New Investors and Bubbles:

An Analysis of the Baosteel Call Warrant Bubble

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ABSTRACT

This paper provides an empirical analysis of the trading behavior and the impact of new investors on the bubble surrounding the Baosteel call warrant, the first derivative traded in China after a nine-year suspension. First, we find that the new investors initiated the bubble. Second, echoing common wisdom, we empirically show that the continuous entries of new investors sustained the bubble. Third, we attribute the slow drop of the warrant price at the approach of maturity to new investors. Compared with other factors, the continuous inflow of new investors was the most powerful driving force of the bubble over the whole trading period.

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1. Introduction

Over the centuries, there have been remarkable episodes of market overvaluation, from Tulipmania, about four hundred years ago, to the recent price rises of real estate before the worldwide credit crisis. Almost all historical bubbles are accompanied by a flood of new investors. According to Mackay (1841), the growing popularity of tulips in the early 17th century caught the attention of the entire Netherlands; "the rage among the Dutch to possess them was so great that the ordinary industry of the country was neglected, and the population, even to its lowest dregs, embarked in the tulip trade." In a later example, Brennan (2004) proposes that increases in the numbers of individual participants could have been the driving force of the Internet stock price boom of the late 1990s. More recently still, the overall U.S. homeownership rate increased from 64% in 1994 (where it had been since 1980) to peak at the end of 2004 of an all-time high of 69%[1]; housing prices, however, peaked in early 2005, started to decline in 2006 and 2007, and recorded the largest year to year drop in 2008.

The crucial role of new investors in financial bubbles and their dynamics were described by Anderson (1787) more than two hundred years ago. Anderson speculates that good potential gains lead to increasing investment, resulting in price appreciation that attracts new investors. The novel sources of funds lead to further price appreciation that continues to attract new investors. Although the same mechanism underlying bubbles is widely believed to repeat itself over the centuries and across countries, few studies (including theoretical,

[1] "Census Bureau Reports on Residential Vacancies and Homeownership." U.S. Census Bureau. 2007-10-26.

empirical and experimental works) have focused on exhibiting a direct link between new investors and financial bubbles.

The theoretical literature on bubbles has mostly focused on the macro and micro conditions under which a bubble arises, but has not considered the role of new investors in either initiating, aggravating or sustaining a bubble. Mostly due to the lack of account level data, empirical research using naturally occurring data has not done much to address this issue, either. Greenwood and Nagel (2009) find that around the peak of the technology bubble, mutual funds run by younger managers invested in technology stocks more heavily than those run by older ones. Younger managers, however, are not equivalent to new investors.

Since Smith, Suchanek, and Williams (1988) introduced their groundbreaking methodology and found that market prices strongly deviate from fundamental value, numerous replications and modifications to its experimental settings have followed, in order to test how factors like information, experience, short sale constraints, constant or changing fundamental value, cash to asset ratio, excess money, and futures markets affect bubble formation. However, all existing experimental studies only focus on a given set of subjects.[2]

In this paper, we study the effect of new investors in the bubble of the Baosteel call warrant (Baosteel JTB1, 580000), the first derivative in China's financial market after a nine year suspension. This warrant attracted frenzied speculation and generated a large bubble. The warrant price was on average five times higher than the fundamental value estimated

[2] Noussair, Robin, and Ruffieux (2001) and Huber, Kirchler, and Stockl (2010) find that increasing cash to asset ratio has a positive effect on bubble formation. However, they only look at the effect of new money held by old investors, not new investors entering the market.

with the Black-Scholes equation. Different from most other financial bubbles, this bubble is unique in that the underlying stock prices make warrant fundamentals publicly observable and the warrant has predetermined finite maturities. The study of the effect of new investors is made possible by our data, in which orders and transactions of every investor can be identified.

Defining new investors as those who had never owned the Baosteel warrant before, our main findings are summarized as follows. First, new investors initiated the bubble. On the first trading day, the opening price of the Baosteel call warrant reached its upper limit (1.263 Yuan) and generated a significant bubble (84% higher than the estimated fundamental value). Because the opening call auction on the first trading day released no information during the process, it provides a rare opportunity to observe original beliefs without having to account for investor interactions. The order prices in the call auction show huge diversity within investor opinion about the warrant price. Under the restriction on short sale, the price is not determined by the majority of investors, but rather by the most optimistic ones. Furthermore, we find that although heterogeneity exists in both the original warrant holders and the new investors, the most aggressive buyers are dominantly the new ones. New investors account for 93% of bidders and 90% of bid volume. In fact, all the bids at the upper limit price come from new investors, and the order volume already exceeds the total volume at all prices on the sell side. Therefore, it is of no doubt that the new investors created this bubble.

Second, new investors sustained the bubble. From its opening on the first trading day until the last minute on the last trading day, when the warrant price finally hit the fundamental value, the bubble of the Baosteel call warrant was sustained for the entire

trading period (a year, 243 trading days). Using daily data and five minute data, and defining new investors as those who held the warrant for the first time on that day or that five minute interval,[3] our regressions show that the contribution of new investors to the bubble is sizable. In an average trading day, new investors increased the bubble size by 0.364 Yuan and accounted for about 34% of the volatility of the bubble growth on average. Without the continuous inflow of new investors, the warrant bubble would have disappeared in several trading days rather than persisting through the entire trading period. Moreover, new investors contributed to the bubble much more than other factors such as turnover rate, volatility, market return, etc.

Third, new investors explain the slow drop of the warrant price as the maturity approaches. During the last 60 trading days, the warrant price slumped from above 1.6 Yuan to virtually zero. While there was a clear downward trend, the price drop was slow in that there was no dramatic crash. Our quantile regressions show that the entry of new investors curbed the severe dropping of the warrant price.

Our findings empirically show the importance of new investors in the lifecycle of a financial bubble for the first time. The effect of new investors is consistent with the standard assumption of heterogeneous investor belief made in theoretical works such as Harrison and Kreps (1978) and Scheinkman and Xiong (2003), and empirically confirmed in Ofek and Richardson (2003) and Xiong and Yu (2011). While the empirical literature fails to identify where the heterogeneity comes from, theoretical models in Allen, Morris, and Postlewaite

[3] The definition of new investors is more stringent for five-minute data than that for daily data. However, when using five-minute data, results are not only significant, but also consistent with results obtained using daily data.

(1993) and Scheinkman and Xiong (2003) explain it in terms of asymmetric information[4] and different learning schemes,[5] respectively. We show that the continuous inflow of new investors is an important source of persistent heterogeneity.

Xiong and Yu (2011) studied the bubble created on 18 put warrants in China, and highlight the joint effects of short-sales constraints and heterogeneous beliefs in driving bubbles.[6] Nevertheless, conflicting with many empirical and experimental studies, they find no significant effect attributable to investor learning. They suggest that the entry of new investors may be a possible explanation, but do not test it, since they cannot identify new investors in their high frequency data. In this paper, we provide empirical evidence on the link between new investors and a warrant bubble. One speculation is that even when many investors in the market have experienced the crash of a financial bubble, a new bubble can appear if only there is a continuous inflow of new investors.

Our results also help to explain the puzzling phenomenon of more and more frequent financial bubbles in the recent two decades. Both empirical studies[7] and experimental studies[8] have shown a robust learning effect—once investors have experienced a bubble and

[4] As for the Baosteel call warrant, it is unlikely investors would possess asymmetric information about the underlying stock prices as they are publicly observable.

[5] Overconfident investors overweigh their private signals in inferring the fundamental value. This results in a time-varying difference of beliefs across investors.

[6] Bubbles concerning these 18 put warrants all happened after the crash of the Baosteel call warrant.

[7] E.g., Nagel and Malmendier (2011); Menkhoff, Schmidt, and Brozynski (2006).

