



# Does short selling reduce analysts' optimism bias in earnings forecasts?

Deshuai Hou<sup>a</sup>, Qingbin Meng<sup>b</sup>, Kam C. Chan<sup>c,\*</sup>

<sup>a</sup> School of Accounting, Capital University of Economics and Business, Beijing, China

<sup>b</sup> School of Business, Renmin University of China, Beijing, 100872, China

<sup>c</sup> School of Accounting, Zhongnan University of Economics and Law, Wuhan, China

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## ABSTRACT

We examine the relationship between short selling and analyst optimism bias of earnings forecasts of stocks in China. We propose two possible hypotheses: short selling enhances analysts' information set to lower optimism bias and analysts drum up optimistic earnings forecasts to counter short selling. Our results suggest that short selling and earnings optimism bias are negatively correlated. The findings are robust to a two-stage least square method, a difference-in-differences fixed effect model, an alternative measure of optimism bias, incorporated different time windows to calculate short selling, considered bull and bear market conditions, accounting for media coverage, and using abnormal short selling. By leveraging rich data, we conduct additional analyses using stocks with different forecasting horizons and earnings forecasts that were made after the accounting year but prior to the earnings announcement to further support expanding the information set argument. Lastly, we document that short selling information improves the accuracy of earnings forecasts.

## 1. Introduction

Analysts generate information and disseminate their findings to clients. An important element of analysts' research output is their earnings forecasts for firms. These forecasts receive significant attention because they affect security pricing and investor trading decisions (Kelly and Ljungqvist, 2008, 2012; Yu, 2008). Analysts that engage in earnings forecast research consider information about the economy, the industry, and the firm. Prior studies generally report that analysts focus more on researching the economy and the industry, rather than the firm (Piotroski and Roulstone, 2004; Chan and Hameed, 2006). Analysts are seldom able to fully uncover or unable to incorporate negative information regarding firms in their earnings forecasts (Easterwood and Nutt, 1999). Accordingly, analysts' earnings forecasts are typically optimistically biased.

Studies generally explain the optimism bias of analysts' earnings forecasts (hereafter, analyst optimism bias) in two perspectives: (1) analysts have conflicts of interest (e.g., Francis and Philbrick, 1993; Hong and Kubik, 2003; O'Brien et al., 2005; Lin and McNichols, 1998) such as promoting their brokerages' trading commissions or pleasing potential clients for future lucrative underwriting business, and (2) analysts do not have the ability to fully process information, particularly negative information regarding their covered firms (e.g., McNichols and O'Brien, 1997; Easterwood and Nutt, 1999 and O'Brien et al., 2005). These studies emphasize factors that are specifically related to the analysts (behavior or ability) or firm-specific factors (media attention on the firm or firm information

\* Corresponding author.

E-mail addresses: [houdeshuai@126.com](mailto:houdeshuai@126.com) (D. Hou), [mengqingbin@rbs.org.cn](mailto:mengqingbin@rbs.org.cn) (Q. Meng), [Johnny.Chan@wku.edu](mailto:Johnny.Chan@wku.edu) (K.C. Chan).

disclosure). Studies seldom examine external factors attribute to the capital market that systematically affect analyst optimism bias. We consider that short selling is such an important external factor.

When a stock faces short selling pressure in the market, it has two possible impacts on analyst earnings forecasts based on the related literature. First, analysts have conflicts of interest. In order to draw trading commissions and/or maintain good relation with corporate executives for future underwriting business, analysts drum up their optimistic earnings forecasts to counter the negative price pressure from short selling. Hence, the magnitude of analyst optimism bias increases when a stock faces a high short selling. Second, short selling provides opportunities for market participants to “air” their negative information regarding the firm (Miller, 1977). Unlike information disclosure or media coverage, which are not necessarily related to negative information, short selling always involves the disclosure of negative information. Most important, there are considerable incentives for short sellers to research negative information regarding a firm; this information can be used to guide their short selling decisions. Additional negative information that is disclosed due to short selling activities draws the attention of all market participants, including analysts. This argument echoes Shyu et al. (2018), who document the spillover effects of short selling and suggest that short sellers serve as information intermediaries for margin buyers. Thus, analysts provide less optimistically biased earnings forecasts. The two views contrast each other. Thus, it is unclear how short selling affects analyst optimism bias.

The objective of this paper is to study the impact of short selling on analyst optimism bias. Our study represents a new perspective on the impact of analyst optimism bias beyond analyst behavior/ability or internal factor of a firm. We conduct our examination using a sample of Chinese firms. The Chinese environment is excellent for several reasons. First, Chinese capital markets are opaque; information efficiency and transparency are poor (Piotroski et al., 2015), especially before short selling deregulation. The cost to obtain firm-specific information is high, and it is natural for analysts to consider short selling activities as important piece of information when conducting their earnings forecast research. Second, similar to other emerging capital markets, it is common that analysts have conflicts of interest due to their pressure to help their brokerage firms in generating trading commission and/or garner underwriting business. Thus, analysts drum up their earnings forecasts when their covered firm faces short selling pressure. Third, unlike the majority of short selling studies for other markets that primarily use monthly data, China maintains statistics regarding daily short selling for each shortable stock. The availability of data regarding daily short selling enhances our ability to relate short selling to analyst optimism bias in earnings forecasts. Last, China is one of the few emerging markets that allow short selling. Having the presence of short sellers, Chinese capital markets may be improving. Hence, it is an interesting issue if analysts are able to leverage the short selling information in their earnings forecasts. Mature markets, such as US, lack a clean setting because US has already allowed some short selling. Short selling deregulation in a mature market, such as the Regulation SHO in the US, focus on the marginal impact of additional short selling. In contrast, short selling deregulation in China is from no short selling allowed to allow some short selling. China's short selling deregulation is a wholesale change (Zhang et al., 2020). The knowledge between the relation between short selling and analyst optimism bias provides valuable lessons for other emerging markets in adopting short selling deregulation.

Our findings suggest that when a firm experiences high short selling, analysts who follow the firm have less analyst optimism bias. The results are robust to a two-stage least square method, a difference-in-differences (DID) model, a fixed effect model, an alternative measure of analyst optimism bias, different time windows to calculate short selling, considered bull and bear market conditions, accounting for media coverage, and using abnormal short selling. Hence, under short selling, short sellers complement analysts by expanding the information set that is available to analysts, particularly in regards to negative information regarding the covered stock. The results do not support the notion that analysts further drum up earnings forecasts when a covered firm faces increase short selling.

We further document that short selling is less informative for two separate conditions: longer forecasting horizons and when analysts make earnings forecasts after the accounting year has ended but prior to a firm's earnings announcement for the year because more information is available to analysts regarding the entire accounting year. Our results indicate that the expanding information set is a better explanation on the relation between short selling and analyst optimism bias. Lastly, we determine that short selling information improves the accuracy of analyst earnings forecasts.

Our study makes several contributions to the literature. First, we document a link between short selling and analyst optimism bias and report new evidence showing that an increase in short selling lowers the magnitude of analyst optimism bias on their covered stocks. Second, our results complement the pioneering work of Miller (1977), who suggests that removing short sale restrictions enhances pricing efficiency because additional negative firm information is available to the market, which limits the overvaluation of stocks. We find evidence to be consistent with the notion that analysts discover more negative information through short selling and this activity reduces analyst optimism bias in a firm's earnings forecasts. Third, we report that short selling information helps to improve analyst earnings forecast accuracy. Overall, our findings support the notion that short selling provides additional negative information to analysts and reduces analyst optimism bias. Therefore, in terms of public policy implications, we document that short selling deregulation restrains analyst optimism bias in earnings forecasts and improves the information environment and allows analysts to make better earnings forecasts for their covered firms.

