Entrepreneurship, Business and Economics Research Journal
ISSN: 2997-6782|
Volume 12 Issue 2, April-June, 2024
Journal Homepage: https://ethanpub.online/Journals/index.php/E15
Official Journal of Ethan Publication

FINANCIAL CONSTRAINTS AND INVESTMENT STRATEGIES UNDER HIGH SHORT INTEREST

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DOI: https://doi.org/10.5281/zenodo.17414822

Abstract
The perpetual debate regarding the rationality of stock markets remains a captivating and ongoing topic of inquiry. Existing literature broadly approaches this issue through two distinct frameworks: the classical and the behavioral perspectives. In the classical view, market efficiency prevails, where stock prices faithfully reflect changes in anticipated future cash flows or discount rates. Consequently, there should be no discernible relationship between share prices and corporate investment, provided that firms' fundamentals are sound. In stark contrast, the behavioral viewpoint posits that managers strategically time their equity issuances to capitalize on moments when stock prices become disconnected from underlying fundamentals, as exemplified by studies like Loughran and Ritter (1995) and Baker and Wurgler (2000).
This study builds upon the works of De Long, Shleifer, Summers, Waldmann (1990) and Stein (1996) and the subsequent challenges posed by Baker, Stein, and Wurgler (2003 to challenge the classical perspective. Their theoretical and empirical framework introduces two investor categories: sophisticated informed investors and uninformed noise traders. Noise traders, influenced by biased beliefs, because stock prices to diverge from their intrinsic values. Stein (1996) asserts that investment decisions become contingent on investor sentiment if the required return on a share is a result of investor overestimation of future payoffs rather than the share's inherent risk. For instance, an overly optimistic investor climate may lead a manager to adopt an aggressive investment strategy to maximize the current share price.

Keywords: Stock market rationality, classical view, behavioral view, investor sentiment, corporate investment.

I. Introduction

The question of whether stock markets are rational or not is ongoing and a fascinating one. Extant prior literature addresses this question broadly under two frameworks namely classical and behavioral. According to the *classical view*, the market is efficient, and stock prices rationally reflect changes either in expected future cashflows or in discount rates; so, there should be no relationship between the share price and the amount of corporate investment given the firms' fundamentals. By contrast, the *behavioral view* argues that managers time their equity issues to take advantage of stock prices that are sometimes too high relative to fundamentals e.g. Loughran and Ritter (1995), Baker and Wurgler (2000). Following De Long, Shleifer, summers, and Waldmann (1990) and Stein (1996), Baker, Stein, and Wurgler (2003) challenge, both theoretically and empirically, the classical view that stock prices do not influence corporate investment activity. Their model assumes two types of investors: sophisticated informed investors and uninformed noise traders. The noise traders have biased beliefs about the fundamental value of shares and cause stock prices to deviate from their fundamental values. Stein (1996) argues that if the required return on a share is not a reflection of the share's fundamental risk but rather a reflection of investors' overestimation of the share's future payoff, then investment decisions will depend on investor sentiment.

For example, if investors are overly optimistic, a manager seeking to maximize the current share price should adopt an aggressive investment policy.

Morck, Shleifer, and Vishny (1990) argue that the debate over market rationality is trivial if stock prices do not affect real economic activity. The assumptions of De Long et al. (1990) and Baker et al. (2003) provide a useful framework to investigate the effect of equity mis-valuation on corporate investment. Both efficient and inefficient market theories imply that higher stock prices should be associated with higher corporate investment. Under the *q* theory of investment, markets are efficient, a high stock price reflects stronger growth opportunities. Thus, it follows that high-priced firms should invest more to take advantage of the investment opportunities. However, if the market overvalues the firm's new investment opportunities, the firm may commit to additional investment either to obtain a high price for newly issued equity or to maintain the current high stock price.

The main objective of this paper is to examine the impact of equity misevaluation on corporate investment. We are not the first to examine this relation. Past literature uses either discretionary accruals (see Polk and Sapienza (2008), Grundy and Li (2010)) or Tobin's Q (see Baker et al. (2003)) as proxies for mis-valuation. Discretionary accruals are hypothesized to be related to mis-valuation because investors fail to distinguish between cash flows and accounting adjustments to earnings. As managers have discretion over accruals adjustments and may use them to manage earnings, this measure suffers from endogeneity. Similarly, many studies have viewed Tobin's *Q* or related variables as proxies for earnings growth prospects, investment opportunities, or managerial effectiveness. So, it is hard to distinguish mis-valuation from other rational effects based solely on *Q* or discretionary accruals as mis-valuation measures. These considerations suggest that it is useful to test the mis-valuation hypothesis using a cleaner measure of equity mis-valuation. Hence, we use equity short interest ratio, a market-based measure, as our proxy for equity misevaluation. While we acknowledge that the equilibrium short interest is endogenously determined based on the demand and supply factors in the securities lending market, it is nonetheless exogeneous to the firm.

