar change in cash. To incorporate our cyclicality measure into the model, we add an interaction term between our correlation measure and the change in cash. Accordingly, our baseline regression specification is:

$$(1) \qquad r_{i,t}^{E} = \alpha_0 + \alpha_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \alpha_2 Corr_{i,t} + \alpha_3 \frac{\Delta C_{i,t} \times Corr_{i,t}}{M_{i,t-1}} + \alpha_4 \frac{C_{i,t-1} \times \Delta C_{i,t}}{M_{i,t-1}} + \alpha_5 \frac{L_{i,t} \times \Delta C_{i,t}}{M_{i,t-1}} + \alpha_6 L_{i,t} +$$

$$+ \alpha_7 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \alpha_8 \frac{\Delta NA_{i,t}}{M_{i,t-1}} + \alpha_9 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \alpha_{10} \frac{\Delta I_{i,t}}{M_{i,t-1}} + \alpha_{11} \frac{\Delta D_{i,t}}{M_{i,t-1}} + \alpha_{12} \frac{C_{i,t-1}}{M_{i,t-1}} + \alpha_{13} \frac{NF_{i,t}}{M_{i,t-1}} + \epsilon_{i,t}$$

The dependent variable in equation (1) is the excess stock return, $r^{E}_{i,t}$, defined as the individual stock return, $r_{i,t}$, of firm *i* over the fiscal year *t* minus the benchmark portfolio return of firm *i* over the fiscal year *t*. The independent variables are firm characteristics, where Δ is the change over the previous year. $C_{i,t}$ is cash holdings, $Corr_{i,t}$ is our correlation measure, $L_{i,t}$ is market leverage, $E_{i,t}$ is earnings, $NA_{i,t}$ is net assets, $RD_{i,t}$ is investments in research and development, $I_{i,t}$ is interest expenses, $D_{i,t}$ is common dividends, and $NF_{i,t}$ is net financing.

[9] See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#HistBenchmarks. In robustness tests, we use stock returns in excess of the risk-free rate as the dependent variable and include two additional control variables for size and book-to-market. Our results (not reported) are robust to this specification.

In the most parsimonious specification (without interaction terms), the estimated coefficient for changes in cash, α_1, is the value shareholders put on an additional dollar of cash. The coefficient that is most interesting in the baseline specification is α_3, which is the estimate for the interaction between the change in cash and our proxy for the cyclicality of growth opportunities ($\Delta C_{i,t} \times Corr_{i,t}$). We expect a negative coefficient on this interaction term. Our hypothesis follows the intuition that low correlation firms have relatively more attractive investment opportunities in bad times (with scarce capital supply) and should thus place more value on cash holdings than high correlation firms, i.e., firms with relatively less attractive investment opportunities in bad times.

To be consistent with Faulkender and Wang (2006), we add the interaction terms $C_{i,t-1} \times \Delta C_{i,t}$ and $L_{i,t} \times \Delta C_{i,t}$ to capture the effects of different levels of cash holdings and leverage on the value of cash, respectively. The more cash a firm already holds, the less valuable one extra dollar of cash should be. If the marginal value of cash is decreasing in the amount of cash the firm has, the coefficient α_4 is expected to be negative. A similar intuition holds for the interaction between leverage and the change in cash. As firms have more leverage, less of the value created by the presence of extra cash should accrue to shareholders. Therefore, the coefficient α_5 is also expected to be negative. Our control variables are market leverage ($L_{i,t}$), the change in earnings ($\Delta E_{i,t}$), the change in net assets ($\Delta NA_{i,t}$), the change in R&D investments ($\Delta RD_{i,t}$), the change in interest payments ($\Delta I_{i,t}$), the change in dividends ($\Delta D_{i,t}$), cash holdings from the previous year ($C_{i,t-1}$), and net financing ($NF_{i,t}$). The effects of these variables are expected to be in line with Faulkender and Wang (2006); they report positive estimates for all these variables, except the change in interest payments.

To test whether the relation between the cyclicality of growth opportunities and the value of cash is dependent on the firm characteristics identified in our univariate analysis (see Section 2), we test several extended model specifications. As already discussed, firms with lower leverage tend to be smaller with many intangible assets and high R&D investments, and it is optimal for them to carry low leverage due to higher bankruptcy costs. Therefore, we incorporate the level of leverage to the interaction between changes in cash and the cyclicality of growth opportunities, resulting in the triple interaction term $\Delta C_{i,t} \times Corr_{i,t} \times L_{i,t}$. We expect a positive coefficient, thus firms with less cyclical growth opportunities and lower leverage exhibit a higher value of cash.

The choice to operate with a low level of leverage might also be driven by prohibitively high costs of external finance. Therefore, we consider the impact of firm size and age, because larger and older firms arguably face lower (demand-side) financial constraints and benefit from lower costs of external finance. We include the triple interaction term $\Delta C_{i,t} \times Corr_{i,t} \times SA_{i,t}$, involving the change in cash, the cyclicality of growth opportunities, and the SA-index. If lower firm size and lower age contribute to an increasing valuation effect of cash holdings for firms with less cyclical growth opportunities, the coefficient of this interaction term should be positive.[10]

An important question is what type of firms tend to exhibit a relatively low level of leverage, are relatively younger, smaller, possibly financially constrained, and have less cyclical growth opportunities. Brown, Fazzari, and Petersen (2009) and Brown and Petersen (2011) show that innovative firms, or firms with high R&D expenses, tend to be more financially constrained, mostly younger and smaller, and have lower leverage. Moreover, these firms smooth R&D spending and are more likely to maintain a relatively high level of growth opportunities over the entire business cycle. During bad times of the business cycle, when capital supply is scarce, it becomes more attractive for these firms, if not even the only possibility, to fund their innovation activities with cash.

In addition to smaller firms, even large and established innovative firms, such as General Electric or Microsoft, assign a high value to holding cash. Hall and Lerner (2010) conclude that large es-

[10] The size of the estimated coefficient depends on how we scale the SA-index. The SA-index is a combination of total assets, squared assets, and age, which results in values that are substantially higher than the values of most other variables in the regression. Therefore, we scale the SA-index by 10x10^8.

tablished firms also seem to prefer internal funds to finance their R&D investments. A recent trend has been that small firms were mostly selling out in trade sales instead of going public and continue growing organically, because getting big fast is nowadays more important than it used to be (Gao, Ritter, and Zhu, 2013).[11] Competing for smaller firms' R&D in private equity or M&A transactions requires a well-equipped "war chest" of cash for large and established innovative firms. This recent trend is consistent with the predictions in Ma, Mello, and Wu's (2014) model, where the first successful launcher of a new product enjoys a "winner's advantage." Their model predicts that both cash holdings and R&D intensity increase with the size of the market share captured by the winner. The model further deduces that industries with a strong winner's advantage are open to only a few firms that compete very aggressively. This effect may explain why firms operating in market sectors that seem to be highly concentrated, such as Google, Microsoft, and Apple, hold extremely large amounts of cash. In addition, it may become more difficult and more expensive even for large firms to raise external funds during severe liquidity crises (Drobetz et al., 2015).

Therefore, we test whether there is a higher correlation between the change in cash, the cyclicality of growth opportunities, and excess stock returns for firms with higher R&D expenses. We add an additional dummy variable, denoted as $HighRD\_d_{i,t}$, to the interaction between the change in cash and our correlation measure. This dummy variable equals one if R&D expenses scaled by total assets of a firm in a particular year are in the top 25% of the R&D expense distribution of all firms (and zero otherwise). The resulting triple interaction term is $\Delta C_{i,t} \times Corr_{i,t} \times HighRD\_d_{i,t}$. Given that highly innovative firms with less cyclical growth opportunities should put a higher value on the marginal dollar cash, we expect the estimate of this interaction term to be negative.

[11] Gao, Ritter, and Zhu (2013) call this the "economies of scope hypothesis", which they argue is responsible for the decline of the U.S. IPO market over the last decade.

Finally, to confirm our hypothesis that macroeconomic dynamics in combination with supply side-financial constraints contribute to the value of cash holdings, we analyze whether our results are more pronounced in bad business cycle years. The underlying intuition is that adverse business cycle states represent exogenous shocks to the conditions for credit supply (Bernanke, 1981; Campello, Graham, and Harvey, 2010; Duchin, Ozbas, and Sensoy, 2010). We add the dummy variable Bad_d_t to the interaction between the change in cash and our proxy for the cyclicality of growth opportunities; the resulting triple interaction term is $\Delta C_{i,t} \times Corr_{i,t} \times Bad\_d_t$. We use two different definitions of a bad business cycle state. In the first definition, the dummy variable takes the value of one if the mean sales growth at time t is within the lowest 25% of its distribution (and 0 otherwise). In the second definition, the dummy variable takes the value of one if the mean excess return at time t is within the lowest 25% of its distribution (and 0 otherwise). We expect a negative coefficient regardless of the bad state definition, indicating that the degree of cyclicality of a firm's growth opportunities becomes an even more important determinant for the value of cash holdings during times when capital supply is scarce.

3.2. *Cyclicality of growth and the value of cash: Main results*

The results of our OLS regressions are shown in Table 3. Column (1) is the starting point of our analysis; it summarizes the results of Faulkender and Wang's (2006) baseline regression. The estimate for the change in cash ($\Delta C_{i,t}$) is 1.050 (statistically significant at the 1% level). Since the dependent variable and all independent variables, including the change in cash, are scaled by lagged market equity, an extra dollar a firm adds to its cash holdings results in a change in firm value of \$1.05. This result is similar to Faulkender and Wang (2006).

Column (2) of Table 3 shows the results for Faulkender and Wang's (2006) extended specification, which adds the interactions of the change in cash with the level of cash holdings ($C_{i,t-1} \times \Delta C_{i,t}$) and with the level of leverage ($\Delta C_{i,t} \times L_{i,t}$), respectively, at the beginning of the fiscal year to the model.

The coefficient on the change in cash is 1.690. As expected, the coefficients on both interaction terms are negative and statistically significant. The estimates imply that the value of an extra dollar of cash for the average firm in our sample (with leverage of 25.6% and cash holdings of 18.2% at the beginning of the fiscal year) is $1.26 [=1.690+(–0.333×0.182)+(–1.457×0.256)]. Given that the estimates for both interaction terms are negative, the marginal value of cash is higher for a firm with lower cash holdings and lower leverage. For example, the value of an extra dollar of cash for a firm with leverage of 10% and cash holdings of 5% increases sharply to $1.53.

[Insert Table 3 here]

Column (3) shows our main result, where we add the interaction term between the change in cash and our correlation measure ($\Delta C_{i,t} \times Corr_{i,t}$). The estimate of the change in cash is 1.507, and the estimate of the interaction term is –0.088; the coefficients are significant at the 1% and 5% level, respectively. Considering the average firm, if the correlation measure takes a value of zero, the value of one additional dollar of cash is $1.12 [=1.507+(–0.088×0)+(–0.317×0.182)+(–1.268×0.256)]. In the extreme case, assuming a correlation measure of –1 (indicating a firm whose growth opportunities are always relatively more attractive in bad states of the economy), the value of an extra dollar of cash increases to $1.26. In contrast, the value of an extra dollar of cash with a correlation measure of +1 (indicating a firm that always benefits from its most attractive growth opportunities in good states) is only $1.04. The positive correlation of +1 leads to only a four cents add-on on the value of a dollar of cash, which is economically negligible. In comparison, the negative correlation of –1 has a positive effect that is six times stronger. The difference is economically relevant and confirms our main hypothesis that the less cyclical a firm's growth opportunities are, the higher is the value of cash.

The next three regressions in columns (4)-(6) of Table 3 test whether the relation between the cyclicality of growth options and the value of cash is dependent on firm characteristics. In column (4), the estimate for the change in cash is 1.520, and the coefficient on the triple interaction term involving the change in cash, the correlation measure, and leverage ($\Delta C_{i,t} \times Corr_{i,t} \times L_{i,t}$) is 0.401; the coefficients are statistically significant at 1% and 5% level, respectively. As predicted, the coefficient of the triple interaction term is positive, implying that the value of one additional dollar of cash becomes higher for less cyclical firms that operate with a low level of leverage. For a correlation measure of zero and a leverage of 25.6% (the average leverage in our sample), the value of one additional dollar of cash is \$1.13.[12] The same level of leverage but with a correlation measure of –1 results in a value of an additional dollar cash of \$1.24. To highlight the effect of leverage, consider a change in leverage conditional on an extreme correlation of –1. First, with a low leverage of 5%, an additional dollar of cash is valued higher at \$1.59. Second, with a high leverage of 95%, the marginal value of cash becomes as low as \$0.05. These results support our hypothesis that the lower the level of leverage is for a very low correlation firm, the higher is the value of an extra dollar of cash.

In column (5), the coefficient on the triple interaction term involving the change in cash, our correlation measure, and the SA-index ($\Delta C_{i,t} \times Corr_{i,t} \times SA_{i,t}$) is positive with 0.021. However, it is statistically insignificant, again indicating that low correlation firms are not limited to smaller or younger firms, but low correlation firms are represented in all size and age groups of our sample. Most importantly, the valuation effect of cash relating to a firm's cyclicality of growth opportunities is independent from its status as financially constrained or unconstrained.