## 2. Institutional background of short selling

The China Securities Regulatory Commission (CSRC) laid the groundwork to allow short selling in October 2005 when it released the “Administration Supervision of Securities Company and Regulations” that allows brokerage firms to engage in short selling. After several years of preparation, short selling in China took effect on March 31, 2010 when the CSRC allowed the largest 90 A-share stocks be shortable. These 90 stocks were the constituent stocks of the market indices in both the Shanghai and Shenzhen Stock Exchanges. In addition to using only designated shortable stocks, the CSRC enforces an uptick rule. Investors cannot borrow stocks to sell short stocks (this requirement was removed in 2013). The number of shortable stocks gradually increased from 2011 to 2014 to 285, 288, 748, and

901, respectively.<sup>1</sup> The CSRC applies additional rules to brokerage firms and investors as follows:

- (a) The investor must have maintained a brokerage account with the firm for a minimum of 18 months;
- (b) The investor must have a minimum brokerage balance of RMB500,000 (about US \$80,000);
- (c) A brokerage firm must assess the customer's trading experience, risk tolerance, and personal wealth to determine if the customer is an appropriate short seller;
- (d) The investor must pay interest to use borrowed stocks from the brokerage firm. As of February 23, 2015, the interest rate is 10.6 % per year and applies to the market value of the borrowed stocks.<sup>2</sup>
- (e) There is a six-month time limit for maintaining a short position with a 50 % margin.

### 3. Literature review and hypothesis development

#### 3.1. Short selling

There are three different strands of literature of short selling. The first strand analyzes whether short selling is informed trading or speculative trading. Irvine et al. (2007); Christophe et al. (2010), and Nefedova (2012) report evidence that short selling is informed trading in the US. For example, Christophe et al. (2010) document abnormally high short selling before analysts downgraded a stock, resulting in abnormal profits. Meng et al. (2017) report that short sellers in the Chinese market engage in abnormal short selling before star analysts downgrade stocks, which suggests that they are informed traders. In contrast, Daske et al. (2005); Blau and Wade (2012), and Blau and Pinegar (2013) provide evidences that are not consistent with informed trading by short sellers in the US. For example, Blau and Wade (2012) determine that short sellers engage in increased short selling prior to analyst downgrades and upgrades. Short selling before an analyst upgrades a stock is not consistent with informed trading and reflects speculative trading by short sellers. Prior studies regarding short sellers and informed trading have reported mixed results; studies suggest that the act of short selling indicates that certain short sellers have an informational advantage.

The second strand of literature examines whether short selling is undesirable in the context of causing excessive downward price pressure on a stock or whether short selling enhances informational efficiency. Fox et al. (2010) suggest that regulators and corporate executives consider that short selling places downward pressure on stock prices because short sellers engage in an abnormally high volume of short selling prior to abnormal negative stock returns. Similarly, To et al. (2018) document that insiders can leverage credit default swap tool to engage in short-selling in extracting rent to benefit themselves, suggesting that short-selling is a channel for insiders' to conduct opportunistic activities.

In contrast, Miller (1977); Bris et al. (2007), and Saffi and Sigurdsson (2011) suggest that short selling allows negative information to impound into the stock price, which increases pricing efficiency and enhances a smooth adjustment of a stock price. Using the 2011 short selling bans in Europe, Alves et al. (2016) document that the short selling restriction raises stock price volatility when compared to other financial markets. Chmura et al. (2019) show that stock return volatility is lowered when an insider is allowed to engage in short selling.

The third strand of literature studies the relationship between short selling and corporate behavior. This emerging body of literature analyzes issues other than the nature of short selling and do not relate to how short selling impacts overall market efficiency. Massa et al. (2015) report that short selling disciplines managers and restrains their earnings management, i.e., by researching negative information about a firm, short sellers act as monitors. Similarly, Chang et al. (2014, 2015, and 2019) document that short selling restrains managerial empire building, overinvestments in firms, and generate better abnormal returns in mergers, which confirms the corporate governance role of short sellers. Chang and Tian (2016) indicate that after the Regulation SHO in the US, a reduction in restrictions related to short selling resulted in more and better patents from these firms when compared to control firms. Deng and Gao (2018) document that short selling is positively associated with the likelihood of being scrutinized or punished by the CSRC and negatively associated with future stock price crash risk in China. Overall, these studies suggest that short selling has a spillover effect on corporate behavior, such as firm governance, innovation, and information disclosure. We note that the impact of short selling on corporate behavior is *internal* to a firm. It is unclear if short selling influences analyst behavior (which is external to a firm) for the covered stock.

#### 3.2. Analyst optimism bias in earnings forecasts

In regards to analyst optimism bias in earnings forecasts, there are two types of studies. The first type of study suggests that analysts are overly optimistic because they have conflicts of interest including: Curry favor to management (Francis and Philbrick, 1993), maintain good relationships with investment banks (O'Brien et al., 2005), seek repeat underwriting business (Agrawal and Chen, 2012; Cowen et al., 2006), protect, enhance their careers (Hong and Kubik, 2003), or are pressured by institutional investors (Mola and Guidolin, 2009; Firth et al., 2013; Gu et al., 2013). O'Brien et al. (2005) report that analysts quickly respond to good news but delay bad news when their investment bank clients hold substantial positions in the covered stocks. Similarly, Mola and Guidolin (2009) find

<sup>1</sup> There were 901 shortable stocks in 2015.

<sup>2</sup> For example, if the market value of the borrowed stocks is RMB100,000 for a period of one month, then the interest is RMB883.33 (RMB100,000\*10.6%\*1/12).

that when an analyst's brokerage firm engages in trades for mutual fund clients, the brokerage firm frequently makes favorable recommendations regarding the stocks that are held in these mutual funds. These studies generally report that analysts have strong incentives to refrain from reporting information that may negatively affect stock prices so as to please clients.

Second, analysts operate in different information environments that make it challenging to discover negative information. Lang and Lundholm (1996) suggest that firms may not fully disclose all (negative) information, which implies that analysts do not have sufficient information to make less optimistic earnings forecasts. Fang and Peress (2009) indicate that a lack of media coverage results in high informational frictions. Therefore, analysts obtain less (negative) information about their covered stocks. Several studies indicate that other issues may impact the ability of analysts to obtain negative information. Analysts may underestimate the impact of negative information (O'Brien et al., 2005; Easterwood and Nutt, 1999), misjudge the negative information (Bondt and Thaler, 1990; Elliot et al., 1995; Teoh and Wong, 2002), or may be unable to process accounting information (Abarbanell and Bushee, 1998).

We conclude that analysts' conflicts of interest and their inability to obtain negative information are channels that less negative information is channeled to the market. The overall effect is more optimism bias.

### 3.3. Hypothesis development and transmission mechanism

We conclude from the literature that: (1) Short selling can provide credible (negative) information about a stock. The short selling information is potentially helpful for analysts who may not have the ability to uncover negative firm information, and (2) analysts have conflicts of interest.

