JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS Vol. 53, No. 3, June 2018, pp. 1135–1161
COPYRIGHT 2018, MICHAEL G. FOSTER SCHOOL OF BUSINESS, UNIVERSITY OF WASHINGTON, SEATTLE, WA 98195
doi:10.1017/S0022109018000078

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

Market Sentiment and Innovation Activities

Tri Vi Dang and Zhaoxia Xu*

Abstract

We investigate potential mechanisms through which market-wide sentiment affects firms' innovation activities. We provide evidence for the financing channel by showing that financially constrained firms are more likely to issue equity and invest more in research and development (R&D) than financially unconstrained firms at high market sentiment. Using time-varying manager sentiment measures, we find suggestive evidence for a sentiment spillover channel whereby market sentiment affects R&D investments through influencing manager sentiment. Furthermore, better patent portfolios are produced from R&D investments stimulated by high market sentiment. Market sentiment has a stronger impact on R&D than the capital expenditures of financially constrained firms.

I. Introduction

Classical finance theory based on investor and manager rationality predicts no role for market sentiment in corporate investments. Earlier studies provide support for this theory (Morck, Shleifer, and Vishny (1990), Blanchard, Rhee, and Summers (1993)). However, this view has been challenged by recent studies that show investments are responsive to nonfundamental movements of stock prices (e.g., Chirinko and Schaller (2001), Baker, Stein, and Wurgler (2003), Gilchrist, Himmelberg, and Huberman (2005), Lamont and Stein (2006), Polk and Sapienza (2009), Arif and Lee (2014), and McLean and Zhao (2014)). An interesting question is whether market-wide sentiment has an impact on corporate innovation activities.

A better understanding of the real effects of market sentiment on innovative activities is important because innovation is essential to economic growth. Endogenous growth models emphasize that the economic growth rate is driven by the rate of technological progress, which takes place through innovation (Romer (1990), Aghion and Howitt (1992)). Furthermore, the unique features of

*Dang, td2332@columbia.edu, Columbia University Department of Economics; Xu (corresponding author), zhaoxia.xu@unsw.edu.au, University of New South Wales (UNSW) Business School, School of Banking and Finance. We thank an anonymous referee, Viral Acharya, Soku Byoun, Gary Gorton, Paul Malatesta (the editor), Bernard Salanie, Robert Shiller, Harald Uhlig, and participants at the 2013 Applied Economics Workshop at Columbia University and the 2014 Tsinghua University Finance Workshop for very helpful comments.

innovation and the evidence that economic factors affect research and development (R&D) investments and other investments differently warrant studying innovation activities separately.

First, it is more costly to finance innovation due to the high uncertainty of innovation outcomes (Hall and Lerner (2010)). Second, investments in innovation produce intangible assets that are harder to use as collateral for borrowing, whereas capital expenditures generate tangible assets. Third, innovation investments generate knowledge, which is a public good. Such externality could lower firms' incentives to invest up to a socially optimal level of R&D investment (Hall and Lerner (2010)). Additionally, the cross-country analyses of Brown, Martinsson, and Petersen (2013) show that the development of stock markets and credit markets has differential impacts on R&D and fixed asset investments due to the intangible nature and uncertainty of R&D investment outcome. Stock liquidity and short selling are also found to affect capital expenditures and innovation differently (Becker-Blease and Paul (2006), Fang, Tian, and Tice (2014), He and Tian (2014), and Grullon, Michenaud, and Weston (2015)).

In this article, we provide a theoretical model that links market sentiment to subjective-belief formation and analyze three (interrelated) mechanisms through which stock market sentiment might affect the innovation activities of firms. The first mechanism is the financing channel. When market sentiment increases, investors become more optimistic about future cash flows, and the cost of capital decreases. Thus, financially constrained firms can obtain cheaper funding and invest in projects with positive net present value (NPV) that otherwise cannot be funded. The second mechanism is the NPV channel in which a lower cost of capital can turn negative-NPV projects into positive ones even in the absence of financial constraints. The third potential transmission mechanism is the sentiment spillover channel. Shiller ((1984), p. 459) claims that "mass psychology may well be the dominant cause of movements in the price of the aggregate stock markets." The crowd (or mass) psychology literature shows that individual opinions and actions are influenced by group or mass opinions and actions (Sherif (1935), Asch (1951), (1955), and Moscovici (1985)). Our model formalizes how investor sentiment affects managers' sentiments and thus their perceptions of returns on R&D investments and willingness to conduct innovative projects. The three channels can have a reinforcing effect on investments in innovation.

To empirically examine the real effects of time-varying market-wide sentiment on innovations, we address five main questions. First, are the R&D investments of individual firms sensitive to market-wide sentiment? Second, are financially constrained firms more likely to issue equity and invest in R&D when market-wide sentiment is high (the financing channel)? Third, are investments in R&D responsive to both manager sentiment and market-wide sentiment (the sentiment spillover channel)? Fourth, do firms generate more and higher-quality patents from these R&D investments? Fifth, does market-wide sentiment affect R&D and fixed asset investments differently?

We conduct our analyses using a panel sample of 6,139 U.S. public firms over the period of 1985 to 2010. Using the "orthogonalized" component of Robert Shiller's cyclically adjusted price–earnings ratio (CAPE) and the Baker and Wurgler (2006) sentiment index as proxies for stock market sentiment, we

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

document a positive correlation between firm-level inputs (R&D) as well as outcomes (patents) of innovation and aggregate stock market sentiment while controlling for various observable and unobservable factors that are expected to affect innovation and investment opportunities. At the aggregate level, aggregate R&D and market sentiment are also positively related. We then investigate the economic mechanisms underlying the sensitivity of R&D investments to market sentiment.

Our analyses show that financially constrained firms invest more in innovation when stock markets are more optimistic, whereas a similar relation is not observed for financially unconstrained firms. Furthermore, financially constrained firms have a higher propensity to issue equity in optimistic markets. These results are consistent with the prediction of the financing channel. To investigate the sentiment spillover channel, we construct two time-varying measures of manager sentiment in order to capture the dynamics of a manager's view on future cash flows. Applying these two measures of manager sentiment and using the cumulant estimators from Erickson, Jiang, and Whited (2014), we find suggestive evidence for the sentiment spillover channel that optimistic managers invest significantly more in innovation than less optimistic managers do when investors are more optimistic. There is weak evidence for the NPV channel. In terms of innovation outcome, we document that R&D investments at higher market sentiment produce more and better-quality patents.

Finally, we find that market-wide sentiment has differential effects on the capital expenditure (CAPEX) of firms with R&D spending (R&D firms) and firms without R&D spending (non-R&D firms). For R&D firms, market sentiment has a significant impact on the CAPEX of financially constrained firms, but not that of financially unconstrained firms. For non-R&D firms, market sentiment has a positive and significant impact on the CAPEX of both financially constrained and unconstrained firms. The results suggest that the financing channel is relatively more important for the investments of R&D firms. The NPV channel might play a role in investments by financially unconstrained firms without R&D spending. We also find suggestive evidence for the sentiment spillover channel through which market sentiment affects the fixed asset investments of non-R&D firms, but we find no such evidence for R&D firms. Additionally, for financially constrained firms that invest both in R&D and fixed assets, R&D investments are more sensitive to market sentiment than CAPEX.

Our article is related to the literature on the effects of financial markets on corporate investments (reviewed by Bond, Edmans, and Goldstein (2012)). Morck et al. (1990) and Blanchard et al. (1993) document that stock markets have little impact on investments after controlling for fundamentals. Chen, Goldstein, and Jiang (2007) and Bakke and Whited (2010) argue that corporate investments are sensitive to the private-information component of stock prices because it is useful for firms' decision making. Chirinko and Schaller (2001), Baker et al. (2003), Gilchrist et al. (2005), Lamont and Stein (2006), Polk and Sapienza (2009), and Edmans, Goldstein, and Jiang (2012) find that investments in capital expenditures and mergers and acquisitions are affected by mispricing. McLean and Zhao (2014) show that investment sensitivity to Tobin's Q varies with business cycle and investor sentiment. Arif and Lee (2014) document that aggregate investments vary with investor sentiment and future aggregate returns. Our study focuses on

the influence of market-wide sentiment on firms' R&D investments and patent production and explores potential transmission channels.

This article makes several contributions to the literature. We provide a model to formalize how market sentiment affects subjective-belief formation and analyze different transmission mechanisms of how market-wide sentiment affects R&D investments. Our empirical analyses offer several new findings to the literature. First, we show that the R&D investments of financially constrained and unconstrained firms are affected differently by market sentiment. As suggested by the financing channel, financially constrained firms invest more in R&D and are more likely to issue equity when market sentiment is high. Second, we provide novel and suggestive evidence for a sentiment spillover channel by which market-wide sentiment affects investments in innovation through its spillover effect on manager sentiment. Third, we provide a new finding that R&D investments stimulated by high market sentiment generate patents of higher quality and quantity. Fourth, we show that market sentiment has differential effects on the R&D investments and capital expenditures of financially constrained firms.[1]

Our study also contributes to the debate on the welfare effects of stock market optimism. On the one hand, stock market bubbles are regarded as undesirable because they can lead to overinvestment of firms and misallocation of resources (Gilchrist et al. (2005)). On the other hand, Olivier (2000), Caballero, Farhi, and Hammour (2006), and Jermann and Quadrini (2007) propose models that illustrate a growth-enhancing effect of market optimism in which asset bubbles can encourage entrepreneurship, firm creation, and investments.[2] Our article provides empirical evidence for the growth-enhancing view by showing that market optimism facilitates innovation in financially constrained firms.

[1]Recent literature shows that R&D investments and capital expenditures are of different natures and are affected differently by various economic factors, such as financial market development, stock liquidity, and short selling (Brown et al. (2013), Becker-Blease and Paul (2006), Fang et al. (2014), He and Tian (2014), and Grullon et al. (2015)). We highlight another economic force, namely, market sentiment.

[2]Venture capitalists tend to have a view that stock market optimism fosters innovation, which is similar to Keynes's (1931) interpretation of the investment and stock market boom preceding the Great Depression. For example, the Nov. 19, 2010, *New York Times* article, "As Technology Deals Boom, the Talk Turns to Bubbles" by Heidi N. Moore (https://dealbook.nytimes.com/2010/11/19/as-tech-deals-boom-talk-turns-to-bubbles/) summarizes a conversation between two venture capitalists about the social media and mobile boom:

"Mr. Doerr: I prefer to think of these bubbles as booms. I think booms are good. Booms lead to overinvestment, booms lead to full employment, booms lead to lots of innovation.