[8] E.g., Dufwenberg, Lindqvist, and Moore (2005); Haruvy, Lahav, and Noussair (2007); Hussam, Porter, and Smith (2008); Gong, Lei, and Pan (2011). Dufwenberg, Lindqvist, and Moore (2005) conduct a laboratory financial market with a mixture of experienced and inexperience investors and demonstrate that even with a small fraction of experienced investors, bubbles are eliminated, or at

subsequent crash, they are less willing to participate the next time. Thus, a bubble can arise only following the arrival of a new generation of investors willing to commit their capital to buy overpriced stocks. Galbraith (1993) even claim that twenty years is the normal time it takes for the recollection of one disaster to be erased. However, the recent reoccurring bubbles seem to imply that experience alone may not be a sufficient condition to ensure the elimination of bubbles. As the market environment changes rapidly under the influences of factors like globalization and emerging markets, new investors can flood in much more quickly than before and therefore it does not take as long to create another bubble.[9] This also indicates that experimental studies may have neglected certain important factors happening in the field of asset markets, such as the constant entries of new investors.

One may naturally ask why these new investors kept rushing into the market. Although we do observe new investors crowding into the market in almost every historical bubble, they may have entered for different reasons. For example, Brennan (2004) proposes that increases in the number of individual participants during the Internet bubble was in part due to regulatory changes in the provision of pensions in the USA. As for the bubble of the Baosteel call warrant, because it was the first warrant in China's financial market after a nine-year suspension, it was natural for it to attract so many new investors. As every bubble is more or less different, we believe it is more important to address a common phenomenon that may exist across all bubbles, rather than something specific to a particular bubble. Therefore, in

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least substantially abated.

[9] Hussam, Porter and Smith (2008) show with experimental data that if the environment is subject to changes in liquidity and uncertainty, then experience is not sufficient to eliminate bubbles. This, however, may not be the only answer as we have explained above.

this paper, we pay more attention to the entry of new investors rather than to their reasons for their crowding in.

Because Xiong and Yu (2011) find little evidence to support theories based on investors' hedging needs, rational bubbles, agency problems of institutions, or investors' gambling behavior, we here omit discussion relative to these topics.

The rest of the paper is organized as follows. Section 2 describes the Baosteel call warrant bubble and the data. Section 3 presents the effects of new investors on the beginning, maintenance, and burst of the bubble. Section 4 discusses the exogeneity of new investors and the relationship between the new investor effect and the experience effect in bubbles. Section 5 concludes.

2. Data

We start by introducing the background of the Baosteel call warrant, and then describe the bubble and our data.

2.1. Background

The Shanghai Stock Exchange (SSE), established in 1990, is one of the two main stock exchanges in China. Paralleling the rapid growth of the economy, the growth of the SSE has been remarkable. At the end of 2010, there were over 80 million investors, 894 listed companies, and a total market capitalization of RMB 18 trillion (US $2.7 trillion).

Baoshan Iron & Steel is the largest and most advanced integrated steel company in

China, and was listed on the SSE in December 2000. By June 2005, Baosteel had 17.5 billion shares, of which 78% were held by the government, represented by the Baosteel Group. These shares were restricted from trading in the public market. This kind of "equity division" was common in China, but not suitable for the governance of public firms. In 2005, the central government of China decided to convert its non-tradable shares into tradable shares. However, public holders wanted compensation for potential losses caused by the dramatic increase in tradable shares.

Baosteel, as a pioneer firm, initiated the reform in July 2005 at the request of the China Securities Regulatory Commission (CSRC).[10] According to the reform scheme, for every 10 tradable shares, the Baosteel Group gave public holders 2.2 shares and 1 call warrant. One share of the Baosteel call warrant gave its holder the right to buy one share of Baosteel stock from the Baosteel Group at the strike price of 4.5 Yuan[11] on 30 August 2006. Table 1 summarizes the basic information about the Baosteel call warrant, which is identical to a typical European option.

[Table 1 about here.]

The first warrant in China was issued in June 1992. Because of rampant speculation and market manipulation, the central government halted the issuance and trading of warrants in June 1996. During the following nine years, Chinese investors had no investment alternatives to stocks. In 2005, the CSRC decided to introduce warrants again as part of the compensation

[10] The trading of Baosteel stock was halted from 25 July to 18 August 2005.

[11] The strike price adjusted from 4.5 Yuan to 4.2 Yuan for the dividend payout of the Baosteel stock on 25 May 2006. The public knew the adjustment method before the issuance of the Baosteel call warrant.

package to public investors. The Baosteel call warrant became the first warrant on the market since the nine-year suspension and was followed by many others. By the end of 2011, there had been 18 put warrants and 37 call warrants issued to the public.

Like all stock investors in China, investors in the Baosteel call warrant face a stringent restriction of short sales, with selling short prohibited by law. Moreover, the trading system makes it technically impossible to illegally engineer short selling operations. Meanwhile, companies cannot issue more warrants to arbitrate overvaluation, because the issuance is only for equity division reform. About three months after the issuance of the Baosteel call warrant, the SSE experimented with a creation program, a very limited short-selling mechanism, for some other warrants. However, the creation program did not eliminate the overvaluation of these warrants because of the program's limited scope.

The CSRC considered reintroducing the warrant business as an initial step towards opening the financial derivatives market, a move enthusiastically anticipated by many investors. To maintain the advantages of financial derivatives for hedging and speculation purpose, the CSRC and SSE has provided a friendlier trading environment for the warrants market in several dimensions, as compared to the stock market. First, investors are exempt from paying a stamp tax to the government and a registration fee to the stock exchange when trading warrants. The only transaction cost investors pay is a negotiable brokerage fee capped at 0.3%. According to our survey, the brokerage fee of ordinary individual investors ranged from 0.08% to 0.3%.

Second, warrant trading is subject to the "T+0" rule, while stock trading is subject to the "T+1" rule. Investors can sell warrants on the same day they bought them, whereas they have

to hold stocks at least overnight.

Third, warrants are subject to a much wider daily price change limit. Since 16 December 1996, the CSRC has imposed a ±10% price change limit for stocks. Orders with prices over 10% higher/lower relative to the previous day's closing price cannot be accepted by the trading system. As for a warrant, the price limit in Yuan is equal to 1.25 times the underlying stock price limit in Yuan.[12] Since the price of warrants is usually much lower than the price of the underlying stock, the price change limit of warrants is much looser in percentage terms than that of stocks. In practice, warrants seldom hit their price change limits. As for the Baosteel call warrant, only on the first trading day did it hit the upper limit.

2.2. The bubble

Despite the best efforts of the CSRC, the Baosteel call warrant attracted a trading frenzy, which provides a good opportunity for bubble research.

It is difficult to determine the fundamental value of an asset, as fundamentals are in general unobservable. An exception is the fundamental value of warrants that are determined by the price and volatility of the underlying stock. The celebrated Black-Scholes model provides a convenient tool for estimating the warrant's fundamental value.

[12] For example, consider the Baosteel call warrant on the first trading day, 22 August 2005. Because there was no previous trading day for the warrant, the SSE announced a benchmark price of 0.688 Yuan. The previous closing price of the underlying Baosteel stock is 4.62 Yuan. With the ±10% limit, the price of the Baosteel was allowed to increase or decrease by 0.46 Yuan. Then, the warrant price was allowed to change by 0.46×1.25 = 0.575 Yuan. The minimum trading tick of stocks is 1 penny and that of warrants is 0.1 penny.

The daily closing price and previous one-year rolling daily return volatility[13] of the Baosteel stock leads to the Black-Scholes value. Figure 1 plots the daily Black-Scholes value alongside the daily market price of the Baosteel call warrant. Table 2 reports summary statistics of the daily data. Two observations are immediate when we compare the warrant price and the fundamental value. First, it is a large bubble. The average warrant price amounts to 1.30 Yuan, more than five times higher than the average fundamental value of 0.24 Yuan. Second, this is a textbook bubble in the sense that the warrant price declined during the last several days, and hit the fundamental value in the last minute.