Evidence regarding the impact of short selling on corporate governance aligns with perspective of the negative information production role of short sellers. Short sellers effectively discover negative information; therefore, firms must restrain earnings management, empire building, excessive overinvestment, and managerial decisions in mergers (Massa et al., 2015; Chang et al., 2014 2015, and 2019). Extant literature focuses on the impact of short selling as *internal* in nature (e.g., it affects the corporate governance of a firm).

In alignment with Shyu et al. (2018), we argue that the information revealed by short selling is generally bad news. In addition to the impact of short selling on a firm, it causes spillovers to a firm's stakeholders. These third parties include margin buyers in Shyu et al. (2018) and analysts in our case. According to Miller (1977) and Diamond and Verrecchia (1987), in a market that does not allow short selling, optimistic investors determine stock prices, which results in the overvaluation of stocks. When a market allows short selling, it becomes more efficient because short selling provides a channel for pessimistic investors to sell stocks that they do not own and therefore allows the stock price to incorporate more negative information regarding the stock. In the process of generating information, short sellers provide negative information for all market participants, including analysts. Therefore, short selling enhances analysts' information set. Accordingly, analysts can more easily recognize negative firm information when a stock experiences high short selling and provide less optimistically biased earnings forecasts for these firms.

As an alternative, analysts have conflicts of interest. When a covered firm faces short selling pressure, for reasons described in the literature, analysts drum up their effort to maintain positive outlook of the firm to counter the negative price pressure on the stock from short selling. Analysts are under explicit or implicit pressure from their brokerage firms (Francis and Philbrick, 1993; Hong and Kubik, 2003; O'Brien et al., 2005; Lin and McNichols, 1998). Thus, analysts have motivation to raise their optimism bias level in earnings forecasts to brokerages' objectives. Both arguments are possible. Therefore, the testable hypothesis has two parts:

**H1A.** Short selling and analyst optimism bias in a firm's earnings forecast are negatively correlated.

**H1B.** Short selling and analyst optimism bias in a firm's earnings forecast are positively correlated.

## 4. Variable definitions, data and methods

### 4.1. Primary variable definitions

We align with Huberts and Fuller (1995) and use the following formula to calculate analyst optimism bias on the current year's earnings forecasts:

$$OPT\_BIAS_{i,j,t} = (FEPS_{i,j,t} - EPS_{i,t}) / (|EPS_{i,t}| + 0.5) \quad (1)$$

Where  $FEPS_{i,j,t}$  represents the forecasted earnings per share (EPS) for the  $i$ th firm by  $j$ th analyst in year  $t$ ;  $EPS_{i,t}$  represents the earnings per share of the  $i$ th firm in year  $t$ ; and  $|EPS_{i,t}|$  represents the absolute value of the actual earnings per share. We include 0.5 in Eq. (1) to ensure a non-zero denominator.

To capture the extent of short selling for a stock, we use the firm's short ratio (*SHORT\_RATIO*), which refers the daily number of shares that are sold short divided by the total outstanding shares. A short ratio typically spikes several days prior to earnings announcements (Christophe et al., 2010). Therefore, we use short selling between  $t-40$  to  $t-10$  (where  $t$  represents the earnings announcement date) and calculate the daily average short ratio during the 30 days interval to capture the extent of short selling for a stock. For robustness, we use different windows to calculate short ratios.

## 4.2. Data

We include all A-share stocks that are traded in the Shanghai and Shenzhen Stock Exchanges from 2010 to 2019 with the exception of financial firms. Among all shortable stocks, we obtained 133,113 analyst earnings forecasts. The financial and short selling information for each stock is obtained from the China Stock Market and Accounting Research database. We winsorize the data at the 1% and 99 % levels. Media coverage data were obtained from RESSET database.

## 4.3. Methods

To examine our core hypothesis, we use the following regression equation:

$$OPT\_BIAS_{i,j,t} = \alpha_1 + \alpha_2 * SHORT\_RATIO_{i,t} + \sum \alpha_j * CONTROL_{i,t} + \mu_{i,t} \quad (2)$$

Following Lorenz and Homburg (2018), we include a set of control variables include the following: ownership concentration (*BIGHOLDER*), institutional investor ownership (*INSTITUTION*), earnings per share (EPS) volatility (*VAR\_EPS*), firm size (*SIZE*), a state-ownership indicator variable (*STATE*), financial leverage (*LEV*), the number of analysts following the stock (*ANALYST*), the number of reports analyzing the firm (*REPOR*), a star analyst indicator variable (*STAR*), the analyst's relative work experience (*R\_EXP*), the relative number of firms followed by the analyst (*R\_NUMC*), the relative number of forecast reports issued by the analyst (*R\_NUMP*), the relative forecasting accuracy of the analyst (*R\_ACCURACY*), and forecasting range (*RANGE*). In addition, we include year and industry dummy variables. The detailed variable definitions are shown in Table 1. The reported t-statistics are based on standard errors that are clustered at the firm level in Eq. (2).

## 5. Results and discussions

### 5.1. Summary statistics

We present the summary statistics of the variables in Table 2. The mean of *OPT\_BIAS* is 12.17 % with a standard deviation of 28.66 %, which suggests a large variation among analyst earnings forecasts. The positive mean indicates a general optimism bias among analysts.

### 5.2. Baseline findings

We present the results for the core hypothesis in using a simplified and a complete model of Eq. (2) in columns (1) and (2) of Table 3. Across both columns, the coefficients of *SHORT\_RATIO* are negative and significant at the 1% level, which suggest a high short selling lead to a lower analyst optimism bias in earnings forecasts. The results support H1A. For the control variables in column (2), the coefficients, if significant, have the expected signs. For example, the coefficients of *INSTITUTION*, *VAR\_EPS*, *STATE*, *REPOR*, *R\_EXP*,

**Table 1**  
defines all major variables.

	Variables	Definitions
Dependent variable	<i>OPT_BIAS</i>	Analyst optimism bias is measured by the following calculation: $OPT\_BIAS_{i,j,t} = (FEPS_{i,j,t} - EPS_{i,t}) / ( EPS_{i,t}  + 0.5)$ ; where $FEPS_{i,j,t}$ represents the forecasted earnings per share (EPS) for the $i^{th}$ firm by the $j^{th}$ analyst in year $t$ ; $EPS_{i,t}$ represents the earnings per share of the $i^{th}$ firm in year $t$ ; and $ EPS_{i,t} $ represents the absolute value of the actual earnings per share. 0.5 is included to ensure a non-zero denominator. We time the variable by 100.
Explanatory variable	<i>SHORT_RATIO</i>	Extent of short selling is the ratio of the number of shorted shares to the total number of outstanding shares, and then Multiplied by 1000
	<i>BIGHOLDER</i>	Ownership concentration is the largest shareholder's percent of share ownership.
	<i>INSTITUTION</i>	Institutional investor ownership is the percent of institutional ownership.
	<i>VAR_EPS</i>	Volatility of earnings per share is the standard deviation of EPS in the previous year.
	<i>SIZE</i>	Firm size is the logarithm of the market capitalization of a stock.
	<i>STATE</i>	State-ownership indicator variable. If the firm is state-owned, then the value is 1; otherwise the value is zero.
	<i>LEV</i>	This variable is the total liability to total assets ratio.
	<i>ANALYST</i>	Number of analysts following a logarithm.
	<i>REPOR</i>	Natural logarithm of the number of analyst reports following a logarithm.
Control variables	<i>STAR</i>	Star analyst indicator variable. If the analyst appears on the New Fortune star analyst list, the value is 1; otherwise the value is zero.
	<i>R_EXP</i>	For a stock, the experience of an analyst minus the average experience of all analysts.
	<i>R_NUMC</i>	The number of firms an analyst forecasts minus the average of all the analysts' forecasts for the same company.
	<i>R_NUMP</i>	The number of analyst forecasts by an analyst minus the average of all analyst forecasts for the same company.
	<i>R_ACCURACY</i>	The average of the absolute value of an analyst's error in a particular stock minus the absolute value of the error of all the other analysts divided by the average of the absolute value of the error of all the other analysts.
	<i>RANGE</i>	Analyst earnings forecasts time range is the logarithm value of the days between an analyst's forecasting date and December 31 for each year.
	<i>YEAR</i>	Year dummy variable
	<i>INDUSTRY</i>	Industry dummy variable.