Mr. Wilson: My friend says that nothing great is ever created without irrational exuberance. That's totally accurate. This frothy time will finance a lot of great ideas that will become great companies."

Keynes (as cited in De Long, Shleifer, Summers, and Waldmann (1989), p. 695) describes the investment booms accompanying the stock market boom preceding the Great Depression as follows:

> While some part of the investment which was going on … was doubtless ill-judged and unfruitful, there can, I think, be no doubt that the world was enormously enriched by the constructions of the quinquennium from 1925 to 1929, its wealth expanded in those five years by as much as in any other ten or twenty years in its history. … A few more quinquennia of equal activity might, indeed, have brought us near to the economic Eldorado where all our reasonable economic needs would be satisfied.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

The remainder of the article is organized as follows: In the next section, we develop a simple theoretical framework and the testing hypotheses. Section III describes the data, the measures of market sentiment and manager sentiment, and the descriptive statistics of the sample. Section IV provides evidence for the relation between market sentiment and R&D investments. Section V provides evidence for the financing and the sentiment spillover channels through which market sentiment affects R&D investments. Section VI investigates patent production. Section VII investigates the effects of market sentiment on fixed asset investments and compares it to R&D investments. Section VIII performs robustness checks. Section IX concludes.

II. The Model and Hypothesis Development

A. The Setting

We provide a theoretical model that links market sentiment to subjective-belief formation and analyze three (interrelated) mechanisms through which stock market sentiment might affect R&D investments. We consider a setting with two agents, a risk-averse entrepreneur (also referred to as *he*) with utility function U, where $U(0)=0$, $U'>0$ and $U''<0$, and a risk-neutral investor (also referred to as *she*) with utility function V, where $V'>0$ and $V''=0$. The entrepreneur has wealth $w\geq 0$ and limited liability. He can invest in an indivisible project that requires an investment $Z>w$. The entrepreneur needs to raise the amount $K=Z-w$ of equity capital to finance the project.[3] The investor has wealth K. If equity is issued, the investor obtains a fraction $\beta\in[0,1]$ of the payoff, and the entrepreneur keeps the remaining fraction $(1-\beta)$. The risk-free rate is normalized to 0.

The project delivers a verifiable payoff X which is either 0 (failure) or $x>0$ (success). The probability of success depends on how the entrepreneur implements the project. If the entrepreneur implements it efficiently, then the probability of success is q. If the entrepreneur implements it inefficiently, then the probability of success is p $(p<q)$, but he enjoys a private benefit of $B>0$.[4] We formalize market sentiment and subjective-belief formation about the payoff x of the project as follows: Initially, the entrepreneur believes that $x=x_E$, and the investor believes that $x=x_I$. When market (or investor) sentiment goes up, the investor becomes more optimistic, such that x_I changes to x_I^H, where $x_I^H>x_I$.[5]

[3]We focus on equity finance because the empirical evidence shows that equity is preferable to debt for innovation financing (Hall and Lerner (2010)). Brown et al. (2013) provide empirical evidence that credit market development has no impact on R&D.

[4]The objectives of the entrepreneur and the investor are not necessarily the same. The investor is mainly interested in return on investment, whereas the entrepreneur might also care about the types of innovation and technological spillovers. Note that the moral hazard in the model can be given alternative interpretations. For example, the entrepreneur can choose a high or low level of effort, and B represents the entrepreneur's utility from shirking, following Holmstrom and Tirole (1997) and Tirole (2006).

[5]Because of the high uncertainty of innovation outcomes, the entrepreneur and the investor could have different opinions and expectations. Our model allows for different prior beliefs. We assume that the investor observes x_E. We discuss how market sentiment affects the posterior belief of the entrepreneur in Section II.D.

We assume that the investor cannot break even (under initial or high market sentiment) if the project is implemented inefficiently, that is, even if $\beta = 1$, $E_p^I(X) = px_I^H < K$, which implies that the investor will not provide funding if she anticipates that the entrepreneur would invest inefficiently. If the entrepreneur implements the project efficiently and the investor gets a fraction $\underline{\beta}$ of the payoff, the investor's expected utility is $EV(\underline{\beta}X) = \underline{\beta}E_q^I(X) = \underline{\beta}((1-q)\times 0 + qx_I) = \underline{\beta}qx_I$. For the investor to be willing to provide funding, she must break even (i.e., $\underline{\beta}qx_I = K$ or $\underline{\beta} = K/qx_I$). We let $\underline{\beta}$ denote the investor's breakeven fraction of the payoff.

The entrepreneur has an incentive to issue equity and conduct the project if $EU((1-\underline{\beta})X) = (1-q)U(0) + qU((1-\underline{\beta})x_E) = qU((1-\underline{\beta})x_E) > U(w)$. In other words, the risk-averse entrepreneur evaluates the expected payoff that he obtains from the project and the investment cost that he pays according to his utility function. We say the project is perceived to have a positive NPV by the entrepreneur if his expected utility from investing in the project is higher than the utility from consuming his initial wealth, given the investor's breakeven fraction of the payoff.

For the entrepreneur to have an incentive to implement the project efficiently, only a fraction of the payoff can be pledged to the investor ($\beta < 1$). Because the entrepreneur enjoys a private benefit when the project is implemented inefficiently, the incentive-compatibility (IC) constraint for the entrepreneur is

$$\text{(IC)} \quad qU((1-\beta)x_E) \;\geq\; pU((1-\beta)x_E) + B \;\Leftrightarrow\; U((1-\beta)x_E) \;\geq\; \frac{B}{q-p}.$$

We define the entrepreneur's incentive-compatible fraction of the payoff as β^{IC}, such that $U((1-\beta^{IC})x_E) = B/(q-p)$. The maximum fraction of the payoff that can be pledged to the investor without jeopardizing the entrepreneur's incentive is β^{IC} ($\beta^{\text{IC}} < 1$). If the investor's breakeven fraction of the payoff is smaller than the entrepreneur's incentive-compatible fraction of the payoff ($\underline{\beta} \leq \beta^{\text{IC}}$), the project will be funded, and the entrepreneur will implement the project efficiently.

Thus, the conditions for the investor to provide capital K and for the entrepreneur to invest in a positive-NPV project efficiently are $\underline{\beta} \leq \beta^{\text{IC}}$ and $qU((1-\underline{\beta})x_E) > U(w)$. We analyze three channels through which market sentiment affects R&D investments by influencing the investor's breakeven $\underline{\beta}$, the entrepreneur's incentive-compatible fraction β^{IC}, and the perceived NPV of the project.

B. The Financing Channel

Suppose the project is perceived to have a positive NPV by the entrepreneur, that is, $qU((1-\underline{\beta})x_E) > U(w)$, where $\underline{\beta} = K/qx_I$ under the initial beliefs. When $\underline{\beta} > \beta^{\text{IC}}$, the incentive-compatibility constraint implies that the entrepreneur will implement the project inefficiently if he obtains the funding. The investor will not provide the capital K ex ante because she cannot break even when the project is implemented inefficiently. Therefore, the entrepreneur cannot raise the capital needed and is financially constrained.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

If market sentiment increases, the investor is more optimistic about x and believes that $x = x_I^H$. The breakeven condition of the investor is $\underline{\beta}^H = K/qx_I^H$. Because $x_I^H > x_I$, this implies that $\underline{\beta}^H < \underline{\beta}$. If sentiment is sufficiently high such that $\underline{\beta}^H$ falls below β^{IC}, then financial constraint is relaxed, and the entrepreneur is able to raise equity to conduct the positive-NPV project. This leads to the first hypothesis.

Hypothesis 1. Optimistic stock markets enable financially constrained firms to raise equity at a lower cost and thus enhance innovation (the financing channel).

C. The NPV Channel

Market sentiment could also affect R&D investments by shifting the perceptions of a project's NPV from negative to positive. Suppose the project is perceived to have a negative NPV by the entrepreneur (i.e., $qU((1-\underline{\beta})x_E) < U(w)$). When market sentiment goes up, the investor requires a smaller fraction of the payoff ($\underline{\beta}^H < \underline{\beta}$), as discussed previously. If $\underline{\beta}^H$ is sufficiently low such that $qU((1-\underline{\beta}^H)x_E) > U(w)$, the project becomes a positive-NPV project.[6] This leads to the second hypothesis.

Hypothesis 2. High market sentiment stimulates more R&D investments by turning negative-NPV projects into positive-NPV projects (the NPV channel).

D. The Sentiment Spillover Channel

The crowd psychology literature argues that individual beliefs are affected by the beliefs of others. The influence can be informational, normative, or referent informational. The informational influence occurs when a person lacks information or faces uncertainty. The person hence seeks information from the group and accepts the views of others (Sherif (1935)).[7] The normative influence works when a person conforms to others in order to gain social approval or to avoid social disapproval (Asch (1955)).[8] Under referent informational influence, people establish a frame of reference using the behavior of others and adopt the common beliefs (Turner (1991)). These experiments suggest a contagious effect of group opinion. This contagion of opinions might be simply psychologically driven rather than information driven. Shiller (1984) uses this kind of social movement to explain excessive optimism in stock markets.

Motivated by the crowd psychology literature and Shiller (1984), we postulate a behavioral hypothesis about the spillover effect of the investor's belief (or market sentiment) on the entrepreneur's belief. It is worth noting that our

[6] Formally, $d\underline{\beta}/dx_I < 0$ and $dU/d\underline{\beta} < 0$ since U is a strictly increasing function and thus $U((1-\underline{\beta})x_E)$ increases when $\underline{\beta}$ declines. Note that this channel works even in the absence of financial constraints.

[7] Sherif (1935) conducts the autokinetic effect experiment in which participants were asked to estimate how far a seemingly moving spot of light in a dark room had moved. The estimates of light movement varied substantially when the participants were tested individually. However, the estimates converged to a common estimate when one participant who has a quite different estimate was tested together with two participants who have similar estimates.

