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Cognitive reference points, institutional investors' bid prices, and IPO pricing: Evidence from IPO auctions in China ☆

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ABSTRACT

We study institutional investors' bidding behavior in initial public offering (IPO) auctions. Our findings suggest that institutional investors exhibit cognitive reference point (CRP) anchoring. That is, investors focus on integer numbers closest to non-integer endpoints of proposed IPO price range as CRPs when making IPO bids. When institutional investors round up (down) the endpoints of the proposed IPO price range to arrive at CRPs, we find: (1) the average bid price is higher (lower), (2) the subsequent IPO offer price is higher (lower), and (3) IPO first day return is lower (higher).

1. Introduction

Round numbers, such as 0 and 5, have high cognitive accessibility and recognition due to their status in the decimal number system. Subject to bounded rationality (Simon, 1955; Hirshleifer, 2001), individuals tend to use round numbers as cognitive reference points (CRPs) when processing numerical information. Recently, the literature on CRP anchoring has begun to extend from individuals in experiments to investors in financial markets. For example, Bhattacharya et al. (2012) find that investors in the secondary stock market use round numbers as CRPs for valuation, resulting in a disproportionate higher amount of transactions with one penny below or above round numbers. Kuo et al. (2015) report that both retail and institutional investors use round number prices as CRPs in the Taiwan futures and options markets. Investors who employ

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CRP anchoring may incur greater losses in the future. The CRP literature for the financial markets, however, focuses on investors in secondary markets, with limited clarity around how investors use CRPs in the primary (IPO) market.

In this paper, we add to the literature by leveraging institutional investor bid data in Chinese IPO auctions to examine CRPs in the primary market. We contend that institutional investors anchor on the rounded endpoints of the price range proposed by underwriters (hereafter proposed endpoints) before the start of IPO auctions when submitting bids. For example, if an underwriter proposes a price range of RMB 10.2–RMB 11.2 for an IPO, an institutional investor will anchor on either RMB 10 or RMB 11. If our contention is true, what are the economic consequences of this CRP anchoring on institutional investor bid price, IPO offer price, and IPO first day return? Our analyses are possible due to a recent regulatory change to IPO procedures in China mandating the disclosure of institutional investor bid data.

To examine our research questions, we obtain and analyze 41,908 institutional investor bids on 424 IPOs from November 1, 2010 to December 31, 2012. The sample firms are characterized with non-integer proposed endpoints by underwriters (e.g., RMB 10.2–RMB 11.2 per share). We find that institutional investor bid prices cluster at the rounded proposed endpoints (i.e., at RMB 10 and RMB 11 in the above example). The number of bids clustered at these endpoints is greater than the number of bids clustered at the exact proposed endpoints. Our results suggest that institutional investors anchor on the rounded endpoints proposed by underwriters.

Given the presence of CRP anchoring in the IPO market, we then examine its economic consequences. In CRP rounding, when the decimal fractions of a proposed endpoint are equal to, or more (less) than 0.5, the price will be rounded up (down) to arrive at its nearest integer (rounded point). We define IPO firms whose proposed endpoints need to be rounded-up (rounded-down) to get its nearest integers as rounded-up (rounded-down) firms. For instance, the above numerical example demonstrates a rounded-down IPO firm because most bids come in at RMB 10 or RMB 11 given the proposed endpoints are RMB 10.2 and 11.2. An example of a rounded-up firm would be one where underwriters have proposed endpoints at RMB 7.8–8.9 with most bids coming in at RMB 8 or 9.

We offer several findings on the economic consequences of institutional investor CRP anchoring in IPO markets. First, we find that for rounded-up firms, institutional investors, on average, bid higher than they do for rounded-down firms. Second, we document that the CRP anchoring of institutional investor bid prices is channeled through to the IPO offer price. That is, the IPO offer price for rounded-up firms, on average, is higher than that of rounded-down firms. Finally, we report that the IPO first day return of the rounded-up firms, on average, is lower than that of rounded-down firms. In sum, our findings suggest that the CRP anchoring of institutional investors during IPO auctions impacts IPO pricing and first day IPO returns.

We contribute to the literature in two ways. First, we document new evidence of CRP anchoring by institutional investors in the IPO market. Although several researchers discuss and document CRP anchoring in the secondary markets (Bhattacharya et al., 2012; Kuo et al., 2015), no effect has yet been reported for the primary market. We offer insights into the economic consequences of CRP anchoring effects on IPOs. Second, our findings contribute to the IPO pricing literature. In the literature, IPO pricing is primarily used as a rational expectation paradigm, the information production role of institutional investors is typically investigated, and institutional investors are assumed to be rational agents who possess private information (e.g., Benveniste and Spindt, 1989; Spatt and Srivastava, 1991; Cornelli and Goldreich, 2003). In contrast, many studies find that investors, even institutional investors, exhibit systematic departure from what rational theory predicts in the secondary market (e.g., Coval and Moskowitz, 1999; Hirshleifer, 2001; Frazzini, 2006; O'Connell and Teo, 2009). However, we do not know whether institutional investors are subject to behavioral bias in the IPO pricing process and the related economic consequences of such biases, if any. Our findings add to this strand of literature by documenting that institutional investors exhibit CRP anchoring during IPO auctions and such anchoring materially impacts IPO offer prices and first day returns.

The remainder proceeds as follows. In Section 2, we introduce some institutional background information on the Chinese IPO market, review the related literature, and develop testable hypotheses. In Section 3, we discuss data sources and present the research methods. In Section 4, we present the evidence on the presence of CRP anchoring and the associated economic consequences. We provide a summary in Section 5.

2. Institutional background, literature review, and testable hypotheses

We discuss institutional background, literature review, and testable hypotheses below.

2.1. Institutional background of China's IPO market

Since 1990, China's economy has grown rapidly. Economic growth and success depend, in part, on stock markets to facilitate capital formation. Since 1990, many Chinese firms have raised capital through IPOs to fund growth ambitions. As of December 31, 2015, 2878 firms were listed on the Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE), with a total market value of RMB 53,130.42 billion. The effectiveness of capital formation hinges on a smooth IPO process. These two exchanges are regulated by the China Securities and Regulatory Commission (CSRC) and they have implemented a series of reforms since 1990 to improve the price and allocation efficiency of IPOs. These reforms have transformed the Chinese IPO process from a highly regulated process to a market-oriented arrangement.

Before July 1999, IPO pricing in China followed a method known as the "online fixed-price method". Under this mechanism, the IPO offer price is set to be a multiple of a firm's after-tax earnings per share (EPS) and a mandatory P/E ratio.

For instance, if the mandated P/E ratio is 10 and an IPO firm has an EPS of RMB 10, then the IPO offer price is fixed at RMB 100 (10 * RMB10).

The first systemic change to China's IPO pricing process happened in July 1999. Beginning in July 1999 and lasting until December 2004, the CSRC switched from the online fixed price method to a regulated auction system. Under this system, an underwriter first proposed an IPO price range in consultation with the issuer and submitted the proposed price range to the CSRC for approval. After the CSRC approved a price range, the underwriter conducted a road show to gauge the initial reaction of investors and then set the final IPO offer price. Thus, during this period, IPO pricing depended in part on government approval (intervention) and in part on market dynamics.

The next major reform happened in December 2004. In December 2004, the CSRC abolished the regulated auction system for IPOs and adopted a hybrid auction/fixed price mechanism. As described in Gao et al. (2016, 2017a, 2017b), the hybrid system has two phases. In the first "offline" phase, an underwriter, in consultation with the issuing firm, proposes an IPO price range. Then, the underwriter begins to solicit bids. Only institutional investors can submit bids at this stage with their bid prices and quantities.[1] Each institutional investor can submit no more than three bids with a maximum quantity of up to 50% of the IPO shares. After receiving bids from institutional investors, the underwriter sets the IPO offer price in consultation with the issuing firm. In the second "online" phase, retail investors then submit their IPO subscription quantities based on the IPO offer price set in the offline stage. Hence, there is a separation of institutional and retail investors in this process. The CSRC continued to intervene in the IPO pricing process with an implicit guiding P/E ratio of no more than 30 for most IPOs before June 10, 2009.