**Table 2**

presents the summary statistics of the primary variables. The sample size is 53,652. Variable definitions are provided in Table 1.

	Mean	Std	Min	Max	Q1	Median	Q3
<i>OPT_BIAS</i>	12.170	28.660	-41.010	270.900	-1.296	4.444	16.190
<i>SHORT_RATIO</i>	0.085	0.164	0.000	0.964	0.006	0.020	0.076
<i>BIGHOLDER</i>	36.610	16.380	7.820	75.050	23.140	35.510	48.810
<i>INSTITUTION</i>	56.980	21.430	1.505	95.920	43.230	60.660	72.650
<i>VAR_EPS</i>	0.109	1.030	-4.662	6.060	-0.200	0.072	0.307
<i>SIZE</i>	17.140	1.086	15.160	20.300	16.340	16.980	17.780
<i>STATE</i>	0.480	0.500	0.000	1.000	0.000	0.000	1.000
<i>LEV</i>	0.513	0.215	0.079	0.944	0.347	0.515	0.666
<i>ANALYST</i>	3.153	0.620	1.099	4.143	2.833	3.258	3.611
<i>REPOR</i>	3.950	0.770	1.609	5.293	3.497	4.078	4.511
<i>STAR</i>	0.541	0.498	0.000	1.000	0.000	1.000	1.000
<i>R_EXP</i>	0.483	8.775	-14.610	30.340	-5.280	-0.090	3.010
<i>R_NUMC</i>	-0.156	24.740	-50.500	126.400	-13.150	-1.090	5.000
<i>R_NUMP</i>	1.675	95.920	-174.200	404.000	-54.000	-6.120	20.880
<i>R_ACCURACY</i>	-0.062	0.810	-4.850	1.000	-0.170	0.000	0.320
<i>RANGE</i>	5.541	0.392	3.135	6.286	5.226	5.541	5.900

and *R\_ACCURACY* are negative and significant at the 1%, 5%, or 10 % level, which is consistent with the concept that analysts make less biased earnings forecast when (1) the firm has a high institutional ownership, (2) the firm's EPS is volatile, (3) the firm is state-owned, (4) more reports on the firm, (5) the analyst has more work experience; or (6) The analyst's forecast is more accurate. In contrast, the coefficients of *LEV* and *RANGE* are positive and significant at the 1% or 10 % levels, which is consistent with the intuition that earnings forecast is less accurate when: (1) the firm has high financial leverage, or (2) the forecast horizon is long.

### 5.3. Further examination of H1A

To further examine the expanding information set argument in H1A, we conduct additional analyses on the following: (1) the effect of forecasting horizons, (2) earnings forecasts made by analysts after the accounting year but prior to earnings announcements, and (3) the effect of the information environment. We provide our reasoning below:

- (1) The effect of forecasting horizons: If short selling enhances the information base of analysts, we expect that additional negative information from short sellers is more useful for short horizons than for long horizons because making long-term forecasts is more challenging than short-term forecasts; less information is available for long-term forecasts. Therefore, different results for long-term vis-à-vis short-term forecast horizons would indicate that the expanding information set argument is more appropriate.
- (2) Earnings forecasts that are made by analysts after the full accounting year but prior to earnings announcement: We leverage several unique accounting features in China to examine the validity of the expanding information set channel. These features include the following: (a) every Chinese firm utilizes the same accounting year from January 1 to December 31; and (b) every Chinese firm announces their previous year earnings before April 30 each year. If the expanding information set argument is valid, we expect that analysts make earnings forecasts after December 31 but before April 30 of the next year that are superior to other forecasts made in the middle of the year because of the additional information they have gained. After December 31, analysts have had sufficient time throughout the year to analyze the firm and they have access to information for the entire accounting year as well as other information.
- (3) The effect of the information environment: We study the relationship between short selling and optimism bias in sub-samples of firms that operate in high vs. low information environments. For firms that operate in a low information environment, it is challenging for analysts to conduct earnings forecasts. Therefore, we expect that analysts are eager to obtain more information regarding the covered stocks in low information environments via various means, including short selling. Therefore, we expect that the negative relationship between short selling and analyst optimism bias remains strong for firms that operate in low information environments. In contrast, for firms that operate in a high information environment, the marginal contribution of information production from short sellers is less because analysts have obtained useful information elsewhere. Therefore, the negative relationship between short selling and optimism bias weakens.

#### 5.3.1. The effect of forecasting horizons

We examine the impact of forecasting horizons on the negative relationship between short selling and analyst optimism bias using Eq. (2). The horizons include the following: (1) the subsequent year, and (2) the next two years. The results are presented in columns (3) and (4) of Table 3. The coefficients of *SHORT\_RATIO* in both columns are insignificant. Thus, the results in columns (1) and (2) are consistent with the expanding information set argument in H1A.



**Table 3**

presents the relationship between short selling and analyst optimism bias in earnings forecast. Columns (1) and (2) present the results for current year forecast bias. Columns (3) and (4) show the results for subsequent year and next two year forecast bias. Column (5) displays the results of a sub-sample for which the analysts made earnings forecasts after the accounting year ended on December 31 but before the firm announced their prior year earnings. The sample includes analysts' earnings forecast for all shortable stocks. Column (6) uses *ABS\_OPT\_BIAS* (the absolute value of *OPT\_BIAS*) to capture the accuracy of analyst earnings forecasts. Variable definitions are presented in Table 1. t-statistics appear in parentheses and are based on standard errors that are clustered at the firm level. \*, \*\*, and \*\*\* indicate 10 %, 5%, and 1% significance, respectively.