In column (6), we test the relation between the cyclicality of growth opportunities, R&D spending, and the marginal value of cash. The dummy variable $HighRD\_d_{i,t}$ takes a value of one if a firm belongs to the top 25% of the R&D expenses distribution (and zero otherwise). Estimating the cash valuation regression including the triple interaction term $\Delta C_{i,t} \times Corr_{i,t} \times HighRD\_d_{i,t}$, the corresponding

[12] This value is computed as: \$1.13=1.520+(–0.219×0)+(0.401×0×0.256)+(–0.321×0.182)+(–1.314×0.256). All following values of cash that involve triple interaction terms are computed in the same way.

coefficient is negative with –0.310 (with statistical significance at the 5% level). This result confirms our hypothesis that high R&D firms place a higher value on cash than other firms. Even assuming a correlation measure of zero, the value of an extra dollar of cash is as high as $1.51 for a high R&D firm (with average leverage and cash). With more extreme correlations, the spread in cash valuations can become very large. A correlation measure of +1 results in a marginal value of cash of $1.18 for a high R&D firm. As already shown, however, high R&D firms exhibit a lower level of cyclicality in their growth opportunities than other firms. With the lowest possible correlation measure of –1, the value of an extra dollar of cash becomes as high as $1.85 for a high R&D firm.

These findings are consistent with the idea that cash has a strategic importance. For example, Schroth and Szalay (2010) find that firms with more cash and assets are more likely to win patent races. In the model of Ma, Mello, and Wu (2014), firms first engage in R&D, and then invest to create and scale up new markets for discoveries hoping to benefit from the winner's advantage. Cash avoids the time delay in the launch of innovations and can deter competitors from implementing their innovations. In contrast, in Lyandres and Palazzo's (2014) model, competition intensity is captured by product substitutability (rather than a winner's advantage). Higher cash holdings increase the chances for successful implementation of a firm's innovation and reduce the expected profits of successful competitors. Frèsard (2010) finds that large cash reserves lead to systematic future market share gains at the expense of industry rivals. Cash rich firms may induce losses for financially weak rival firms and drive them out of the market, thereby reducing competition. Moreover, Morellec, Nikolov, and Zucchi (2013) show that firms in more competitive industries hold more cash.[13] Our results are generally in line with all these predictions. Among the firms with low cyclicality of growth opportunities, we find that the value of cash holdings is highest for the most innovative firms with highest R&D spending, thereby at least indirectly reinforcing the role of cash as a commitment device.

[13] However, the focus of Morellec, Nikolov, and Zucchi's (2013) study is on the role of cash in financing operating losses and in preventing inefficient asset sale, not in financing product innovations.

In a final step, we focus on bad business cycle years. To support our hypothesis that business cycle dynamics impact the value of cash, we add the triple interaction term $\Delta C_{i,t} \times Corr_{i,t} \times Bad\_d_t$, where Bad_d_t denotes a dummy variable that indicates a bad macroeconomic state. In column (7), the bad state dummy variable takes a value of one if the mean sales growth is within the lowest 25% of its distribution in a given year (and 0 otherwise). Alternatively, in column (8), the dummy variable takes a value of one if the mean excess stock return is within the lowest 25% of its distribution in a given year (and 0 otherwise). These model specifications put a focus on exactly the type of firm we want to emphasize: less cyclical firms (or low correlation firms), which have relatively more attractive growth opportunities in bad states of the economy.

In column (7), the estimate for the change in cash is 1.485, and the coefficient for the triple interaction term is –0.184; the coefficients are statistically significant at the 1% and 10% level, respectively. For the average firm in our sample, a correlation measure of zero results in a marginal value of cash of $1.18 in a bad state of the economy. While the value of an additional dollar of cash becomes as high as $1.39 in bad business cycle states (with supply-side financial constraints) assuming a correlation measure of –1, this value reduces to only 96 cents for a correlation measure of +1. These results corroborate our hypothesis that less cyclical (low correlation) firms put a higher value on an extra dollar of cash than other (high correlation) firms, and this valuation pattern is even more pronounced if the economy is in a bad state.

The results for our alternative bad state definition in column (8) are similar: the estimate for the change in cash is 1.434, and the coefficient for the triple interaction term is –0.250; both are significant at the 1% level. The resulting marginal values of cash for the average firm are: $1.19 for a correlation measure of zero, $1.41 for a correlation measure of –1, and $0.98 for a correlation measure of +1. In what follows, we proceed using only the aggregated sales growth-based measure as an indicator for the state of the economy. Stock market turmoils could be related to sudden shocks that need not necessarily translate into business cycle downturns. In contrast, sharp declines in sales growth are a direct consequence of a deteriorating business climate.

3.3. The effect of cash holdings on investment

Our results show that investors in firms with less cyclical growth opportunities place a higher value on cash holdings. Next, we analyze whether cash holdings of firms with less cyclical growth opportunities are also associated with more investment activities. To assess the influence cash has on net investment, we take into account that net investment will also have an impact on cash holdings. As emphasized by Denis and Sibilkov (2010), the levels of both investment and cash holdings are simultaneously determined by investment opportunities, thereby implying an endogeneity problem. On the one hand, firms with greater investment opportunities invest more and require more cash holdings to support operations. On the other hand, firms with more profitable investment opportunities can hold more cash to ensure their ability to fund future investment opportunities and to avoid the cost of underinvestment, even if they ultimately do not use the cash to invest.

To account for a spurious correlation and a simultaneous determination of investment and cash holdings, we estimate a three-stage least square (3SLS) system of simultaneous equations. This setup allows us to examine the direct effect of cash holdings on investment after netting out the level of operating and precautionary cash held. Following Kim, Mauer, and Shermann (1998) and Denis and Sibilkov (2010), the system of equations consists of models for cash holdings and net investment:

$$\text{(2a)} \quad Netinv_{i,t+1} = \gamma_0 + \gamma_1 Cash_{i,t} + \gamma_2 CF_{i,t} + \gamma_3 \frac{ME_{i,t}}{BE_{i,t}} + \gamma_4 Prior\ \Delta sales_{i,t} + \varepsilon_{i,t}$$

$$\text{(2b)} \quad Cash_{i,t} = \theta_0 + \theta_1 CF_{i,t} + \theta_2 \frac{ME_{i,t}}{BE_{i,t}} + \theta_3 Size_{i,t} + \theta_4 Lev_{i,t} + \theta_5 Ind.CF\ vola_{i,t} + \\ + \theta_6 CCDur_{i,t} + \theta_7 Zscore_{i,t} + \theta_8 Ret.spr_{i,t} + \theta_9 \Delta Ind.prod_{i,t} + \varepsilon_{i,t}$$

In equation (2a), the dependent variable is net investment (*Netinv*$_{i,t+1}$), defined as capital expenditures plus R&D expenditures less depreciation of firm *i* at time *t+1*. Net investment is regressed on cash holdings, operating cash flow, the market-to-book ratio, and prior sales growth. $Cash_{i,t}$ is cash and short-term equivalents. Operating cash flow ($CF_{i,t}$) is earnings before interest, taxes, depreciation, and amortization divided by sales. The market-to-book ratio ($ME/BE_{i,t}$) is market equity divided by book equity. Prior sales growth ($Prior\Delta sales_{i,t}$) is the logarithm of the growth rate of sales over the last two years.

In equation (2b), the level of cash holdings is regressed on operating cash flow, the market-to-book ratio, firm size, leverage, the industry cash flow volatility, the cash cycle duration, the Z-score, the return spread, and industry production growth. Firm size ($Size_{i,t}$) is the logarithm of total assets. Leverage ($Lev_{i,t}$) is long-term debt and short-term debt divided by total assets. Industry cash flow volatility ($Ind.CFvola_{i,t}$) is taken as the median of the firm-level standard deviation of first differences in earnings before interest, taxes, depreciation, and amortization in SIC2-industry level over the prior twenty years. Cash cycle duration ($CCDur_{i,t}$) is the sum of average inventory age and average collection period less the average payment period. The Z-score ($Zscore_{i,t}$) is based on Altman (1968). The return spread ($Ret.spr_{i,t}$) is the return on investment (earnings before interest and taxes scaled by total assets) minus the risk-free rate (the annualized T-bill return over the fiscal year). Finally, industry production growth ($\Delta Ind.prod_{i,t}$) is the logarithm of the growth rate of industrial production (mean of sales growth at SIC2-industry level).

We include industry and year fixed effects in our 3SLS regressions. Identification of the system is achieved by excluding some of the explanatory variables that determine the level of cash holdings from the investment equation. Investment is determined primarily by investment opportunities and available resources to fund these opportunities, i.e., cash flow and cash holdings, and not directly by other variables, such as industry cash flow volatility, the duration of a firm's cash cycle, and the growth rate of industrial production. This identification strategy cannot completely solve the potential endogeneity problem. It does, however, provide a fairly strong test of the actual relation between cash and investment (see the discussion in Denis and Sibilkov, 2010). To make the results comparable across the different subsamples, we standardize the regression coefficients. Following Bring (1994), all coefficients are standardized by multiplying the coefficient estimates with the ratio of the standard deviation of the independent variable to the standard deviation of the respective dependent variable (within a given subsample).

[Insert Table 4 here]

The columns in Table 4 show the 3SLS results for different subsample pairs. Column (1) uses firms with a high correlation measure (firms with a correlation measure within the top 25% of its distribution), while column (2) uses firms with a low correlation measure (firms with a correlation measure within the lowest 25% of its distribution). Comparing the cash coefficients in the investment regression across these two subsamples, we find the estimate in column (2) with 0.416 to be higher than in column (1) with 0.408. Based on a Chow-test, even this small difference in the coefficients is statistically significant at the 1% level. To assess economic significance, these estimates imply that a one standard deviation increase in cash holdings leads to a change in net investment by 3.08 percentage points for high correlation firms and 3.30 percentage points for low correlation firms (computed using non-standardized coefficients). Focusing on the mean (median) firm in each subsample, in response to a one standard deviation increase in cash holdings, net investment rises to 7.90% (6.08%) for the mean (median) high correlation firm and to 8.75% (6.72%) for the mean (median) low correlation firm, i.e., net investment in low correlation firms is 10.78% (10.40%) higher than in high correlation firms. As hypothesized, for low correlation (or less cyclical) firms, cash is more important as a source of investment funding than it is for high correlation firms.

The next two columns focus on the subsample of firms with high R&D expenses (the top 25% of R&D expenses to total assets ratio in the sample). Column (3) shows the results for the subsample of firms with high R&D expenses and a high correlation measure, and column (4) for the subsample with high R&D expenses and a low correlation measure. As expected, the estimated cash coefficient for low correlation firms is higher than for high correlation firms (conditional on high R&D spending), and the difference becomes more pronounced (0.397 versus 0.316). In economic terms, these estimates imply that for low correlation and high R&D firms (column 4) an increase in cash by one standard deviation increases net investment by 34.54% (41.40%) for the mean (median) firm in the subsample, respectively. In contrast, for high correlation and high R&D firms (column 3) an increase in cash by one standard deviation increases net investment of the mean (median) firm in the subsample by 30.16% (36.94%). Therefore, investment activities seem particularly sensitive to cash holdings in less cyclical firms with high R&D expenses, thus supporting our main finding that holding a marginal dollar cash is highly valuable for this group of firms.

Narrowing down the subsample even further, the results in the next two columns are based on high tech firms with high R&D expenses. Arguably, this group of firms is the most innovative one, and thus needs to spend the most on new investment.[14] As expected, among high tech firms with high R&D expenses, less cyclical (low correlation) firms in column (6) exhibit a higher cash estimate than high correlation firms in column (5); the estimates are 0.370 and 0.278, respectively. These findings are again consistent with recent theoretical models that emphasize the strategic use of cash in innovative and competitive industries (Morellec, Nikolov, and Zucchi, 2013; Ma, Mello, and Wu, 2014; Lyandres and Palazzo, 2015).

Next, we analyze whether less cyclical firms with low leverage have a higher tendency to spend their cash on investment. A firm is classified as a low leverage firm if its leverage is within the bottom 25% of the leverage distribution. This test is based on our earlier finding that low leverage firms place a higher value on cash than high leverage firms. The results confirm that low leverage and low corre-

[14] A firm is classified as high tech if its SIC code starts with 28, 35, 36, 37 (except for 372 and 376), 38, or 73.

lation firms in column (8) are more dependent on cash for their investment than low leverage and high correlation firms in column (7); the estimates for cash are 0.359 and 0.235, respectively.

Finally, we focus on years with a bad economic state. A year is classified as bad state year if its mean sales growth is within the lowest 25% of the distribution. Comparing low correlation firms in a bad state (column 10) and high correlation firms in a bad state (column 9) reveals that low correlation firms rely on cash for investment more than high correlation firms in a bad state year, with estimates of 0.285 and 0.265, respectively.

Taken together, the 3SLS regression results confirm our main prediction that the group of firms identified as having a higher marginal value of cash – firms with a low cyclicality of growth opportunities (and a low correlation measure), high R&D expenses, low leverage, and firm-years falling in a bad economic state – also has a higher need for cash to finance their investments. As shown in Table 4, all pairwise differences for the cash estimates are statistically significant based on a Chow-test (except for the leverage subsamples).