On June 10, 2009, the CSRC adopted The Guiding Advice on Further Reform of the IPO Pricing Method and announced that it would no longer interfere in the pricing of IPOs. Since then, underwriters, together with issuers, are fully responsible for the IPO pricing process, which is similar to the IPO pricing process in the United States.[2] Specifically, underwriters solicit investor information from investor bids in the offline phase and then set the offer price accordingly. The IPO offer price is not necessarily set at the market-clearing bid price, where the offline demand quantity is equal to the corresponding supply quantity. Underwriters can choose to set any price below the market-clearing price. Because of this history, the Chinese government intervention in IPO pricing should not impact our study given our dataset consists of IPOs conducted after June 10, 2009.

On November 1, 2010, the CSRC issued the Guiding Opinions on Further Reforming the System of Issuance of New Shares mandating underwriters and IPO firms to disclose institutional investors' bid prices and quantities to the public in the offline auction process. This disclosure policy provides us with an opportunity to investigate the research questions and hypotheses.

2.2. Literature review and testable hypotheses

An underwriter proposes a price range before an IPO auction. In terms of valuation, the proposed IPO price range reflects the underwriter's assessment of the value of the IPO shares. We contend that the proposed endpoints by underwriters serve as anchors for institutional investors in their bidding. Our argument is based on the psychology that people are subject to bounded rationality (Simon, 1955; Hirshleifer, 2001), and hence, they tend to rely on heuristics to simplify the complex task of valuation under uncertainty (Tversky and Kahneman, 1974).

One of the most common heuristics is anchoring (e.g., Chapman and Johnson, 2002; Furnham and Boo, 2011). Given the high uncertainty of IPO valuation (Lowry et al., 2010), investors, even institutional investors, are susceptible to anchoring heuristics when making bids in an IPO auction. Our study of IPO markets mirrors several studies in other aspects of business—real estate, marketing, and business negotiation. In real estate markets, Northcraft and Neale (1987) find that real estate agents and assessors anchor on a home's list price when conducting appraisals. In marketing, Biswas and Blair (1991) and Biswas (1992), among others, find that advertised prices, even exaggerated, are effective in price anchoring and influencing consumer behavior. In business negotiations, negotiators commonly use initial offers as anchors to negotiate a final settlement price (Kahneman, 1992; Galinsky and Mussweiler, 2001). While there is no previous study on the anchoring effect of underwriters' proposed price range in the IPO market, the evidence in real estate, marketing, and business negotiation points to such a possibility.

Given the high cognitive accessibility of round numbers (Rosch, 1975; Schindler and Kirby, 1997), investors may not anchor on the actual proposed endpoints directly, but rather on the nearby integer numbers if the proposed endpoints by underwriters are not integers. Institutional investors may round underwriters' proposed endpoints up or down to the nearest integers when assessing the value of IPO shares, and then use these rounded integers as CRPs. Several related

[1] The CSRC released an update to this regulation in 2012. In addition to institutional investors, retail investors with experience and adequate funding can also participate in the offline auction process with a recommendation from an underwriter. However, the participation of retail investors is very limited. In addition, underwriters usually recommend experienced retail investors, whose behavior is more similar to institutional investors than to typical retail investors.

[2] Huyghebaert and Xu (2016) leverage the regulatory change on June 10, 2009 as a natural experiment to examine the bias in the post-IPO earnings forecasts of analysts affiliated with the lead underwriter. They document that affiliated analysts' earnings forecast bias increases after the regulatory change. This is because underwriters are responsible for the IPO aftermarket price after the regulatory change. To support the aftermarket price, the underwriters enlist their affiliated analysts to inflate the earnings forecasts.

studies offer some support to our argument. Rosch (1975) documents experimental evidence that numbers being multiples of 10 are CRPs for nearby numbers within the decimal system. Bhattacharya et al. (2012) report that investors focus on round numbers as CRPs for valuations in the secondary market using a random sample of over 100 million stock transactions. Kuo et al. (2015) document that retail and institutional investors use round numbers as CRPs in the Taiwan futures and options markets. Based on our analysis, we propose the following testable hypothesis:

H1. Institutional investors anchor on the rounded proposed endpoints by underwriters in the IPO auctions when the proposed endpoints are non-integers.

Having established the presence of institutional investors' CRP anchoring, we next examine the effect of CRP anchoring on their bid prices. The integers will serve as CRPs for institutional investors under CRP anchoring. This process leads to CRPs being larger (smaller) than the actual value of underwriters' proposed endpoints for rounded-up (rounded-down) firms. If institutional investors indeed anchor on the CRPs, they over-pay (relative to their bid price if no CRP anchoring) for rounded-up firms while they under-pay (relative to their bid price if no CRP anchoring) for rounded-down ones. We thus predict that, ceteris paribus, the bid prices for rounded-up firms, on average, are higher than those for rounded-down firms. Our second testable hypothesis is:

H2. Institutional investor bid prices for rounded-up firms are higher than those for rounded-down firms.

The evidence on IPO pricing (e.g., Benveniste and Spindt, 1989; Spatt and Srivastava, 1991; Cornelli and Goldreich, 2003) suggests that issuers and underwriters aggregate the demand information shown in the order book and set the IPO offer price accordingly. Hence, the effect of CRP anchoring on institutional investor bid prices likely channels through to the IPO offer price. If so, ceteris paribus, the offer price for rounded-up (rounded-down) firms will be higher (lower) than that for rounded-down firms because underwriters and issuers encounter higher (lower) bid prices. Finally, if the offer price of IPOs is higher (lower) for rounded-up (rounded-down) firms, the IPO first day return of these firms will be lower (higher). It is because the first day return is the percentage difference between the close price on the first day and the offering price. Our next two testable hypotheses are:

H3. The IPO offer prices for rounded-up firms are higher than those for rounded-down firms.

H4. The IPO first-day returns for rounded-up firms are lower than those for rounded-down firms.

3. Data and methods

We explain our data and research methods below.

3.1. Data

Our initial sample covers all Chinese IPOs from November 1, 2010 to December 31, 2012. Only IPOs after November 1, 2010 have the institutional investor bidding information available per the CSRC regulation in the Guidance of Regulating Initial Public Offerings. Our sample period ends on December 31, 2012 because China experienced a structural change in the IPO market in that the CSRC suspended IPOs in 2013. After reopening the IPO market in 2014, the CSRC mandated that IPO issuers delete at least 10% of the highest bids in setting the IPO offer prices. Such deletion distorts the IPO offer price and IPO first day return. To obtain clean results, we do not use IPO data after December 31, 2012. Our initial samples are the same as those in Gao et al. (2016, 2017a, 2017b).

The initial sample contains 479 IPO applications. We delete one unsuccessful application and four IPOs in the financial industry. Our final sample contains 474 IPO firms. The industry and year distributions of our sample are presented in Panels A and B of Table 1. The firms in the manufacturing industry dominate the sample with 340 IPOs, and 2011 had the most IPOs with 267.

For the IPO samples, we hand-collect information on institutional investor bid prices and quantities. There are 1483 bidders from 467 distinct institutional investors[3] submitting IPO bids. We obtain IPO firms' pre-IPO financial and other information from the China Stock Market & Accounting Research Database (CSMAR).

In examining the presence of CRP anchoring, we analyze a total of 41,908 institutional investor bids for 424 IPOs with a non-integer proposed IPO price range. The 424 IPOs are less than the 474 IPOs in the sample due to some proposed endpoints being integers.

3.2. Methods

We use several methods to examine our research questions including the presence of CRP anchoring and the effect of anchoring on bid prices, IPO offer price, and first day return.

[3] An institutional investor may include multiple bidders. For example, a mutual fund company has several subsidiary funds and each fund can become a bidder.

Table 1
Sample distribution.
This table displays the sample distribution across industries and years. Industries are defined using the CSRC classification standards.