	Dependent variable = <i>OPT_BIAS</i>					Dependent variable = <i>ABS_OPT_BIAS</i>
	(1) Current year	(2) Current year	(3) Subsequent year	(4) Next two years	(5) Earnings forecasts made after the accounting year but before the firm announced their previous year earnings	(6) Current year
<i>SHORT_RATIO</i>	-4.845*** (-2.99)	-5.267*** (-3.34)	2.658 (0.63)	-1.556 (-0.21)	-1.114* (-1.75)	-0.014*** (-3.45)
<i>BIGHOLDER</i>		0.012 (0.36)	0.017 (0.18)	-0.094 (-0.55)	-0.011 (-0.71)	0.000 (0.05)
<i>INSTITUTION</i>		-0.061** (-2.03)	-0.130 (-1.51)	-0.196 (-1.46)	0.001 (0.09)	-0.001*** (-10.73)
<i>VAR_EPS</i>		-0.357** (-2.06)	-0.197 (-1.13)	0.055 (0.30)	0.018 (0.71)	-0.002*** (-12.90)
<i>SIZE</i>		-0.468 (-0.96)	-4.035*** (-2.71)	-8.313*** (-3.01)	0.185 (0.70)	-0.010*** (-8.83)
<i>STATE</i>		-3.574*** (-3.05)	-12.716*** (-4.40)	-20.841*** (-3.92)	0.205 (0.44)	-0.028*** (-14.18)
<i>LEV</i>		11.409*** (3.47)	6.376 (0.84)	2.325 (0.17)	5.191*** (3.84)	0.133*** (23.55)
<i>ANALYST</i>		0.924 (0.38)	2.481 (0.38)	11.959 (1.16)	-0.136 (-0.14)	-0.009* (-1.81)
<i>REPOR</i>		-3.759* (-1.78)	0.234 (0.04)	4.835 (0.58)	-1.233 (-1.26)	-0.013*** (-3.50)
<i>STAR</i>		-0.054 (-0.15)	-0.143 (-0.18)	-0.795 (-0.51)	0.326 (1.10)	-0.000 (-0.03)
<i>R_EXP</i>		-0.025** (-2.20)	-0.029 (-1.41)	-0.028 (-0.60)	0.012 (0.54)	-0.000 (-1.59)
<i>R_NUMC</i>		0.004 (0.80)	-0.002 (-0.19)	0.037* (1.76)	0.004 (0.30)	0.000* (1.85)
<i>R_NUMP</i>		0.001 (0.92)	0.001 (0.46)	-0.008 (-1.17)	-0.004* (-1.77)	-0.000 (-0.54)
<i>R_ACCURACY</i>		-0.356* (-1.70)	-0.243* (-1.67)	-0.280* (-1.84)	-0.094 (-0.83)	-0.004*** (-46.11)
<i>RANGE</i>		16.320*** (20.57)	62.835*** (18.67)	110.183*** (11.41)	-0.236 (-0.99)	0.177*** (81.89)
<i>CONS</i>	18.842*** (3.47)	-52.235*** (-4.92)	-292.500*** (-9.69)	-593.117*** (-6.86)	4.754 (1.33)	-0.480*** (-21.78)
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.032	0.095	0.115	0.123	0.025	0.097
<i>N</i>	133113	133113	118096	69701	16410	133113
$\chi^2$ (for equality of coefficients of <i>SHORT_RATIO</i> in columns (5) and (2))					6.79*** (p-value = 0.009)	

### 5.3.2. Earnings forecasts made after the accounting year but prior to the earnings announcement

We present the results regarding earnings forecasts that are made after the accounting year but prior to earnings announcements in column (5) of Table 3. The coefficient of *SHORT\_RATIO* is significant at the 10 % level. However, according to the  $\chi^2$  statistics (for equal coefficients of *SHORT\_RATIO* in the columns (2) and (5) of the Table 3, the p-value is 0.009, suggesting that coefficient of *SHORT\_RATIO* in the column (5) is significantly smaller than the coefficients of *SHORT\_RATIO* in the column (2). That is, when a large amount of information is available after December 31, the impact of short selling activities on lowering analyst optimism bias is minimal. The results columns (1) to (5) of Table 3 corroborate with the expanding information set channel in H1A.

### 5.4. Do earnings forecasts improve using short selling information?

Another research question is whether earnings forecast accuracy improves after using short selling information. If short selling provides information to analysts, then they are able to improve their forecast accuracy. We modify Eq. (2) to examine this question by using the absolute value of the forecasting bias (*ABS\_OPT\_BIAS*) as the dependent variable to capture the forecasting accuracy (Van Ness and Warr, 2001). If the answer to the research question is “yes”, we expect that *SHORT\_RATIO* and *ABS\_OPT\_BIAS* are negatively

correlated. The results are presented in column (6) of Table 3. The coefficient of *SHORT\_RATIO* is negative and significant at the 1% level, suggesting that short selling information improves analysts' earnings forecast accuracy.

### 5.5. The effect of information environment

We use the quality of accounting information and whether a firm hires a Big 4 auditor to capture the impact of the information environment. To ensure that the results are operational, we apply Dechow et al. (1996)'s model to the following cross-sectional regression equation for firms in each industry in each year in our sample period:

$$\frac{TA_{i,t}}{ASSET_{i,t-1}} = \alpha_0 \frac{1}{ASSET_{i,t-1}} + \beta_1 \frac{\Delta SALES_{i,t}}{ASSET_{i,t-1}} + \beta_2 \frac{FA_{i,t}}{ASSET_{i,t-1}} + \theta_{i,t} \quad (4)$$

where  $TA_{i,t}$  is total accruals in a year,  $\Delta SALES_{i,t}$  is the change in sales,  $FA_{i,t}$  is fixed assets,  $ASSETS$  is total assets,  $ROA$  is the return on assets, and  $\theta$  is a residual. The discretionary accrual ( $DA$ ) level is calculated as follows:

$$DA_{i,t} = \frac{TA_{i,t}}{ASSET_{i,t-1}} - \hat{\alpha}_0 \frac{1}{ASSET_{i,t-1}} + \hat{\beta}_1 \left( \frac{\Delta SALES_{i,t} - \Delta REC_{i,t}}{ASSET_{i,t-1}} \right) + \hat{\beta}_2 \left( \frac{PPE_{i,t}}{ASSET_{i,t-1}} \right) \quad (5)$$

where the hats over the coefficients denote estimated values from regression Eq. (4) and  $\Delta REC$  represents the change in accounts receivable. A large value for  $DA_{i,t}$  implies that the firm has poor earnings management. Therefore, the information quality of the firm is low and the converse is also true. In addition, we use a Big 4 (non-Big 4) auditor to proxy for high (low) information environments because Big 4 audit firms generally result in superior audit information.

The results are presented in columns (1) to (4) in Table 4. The coefficients of *SHORT\_RATIO* are negative and significant at the 10% and 5% level for the low information environment sub-samples in columns (1) and (3), respectively; the same coefficients are not significant for the high information environment subsamples in columns (2) and (4). These results suggest that analysts use the short selling to expand their information set, particularly when firms operate in low information environments. The results are consistent with the expanding information set channel in H1A.

### 5.6. Robustness analysis

#### 5.6.1. Two stage least squares

It is unlikely that the negative relationship between short selling and analyst optimism bias is affected by endogeneity because short sellers conduct research on a stock and engage in short selling only if they discover negative information about the stock. Analyst optimism bias suggests that analysts are optimistic about the price of the stock, which is not the same information that short sellers rely on. Nonetheless, we address the endogeneity concern by conducting a two stage least square estimation.

We use the number of days between the date that a stock became newly shortable and the date of the analysts' earnings forecast (*HORIZON*) as the instrumental variable during the first stage to produce a predicted short ratio variable (*PRED\_SHORT\_RATIO*). The decision to allow a stock to be shortable is made by the CSRC. Therefore, the *HORIZON* variable is not affected by analyst optimism bias but correlates with short selling. Then, we replace *SHORT\_RATIO* with *PRED\_SHORT\_RATIO* for the second stage of the estimation. The results are presented in Panel A of Table 5. The results indicate that the coefficient of *HORIZON* is positive and significant at the 1% level in column (1), which indicates that the instrument performs well. In column (2), the coefficient of *PRED\_SHORT\_RATIO* is negative and significant at the 1% level, which suggests that the negative relationship between short selling and analyst optimism bias remains intact. Therefore, the core findings in Table 3 are robust.