According to Brent, Morse, and Stice (1990), short interest is driven by tax, hedging, and speculative incentives. In 1997, the tax rules for shorting against the box were strengthened and this technique was eliminated with the introduction of "constructive sale" rules. Special anti-abuse rules prevent traders from converting short-term capital gains into long-term capital gains and long-term capital losses into short-term capital losses. Thus, the use of the shorting against the box technique to postpone tax reconciliation forever has been effectively eliminated. It is well documented that short sellers exhibit superior analytical skills in processing publicly available information and appear well informed in terms of identifying which firms to short. Thus, short selling is motivated, to a large extent, by deteriorating firm fundamentals. Consequently, short interest data should serve as an important input in the capital allocation decisions of investors. Further, short interest contains useful information with respect to a firm's earnings restatements, earnings, and accrual quality. For example, if short interest predicts operating performance, then short sellers play a role in the price discovery process and in making markets more efficient. Recently, Akbas, Boehmer, Erturk, and Sorescu (2017) document that short sellers' information regarding future firm performance is not short lived, but extends up to 12 calendar months and that professional short sellers are able to detect firms that will experience a decline in fundamental value in the future. Hence, for any given firm, we expect the higher the equity overvaluation, the higher the short interest ratio.

There is extant literature on the impact of short interest ratio in predicting future stock returns (see Asquith, Pathak, and Ritter (2005); Boehmer, Jones, and Zhang (2008), and Desai, Krishnamurthy, and Venkataraman (2006)) and future bond returns (see Kecskés, Mansi, and Zhang (2012), Erturk and Nejadmalayeri (2012)). Recently Deshmukh, Gamble, and Howe (2015) find that increases in short interest are associated with significant decreases in firm operating performance in subsequent years. However, the current literature on short interest does not directly examine the impact of short interest ratio on the firm's real investment policy. The limited prior research focuses on the impact of exogenous short selling constraints on investment rather than the direct relation between short interest ratio and investment. For example, Grullon, Michenaud, and Weston (2015) use Reg SHO pilot program as a controlled experiment on shortselling constraints and document that an increase in short-selling activity causes prices to fall, and that small firms react to these lower prices by reducing equity issues and investment. Edmans, Goldstein, and Jiang (2012) use forced mutual fund redemption as an exogenous shock to the valuation of stocks held by these mutual funds and report that financial markets have real effects i.e., they impose discipline on managers by triggering takeover threats. We bridge this gap in the literature by integrating literature on short interest and on equity misevaluation and investment.

Under what we call *the overvaluation hypothesis*, firms respond to overvaluation, as proxied by short interest ratio, by investing more. To the best of our knowledge, we are the first to use a broad-based panel data sample of Standard and Poor's 1500 firms for the period of 2003-2015 to directly examine the impact of short interest ratio on corporate investment. We find evidence consistent with investment *catering* theory for capital expenditures. The rest of the paper is organized as follows: Section-II deals with data and measurement. Empirical methods and results are discussed in section-III. Finally, section-IV concludes.

II. Data and Variables Measurement

The Compustat Short Interest file contains monthly data for NYSE and Amex firms beginning in 1973 and for NASDAQ firms beginning in 2003. The monthly reported data provide the number of shares sold short for a given firm. Hence, to include data for firms from all three major US stock exchanges, we collect annual data for the period of 2003-2015 on S&P 1500 firms from COMPUSTAT annual database. This sample contains a wide range of firms and thus better reflects the differences across the firms with respect to short interest, investment opportunities and financial constraints. We exclude the highly regulated financial firms (SIC codes: 60-67) and utilities (SIC code of 49) from the sample. We exclude firms with missing values for sales, total assets and property, plant and equipment (PPE). To mitigate the influence of extreme observations, we further exclude all firms with the book value of assets less than $10 million. Further, we minorize all the variables at the 1% level to remove outliers/influential observations and to mitigate any data recording errors. We are left with 10,865 firm-year observations representing 1,018 unique firms.

Short Interest Ratio:

We first collect the monthly adjusted equity short interest (*shortintadj*) from the Compustat supplemental short interest file. We obtain the monthly number of shares outstanding (*shrout*) and the cumulative factor to adjust number of shares outstanding (*cfacshr*) from Center for Research in Security Prices (CRSP) monthly stock files and compute the adjusted number of shares outstanding as product of *shrout* and *cfacshr*. If the adjustment factor is missing or zero then adjusted shares outstanding is same as the shares outstanding. We exclude observations with missing data on shares outstanding. Then we calculate the level of monthly short interest ratio (SIR) as the ratio of the monthly short interest, adjusted for stock splits, to

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the adjusted number of shares outstanding. Since our other COMPUSTAT data on firm fundamentals is at annual frequency, we use the average monthly short interest ratio for a given year as the annual short interest ratio. This measure is our proxy for equity mis-valuation and computed as below:

$$SIR_{it} = 1/12 \sum_{t=1}^{12} \frac{Shortintadj_{it}}{shrout_{it} * cfacshr_{it}}$$

We expect that the higher the short interest ratio, the higher the equity mis-valuation. Let us examine this measure further for its suitability for equity misevaluation. The higher the equity overvaluation, the higher will be the demand for shorting the stock and accordingly we expect higher short interest ratio. If the ability to short the stock is constrained because of supply related factors such as difficulty in locating and borrowing the stock, high cost of borrowing in the securities lending market etc. then the short interest ratio may be lower even though the stock is overvalued. However, given the fact that most of S&P 1500 stocks are widely held and have higher institutional ownership relative to retail ownership, this should not be a major concern. To this extent, we acknowledge that the short interest ratio is a bit noisy proxy for equity overvaluation.