3.4. Cash and operating performance

So far, we have established that a low cyclicality of growth opportunities is associated with a higher value of cash holdings and a higher sensitivity of investment to cash holdings. The reason why investors may place a higher value on cash than its par value, however, is not solely a firm's investment activity but rather the prospect of future returns from these investments, that is, a higher operating performance or a higher return on equity. Therefore, we next analyze whether higher cash holdings in less cyclical firms are associated with higher operating performance, defined as the average of a firm's net income scaled by market equity over the following two years. We modify our regression set up in equation (1) in order to measure operating performance instead of excess stock returns as follows:

(3) $op_{i,t,t+2} = \sigma_0 + \sigma_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \sigma_2 Corr_{i,t} + \sigma_3 \frac{\Delta C_{i,t} \times Corr_{i,t}}{M_{i,t-1}} + \sigma_4 L_{i,t} + \sigma_5 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \sigma_6 \frac{\Delta NA_{i,t}}{M_{i,t-1}} +$

$$\sigma_7 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \sigma_8 \frac{\Delta I_{i,t}}{M_{i,t-1}} + \sigma_9 \frac{\Delta D_{i,t}}{M_{i,t-1}} + \sigma_{10} \frac{NF_{i,t}}{M_{i,t-1}} + \sigma_{11} Size_{i,t} + \epsilon_{i,t}.$$

In equation (3), operating performance ($op_{i,t,t+2}$) is regressed on the change in cash ($\Delta C_{i,t}$), our correlation measure ($Corr_{i,t}$), the interaction of the change in cash and the correlation measure ($\Delta C_{i,t} \times Corr_{i,t}$), firm size ($Size_{i,t}$), and Faulkender and Wang's (2006) control variables. Firm size is the logarithm of a firm's total assets. Industry and year fixed effects are included. We expect the coefficient of the change in cash (σ_1) to be positive, and the coefficient of the interaction term to be negative (σ_3), indicating that the change in cash has a higher impact on operating performance for less cyclical firms.

Table 5 shows our standardized regression results.[15] In column (1), the coefficient of the change in cash is positive and highly significant. In column (2), our interaction term $\Delta C_{i,t} \times Corr_{i,t}$ is included. The corresponding coefficient is negative and statistically significant at the 10% level, indicating that a change in cash has a higher impact on operating performance for less cyclical firms compared to more cyclical firms. The remaining columns (3)-(6) show the results for different subsamples. Column (3) contains only firms with a high correlation measure (top 25% of its distribution), and column (4) only high correlation firms with a high level of net investment (top 25% of its distribution). The remaining two columns present the results for low correlation firms (column 5) and low correlation firms with high net investment (column 6). As expected, the estimated cash coefficient is higher for low correlation firms (0.364) than for high correlation firms (0.207) and, in particular, it is highest for low correlation firms with a high level of net investment (0.873).

[Insert Table 5 here]

[15] The regression coefficients are again standardized following Bring (1994). As a robustness test, we repeat the same regression using book values instead of market values and get qualitatively very similar results.

Taken together, our results indicate that firms with a low cyclicality of their growth opportunities, for which cash holdings are more valuable, effectively invest more. Subsequently, their operating performance increases significantly more compared to high correlation firms, which can explain why investors place a higher value on cash holdings in low correlation firms.

4. Robustness tests

4.1. Cyclicality of growth opportunities, financial distress, and corporate governance

To ensure that our main results for the cyclicality of growth opportunities and the value of cash in Table 3 are not driven by other factors that we have not considered in our set of control variables, we implement several robustness checks. Table 6 shows the results for alternative specifications of the valuation regression in equation (1). In column (1), we include a triple interaction term to the baseline regression model that involves the change in cash, the correlation measure, and Altman's (1968) Z-score ($\Delta C_{i,t} \times Corr_{i,t} \times Zscore_{i,t}$). The coefficient on this interaction term can shed light on whether our results are affected by financially distressed firms, which arguably suffer from bankruptcy costs and thus place a high value on extra cash. However, the estimate for the triple interaction term is negative and insignificant, which confirms that financial distress does not drive our results.

Another factor that might influence our results is corporate governance. Jensen and Meckling (1976) point out that managers waste firm resources to maximize their personal wealth. Accordingly, good corporate governance and shareholder protection that limit managers' discretionary power in using free cash flow is believed to enhance firm value. For example, Dittmar and Mahrt-Smith (2007) show that good corporate governance can reverse the negative impact that excessive amounts of cash may have on firm performance.[16]

[16] Other papers on the relation between cash and corporate governance are Dittmar, Mahrt-Smith, and Servaes (2003), Kalcheva and Lins (2007), Drobetz, Grüninger, and Hirschvogl (2010), and Frèsard and Salva (2010).

To address potential corporate governance related issues, we use data on corporate governance from RiskMetrics, which covers all S&P 1,500 firms from 1990 to 2012. In column (2), we first run our main regression, described in equation (1), on this smaller sample to ensure that our earlier results hold. The estimated coefficient on the interaction term between the change in cash and our correlation measure ($\Delta C_{i,t} \times Corr_{i,t}$) remains negative and statistically significant. Column (3) replicates and extends Dittmar and Mahrt-Smith's (2007) findings on corporate governance and the value of cash. We include another triple interaction term involving the change in cash and two dummy variables, one for firms with poor corporate governance practices, and the other one for the bad business cycle state ($\Delta C_{i,t} \times LowGov\_d_{i,t} \times Bad\_d_t$). A firm is classified as a poor corporate governance firm if it shows an E-Index of 4 or higher.[17] The estimated coefficient on the interaction between the change in cash and the low governance dummy ($\Delta C_{i,t} \times LowGov\_d_{i,t}$) is negative and statistically significant. This result confirms Dittmar and Mahrt-Smith's (2007) findings that poor corporate governance firms experience a discount on the value of their cash holdings, i.e., shareholders fear that managers of firms with poor corporate governance practices waste the cash for personal benefits rather than invest in firm value-increasing projects. In a bad business cycle state, however, the estimated coefficient on the triple interaction term ($\Delta C_{i,t} \times LowGov\_d_{i,t} \times Bad\_d_t$) becomes positive and statistically significant. An explanation may be that with external capital supply being scarce, managers are less likely to implement value-decreasing investments and have higher need for precautionary cash holding. As a result, the valuation discount on cash holdings arising from agency problems is (at least partially) offset by the business cycle dynamics.

Finally, in column (4), we add our correlation measure to the interaction between the change in cash and the bad corporate governance dummy. The estimated coefficient of the triple interaction term $\Delta C_{i,t} \times Corr_{i,t} \times LowGov\_d_{i,t}$ is positive but insignificant, indicating that corporate governance does not

[17] The E-Index is the entrenchment index by Bebchuk, Cohen, and Ferrell (2004).

have a pivotal role in our analysis of the relation between the cyclicality of growth opportunities and the value of cash.

4.2. Cash, investment, and cyclicality of growth opportunities during the financial crisis

One recent example of a sharp decline in business and external financing conditions is the financial crisis of 2007-2009. Firms suffered severely from this very severe crisis, and the empirical literature has exploited this period as a study laboratory of the impact of financial crises, capital supply constraints, or systemic risk on investment and financing decisions (Campello, Graham, and Harvey, 2010; Ivashina and Scharfstein, 2010; Almeida et al., 2011; Bliss, Cheng, and Denis, 2015).

To test our hypothesis on the value of cash, investment, and the cyclicality of growth opportunities in an alternative way and to address the endogeneity problem associated with these variables (see section 3.3 for the details), we follow Duchin, Ozbas, and Sensoy (2010) and estimate a difference-in-differences model to compare net investment of firms dependent on cash holdings before and during the recent financial crisis. Therefore, we estimate the following regression on a shortened sample including the years from 2005 until the end of the financial crisis in June 2008:[18]

$$(4) \quad Netinv_{i,t} = \vartheta_0 + \vartheta_1 Crisis_t + \vartheta_2 \Delta Cash_{i,t-1} \times Corr_{i,t-1} \times Crisis_t + \\ + \vartheta_3 \Delta Cash_{i,t-1} \times Crisis_t + \vartheta_4 Corr_{i,t-1} \times Crisis_t + \vartheta_5 \Delta Cash_{i,t-1} \times Corr_{i,t-1} + \\ + \vartheta_6 \Delta Cash_{i,t-1} + \vartheta_7 Corr_{i,t-1} + \vartheta_8 Q_{i,t-1} + \vartheta_9 CF_{i,t-1} + \varepsilon_{i,t}$$

where $Netinv_{i,t}$ is again defined as firm *i*'s capital expenditures plus R&D expenditures less depreciation scaled by total assets at time *t*. $Netinv_{i,t}$ is regressed on the triple interaction between a crisis indicato, our correlation measure, and the change in cash together with control variables. The crisis indicator, $Crisis_t$, is a dummy variable that takes the value of one during the financial crisis, which we

[18] In contrast to Duchin, Ozbas, and Sensoy (2010), who use quarterly data, we use yearly data, which is why we extended the pre-crisis period until January 2005 instead of defining only one year as pre-crisis. This approach ensures that we have sufficient observations for our analysis.

approximate from July 2007 to June 2008 (Duchin, Ozbas, and Sensoy, 2010). Our correlation measure and the change in cash are defined as before. Control variables are Tobin's Q ($Q_{i,t-1}$) and the operating cash flow ($CF_{i,t-1}$), where the latter is defined as earnings before interest, taxes, depreciation, and amortization divided by total assets. Firm fixed effects are included in the model.

The motivation for testing the model in equation (4) is that if business cycle dynamics and, in particular, external capital supply effects drive our results, we expect to find particularly strong valuation effects during the recent financial crisis. Specifically, we expect the coefficient ϑ_2 of the triple interaction term $\Delta Cash_{i,t-1} \times Corr_{i,t-1} \times Crisis_{i,t}$ to be negative. As already shown, cash is more important for investment in low correlation firms, and this negative relation combined with a positive crisis dummy variable should result in a negative coefficient on the triple interaction term involving cash holdings.

Our results, shown in Table 7, are comparable to Duchin, Ozbas, and Sensoy (2010). In column (1), net investment is regressed only on the crisis dummy. We find a negative and highly significant coefficient on the crisis dummy, indicating that the crisis affected firms in a way that led to reduced investments during that time period. This result is not surprising, since the crisis caused capital supply constraints and uncertainties regarding future economic as well as financial conditions. In column (2), we add the triple interaction term involving the crisis dummy variable ($\Delta Cash_{i,t-1} \times Corr_{i,t-1} \times Crisis_{i,t}$). Its coefficient is with -0.117 negative and statistically significant at the 1% level, thus suggesting that firms with a low cyclicality of growth opportunities (low correlation firms) have a higher need for cash to fund their investments than high correlation firms, especially during crisis periods. This result strengthens our earlier finding that the value of cash for low correlation firms is higher in a bad business cycle state. Our results are robust when we further add Tobin's Q and the operating cash flow as control variables in columns (3) and (4).

Overall, the results from the financial crisis of 2007-2009 support our main findings. Cash is a valuable source of investment funding for firms with less cyclical growth opportunities, particularly in bad states of the economy or during crisis periods. Our analysis thus provides an explanation why some firms find it valuable to hold a lot of cash despite all the related agency cost issues.

4.3. *Sensitivity of annual stock returns to cash holdings*

In a final step, we again address the identification issues that potentially plague our analysis of the value of cash and the relation between cash and investment. An alternative way of testing the robustness of our results is to examine whether the sensitivity of stock returns to cash holdings is different over the business cycle for firms with higher or lower cyclicality of growth opportunities. Again, the underlying intuition is that adverse business cycle states represent exogenous shocks to the conditions for credit supply. All firms are affected by this shock, but their ability to extract value from cash evolves differently over the business cycle, depending on the cyclicality of growth opportunities.

Our two-step estimation procedure follows the setup developed in Campello (2003), who studies the impact of economic regimes to solve the endogeneity problem between capital structure and product market competition. In a first step, we estimate the return-cash sensitivity:

$$(5) \qquad log(r_{i,t}) = \vartheta_0 + \vartheta_1 log(r_{i,t-1}) + \beta_2 \Delta log(PPE_{i,t-1}) + \beta_3 log(at_{i,t-1}) + \delta Cash_{i,t-1} + \varepsilon_{i,t},$$

where $log(r_{i,t})$ is the logarithm of the annual stock return of firm *i* at time *t*, $\Delta log(PPE_{i,t-1})$ is the logarithm of the growth rate of property, plant, and equipment, $log(at_{i,t-1})$ is the logarithm of total assets, and $Cash_{i,t-1}$ is cash and short-term investments. All variables in equation (5) are SIC3-industry-adjusted. The coefficient of interest is δ, which measures the return-cash sensitivity. The regression is estimated on a per year basis, and the estimates for δ generate a time-series vector (δ_t). We estimate the first-step model using both OLS and 2SLS. Lagged cash might be endogenous, and thus we instrument $Cash_{i,t-1}$ with its lags of the last two years when estimating using the 2SLS technique.