Panel A: Sample distribution by industry		
Industry	Number	Percentage
Agriculture, forestry, stock raising and fishing	7	1.48%
Mining	8	1.69%
Manufacturing	340	71.73%
Utilities	2	0.42%
Construction	13	2.74%
Transportation and warehousing	6	1.27%
Information and technology	58	12.24%
Wholesale and retail	14	2.95%
Social service	17	3.59%
Media and Entertainment	9	1.90%
Total	474	100%
Panel B: Sample distribution by year		
Year	Number	Percentage
2010	64	13.50%
2011	267	56.33%
2012	143	30.17%
Total	474	100%

3.2.1. The presence of CRP anchoring

We characterize the distribution of institutional investor bid prices from two views to document the relevance of CRP anchoring during the IPO auction process. First, we examine the distributions of institutional investor bid prices normalized by the *rounded* proposed endpoints by underwriters. Second, we compare such distributions to those of institutional investor bid prices normalized by *actual* endpoints.

Following Baker et al. (2012) and Dougal et al. (2015), we normalize investor bid prices by the rounded lower or upper proposed endpoint, respectively. Specifically, we divide each investor bid price by the rounded lower or upper endpoint and then depict the distributions of the natural logarithm of the values, *Ln* (*BID/RFLOOR*) and *Ln* (*BID/RCEIL*), where *BID* is the bid price, *RFLOOR* is the rounded lower proposed endpoint, and *RCEIL* is the rounded upper proposed endpoint. For comparison, we also normalize investors' bidding prices by the actual lower or upper endpoint (*FLOOR* and *CEIL*), respectively, and depict the distributions of the natural logarithm of them, *Ln* (*BID/FLOOR*) and *Ln* (*BID/CEIL*).

If there is CRP anchoring, we should see the distributions of *Ln* (*BID/RFLOOR*) and *Ln* (*BID/RCEIL*) show sharp spikes at zero. In contrast, if there is no CRP anchoring, we should not observe such spikes because it is unlikely most institutional investors valuate the IPO shares exactly on the rounded proposed endpoints without CRP anchoring. In addition, we should not observe a high degree of spike for *Ln* (*BID/FLOOR*) and *Ln* (*BID/CEIL*) around zero if the CRP anchoring occurs at the rounded proposed endpoints.

3.2.2. The CRP anchoring effect on investor bid prices

Having established the presence of CRP anchoring, we next examine its impact on investor bid prices. Specifically, we run the following multiple regression model:

$$INST\_ABID_i = \alpha_0 + \alpha_1 * ROUNDUP1_i(\text{ or } ROUNDUP2_i) + \Sigma\, \alpha_j * Control_i + Year + Industry + \mu_i, \quad (1)$$

where $INST\_ABID = (WBID - MIDPOINT)/MIDPOINT$), where *WBID* is the weighted average of investor bid prices for each IPO, using bid quantities as weights, and *MIDPOINT* is the midpoint of the proposed price range. *INST_ABID* measures the average valuation of institutional investors relative to the proposed price range.

For robustness, we use two measures, *ROUNDUP1* and *ROUNDUP2*, to capture the effect of CRP anchoring on institutional investor bid prices. *ROUNDUP1* is equal to 1 when both proposed endpoints have decimal fractions equal to, or more than 0.5, and 0 when both proposed endpoints have decimal fractions less than 0.5. For instance, if the upper and lower proposed endpoint are RMB5.60 and RMB4.75, then *ROUNDUP1* is 1; if the upper and lower endpoints are RMB 5.45 and RMB 4.15, then *ROUNDUP1* is zero. *ROUNDUP2* is equal to 0 when both proposed endpoints have decimal fractions less than 0.5, 1 when both proposed endpoints are integers, and 2 when both proposed endpoints have decimal fractions equal to, or more than 0.5. For instance, if the proposed IPO price range is 18.1 to 19.3, then *ROUNDUP2* is 0. If the proposed IPO price range is 18 to 19, then *ROUNDUP2* is 1. If the proposed IPO price range is 18.6 and 19.8, then *ROUNDUP2* is 2.

ROUNDUP1 measures the potential impact of rounding up the proposed endpoints on *INST_ABID* while *ROUNDUP2* allows the comparison related to the effect of rounding down, no rounding, and rounding up of proposed endpoints on *INST_ABID*.

For the regressions with *ROUNDUP1* as main independent variable, there are 216 observations and for those with *ROUNDUP2*, there are 264 observations.

Per the definition of *ROUNDUP1*, the CRP anchoring points are larger (smaller) than the actual values of the proposed endpoints when *ROUNDUP1* is equal to 1 (0). Per the definition of *ROUNDUP2*, the CRP anchoring points are lower than the actual values of the proposed endpoints when *ROUNDUP2* is equal to 0; the CRP anchoring points are equal to the actual values of the proposed endpoints when *ROUNDUP2* is equal to 1; and the CRP anchoring points are higher than the actual values of the proposed endpoints when *ROUNDUP2* is equal to 2. We predict α_1 is positive, suggesting that institutional investors overestimate (underestimate) the value of rounded-up (rounded-down) firms.

In Eq. (1), we include a set of control variables to account for their impact on institutional investors' bidding behavior. These variables fall into several categories. The first category is IPO firms' fundamentals, including: return on assets (*ROA*), firm size (*SIZE*), firm leverage (*LEV*), sales growth rate (*GROWTH*), and the percentage of tangible assets (*TANG*). The second category is the IPO issuance characteristics: the natural logarithm of expected capital to raise (*LNFIN*), the bandwidth of proposed price range of underwriters (*RANGE*), and the underwriter's reputation (*REPU*). In the third category, we control for investors' sentiment for IPOs: the natural logarithm of average oversubscription multiples of the ten most recent IPOs (*LNLAG*10) and the natural logarithm of the number of IPOs in the same industry in the prior 90 days (*INDACT*). In addition, we control for the IPO listing avenue: main board or other boards[4] by including a dummy variable, *MAIN*, in the regressions. On April 28, 2012, the CSRC issued Guidance for the Further Deepening of Reform of the IPO System and removed the three-month lock-up period for institutional investors' allotted shares. This institutional change may have an impact on institutional investor bids (Gao et al., 2017a). Thus, we add a dummy *REFORM* to control its effect. Finally, we include year and industry dummies to account for year effects and industry effects. Detailed definitions of the control variables are in the Appendix A.

3.2.3. CRP anchoring and the IPO offer price

According to IPO pricing theory, issuers and underwriters aggregate the demand information shown in the order book and then set the IPO offer price (Benveniste and Spindt, 1989; Spatt and Srivastava, 1991; Cornelli and Goldreich, 2003). Given the impact of institutional investor bid prices on the IPO offer price, we conjecture that the effect of CRP anchoring on institutional investor bid prices is channeled to the IPO offer price. We use the following regression model to examine the conjecture:

$$RELATIVE\_OFFER_i = \beta_0 + \beta_1 * ROUNDUP1_i(or\ ROUNDUP2_i) + \Sigma\beta_j * Control + Year + Industry + \pi_i, \quad (2)$$

where *RELATIVE_OFFER* = (*OFFER* – *MIDPOINT*)/*MIDPOINT*; *OFFER* is the IPO offer price set by the issuer. *RELATIVE_OFFER* captures the IPO offer price relative to the midpoint of the proposed price range. The control variables are the same as those in Eq. (1).

We predict β_1 is positive, suggesting that when institutional investors round up (down) the endpoints of the proposed price range, the IPO offer price is higher (lower).

3.2.4. CRP anchoring and IPO first day return

If the IPO offer price is higher for rounded-up firms, the first day return of these firms will be lower (higher) given that the first day return is defined as the percentage difference between the close price on the first day and the offering price. We examine this reasoning using the following multiple regression model:

$$FDRET_i = \gamma_0 + \gamma_1 * ROUNDUP1_i(or\ ROUNDUP2_i) + \Sigma\gamma_j * Control_i + Year + Industry + \theta_i, \quad (3)$$

where *FDRET* is the IPO first day return, which is (*CLOSE* – *OFFER*)/*OFFER; CLOSE* is the closing price on its first trading day. We predict that γ_1 is negative, suggesting that the IPO first day return is lower (higher) for rounded-up (rounded-down) firms.

4. Results and discussion

We present and discuss our results below.

[4] China has three boards: the main board, small- and medium-sized enterprises (SME) board, and growth enterprises market (GEM or ChiNext). The main board is for large firms.