[Figure 1 about here.]

[Table 2 about here.]

The first concern of any empirical research on a possible bubble is whether it is in fact a bubble. Even for historically famous bubbles, there is an open debate, as in Garber (2000), or Pastor and Veronesi (2006). However, the bubble of the Baosteel call warrant seems indubitable for the following reasons.

First, the overvaluation is not due to lack of liquidity. Low liquidity in less developed financial markets from time to time leads to temporary but rather persistent deviations from fundamentals. These deviations are not considered bubbles. However, even though the securities market in China is far from fully developed, temporary shocks hardly affect the warrant price because the liquidity is extremely good (as seen in the bid-ask spread in Table

[13] Under alternative assumptions concerning volatility such as GARCH(1,1) and Garman and Klass (1980), the Black-Scholes value will change a little, but the gap between warrant price and Black-Scholes value is still large and significant.

2). In fact, the liquidity of the Baosteel call warrant is extremely good according to any traditional measure of liquidity.

Second, there is no evidence of price manipulation. Investors held the warrant evenly, with a minimum of 42,873 investors, and only two investors had records of owning a proportion over 5%. One lasted for two days, the other lasted for four days, and there was no overlap. Moreover, warned by the notorious manipulation scandal nine years earlier, the Market Surveillance Department of SSE paid extra attention and deterred any suspicious trading immediately. Additionally, the CSRC and SSE tried their best to make relevant information transparent so that rumors and misunderstandings were clarified immediately.

Third, investors can judge the bubble through comparing the profitability and safety of the warrant and the underlying stock. Although the Black-Scholes model does not generate a perfect estimation of fundamental value for the warrant because it builds on an arbitrage mechanism that is invalid for the ban on short selling in China, the much worse profitability and safety of the warrant compared to the underlying stock clearly indicate that the warrant is severely overpriced. For example, in Figure 2, on 29 May 2006, the closing price of the warrant was 2.253 Yuan and the closing price of the underlying stock was 4.61 Yuan. On the maturity day (30 August 2006, about three months later), if the stock price were lower than 4.2 Yuan, the strike price then, warrant holders would lose everything. Only if the stock price were above 6.453 Yuan would warrant holders see a positive profit. Only if the stock price were above 8.28 Yuan, meaning that the underlying stock price would have to rise by 80%, would warrant holders get higher return than stockholders do. Almost every investor would agree that the possibility of the underlying stock price rising more than 80% is very low, so it

is obvious that investors buying the warrant do not think the price is reasonable but want only to sell the warrant to another investor at a higher price. In fact, in our telephone interviews, most warrant investors confirmed that they thought this way.

[Figure 2 about here.]

Fourth, most investors clearly knew the meaning and risk of a warrant. If an investor wants to trade warrants, he needs to undertake risk education within his brokerage firm, and sign a document declaring complete understanding of the meaning and risks of warrants. Though not required, due to the possibility of lawsuits, many brokers even videotaped the whole process.

[Table 3 about here.]

Finally, it is important to note that most investors of the Baosteel call warrant believed it was a bubble. In December 2005, we interviewed by telephone 100 investors from three cities and six stock companies, who had at least one trading record of the warrant in the previous two weeks. Although the original purpose was not academic research, two questions from this telephone interview closely relate to ordinary investors' views about the warrant. Table 3 reports the two questions and answers from the 100 investors. The first question was "Is there a bubble of the Baosteel call warrant?" 86 investors believed that there had been a bubble in the Baosteel call warrant, nine did not think so, and the other five could not tell. The second question was "if you need to leave the market for half a year, which would you choose to hold, the warrant or the underlying stock?" 97 investors chose the underlying stock, no one chose the warrant, and the other three could not make a clear decision. In January 2006, we called the nine investors whose answer to the first question was "No," to ask their own

definition of bubbles. Five of them said that if they can sell the warrant to other investors at a higher price, then there is no bubble. Based on the telephone interviews, we can say that ordinary investors not only clearly recognized the existence of the bubble but also knew how to tell a bubble. Although it is hard for experts to calculate the fundamental value of stocks, warrants are not that complicated, and investors are very likely to be aware of the price bubble given some basic facts.

2.3. Structure of the data set

Our data set is kindly provided by the SSE under the condition that information on the disaggregate level is not revealed to any unauthorized third party. It is generally rare to have such rich and detailed data for research on bubbles. The data set consists of three parts. The first part contains data on the initial position of each investor, originating from the equity division reform described above, before the first trading day. This part of the data has 166,228 records with two fields: investor ID and the shares of warrant held by each. These investors held tradable shares of the Baosteel stock, and had received the warrant through the reform scheme. The second part records information regarding each transaction. Each record contains 11 fields, including the sequential number, price, volume, date and time of each transaction, investor ID, the state of buying or selling, and the sequential number of the corresponding order.[14] The third part records information concerning each order, and contains the first 10 fields of the trade data.[15] Table 4 reports summary statistics of the data

[14] Information on the remaining volume of corresponding order after the transaction, the withdrawing state, and the seat ID is also included.

[15] Information on the remaining volume, the withdrawing state, and the seat ID is also included.

set.

[Table 4 about here.]

The dynamics of the positions of each investor are calculated by integrating the first two parts of the data via the unique investor ID. The second and third data sets, linked through the unique sequential number of each order, result in the dynamics of the order book.

3. Results

Throughout the life time of the Baosteel warrant, new investors have been the majority of buyers. In fact, 51.37% of the buyers only purchased it once. Weighted with the number of shares they purchased, new investors account for an even bigger share of the market. So, how do these new investors affect the market? In the following analysis, we present the new investors effects during three phases of the bubble: beginning, maintenance and burst.

3.1. The bubble begins

There are many questions about bubbles; but perhaps none is more important than why bubbles ever start in the first place. This subsection aims to answer the question: who initiated the bubble?

The SSE opened with a call auction between 09:15 and 09:25, followed by continuous auctions running from 09:30 to 11:30 and 13:00 to 15:00. The opening call auction only

received orders; it did not release any information.[16] On the first trading day, starting at its opening price, the Baosteel call warrant reached the upper price limit (1.263 Yuan) and generated a significant bubble (84% higher than the fundamental value). This opacity of call auction on the first trading day provides a rare opportunity to reveal original beliefs without complications due to investor interaction.

[Table 5 about here.]

Table 5 reports summary statistics of the order book in the call auction of the Baosteel warrant on the first trading day. Three observations are immediate. First, the average bid and ask prices were not far from the fundamental value. Second, the large standard deviation indicates huge diversity in investor belief. Third, there is an extreme imbalance between buying and selling. The number of investors on the buy side is about 20 times greater than that on the sell side, while the ratio is about 300 when it comes to order volume. The total order volume on the buy side is 719.3 million shares, about two times the total amount of the warrant.

These three observations provide support for a suggestion by Miller (1977). In a static setting, where short selling is forbidden and investors hold heterogeneous beliefs about the fundamental value, Miller suggests that the asset price is biased toward the beliefs of optimists, because pessimists cannot sell short. These observations are also consistent with the main argument of Xiong and Yu (2011) that heterogeneous beliefs play an important role in the Chinese warrant bubble.

[16] Since 1 July 2006, the SSE has begun to release real-time quotations of opening call auctions that include the virtual opening reference price, virtual matched volume, and virtual unmatched volume.

Table 5 also reports summary statistics of new and old investors on the buy side. New investor refers to those who had never held the warrant before and who placed a buy order; old investor refers to initial warrant holders who placed an order to buy more. Because this is the opening call auction on the first trading day, all old investors in Table 5 also belong to the group of initial investors who received the warrant passively for their holdings of Baosteel stock in the equity division reform.