[8] In the Asch (1955) conformity experiment, one real participant and several confederates were asked to compare the lengths of line segments. The confederates had been coached beforehand to give unanimously correct or unanimously wrong answers. The experiment found that the real participant tended to change his perception when the confederates gave the same answer.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

sentiment spillover channel includes but is not restricted to the rational learning channel in which the manager infers information from the actions of the investor and adjusts his posterior belief according to Bayesian updating. Our mechanism is more general in the sense that the manager sentiment may change for a psychological reason (social influence).

As market sentiment goes up, the entrepreneur also becomes more optimistic about x because of the sentiment spillover effect and believes that $x = x_E^H > x_E$. This has two effects. First, the entrepreneur's expected utility from doing the project increases because $EU = qU((1-\underline{\beta})x_E)$ increases in x_E. Second, the incentive-compatible fraction of the payoff $\underline{\beta}^{\text{IC}}$ increases because β^{IC} is defined as $U((1-\beta^{\text{IC}})x_E) = B/(q-p)$, and U is strictly increasing in x_E.[9] If x_E^H is sufficiently high such that $\beta^{\text{IC}} \geq \underline{\beta}$, then market sentiment mitigates the incentive-compatibility constraint of the entrepreneur. Consequently, the entrepreneur will implement the project efficiently and the investor is willing to provide financing. Accordingly, our third hypothesis is as follows:

Hypothesis 3. High market sentiment stimulates more R&D investments of firms through its spillover effect on manager sentiment (sentiment spillover channel).

E. Comparative Analysis

To compare the impacts of market sentiment on financially constrained and unconstrained firms, we assume there are two entrepreneurs $\{1,2\}$ and two identical investors. The two entrepreneurs have the same utility function and investment opportunity as described previously. The two projects have the same expected payoff structure, and the entrepreneurs enjoy the same private benefit B if the project is implemented inefficiently. The only difference is that entrepreneur 1 has wealth w_1, whereas entrepreneur 2 has wealth $w_2 < w_1$. Suppose the project has a positive NPV if implemented efficiently; that is, $qU((1-\underline{\beta}_j)x_E) > U(w_j)$, where $\underline{\beta}_j = (Z-w)/qx_I$ (for $j=1,2$). Because $w_2 < w_1$, we have $\underline{\beta}_1 < \underline{\beta}_2$. Suppose $\underline{\beta}_1 < \beta^{\text{IC}} < \underline{\beta}_2$, where β^{IC} is such that $U((1-\beta^{\text{IC}})x_E) = B/(q-p)$ and is the same for both entrepreneurs. Thus, entrepreneur 1 can raise equity to conduct the project, whereas entrepreneur 2 is financially constrained and cannot conduct the project. When market sentiment increases, $\underline{\beta}_2$ decreases. If $\underline{\beta}_2^H$ falls below β^{IC}, then entrepreneur 2 can raise equity capital and conduct the project. The higher market sentiment, however, does not affect the investment of the financially unconstrained entrepreneur 1. This leads to the fourth hypothesis:

Hypothesis 4. Market sentiment has a stronger effect on the R&D investments of financially constrained firms than financially unconstrained firms.

III. Data and Measures

A. Data Sample

The firm-level financial data are from the merged Center for Research in Security Prices (CRSP)–Compustat database, and the return data are from the

[9] Formally, define a such that $U(a) = B/(q-p)$. Let $(1-\beta^{\text{IC}})x_E = a$ and $(1-\beta^{\text{IC}(H)})x_E^H = a$. So $\beta^{\text{IC}} = 1 - a/x_E$ and $\beta^{\text{IC}(H)} = 1 - a/x_E^H$. Because $x_E^H > x_E$, $\beta^{\text{IC}(H)} > \beta^{\text{IC}}$.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

CRSP monthly stock database. We compute each firm's annual compound returns over the fiscal year using monthly stock returns and match them with the financial data. The sample period is from Jan. 1, 1985, to Dec. 31, 2010. The management earnings forecast data are between 1995 and 2010 because First Call's Company Issued Guidance (CIG) database has a limited number of management forecasts before 1995. To be consistent with the frequency of financial data, we only use annual earnings guidance. All earnings per share (EPS) forecasts not in US$ ("USD") and preannouncement (i.e., forecasts made after the end of the fiscal period) are excluded. We merge management earnings forecast data with our financial data. The regulated financial (Standard Industrial Classification (SIC) codes 6000–6999) and utility (SIC codes 4900–4999) sectors are excluded. Also omitted are firms with total assets of less than $10 million or with missing sales values. We also require firms to have a minimum of 5 years of consecutive observations. As a result of this screening, our sample consists of 6,139 firms and 77,863 firm-year observations.

B. Market Sentiment Measures

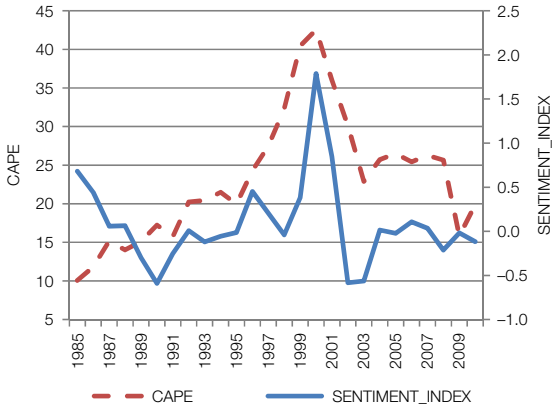
We use two measures for market sentiment. One measure is an orthogonalized version of Robert Shiller's cyclically adjusted price–earnings ratio (ORTH_CAPE) that removes the components reflecting macroeconomic conditions. CAPE is defined as the real ("inflation-adjusted") price level of the Standard & Poor's (S&P) 500 divided by the moving average of the preceding 10 years of S&P 500 real reported earnings.[10] It is possible that CAPE simply reveals overall economic conditions related to growth opportunities. Firms may invest less in innovation during recessions because of fewer growth opportunities. To isolate the exogenous component of the market sentiment effect, we adopt an approach similar to Baker and Wurgler (2006) to orthogonalize CAPE. Specifically, we first regress CAPE on six macroeconomic variables used by Baker and Wurgler (2006): growth in industrial production, real growth in durable consumption, nondurable consumption, services consumption, growth in employment, and a National Bureau of Economic Research (NBER) recession indicator. We then use the residuals from this regression to capture the component in market sentiment index beyond macroeconomic conditions.

The second measure is the investor sentiment index developed by Baker and Wurgler (2006). The Baker and Wurgler sentiment index is formed based on the first principal component of six investor sentiment proxies: the closed-end fund discount, the New York Stock Exchange (NYSE) share turnover, the number of initial public offerings, the average first day's return of initial public offerings, the equity share in new issues, and the dividend premium. To minimize the influence of economic conditions, each of the six proxies is orthogonalized to a set of macroeconomic variables. A high value of market sentiment index indicates that investors are more optimistic and have higher risk tolerance. Stock market sentiment varies substantially over time (Figure 1).

[10]Because CAPE is scaled by the moving average of 10 years of S&P real earnings, it is less likely to be mechanically related to individual firms' R&D in a given year. The annual CAPE data are used in the analysis.

FIGURE 1
Market Sentiment Indexes from 1985–2010

Figure 1 plots the two market sentiment indexes over the period of 1985 through 2010. CAPE is Robert Shiller's cyclically adjusted price–earnings ratio. SENTIMENT_INDEX is the stock market sentiment index from Baker and Wurgler (2006).



C. Manager Sentiment Measures

Measuring manager sentiment empirically is difficult because it cannot be observed directly. The literature on managerial optimism/overconfidence suggests that managers may have some self-attribution bias. The existing studies usually measure managerial optimism based on the description of the manager by outsiders or on the manager's personal portfolio decisions. For example, Malmendier and Tate (2008) identify CEO overconfidence using the market perception of a CEO's personality from the media. Malmendier and Tate (2005), (2008) and Campbell, Gallmeyer, Johnson, and Rutherford (2011) use a CEO's stock option holdings and exercise decisions. Overconfident CEOs postpone the exercise of options that are deep in the money. The commonly used manager overconfidence indices are time invariant and are not suitable to capture the sentiment spillover effect.

To construct a new measure of managerial sentiment that allows for time variation, we use earnings forecasts from management earnings guidance. Management earnings guidance is a firm's disclosure about its expected future earnings. It is a major channel for managers to convey their view of the firm's financial outlook to investors. We obtain management earnings forecast data from the CIG database. We construct two measures of managerial sentiment.

The first measure uses changes in management earnings forecasts for the same fiscal-year earnings when a firm issues multiple forecasts throughout the year. An upward (downward) revision of forecasts indicates that managers become more optimistic (pessimistic) about future earnings. The differencing procedure removes the time-invariant manager attributes such as managerial overconfidence that may influence management earnings forecasts. Although this approach

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

helps to eliminate time-invariant factors that drive the cross-sectional differences in changes in management earnings forecasts, there may still be other factors driving the differences. The proxy may suffer from a measurement-error problem. We address this measurement-error problem using the Erickson et al. (2014) estimator in Section V.B. We assign a value of 1, −1, or 0 if managers revise earnings forecasts upward, revise downward, or make no change, respectively. To construct the first manager sentiment measure (MANAGER_SENT1), we sum all values over the multiple revisions. A higher value of the measure indicates that managers become more optimistic.

The second measure of manager sentiment is constructed as the difference between management earnings forecasts and the actual earnings per share reported by the firm (MANAGER_SENT2). The actual earnings-per-share data are obtained from the Institutional Brokers' Estimate System (IBES). A higher value of this measure indicates that the management is optimistic about the earnings perspective of the firm.

D. Descriptive Statistics

Table 1 describes the summary statistics of market sentiment measures, manager sentiment measures, and characteristics of firms in the sample. We report the statistics of market sentiment measures. The average CAPE over the period of 1985 to 2010 is 23.18, and the mean value of the investor sentiment index is 0.08. The correlation between CAPE and the investor sentiment index is 0.50. Manager sentiment measures are based on management earnings forecasts. The average of MANAGER_SENT2 is 0.11, indicating that managers on average are optimistic.