Table 2
Summary statistics.
This table reports the summary statistics of the key variables for the whole sample. We tabulate the number of observations (*N*), the sample average (*Mean*), the standard deviation (*Std*), the first quartile (*P25*), the median (*Median*), and the third quartile (*P75*). Variable definitions are in the Appendix A.

Variables	*N*	Mean	Std	P25	Median	P75
INST_ABID	474	− 0.177	0.177	− 0.306	− 0.184	− 0.067
INST_OBID	474	0.016	0.199	− 0.129	0.00200	0.124
INST_PBID	474	− 0.393	0.147	− 0.500	− 0.397	− 0.306
RELATIVE_OFFER	474	− 0.111	0.176	− 0.227	− 0.110	0.007
FDRET	474	0.235	0.322	0.002	0.164	0.354
$ROUNDUP_1$	216	0.463	0.500	0	0	1
$ROUNDUP_2$	264	0.939	0.904	0	1	2
ROA	474	0.141	0.072	0.091	0.127	0.174
SIZE	474	20.20	0.986	19.51	20.00	20.77
LEV	474	0.412	0.163	0.302	0.412	0.527
TANG	474	0.358	0.291	0.178	0.306	0.464
GROWTH	474	0.283	0.186	0.140	0.258	0.389
LNFIN	474	5.793	0.711	5.283	5.672	6.174
RANGE	474	0.159	0.059	0.118	0.154	0.186
REPU	474	0.565	0.496	0	1	1
LNLAG10	474	4.666	0.470	4.372	4.728	5.058
INDACT	474	1.970	0.987	1.099	2.079	2.890
MAIN	474	0.175	0.380	0	0	0
REFORM	474	0.137	0.344	0	0	0
LNOVER	474	4.461	0.881	3.951	4.600	5.063
MRET	474	− 0.005	0.046	− 0.036	− 0.002	0.025

4.1. Summary statistics

Table 2 reports the summary statistics for the full sample. The mean values of *INST_ABID* and *RELATIVE_OFFER* are − 0.177 and − 0.111, respectively. That is, the bid prices are, on average, 17.7% less than the midpoint of the underwriters' proposed price range while the average IPO offer price is 11.1% below the midpoint. Both negative mean values of *INST_ABID* and *RELATIVE_OFFER* suggest that, on average, underwriters and IPO issuing firms respond to institutional investors' bid prices by adjusting IPO offer prices downward from their initial proposed prices.

On average, investors earn an initial day return (*FDRET*) of 23.5% if they receive an allocation of IPO shares and sell them at the closing price of the first trading day. Our sample IPO firms earn an average return on assets (*ROA*) of 14.1% and have an average sales growth rate (*GROWTH*) of 35.8% in the most recent year before the IPOs. They control an average RMB 592.6 million ($e^{20.2}$) of total assets at the end of most recent year before IPOs. The average leverage ratio is 41.2% and property, plant, and equipment accounts for 28.3% of total assets at the end of the prior IPO year. The online oversubscription multiples of the ten most recent IPOs are 106.27 times ($e^{4.666}$), indicating the IPO market in China was relatively hot in 2010–2012.

In our sample, there are 100 observations with both proposed endpoints by underwriters having decimal fractions not less than 0.5 and 116 observations with both endpoints having decimal fractions less than 0.5. The mean value of *ROUNDUP1* is thus 0.463 (100/216). The mean of *ROUNDUP2* is 0.919.

4.2. The presence of CRP anchoring

We present the base and robust results on our key findings below.

4.2.1. Base results

Panels A–D of Fig. 1 depict the distributions of investor bid prices. Panels A and B show the distributions of *Ln* (*BID/RFLOOR*) and *Ln* (*BID/RCEIL*) while Panels C and D depict those of *Ln* (*BID/FLOOR*) and *Ln* (*BID/CEIL*). Panels A and B show sharp spikes at zero. Specifically, over 2000 bids are in the bin around zero for *Ln* (*BID/RFLOOR*) and more than 1500 bids fall in the bin around zero for *Ln* (*BID/RCEIL*). The results are consistent with the notion that a considerable number of institutional investors bid exactly at the rounded upper and lower proposed endpoints by underwriters', consistent with H1. Without anchoring, it is hard to explain why so many investors bid exactly at the rounded proposed endpoints by underwriters. Moreover, the degree of price clustering around zero for *Ln* (*BID/RFLOOR*) in Panel A is larger than that for *Ln* (*BID/FLOOR*) in Panel C. Specifically, over 2000 bids are in the bin around zero for *Ln* (*BID/RFLOOR*) while less than 800 bids are in the bin around zero for *Ln* (*BID/FLOOR*). We find qualitatively similar results for the degree of price clustering around zero for *Ln* (*BID/RCEIL*), compared with that for *Ln* (*BID/CEIL*). The results suggest that institutional investors bid more at the rounded proposed endpoints than at the actual proposed endpoints, providing further support for H1.

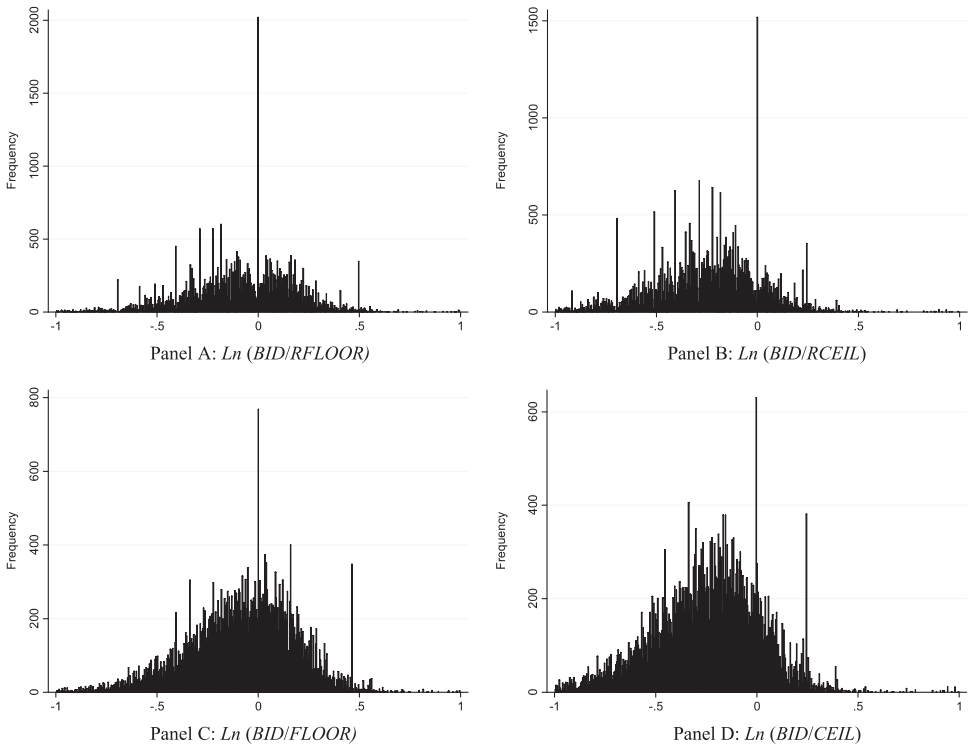


Fig. 1. The distributions of investor bid prices normalized by the rounded and actual proposed endpoints. We present the distributions of investor bid prices normalized by the rounded lower or upper proposed endpoints by underwriters: *Ln* (*BID/RFLOOR*) and *Ln* (*BID/RCEIL*), where *BID* is the bid price, *RFLOOR* is the rounded proposed lower endpoint, and *RCEIL* is the rounded proposed upper endpoint. For comparison, we normalize investors bid prices by the actual lower or upper proposed endpoint (*FLOOR* and *CEIL*), respectively, and depict the distributions of their natural logarithms at the same time.