Financial Constraints:

Hadlock and Pierce (2010) conclude that firm size and age are particularly useful predictors of financial constraint levels. Given that leverage and cash flow are endogenous, they advocate a conservative approach using only firm size and age in creating a measure of financial constraints and question the validity of commonly used measures of financial constraints such asKaplan and Zingales (1997) and Whited and Wu (2006) indices. The *SA index* based on firm size and age is calculated as: (−0.737* Size) + (0.043* Size^2)−(0.040*Age), where size is the log of inflation adjusted (to 2015) book assets, and age is the number of years the firm has been on Compustat with a nonmissing stock price.

In calculating this index, size is replaced with log($4.5 billion) and age with 37 years if the actual values exceed these thresholds. Growth Opportunities:

Richardson (2006) argues that either market-to-book or price-to-earnings or some arbitrary combination of the two will generate an inefficient estimate of growth opportunities because knowledge of earnings persistence is ignored. Using the residual income framework, Richardson (2006) constructs a parsimonious measure of growth opportunities. The residual income framework incorporates analyst forecasts of future earnings in addition to the historical information contained in book value and it is designed to be invariant to various accounting treatments to the extent that the ”clean surplus” accounting identity holds; see Ohlson (1995). The clean-surplus relation articulates that the change in book value of equity equals earnings minus dividends. Assuming price is equal to discounted expected dividends and abnormal earnings follow an auto-regressive process with persistence parameter, ώ, one can express the value of assets in place as below:

$V_{AIP} = (1 - \alpha r)BV + \alpha(1 + r)X - \alpha rd$

where BV is the book value of common equity, X is earnings, r is the discount t rate, d is dividends, ώ is a fixed persistence parameter restricted to be positive and less than one, and α= ώ /(1+r− ώ).The value of r is set at 0.12 and u is set at 0.62 as reported in Dechow, Hutton, and Sloan (1999) and Richardson (2006). V_{AIP} reflects the value of the firm indicated by current book values and current earnings and accordingly provides an estimate of firm value attributable to assets in place. Thus, to capture growth opportunities

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from both accounting and market information, *Growth* is measured as the ratio of V_{AIP} to market value of firm's equity (prcc_f*csho). This measure incorporates information in market price in conjunction with measures of the value of a firm's assets in place as reflected by their book value and current earnings. Following Grundy and Li (2010), we use this variable as an alternative proxy for growth opportunities in addition to Tobin's Q measured as a ratio of market to book value of assets i.e. [Total Assets (at) – Book Equity (ceq +txdb) + Market equity(prcc_f*csho)] / Total Assets (at). Recently, Peters and Taylor (2017) propose a new measure of Tobin's Q, viz. "*totalQ*", that accounts for the replacements cost of intangible capital and argue that it is a superior proxy for both physical and intangible investment opportunities. Since short interest ratio is our proxy for equity mis-valuation, we further use the ratio of market to book value of equity (MBE) as another proxy for growth opportunities. We also include ratio of sales growth to sales (SG) as an additional measure of growth opportunities unrelated to stock prices.

Keeping with prior literature, we measure cash-flow (CF) as income before extraordinary items (ib) plus depreciation and amortization (dp). We also measure cash holdings (ch) at the beginning of period. We compute debt ratio (DR) as a ratio of total debt(dltt+dlc) to total assets. We measure annual capital investment (I) as (capx). We follow Peters and Taylor (2017) and measure intangible investments (INTAN) as Research and Development (xrd) + 0.3*Selling, General and Administrative expenses (xsga). This notion assumes 30% of SG&A represents an investment and the remaining 70% as operating costs that support the current period's earnings and is consistent with prior studies by Lev and Radhakrishnan (2005), Eisfeldt and Papanikolaou (2014).

III. Empirical Models and Results

3a. Univariate Analysis:

Descriptive statistics for key variables are reported in table-I and briefly discussed here. The mean value of scaled capital expenditures (I_{it}/A_{it-1}) is 5.6% and median value is 3.6% whereas the minimum and maximum values are 0.3% and 34.4% respectively. The mean value of scaled intangible expenditures ($Intan_{it}/A_{it-1}$) is 10.8% and median value is 8.7% whereas the minimum and maximum values are 0% and 45.6% respectively. Thus, intangible investments are much larger relative to capital expenditures in our sample. The average short interest ratio (SIR) is 5.7% and median short interest ratio is 4%. The minimum and maximum short interest ratios are 0.2% and 26.5% respectively. The mean value for financial constraints proxied by *SA Index* is2.932 and median is 3.195. The minimum and maximum *SA Index* values are 0.43 and 4.743 respectively. The mean value of Tobin's Q is 2.092 and median value is 1.691 whereas the minimum and maximum values are 0.736 and 8.78 respectively.

The mean value of *total Q (Q_T)* is 1.417 and median value is 0.941 whereas the minimum and maximum values are -0.315 and 9.965 respectively. The mean value of scaled cash flows (CF_{it}/A_{it-1}) is 11.5% and median value is 11.1% whereas the minimum and maximum values are are -21.3% and 39.5% respectively. The mean debt ratio (DR) is 20.2% and median is 18.8% whereas the minimum and maximum debt ratios are 0% and 72.5% respectively. Please refer table-I for additional details. In figure-1, the annual cross-sectional average short interest ratio over the sample period 2003-2015 is plotted.