When we look further at Table 5, we can see that most buy orders came from new investors. On the buy side, new investors account for 93% of the total investor number, 94% of the order number, and 90% of order volume. On average, new investors bid significantly higher prices than old investors did. If we take standard deviation of order price as a measure of heterogeneity, new investors' opinions are more diverse than old investors are. Furthermore, all the buy orders at the upper limit price (1.263 Yuan) come from new investors, and the order volume already exceeds the total volume at all prices on the sell side.

After a nine-year suspension, the Baosteel call warrant was the first warrant issued, and attracted too much attention. Compared with the whole market, this warrant is small, so it is of no surprise that so many new investors squeezed into the call auction. After the call auction on the first trading day, new investors continued to squeeze in. By the end of the fifth trading day, 86% of all shares had been transferred from their initial holders to new investors. Because the stringent restrictions on short sales, the flood of new investors also meant the departure of initial holders. During the first week (five trading days) about one third (57,091 or 34%) of the initial holders closed out their holding positions. Most initial holders, both individuals and institutions, never came back. Institutions that were not initial holders were

not interested in investing in the Baosteel call warrant and accounted for only 0.9% of the trading volume.

3.2. Sustaining the bubble

From the opening on the first trading day to the last minute on the last trading day, when the warrant price hit fundamental value, the bubble of the Baosteel call warrant was sustained for the entire trading period (Figure 1). This subsection aims to understand whether and how new investors sustained the bubble of the Baosteel call warrant.

The term new investors here refers to those who held the warrant for the first time. In daily (or five minute) data, the term refers to accounts with purchase records on this trading day (or during this five minute interval) that have never held the warrant before. We should notice that the definition of new investors is more stringent for five-minute data than it is in daily data. For example, an investor may have two transaction records in a trading day and have no other transaction record before. In daily data, his tow orders are both counted as being from a new investor; in five-minute data, however, his first record of the day is sure to be counted as being from a new investor, while the latter is very likely to be counted among old investors.

A natural measure of new investors is the number of warrant shares they bought on the market, but this variable is highly correlated with trading volume. To distinguish the effects of new investors and trading volume, we use percentage of shares bought by new investors as the measure of new investors instead, that is:

$$NI_t = \frac{net\ shares\ purchaesed\ by\ new\ investors}{net\ shares\ purchaesed\ by\ new\ and\ old\ investors} \quad (1)$$

Figure 3 plots the daily data tracking new investors ($\boldsymbol{NI}$). Table 6 reports summary statistics at different frequency levels. $\boldsymbol{NI}$ is sizable, with a mean of 73% from daily data, which means new investors bought about three-fourths of the shares traded in an average trading day. Table 6 also reports bubble growth ($\Delta\boldsymbol{B}$) that stands for the first-order difference (in 0.1 penny, the minimum tick size) of the bubble size, which is computed as the warrant price minus the fundamental value according to the Black-Scholes equation. To eliminate the effect of the call auction and overnight events, for daily data, we use the closing price minus opening price in one trading day, instead of the closing price minus the last day's closing price, to compute $\Delta\boldsymbol{B}$. We can also see that the turnover rate is very high, at 148% daily or 3.09% in five minutes, which means that each share is on average only held for around 152 minutes.

[Figure 3 about here.]

[Table 6 about here.]

The correlation coefficients for $\boldsymbol{NI}$ and $\Delta\boldsymbol{B}$ equal 0.32 and 0.13 at the daily and five-minute frequencies, respectively. We ran the following regression to test whether inflows of new investors can amplify the bubble:

$$\Delta\boldsymbol{B_t} = \boldsymbol{\alpha_1} + \sum_{\boldsymbol{i=1}}^{\boldsymbol{q}} \boldsymbol{\beta_i}\, \Delta\boldsymbol{B_{t-i}} + \boldsymbol{\gamma_1 NI_t} + \boldsymbol{\varepsilon_t}, \quad (2)$$

$\boldsymbol{\varepsilon}$ is a generic term capturing sampling noise. Augmented Dickey-Fuller tests for unit roots reject the existence of unit roots for $\boldsymbol{NI}$ and $\Delta\boldsymbol{B}$ at the 1% level. Two and twelve lags are included for the daily and five-minute data. Our main results are robust to the number of lags.

[Table 7 about here.]

Column (1) in Panels A and B of Table 7 reports the estimated results using daily data and five minute data, respectively. The key coefficient $\boldsymbol{\gamma_1}$ on new investors is positive and highly significant, showing a strong contemporaneous correlation between new investors and the bubble's growth. The effect of new investors is sizable. Using daily data, the regression suggests that a one percentage point increase in $\boldsymbol{NI}$ leads to a contemporaneous increase of $\Delta\boldsymbol{B}$ by 0.00497 Yuan. The estimation also implies that $\boldsymbol{NI}$ with a standard deviation of 7.45 accounts for about 34% of the volatility of $\Delta\boldsymbol{B}$. Also, note that $\boldsymbol{\alpha_1}$ is significantly negative in all specifications, suggesting that the size of the bubble tends to shrink over time. In an average trading day, $\boldsymbol{NI}$, with its 73.24% mean, can increase the bubble growth by 0.364 Yuan. This nearly offsets the decline of $\Delta\boldsymbol{B}$ caused by $\boldsymbol{\alpha_1}$. In fact, the regression results imply that in the absence of new investors, the warrant bubble would disappear in several trading days, rather than a total of 243 days. When using five-minute data, regressions deliver a lower estimation of $\boldsymbol{\gamma_1}$. This is quite reasonable, because the definition of new investor becomes stricter. The null hypothesis, however, can still be rejected at the 1% level. The contribution of $\boldsymbol{NI}$ alone can account for 15% of the volatility of $\Delta\boldsymbol{B}$ using the five-minute trading data.

Certainly, new investors are not the only factor affecting the bubble. Next, we try to include in the regression other factors like turnover rate, volatility, market return, and the number of new accounts on the Shanghai Stock Exchange. We first regress the bubble growth on each of these variables alone:

$$\Delta\boldsymbol{B_t} = \boldsymbol{\alpha_2} + \sum_{\boldsymbol{i=1}}^{\boldsymbol{q}} \boldsymbol{\beta_i}\, \Delta\boldsymbol{B_{t-i}} + \boldsymbol{\gamma X_t} + \boldsymbol{\varepsilon_t}, \tag{3}$$

where X refers to one of the above variables. Here, volatility refers to the return volatility

constructed from one-minute intraday return. Market return is measured by the return of the Shanghai Composite Index, the most popular index in China. As for $\Delta \boldsymbol{B}$, we also use the closing index minus the opening index for one trading day to compute market return.

The regression results are shown in Columns (2) to (5) of Panel A and Columns (2) to (4) in Panel B of Table 7, which reports the estimated results.[17] Turnover rate has a significant positive effect on bubble growth at both daily and five-minute frequencies. This finding corroborates observation on historical bubbles and is consistent with in the findings of Xiong and Yu (2011) for over a dozen put warrants traded in China. However, we should also notice that, compared with new investors, the contribution of turnover rate is very small. During each trading day, turnover rate, with its 148% mean, can increase the bubble growth only by 0.019 Yuan; and in five minutes, the average turnover rate of 3% can only increase the bubble growth by 0.001 Yuan. Volatility shows no significance using either daily or five-minute data. A positive correlation between the bubble growth and market return is confirmed at both frequencies. However, the effect is economically negligible, at an average of only 0.002 Yuan in an average trading day. The number of new accounts has no significant effect on bubble growth, which means that investors new to the Baosteel call warrant, not investors new to the Shanghai Exchange as a whole, sustained the warrant bubble. This is of no surprise, because trading warrants requires special certification. Most of the time, brokerage companies reject applications for certification from investors who are very inexperienced.