TABLE 1
Sample Descriptive Statistics

Table 1 reports the summary statistics for the variables used in the study. The sample period is from Jan. 1, 1985, to Dec. 31, 2010. CAPE is the cyclically adjusted price–earnings ratio developed by Robert Shiller. SENTIMENT_INDEX is the stock market sentiment index from Baker and Wurgler (2006). To construct MANAGER_SENT1, we assign a value of 1 (−1) if managers who issue multiple forecasts for the fiscal-year-end earnings revise earnings forecasts upward (downward), and we assign a value of 0 if there is no change in forecasts. We then sum the values over the multiple revisions for the fiscal-year-end earnings forecast. The second measure, MANAGER_SENT2, is defined as the difference between management earnings forecast and the actual earnings per share. RD is research and development expenditure scaled by total assets at the beginning of the fiscal year. ln(SALES) is the natural logarithm of sales. ln(PPE/EMP) is the natural logarithm of investment in property, plant, and equipment scaled by the number of employees. TOBINS_Q is defined as the ratio of the market value of assets to the book value of assets. ROA is income before extraordinary items scaled by lagged total assets. BOOK_LEVERAGE is the ratio of long- and short-term debt to total assets. CASH is the ratio of cash to total assets. RD, ROA, and BOOK_LEVERAGE are winsorized at the 1% and 99% levels to mitigate the effect of outliers. RD, ROA, BOOK_LEVERAGE, and CASH are in percentages.

Sentiment Measures	Mean	Q1	Q3	*N*
CAPE	23.18	15.83	26.52	26
SENTIMENT_INDEX	0.08	−0.12	0.20	26
MANAGER_SENT1	0.19	0.00	1.00	11,336
MANAGER_SENT2	0.11	−0.05	0.07	9,181
Variable	**All Firms**			
RD	4.68	0.00	5.55	76,649
ln(SALES)	5.43	4.04	6.73	77,863
ln(PPE/EMP)	3.51	2.71	4.13	76,674
TOBINS_Q	1.84	1.05	2.03	77,357
ROA	1.04	−1.84	8.87	76,648
BOOK_LEVERAGE	23.22	4.13	35.74	77,565
CASH	16.39	2.26	23.39	77,845

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

The ratio of R&D expenditures to total assets is 4.68% on average.[11] The size of firms, measured by the natural logarithm of sales, is 5.43 on average, and the mean value of capital intensity, measured by the natural logarithm of investment in property, plant, and equipment (PPE) scaled by the number of employees, is 3.51. Tobin's Q, measured as the ratio of market value of assets to book values of assets, on average is 1.84. Return on assets, defined as income before extraordinary items scaled by lagged total assets, is 1.04% on average. Firms in the sample have an average book leverage of 23.22% and a cash ratio of 16.39%.

IV. Market Sentiment and R&D Investments

A. Firm-Level Evidence

We first test whether or not firms spend more on innovation as measured by R&D ratio when market sentiment is high. In the firm-level analysis, we run a series of panel regressions with our sample firms. The baseline specification is

$$(1) \quad \mathrm{RD}_{i,t} = \alpha + \beta\,\mathrm{MARKET_SENTIMENT}_t + \gamma X_{i,t-1} + \sum \delta_i + \varepsilon_{i,t},$$

where $\mathrm{RD}_{i,t}$ is the R&D expenditures in year t scaled by the total assets of firm i at the beginning of the fiscal year. $\mathrm{MARKET_SENTIMENT}_t$ is a measure of stock market sentiment using annual CAPE, ORTH_CAPE, or the investor sentiment index. The coefficient on the market sentiment measure, β, captures changes in R&D investments in response to market-level sentiment, controlling for other observable and unobservable factors that influence R&D.

The estimation of β potentially involves an endogeneity problem. If changes in firms' characteristics (or investment opportunity sets) coincide with changes in market sentiment, then R&D investments may potentially be induced by the changes in firm characteristics rather than market sentiment. This concern can be partially addressed by including a set of determinant variables of R&D investments. For example, if firms have more investment opportunities at good market conditions, the increase in R&D may be due to the increased investment opportunities. We can mitigate this problem by including control variables such as Tobin's Q. We control for a set of firm-characteristic variables $X_{i,t-1}$, including lag values of ln(SALES), ln(PPE/EMP), TOBINS_Q, ROA, BOOK_LEVERAGE, and CASH, that might affect a firm's R&D spending. Furthermore, we also include firm fixed effects to separate market effects from unobservable firm effects ($\sum \delta_i$). The estimation of firm fixed effects exploits the time-series variation within each firm.

Additionally, we adopt the identification strategy used by Bernanke, Gertler, and Gilchrist (1996) and McLean and Zhao (2014) to ease the concern about the potential confounding effect of growth opportunities and explore cross-sectional variation in the responsiveness of R&D to changes in market sentiment.[12]

[11] We include firm-year observations with missing or zero R&D expenditures because patents are produced in those years. Missing values of R&D are replaced by 0. Our results also hold for the sample excluding firms with zero R&D expenditures.

[12] We investigate the differential effects of market sentiment on the R&D investments of financially constrained and unconstrained firms in Section V.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

Table 2 presents the estimation results using CAPE, ORTH_CAPE, and the investor sentiment index as a measure of market sentiment. The coefficients on market sentiment in all the specifications are positive and significant. For example, the coefficient in regression 5 shows that a 1-standard-deviation increase in the investor sentiment index is associated with an increase in R&D as a ratio of total assets by 0.3406%. Given an average R&D ratio of 4.68%, the change is also economically significant. After controlling for firm-characteristic variables that may affect firms' R&D investments, market sentiment still has a positive and significant influence on R&D. The coefficients on the control variables suggest that smaller firms have a higher R&D ratio and that firms with lower tangibility, higher Tobin's Q, lower ROA, lower debt ratio, and lower cash reserves spend more on R&D.

TABLE 2
Firm-Level R&D and Market Sentiment

Table 2 reports the relation between market sentiment and firm-level research and development (R&D) investments. The sample period is from Jan. 1, 1985, to Dec. 31, 2010. The dependent variable, RD, is R&D expenditure scaled by total assets at the beginning of the fiscal year. CAPE is the annual cyclically adjusted price–earnings ratio developed by Robert Shiller. ORTH_CAPE is the exogenous component of CAPE after purging the effect of macroeconomic conditions. SENTIMENT_INDEX is the annual stock market sentiment index from Baker and Wurgler (2006). ln(SALES) is the natural logarithm of sales. ln(PPE/EMP) is the natural logarithm of investment in property, plant, and equipment scaled by the number of employees. TOBINS_Q is defined as the ratio of the market value of assets to the book value of assets. ROA is income before extraordinary items scaled by lagged total assets. BOOK_LEVERAGE is the ratio of long- and short-term debt to total assets. CASH is the ratio of cash to total assets. The control variables are in year $t-1$. All regressions control for firm fixed effects. Robust standard errors clustered by firm and year are reported in square brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: RD					
Variable	1	2	3	4	5	6
CAPE	0.0116*** [0.0021]	0.0144*** [0.0022]				
ORTH_CAPE			0.0159*** [0.0022]	0.0088*** [0.0030]		
SENTIMENT_INDEX					0.3274*** [0.0334]	0.1143*** [0.0306]
ln(SALES)		−0.6463*** [0.0351]		−0.6166*** [0.0342]		−0.6206*** [0.0342]
ln(PPE/EMP)		−0.2592*** [0.0411]		−0.2369*** [0.0408]		−0.2357*** [0.0407]
TOBINS_Q		0.5452*** [0.0407]		0.5541*** [0.0407]		0.5513*** [0.0407]
ROA		−0.0319*** [0.0026]		−0.0322*** [0.0026]		−0.0324*** [0.0026]
BOOK_LEVERAGE		−0.0183*** [0.0017]		−0.0184*** [0.0017]		−0.0183*** [0.0017]
CASH		−0.0068*** [0.0025]		−0.0067*** [0.0025]		−0.0067*** [0.0025]
Constant	4.3984*** [0.0518]	8.2183*** [0.2222]	4.7110*** [0.0144]	8.3168*** [0.2260]	4.6483*** [0.0141]	8.3318*** [0.2263]
No. of obs.	76,649	68,803	74,835	68,803	76,649	68,803
Adj. R^2	0.8074	0.8335	0.8074	0.8334	0.8077	0.8334

B. Aggregate-Level Evidence

Having established that firm-level R&D is positively related to market sentiment, we next investigate whether aggregate R&D is related to market sentiment. The rational investment model based on efficient markets predicts no relation between aggregate R&D and market sentiment. Our model predicts a

positive relation between aggregate R&D and market sentiment because financially constrained firms would invest more as financing costs decline or managers would undertake more innovative projects as they become more optimistic.

To investigate the relation of aggregate R&D and market sentiment, we regress aggregate time-series R&D on the market sentiment index. We compute time-series aggregate R&D by value-weighting annual firm-level R&D using the fiscal-year-end market capitalizations as weights. Arif and Lee (2014) compute aggregate investments using a similar methodology. Table 3 presents the estimation results of regression using CAPE, ORTH_CAPE, and the investor sentiment index as a proxy for market sentiment. The estimation results show that aggregate R&D and market sentiment are positively related.

TABLE 3
Aggregate-Level R&D and Market Sentiment

Table 3 reports the relation between market sentiment and aggregate-level research and development (R&D) investments. The sample period is from Jan. 1, 1985, to Dec. 31, 2010. CAPE is the annual cyclically adjusted price–earnings ratio developed by Robert Shiller. AGG_RD is the value-weighted sum of annual firm-level R&D using the fiscal-year-end market capitalizations as weights. ORTH_CAPE is the exogenous component of CAPE after purging the effect of macroeconomic conditions. SENTIMENT_INDEX is the annual stock market sentiment index from Baker and Wurgler (2006). Robust standard errors are reported in square brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: AGG_RD		
Variable	1	2	3
CAPE	0.1101*** [0.0182]		
ORTH_CAPE		0.1111*** [0.0240]	
SENTIMENT_INDEX			1.2276** [0.4712]
Adj. R^2	0.6120	0.3394	0.3025

V. The Transmission Channels of Market Sentiment on R&D Investments

We find that firms' spending on R&D is positively related to stock market sentiment. Our theoretical model highlights three transmission mechanisms and thus potential explanations for why firms might invest more in R&D when market-wide sentiment increases. This section empirically examines these transmission channels.