In a second step, we regress the estimated return-cash sensitivity on the lagged aggregated sales growth and a time trend to assess the effect the business cycle exhibits on the return-cash sensitivity:

(6) $$\delta_t = \gamma_0 + \gamma_1 \Delta Aggr.sales_{t-1} + \gamma_2 Trend_t + \epsilon_t$$

where δ_t is the estimated return-cash sensitivity from equation (5) at time *t*, $\Delta Aggr.sales_{t-1}$ is the mean lagged sales growth of all sample firms, and $Trend_t$ is the year of the observation. The coefficient of interest is γ_1, which measures the effect the business cycle exerts on the return-cash sensitivity. We estimate two modifications of equation (6), replacing $\Delta Aggr.sales_{t-1}$ with either Bad_d_{t-1} or $Good\_d_{t-1}$. $Bad(Good)\_d_{t-1}$ is a dummy variable that takes a value of one if the mean sales growth of all sample firms at time *t* is within the bottom (top) 25% of its distribution (and zero otherwise).

Table 8 summarizes our results for the second step regression in equation (6). Columns (1)-(3) show the results for the full sample, columns (4)-(6) include only high correlation firms (top 33% of the distribution of our correlation measure), and columns (7)-(9) only low correlation firms (bottom 33% of the distribution of our correlation measure). When we compare the results for the low correlation subsample with the results for the high correlation subsample, coefficients have different signs, regardless of the estimation method OLS or 2SLS. For example, in column (7) of Panel A, the γ_1 coefficient of aggregated sales growth is –0.026 for low correlation firms. To interpret this coefficient, assume that lagged aggregate sales growth is negative in a given year, i.e., the economy tends to worsen in the near future. A negative lagged sales growth combined with a negative estimated coefficient implies a positive impact on the estimated return-cash sensitivity, i.e., the stock returns of firms with less cyclical growth opportunities react more sensitive to changes in cash holdings. Or put differently, low correlation firms have a higher sensitivity of returns to cash in bad states. Since they have relatively better growth opportunities in bad economic states, cash is a more valuable source of investment funding for them during these adverse time periods.

Columns (8) and (9) corroborate these results. The positive (negative) coefficient for the good state (bad state) dummy variable indicates a higher (lower) return-cash sensitivity in bad (good) economic states. In contrast, high correlation firms in columns (4)-(6) exhibit the opposite patterns. For example, in column (4) of Panel A, the γ_1 coefficient of aggregated sales growth is 0.018. Accordingly, with worsening economy activities in the near future, the returns of firms with more cyclical growth opportunities exhibit a lower sensitivity to changes in cash.

Overall, the results of these robustness tests support our earlier findings for the relation between the cyclicality of growth opportunities and the value of cash. The different effects the business cycle exerts on the return-cash sensitivity conditional on the correlation measure corroborate our main finding that cash is more important and has a higher value for firms with less cyclical growth opportunities compared to more cyclical firms.

5. Conclusion

In this study, we investigate the effect of cash holdings on firm value. In particular, we focus on firms' cyclicality of growth opportunities. In bad economic states, the costs of external finance tend to increase and investment opportunities become scarcer. For more cyclical firms, whose growth opportunities move strongly in line with the business cycle, this environment does not further weaken their operations because they lack profitable investment opportunities that need funding. In contrast, less cyclical firms benefit from relatively more attractive investment opportunities during bad economic times, but they face funding problems if external finance becomes difficult. These firms use their cash holdings to transfer financial resources into bad business cycle states and implement their investment projects, suggesting that the value of an additional dollar of cash is higher for this group of firms.

The empirical analyses strongly confirm our predictions. Most importantly, firms whose growth opportunities move less cyclical with the business cycle exhibit a higher marginal value of cash than more cyclical firms. As expected, this valuation effect is even more pronounced for low leverage and high R&D firms as well as in bad states of the business cycle. Cash also matters for firms' investment decisions. Firms with higher cash holdings, and with a higher value of an additional dollar of cash, are associated with higher levels of investment and higher operating performance.

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Tables

Table 1
Descriptive statistics

This table reports descriptive statistics of all firms excluding utilities (SIC codes 4910 – 4939) and financial firms (SIC codes 6000 – 6999) from 1968 to 2012. Data are from the Compustat North America annual files. All variables are reported in constant 2001 USD. Panel A includes all variables of the value of cash regressions. r_t^E is the annual stock return at time *t* minus the portfolio benchmark return at time *t*. The annual stock return is the CRSP annualized stock return, and the portfolio benchmark return is the corresponding benchmark return from Fama and French's 25 size and book-to-market based portfolios. C_{t-1} is cash and short term investments at time *t-1*. $Corr_t$ is the rolling correlation of Tobin's Q scaled by its SIC3-industry mean and the lagged mean sales growth over a five-year rolling window at time *t*. E_t is earnings before extraordinary items plus interest, deferred income taxes, and investment tax credit at time *t*. NA_t is total assets minus cash and short term equivalents at time *t*. RD_t is investments in research and development at time *t*. I_t is interest expenses at time *t*. D_t is common dividends paid at time *t*. L_t is market leverage at time *t*. NF_t is net financing at time *t*, calculated as total equity issuance minus repurchases plus debt issuance minus redemption. All variables in Panel A are scaled with lagged market equity except for $Corr_t$ and L_t. Panel B includes all variables of the investment regressions. $Netinv_{t+1}$ is capital expenditures and investments in research and development less depreciation at time *t+1*. C_t is cash and short term investments at time *t*. $Netinv_{t+1}$ and C_t are scaled by total assets. CF_t is operating cash flow at time *t*. M/B_t is the market equity to book equity ratio at time *t*. $Prior\Delta sales_t$ is the log of sales growth over the previous two years at time *t*. Lev_t in Panel B is book leverage, and $Size_t$ is the log of total assets at time *t*. $Ind.CFvola_t$ is the industry cash flow volatility, measured as the median of the firm-level standard deviation of first differences in EBITDA over the prior 20 years at time *t*. $CCDur_t$ is the cash cycle duration, calculated as the average inventory age plus average collection period minus average payment period at time *t*. The *Zscore* is Altman's (1968) Z-score at time *t*. $Ret.spr_t$ is EBIT scaled by total assets minus the annualized Treasury bill return at time *t*. $\Delta Ind.prod_t$ is the log of sales growth on SIC2-industry level at time *t*.

				Percentiles	
	Mean	S.D.	Median	25th	75th
Panel A. Value of cash regressions					
r_t^E	0.0122	0.6301	-0.0802	-0.3418	0.2120
ΔC_t	0.0044	0.1539	0.0000	-0.0370	0.0366
$Corr_t$	0.0466	0.4999	0.0608	-0.3542	0.4526
C_{t-1}	0.1824	0.2488	0.0987	0.0364	0.2245
ΔE_t	0.0167	0.2558	0.0058	-0.0360	0.0445
ΔNA_t	0.0174	0.5139	0.0215	-0.0798	0.1391
ΔRD_t	0.0000	0.0242	0.0000	0.0000	0.0009
ΔI_t	0.0003	0.0322	0.0000	-0.0035	0.0049
ΔD_t	-0.0002	0.0113	0.0000	0.0000	0.0000
L_t	0.2558	0.2375	0.1965	0.0435	0.4113
NF_t	0.0449	0.2544	0.0008	-0.0328	0.0752
Panel B. Investment regressions					
$Netinv_{t+1}$	0.0547	0.0859	0.0324	0.0028	0.0827
C_t	0.1439	0.1733	0.0743	0.0267	0.1939
CF_t	0.1185	0.1500	0.1114	0.0591	0.1783
M/B_t	2.6070	3.3985	1.6595	0.9871	2.8860
$Prior\Delta sales_t$	-1.1937	1.2642	-1.1684	-1.8746	-0.4865
$Size_t$	5.5472	2.0045	5.4257	4.1270	6.8690
Lev_t	0.2174	0.1753	0.2015	0.0599	0.3324
$Ind.CFvola_t$	0.0568	0.0211	0.0544	0.0393	0.0751
$CCDur_t$	89.5366	115.2280	82.8436	37.0697	138.1092
$Zscore_t$	4.9145	6.2985	3.6136	2.4153	5.4642
$Ret.spr_t$	0.0672	0.1524	0.0850	0.0277	0.1411
$\Delta Ind.prod_t$	-1.4070	1.1428	-1.5636	-2.0983	-0.7936

Table 2
Summary statistics for correlation measure

This table reports means and medians of firm characteristics of all firms excluding utilities (SIC codes 4910 – 4939) and financial firms (SIC codes 6000 – 6999) from 1968 to 2012. Data are from the Compustat North America annual files. All variables are reported in constant 2001 USD. *Leverage* is market leverage. *Cash Holdings* is cash and short term investments scaled by total assets. *Cash Flow* is the sum of net cash flows from operating activities, financing activities, and investing activities scaled by total assets. *Tobin's Q* is the sum of long term debt, short term debt, and market equity divided by total assets. *Zscore* is Altman's (1968) Z-score. Firms are sorted in five bins according to their annual correlation measure, $Corr_t$, where bin 1 includes firms with the lowest correlation measure, and bin 5 firms with the highest correlation measure. Panel A shows means and medians for the full sample. Panels B-E show means and medians for different subsamples: (B) firms with high R&D expenses (R&D expenses within the highest third of its distribution) and firms with low R&D expenses (R&D expenses within the lowest two thirds of its distribution). t-statistics for difference in means tests are reported.

			Mean / *Median*				
Bin	Correlation measure	N	Leverage	Cash holdings	Cash flow	Tobin's Q	Zscore
Panel A. Full sample							
1	[-1;-0.6)	10,961	0.2469	0.1370	0.0018	1.4002	8.5036
			0.1935	*0.0680*	*0.0016*	*0.9777*	*3.5103*
2	[-0.6;-0.2)	20,542	0.2231	0.1575	0.0039	1.7079	5.3763
			0.1615	*0.0821*	*0.0020*	*1.0738*	*3.5801*
3	[-0.2;0.2)	22,740	0.2389	0.1491	0.0038	1.5759	4.7193
			0.1799	*0.0785*	*0.0018*	*1.0009*	*3.4005*
4	[0.2;0.6)	22,709	0.2621	0.1385	0.0032	1.2502	4.2879
			0.2079	*0.0720*	*0.0014*	*0.9393*	*3.2524*
5	[0.6;1]	14,790	0.2701	0.1427	0.0016	1.2631	4.3170
			0.2135	*0.0737*	*0.0014*	*0.9235*	*3.2576*
	t-statistic (bin 1 vs. 5)	25,751	-7.7983	-2.6122	0.0859	4.5914	1.8860
Panel B. R&D expenses							
Firms with high R&D expenses:							
1	[-1;-0.6)	2,503	0.1163	0.2547	-0.0074	2.1256	5.9713
			0.0535	*0.1807*	*0.0027*	*1.4504*	*4.0828*
2	[-0.6;-0.2)	5,284	0.1007	0.2941	-0.0029	2.3928	6.3757
			0.0369	*0.2308*	*0.0055*	*1.6023*	*4.2062*
3	[-0.2;0.2)	5,579	0.1164	0.2775	0.0007	2.0383	5.8159
			0.0496	*0.2170*	*0.0049*	*1.4197*	*3.8418*
4	[0.2;0.6)	5,214	0.1295	0.2544	-0.0003	1.7419	5.1601
			0.0639	*0.1943*	*0.0042*	*1.2693*	*3.7135*
5	[0.6;1]	3,649	0.1348	0.2586	-0.0052	1.7508	5.0974
			0.0600	*0.1999*	*0.0030*	*1.2262*	*3.7455*
	t-statistic (bin 1 vs. 5)	6,152	-4.2601	-0.6455	-0.3852	7.0426	2.3844
Firms with low R&D expense:							
1	[-1;-0.6)	8,458	0.2855	0.1021	0.0053	1.1856	9.2736
			0.2429	*0.0527*	*0.0015*	*0.8981*	*3.4020*
2	[-0.6;-0.2)	15,258	0.2655	0.1102	0.0069	1.4707	5.0204
			0.2178	*0.0574*	*0.0014*	*0.9690*	*3.4546*
3	[-0.2;0.2)	17,161	0.2787	0.1074	0.0050	1.4255	4.3510
			0.2332	*0.0578*	*0.0014*	*0.9193*	*3.3191*
4	[0.2;0.6)	17,495	0.3017	0.1040	0.0044	1.1036	4.0195
			0.2600	*0.0553*	*0.0011*	*0.8773*	*3.1438*
5	[0.6;1]	11,141	0.3144	0.1048	0.0046	1.1033	4.0547
			0.2763	*0.0556*	*0.0012*	*0.8558*	*3.1429*
	t-statistic (bin 1 vs. 5)	19,599	-8.3773	-1.3751	0.4856	2.3454	1.7826
	t-statistic (high vs. low R&D)	91,742	-100.0000	129.8567	-7.1879	7.3897	0.9968

Table 2 (continued)

Summary statistics for correlation measure

This table reports means and medians of firm characteristics of all firms excluding utilities (SIC codes 4910 – 4939) and financial firms (SIC codes 6000 – 6999) from 1968 to 2012. Data are from the Compustat North America annual files. All variables are reported in constant 2001 USD. *Leverage* is market leverage. *Cash Holdings* is cash and short term investments scaled by total assets. *Cash Flow* is the sum of net cash flows from operating activities, financing activities, and investing activities scaled by total assets. *Tobin's Q* is the sum of long term debt, short term debt, and market equity divided by total assets. *Zscore* is Altman's (1968) Z-score. Firms are sorted in five bins according to their annual correlation measure, $Corr_t$, where bin 1 includes firms with the lowest correlation measure, and bin 5 includes firms with the highest correlation measure. Panels B-E show means and medians for different subsamples: (C) young firms (firms that are 14 years old or younger) and old firms (firms that are at least 15 years old), (D) firms with a high SA-index (SA-index within the highest 25% of its distribution). t-statistics for difference in means tests are reported.