4.2.2. Robustness

One concern for the evidence related to CRP anchoring in Section 4.2.1 is that it only shows whether investor bid prices anchor on the nearby rounded proposed endpoints. To demonstrate whether all investor bid prices tend to anchor on the rounded proposed endpoints globally, we construct a variable, *NORMBID1*, for each investor bid price, following Cornelli and Goldreich (2003). *NORMBID1* is calculated as:

$$NORMBID1 = (BID - RFLOOR)/(RCEIL–RFLOOR), \tag{4}$$

where *BID* is the bid price and *RFLOOR* and *RCEIL* are the rounded lower and upper proposed endpoints, respectively. Eq. (4) transforms an investor bid price into the weight an investor puts on the rounded upper and lower proposed endpoints when submitting a bid. The point can be shown more explicitly when we rewrite Eq. (4) as:

$$BID = (1 - NORMBID1)*RFLOOR + NORMBID1*RCEIL. \tag{5}$$

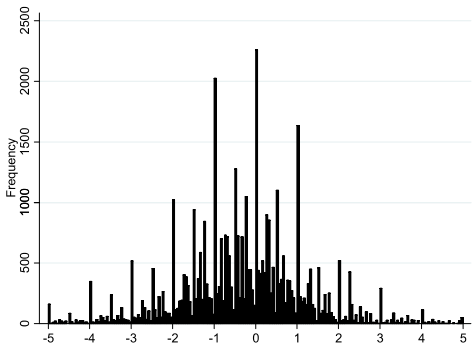
In Eq. (5), we can see that $(1 - NORMBID1)$ corresponds to the weight an investor puts on the rounded lower proposed endpoint while *NORMBID1* is the weight the same investor assigns to the rounded upper proposed endpoint.

For comparison, we construct another variable *NORMBID2* as:

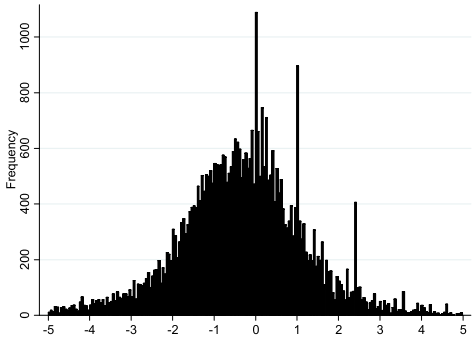
$$NORMBID2 = (BID–FLOOR)/(CEIL–FLOOR), \tag{6}$$

where *CEIL* and *FLOOR* are the actual upper and lower endpoints of the proposed price range. Similar to Eq. (5), *NORMBID2* and $(1 - NORMBID2)$ correspond to the weight an institutional investor puts on the actual upper and lower proposed endpoints, respectively.

If institutional investors indeed anchor on the rounded proposed endpoints by underwriters, we should observe price clustering of *NORMBID1* at round numbers. That is, institutional investors tend to put greater weight on the rounded proposed endpoints. If institutional investors anchor more on the rounded endpoints than on the actual ones, there should be more price clustering of *NORMBID1* at round numbers than *NORMBID2*.



Panel A: *NORMBID1*



Panel B: *NORMBID2*

Fig. 2. The distribution of investor bid prices normalized by the Cornelli and Goldreich (2003) method. We present the distribution of investor bid prices normalized by the rounded and actual endpoints of the proposed price ranges following Cornelli and Goldreich (2003), respectively. *NORMBID1* equals to (*BID-RFLOOR*)/(*RCEIL-RFLOOR*), where *BID* is an investor bid price and *RCEIL* and *RFLOOR* are the rounded upper and lower endpoints. *NORMBID2* equals to (*BID-FLOOR*)/(*CEIL-FLOOR*), where *BID* is an investor bid and *CEIL* and *FLOOR* are the actual endpoints. For instance, suppose the upper and lower endpoints of a proposed price range are 18.1 and 19.9, and an investor bid price is 18.9, then *NORMBID1* is 0.45 ((18.9-18/(20-18)) and *NORMBID2* is approximately 0.44 ((18.9-18.1)/(19.9-18.1)).

Table 3
The frequency at round numbers of investor bid prices normalized by the Cornelli and Goldreich (2003) method.

This table reports the frequency of bid price normalized by Cornelli and Goldreich (2003) method at round numbers, which are defined as multiples of ones, multiples of halves, multiples of quarters, or multiples of tenth. All the normalized bid prices are reserved with two decimal points. In columns (1) and (2), we present the frequency and percentage of *NORMBID1* at round numbers. In columns (3) and (4), we present the frequency and percentage of *NORMBID2* at round numbers. In columns (5) and (6), we present the frequency and percentage difference of *NORMBID1* and *NORMBID2* at round numbers. Our sample contains 41,908 bids from institutional investors for 424 distinct IPOs announced during November 1, 2010–December 31, 2012. Columns (1) and (3) only show 24,827 and 6888 IPO bids because we only present the data at some decimal points.

Decimal	*NORMBID1*		*NORMBID2*		Difference	
	Frequency (1)	Percent (%) (2)	Frequency (3)	Percent (%) (4)	Frequency (5)	Percent (%) (6)
00	8652	20.65	1564	3.73	7088	16.92
10	732	1.75	410	0.98	322	0.77
20	1597	3.81	541	1.29	1056	2.52
25	2644	6.31	643	1.53	2001	4.78
30	563	1.34	500	1.19	63	0.15
40	1480	3.53	922	2.2	558	1.33
50	4337	10.35	659	1.57	3678	8.78
60	1335	3.19	491	1.17	844	2.02
70	440	1.05	280	0.67	160	0.38
75	1583	3.78	364	0.87	1219	2.91
80	991	2.36	311	0.74	680	1.62
90	473	1.13	203	0.48	270	0.65
Total	24,827	59.25	6888	16.42	17,939	42.83

Panel A of Fig. 2 depicts the distribution of *NORMBID1*. To keep the figure manageable, we confine it to be within the interval between − 5 and 5. A notable feature of Panel A is that it shows sharp spikes at numbers such as − 1, 0, and 1. We do not find such a pattern in the distribution of *NORMBID2*, as shown in Panel B of Fig. 2. We present the exact distribution of *NORMBID1* and *NORMBID2* at round numbers in Table 3. The distribution of *NORMBID1* clusters at round numbers and the degree of such price clustering is larger than that for *NORMBID2*. The results are consistent with notion that investor bid prices anchor on the rounded proposed endpoints, lending further support for H1.

4.3. The impact of CRP anchoring on investor bid prices

After showing the presence of CRP anchoring in Section 4.2, we discuss the impact of CRP on investor bid prices below.

4.3.1. Base results

The results for Eq. (1) are presented in Table 4. In columns (1) and (2), we present the results of two simplified regression models that include *ROUNDUP1* or *ROUNDUP2* as the explanatory variable. We find that the coefficients for *ROUNDUP1* and *ROUNDUP2* are positive and significant at the 1% level, which is consistent with our prediction. Columns (3) and (4), we present the full regression results. The coefficients for *ROUNDUP1* and *ROUNDUP2* are 0.034 and 0.018, respectively, and both are statistically significant at the 1% level. The results support H2 that institutional investors, on average, bid low among rounded-down IPOs and bid high among rounded-up ones. The control variables in columns (3) and (4) carry the expected signs such as, the coefficients of *GROWTH, LNFIN, REPU, LNLAG10, INDACT,* and *MAIN* are positive and significant at the 1%, 5%, or 10% levels, suggesting that institutional investors, on average, bid higher for an IPO firm with a higher sales growth rate, more expected capital to raise, more reputable underwriters, a hot IPO market (in terms of a high oversubscription ratios of

Table 4
CRP anchoring and institutional investor bid prices.
This table reports OLS regression results on the association between rounding indicators and average bid price. The dependent variable is *INST_ABID*. *ROUNDUP1* is equal to 1 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers and 0 if the two endpoints need to be rounded down. *ROUNDUP2* is equal to 2 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers, 1 if the two endpoints are integers and 0 if the two endpoints need to be rounded down. The *t*-statistics reported in parentheses are based on standard errors clustered at the industry level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Variable definitions are in the Appendix A.