#### 5.6.2. Difference-in-Differences (DID) model

For robustness in mitigating endogeneity between short selling and analyst optimism bias, we conduct a DID research design to take advantage of the China short selling deregulation from no short selling to some short selling. Although the number of the shortable stocks is increasing, there are still some unshorable stocks. We can compare treatment firms (those shortable) with control firms (those continue to be unshorable) in a pre- and post-short selling deregulation. Thus, China provides an ideal quasi-natural experimental environment to conduct a double DID design to mitigate endogeneity. The model is:

$$OPT\_BIAS_{i,t} = \delta_0 + \delta_1 * POST_{i,t} + \delta_2 * TREAT_{i,t} + \delta_3 * (POST_{i,t} * TREAT_{i,t}) + \sum \alpha_j * CONTROL_{i,t} + \mu_{i,t} \quad (6)$$

Where *POST* is a dummy variable with a value of 1 if the time periods fall into the short selling deregulation and 0 otherwise; *TREAT* is a dummy variable with a value of 1 if a firm is shortable and 0 otherwise. Thus, *POST\*TREAT* captures the net effect on analyst optimism bias on the underlying stock when the firm is shortable in a short selling deregulation period.

The results are presented in Panel B of Table 5. According to the results of the DID model in both columns (1) and (2), the coefficients of *POST\*TREAT* are negative and significant at the 1% or 5% level. Thus, after short selling deregulation, analyst optimism bias lowers. That is, the results of the DID model confirm that short selling reduces the optimism bias of analysts and further supports hypothesis H1A.

#### 5.6.3. Accounting for the possible influence of adverse factors

Research shows that adverse factors such as corporate fraud, environmental, social, and governance issues (Jain et al., 2016) will



**Table 4**

presents the impact of an information environment on the relationship between short selling and optimism bias. Variable definitions are presented in Table 1. t-statistics appear in parentheses and are based on standard errors that are clustered at the firm level. \*, \*\*, and \*\*\* indicate 10 %, 5 %, and 1 % significance, respectively.

	Dependent variable = <i>OPT_BIAS</i>			
	Accounting information quality		Big 4 auditor	
	(1) Low	(2) High	(1) Low (No)	(2) High (Yes)
<i>SHORT_RATIO</i>	-5.240* (-1.79)	-5.499 (-1.41)	-4.335** (-2.19)	-6.139 (-1.61)
<i>BIGHOLDER</i>	0.042 (0.81)	-0.018 (-0.46)	0.039 (0.94)	-0.070 (-1.34)
<i>INSTITUTION</i>	-0.045 (-1.04)	-0.089** (-2.34)	-0.126*** (-4.03)	0.086* (1.74)
<i>VAR_EPS</i>	-0.391 (-1.43)	-0.295** (-2.17)	-0.270* (-1.95)	-3.766*** (-3.92)
<i>SIZE</i>	-0.208 (-0.28)	-0.583 (-0.91)	-0.307 (-0.46)	-0.473 (-0.55)
<i>STATE</i>	-2.911* (-1.72)	-3.799*** (-3.15)	-3.006*** (-2.75)	-3.741 (-1.42)
<i>LEV</i>	16.267*** (3.58)	3.958 (1.08)	12.450*** (3.45)	7.870 (0.88)
<i>ANALYST</i>	0.731 (0.20)	1.655 (0.70)	5.963** (2.40)	-11.174** (-2.14)
<i>REPOR</i>	-4.315 (-1.32)	-3.566* (-1.80)	-7.718*** (-3.70)	7.537* (1.73)
<i>STAR</i>	-0.822* (-1.83)	0.894 (1.49)	-0.084 (-0.19)	0.021 (0.04)
<i>R_EXP</i>	-0.021 (-1.42)	-0.027 (-1.54)	-0.028* (-1.88)	-0.018 (-1.43)
<i>R_NUMC</i>	0.003 (0.40)	0.004 (0.66)	0.007 (1.28)	-0.002 (-0.20)
<i>R_NUMP</i>	0.002 (1.02)	0.001 (0.27)	0.001 (0.44)	0.002 (0.83)
<i>R_ACCURACY</i>	-0.134 (-1.34)	-0.904*** (-2.83)	-0.200 (-1.27)	-0.885*** (-3.29)
<i>RANGE</i>	16.585*** (14.00)	16.040*** (15.91)	18.479*** (22.40)	10.385*** (6.18)
<i>CONS</i>	-51.129*** (-3.06)	-62.819*** (-5.65)	-66.117*** (-5.59)	-36.500* (-1.95)
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>Adj. R2</i>	0.101	0.120	0.099	0.165
<i>N</i>	72,555	60,558	95,261	37,852

not only reduce analysts' optimism, but also lead to more short selling.

Following the spirit of Jian et al. (2016), we construct the ESG variable for each Chinese firm. We consider the risk of legal action faced by a firm (*LAW* is a dummy variable with a value of 1 if a firm faces the risk of legal action; otherwise 0), corporate fraud (*VIOL* is a dummy variable with a value of 1 if a firm has violation; otherwise 0), and whether a firm discloses corporate social responsibility report (*CSR* is a dummy variable with a value of 1 if a firm discloses corporate social responsibility report; otherwise 0). The information is required to disclose in a firm's annual report. Then, the ESG comprehensive score (*ESG*) is the sum of *LAW*, *VIOL*, and *CSR*. We add the *ESG* in Eq. (2).

The results are presented in Panel C of Table 5. The coefficient of *SHORT\_RATIO* continues to be negative and significant at the 1% level after adding the *ESG* variable. Hence, the conclusions of this paper continue to hold after considering the influence of the *ESG* adverse factors. Interestingly, the coefficient of *ESG* is positive and significant at the 10 % level, supporting the findings in Jian et al. (2016).

#### 5.6.4. Alternative measure of optimism bias and short sales and subsample analyses

To ensure robust results, we align with Jackson (2005) and use an alternative definition for analyst optimism bias (*OPT\_BIAS2*):  $(FEPS_{i,j,t} - EPS_{i,t}) / P_i$ ; where  $P_i$  represents the closing price of the stock on the day before an analyst making earnings forecast. The results of using *OPT\_BIAS2* are presented in column (1) of Panel D in Table 5. The coefficient of *SHORT\_RATIO* is negative and significant at the 10 % level when *OPT\_BIAS2* is the dependent variable. These results are consistent with those in Table 3. The findings are robust with respect to using a different measure of analyst optimism bias.