			Mean / *Median*				
Bin	Correlation measure	N	Leverage	Cash holdings	Cash flow	Tobin's Q	Zscore
Panel C. Age							
Young firms:							
1	[-1;-0.6)	7,162	0.2479	0.1510	0.0024	1.4394	10.1391
			0.1892	*0.0747*	*0.0015*	*0.9635*	*3.5170*
2	[-0.6;-0.2)	13,367	0.2286	0.1692	0.0034	1.8168	5.7600
			0.1618	*0.0869*	*0.0023*	*1.0573*	*3.5731*
3	[-0.2;0.2)	14,307	0.2467	0.1627	0.0024	1.7136	4.8213
			0.1832	*0.0848*	*0.0020*	*0.9778*	*3.3592*
4	[0.2;0.6)	13,787	0.2752	0.1477	0.0031	1.2752	4.3375
			0.2208	*0.0750*	*0.0013*	*0.9119*	*3.2237*
5	[0.6;1]	9,398	0.2922	0.1490	0.0009	1.2822	4.5113
			0.2435	*0.0750*	*0.0013*	*0.8670*	*3.1989*
	t-statistic (bin 1 vs. 5)	16,560	-11.4113	0.7082	0.5320	3.4993	1.6623
Old firms:							
1	[-1;-0.6)	3,799	0.2449	0.1105	0.0010	1.3264	5.3763
			0.1988	*0.0577*	*0.0017*	*1.0054*	*3.5002*
2	[-0.6;-0.2)	7,175	0.2127	0.1358	0.0047	1.5051	4.6586
			0.1613	*0.0738*	*0.0017*	*1.1039*	*3.5994*
3	[-0.2;0.2)	8,433	0.2256	0.1261	0.0057	1.3423	4.5454
			0.1765	*0.0700*	*0.0016*	*1.0372*	*3.4828*
4	[0.2;0.6)	8,922	0.2420	0.1243	0.0033	1.2115	4.2113
			0.1951	*0.0672*	*0.0014*	*0.9757*	*3.3025*
5	[0.6;1]	5,392	0.2317	0.1319	0.0025	1.2298	3.9775
			0.1819	*0.0719*	*0.0014*	*0.9945*	*3.3498*
	t- statistic (bin 1 vs. 5)	9,191	2.9480	-6.6381	-0.5700	4.6770	1.3161
	t- statistic (young vs. old)	91,742	16.7544	24.7017	-1.3339	2.3181	1.6069
Panel D. SA-index							
Firms with high SA-index:							
1	[-1;-0.6)	3,648	0.2703	0.0932	0.0061	1.3244	15.3618
			0.2274	*0.0553*	*0.0016*	*1.0350*	*3.2479*
2	[-0.6;-0.2)	6,847	0.2546	0.1041	0.0081	1.4709	4.8191
			0.2101	*0.0606*	*0.0025*	*1.1052*	*3.2930*
3	[-0.2;0.2)	7,559	0.2761	0.0989	0.0072	1.3321	3.9183
			0.2325	*0.0589*	*0.0022*	*1.0434*	*3.0566*
4	[0.2;0.6)	7,675	0.2933	0.0959	0.0068	1.2291	3.4389
			0.2515	*0.0574*	*0.0023*	*0.9949*	*2.9055*
5	[0.6;1]	4,446	0.3006	0.0998	0.0083	1.2129	3.5249
			0.2598	*0.0596*	*0.0022*	*0.9825*	*2.9188*
	t- statistic (bin 1 vs. 5)	8,094	-6.2789	-2.6108	-1.4751	5.4957	1.6622

Table 2 (continued)
Summary statistics for correlation measure

This table reports means and medians of firm characteristics of all firms excluding utilities (SIC codes 4910 – 4939) and financial firms (SIC codes 6000 – 6999) from 1968 to 2012. Data are from the Compustat North America annual files. All variables are reported in constant 2001 USD. *Leverage* is market leverage. *Cash Holdings* is cash and short term investments scaled by total assets. *Cash Flow* is the sum of net cash flows from operating activities, financing activities, and investing activities scaled by total assets. *Tobin's Q* is the sum of long term debt, short term debt, and market equity divided by total assets. *Zscore* is Altman's (1968) Z-score. Firms are sorted in five bins according to their annual correlation measure, $Corr_t$, where bin 1 includes firms with the lowest correlation measure, and bin 5 includes firms with the highest correlation measure. Panels B-E show means and medians for different subsamples: (D) firms with a low SA-index (SA-index within the lowest 75% of its distribution), (E) years in a bad state (mean sales growth is within the lowest 25% of its distribution), and years in other states (mean sales growth is within the highest 75% of its distribution). t-statistics for difference in means tests are reported.

			Mean / *Median*				
Bin	Correlation measure	N	Leverage	Cash holdings	Cash flow	Tobin's Q	Zscore
Panel D. SA-index							
Firms with low SA-index:							
1	[-1;-0.6)	7,313	0.2352	0.1588	-0.0005	1.4381	5.1650
			0.1671	*0.0783*	*0.0017*	*0.9530*	*3.6710*
2	[-0.6;-0.2)	13,695	0.2073	0.1842	0.0018	1.8264	5.6470
			0.1279	*0.0990*	*0.0015*	*1.0573*	*3.7604*
3	[-0.2;0.2)	15,181	0.2204	0.1742	0.0021	1.6973	5.1051
			0.1430	*0.0947*	*0.0015*	*0.9821*	*3.6109*
4	[0.2;0.6)	15,034	0.2462	0.1603	0.0013	1.2610	4.7094
			0.1761	*0.0844*	*0.0008*	*0.9073*	*3.4750*
5	[0.6;1]	10,344	0.2570	0.1612	-0.0013	1.2846	4.6499
			0.1862	*0.0835*	*0.0008*	*0.8972*	*3.4505*
	t- statistic (bin 1 vs. 5)	17,657	-5.8466	-0.8016	0.3086	3.5928	2.9832
	t- statistic (high vs. low SA)	91,742	28.9381	-56.9379	6.4438	-2.1880	0.4047
Panel E. Bad state							
Years in a bad state:							
1	[-1;-0.6)	2,341	0.2830	0.1224	-0.0046	1.0612	3.9517
			0.2388	*0.0651*	*0.0025*	*0.8004*	*3.4634*
2	[-0.6;-0.2)	4,711	0.2596	0.1501	-0.0072	1.2041	4.0124
			0.2132	*0.0769*	*0.0036*	*0.8723*	*3.4585*
3	[-0.2;0.2)	5,227	0.2719	0.1451	0.0022	1.1558	3.9244
			0.2232	*0.0771*	*0.0040*	*0.8516*	*3.3218*
4	[0.2;0.6)	5,297	0.2839	0.1417	0.0071	1.0833	3.7269
			0.2375	*0.0766*	*0.0049*	*0.8305*	*3.2405*
5	[0.6;1]	3,490	0.3387	0.1237	0.0024	1.0962	3.7545
			0.3120	*0.0667*	*0.0032*	*0.7459*	*3.1730*
	t- statistic (bin 1 vs. 5)	5,831	-8.3414	-0.3194	-0.8467	-0.3109	1.1274
Years in other states:							
1	[-1;-0.6)	8,620	0.2371	0.1410	0.0026	1.4923	9.7554
			0.1811	*0.0688*	*0.0016*	*1.0390*	*3.5286*
2	[-0.6;-0.2)	15,831	0.2122	0.1597	0.0061	1.8578	5.7849
			0.1464	*0.0836*	*0.0018*	*1.1424*	*3.6383*
3	[-0.2;0.2)	17,513	0.2290	0.1503	0.0042	1.7013	4.9595
			0.1672	*0.0790*	*0.0015*	*1.0528*	*3.4439*
4	[0.2;0.6)	17,412	0.2555	0.1375	0.0023	1.3009	4.4609
			0.2007	*0.0705*	*0.0009*	*0.9718*	*3.2591*
5	[0.6;1]	11,300	0.2489	0.1486	0.0015	1.3146	4.4931
			0.1886	*0.0768*	*0.0012*	*0.9831*	*3.2931*
	t- statistic (bin 1 vs. 5)	19,920	-3.6069	-2.9755	0.5679	8.7113	1.8325
	t- statistic (bad vs. other states)	91,742	26.8484	-6.1158	-1.8662	-4.1280	-2.2307

Table 3
OLS regression results

This table shows the regression results with the excess stock return as the dependent variable and firm characteristics as independent variables, where C_t is cash and short term investments at time t. $Corr_t$ is the rolling correlation of Tobin's Q scaled by its SIC3-industry mean and the lagged mean sales growth over a five-year rolling window at time t. L_t is market leverage at time t. E_t is earnings before extraordinary items plus interest, deferred income taxes and investment tax credit at time t. NA_t is total assets minus cash and short term investments at time t. RD_t is investments in research and development at time t. I_t is interest expenses at time t. D_t is common dividends paid at time t. NF_t is net financing at time t, calculated as total equity issuance minus repurchases plus debt issuance minus redemption. All independent variables are scaled with lagged market equity except for $Corr_t$ and L_t. Standard errors are heteroscedasticity-consistent and clustered at the firm level. The absolute value of the t-statistics is reported in parentheses. *, **, and *** correspond to statistical significance at 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)
Intercept	0.033***	0.032***	0.060***	0.060***
	(9.133)	(9.182)	(14.581)	(14.673)
ΔC_t	1.050***	1.690***	1.507***	1.520***
	(46.426)	(44.381)	(32.147)	(31.402)
$Corr_t$			-0.003	-0.017***
			(-0.935)	(-3.020)
$\Delta C_t \times Corr_t$			-0.088**	-0.219***
			(-1.985)	(-2.744)
$\Delta C_t \times Corr_t \times L_t$				0.401**
				(2.358)
$Corr_t \times L_t$				0.056***
				(3.672)
$C_{t-1} \times \Delta C_t$		-0.333***	-0.317***	-0.321***
		(-6.487)	(-4.863)	(-4.890)
$\Delta C_t \times L_t$		-1.457***	-1.268***	-1.314***
		(-22.008)	(-14.577)	(-14.115)
L_t	-0.613***	-0.607***	-0.585***	-0.589***
	(-71.593)	(-72.102)	(-56.509)	(-56.369)
ΔE_t	0.477***	0.473***	0.494***	0.494***
	(36.281)	(36.169)	(30.272)	(30.279)
ΔNA_t	0.153***	0.164***	0.161***	0.162***
	(22.724)	(24.680)	(18.763)	(18.862)
ΔRD_t	0.337**	0.259*	0.300	0.296
	(2.338)	(1.812)	(1.637)	(1.617)
ΔI_t	-1.573***	-1.497***	-1.715***	-1.714***
	(-18.360)	(-17.590)	(-15.728)	(-15.720)
ΔD_t	1.424***	1.357***	1.377***	1.370***
	(8.638)	(8.127)	(6.353)	(6.314)
C_{t-1}	0.556***	0.527***	0.467***	0.467***
	(37.840)	(34.327)	(26.146)	(26.118)
NF_t	0.090***	0.060***	0.036**	0.036**
	(6.520)	(4.453)	(2.092)	(2.043)
Observations	131,855	131,855	83,823	83,823

Table 3 (continued)

OLS regression results

This table shows the regression results with the excess stock return as the dependent variable and firm characteristics as independent variables, where C_t is cash and short term investments at time *t*. $Corr_t$ is the rolling correlation of Tobin's Q scaled by its SIC3-industry mean and the lagged mean sales growth over a five-year rolling window at time *t*. L_t is market leverage at time *t*. SA_t is the SA-index at time *t* (scaled with 10*10^8). $HighRD\_d_t$ is a dummy variable, which takes a value of 1 if a firm has investments in research and development within the top 25% of its distribution at time *t* and 0 otherwise. Bad_d_t is a dummy variable, which in column (7) takes a value of 1 if the mean sales growth at time *t* is within the lowest 25% of its distribution and 0 otherwise, and in column (8) takes a value of 1 if the mean excess return at time *t* is within the lowest 25% of its distribution and 0 otherwise. E_t is earnings before extraordinary items plus interest, deferred income taxes and investment tax credit at time *t*. NA_t is total assets minus cash and short term investments at time *t*. RD_t is investments in research and development at time *t*. I_t is interest expenses at time *t*. D_t is common dividends paid at time *t*. NF_t is net financing at time *t*, calculated as total equity issuance minus repurchases plus debt issuance minus redemption. All independent variables are scaled with lagged market equity except for $Corr_t$ and L_t. Standard errors are heteroscedasticity-consistent and clustered at the firm level. The absolute value of the t-statistics is reported in parentheses. *, **, and *** correspond to statistical significance at 10%, 5%, and 1% level, respectively.