INST_ABID	(1)	(2)	(3)	(4)
INTERCEPT	− 0.202***	− 0.196***	0.507**	0.456*
	(− 20.58)	(− 28.59)	(2.39)	(1.91)
ROUNDUP1	0.040***		0.034***	
	(4.47)		(3.58)	
ROUNDUP2		0.020***		0.018***
		(4.15)		(3.57)
ROA			− 0.283**	− 0.368***
			(− 2.83)	(− 3.54)
SIZE			− 0.072***	− 0.066***
			(− 5.47)	(− 3.99)
LEV			− 0.028	− 0.088**
			(− 0.80)	(− 2.88)
GROWTH			0.051**	0.056***
			(3.21)	(3.74)
TANG			− 0.119**	− 0.103**
			(− 2.64)	(− 2.80)
LNFIN			0.053***	0.048**
			(3.51)	(2.41)
RANGE			− 0.101	− 0.100
			(− 1.07)	(− 1.46)
REPU			0.026**	0.024**
			(2.39)	(2.47)
LNLAG10			0.119***	0.108***
			(12.65)	(15.36)
INDACT			0.011*	0.014**
			(2.22)	(3.13)
MAIN			0.126**	0.137***
			(2.84)	(3.38)
REFORM			0.021	0.013
			(1.05)	(0.64)
Year Effects	No	No	Yes	Yes
Industry Effects	No	No	Yes	Yes
Adj. R^2	0.008	0.007	0.561	0.557
N	216	264	216	264

Table 5
CRP anchoring and optimistic/pessimistic institutional investor bid prices.

This table reports OLS regression results on the association between rounding indicators and average bid price of optimistic and pessimistic investors. We define optimistic (pessimistic) investors as investors whose bid prices rank in the top (bottom) 10% for each IPO. The dependent variables are *INST_OBID* and *INST_PBID*. *ROUNDUP1* is equal to 1 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers and 0 if the two endpoints need to be rounded down. *ROUNDUP2* is equal to 2 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers, 1 if the two endpoints are integers and 0 if the two endpoints need to be rounded down. The *t*-statistics reported in parentheses are based on standard errors clustered at the industry level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Variable definitions are in the Appendix A.

	INST_OBID		*INST_PBID*	
	(1)	(2)	(3)	(4)
INTERCEPT	0.377	0.297	0.319*	0.316*
	(1.67)	(0.99)	(1.99)	(2.06)
ROUNDUP1	0.036***		0.040***	
	(3.53)		(4.31)	
ROUNDUP2		0.018***		0.020***
		(3.64)		(4.33)
ROA	− 0.221**	− 0.331***	− 0.318***	− 0.354***
	(− 2.74)	(− 3.83)	(− 3.46)	(− 3.93)
SIZE	− 0.053***	− 0.044**	− 0.061***	− 0.060***
	(− 4.34)	(− 2.33)	(− 7.44)	(− 5.92)
LEV	− 0.051	− 0.119***	− 0.048	− 0.079**
	(− 1.44)	(− 4.50)	(− 1.55)	(− 2.49)
GROWTH	0.053*	0.045*	0.062**	0.060***
	(2.13)	(1.88)	(2.74)	(3.52)
TANG	− 0.123**	− 0.106**	− 0.112**	− 0.095***
	(− 2.31)	(− 2.29)	(− 3.06)	(− 3.41)
LNFIN	0.047***	0.034*	0.034***	0.040***
	(4.33)	(1.84)	(4.90)	(3.45)
RANGE	− 0.118	− 0.117	− 0.158	− 0.163**
	(− 1.04)	(− 1.63)	(− 1.76)	(− 2.42)
REPU	0.016	0.016	0.031**	0.027**
	(0.98)	(1.15)	(2.90)	(3.21)
LNLAG10	0.113***	0.103***	0.085***	0.074***
	(11.27)	(13.56)	(8.42)	(9.81)
INDACT	0.022***	0.021***	0.008*	0.009**
	(3.48)	(3.51)	(1.87)	(2.29)
MAIN	0.117**	0.126**	0.089**	0.093**
	(2.61)	(2.97)	(2.66)	(2.94)
REFORM	− 0.016	− 0.017	0.045***	0.033**
	(− 0.63)	(− 0.70)	(3.26)	(2.37)
Year Effects	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes
Adj. R^2	0.548	0.532	0.499	0.492
N	216	264	216	264

ten most recent IPOs and a large number of IPOs in the same industry), and to be listed in the main board. In contrast, the coefficients of *ROA*, *SIZE*, and *TANG* are negative and significant at the 1% or 5% levels. The negative coefficients suggest that for IPO firms with higher profitability, larger size, and more tangible assets, underwriters lean toward providing more optimistic valuation of IPO shares. Thus, institutional investors bid lower in the anticipation of optimistic valuation.

The coefficients on *ROUNDUP1* and *ROUNDUP2* in columns (3) and (4) of Table 4 are also economically significant. For instance, the coefficient on *ROUNDUP1*, 0.034, indicates that the relative average bid price of institutional investors for rounded-down firms is 3.4% less than that for rounded-up firms. This number, on average, corresponds to RMB 13.12 (382.00[5] × 3.4%) million.

4.3.2. Robustness

Our analyses in Section 4.3.1 rely on the average bid prices of institutional investors for IPO shares. One concern is that only overly optimistic or pessimistic investors drive our empirical results. For robustness, we consider the impact of CRP anchoring on overly optimistic and pessimistic investors. We define *INST_OBID* and *INST_PBID* as the weighted average bid price of the highest 10% bids and the lowest 10% bids and use them as the dependent variables in Eq. (1). The results are presented in Table 5. The coefficients of *ROUNDUP1* and *ROUNDUP2* are positive and significant at the 1% level in all four columns. The sign and significance of the control variables are similar to those in Table 4. Taken together, these results

[5] The IPO prospectuses indicate, on average, that issuers expect to raise RMB 382.00 million.

Table 6
CRP anchoring and institutional investor bid prices: the moderating effect of underwriter reputation.

This table reports OLS regression results examining the moderating effect of underwriter reputation on the association between rounding indicators and average bid price. The dependent variable is *INST_ABID*. *ROUNDUP1* is equal to 1 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers and 0 if the two endpoints need to be rounded down. *ROUNDUP2* is equal to 2 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers, 1 if the two endpoints are integers and 0 if the two endpoints need to be rounded down. The *t*-statistics reported in parentheses are based on standard errors clustered at the industry level. *, **, and ***, denote statistical significance at the 10%, 5%, and 1% levels, respectively. Variable definitions are in the Appendix A.

INST_ABID	(1) High	(2) Low	(3) High	(4) Low
INTERCEPT	− 0.093	0.317	− 0.194	0.249
	(− 0.20)	(0.58)	(− 0.54)	(0.59)
ROUNDUP1	0.058***	0.013		
	(6.31)	(1.00)		
ROUNDUP2			0.028***	0.008
			(5.87)	(1.09)
P-value	< 0.001		< 0.001	
ROA	− 0.384	− 0.297	− 0.452	− 0.363
	(− 1.76)	(− 1.00)	(− 1.72)	(− 1.42)
SIZE	− 0.100***	− 0.051*	− 0.077**	− 0.047**
	(− 3.57)	(− 1.97)	(− 3.26)	(− 3.13)
LEV	0.033	− 0.029	− 0.062	− 0.126**
	(1.08)	(− 0.34)	(− 1.42)	(− 2.42)
GROWTH	0.166***	− 0.036	0.127**	0.003
	(3.65)	(− 0.52)	(3.14)	(0.05)
TANG	− 0.181**	− 0.035	− 0.153**	− 0.053
	(− 2.51)	(− 0.64)	(− 2.38)	(− 1.09)
LNFIN	0.138***	− 0.011	0.106**	− 0.006
	(3.55)	(− 0.35)	(2.71)	(− 0.33)
RANGE	0.341**	− 0.376**	0.186**	− 0.424**
	(2.62)	(− 2.60)	(3.15)	(− 2.82)
LNLAG10	0.131***	0.127***	0.104***	0.121***
	(4.63)	(8.73)	(4.89)	(5.28)
INDACT	− 0.004	0.017***	0.010*	0.012**
	(− 0.92)	(4.38)	(2.17)	(3.09)
MAIN	0.189***	0.093	0.153***	0.118
	(9.24)	(0.82)	(6.14)	(1.36)
REFORM	− 0.047*	0.073***	− 0.046**	0.064***
	(− 2.12)	(15.04)	(− 2.45)	(5.04)
Year Effects	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes
Adj. R^2	0.628	0.523	0.580	0.559
N	117	99	149	115

suggest that the impact of CRP anchoring on institutional investors' bid prices is not merely due to optimistic or pessimistic institutional investors.