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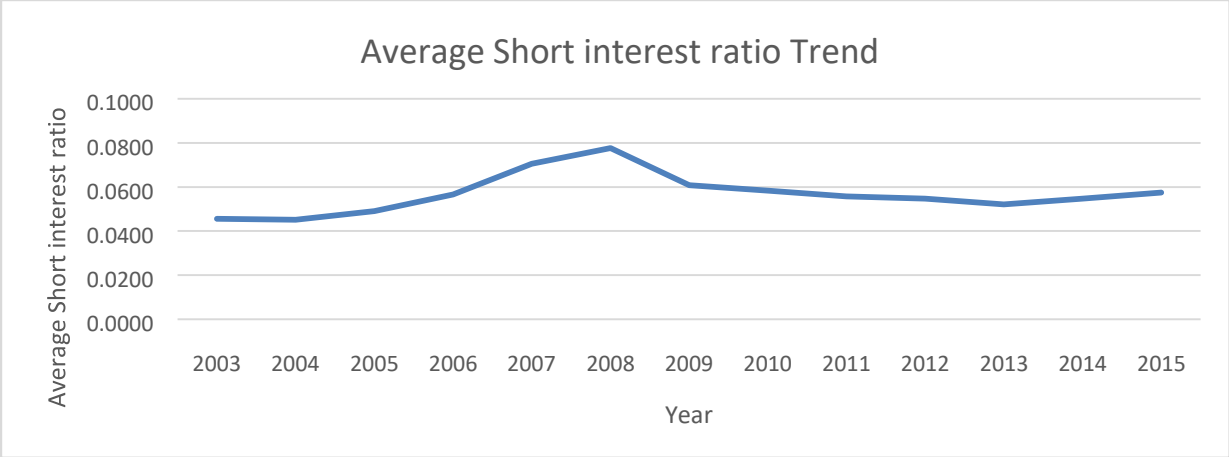
Figure-1 Annual Average Short interest ratio Vs Time



The minimum short interest ratio is 4.51% in year 2004 whereas the maximum short interest ratio of 7.76% is during the height of great recession in year 2008. The average short interest ratio exhibits a positive trend leading up to the great recession and a downward trend post-recession up to the year 2013. Pairwise correlation coefficients for key variables are reported in table-II and briefly discussed here. The scaled capital expenditures (I_{it}/A_{it-1}) has a positive correlation of 0.08 with lagged Tobin's Q where as it has a correlation of 0.05 with lagged *total Q* (Q_T). The scaled capital expenditures has a correlation of 0.31 with scaled cash flow (CF_{it}/A_{it-1}) and has a correlation of 0.16 with scaled total cash flow (CF_T_{it}/A_{it-1}). The scaled capital expenditures has a positive correlation of 0.11 with short interest ratio and a negative correlation of -0.02 with lagged debt ratio (DR). Further, the scaled capital expenditures has a positive correlation of 0.15 with sales growth (SG), a correlation of 0.02 with market to book equity ratio (MBE), and a negative correlation of -0.011 with *Growth* respectively. Short interest ratio (SIR) has positive correlation with all the proxies for lagged growth opportunities and debt ratio whereas it has a negative correlation with scaled cashflow and financial constraints (*SA Index*). This suggests that firms with high growth opportunities and high leverage ratios to begin with are shorted more and firms with higher scaled cash flows and higher financial constraints are shorted less. Please see table-II for further details.

In panel A of table-III, we report the mean values for key variables split into lowest quartile (quartile-1) and highest quartile (quartile-4) based on short interest ratio. We test and report the corresponding T-statistic for the mean differences of each variable. It appears that there is a significantly positive difference for scaled capital expenditures between firms in the highest versus lowest short interest ratio quartiles. The highest quartile shorted firms have an average of 6.52% and lowest quartile shorted firms have an average of 4.83% for capital expenditures scaled by lagged total assets. Also, highly shorted firms in quartile-4 have significantly higher debt ratios, sales growth rates, Tobin Q, *Growth* and *total Q* (Q_T) compared to the less shorted firms in quartile-1. Further, highly shorted firms have significantly lower financial constraints (*SAIndex*) and lower cashflows scaled by lagged total assets compared to the less shorted firms.

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In panel B, we report the mean values and the corresponding T-statistics for the mean differences of key variables split into lowest quartile (quartile-1) and highest quartile (quartile-4) based on financial constraints (*SAIndex*). Firms in highest financial constraints quartile tend to have significantly lower lagged cash holdings scaled by lagged assets, lower short interest ratios, lower Tobin's Q, lower *total Q,* lower market to book value of equity ratios compared to those firms in lowest financial constraints quartile. However, firms in highest financial constraints quartile appear to have significantly higher lagged debt ratios compared to those in lowest quartile. Please refer to table-III for additional details.