	(5)	(6)	(7)	(8)
Intercept	0.060***	0.087***	0.051***	0.057***
	(14.577)	(19.189)	(12.317)	(12.820)
ΔC_t	1.507***	1.309***	1.485***	1.434***
	(32.136)	(26.892)	(30.741)	(27.901)
$Corr_t$	-0.003	0.001	0.007*	0.027***
	(-0.953)	(0.339)	(1.797)	(5.859)
$\Delta C_t \times Corr_t$	-0.088**	-0.027	-0.029	0.035
	(-1.983)	(-0.594)	(-0.558)	(0.642)
$\Delta C_t \times Corr_t \times SA_t$	0.021			
	(0.183)			
$Corr_t \times SA_t$	0.004*			
	(1.760)			
SA_t	0.004			
	(0.994)			
$\Delta C_t \times SA_t$	0.012			
	(0.339)			
$\Delta C_t \times Corr_t \times HighRD\_d_t$		-0.310**		
		(-2.399)		
$Corr_t \times HighRD\_d_t$		-0.021**		
		(-2.431)		
$HighRD\_d_t$		-0.078***		
		(-13.177)		
$\Delta C_t \times HighRD\_d_t$		0.518***		
		(7.173)		
$\Delta C_t \times Corr_t \times Bad\_d_t$			-0.184*	-0.250***
			(-1.894)	(-2.905)
$Corr_t \times Bad\_d_t$			-0.047***	-0.062***
			(-5.770)	(-9.223)
Bad_d_t			0.054***	0.006
			(12.732)	(1.620)
$\Delta C_t \times Bad\_d_t$			0.077	0.143***
			(1.400)	(2.946)
$C_{t-1} \times \Delta C_t$	-0.317***	-0.344***	-0.325***	-0.328***
	(-4.860)	(-5.299)	(-5.049)	(-5.032)
$\Delta C_t \times L_t$	-1.268***	-0.979***	-1.272***	-1.265***
	(-14.568)	(-11.515)	(-14.647)	(-14.587)
L_t	-0.585***	-0.622***	-0.591***	-0.581***
	(-56.507)	(-56.830)	(-57.122)	(-56.364)
ΔE_t	0.494***	0.493***	0.492***	0.493***
	(30.270)	(30.277)	(30.195)	(30.218)
ΔNA_t	0.161***	0.157***	0.164***	0.162***
	(18.750)	(18.347)	(19.178)	(18.878)
ΔRD_t	0.301*	0.284	0.326*	0.285
	(1.638)	(1.547)	(1.782)	(1.547)
ΔI_t	-1.714***	-1.669***	-1.727***	-1.730***
	(-15.717)	(-15.348)	(-15.859)	(-15.916)
ΔD_t	1.377***	1.365***	1.421***	1.373***
	(6.351)	(6.324)	(6.615)	(6.356)
C_{t-1}	0.467***	0.480***	0.458***	0.464***
	(26.113)	(26.720)	(25.858)	(26.113)
NF_t	0.037**	0.036**	0.036**	0.035**
	(2.093)	(2.057)	(2.054)	(2.017)
Observations	83,823	83,823	83,823	83,823

Table 4
3SLS regression results

This table shows the standardized results of the three-stage least squares (3SLS) regressions, involving a cash model and an investment model, calculated via conditional mixed process: 1) $Cash_{i,t} = \theta_0 + \theta_1 CF_{i,t} + \theta_2 M/B_{i,t} + \theta_3 Size_{i,t} + \theta_4 Lev_{i,t} + \theta_5 Ind.CFVola_{i,t} + \theta_6 CCDur_{i,t} + \theta_7 Zscore_{i,t} + \theta_8 Ret.spr_{i,t} + \theta_9 \Delta Ind.prod_{i,t} + \varepsilon_{i,t}$, and 2) $Netinv_{i,t+1} = \gamma_0 + \gamma_1 Cash_{i,t} + \gamma_2 CF_{i,t} + \gamma_3 M/B_{i,t} + \gamma_4 \Delta Sales_{i,t} + \varepsilon_{i,t}$. The cash model has as dependent variable cash and short term equivalents scaled by total assets at time *t*, labelled $Cash_{i,t}$. CF_t is operating cash flow at time *t*, calculated as earnings before interest, taxes, depreciation, and amortization divided by sales. M/B_t is the ratio of market equity to book equity at time *t*. $Size_t$ is the logarithm of total assets at time *t*. Lev_t is leverage at time *t*, calculated as the sum of long term debt and short term debt divided by total assets. $Ind.CFvola_t$ is the industry cash flow volatility at time *t*, calculated as the median of the firm-level standard deviation of first differences in earnings before interest, taxes, depreciation, and amortization over the prior 20 years. $CCDur_t$ is the cash cycle duration at time *t*, calculated as the sum of average inventory age and average collection period less the average payment period. $Zscore_t$ is Altman's (1968) Z-score at time *t*. $Ret.spr_t$ is the return on investment less the risk free rate at time *t*. The return on investment is calculated as earnings before interest and taxes divided by total assets, and the risk-free rate is annualized Treasury bill return over the fiscal year. $\Delta Ind.prod_t$ is the industry production growth at time *t*, calculated as the logarithm of the growth rate of industrial production, which is the mean of sales growth at SIC2-industry level. The second model has net investment as dependent variable. $Netinv_{t+1}$ is calculated as capital expenditures minus depreciation plus R&D expenses scaled by total assets at time *t+1*. Independent variables in this model are $Cash_t$, CF_t, M/B_t and $\Delta Sales_t$, which is the logarithm of sales growth over the previous two years at time *t*. High (low) *Corr* firms are firms with a correlation measure within the top (lowest) 25% of its distribution. High R&D firms are firms with investments in research and development within the top 25% of its distribution. High tech firms are firms with a SIC code that starts with 28, 35, 36, 37 (except for 372 and 376), 38, or 73. SIC2-industry and firm fixed effects are included. Standard errors are heteroscedasticity-consistent and clustered at the firm level. The absolute value of the t-statistics is reported in parentheses. *, **, and *** correspond to statistical significance at 10%, 5%, and 1% level, respectively.

	Full sample		High R&D firms		High R&D and high tech firms	
	(1) High *Corr*	(2) Low *Corr*	(3) High *Corr*	(4) Low *Corr*	(5) High *Corr*	(6) Low *Corr*
Net investment regression:						
$Cash_t$	0.408***	0.416***	0.316***	0.397***	0.278***	0.370***
	(13.193)	(12.189)	(6.731)	(7.995)	(5.659)	(7.025)
CF_t	-0.018	-0.039**	-0.136***	-0.147***	-0.139***	-0.157***
	(-0.932)	(-2.392)	(-4.728)	(-6.122)	(-4.541)	(-6.209)
M/B_t	0.096***	0.038***	0.158***	0.000	0.119***	0.000
	(6.218)	(2.659)	(4.765)	(-0.981)	(3.960)	(-0.532)
$\Delta Sales_t$	0.108***	0.118***	0.073***	0.118***	0.084***	0.117***
	(10.955)	(12.103)	(3.665)	(5.952)	(4.022)	(5.162)
Cash regression:						
CF_t	0.045**	0.078***	-0.034	-0.040	-0.019	-0.027
	(2.328)	(3.856)	(-0.622)	(-0.838)	(-0.320)	(-0.517)
M/B_t	0.108***	0.126***	0.062***	0.057**	0.073***	0.059**
	(6.614)	(8.313)	(2.739)	(2.481)	(2.737)	(2.228)
$Size_t$	-0.038***	-0.048***	0.031	0.029	0.032	0.049**
	(-3.680)	(-4.118)	(1.496)	(1.525)	(1.463)	(2.175)
Lev_t	-0.340***	-0.346***	-0.288***	-0.294***	-0.279***	-0.293***
	(-25.882)	(-29.089)	(-12.506)	(-14.222)	(-11.285)	(-13.448)
$Ind.CFvola_t$	0.142***	0.135***	0.122***	0.131***	0.143***	0.163***
	(11.534)	(11.515)	(6.372)	(6.784)	(7.566)	(8.032)
$CCDur_t$	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(-6.574)	(-9.511)	(-10.290)	(-7.468)	(-9.542)	(-6.641)
$Zscore_t$	0.211***	0.184***	0.235***	0.201***	0.236***	0.202***
	(9.155)	(10.330)	(6.844)	(7.911)	(7.047)	(7.650)
$Ret.spr_t$	-0.253***	-0.297***	-0.267***	-0.317***	-0.268***	-0.332***
	(-12.375)	(-14.580)	(-5.303)	(-7.632)	(-5.115)	(-7.357)
$\Delta Ind.prod_t$	0.021**	0.013	0.044***	0.053***	0.015	0.023
	(2.159)	(1.589)	(2.658)	(3.521)	(0.922)	(1.329)
Observations	15,311	15,994	3,622	3,900	3,286	3,420

Chow-test on cash	(2) versus (1)	(4) versus (3)	(6) versus (5)
	10.73	6.23	6.79
p(diff=0)	0.0047	0.0444	0.0335

Table 4 (continued)
3SLS regression results

This table shows the standardized results of the three-stage least squares (3SLS) regressions, involving a cash model and an investment model, calculated via conditional mixed process: 1) $Cash_{i,t} = \theta_0 + \theta_1 CF_{i,t} + \theta_2 M/B_{i,t} + \theta_3 Size_{i,t} + \theta_4 Lev_{i,t} + \theta_5 Ind.CFVola_{i,t} + \theta_6 CCDur_{i,t} + \theta_7 Zscore_{i,t} + \theta_8 Ret.spr_{i,t} + \theta_9 \Delta Ind.prod_{i,t} + \varepsilon_{i,t}$, and 2) $Netinv_{i,t+1} = \gamma_0 + \gamma_1 Cash_{i,t} + \gamma_2 CF_{i,t} + \gamma_3 M/B_{i,t} + \gamma_4 \Delta Sales_{i,t} + \varepsilon_{i,t}$. The cash model has as dependent variable cash and short term equivalents scaled by total assets at time *t*, labelled $Cash_{i,t}$. CF_t is operating cash flow at time *t*, calculated as earnings before interest, taxes, depreciation, and amortization divided by sales. M/B_t is the ratio of market equity to book equity at time *t*. $Size_t$ is the logarithm of total assets at time *t*. Lev_t is leverage at time *t*, calculated as the sum of long term debt and short term debt divided by total assets. $Ind.CFvola_t$ is the industry cash flow volatility at time *t*, calculated as the median of the firm-level standard deviation of first differences in earnings before interest, taxes, depreciation, and amortization over the prior 20 years. $CCDur_t$ is the cash cycle duration at time *t*, calculated as the sum of average inventory age and average collection period less the average payment period. $Zscore_t$ is Altman's (1968) Z-score at time *t*. $Ret.spr_t$ is the return on investment less the risk free rate at time *t*. The return on investment is calculated as earnings before interest and taxes divided by total assets, and the risk-free rate is annualized Treasury bill return over the fiscal year. $\Delta Ind.prod_t$ is the industry production growth at time *t*, calculated as the logarithm of the growth rate of industrial production, which is the mean of sales growth at SIC2-industry level. The second model has net investment as dependent variable. $Netinv_{t+1}$ is calculated as capital expenditures minus depreciation plus R&D expenses scaled by total assets at time *t+1*. Independent variables in this model are $Cash_t$, CF_t, M/B_t and $\Delta Sales_t$, which is the logarithm of sales growth over the previous two years at time *t*. High (low) *Corr* firms are firms with a correlation measure within the top (lowest) 25% of its distribution. Low leverage firms are firms with leverage within the bottom 25% of its distribution. Years in a bad state are years with a mean sales growth within the lowest 25% of its distribution. SIC2-industry and firm fixed effects are included. Standard errors are heteroscedasticity-consistent and clustered at the firm level. The absolute value of the t-statistics is reported in parentheses. *, **, and *** correspond to statistical significance at 10%, 5%, and 1% level, respectively.