A. The Financing Channel

One potential explanation for the positive relation between firm-level R&D spending and market sentiment is that high stock market sentiment reduces the cost of equity and facilitates funding for innovation, as illustrated in our model (the financing channel). If market sentiment encourages investments in innovation through the financing channel, we would expect the effect to be stronger among firms that are financially constrained. The capital provided by optimistic investors should ease the constraint faced by financially constrained firms and enable them to invest more in R&D. To test this conjecture, we estimate the baseline model for financially constrained and unconstrained firms separately.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

1. Financially Constrained versus Unconstrained Firms

Following the literature, we use five measures of financial constraints to split our sample.[13] The first measure is firm size, following Erickson and Whited (2000), Acharya, Almeida, and Campello (2007), and many others. Firms are ranked annually based on total assets and are allocated to the financially constrained (unconstrained) group for the bottom (top) tertile. Small firms are generally more vulnerable to capital market imperfections (Frank and Goyal (2003)).

Fazzari, Hubbard, and Petersen (1988), among many others, argue that financially constrained firms are reluctant to pay dividends. The second financial constraint measure is the payout ratio, defined as dividends plus stock repurchases scaled by total assets. The total distribution of funds is used so that firms not paying dividends but conducting stock repurchase are not classified as constrained. In every year over the sample period, we rank firms based on their payout ratios and assign them to the financially constrained (unconstrained) group. Firms in the bottom (top) tertile are constrained (unconstrained).

The third measure is the size–age (SA) index derived by Hadlock and Pierce (2010). By analyzing qualitative information from financial filings, Hadlock and Pierce (2010) show that firm size and age are the most useful proxy for financial constraints. They develop an SA index to measure financial constraints. The SA index is constructed as $\text{SA} = -0.737\ \text{SIZE} + 0.043\ \text{SIZE}^2 - 0.040\ \text{AGE}$, where SIZE is the natural logarithm of inflation-adjusted total assets. Total assets are in 2004 dollars. AGE is defined as the number of years after the firm goes public or the number of years the firm appears on Compustat with a nonmissing stock price if no initial public offering date is available. Following Hadlock and Pierce (2010), we replace firm size with log($4.5 billion) and age with 37 years if the actual values exceed these thresholds. Firms with a higher value of the SA index are more constrained. We rank firms each year based on the SA index and group the top (bottom) tertile into constrained (unconstrained) portfolios.

A potential concern about the size and the SA index is that these measures may capture young and/or small firms that are especially likely to have time-varying investment opportunities. To minimize this concern, we adopt another financial constraint measure introduced by Lewellen and Lewellen (2016). This measure is based on forecasts of a firm's free cash flow (FCF), which is not necessarily highly correlated with investment opportunities.[14] Free cash flow is measured as the difference between cash flow (CF) and net capital expenditures. Cash flow is defined as the sum of income before extraordinary items, extraordinary items and discontinued operations, depreciation and amortization, deferred taxes,

[13] We also perform the test using the WW index derived by Whited and Wu (2006) based on an Euler equation approach from a structural model of investment. The WW index is a linear combination of six factors according to the following formula: $\text{WW} = -0.091\ \text{CF} - 0.062\ \text{DIVPOS} + 0.021\ \text{TLTD} - 0.044\ \ln(\text{TA}) + 0.102\ \text{ISG} - 0.035\ \text{SG}$, where CF is the ratio of cash flow to total assets, DIVPOS is a dummy variable that takes the value of 1 if the firm pays cash dividends, TLTD is the ratio of the long-term debt to total assets, ln(TA) is the natural log of total assets, ISG is the firm's 3-digit industry sales growth, and SG is firm sales growth. Firms with a higher value of the WW index are more constrained. We rank firms based on the WW index and group the top (bottom) tertile into constrained (unconstrained) portfolios. Similar results are found using the WW index.

[14] Using Tobin's Q as a proxy for investment opportunities, the correlation between expected FCF and Tobin's Q is −0.0462.

equity in net loss of unconsolidated subsidiaries, losses from the sale of PPE, and funds from operations/other. Net capital expenditures represent the difference between capital expenditures and depreciation. Following Lewellen and Lewellen (2016), we rank firms each year based on expected FCF to avoid sorting on realized investment. Expected cash flow is estimated by the predicted value from a cross-sectional regression of FCF on lagged firm characteristics including CF, stock returns, net capital expenditures, dividends, book leverage, market-to-book ratio, sales, PPE, depreciation, cash, and changes in cash. The level variables are scaled by total assets, and the flow variables are scaled by total assets at the beginning of the fiscal year. Firms with expected free cash flow in the top one-third are classified unconstrained, and those in the bottom one-third are classified as constrained.

The fifth financial constraint measure that we use is investment–cash flow sensitivity. Fazzari et al. ((1988), Fazzari, Hubbard, and Petersen (2000)) find a positive sensitivity of investment to cash flow and interpret the sensitivity as evidence for financial constraints. The basis is that the investments of a financially constrained firm rely heavily on internal funds due to the unavailability of external capital. Hence, the investments of financially constrained firms are more sensitive to cash flows.[15] To classify firms as financially constrained or unconstrained, we first estimate investment–cash flow sensitivity for each firm with minimum 20 years of observations. We then rank firms based on the sensitivities and categorize firms in the top tertile as financially constrained and those in the bottom tertile as financially unconstrained.

Table 4 presents the estimation results using ORTH_CAPE as a measure for market sentiment. Similar results are obtained with CAPE and investor sentiment as a market sentiment measure. The relation between market sentiment and R&D investments is concentrated on firms that are younger, pay a lower amount of dividends, have a smaller value of SA index, have lower expected FCFs, and have higher investment–cash flow sensitivity. These are firms, suggested by existing evidence, that are most likely to be financially constrained. In contrast, the R&D investments of unconstrained firms exhibit no response to movements in market sentiment. The rationale behind this finding might be that unconstrained firms do not have to wait for optimism in stock markets to reduce the cost of capital in order to finance innovation.

2. Financing Decisions

The previous section shows that financially constrained firms invest more in R&D when market sentiment is high. The evidence that the relation between market sentiment and innovation investments is stronger for financially constrained firms indicates a role of the financing channel. Our model illustrates that optimism in stock markets may lower the cost of equity, and therefore firms raise cheaper equity capital to finance innovation.

[15]However, Kaplan and Zingales (1997), Cleary (1999), Erickson and Whited (2000), Gomes (2001), Alti (2003), and Chen and Chen (2012) find a much weaker or disappearing sensitivity of firms' investment to cash flows. The results using this financial constraint measure should be interpreted with some caution.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

TABLE 4

R&D, Market Sentiment, and Financial Constraints

Table 4 reports the influence of stock market sentiment on firm-level research and development (R&D) investments for financially constrained and unconstrained firms. Firms are classified as constrained and unconstrained based on five financial constraint measures: firm size (FIRM_SIZE), dividend payout ratio (DIV_PAYOUT), SA_INDEX, forecasted free cash flow (FCF), and investment–cash flow sensitivity (ICFS). The dependent variable, RD, is R&D expenditure scaled by total assets at the beginning of the fiscal year. ORTH_CAPE is the exogenous component of CAPE after purging the effect of macroeconomic conditions. The control variables include ln(SALES), TOBINS_Q, ROA, BOOK_LEVERAGE, and CASH. All regressions also control for firm fixed effects. Robust standard errors clustered by firm and year are reported in square brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	FIRM_SIZE		DIV_PAYOUT		SA_INDEX		FCF		ICFS	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
ORTH_CAPE	0.0230***	0.0001	0.0298***	0.0034	0.0163***	−0.0031	0.0211*	0.0058	0.0149***	0.0058
	[0.0054]	[0.0030]	[0.0055]	[0.0023]	[0.0061]	[0.0022]	[0.0115]	[0.0048]	[0.0037]	[0.0044]
No. of obs.	21,798	23,896	28,006	23,826	20,971	24,567	12,934	12,996	7,906	8,055
Adj. R^2	0.8530	0.7994	0.8246	0.8697	0.8571	0.8151	0.8315	0.8201	0.7806	0.8022

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

Now we examine whether financially constrained firms are more likely to issue stocks when market sentiment is high. Our empirical specification estimates a probit model with an equity-issuance dummy as the dependent variable. The independent variables include market sentiment index, financial constraint dummy, the interaction term between the market sentiment index and financial constraint dummy, and other factors that affect the decision of stock issuance, such as ln(SALES), ln(PPE/EMP), TOBINS_Q, ROA, BOOK_LEVERAGE, CASH, and STOCK_RETURN. Following the literature, we consider a firm as issuing equity if the sale of common and preferred stock minus purchase of common and preferred stock scaled by total assets at the beginning of the fiscal year is more than 5%. We include stock returns in the preceding fiscal year in light of the stylized fact that firms tend to issue equity following periods of high stock returns.[16]

Table 5 presents the estimation results using ORTH_CAPE. The negative and mostly insignificant coefficients on ORTH_CAPE indicate that financially unconstrained firms are not more likely to issue equity when market sentiment is high. The coefficients on the interaction term between market sentiment and the financial constraint dummy are all positive and statistically significant, supporting the view that financially constrained firms have a higher propensity to issue equity when the market is more optimistic. Overall, the results provide support for the financing channel through which optimistic markets stimulate innovation by enabling financially constrained firms to raise equity capital for R&D investments.

TABLE 5

Market Sentiment, Stock Issuances, and Financial Constraints

Table 5 reports the estimation results of the probability of equity issuance by constrained and unconstrained firms conditional on market sentiment. The dependent variable of the probit model is an equity-issuance dummy variable equal to 1 if a firm's sale of common and preferred stock minus purchase of common and preferred stock scaled by total assets at the beginning of the fiscal year is more than 5%, and 0 otherwise. ORTH_CAPE is the exogenous component of CAPE after purging the effect of macroeconomic conditions. CONSTRAINED is a dummy variable that is equal to 1 if a firm is financially constrained, and 0 otherwise. Firms are classified as constrained and unconstrained based on five financial constraint measures: FIRM_SIZE, DIV_PAYOUT, SA_INDEX, FCF, and ICFS. The control variables include ln(SALES), ln(PPE/EMP), TOBINS_Q, ROA, BOOK_LEVERAGE, CASH, and STOCK_RETURN. STOCK_RETURN is a firm's stock returns from the last 12 months preceding the fiscal year of the dependent variable. The coefficients on the control variables are not reported. Standard errors are reported in square brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Variable	FIRM_SIZE	DIV_PAYOUT	SA_INDEX	FCF	ICFS
ORTH_CAPE	−0.0014	−0.0015	−0.0046***	0.0015	−0.0068**
	[0.0017]	[0.0021]	[0.0018]	[0.0023]	[0.0032]
CONSTRAINED	−0.4778***	0.5664***	−0.1953***	−0.0799***	−0.1019***
	[0.0326]	[0.0194]	[0.0298]	[0.0295]	[0.0363]
ORTH_CAPE × CONSTRAINED	0.0089***	0.0172***	0.0120***	0.0113***	0.0075*
	[0.0023]	[0.0024]	[0.0023]	[0.0031]	[0.0044]
No. of obs.	46,303	52,693	46,129	25,930	16,032

B. The Sentiment Spillover Channel

The positive relation between market sentiment and spending on innovation may also arise because managers become more optimistic about their firms' future earnings or more risk tolerant when investors in the markets are optimistic. The influence of market sentiment on manager sentiment could come from

[16]The empirical evidence includes Asquith and Mullins (1986), Jung, Kim, and Stulz (1996), and Hovakimian, Opler, and Titman (2001), among many others.

psychological impacts and/or informational effects as suggested in our model. Optimistic managers are more likely to undertake riskier projects. Under this circumstance, we expect that market sentiment affects R&D by influencing managers' willingness to undertake risky innovative projects (the sentiment spillover channel).