3b. Multivariate Analysis:

3b.1. Capital Expenditures

The *investment catering theory* reli**es on the assumption that either the shareholders or the manager of the firm have short-term horizons; see Stein (1996)**. Managers with long horizons make efficient investment decisions by assumption. However, if stock market valuation affects investment decision through a catering channel, managers with short-term focus on quarterly earnings per share may make an investment that has a negative net present value (NPV) and avoid investment that has a positive NPV as-long-as this strategy increases the stock price in the short run. We begin with the seminal Fazzari, Hubbard, and Petersen (1988) model of investment-cash flow sensitivity and augment it to include our hypothesized variable for equity overvaluation viz. Short interest ratio. We also control for growth opportunities using various proxies defined earlier, cash flow, leverage and cash holdings. The beginning of the period cash holdings is an important source of internal capital for firms besides the operating cash flows generated during the period. Hence, we include lagged cash holdings scaled by lagged total assets in the following baseline specification:

Iit/Ait-1 = β0 + β1*Growth Opportuityit-1+ β2*CFit/Ait-1+ β3* CHit-1 /Ait-1+ β4*SIRit+ β5* DRit-1 + Firm
Dummies +Year Dummies+ $\grave{\varepsilon}_{it}$ (1)

The above equation is estimated using fixed effects regression model for panel data. We use robust standard errors clustered by firm for inference. The results are reported in panel A of table-IV and a brief discussion follows: The coefficient on short interest ratio (SIR) is positive and significant in models 1 and 2 where we used Tobin's Q and ratio of market to book value of equity respectively as growth opportunities. In model 3, when we used *Growth* as a measure of growth/investment opportunities, the coefficient on short interest ratio is highly significant. The coefficient on *Growth* is negative as expected and highly significant. Hence it appears that firms with highly overvalued equity tend to pursue capital expenditures in order to maintain their high stock valuations. This result is consistent with the investment *catering theory*, as in Polk and Sapienza (2008) and Dong, Hirshleifer, and Teoh (2007). All the other control variables have their expected signs and highly significant except the lagged cash holdings which has positive coefficients but varied in significance depending on the model. To gauge the economic importance of the investment- equity valuation relation, we examine the effect of a one-standard-deviation change in short interest ration capital expenditure levels; and compare this to the effect of a similar shift in cash flow.Table-I provides data on the standard deviations of short interest ratio as 5.1% and scaled cash-flow (CF_{it}/A_{it-1}) as 9%. Let us examine model-3 in table-IV. A one standard deviation shift in short interest ratioimplies 0.2127% (0.0417*5%) change in scaled capital expenditures (I_{it}/A_{it-1}). This compares with 0.7965% (0.0885*9%) change in scaled capital expenditures for a similar shift in scaled cash-flow.

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Thus, the effect of mis-valuation on capital expenditures is around 27% (0.2127/0.7965) of the effect of cash flow. While we have included various measures for growth opportunities in equation-1, all of them are based on stock price. To analyze whether investment responds to irrational variations in stock prices or rational changes in the investment opportunity set i.e. firm fundamentals, following Ovtchinnikov and McConnell (2009), Morck et al. (1990), we include ratio of sales growth to sales (SG) as additional measure of growth opportunities.

Because this measure is not directly related to stock prices, any sensitivity of investment to sales growth rate cannot be attributed to variations in stock prices, especially after sequentially controlling for stock prices directly with aforementioned measures of growth opportunities. We estimate the following equation:

Iit/Ait-1 = β0 + β1*Growth Opportuityit-1+ β2*CFit/Ait-1+ β3* CHit-1 /Ait-1+ β4*SIRit+ β5* DRit-1 + β6* SGit +Firm Dummies +Year Dummies+ $\grave{\varepsilon}_{it}$ (2)

The estimation results are reported in panel B of table- IV and a brief discussion follows:

The coefficient on short interest ratio (SIR) is positive and highly significant in all the models. Sales growth (SG) is positive and highly significant in all the models. All the other control variables have their expected signs and highly significant except the lagged cash holdings which is insignificant in all the models. We examine model-6 in table-IV for the economic significance. A one standard deviation shift from mean short interest ratio implies 0.226% (0.0452*5%) change in scaled capital expenditures (I_{it}/A_{it-1}). This compares with 0.6624% (0.0736*9%) change in scaled capital expenditures for a similar shift in scaled cash-flow. Hence the effect of mis-valuation on capital expenditures is around 34% (0.226/0.6624) of the effect of cash flow. Thus, the inclusion of sales growth, as an additional proxy for growth opportunities, has not diminished the positive impact of short interest ratio on scaled investment expenditures and the economic significance has increased from the baseline model where we excluded sales growth.