	Low leverage firms		Years in a bad state	
	(7) High *Corr*	(8) Low *Corr*	(9) High *Corr*	(10) Low *Corr*
Net investment regression:				
$Cash_t$	0.235***	0.359***	0.265***	0.285***
	(4.389)	(5.077)	(4.284)	(3.551)
CF_t	-0.151***	-0.162***	-0.072	-0.030
	(-5.047)	(-5.888)	(-1.613)	(-0.851)
M/B_t	0.166***	0.031	0.136***	0.078**
	(5.037)	(1.181)	(3.007)	(2.560)
$\Delta Sales_t$	0.078***	0.137***	0.153***	0.161***
	(3.997)	(6.305)	(7.808)	(9.281)
Cash regression:				
CF_t	0.027	-0.018	0.017	0.030
	(0.592)	(-0.425)	(0.481)	(0.951)
M/B_t	0.000	0.078**	0.159***	0.192***
	(0.057)	(2.506)	(5.297)	(6.924)
$Size_t$	-0.024	-0.016	-0.052***	-0.067***
	(-0.961)	(-0.733)	(-3.150)	(-3.738)
Lev_t	-0.210***	-0.178***	-0.314***	-0.330***
	(-11.328)	(-10.386)	(-14.509)	(-14.407)
$Ind.CFvola_t$	0.197***	0.176***	0.194***	0.192***
	(7.348)	(7.866)	(8.380)	(7.936)
$CCDur_t$	0.000***	0.000***	0.000***	0.000***
	(-6.752)	(-7.714)	(-6.477)	(-7.249)
$Zscore_t$	0.206***	0.153***	0.209***	0.156***
	(6.845)	(4.800)	(5.984)	(4.127)
$Ret.spr_t$	-0.251***	-0.312***	-0.227***	-0.282***
	(-5.726)	(-7.932)	(-5.716)	(-7.231)
$\Delta Ind.prod_t$	0.017	0.016	0.028*	0.026
	(0.862)	(0.900)	(1.683)	(1.265)
Observations	3,173	3,513	3,458	3,550
Chow-test on cash	(8) versus (7)		(10) versus (9)	
	2.89		12.04	
p(diff=0)	0.2354		0.0024	

Table 5
OLS regression results on operating performance

This table shows the regression results with the operating performance as the dependent variable and firm characteristics as independent variables: $op_{i,t} = \sigma_0 + \sigma_1\Delta C_{i,t} + \sigma_2 Corr_{i,t} + \sigma_3\Delta C_{i,t}\times Corr_{i,t} + \sigma_4 L_{i,t} + \sigma_5\Delta E_{i,t} + \sigma_6\Delta NA_{i,t} + \sigma_7\Delta RD_{i,t} + \sigma_8\Delta I_{i,t} + \sigma_9\Delta D_{i,t} + \sigma_{10}NF_{i,t} + \sigma_{11}Size_{i,t} + \varepsilon_{i,t}$, where op_t is the average of the two following years of net income scaled by market equity at time t. C_t is cash and short term investments at time t. $Corr_t$ is the rolling correlation of Tobin's Q scaled by its SIC3-industry mean and the lagged mean sales growth over a five-year rolling window at time t. L_t is market leverage at time t. E_t is earnings before extraordinary items plus interest, deferred income taxes and investment tax credit at time t. NA_t is total assets minus cash and short term investments at time t. RD_t is investments in research and development at time t. I_t is interest expenses at time t. D_t is common dividends paid at time t. NF_t is net financing at time t, calculated as total equity issuance minus repurchases plus debt issuance minus redemption. $Size_t$ is the logarithm of total assets at time t. High (low) *Corr* firms are firms with a correlation measure within the top (lowest) 25% of its distribution. High net investment firms are firms with a high level of net investment (within the top 25% of its distribution). All independent variables are scaled with lagged market equity except for $Corr_t$, L_t and $Size_t$. SIC2-industry and year fixed effects are included. Standard errors are heteroscedasticity-consistent and clustered at the firm level. The absolute value of the t-statistics is reported in parentheses.*, **, and *** correspond to statistical significance at 10%, 5%, and 1% level, respectively.

	(1) Full sample	(2) Full sample	(3) High *Corr*	(4) High *Corr* & high net investm.	(5) Low *Corr*	(6) Low *Corr* & high net investm.
ΔC_t	0.289***	0.258***	0.207***	0.239**	0.364***	0.873***
	(4.717)	(4.368)	(3.103)	(1.659)	(3.661)	(3.449)
$Corr_t$		0.008**				
		(2.097)				
$\Delta C_t \times Corr_t$		-0.346*				
		(-1.827)				
L_t	-0.514***	-0.481***	-0.445***	-0.220	-0.318***	0.072
	(-12.567)	(-12.951)	(-7.046)	(-1.337)	(-6.628)	(0.382)
ΔE_t	0.292***	0.246***	0.099***	0.087*	0.199***	0.116
	(11.930)	(10.389)	(2.595)	(1.955)	(3.898)	(1.092)
ΔNA_t	0.010	0.018***	0.026***	0.073	0.016	0.252**
	(1.160)	(2.579)	(2.791)	(1.388)	(1.366)	(2.182)
ΔRD_t	-0.789	-0.386	-4.843	0.177	-1.022	0.903
	(-0.532)	(-0.221)	(-1.509)	(0.056)	(-0.392)	(0.477)
ΔI_t	-5.578***	-5.872***	-6.095***	-3.301	-4.026*	-18.386
	(-3.765)	(-4.196)	(-3.327)	(-0.150)	(-1.872)	(-0.690)
ΔD_t	36.143***	26.277***	27.196**	-7.292	-1.884	99.421
	(3.195)	(4.175)	(2.172)	(-0.197)	(-0.243)	(1.544)
NF_t	-0.063*	-0.083**	-0.088**	-0.319**	-0.054	-0.632***
	(-1.738)	(-2.019)	(-2.518)	(-2.482)	(-1.263)	(-3.249)
$Size_t$	-0.001	0.003***	0.004***	0.004***	0.004***	0.006***
	(-0.699)	(4.977)	(7.707)	(5.871)	(8.045)	(6.433)
Observations	104,521	66,830	16,890	1,534	16,748	1,760

Table 6
Robustness test: OLS regression results

This table shows the regression results with the excess stock return as dependent variable and firm characteristics as independent variables: $r^E_{i,t} = \alpha_0 + \alpha_1\Delta C_{i,t} + \alpha_2 Corr_{i,t} + \alpha_3\Delta C_{i,t}\times Corr_{i,t} + \alpha_4 C_{i,t-1}\times\Delta C_{i,t} + \alpha_5 L_{i,t}\times\Delta C_{i,t} + \alpha_6 L_{i,t} + \alpha_7\Delta E_{i,t} + \alpha_8\Delta NA_{i,t} + \alpha_9\Delta RD_{i,t} + \alpha_{10}\Delta I_{i,t} + \alpha_{11}\Delta D_{i,t} + \alpha_{12}C_{i,t-1} + \alpha_{13}NF_{i,t} + \varepsilon_{i,t}$, where C_t is cash and short term investments at time *t*. $Corr_t$ is the rolling correlation of Tobin's Q scaled by its SIC3-industry mean and the lagged mean sales growth over a five-year rolling window at time *t*. $Zscore_t$ is Altman's (1968) Z-score at time *t*. $LowGov\_d_t$ is a dummy variable that takes a value of 1 if the firm has an E-Index of 4 or higher at time *t*, and 0 otherwise. Bad_d_t is a dummy variable, which takes a value of 1 if the mean sales growth at time *t* is within the lowest 25% of its distribution, and 0 otherwise. L_t is market leverage at time *t*. E_t is earnings before extraordinary items plus interest, deferred income taxes, and investment tax credit at time *t*. NA_t is total assets minus cash and short term investments at time *t*. RD_t is investments in research and development at time *t*. I_t is interest expenses at time *t*. D_t is common dividends paid at time *t*. NF_t is net financing at time *t*, calculated as total equity issuance minus repurchases plus debt issuance minus redemption. All independent variables are scaled with lagged market equity except for $Corr_t$ and L_t. Standard errors are heteroscedasticity-consistent and clustered at the firm level. The absolute value of the t-statistics is reported in parentheses, *, **, and *** correspond to statistical significance at 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)
Intercept	0.029***	0.048***	0.041***	0.041***
	(4.552)	(5.727)	(4.897)	(4.973)
ΔC_t	1.708***	1.729***	1.836***	1.751***
	(28.505)	(14.118)	(14.676)	(14.162)
$Corr_t$	-0.039***	-0.019***		-0.009
	(-6.482)	(-3.002)		(-1.254)
$\Delta C_t \times Corr_t$	-0.226***	-0.236*		-0.244*
	(-3.430)	(-1.752)		(-1.758)
$\Delta C_t \times Corr_t \times Zscore_t$	-0.009			
	(-1.107)			
$Corr_t \times Zscore_t$	0.003***			
	(4.199)			
$\Delta C_t \times Zscore_t$	0.019***			
	(4.277)			
$Zscore_t$	0.002***			
	(4.234)			
$\Delta C_t \times LowGov\_d_t \times Bad\_d_t$			0.926**	
			(2.395)	
$LowGov\_d_t \times Bad\_d_t$			0.018	
			(0.941)	
$\Delta C_t \times Bad\_d_t$			0.031	
			(0.190)	
Bad_d_t			0.020**	
			(2.329)	
$\Delta C_t \times LowGov\_d_t$			-0.857***	-0.252
			(-4.056)	(-1.095)
$LowGov\_d_t$			0.031***	0.049***
			(2.990)	(5.283)
$\Delta C_t \times Corr_t \times LowGov\_d_t$				0.052
				(0.117)
$Corr_t \times LowGov\_d_t$				-0.089***
				(-4.748)
$C_{t-1} \times \Delta C_t$	-0.425***	-0.405**	-0.385**	-0.405**
	(-5.227)	(-2.010)	(-2.077)	(-2.037)
$\Delta C_t \times L_t$	-1.321***	-1.183***	-1.399***	-1.175***
	(-11.372)	(-4.253)	(-5.430)	(-4.241)
L_t	-0.572***	-0.520***	-0.564***	-0.512***
	(-39.226)	(-22.104)	(-24.908)	(-22.083)
ΔE_t	0.495***	0.439***	0.411***	0.443***
	(24.481)	(10.885)	(11.341)	(10.934)
ΔNA_t	0.210***	0.201***	0.186***	0.203***
	(15.901)	(7.875)	(8.006)	(7.977)
ΔRD_t	0.211	-0.152	-0.345	-0.118
	(0.993)	(-0.326)	(-0.767)	(-0.253)
ΔI_t	-2.331***	-2.518***	-2.197***	-2.566***
	(-11.479)	(-5.307)	(-5.419)	(-5.440)
ΔD_t	0.606**	0.385	0.318	0.422
	(2.066)	(0.889)	(0.809)	(0.953)
C_{t-1}	0.504***	0.448***	0.480***	0.440***
	(23.004)	(10.416)	(11.290)	(10.381)
NF_t	-0.013	-0.169***	-0.137***	-0.168***
	(-0.466)	(-3.380)	(-2.986)	(-3.386)
Observations	53,052	18,597	20,871	18,597

Table 7

Robustness test: OLS regression results using the recent financial crisis

This table shows the results of the following regression model: $Netinv_{i,t} = \vartheta_0 + \vartheta_1 Crisis_t + \vartheta_2 \Delta C_{i,t-1} \times Corr_{i,t-1} \times Crisis_t + \vartheta_3 \Delta C_{i,t-1} \times Crisis_t + \vartheta_4 Corr_{i,t-1} \times Crisis_t + \vartheta_5 \Delta C_{i,t-1} \times Corr_{i,t-1} + \vartheta_6 \Delta C_{i,t-1} + \vartheta_7 Corr_{i,t-1} + \vartheta_8 Q_{i,t-1} + \vartheta_9 CF_{i,t-1} + \varepsilon_{i,t}$. The independent variable, $Netinv_{i,t}$, is calculated as capital expenditures minus depreciation plus R&D expenses scaled by total assets at time *t*. $Crisis_t$ is a dummy variable that takes a value of 1 if *t* is between July 2007 and June 2008, and 0 otherwise. $\Delta C_{i,t}$ is the change in cash and short term investments during the fiscal year in *t*. $Corr_{i,t}$ is the rolling correlation of Tobin's Q scaled by its SIC3-industry mean and the lagged mean sales growth over a 5 year window at time *t*. *Tobin's* $Q_{i,t}$ is Tobin's Q at time *t*. *Operating* $CF_{i,t}$ is EBITDA scaled by total assets at time *t*. Firm fixed effects are included. Standard errors are heteroscedasticity-consistent and clustered at the firm level. The absolute value of the t-statistics is reported in parentheses. *, **, and *** correspond to statistical significance at 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)
Intercept	0.072***	0.060***	0.056***	0.052***
	(100.273)	(81.410)	(29.538)	(26.302)
$Crisis_t$	-0.007***	-0.005***	-0.005***	-0.005***
	(-4.833)	(-3.611)	(-3.682)	(-3.503)
$\Delta C_{t-1} \times Corr_{t-1} \times Crisis_t$		-0.117***	-0.118***	-0.121***
		(-4.182)	(-4.197)	(-4.340)
$\Delta C_{t-1} \times Crisis_t$		-0.015	-0.013	-0.011
		(-1.335)	(-1.177)	(-0.963)
$Corr_{t-1} \times Crisis_t$		0.003	0.002	0.002
		(0.991)	(0.865)	(0.839)
$\Delta C_{t-1} \times Corr_{t-1}$		0.021	0.022	0.025*
		(1.521)	(1.556)	(1.823)
ΔC_{t-1}		0.017***	0.017***	0.006
		(2.976)	(2.957)	(0.954)
$Corr_{t-1}$		-0.002	-0.003	-0.003
		(-1.139)	(-1.202)	(-1.580)
Tobin's Q_{t-1}			0.003***	0.002*
			(2.580)	(1.714)
Operating CF_{t-1}				0.074***
				(7.478)
Observations	12,918	9,068	9,068	9,067