Finally, we combine new investors, turnover rate and market return in a single

[17] Since there is no high frequency data for new account numbers, we cannot report estimates of its effect on bubble growth for the five-minute frequency.

regression. Column (6) in Panel A and column (5) in Panel B of Table 7 report the estimated results. Each variable has an effect on the bubble's growth similar to that seen in individual regressions. Overall, the regression results in Table 7 show that new investors are the main force sustaining the bubble.[18]

3.3. The bubble bursts

The Baosteel call warrant has a predetermined last trading day. During the last 60 trading days, the warrant price slumped from above 1.6 Yuan to virtually zero (Figure 1). While there was a clear downward trend, the price drop was slow in that there was no dramatic crash. This pattern of gradual price drop as maturity approaches has also occurred in the bubbles of other warrants in China.

According to resale option theories such as Scheinkman and Xiong (2003), as maturity approaches, a buyer anticipates that there is less time for reselling shares in the future and values the resale option less, leading to a smaller price bubble. The maturity effect indicates that the basic backward induction mechanism is still functioning. The slow drop in the price, however, still needs explanation.

Although new investors (***NI***) are important in sustaining the Baosteel call warrant bubble, their presence is not a good candidate for explaining the burst. Actually, ***NI*** rose rapidly in the last 60 trading days (see Figure 3). As a further check, consider the impact of ***NI*** from the perspective of conditional quantiles. This approach allows estimation of the new

[18] The results are robust even if we use other measures of new investors, such as the percentage of trading volume produced by new investors (in Yuan and share) or the percentage of new investors among buyers. Relative results are available upon request.

investor effect in different quantile ranges, and identification of the quantile range for which new investors are relevant. Specifically, consider an extension of regression (1),

$$\Delta \boldsymbol{B}_{\boldsymbol{t}} = \boldsymbol{\alpha}(\boldsymbol{\tau}) + \sum_{\boldsymbol{i}=\mathbf{1}}^{\boldsymbol{q}} \boldsymbol{\beta}_{\boldsymbol{i}}(\boldsymbol{\tau})\, \Delta \boldsymbol{B}_{\boldsymbol{t}-\boldsymbol{i}} + \boldsymbol{\gamma}(\boldsymbol{\tau}) \boldsymbol{NI}_{\boldsymbol{t}} + \boldsymbol{\varepsilon}_{\boldsymbol{t}}, \quad (4)$$

where $\boldsymbol{\tau} \in (\mathbf{0}, \mathbf{1})$ denotes the $\boldsymbol{\tau}$-th quantile. Figure 4 plots the estimated $\boldsymbol{\gamma}(\boldsymbol{\tau})$ from the regressions and their 95% confidence intervals (in shaded area) against $\boldsymbol{\tau}$.[19]

[Figure 4 about here.]

Figure 4 shows that the impact of new investors on bubble growth is significantly positive for most quantiles, but becomes significantly negative for the lowest quantiles ($\boldsymbol{\tau}$<20%). Furthermore, the magnitude of these estimates increases when $\boldsymbol{\tau}$ moves toward zero or one. Thus, new money exerts opposite and heterogeneous effects on both sides of the distribution of $\Delta \boldsymbol{B}$, and such effects become stronger at more extreme quantiles.

The entry of new investors drives the bubble and curbs the dropping of the warrant price. Unable to short sell when the price is going up, it is natural for a smart or overconfident investor to speculate on selling an overvalued warrant at an even higher price to another investor in the future. When the price is falling, especially when it is dropping quickly, the low price is perceived by some investors as cheap and attracts more speculative trading. While the nominal price level does not contain any specific economic meaning, Benartzi et al. (2007) also point out that it can affect investor demand for financial assets through the pressure of social norms.

[19] A summary of quantile regression results for other covariates is available upon request.

4. Discussion

4.1. The exogeneity of new investors

Obviously, if new investors were merely endogenous to a bubble, or in other words, if they were just attracted by an existing bubble, their role would be much less important. However, regarding the Baosteel call warrant bubble, we believe this is not the case for the following reasons. First, new investors initiated the bubble in the call auction on the first day of the Baosteel call warrant, when no one could have known of the existence of the bubble. Secondly, to address how the inflow of new investors responds to the growth in bubble size, we conducted a bi-viariate structural vector autoregressive regression (SVAR). The results are similar to those in Table 7 (see Figure 5 in Appendix). Third, during the last 60 trading days, when the bubble began to shrink, new investors continued to flood in.

As for the historical bubbles, the common phenomenon of the inflows of new investors may have been caused by different exogenous factors. For the Tulipmania, a rise in demand corresponded with a lull in the Thirty Years' War. For the Internet bubble, Brennan (2004) proposes that an increase in the number of individual participants was in part due to regulatory changes in the provision of pensions in the USA. For the recent real estate bubble in the USA, historically low interest rates and the expansion of subprime lending made many Americans who could not afford home purchases before able to afford them. Further, President Bush's 2004 campaign slogan "the ownership society" indicates the strong preference of Americans to own the homes they live in, as opposed to renting. These different reasons for new investors to crowd into the market in historical bubbles indicate that new

investors were not merely attracted by bubbles, but were at least partly exogenous as an important cause of the bubbles.

4.2. New investors vs. inexperienced investors

Many studies have followed the pioneering work of Smith, Suchanek and Williams (1988) in order to test the robustness of the price bubble phenomenon. To date, the only treatment variable that appears to consistently eliminate the existence of the price bubble is the experience of all or some of the market participants gained through participation in previous asset market sessions of the same kind (Van Boening, Williams and LaMaster 1993; Dufwenberg, Lindqvist and Moore, 2005). More specifically, experience in these experimental studies means living through an experimental bubble and its subsequent crash.

However, the experience effect in the field has not been directly tested. One reason is that the experience of investors is rarely observable or measurable in naturally occurring data. Greenwood and Nagel (2009) use the age of mutual funds managers as a proxy for their investment experience. Still, such experience is different from that in the experimental settings.

Note that in our story, old investors as well as new ones should be considered inexperienced, since the Baosteel call warrant was the first warrant in China after a nine-year suspension, and therefore neither new nor old investors had experienced a crash in the Chinese warrant market. Thus, the new investor effect found in our study is not equivalent to the inexperienced investor effect.

Historically, the bubbles usually happened long after the preceding ones, which is

consistent with the experience effect. Nonetheless, more frequent occurrences of financial bubbles in the last two decades than before seem to indicate that experience alone may not be a sufficient condition to ensure the elimination of bubbles. Between 2005 and 2011, dozens of warrants traded in China went to substantially inflated prices and crashed. Because these warrants were issued and matured at different times, it provides a rare opportunity to test the experience effect. However, no one found significant evidence. For example, Xiong and Yu (2011) split 18 Chinese put warrants issued after the crash of the Baosteel call warrant into two halves (each with nine warrants) based on their expiration dates and found that the last nine warrants on average had a larger bubble than the first nine. Our findings might suggest that the experience effect was only invisible in the Chinese warrants bubble, because too many new investors entered the markets and washed the effect away. Finding the precise relationship between the new investor effect and the inexperienced investor effect awaits empirical investigation with richer data or well-designed experimental studies.

5. Conclusions

The bubble of the Baosteel call warrant in China presents a rare opportunity for us to study the mechanism behind a bubble, because of its publicly observable fundamental value and completely recorded trading activities together with investor identities. In this paper, we studied the effect of new investors during three different phases of the bubble: beginning, maintenance and burst. We find that the new investors initiated the bubble, and that the continuous inflow of new investors both sustained the bubble and slowed its crash. Over the lifetime of this warrant bubble, compared with other factors, the continuous inflow of new

investors was the most powerful driving force.