The main focus of Fazzari et al. (1988) is the impact of financial constraints on corporate investment. Hence, we follow Hadlock and Pierce (2010) and include *SA Index* based on firm size and age as a proxy for financial constraints. We also include the interaction terms of growth opportunities with short interest ratio and financial constraints with short interest ratio to capture the impact of growth opportunities and financial constraints respectively on the sensitivity the capital expenditures to equity overvaluation. We have measured Tobin's Q as the ratio of market value to the book value of assets. However, because U.S. accounting rules treat R&D and SG&A as operating expenses and not as capital investments, the balance sheet assets exclude majority of firms' intangible capital. Recently, Peters and Taylor (2017) propose a new measure of Tobin's Q, viz. "*totalQ*", that accounts for the replacements cost of intangible capital and argue that it is a superior proxy for both physical and intangible investment opportunities. "*totalQ*" is an improved Tobin's Q proxy that includes intangible capital in the denominator, i.e., in the replacement cost of firms' capital. Peters and Taylor (2017) estimate the replacement cost of firms' intangible capital by accumulating past investments in R&D and SG&A. A brief description of this measure follows:

Total Q = $(V_{it} / K_{it}^{phy} + K_{it}^{int})$

Firm's market value V is measured as the market value of outstanding equity (prcc_f *csho), plus the book value of debt (dltt+dlc), minus the firm's current assets (act), which include cash, inventory, and marketable securities. The replacement cost of physical capital, K_{phy}, is measured as the book value of

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property, plant and equipment (ppegt). By accumulating past research and development (R&D) spending (xrd) and using a perpetual inventory method they first calculate a firm's knowledge capital. Then firm's organization capital is calculated by accumulating a fraction of selling, general and administrative (SG&A) expenses (xsga) and using a perpetual inventory method. Finally, the replacement cost of intangible capital, K_{int} is measured as sum of knowledge capital and organization capital. Please see Peters and Taylor (2017) for further details. We collect data, for our sample firms and time-period, on this new measure from Wharton Research Data Services (WRDS) and sequentially use it as our fifth measure of growth opportunities and estimate the following equation:

Iit/Ait-1 = β0 + β1*Growth Opportuityit-1+ β2*CFit/Ait-1+ β3* CHit-1 /Ait-1+ β4*SIRit+ β5* DRit-1 + β6* SGit + β7* SAit-1 + β8* SAit-1*SIRit + β9*Growth Opportuityit-1* SIRit + Firm Dummies +Year Dummies+ $\dot{\varepsilon}$it (3)

The estimation results are reported in table-V and a brief discussion follows: The coefficient on short interest ratio (SIR) is significantly positive in all the models. The coefficient on lagged financial constraints is negative implying that financial constraints adversely impact scaled capital expenditures consistent with prior literature. The coefficient (**β9**) on the interaction term between short interest ratioand growth opportunities (Q and MBE) is positive and significant suggesting that growth opportunities increase the sensitivity of capital expenditures to equity mis-valuation as proxied by the level of short interest ratio. However, the coefficient **β9** is positive but not significant when we used *total Q* as the measure of growth opportunities. Let us quantify this impact by examining model-2. For an average firm in our sample with a ratio of equity market to book value (MBE) of 3.23, the impact of short interest ratio on scaled capital expenditures increases from 0.1273 to 0.146 (0.1273+0.0058*3.23). This is an increase of around 15% ((0.146/0.1273)-1). The coefficient **β8** on the interaction term between short interest ratio and lagged financial constraints is negative suggesting that financial constraints decrease the sensitivity of capital expenditures to equity overvaluation. However, the coefficient **β8** is significant only when we used either ratio of market to book value of equity (MBE) or *total Q*as the measure of growth opportunities. All the other control variables have their expected signs and significant except the lagged cash holdings which is insignificant in all the models.

3b.2. Robustness Checks

Sub-sample Analysis:

Given the mixed results of financial constraints influence on the effect of equity mis-valuation on capital expenditures, we further examine this result by dividing the sample into four quartiles based on our proxy for financial constraints (*SA Index*). The first quartile corresponds to lowest financial constraints and the last quartile corresponds to the highest financial constraints. We re-estimate equation-3 and report the results in table-VI. We find that the coefficient **β4** on equity mis-valuation is positive and highly significant in the lowest financial constraints (Low FC) subsample (corresponds to odd model numbers) in table-VI whereas it is insignificantly negative, except in model2, in case of highest financial constraints (High FC) subsamples (corresponds to odd model numbers) in table-VI.

The coefficient **β8** on the interaction term between short interest ratio and lagged financial constraints is negative and significant in case of the lowest financial constraints subsample but insignificantly positive in case of highest financial constraints subsample for all the models. This is consistent with the findings of

Ovtchinnikov and McConnell (2009) that, for highly financially constrained firms, investment is actually less dependent on equity financing which is counter intuitive. These results make sense because even though a firm's equity is overvalued, its impact on capital expenditures will be muted if the firm is facing severe financial constraints.

Let us look at the other variables in the equation. The various proxies for growth opportunities are significantly positive in the lowest financial constraints subsamples whereas the sign and significance varied across the models in case of the highest financial constraints subsamples. Consistent with prior literature, cash-flow scaled with lagged assets is consistently positive and significant across all the models. However, the magnitude of the coefficient in highest financial constraints subsample was 1.73 to 2.40 times larger compared to lowest financial constraints subsample. It implies that capital expenditures are lot more sensitive to operating cash-flow in case of financially constrained firms versus less constrained firms. Scaled cash-holdings were insignificant in all the models. As expected, lagged leverage is negative and significant in all the models. However, the magnitude of the coefficient in lowest constraints subsample was 1.72 to 2.50 times larger compared to highest financial constraints subsample. It implies that capital expenditures are lot more sensitive to lagged leverage in case of less constrained firms versus high constrained firms. This might appear counterintuitive at first but makes sense because if the firm is already highly financially constrained to begin with, then the marginal impact of taking on additional debt on capital expenditures should be lower for highly constrained firm compared to that of a lower or unconstrained firm.