To investigate this transmission channel, we include a measure of manager sentiment and an interaction term between manager sentiment and market sentiment in the baseline regression model. If the sentiment spillover channel is in force, we expect the coefficient on the interaction term to be significant. We first estimate our model controlling for the firm fixed effects and report the results using the two measures of manager sentiment. Panel A of Table 6 shows that the coefficients on the interaction term between manager sentiment and market sentiment are positive but statistically insignificant.

TABLE 6

R&D, Market Sentiment, and Manager Sentiment

Table 6 reports the influence of manager sentiment on firm-level research and development (R&D) investments. The model is estimated by fixed-effects estimation (Panel A) and the higher-order cumulant estimators for mismeasured regressors as in Erickson et al. (2014) (Panel B). The dependent variable, RD, is R&D expenditure scaled by total assets at the beginning of the fiscal year. ORTH_CAPE is the exogenous component of CAPE after purging the effect of macroeconomic conditions. SENTIMENT_INDEX is the stock market sentiment index from Baker and Wurgler (2006). Two measures of manager sentiment are used. In models 1 and 2, MANAGER_SENT is MANAGER_SENT1, which is the sum of the value of management earnings revisions. The value of earnings revisions equals to 1 (−1) if a management earnings forecast for the fiscal year is revised upward (downward) during the forecast period, and it equals to 0 if the forecast is not revised. In model 3 and 4, MANAGER_SENT is MANAGER_SENT2, which is defined as the difference between the management earnings forecast and the actual earnings per share reported by the firm. We control for ln(SALES), ln(PPE/EMP), TOBINS_Q, ROA, BOOK_LEVERAGE, and CASH. Regressions in Panel A control for firm fixed effects. Standard errors clustered by firm and year are reported in square brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Variable	1	2	3	4
Panel A. Fixed-Effects Estimation				
MANAGER_SENT	0.0131 [0.0164]	0.0182 [0.0165]	0.0389 [0.0291]	0.0393 [0.0282]
ORTH_CAPE	−0.0064 [0.0053]		−0.0032 [0.0059]	
MANAGER_SENT × ORTH_CAPE	0.0007 [0.0032]		0.0026 [0.0069]	
SENTIMENT_INDEX		0.0037 [0.0559]		−0.0108 [0.0678]
MANAGER_SENT × SENTIMENT_INDEX		0.0631 [0.0138]		0.0805 [0.0036]
No. of obs.	10,838	10,838	8,851	8,851
Panel B. Higher-Order Cumulant Estimation				
MANAGER_SENT	0.0253** [0.0107]	0.0273*** [0.0102]	0.0182*** [0.0013]	0.0187*** [0.0018]
ORTH_CAPE	0.0105 [0.0078]		0.0046 [0.0088]	
MANAGER_SENT × ORTH_CAPE	0.0070*** [0.0020]		0.0015*** [0.0004]	
SENTIMENT_INDEX		0.1376* [0.0797]		0.0345 [0.1054]
MANAGER_SENT × SENTIMENT_INDEX		0.1627*** [0.0138]		0.0166*** [0.0036]
No. of obs.	10,838	10,838	8,851	8,851

Our manager sentiment measures potentially suffer from the measurement-error problem. Management earnings forecasts may reflect factors other than

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

manager sentiment. In the presence of errors in variables, the ordinary least squares estimates of the coefficients are biased. To address the measurement-error problem, we use the cumulant estimators for mismeasured regressors developed by Erickson et al. (2014) to estimate the coefficients. The cumulant estimators are closed-form minimum distance estimators that are linear in the third and higher cumulants of the regressors. The estimation of coefficients is based on higher-order moments. The cumulant estimators only require that the mismeasured regressors are not normally distributed. We verified that this condition is satisfied in our estimations. Erickson et al. (2014) find that the cumulant estimators have better finite-sample performance than the moment estimators from Erickson and Whited (2000).

Panel B of Table 6 shows that the coefficients on the manager sentiment measure are positive and significant after correcting for the measurement-error problem. The results indicate that optimistic managers tend to spend more on R&D. The coefficients on the interaction term between the market sentiment measure and the manager sentiment measure are all positive and statistically significant, indicating that more optimistic managers invest more in R&D when market sentiment is high. A potential concern about our manager sentiment measure is that management earnings forecasts may simply reflect true future fundamentals. However, the significance of the coefficient on the interaction term between manager sentiment and market sentiment indicates that the manager sentiment measure captures managerial optimism beyond forecasts of true fundamentals. The results provide suggestive evidence that market sentiment affects R&D investments by influencing managers' sentiment regarding investments in innovative projects.

VI. Patent Production

Although market-wide sentiment affects firms' innovation inputs, that is, R&D investments, its impact on innovation outputs is unclear. On the one hand, more R&D investments could lead to lower efficiency in generating patents if more marginal projects are funded. On the other hand, more investments in innovation could bring economy of scale and create synergy among innovative projects. Therefore, we investigate empirically whether R&D investments stimulated by market sentiment lead to more innovation outcomes in the future.

To examine the real effects of R&D spending, we explore the quantity and quality of firms' patents as well as innovation productivity. Patents represent successful outcomes of past R&D investments. The firm-year patent counts and patent citations data are obtained from the NBER Patent Citation database. Our sample for this analysis stops in 2004 because the average time lag between patent application date and grant date is 2 years, and the NBER database contains patent data up to 2006.

We measure the quantity of innovation outcome as the number of patents applied for by a firm in a given year. The quality of patents is measured by the number of citations. Patent citations are subject to a truncation bias because citations are received over a long period of time, and therefore patents created in later years have less time to accumulate citations compared with patents created

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

in earlier years. Additionally, the citation intensities of patents might vary across different industries. To correct for the truncation bias, we follow Hall, Jaffe, and Trajtenberg (2001) and scale the raw patent citation counts by the average citation counts of all patents applied for in the same year and technology class. The innovation productivity measure reveals the number of patents produced in subsequent years for every million dollars of R&D expenditure ($PATENT_{t+1}/RD_t$, $PATENT_{t+2}/RD_t$). If R&D investments stimulated by market sentiment lead to more innovation, we would expect a positive relation between innovation productivity and market sentiment.

We estimate our model with patent measures as the dependent variable. Because patent production may take time, we check patents applied for in the subsequent few years. For brevity, Table 7 presents the estimation results only for the subsequent 2 years using the two sentiment indexes. Our results also hold for a longer time period. The coefficients on market-wide sentiment indexes are all positive and significant, suggesting that higher-quantity and better-quality patents are produced in more optimistic markets. More patents are produced for every million dollars of investment in R&D in more optimistic markets. The higher efficiency in patent production leads to better quantity and quality of patents. The results indicate that market sentiment not only affects innovation inputs but also innovation outcomes.

TABLE 7
Firm Innovation and Market Sentiment

Table 7 reports the relation between market sentiment and firm innovation. The sample period is from Jan. 1, 1985, to Dec. 31, 2004. We measure firm innovation by the number of patents and the truncation-bias-adjusted citations. PATENT is the number of patents applied for by a firm in a given year. CITATION is citations per patent adjusted for truncation bias. $PRODUCTIVITY_{t+1}$ ($PRODUCTIVITY_{t+2}$) is defined as patents in year $t+1$ ($t+2$) scaled by R&D expenditures in year t. ORTH_CAPE is the exogenous component of CAPE after purging the effect of macroeconomic conditions. SENTIMENT_INDEX is the stock market sentiment index from Baker and Wurgler (2006). The control variables include ln(SALES), ln(PPE/EMP), TOBINS_Q, ROA, BOOK_LEVERAGE, and CASH. All regressions control for firm fixed effects. The coefficients on control variables are not reported. Robust standard errors clustered by firm and year are reported in square brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	$PATENT_{t+1}$	$CITATION_{t+1}$	$PRODUCTIVITY_{t+1}$	$PATENT_{t+2}$	$CITATION_{t+2}$	$PRODUCTIVITY_{t+2}$
Panel A. Orthogonalized CAPE						
ORTH_CAPE	0.4073***	0.0057***	0.0038**	0.3827***	0.0077***	0.0039*
	[0.0479]	[0.0010]	[0.0016]	[0.0502]	[0.0009]	[0.0022]
Adj. R^2	0.6778	0.2497	0.1733	0.6488	0.2297	0.1347
Panel B. Sentiment Index						
SENTIMENT_INDEX	1.9916***	0.0322***	0.0439**	2.1680***	0.0460***	0.0535**
	[0.4445]	[0.0089]	[0.0205]	[0.4058]	[0.0098]	[0.0222]
Adj. R^2	0.6776	0.2495	0.1733	0.6487	0.2294	0.1347

VII. Capital Expenditures

Our analyses have shown that market sentiment affects innovation inputs and outputs. Recent studies find that economic forces have differential effects on

R&D and fixed asset investments due to the intangible nature and uncertainty of R&D investment outcome (Brown et al. (2013), Becker-Blease and Paul (2006), Fang et al. (2014), He and Tian (2014), and Grullon et al. (2015)). The survey study of Hall and Lerner (2010) highlights that equity financing is particularly important for R&D investments. Debt financing is more difficult for innovation because the intangible assets generated by R&D investments offer little collateral value. Additionally, creditors have lower incentives to fund risky innovative activities because they cannot share the unlimited upside returns associated with innovation. In contrast, the collateral value of fixed asset investments makes it easier to finance them with debt. In light of differences in the nature of R&D investments and fixed asset investments, we investigate whether market-wide sentiment affects capital expenditures differently from R&D.