On a more speculative note, the effect of new investors we show in this paper could shed light on the puzzling question: can we identify a bubble when it occurs? Brunnermeier (2007), in the *New Palmgrave Dictionary of Economics*, gives a popular definition: "Bubbles arise if the price exceeds the asset's fundamental value." The only problem with this definition is that in most cases, no one seems to agree on what an asset's fundamental value is. The disagreement arises because fundamental value is a function of expected cash flows and discount rates, and neither is observable. Many economists even suggest that there would never be agreement about the existence or nonexistence of a bubble ex ante. However, we believe that flooding by enormous numbers of new investors can be a measurable and effective criterion to help us identify a bubble before its crash. Once a bubble is detected, we can decide whether to take measures to deflate it before it becomes too big and collapses afterwards. Of course, any rapid development, such as the implementation of new information technology in the late 1990s, requires massive investment. It is very difficult for policy makers to decide whether they are squelching a possible bubble or risking the forfeit of an opportunity for quick development, but it is not impossible.

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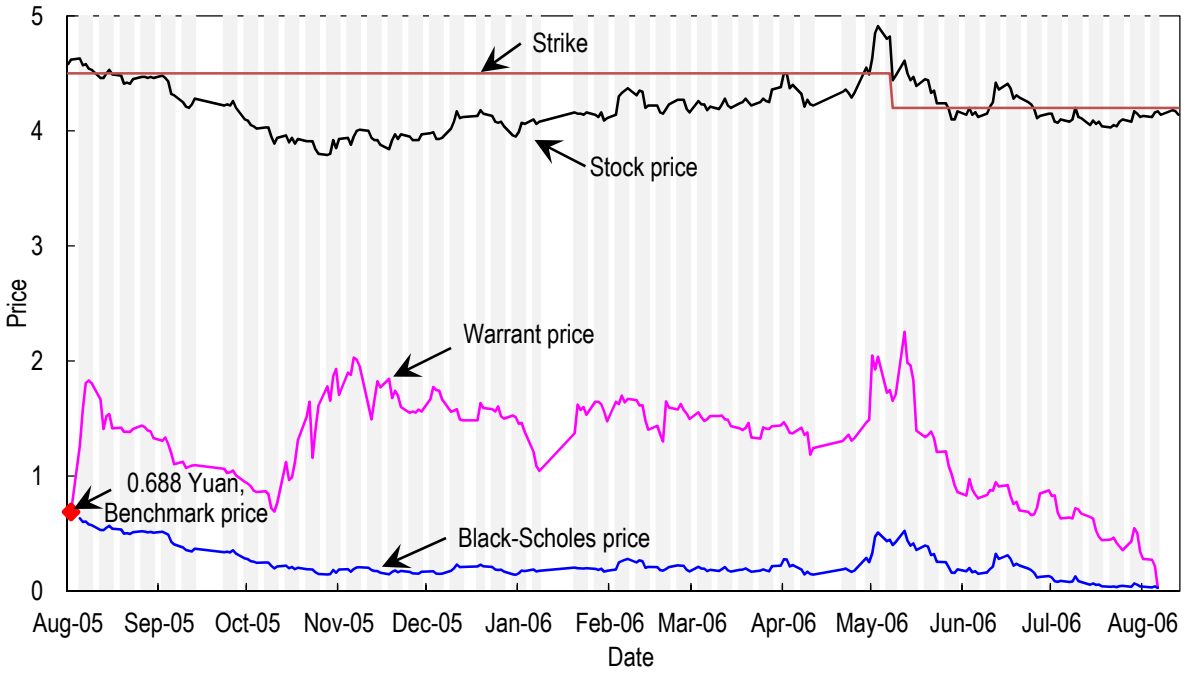

Figure 1: Daily prices. This figure graphs the daily closing prices of the Baosteel call warrant and the Baosteel stock, along with the strike price and the Black-Scholes value, using the Baosteel stock's previous one-year rolling daily return volatility. The strike price was adjusted from 4.5 Yuan to 4.2 Yuan for the dividend payout of Baosteel stock on 25 May 2006. The public knew the adjustment method before the issuance of the Baosteel call warrant. The SSE announced the benchmark price, 0.688 Yuan, before the debut of the Baosteel call warrant to define the price limit of the first trading day. The benchmark price was computed with the Black-Scholes formula. The shaded parts indicate trading days and lighter parts indicate weekends and other public holidays.

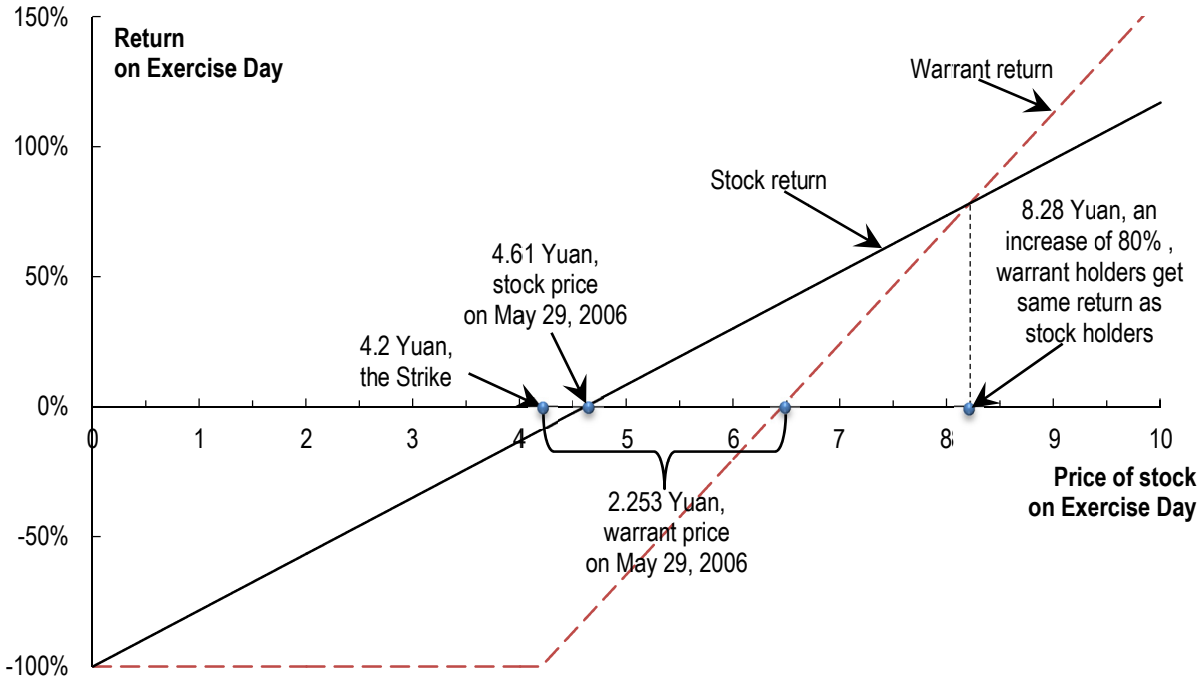

Figure 2: An example of the comparison of warrant and stock. Arbitrage is only the mechanism perfectly linking the warrant price to the underlying stock price. Alternatively, the two prices can be connected through direct comparison of the profitability and safety of the warrant and the underlying stock. In other words, hold the underlying stock if the warrant is overpriced. This figure shows an example. On 29 May 2006, the closing price of the Baosteel call warrant and stock were 2.253 Yuan and 4.61 Yuan respectively. If, on 30 August 2006, only about three months later, the stock price is below 4.2 Yuan warrant holders will lose all; if the stock price is above 6.453 Yuan, an increase of 40%, warrant holders would see a positive profit; if the stock price is above 8.28 Yuan, an increase of 80%, warrant holders get a higher return than stock holders. Almost every investor would agree that the possibility of the underlying stock price rising more than 80% is very low, so it is obvious that investors buying the warrant do not think the price is reasonable but want only to sell the warrant to another investor at a higher price. In fact, our telephone interviews indicate that most warrant investors think this way.