4.4. The moderating effect of underwriter reputation

The literature suggests that underwriter reputation plays an important role in the IPO pricing process. We explore the moderating effect of underwriter reputation in this subsection. We contend that when underwriters are more reputable, their proposed price ranges (i.e. CRPs to institutional investors) are more credible (e.g., Chemmanur and Fulghieri, 1994; Carter et al., 1998). When the CRPs are more credible, their anchoring effect is stronger (Chapman and Johnson, 1994). We thus predict the impact of CRP anchoring on institutional investor bid prices is more pronounced for IPOs with more prestigious underwriters.

To test this conjecture, we divide our full samples into two subsamples by strong vs. weak underwriter reputation. Practically, we define an underwriter as having a strong reputation when its underwriting revenue ranks in the top 10 in a given year; otherwise the underwriter is classified as having a weak reputation. The results are reported in Table 6. The coefficients of *ROUNDUP1* and *ROUNDUP2* are positive and significant at the 5% and 1% levels, respectively, only in the subsamples with more reputable underwriters while the same coefficients are not significant in the less reputable underwriter

Table 7
CRP anchoring and the IPO offer price.

This table reports OLS regression results on the association between rounding indicators and the offering price. The dependent variable is *RELATIVE_OFFER*. *ROUNDUP1* is equal to 1 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers and 0 if the two endpoints need to be rounded down. *ROUNDUP2* is equal to 2 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers, 1 if the two endpoints are integers and 0 if the two endpoints need to be rounded down. The *t*-statistics reported in parentheses are based on standard errors clustered at the industry level. *, **, and ***, denote statistical significance at the 10%, 5%, and 1% levels, respectively. Variable definitions are in the Appendix A.

RELATIVE_OFFER	(1)	(2)	(3)	(4)
INTERCEPT	− 0.141***	− 0.135***	0.374	0.269
	(− 16.33)	(− 18.50)	(0.92)	(0.70)
ROUNDUP1	0.044**		0.041***	
	(3.21)		(3.26)	
ROUNDUP2		0.023**		0.021**
		(3.12)		(3.13)
ROA			− 0.130	− 0.221*
			(− 0.91)	(− 1.93)
SIZE			− 0.071**	− 0.063**
			(− 2.98)	(− 2.68)
LEV			0.066	0.004
			(1.57)	(0.17)
GROWTH			0.017	0.029*
			(0.93)	(2.02)
TANG			− 0.142**	− 0.117**
			(− 2.55)	(− 2.57)
LNFIN			0.054**	0.046*
			(2.69)	(2.17)
RANGE			− 0.119	− 0.128
			(− 1.50)	(− 1.76)
REPU			0.021**	0.019**
			(3.01)	(2.53)
LNLAG10			0.157***	0.143***
			(18.07)	(22.67)
INDACT			0.012*	0.010*
			(2.12)	(2.25)
MAIN			0.106**	0.111**
			(2.47)	(2.92)
REFORM			0.026	0.025
			(0.99)	(1.01)
Year Effects	No	No	Yes	Yes
Industry Effects	No	No	Yes	Yes
Adj. R^2	0.011	0.010	0.509	0.502
N	216	264	474	216

sub-samples. The *F*-test results suggest that the two coefficients on $ROUNDUP_1$ and $ROUNDUP_2$ in columns (1) and (3) are significantly larger than their counterparts in columns (2) and (4). In summary, the impact of CRP anchoring on institutional investor bid prices is stronger when IPOs have more prestigious underwriters.

4.5. CRP anchoring and the IPO offer price

The results of the impact of CRP anchoring on the offer price are presented in Table 7. Similar to those in Table 4, the coefficients of *ROUNDUP1* and *ROUNDUP2* are positive and significant at the 5% or 1% levels across columns (1)–(4), suggesting that the CRP anchoring effect is positively correlated with IPO offer prices. Interestingly, the sign and significance of control variables are qualitatively similar to those in Table 4, suggesting that the same set of variables exert a similar impact on both institutional investor bid prices and IPO offer prices.

The coefficients on *ROUNDUP1* and *ROUNDUP2* are also economically significant. For instance, the coefficient on *ROUNDUP1* in column (3) is 0.041, which indicates that the IPO offer price for rounded-down firms is 4.1% less than that for rounded-up firms. This corresponds to RMB 27.45 (669.41[6] × 4.1%) million. That is, institutional investors, on average, pay RMB 27.45 million more for rounded-up firms than for rounded-down ones because of their CRP anchoring. The results in Table 7 support H3.

The results in Table 7 suggest that the impact of CRP anchoring on the IPO offer price is channeled by institutional investor bid prices. To provide evidence for this point, we add *INST_ABID* into the regressions in Eq. (2) and examine the channeling

[6] The average amount of capital raised through an IPO is RMB 669.41 million for our sample firms.

Table 8
CRP anchoring and the IPO offer price: the mediating effect of institutional investor bid prices.

This table reports OLS regression results examining the mediating effect of investor bid prices on the association between rounding indicators and the offering price. The dependent variable is *RELATIVE_OFFER*. *ROUNDUP1* is equal to 1 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers and 0 if the two endpoints need to be rounded down. *ROUNDUP2* is equal to 2 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers, 1 if the two endpoints are integers and 0 if the two endpoints need to be rounded down. The *t*-statistics reported in parentheses are based on standard errors clustered at the industry level. *, **, and ***, denote statistical significance at the 10%, 5%, and 1% levels, respectively. Variable definitions are in the Appendix A.

RELATIVE_OFFER	(1)	(2)	(3)	(4)
INTERCEPT	0.050***	0.047***	− 0.105	− 0.156
	(9.43)	(11.11)	(− 0.44)	(− 0.80)
ROUNDUP1	0.006		0.009	
	(0.91)		(0.90)	
ROUNDUP2		0.004		0.004
		(1.01)		(0.91)
INST_ABID	0.947***	0.931***	0.944***	0.932***
	(72.77)	(83.65)	(29.41)	(36.64)
ROA			0.137**	0.122**
			(2.84)	(2.68)
SIZE			− 0.003	− 0.002
			(− 0.25)	(− 0.20)
LEV			0.093**	0.086**
			(2.61)	(3.03)
GROWTH			− 0.032*	− 0.023**
			(− 1.85)	(− 2.41)
TANG			− 0.030**	− 0.020
			(− 2.76)	(− 1.63)
LNFIN			0.004	0.001
			(0.51)	(0.15)
RANGE			− 0.023	− 0.036
			(− 0.40)	(− 0.51)
REPU			− 0.004	− 0.004
			(− 0.71)	(− 0.66)
LNLAG10			0.045***	0.043***
			(6.42)	(9.64)
INDACT			0.002	− 0.003
			(0.55)	(− 1.42)
MAIN			− 0.013	− 0.017
			(− 0.62)	(− 0.78)
REFORM			0.006	0.012
			(0.57)	(1.79)
Year Effects	No	No	Yes	Yes
Industry Effects	No	No	Yes	Yes
Adj. R^2	0.873	0.873	0.889	0.888
N	216	264	474	216

effect. The results are presented in Table 8. The coefficients of *INST_ABID* are consistently positive and significant in all four columns, which echo the findings in Cornelli and Goldreich (2003). More importantly, the coefficients of *ROUNDUP1* and *ROUNDUP2* are not statistically significant in all four columns, suggesting that the impact of CRP anchoring on the IPO offer price is indeed channeled by institutional investor bid prices. The findings in Table 8 corroborate those in Table 7.

4.6. CRP anchoring and IPO first day return

The results on the impact of CRP anchoring on IPO first day return are presented in Table 9. The coefficients for *ROUNDUP1* and *ROUNDUP2* are negative and significant at the 5% or 10% levels in columns (1) and (2), suggesting that the CRP anchoring effect is negatively correlated to the IPO first day returns. This indicates that when institutional investors round up the proposed endpoints by underwriters, the IPO first-day return is lower due to a higher initial offer price.