In addition to alternative metric of optimism bias, we use t-40 to t-10 for the time window to calculate the average short selling level in our analyses. For robustness, we use an alternative time window: t-60 to t-10 (denoted it as *SHORT\_RATIO2*). The results are presented in column (2) of Panel D. The coefficient of *SHORT\_RATIO2* is negative and significant at the 1% level, which indicates that a

**Table 5**

presents several robustness checks on the negative relationship between short selling and analyst optimism bias in earnings forecasts. In Panel A, we use a two-stage least squares using the number of days between the date that a stock became newly shortable and the date of the analysts' earnings forecast (*HORIZON*) as an instrumental variable to predict short selling (*PRED\_SHORT\_RATIO*). In Panel B, we further adopts a difference-in-differences (DID) method to mitigate possible endogeneity problem, where *POST* is a dummy variable with a value of 1 if the time periods fall into the short selling deregulation and 0 otherwise; *TREAT* is a dummy variable with a value of 1 if a firm is shortable and 0 otherwise. Thus, *POST\*TREAT* captures the net effect on analyst optimism bias on the underlying stock when the firm is shortable in a short selling deregulation period. In Panel C, we consider the risk of legal action faced by a firm (*LAW* is a dummy variable with a value of 1 if a firm faces the risk of legal action; otherwise 0), corporate fraud (*VIOL* is a dummy variable with a value of 1 if a firm has violation; otherwise 0), and whether a firm discloses corporate social responsibility report (*CSR* is a dummy variable with a value of 1 if a firm discloses corporate social responsibility report; otherwise 0). The information is required to disclose in a firm's annual report. Then, the ESG comprehensive score (*ESG*) is the sum of *LAW*, *VIOL*, and *CSR*. In column (1) of Panel D, we align with Jackson (2005) to measure analyst optimism bias (*OPT\_BIAS2*) that is calculated by  $(FEPS_{i,t} - EPS_{i,t}) / P_i$ ; where  $P_i$  is the closing price of the stock on the day before an analyst making an earnings forecast, *EPS* is the actual earnings per share, and *FEPS* is the forecasted earnings per share. In column (2), we use an alternative window of t-60 to t-10 to calculate the short selling (*SHORT\_RATIO2*). In columns (3) and (4), we examine subsamples of bull and bear market. In column (5), we exclude firms that issue both A- and H-shares. In column (1) of Panel E, we include firm fixed effect and the impact of media coverage. In column (3), we construct a short interest variable (*SI*) to replace short volume. In column (4), we construct a new variable, *LSELL*, as daily volume of long sell orders in the 10 to 40 trading days prior to the issuance of the analyst's report and divided by the number of outstanding shares. In column (5), we use abnormal short selling to replace shorting sales. For brevity, we only present coefficients of key variables. Other variable definitions are presented in Table 1. t-statistics appear in parentheses and are based on standard errors that are clustered at the firm level. \*, \*\*, and \*\*\* indicate 10 %, 5%, and 1% significance, respectively.

Panel A: Two-stage least square estimation		
	(1) First stage <i>SHORT_RATIO</i>	(2) Second stage <i>OPT_BIAS</i>
<i>PRED_SHORT_RATIO</i>		-41.341*** (-3.08)
<i>HORIZON</i>	0.040***	
<i>Control variables</i>	Yes	Yes
<i>CONS</i>	-0.585*** (-6.52)	-74.225*** (-5.61)
<i>Year</i>	Yes	Yes
<i>Industry</i>	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.156	0.050
<i>N</i>	133113	133113
Panel B: Difference-in-differences Model		
	Dependent variable = <i>OPT_BIAS</i>	
	(1)	(2)
<i>POST</i>	2.585 (1.43)	2.869 (1.56)
<i>TREAT</i>	-7.225*** (-5.52)	-4.307*** (-3.20)
<i>POST* TREAT</i>	-3.065*** (-3.76)	-1.863** (-2.14)
<i>Control variables</i>	Yes	Yes
<i>CONS</i>	46.907*** (6.12)	50.959*** (6.71)
<i>Year</i>	Yes	Yes
<i>Industry</i>	Yes	Yes
<i>Adj. R<sup>2</sup></i>	0.044	0.061
<i>N</i>	498681	498681
Panel C: Eliminate the possible influence of adverse factors		
VARIABLES	(1) Dependent variable = <i>OPT_BIAS</i>	
<i>SHORT_RATIO</i>	-4.694*** (-3.04)	

(continued on next page)

Table 5 (continued)

Panel C: Eliminate the possible influence of adverse factors	
VARIABLES	(1) <i>Dependent variable = OPT_BIAS</i>
BIGHOLDER	0.010 (0.31)
INSTITUTION	−0.066** (-2.27)
VAR_EPS	−0.359** (-2.14)
SIZE	−0.131 (-0.26)
STATE	−3.206*** (-2.74)
LEV	11.315*** (3.48)
ANALYST	1.082 (0.45)
REPOR	−3.691* (-1.78)
STAR	−0.096 (-0.27)
R_EXP	−0.026** (-2.28)
R_NUMC	0.003 (0.67)
R_NUMP	0.002 (1.11)
R_ACCURACY	−0.357* (-1.71)
RANGE	16.279*** (20.89)
LAV	1.694 (1.55)
VIOL	13.785** (2.57)
CSR	−3.798*** (-2.95)
ESG	0.638* (1.71)
CONS	−64.117*** (-5.63)
Year	Yes
Industry	Yes
Adj. R2	0.101
N	133113

Panel D: Alternative measures of optimism bias and short sale ratio and sub-sample analyses					
	(1) <i>Dependent variable = OPT_BIAS2</i>	(2) <i>Dependent variable = OPT_BIAS</i>	(3)	(4)	(5)
	Alternative metric of optimism bias	Alternative metrics of short ratio	Bull market	Bear market	Excluding firms that issue both A- and H-shares
SHORT_RATIO	−0.239** (-2.36)		−4.736*** (-2.84)	−6.589* (-1.87)	−4.095** (-2.19)
SHORT_RATIO2		−6.424*** (-4.20)			
Control variables	Yes	Yes	Yes	Yes	Yes
CONS	−2.825*** (-4.01)	−59.018*** (-7.26)	−49.914*** (-3.39)	−51.484*** (-3.49)	−46.389*** (-4.86)
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Adj. R2	0.096	0.095	0.096	0.127	0.094
N	133113	133113	74465	5848	116542
$\chi^2$ (for equal coefficients of SHORT_RATIO in columns (3) and (4))			0.23 (p-value = 0.631)		

(continued on next page)

Table 5 (continued)

Panel E: Alternative specifications of empirical model					
	Dependent variable = <i>OPT_BIAS</i>				
	(1) Fixed-effect model	(2) Media coverage	(3) Use short interest	(4) Consider only long sellers	(5) Use abnormal short selling
	Fixed-effect model	Media coverage	Use short interest	Consider only long sellers	Use abnormal short selling
<i>SHORT_RATIO</i>	-6.157*** (-3.24)	-5.225*** (-3.29)			
<i>MEDIA</i>		1.003*** (3.02)			
<i>SII</i>			-0.138* (-1.79)		
<i>LSELL</i>				0.000 (0.34)	
					-4.650** (-2.13)
Control variables	Yes	Yes	Yes	Yes	Yes
<i>cons</i>	-189.198*** (-6.20)	0.387* (1.84)	-219.154*** (-3.98)	-0.497*** (-5.22)	-50.562*** (-4.78)
<i>Year</i>	Yes	Yes	Yes	Yes	Yes
<i>Industry</i>	No	Yes	Yes	Yes	Yes
<i>Firm</i>	Yes	No	No	No	No
<i>Adj. R<sup>2</sup></i>	0.084	0.096	0.079	0.130	0.094
<i>N</i>	133113	133113	133113	133113	133113

negative relationship exists between short selling and optimism bias of earnings forecasts.