So far we have examined the direct relation between mis-valuation and capital investment, in the overall sample, and presented a robust evidence, consistent with *investment catering theory*, that equity mis-valuation, as proxied by short interest ratio, has significant positive impact on capital expenditures even after controlling for a comprehensive measure of investment opportunities that includes replacement cost of both tangible and intangible capital, several price and non-price based growth opportunities, cash flow, cash holdings, leverage and financial constraints.

However, based on subsample analysis, we find support for investment catering theory only incase of lower financial constraint firms. Thus, if *catering theory* holds, then we expect that capital expenditures to negatively predict returns, consistent with high-investment firms being overvalued, see Titman, Wei, and Xie (2004). Our results supporting *catering theory* are also consistent with prior literature on short interest and subsequent negative stock returns. If short sellers target firms with deteriorating fundamentals, then the stock prices of these firms should be expected to decline and yield negative equity returns.

Equity Issuance Channel:

Baker et al. (2003) show that mispricing also affects investment decisions indirectly through an equity issuance channel which is independent from investment *catering.* Firms that are overpriced are expected to issue more equity (see Baker and Wurgler (2000)). We follow Ovtchinnikov and McConnell (2009), and measure net equity issuance as the change in book equity (ceq +txdb) minus the change in retained earnings (re) over lagged assets (at). We follow Polk and Sapienza (2008) and include scaled net equity issuance (NEI_{it}/A_{it-1}) as additional control variable to account for the indirect effect of equity issuance channel. We estimate the following equation:

Iit/Ait-1 = β0 + β1*Growth Opportuityit-1+ β2*CFit/Ait-1+ β3* CHit-1 /Ait-1+ β4*SIRit+ β5* DRit-1 + β6*

SGit + β7* SAit-1 + β8 * SAit-1*SIRit + β9*Growth Opportuityit-1* SIRit +β10 * NEIit/Ait-1 + Firm Dummies +Year Dummies+ $\grave{\varepsilon}_{it}$ (4)

The estimation results are reported in table-VII and a brief discussion follows: Even after controlling for the indirect effect of equity issuance, the coefficients on short interest ratio have only slightly decreased in magnitude and remain significant supporting *catering theory*. The coefficient on net equity issuance (NEI/A) is positive and highly significant in all the models. This is consistent with (Baker et al., 2003). However, if high market valuations cause the firms to issue more equity to finance investment, then equity issuance is an endogenous variable that is influenced by mis-valuation. Both theory and past evidence suggest that equity issuance is endogenously related to mis-valuation. Hence, we use both sales growth ratio (SG) and inventory growth ratio (IG) as instruments for net equity issuance and estimate the following equation through two-step generalized method of moments (GMM). This estimator also produces both heteroskedasticity and autocorrelation (HAC) consistent estimates of both the slope coefficients and the corresponding standard errors

Iit/Ait-1 = α0 + α1*Growth Opportuityit-1+ α2*CFit/Ait-1+ α3* CHit-1 /Ait-1+ α4*SIRit+ α5* DRit-1 + α6* SGit + α7* SA_{it-1} + α_{8*} NEI_{it}/A_{it-1} + Firm Dummies +Year Dummies+ μ_{it} (5)

The estimation results are reported in table- VIIIand a brief discussion follows:

For the first stage results, for sake of brevity, we only report the results on the main test variable viz. short interest ratio and the two instruments in panel A of table- VIII[11]. In the first stage regressions, we find that the coefficient on short interest ratio is positive but not significant failing to support the notion that overvalued firms issue equity to take advantage of the market mispricing. The coefficients on both sales growth and inventory growth are positive and highly significant. In the second stage regressions, reported in panel B of table-VIII, the coefficient α_4 on short interest ratio is positive and highly significant consistent with investment *catering theory.* The coefficient on α_8 on predicted scaled net equity issuance is positive and significant lending support to equity issuance channel. The coefficientα_7 on financial constraints is insignificant. Let us examine model-3 in table-VIII for the economic significance. A one standard deviation shift in short interest ratio implies 0.19% (0.0371*5%) direct change in scaled capital expenditures (I_{it}/A_{it-1}). This compares with 0.025% (0.0386*0.1287*5%) indirect change in scaled capital expenditures through equity issue. Hence, the total effect of mis-valuation on capital expenditures is around 0.22% (0.19+0.025). The direct effect through investment catering dominates the indirect effect of equity issuance channel. This makes sense because seasoned equity offerings are not commonly used to finance investment despite stock misevaluations. Also, external equity issuance as such requires board approval, fraught with dilution of existing shareholders equity and information asymmetry problems between firm insiders (managers) vs. outsiders (shareholders) associated with external equity. The relative strength of the direct effect is consistent with the hypothesis that catering incentives (the pressure to maintain a high stock price) is especially strong among overvalued firms as per Jensen (2005).