The coefficients are also economically significant. For instance, the coefficient on *ROUNDUP1*, − 0.040, suggests the IPO first day return for rounded-up firms is 4.0% less than that for rounded-down firms, corresponding to 17.0% (4.0/23.5) of the average first day return of our sample firms. The findings lend support to H4.

5. Conclusion

We examine the CRP anchoring effect on institutional investor bid prices in the IPO auction process and the associated wealth implications in China. While it is well established that CRP anchoring has a real impact on investor performance in

Table 9
CRP anchoring and IPO first day return.

This table reports OLS regression results on the association between rounding indicators and initial day return. The dependent variable is *FDRET*. *ROUNDUP1* is equal to 1 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers and 0 if the two endpoints need to be rounded down. *ROUNDUP2* is equal to 2 if the two endpoints of underwriters' proposed price range need to be rounded up to get their nearest integers, 1 if the two endpoints are integers and 0 if the two endpoints need to be rounded down. The *t*-statistics reported in parentheses are based on standard errors clustered at the industry level. *, **, and ***, denote statistical significance at the 10%, 5%, and 1% levels, respectively. We define all variables in the Appendix A.

FDRET	(1)	(2)
INTERCEPT	− 0.599	− 0.045
	(− 0.99)	(− 0.09)
ROUNDUP1	− 0.040**	
	(− 2.28)	
ROUNDUP2		− 0.021*
		(− 2.21)
ROA	− 0.943***	− 0.993***
	(− 7.43)	(− 4.57)
SIZE	− 0.014	− 0.016
	(− 0.44)	(− 0.64)
LEV	− 0.412***	− 0.450***
	(− 5.24)	(− 5.96)
GROWTH	0.150**	0.130***
	(3.24)	(5.12)
TANG	− 0.062	0.057
	(− 0.87)	(1.10)
LNFIN	0.042	0.042
	(1.43)	(1.57)
RANGE	0.433	0.697
	(1.28)	(1.63)
REPU	0.010	0.010
	(0.48)	(0.64)
LNLAG10	− 0.065	− 0.079
	(− 1.00)	(− 1.66)
INDACT	− 0.012	− 0.019*
	(− 1.22)	(− 2.16)
MAIN	− 0.025	− 0.031
	(− 0.50)	(− 0.60)
REFORM	0.199*	0.136**
	(2.22)	(3.06)
LNOVER	0.197***	0.173***
	(7.94)	(8.15)
MRET	3.152***	2.730***
	(13.90)	(15.10)
Year Effects	Yes	Yes
Industry Effects	Yes	Yes
Adj. R^2	0.389	0.347
N	216	264

secondary financial markets (e.g., Bhattacharya et al., 2012; Kuo et al., 2015), few studies address the concept in IPO pricing. We use a unique IPO database in China that reports institutional investor bid prices in their IPO auctions.

There are several findings. First, we find that the distributions of IPO investor bids show sharp spikes around rounded endpoints proposed by underwriters, suggesting that a considerable number of investor bids anchor on the rounded proposed endpoints. Second, we find that the average institutional bid price is higher (lower) for rounded-up (rounded-down) firms. When underwriters are more prestigious, the association is stronger, suggesting that institutional investors exhibit stronger CRP anchoring when the rounded endpoints are proposed by more credible underwriters. Third, the IPO offer price, on average, for rounded-up firms is higher than that for rounded down firms and thus the IPO first-day return for rounded-up firms, on average, is lower than that for rounded-down ones. Taken together, our findings suggest that institutional investors overvalue (undervalue) IPO firms in rounded-up (round-down) firms. The overvalued IPO shares for rounded up firms translates into a higher IPO offer price and a lower first day IPO return, suggesting that IPO firms can leave less money on the table by altering the proposed price range of the IPO.

There are several caveats for our findings, however. First, there is a potential endogeneity between the endpoints (price range) proposed by underwriters and whether the proposed endpoints are rounded. We conjecture that the proposed endpoints influence whether institutional investors round up or down these endpoints. underwriters' knowledge of institutional investors' CRP anchoring may be used to strategically set endpoints to influence investor behavior. Second, our analysis may suffer from a potential omitted variable bias. That is, underwriter proposed endpoints (in a price range) are not set randomly. There are probably one or more unobservable underlying factors contributing to underwriters' setting of the IPO price range in the auction process, including their conjectures of how CRP anchoring affects institutional investors.

While our investor bid price distribution analysis can alleviate the concern to some extent, it is not perfect.

Overall, we provide new evidence for the presence of CRP anchoring in the IPO market and deepen our understanding of the IPO pricing process. Behavioral bias exists in the IPO market and influences investors, IPO firms, and underwriters. Upon data availability, future research can be conducted to examine similar or other possible behavior bias issues in a more mature IPO market and address the caveats of our research design.

Appendix A

See Appendix Table A1.

Table A1
Variable definitions.

Variables	Definition
INST_ABID	The price difference between the weighted average of institutional investor bid prices and the midpoint of proposed price range, scaled by the same midpoint. We use the demand quantity corresponding to each bid price as the weights.
INST_OBID	The price difference between the weighted average of optimistic institutional investors' bidding prices and the midpoint of proposed price range, scaled by the same midpoint. We define optimistic investors as those whose bidding prices ranked in the top 10% for each IPO. The corresponding demand quantities are used as the weights.
INST_PBID	The price difference between the weighted average of pessimistic institutional investors' bidding prices and the midpoint of proposed price range, scaled by the same midpoint. We define pessimistic investors as those whose bidding prices rank in the bottom 10% for each IPO. The corresponding demand quantities are used as the weights.
RELATIVE_OFFER	The difference between the IPO offer price and the midpoint of the proposed price range divided by the midpoint of the proposed price range.
FDRET	Initial day return, defined as the percentage change from the IPO issuing price to the closing price on the first trading day.
ROUNDUP1	The first rounding indicator, which is equal to 1 if the two endpoints of underwriters' proposed price range are both needed to be rounded up and 0 if the two endpoints are both needed to be rounded down.
ROUNDUP2	The second rounding indicator, which is equal to 2 if the two endpoints of underwriters' proposed IPO price range are both needed to be rounded up, 1 if the two endpoints are both integers and 0 if the two endpoints are both needed to be rounded down.
ROA	The return on assets, defined as the net income of the IPO firm one year prior to the IPO, divided by its total assets.
SIZE	The natural logarithm of total assets at the end of most recent year prior to IPO.
LEV	Leverage ratio, defined as total liabilities of the IPO firm one year prior to the IPO, divided by its total asset.
GROWTH	Revenue growth rate, defined as the change in operating revenue of the IPO firm one year prior to the IPO, divided by operating revenue in the second year prior to the IPO.
TANG	*TANG* is the ratio of fixed assets at the end of most recent year prior to IPO divided by total assets.
LNFIN	*LNFIN* is the natural logarithm of expected capital to be raised, disclosed in the IPO prospectus.
RANGE	*RANGE* is the difference between the upper and lower endpoint of proposed price range, divided by its midpoint.
REPU	Underwriter reputation, which is equal to one if an underwriter ranks top 10 in terms of underwriting revenue in a given year and zero otherwise.
LNLAG10	*LNLAG10* is the natural logarithm of average online oversubscription of ten most recent IPOs. It captures the retail investors' sentiment before book-building.
INDACT	It is the natural logarithm of the number of IPOs in the same industry in most recent 90 days. The industry classification follows the 2001 version of industry classification standards of the CSRC.
MAIN	It is a dummy variable, which equals 1 if an issuer will list on the mainboard of Shanghai Stock Exchange (SSE) or Shenzhen Stock Exchange (SZSE) and 0 otherwise. The allocation mechanism is different between mainboard IPOs and the others (including small and medium enterprises board and growth enterprises market). The shares will be allocated by pro-rata for mainboard IPOs and they will be allocated by lottery for other IPOs.
REFORM	It is a dummy variable, which equals 1 if a firm conducts an IPO after April 28, 2012 and 0 otherwise. Since April 28, 2012, the institutional investors are not mandated to hold IPO shares for not less than 3 months[a].

[a] On April 28, 2012, the CSRC issued the Guidance on Further Enhancing the Reform of IPO System. In the guidance, CSRC cancelled the mandatory 3-month lock-up period for institutional investors.

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