Because we are interested in the differential effects of market sentiment on R&D investments and capital expenditures, we partition the sample into firms with R&D spending and firms without R&D spending. We regress firms' capital expenditures as a ratio of total assets at the beginning of the fiscal year on the market sentiment measure while controlling for other factors and firm fixed effects. The model is estimated separately for R&D firms and non-R&D firms. To investigate whether market sentiment affects the fixed asset investments of financially constrained and unconstrained firms differently, we estimate the baseline model with capital expenditure ratio as the dependent variable for financially constrained and unconstrained firms, separately. For brevity, we report results using firm size as the financial constraint measure and ORTH_CAPE. Similar results are obtained using the investor sentiment index.

The estimation results for R&D firms are reported in columns 1 and 2 in Panel A of Table 8, and those for non-R&D firms are reported in columns 3 and 4. Column 1 shows that the coefficient on market sentiment is positive and significant, indicating that financially constrained R&D firms invest more in fixed assets as market sentiment goes up. However, the coefficient is insignificant in column 2, indicating that financially unconstrained R&D firms do not spend significantly more on capital expenditures at high market sentiment. For non-R&D firms, the coefficients on the market sentiment index are positive and significant for both financially constrained and unconstrained firms. These results indicate that financial constraints seem to matter more for the investments of R&D firms. Additionally, more investments, especially those by financially unconstrained firms, might also arise because the lower cost of capital at high market sentiment turns negative-NPV projects into positive-NPV projects.

In Panels B and C of Table 8, we investigate whether market sentiment affects fixed asset investments through its influence on manager sentiment. We use MANAGER_SENT1 in columns 1 and 2, and MANAGER_SENT2 in columns 3 and 4. Panel B reports the estimation results controlling for firm fixed effects. The coefficients on the interaction term between market sentiment and the manager sentiment measure are insignificant. In Panel C, we use the higher-order cumulant estimators to ease the measurement-error concern. For R&D firms, the coefficients on the interaction term between market sentiment and the manager sentiment measure remain insignificant (columns 1 and 2). The coefficients on the interaction terms are positive and significant for non-R&D firms (columns 3

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

TABLE 8

Capital Expenditures and Market Sentiment

Table 8 reports the relation between market sentiment and firm-level capital expenditures for firms with research and development (R&D) spending (R&D firms) and firms without R&D spending (non-R&D firms). The dependent variable, CAPEX, is capital expenditure scaled by total assets at the beginning of the fiscal year. In Panel A, we regress CAPEX on the market sentiment measure while controlling for control variables and firm fixed effects. The model is estimated for financially constrained and unconstrained firms. The financial constraint is measured by firm size. In Panel B, we regress CAPEX on ORTH_CAPE, MANAGER_SENT, and the interaction term, as well as the control variables. MANAGER_SENT1 and MANAGER_SENT2 are used in columns 1 and 3, and columns 2 and 4, respectively. The model is estimated with firm fixed effects. In Panel C, the cumulant estimators are used to estimate the model. In Panel D, the dependent variable is the difference between R&D expenditure and capital expenditure scaled by total assets at the beginning of the fiscal year. The models are estimated for firms with R&D spending. ORTH_CAPE is the exogenous component of CAPE after purging the effect of macroeconomic conditions. The control variables include ln(SALES), ln(PPE/EMP), TOBINS_Q, ROA, BOOK_LEVERAGE, and CASH in year $t-1$. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	R&D Firms		Non-R&D Firms	
	Constrained	Unconstrained	Constrained	Unconstrained
Panel A. Constrained versus Unconstrained Firms				
ORTH_CAPE	0.0162**	−0.0011	0.0464***	0.0324***
	[0.0076]	[0.0066]	[0.0127]	[0.0080]
No. of obs.	12,367	10,743	9,221	12,878
Adj. R^2	0.3798	0.5442	0.5433	0.6618
	R&D Firms		Non-R&D Firms	
	1	2	3	4
Panel B. Sentiment Spillover Channel Fixed-Effects Estimation				
MANAGER_SENT	0.0145	−0.0547	0.0230	−0.0612
	[0.0258]	[0.0879]	[0.0393]	[0.0741]
ORTH_CAPE	0.0486***	0.0474***	0.0484***	0.0584***
	[0.0090]	[0.0105]	[0.0114]	[0.0134]
MANAGER_SENT × ORTH_CAPE	−0.0008	−0.0219	0.0041	−0.0177
	[0.0060]	[0.0156]	[0.0085]	[0.0152]
No. of obs.	5,579	4,599	5,199	4,201
Adj. R^2	0.6265	0.6624	0.7145	0.7284
Panel C. Sentiment Spillover Channel Higher-Order Cumulant Estimation				
MANAGER_SENT	0.0483***	−0.0017	0.0466	−0.0487
	[0.0125]	[0.0919]	[0.0579]	[0.0354]
ORTH_CAPE	0.0397***	0.4710***	0.0337	0.0174
	[0.0093]	[0.1290]	[0.0227]	[0.0226]
MANAGER_SENT × ORTH_CAPE	−0.0012	−0.0018	0.0162*	0.0143**
	[0.0019]	[0.0145]	[0.0087]	[0.0064]
No. of obs.	5,579	4,599	5,199	4,201
		Constrained		Unconstrained
Panel D. R&D versus CAPEX				
ORTH_CAPE		0.0274**		0.0113
		[0.0112]		[0.0072]
No. of obs.		12,367		10,743
Adj. R^2		0.7645		0.6647

and 4), indicating that more optimistic managers of non-R&D firms tend to spend more on physical assets when market sentiment is high. The sentiment spillover channel seems to matter more for the fixed asset investments of non-R&D firms. The differences in the impact of market sentiment on the CAPEX of R&D firms and non-R&D firms might be due to the relative importance of the three transmission channels or differences in the characteristic of R&D firms and non-R&D firms.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

Finally, we examine whether market-wide sentiment has a differential impact on fixed asset investments and R&D investments. We expect that the R&D investments of financially constrained firms are more sensitive to market sentiment due to the relative importance of equity financing for investments in innovation and the intangible nature of R&D investments. We estimate the model for financially constrained and unconstrained firms with positive R&D expenses. To examine whether the impact of market sentiment is stronger for R&D investments than capital expenditures, we compute the difference between R&D and capital expenditures for each firm in each year and scale the difference by total assets at the beginning of the fiscal year for R&D firms. We regress the difference between R&D and capital expenditures on the market sentiment measure while controlling for observable and unobservable factors affecting investments. Panel D of Table 8 shows that the coefficient on the market sentiment measure is positive and statistically significant for financially constrained firms, but it is insignificant for financially unconstrained firms. The result indicates that financially constrained firms' investments in innovation are more sensitive to market sentiment than investments in fixed assets. These results are also consistent with the view that fixed asset investments depend less on equity financing because they can also be financed with debt relatively easily.

VIII. Robustness Checks

One concern is that firms' investments in innovation and market sentiment are endogenously determined by investment opportunities. In other words, changes in innovation investments can be driven by a demand shift in R&D. We ease this concern by controlling for observable and unobservable factors that might reflect firm-level investment opportunities in our regression models. In the unreported analysis, we use industry fixed effects to control for industry-wide investment opportunities and use a set of macroeconomic variables to control for economy-wide time-varying investment opportunities. Our results remain intact. In addition, we investigate the cross-sectional difference in the sensitivity of R&D investments to changes in market sentiment. To the extent that market sentiment captures investment opportunities, all firms should respond to time-varying investment opportunities. We find that only financially constrained, but not unconstrained, firms invest more in R&D when market sentiment is high. This piece of evidence is inconsistent with the view that investment opportunities drive the relation between market sentiment and R&D investments.

Although the Baker and Wurgler (2006) investor sentiment index and the ORTH_CAPE are constructed to be orthogonal to macroeconomic variables related to growth opportunities, Sibley, Xing, and Zhang (2013) show that the Baker and Wurgler index is correlated with business-cycle variables and risk variables such as the current T-bill rate and liquidity risk. To remove the effect of these fundamental related variables, we orthogonalize the two market sentiment indexes to these factors and reestimate our model. Following Sibley et al. (2013), we use the 3-month Treasury rate as an indicator for the business cycle and use the market average of the firm-level percentage of zero-return days as a proxy for market liquidity risk. We obtain daily stock returns data from the CRSP daily returns file.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

The percentage of zero-return days is defined as the ratio of the number of zero-return days to the total number of trading days in a given month. Using the orthogonalized sentiment indexes, we still observe that firms invest more in R&D as market sentiment increases (Table 9). Overall, investment opportunity is less likely to be the main driver underlying the positive relation between R&D and market sentiment.

TABLE 9

Firm-Level R&D and Market Sentiment: Robustness

Table 9 reports the results of robustness checks for the relation between market sentiment and research and development (R&D) investments. EXOG_CAPE and EXOG_SENTIMENT are the exogenous component of CAPE and the sentiment index from Baker and Wurgler (2006), respectively, after removing the business-cycle effect and the liquidity effect. The control variables include ln(SALES), ln(PPE/EMP), TOBINS_Q, ROA, BOOK_LEVERAGE, and CASH. The control variables are in year $t-1$. All regressions control for firm fixed effects. Robust standard errors clustered by firm and year are reported in square brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	RD	
	1	2
EXOG_CAPE	0.0088***	
	[0.0030]	
EXOG_SENTIMENT		0.0780**
		[0.0323]
No. of obs.	68803	68803
Adj. R^2	0.8334	0.8334

IX. Conclusions

This article analyzes whether the innovation activities of publicly traded firms are responsive to aggregate stock market sentiment and identifies three transmission channels. We provide empirical evidence supporting the view that stock market optimism facilitates investments in innovation through a financing channel where higher market-wide sentiment reduces the financing costs. We document that financially constrained firms are more likely to issue equity and invest more in R&D when the stock market is more optimistic, whereas we do not observe such a relation for financially unconstrained firms. Our analyses also provide suggestive evidence that is consistent with the view that market sentiment affects R&D investments through its influence on manager sentiment. We find weak evidence that firms may invest more because high market sentiment turns negative-NPV projects into positive-NPV projects. Furthermore, we find that more and better-quality patents are generated from R&D investments stimulated by high market sentiment. For financially constrained firms that invest in both R&D and fixed assets, the impact of market-wide sentiment on R&D is stronger than the impact on fixed asset investments.