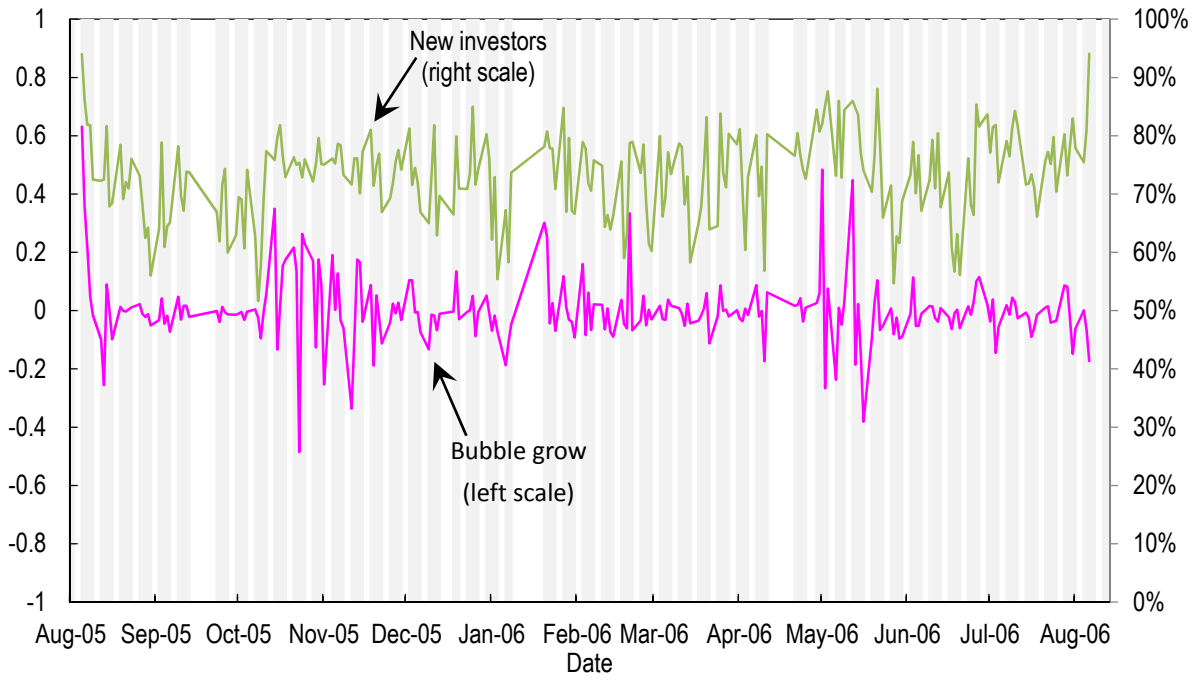

Figure 3: New investors. This figure shows the daily percentage of shares purchased by new investors, along with the bubble growth of the Baosteel call warrant. The shaded parts indicate trading days and lighter parts indicate weekends and other public holidays.

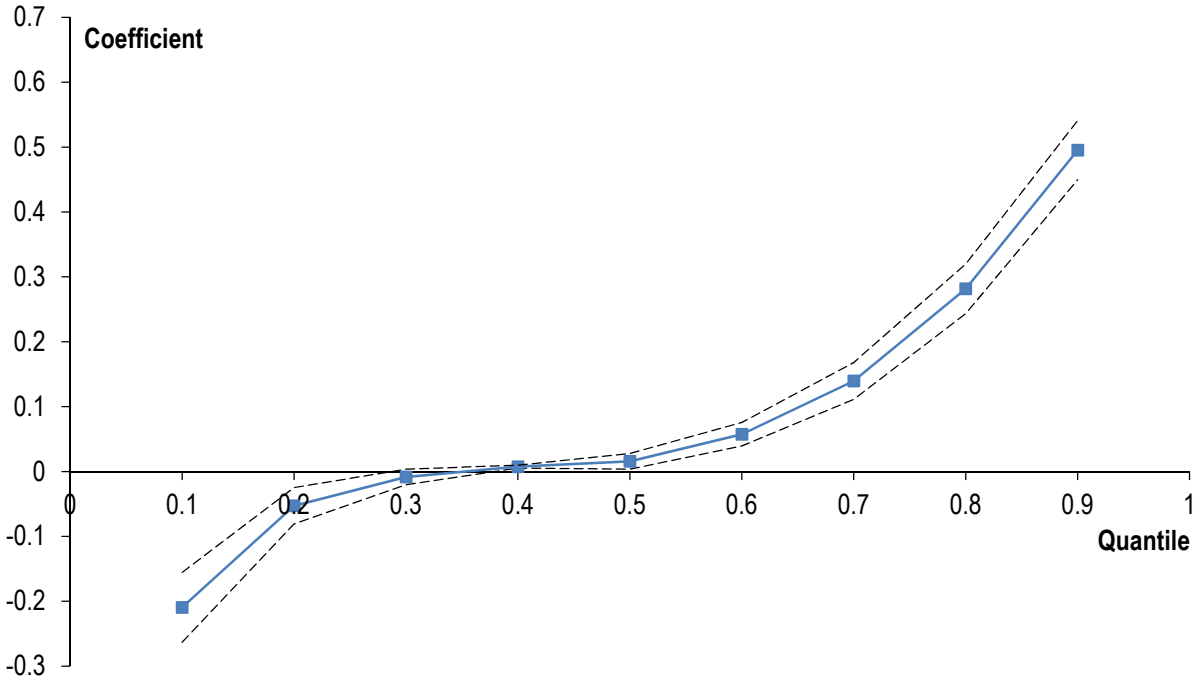

Figure 4: Quantile regression. According to the quantile regression $\Delta \boldsymbol{B_t} = \boldsymbol{\alpha}(\boldsymbol{\tau}) + \sum_{\boldsymbol{i=1}}^{\boldsymbol{q}} \boldsymbol{\beta_i}(\boldsymbol{\tau})\, \Delta \boldsymbol{B_{t-i}} + \boldsymbol{\gamma}(\boldsymbol{\tau}) \boldsymbol{NI_t} + \boldsymbol{\varepsilon_t}$ this figure graphs coefficients $\boldsymbol{\gamma}(\boldsymbol{\tau})$ (solid line) and their 95% confidence intervals (dashed line) against quantile $\boldsymbol{\tau}$. $\Delta \boldsymbol{B}$ and $\boldsymbol{NI}$ stands for bubble growth and new investors.

Table 1. Basic Information of the Baosteel Call Warrant

This table shows the Baosteel call warrant's ticker, total shares outstanding of the warrant, and the underlying stock, strike price, trading period, and exercise day. The strike price was adjusted from 4.5 Yuan to 4.2 Yuan for the dividend payout of Baosteel stock on 25 May 2006. The public knew the adjustment method before the issuance of the Baosteel call warrant.

Ticker	Warrant amount (million)	Stock amount (million)	Strike price (Yuan)	Trading Period		Exercise day
				Begin	End	
580000	387.7	17,512	4.5/4.2	22 Aug 2005	23 Aug 2006	30 Aug 2006

Table 2. Descriptive Statistics of Daily Data

This table shows the mean, standard deviation, minimum and maximum of time-series of the underlying Baosteel stock and the Baosteel call warrant, which includes the daily closing price, turnover rate, trading volume (in million shares and Yuan), and bid-ask spread (in 0.1 penny and percent, the minimum trading ticks of the warrant and stock are 0.1 and 1 penny respectively), the Black-Scholes value computed with the previous one year daily return volatility, and the bubble value computed as warrant price minus Black-Scholes value.