We test the validity of instruments through overidentification test, weak identification test and under identification test and accordingly report appropriate test statistics. To examine instrument validity, we report Hansen *J* statistic for overidentification at the bottom of table-VIII. In model-1, the *J* statistic has a value of 1.242 with a pvalue of 0.27 thus failing to reject the null hypothesis that instruments are valid. We

further check the relevance of instruments through a test of week instruments. In model-1, the Sanderson-WindmeijerF-statistic has a value of 79.93 with a p-value of zero. Hence, we reject the null that the equation is weakly identified. The strong significance of the instruments viz. sales and inventory growth in the first stage equation along with the rejection of weak identification test should mitigate the concern whether the instruments are weakly correlated with the endogenous regressor.

3b.3. Intangible Investment

In our sample, the average value of scaled intangible investments, (R&D plus 0.3*SG&A) by total assets i.e. ($INTAN_{it}/A_{it-1}$) is 0.108 and the median value is 0.087. However, the tangible capital i.e. capital expenditures scaled by total assets (I_{it}/A_{it-1}) has an average of 0.056 and median of 0.036 respectively. Thus, intangible investments are much larger relative to capital expenditures in our sample. This is consistent with the US economy transitioning from the traditional manufacturing sector to modern knowledge and service-based sectors. Lev and Radhakrishnan (2005) and Eisfeldt and Papanikolaou (2014) argue that investment in human/knowledge capital has become an increasingly important factor of production in US gross domestic product (GDP). However, all the three types of internal investment are important as firms invest in *R&D* to develop the product, then in *Capex* to manufacture it, and finally in *S&GA* to market and sell although the proportion of the three types of varies depending on the product life cycle and industry. Now we examine the impact of equity mis-valuation on intangible investment. We closely follow the methodology employed in capital expenditures section above and directly start with the equation-5 where the dependent variable is now $INTAN_{it}/A_{it-1}$and instead of cash flow, we now use total cash flow scaled by lagged total assets. Following Peters and Taylor (2017), we define total cash flow (CF_T) as cash flow (CF) plus (R&D+0.3*SG&A)*(1-marginal tax rate). We obtain the marginal tax rates from the Compustat database provided by the Wharton Research Data Services (WRDS). If the values for marginal tax rates are missing for any firm-year, we use the average value of marginal tax rate during the sample period. We again use sales growth and inventory growth as instruments for net equity issuance and estimate the model using two-step GMM. The abridged first stage results are reported in panel A and the second stage results are reported in panel B of table-IX respectively. A brief discussion of results follows:

In the first stage regressions, we find that the coefficient on short interest ratio is positive but not significant. The coefficients on both sales growth and inventory growth are positive and highly significant. In the second stage regressions, the coefficient α4 on short interest ratio is positive but significant only in model-4 when *total-Q* was used as growth opportunities. Thus, our results fail to support the investment *catering theory* with respect to intangible investments. This result looks counter intuitive but it makes sense because firms with overvalued equity may prefer to invest more on physical capital that appears on the balance sheet which makes it easy to observe and less prone to information asymmetry compared to the intangible capital which is expensed and not reported on balance sheet. The coefficient on α8 on scaled net equity issuance is positive and significant lending support to indirect equity issuance channel. The coefficient α7 on financial constraints is negative and highly significant. The coefficient on lagged leverage is negative and highly significant. The coefficient on cash-flow is positive and significant. Also, the cash-flow sensitivity of intangible investments is 1.45 to 1.65 times that of the cash-flow sensitivity of capital expenditures. This suggests that firms may cut intangible investment more compared to capital expenditures when they face financial constraints. The coefficient on lagged cash-holdings is negative and insignificant. To examine instrument validity, we report Hansen *J* statistic for overidentification at the

bottom of table-IX. In model-1, the *J* statistic has a value of 1.647 with a p-value of 0.19 thus failing to reject the null hypothesis that instruments are valid. We further check the relevance of instruments through a test of week instruments.

In model-1, the Sanderson-WindmeijerF-statistic has a value of 70.66 with a p-value of zero. Hence, we reject the null that the equation is weakly identified. The strong significance of the instruments viz. sales and inventory growth in the first stage equation along with the rejection of weak identification test should mitigate the concern whether the instruments are weakly correlated with the endogenous regressor.

IV. Conclusions

Extant prior literature on short interest has examined the impact of short interest ratio on firm's expected stock returns and bond returns. However, the current literature does not examine the impact of short interest on the firm's real investment policy. We bridge this gap in the literature by integrating literature on short interest and on equity mis-valuation and investment. Using a sample of S&P 1500 non-financial firms for the period of 2003-2015, we study the impact of short interest ratio on corporate investment viz. capital expenditures and intangible investment. Consistent with Polk and Sapienza (2008) our results support that equity overvaluation has significantly positive impact on capital expenditures through direct investment *catering*. Further, our results support that equity mis-valuation positively influences capital expenditures indirectly through the equity issuance channel. We find that the direct effect through investment catering dominates the indirect effect of equity issuance channel. The relative strength of the direct effect is consistent with the hypothesis that catering incentives (the pressure to maintain a high stock price) is especially strong among overvalued firms (Jensen (2005)). However, our results do not support *catering* theory with respect to intangible investments. Based on financial constraints (*SA Index*) subsample analysis, we find that equity mis-valuation is positive and highly significant in the lowest financial constraints quartile whereas it is insignificantly negative in case of highest financial constraints quartile consistent with Ovtchinnikov and McConnell (2009). The overall results are robust to various model specifications and corrections for endogeneity.

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