Table 8

Robustness test: Return-cash sensitivity regression results

This table shows the results of the second step of the two-stage estimation of the return-cash sensitivity depending on the business cycle: $\delta_t = \gamma_0 + \gamma_1 \Delta Aggr.sales_{t-1} + \gamma_2 Timetrend_t + \varepsilon_t$. The dependent variable is the sensitivity of annual return to cash at time *t* [estimated in a first step via an Ordinary Least Squares regression (Panel A) or via a Two-stage Least Squares regression (Panel B)]. $\Delta Aggr.sales_{t-1}$ is the mean sales growth of the sample at time *t-1*. Bad_d_{t-1} is a dummy variable that takes the value of 1 if the mean sales growth at time *t* is within the lowest 25% of its distribution, and 0 otherwise. $Good\_d_{t-1}$ is a dummy variable that takes the value of 1 if the mean sales growth at time *t* is within the top 25% of its distribution, and 0 otherwise. $Timetrend_t$ is the year of the observation. Columns (1)-(3) show the results for the full sample, columns (4)-(6) include only firms with a high correlation measure (top 33% of its distribution), and columns (7)-(9) are based on a sample of only low correlated firms (bottom 33% of its distribution). Standard errors are heteroscedasticity-consistent and clustered at the firm level. The absolute value of the t-statistics is reported in parentheses. *, **, and *** correspond to statistical significance at 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: OLS									
Intercept	0.947***	1.027***	0.781***	1.927***	2.382***	1.605***	-3.072***	-3.082***	-2.950***
	(42.995)	(47.202)	(35.461)	(38.262)	(59.917)	(30.529)	(-23.468)	(-25.880)	(-24.162)
$\Delta Aggr.sales_{t-1}$	0.023***			0.018***			-0.026***		
	(149.885)			(66.651)			(-17.774)		
Bad_d_{t-1}		-0.037***			-0.047***			0.036***	
		(-158.040)			(-75.174)			(18.833)	
$Good\_d_{t-1}$			0.034***			0.009***			-0.046***
			(133.021)			(17.293)			(-28.578)
$Timetrend_t$	-0.000***	-0.001***	-0.000***	-0.001***	-0.001***	-0.001***	0.002***	0.002***	0.001***
	(-43.249)	(-46.414)	(-35.453)	(-38.320)	(-50.555)	(-30.357)	(23.436)	(25.705)	(24.145)
Panel B: 2SLS									
Intercept	0.920***	0.739***	0.718***	2.102***	2.287***	1.669***	-2.039***	-2.539***	-1.795***
	(34.142)	(26.644)	(29.135)	(30.935)	(34.992)	(23.684)	(-17.232)	(-24.058)	(-16.102)
$\Delta Aggr.sales_{t-1}$	0.031***			0.024***			-0.022***		
	(168.943)			(64.450)			(-15.861)		
Bad_d_{t-1}		-0.032***			-0.045***			0.060***	
		(-129.251)			(-69.470)			(44.301)	
$Good\_d_{t-1}$			0.046***			0.010***			-0.025***
			(145.340)			(14.286)			(-16.125)
$Timetrend_t$	-0.001***	-0.000***	-0.000***	-0.001***	-0.001***	-0.001***	0.001***	0.001***	0.001***
	(-34.661)	(-26.869)	(-26.892)	(-31.019)	(-34.646)	(-23.541)	(17.039)	(23.641)	(15.864)
Observations	145,227	145,231	145,231	76,421	76,425	76,425	22,936	22,936	22,936

Figures

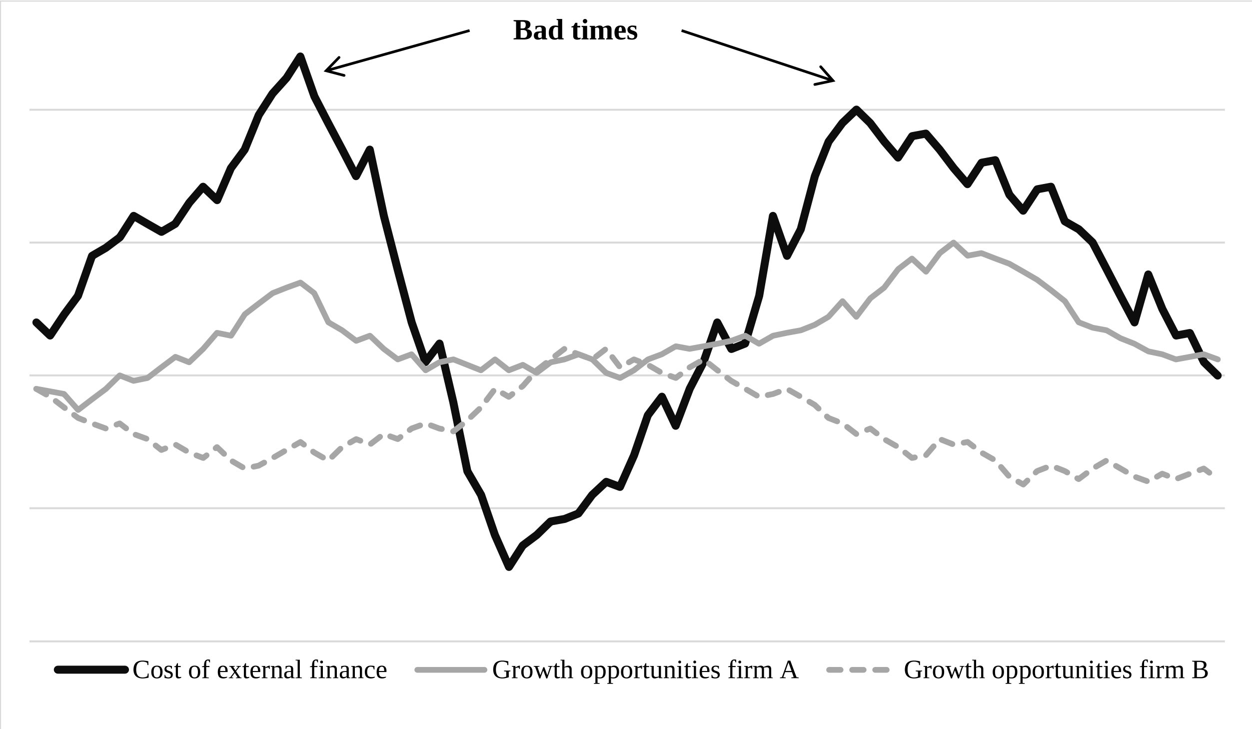

Figure 1. Cyclicality of growth opportunities and cost of external finance.

This figure illustrates our economic intuition. Assume that the cost of external finance is time varying. In particular, the cost of external finance is high in bad times, and low in good times. Firm A exhibits a low cyclicality of growth opportunities and needs cash exactly when raising external funds is costly (in bad states). Firm B is the opposite; this firm has a high cyclicality of growth opportunities and requires funding when it either has sufficient cash flows or the cost of external finance is low (in good states). Therefore, compared to firm B, cash holdings should be more valuable and investment and operating performance more sensitive to cash holdings in firm A.

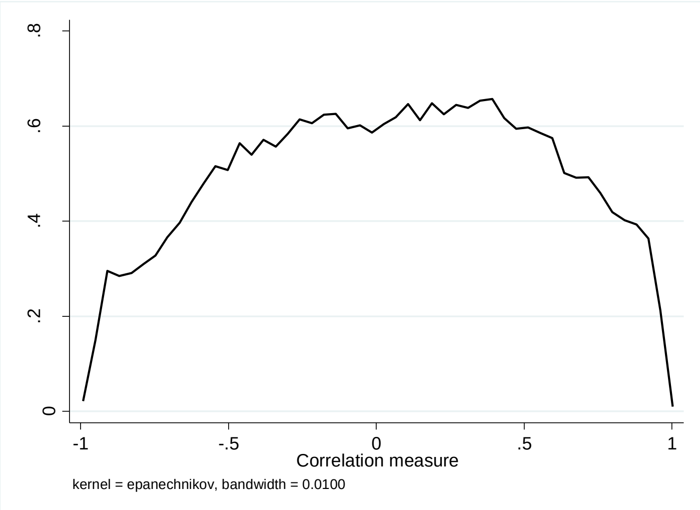

Figure 2. Distribution of correlation measure.

This figure shows the distribution of the correlation measure ranging between -1 and 1. The correlation measure is the correlation of Tobin's Q scaled by its SIC3-industry mean and the lagged mean sales growth over a five-year window. The correlation measure is winsorized at the 1% and 99% level.

Appendix: Variable definitions

Panel A: Value of cash

	Definition	Source
r^E	Annual stock return over the fiscal year minus the return of the Fama and French benchmark return (25 value-weighted portfolios based on size and book-to-market)	CRSP / French's Website[1]
C	Cash and short term investments	Compustat
ΔC	Annual change in cash and short term investments	Compustat
Tobin's Q	Sum of long term debt, short term debt, and market equity scaled by total assets	Compustat
Corr	Five-year rolling window correlation between a firm's Tobin's Q and the lagged aggregate sales growth across all firms	Compustat
ΔE	Annual change in earnings before extraordinary items plus interest, deferred income taxes and investment tax credit	Compustat
ΔNA	Annual change in total assets minus cash and short term equivalents	Compustat
ΔRD	Annual change in research and development expenses	Compustat
ΔI	Annual change in interest expenses	Compustat
ΔD	Annual change in common dividends	Compustat
L	Sum of long term debt and short term debt divided by the sum of long term and short term debt plus market equity	Compustat
NF	Equity issuance minus equity repurchases plus debt issuance minus debt redemption	Compustat
SA	Size-age-index proposed by Hadlock and Pierce, scaled by 10×10^8	Compustat
HighRD_d (dummy)	Dummy equal to 1 if a firm has investments in research and development within the highest 25% of its distribution, and 0 otherwise	Compustat
Bad_d (dummy)	Dummy equal to 1 if the mean sales growth is within the lowest 25% of its distribution, and 0 otherwise	Compustat
Zscore	Z-score (Altman, 1968)	Compustat
LowGov_d (dummy)	Dummy equal to 1 if a firm has an E-Index (Bebchuk et al., 2009) of 4 or higher, and 0 otherwise	RiskMetrics

Panel B: Investment regression

Netinv	Capital expenditures plus research and development expenses minus depreciation	Compustat
C	Cash and short term investments	Compustat
CF	EBITDA scaled by sales	Compustat
M/B	Market equity divided by book equity	Compustat
PriorΔsales	Logarithm of sales growth over the previous two years	Compustat
Size	Logarithm of total assets	Compustat
Lev	Long term debt plus short term debt scaled by total assets	Compustat
Ind.CFvola	Median of the firm-level standard deviation of first differences in ebitda over the prior 20 years	Compustat
CCDur	Average inventory age plus average collection period minus average payment period	Compustat
Zscore	Z-score (Altman, 1968)	Compustat
Ret.spr	EBIT scaled by total assets minus the annualized Treasury Bill return	Compustat / French's Website[1]
Δ*Ind.prod*	Logarithm of sales growth on SIC2-industry level	Compustat

Panel C: Operating performance regression

op	Average of the two following years of net income scaled by market equity at time t	Compustat
ΔC	Annual change in cash and short term investments	Compustat
Corr	Five-year rolling window correlation between a firm's Tobin's Q and the lagged aggregate sales growth across all firms	Compustat
L	Sum of long term debt and short term debt divided by the sum of long term and short term debt plus market equity	Compustat

[1] See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#HistBenchmarks.

	Definition	Source
ΔE	Annual change in earnings before extraordinary items plus interest, deferred income taxes and investment tax credit	Compustat
ΔNA	Annual change in total assets minus cash and short term equivalents	Compustat
ΔRD	Annual change in research and development expenses	Compustat
ΔI	Annual change in interest expenses	Compustat
ΔD	Annual change in common dividends	Compustat
NF	Equity issuance minus equity repurchases plus debt issuance minus debt redemption	Compustat
Size	Logarithm of total assets	Compustat

Panel D: Investment during crisis

Crisis (dummy)	Dummy equal to 1 if the observation is dated between July 2007 and June 2008, and 0 otherwise	Compustat
ΔC	Annual change in cash and short term investments	Compustat
Corr	Five-year rolling window correlation between a firm's Tobin's Q and the lagged aggregate sales growth across all firms	Compustat
Tobin's Q	Sum of long term debt, short term debt and market equity scaled by total assets	Compustat
Operating CF	EBITDA scaled by total assets	Compustat

Panel E: Return-cash sensitivity regression

Δ*Aggr.sales*	Aggregate sales growth of all firms	Compustat
Bad_d (dummy)	Dummy equal to 1 if the mean sales growth is within the lowest 25% of its distribution, and 0 otherwise	Compustat
Good_d (dummy)	Dummy equal to 1 if the mean sales growth is within the top 25% of its distribution, and 0 otherwise	Compustat
Trend	Year of observation	Compustat