Short sellers consider the general bull and bear stock market because a general market trend affects stock price movements, particularly when short sellers engage in speculative trading rather than informed trading. Analysts that engage in speculative short selling are extremely cautious (aggressive) when anticipating a bull (bear) market. Therefore, it is likely that analyst optimism bias differs between bull and bear markets, particularly if short selling creates downward price pressure. Conversely, if short selling primarily provides negative information regarding a shorted stock to analysts, analysts lower earnings forecasts in response to the negative information irrespective of bull or bear markets. We divide the sample into bull vis-à-vis bear market subsamples and examine the impact of *SHORT\_RATIO* on analyst optimism bias. We use the method proposed by Lindahl-Stevens (1980) to classify bull and bear markets.<sup>3</sup> The results are presented in columns (3) and (4) of Panel D. The coefficients of *SHORT\_RATIO* are -4.736 and -6.589 for the bull and bear markets, respectively and they are significant at the 1% and 10 % levels. The  $\chi^2$  statistics for the equal coefficients that are not significant, which suggests that the impact of short selling in bull and bear markets is not statistically significant different. In addition, in a bull market, short selling likely capture “net selling” of short sellers and long sellers (shareholders selling shares due to a firm’s bad news) because there are substantially less amount of sales from long sellers in a bull market. Thus, the net selling of short sellers and long sellers does not change the baseline findings.

Some Chinese firms issue both A-shares and H-shares (stocks trade in the Hong Kong Stock Exchange). Therefore, in order to avoid the cross-influence of short selling in different capital markets, we exclude firms and reexamine Eq. (2) for robustness. The results are presented in column (5) of Panel D. The coefficient of *SHORT\_RATIO* continues to be negative and significant at the 5% level, indicating that the support of H1A is robust after excluding firms that issue A-shares and H-shares simultaneously.

##### 5.6.5. Alternative specifications of empirical model

To mitigate possible omitted variables in Eq. (2), we use a firm fixed-effect model. The results are presented in column (1) of Panel E in Table 5. The coefficient of *SHORT\_RATIO* is negative and significant at the 1% level.

Certain studies (e.g., Fang and Peress, 2009) suggest that media coverage affects stock returns. We account for media coverage by adding *MEDIA* (the number of media coverage news items) into Eq. (2). The results are presented in column (2) of Panel E. The coefficient of *SHORT\_RATIO* continues to be negative and significant at the 1% level. Therefore, the core hypothesis is robust with respect to firm fixed-effect and media coverage.

According to Diether et al. (2009); Thornock (2013), Christensen et al. (2013) and Drake et al. (2015), it is more meaningful to use daily short volume data to measure short selling. However, Rapach et al. (2016); Chang et al. (2019) and other relevant studies also use short interest to measure short selling. For robustness, we use short interest, *SII* (standardized by outstanding shares) to measure the magnitude of short selling in Eq. (2). The findings are presented in column (3) of Panel E. The coefficient of *SII* is negative and significant at the 10 %. Hence, the variation of short interest also explains the variation of analyst optimism bias but the magnitude and significance level are not as strong as using short volume in Table 3.

We argue that using short volume has advantage to gauge the short selling activities of analysts. Short volume reflects the current day trading activity of short sellers, which is an important piece of information that analysts lack in a given day. In contrast, short

<sup>3</sup> When the average stock return for a given period is higher than (less than) the risk-free return, it is a bull (bear) market.

interest reflects the accumulation of information about short selling in the past up to the current day. It is natural that analysts have already incorporated the past short interest information when making current day short selling decision. Hence, short volume is more useful than short interest in guiding analyst earnings forecast activities. The results in column (3) of Panel E corroborate with this view.

When short sellers are absent and news is bad, long sellers play an important role of disseminating negative information to the market (Dixon, 2020). Hence, even if short selling is allowed, long sellers may still send negative information to the market. To gauge the impact of long seller on analyst optimism bias, we construct a new variable, *LSELL*, as daily volume of long sell orders in the 10–40 trading days prior to the issuance of the analyst's report and divided by the number of outstanding shares. *LSELL* does not contain the volume of short selling. Then, we replace *SHORT\_RATIO* in Eq. (2) by *LSELL* to examine if long sellers impact analyst optimism bias. The findings are presented in column (4) of Panel E. The coefficient of *LSELL* is not significant, indicating that long sellers do not provide more valuable information to analysts in their earnings forecasts. The finding is expected. The research reports of analysts mainly drive the investment decisions of investors (not the other way around), especially those of long sellers. Hence, it is unlikely long sellers' selling plays a significant role in affecting analyst research. Overall, the findings in column (4) of Panel E suggest that short sellers, as information traders, can provide more negative information to reduce the analyst optimism bias than those of long sellers.

We follow Meng et al. (2017) to calculate an abnormal short selling level instead of short ratio to capture the impact of short selling. Essentially, we define abnormal short selling, *ABNORMAL\_SHORT*, as:

$$ABNORMAL\_SHORT = SHORT - SHORTNORM$$

Where *SHORT* is the average daily shorted number of shares in *t-40* to *t-10* window (where *t* represents the earnings announcement date) and *SHORTNORM* is the average daily shorted number of shares in the same window by a matched portfolio. We follow Christophe et al. (2010) using 25 matching portfolios by five quintiles of market capitalization and five quintiles of the book-to-market ratio according to their values in previous year.

The results are presented in column (5) of Panel E. The coefficient of *ABNORMAL\_SHORT* is negative and significant at the 5% level, suggesting that when we capture the impact of short selling by abnormal short selling, the results remain intact.<sup>4</sup>

## 6. Summary

We examine the relationship between short selling and analyst optimism bias for earnings forecasts in China. The newly instituted short selling deregulations in China provide rich data to conduct our analyses. Our results suggest that short selling and analyst optimism bias are negatively correlated. Our results are robust to using a two-stage least square method, the use of a fixed effect model, including an alternative measure of optimism bias, the use of different time windows to calculate short selling, differentiating between bull and bear market conditions, accounting for media coverage, and using abnormal short selling.

We propose two possible impact: (1) analysts have conflicts of interest and they drum up their optimism bias to counter short selling pressure on their covered stock. This is to promoting trading and pleases potential clients for underwriting business, and (2) analysts use the negative information reveal in short selling and lower their optimism bias. Our findings are consistent with the hypothesis that short selling enhances the information set of analysts. Leveraging the availability of rich data, we conduct additional analyses using stocks with various forecasting horizons and earnings forecasts that were made after the accounting year but prior to earnings announcements to confirm the expanding information set argument for short selling. Our additional analyses suggest that the negative correlation between short selling and analyst optimism bias is more pronounced among firms that operate in a low information environment and for analysts that have fewer conflicts of interest. Lastly, we document that short selling information improves the accuracy of earnings forecasts.

Overall, our results support Miller's (1977) hypothesis, which indicates that short selling enhances information efficiency. Analysts use short selling information to expand their information set, which reduces analyst optimism bias. We document that short selling directly improves information efficiency by reducing analyst optimism bias for earnings forecasts in China. The results provide valuable implications for other emerging markets that are considering implementing short selling deregulations.

## Author statement

Deshuai Hou leads the conceptualization of the research, and conduct formal analysis  
 Qingbin Meng leads the data curation, project administration, and arranges funding  
 Kam C. Chan leads the investigation, writing, and methodology

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<sup>4</sup> We can consider the magnitude of abnormal short selling already excluded the effect of long sellers.

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