Overall, our results indicate potential positive effects of stock market optimism on facilitating innovation. Therefore, policy makers and central bankers may need to take into account the potential social benefits of high stock market sentiment when they design measures to deflate a high level of market optimism.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

References

Acharya, V.; H. Almeida; and M. Campello. "Is Cash Negative Debt? A Hedging Perspective on Corporate Financial Policies." *Journal of Financial Intermediation*, 16 (2007), 515–554.

Aghion, P., and P. Howitt. "A Model of Growth through Creative Destruction." *Econometrica*, 60 (1992), 323–351.

Alti, A. "How Sensitive Is Investment to Cash Flow When Financing Is Frictionless?" *Journal of Finance*, 58 (2003), 707–722.

Arif, S., and C. M. Lee. "Aggregate Investment and Investor Sentiment." *Review of Financial Studies*, 27 (2014), 3241–3279.

Asch, S. E. "Effects of Group Pressure upon the Modification and Distortion of Judgment." In *Groups, Leadership and Men*, H. Guetzkow, ed. Pittsburgh, PA: Carnegie Press (1951).

Asch, S. E. "Opinions and Social Pressure." *Scientific American*, 193 (1955), 31–35.

Asquith, P., and D. Mullins. "Equity Issues and Offering Dilution." *Journal of Financial Economics*, 15 (1986), 61–89.

Baker, M.; J. Stein; and J. Wurgler. "When Does the Market Matter? Stock Prices and the Investment of Equity-Dependent Firms." *Quarterly Journal of Economics*, 118 (2003), 969–1006.

Baker, M., and J. Wurgler. "Investor Sentiment and the Cross-Section of Stock Returns." *Journal of Finance*, 61 (2006), 1645–1680.

Bakke, T. E., and T. Whited. "Which Firms Follow the Market? An Analysis of Corporate Investment Decisions." *Review of Financial Studies*, 23 (2010), 1941–1980.

Becker-Blease, J. R., and D. L. Paul. "Stock Liquidity and Investment Opportunities: Evidence from Index Additions." *Financial Management*, 35 (2006), 35–51.

Bernanke, B.; M. Gertler; and S. Gilchrist. "The Financial Accelerator and the Flight to Quality." *Review of Economics and Statistics*, 78 (1996), 1–15.

Blanchard, O.; C. Rhee; and L. Summers. "The Stock Market, Profit, and Investment." *Quarterly Journal of Economics*, 108 (1993), 115–136.

Bond, P.; A. Edmans; and I. Goldstein. "The Real Effects of Financial Markets." *Annual Review of Financial Economics*, 4 (2012), 339–360.

Brown, J. R.; G. Martinsson; and B. C. Petersen. "Law, Stock Markets, and Innovation." *Journal of Finance*, 68 (2013), 1517–1549.

Caballero, R.; E. Farhi; and M. Hammour. "Speculative Growth: Hints from the U.S. Economy." *American Economic Review*, 96 (2006), 1159–1192.

Campbell, T. C.; M. Gallmeyer; S. Johnson; J. Rutherford; and B. Stanley. "CEO Optimism and Forced Turnover." *Journal of Financial Economics*, 101 (2011), 695–712.

Chen, H., and S. Chen. "Investment-Cash Flow Sensitivity Cannot Be a Good Measure of Financial Constraints: Evidence from the Time Series." *Journal of Financial Economics*, 103 (2012), 393–410.

Chen, Q.; I. Goldstein; and W. Jiang. "Price Informativeness and Investment Sensitivity to Stock Price." *Review of Financial Studies*, 20 (2007), 619–650.

Chirinko, R., and H. Schaller. "Business Fixed Investment and 'Bubbles': The Japanese Case." *American Economic Review*, 91 (2001), 663–680.

Cleary, S. "The Relationship between Firm Investment and Financial Status." *Journal of Finance*, 54 (1999), 673–692.

De Long, J. B.; A. Shleifer; L. H. Summers; and R. J. Waldmann. "The Size and Incidence of the Losses from Noise Trading." *Journal of Finance*, 44 (1989), 681–696.

Edmans, A.; I. Goldstein; and W. Jiang. "The Real Effects of Financial Markets: The Impact of Prices on Takeovers." *Journal of Finance*, 67 (2012), 933–971.

Erickson, T.; C. H. Jiang; and T. M. Whited. "Minimum Distance Estimation of the Errors-in-Variables Model Using Linear Cumulant Equations." *Journal of Econometrics*, 183 (2014), 211–221.

Erickson, T., and T. M. Whited. "Measurement Error and the Relationship between Investment and *q*." *Journal of Political Economy*, 108 (2000), 1027–1057.

Fang, V. W.; X. Tian; and S. Tice. "Does Stock Liquidity Enhance or Impede Firm Innovation?" *Journal of Finance*, 69 (2014), 2085–2125.

Fazzari, S. M.; R. G. Hubbard; and B. Petersen. "Financing Constraints and Corporate Investment." *Brookings Papers on Economic Activity*, 1 (1988), 141–195.

Fazzari, S. M.; G. R. Hubbard; and B. C. Petersen. "Investment-Cash Flow Sensitivities Are Useful: A Comment on Kaplan and Zingales." *Quarterly Journal of Economics*, 115 (2000), 695–705.

Frank, M., and V. Goyal. "Testing the Pecking Order Theory of Capital Structure." *Journal of Financial Economics*, 67 (2003), 217–248.

Gilchrist, S.; C. Himmelberg; and G. Huberman. "Do Stock Price Bubbles Influence Corporate Investment?" *Journal of Monetary Economics*, 52 (2005), 805–827.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press

Gomes, J. "Financing Investment." *American Economic Review*, 91 (2001), 1263–1285.
Grullon, G.; S. Michenaud; and J. Weston. "The Real Effects of Short-Selling Constraints." *Review of Financial Studies*, 28 (2015), 1737–1767.
Hadlock, C. J., and J. R. Pierce. "New Evidence on Measuring Financial Constraints: Moving beyond the KZ Index." *Review of Financial Studies*, 23 (2010), 1909–1940.
Hall, B. H.; A. B. Jaffe; and M. Trajtenberg. "The NBER Patent and Citation Data File: Lessons, Insights and Methodological Tools." NBER Working Paper No. 8498 (2001).
Hall, B. H., and J. Lerner. "The Financing of R&D and Innovation." In *Handbook of Economics and Innovation*, B. H. Hall and N. Rosenberg, eds. Amsterdam, Netherlands: Elsevier, North-Holland (2010).
He, J., and X. Tian. "Short Sellers and Innovation: Evidence from a Quasi-Natural Experiment." Working Paper, available at http://ssrn.com/abstract=2380352 (2014).
Holmstrom, B., and J. Tirole. "Financial Intermediation, Loanable Funds, and the Real Sector." *Quarterly Journal of Economics*, 112 (1997), 663–691.
Hovakimian, A.; T. Opler; and S. Titman. "The Debt-Equity Choice." *Journal of Financial and Quantitative Analysis*, 36 (2001), 1–24.
Jermann, U., and V. Quadrini. "Stock Market Boom and the Productivity Gains of the 1990s." *Journal of Monetary Economics*, 54 (2007), 413–432.
Jung, K.; Y. C. Kim; and R. M. Stulz. "Timing, Investment Opportunities, Managerial Discretion, and Security Issue Decision." *Journal of Financial Economics*, 42 (1996), 159–185.
Kaplan, S., and L. Zingales. "Do Financing Constraints Explain Why Investment Is Correlated with Cash Flow?" *Quarterly Journal of Economics*, 112 (1997), 169–215.
Keynes, J. M. "An Economic Analysis of Unemployment." In *Collected Writings*, Vol. XII, London: Macmillan (1931).
Lamont, O., and J. Stein. "Investor Sentiment and Corporate Finance: Micro and Macro." *American Economic Review*, 96 (2006), 147–151.
Lewellen, J., and K. Lewellen. "Investment and Cash Flow: New Evidence." *Journal of Financial and Quantitative Analysis*, 51 (2016), 1135–1164.
Malmendier, U., and G. Tate. "CEO Overconfidence and Corporate Investment." *Journal of Finance*, 60 (2005), 2660–2700.
Malmendier, U., and G. Tate. "Who Makes Acquisitions? CEO Overconfidence and the Market's Reaction." *Journal of Financial Economics*, 89 (2008), 20–43.
McLean, R. D., and M. Zhao. "The Business Cycle, Investor Sentiment, and Costly External Finance." *Journal of Finance*, 69 (2014), 1377–1409.
Morck, R.; A. Shleifer; and R. Vishny. "The Stock Market and Investment: Is the Market a Side Show?" *Brookings Papers on Economic Activity*, 2 (1990), 157–215.
Moscovici, S. *Age of the Crowd: A Historical Treatise on Mass Psychology*. Cambridge, England: Cambridge University Press (1985).
Olivier, J. "Growth-Enhancing Bubbles." *International Economic Review*, 41 (2000), 133–151.
Polk, C., and P. Sapienza. "The Stock Market and Corporate Investment: A Test of Catering Theory." *Review of Financial Studies*, 22 (2009), 187–217.
Romer, P. M. "Endogenous Technological Change." *Journal of Political Economy*, 98 (1990), 71–102.
Sherif, M. "A Study of Some Social Factors in Perception." *Archives of Psychology*, 27 (1935), 23–46.
Shiller, R. "Stock Prices and Social Dynamics." *Brookings Papers on Economic Activity*, 2 (1984), 457–498.
Sibley, S.; Y. Xing; and X. Zhang. "Is 'Sentiment' Sentimental?" Working Paper, available at http://ssrn.com/abstract=2176348 (2013).
Tirole, J. *The Theory of Corporate Finance*. Princeton, NJ: Princeton University Press (2006).
Turner, J. C. *Social Influence*. Buckingham, UK: Open University Press (1991).
Whited, T., and G. Wu. "Financial Constraints Risk." *Review of Financial Studies*, 19 (2006), 531–559.

https://doi.org/10.1017/S0022109018000078 Published online by Cambridge University Press