		Mean	St.Dev.	Min	Max
Closing price (Yuan)	Underlying	4.195	0.203	3.790	4.910
	Warrant	1.296	0.420	0.031	2.253
Turnover rate (%)	Underlying	0.27	0.18	0.06	1.16
	Warrant	148.39	154.70	23.24	1,164.77
Share volume (million)	Underlying	46	31	11	203
	Warrant	575	599	90	4516
Yuan volume (million)	Underlying	197	139	49	858
	Warrant	736	775	77	4,171
Bid-ask spread (0.1 penny)	Underlying	10.1	0.129	10	10.25
	Warrant	1.746	0.759	1.005	5.311
Bid-ask spread (%)	Underlying	0.240	0.012	0.210	0.277
	Warrant	0.153	0.098	0.070	0.948
Black-Scholes value	Warrant	0.235	0.132	0.027	0.632
Bubble value	Warrant	1.060	0.387	0.004	1.838

Table 3. Questions and Answers of Telephone Interview

This table reports two questions and one hundred investor answers. The telephone interview was conducted in December 2005 and its original purpose was not for academic research. In January 2006, we called the nine investors whose answer of Q1 is "No" to ask their own definition of bubbles. Five of them said if they can sell the warrant to other investors with a higher price, then there is no bubble. The other four could not clearly define.

		Q1: Is there a bubble of Baosteel call warrant?			
		Yes	No	Don't know	All
Q2: If need to leave the market for half year, which would you choose to hold?	Warrant	0	0	0	0
	Stock	86	8	3	97
	Don't know	0	1	2	3
	All	86	9	5	100

Table 4. Summary Statistics of Data Set

Panel A shows total number and composition of transactions, orders and investors of the data set. Panel B shows summary statistics of daily records.

Panel A: Total Number and Composition

	Total number	Institution		Individual	
		Number	Percentage	Number	Percentage
Transactions	25,483,344	172,873	0.68%	25,310,471	99.32%
Orders	20,412,869	110,273	0.54%	20,302,596	99.46%
Investors	712,057	3,119	0.44%	708,938	99.56%

Panel B: Daily Records

	Mean	Median	St.Dev.	Min	Max
Transactions	104,870	65,198	101,030	17,166	566,606
Orders	84,004	51,658	81,547	14,516	464,556
Investors	18,717	14,177	12131	5,041	66,070

Table 5. Call Auction on the First Trading Day

This table reports the composition of investor number, order number, and order volume on the buy and sell sides. This table also reports summary statistics of new and old investors on the buy side. New investor refers to those who had never held the warrant before and who placed a buy order; old investor refers to initial warrant holders who placed an order to buy more. Because this is the opening call auction on the first trading day, all old investors here also belong to the group of initial investors who received the warrant passively for their holdings of Baosteel stock in the equity division reform.

			Investor number	Order volume (million)	Prices of orders (Yuan)			
					Mean	Difference (*p*-value)	St.Dev.	Difference (*p*-value)
Buy	Institutions		115	78.2	0.745		0.222	
		New	100	50.9	0.750	0.022 *(0.516)*	0.237	0.074 *(0.002)*
		Old	15	27.3	0.728		0.163	
	Individuals		12,062	641.1	0.709		0.220	
		New	10,225	598.4	0.711	0.033 *(0.000)*	0.222	0.041 *(0.000)*
		Old	837	42.7	0.678		0.181	
	Both		12,177	719.3	0.710		0.222	
		New	11,325	649.3	0.712	0.032 *(0.000)*	0.222	0.041 *(0.000)*
		Old	852	70.0	0.680		0.181	
Sell	Institutions		12	0.693	0.815		0.136	
	Individuals		553	1.599	0.817		0.189	
	Both		565	2.292	0.817		0.188	

Table 6. Summary Statistics of Bubble growth, New Investors and Control Variables

This table reports the summary statistics of bubble growth ($\Delta \boldsymbol{B}$) and new investors ($\boldsymbol{NI}$) at daily and five-minutes frequency levels. $\boldsymbol{NI}$ are measured as the percentage of shares purchased by new investors. $\Delta \boldsymbol{B}$ (in 0.1 penny, the minimum tick size) is the first-order difference of the bubble size, which computes as the warrant price minus Black-Sholes value. This table also reports return and new accounts number of the stock market, turnover rate and volatility of the warrant. We use opening price instead of the last closing price to compute return of the bubble and market to eliminate the effect of call auction and events overnight. There is no high frequency data of the new accounts number.

		Mean	St.Dev.	Min	Max
Daily data	New investors (%)	73.24	7.45	51.64	94.05
	Bubble growth (0.1 penny)	-14.92	108.40	-487	527
	Market return (%)	0.20	1.47	-6.37	4.66
	New accounts # (thousand)	8.89	9.14	2.41	77.71
	Turnover rate (%)	148	155	23	1,165
	Volatility (%)	100	81.4	4.64	850
Five minute data	New investors (%)	49.77	11.98	0.00	99.38
	Bubble growth (0.1 penny)	-0.31	15.60	-280	197
	Market return (%)	0.00214	0.150	-2.22	1.89
	Turnover rate (%)	3.09	3.84	0.013	46.53
	Volatility (%)	85.78	99.43	0	1965

Table 7. Regressions of Bubble Growth

This table reports the regression results of bubble growth (in 0.1 penny, the minimum tick size) on new investors (in percentage), market return, new accounts number, turnover rate, and volatility. Panel A and B report results of daily and five-minute data separately. *t*-statistics are in brackets.

Panel A: daily data, AR(2)

	(1)	(2)	(3)	(4)	(5)	(6)
Constant, $\boldsymbol{\alpha}$	-382.59	-20.13	-20.72	-38.86	-16.48	-342.87
(*t*-stat)	*(-5.67)*	*(-2.85)*	*(-2.14)*	*(-3.99)*	*(-1.45)*	*(-4.80)*
New investors, $\boldsymbol{\gamma_1}$	4.97					4.28
(*t*-stat)	*(5.43)*					*(4.25)*
Market return, $\boldsymbol{\gamma_2}$		10.97				9.59
(*t*-stat)		*(2.33)*				*(2.14)*
New accounts #, $\boldsymbol{\gamma_3}$			0.06			
(*t*-stat)			*(0.09)*			
Turnover rate, $\boldsymbol{\gamma_4}$				0.13		0.598
(*t*-stat)				*(3.09)*		*(1.26)*
Volatility, $\boldsymbol{\gamma_5}$					-0.0117	
(*t*-stat)					*(-0.13)*	
Adj $\boldsymbol{R^2}$	0.1063	0.0177	-0.0043	0.0342	0.0067	0.1382

Panel B: five-minute data, AR(12)

	(1)	(2)	(3)	(4)	(5)
Constant, $\boldsymbol{\alpha}$	-10.15	-0.371	-1.536	-0.266	-11.89
(*t*-stat)	*(-16.22)*	*(2.58)*	*(8.24)*	*(-1.40)*	*(-18.47)*
New investors, $\boldsymbol{\gamma_1}$	0.196				0.204
(*t*-stat)	*(16.09)*				*(16.74)*
Market return, $\boldsymbol{\gamma_2}$		8.98			8.31
(*t*-stat)		*(9.33)*			*(8.77)*
Turnover rate, $\boldsymbol{\gamma_4}$			0.378		0.432
(*t*-stat)			*(10.0)*		*(11.57)*
Volatility, $\boldsymbol{\gamma_5}$				-.00098	
(*t*-stat)				*(0.67)*	
Adj $\boldsymbol{R^2}$	0.0335	0.0167	0.0178	0.0094	0.0480

Appendix

To explore the inflow of new investors responds to the changes of the bubble size, we consider a bi-variate system where shocks on bubble growth and new investors are identified. This makes the underlying mechanism highly transparent. Specifically, we assume the following structural form equation.

$$\boldsymbol{A_0 X_t = C + A_1 X_{t-1} + \cdots + A_p X_{t-p} + \varepsilon_t}, \quad \text{(a)}$$

where $\boldsymbol{X_t \equiv (NI_t, \Delta B_t)'}$ and $\boldsymbol{\varepsilon_t \equiv (\varepsilon_t^1, \varepsilon_t^2)'}$ is a vector of structural shocks, which are serially uncorrelated**.** The main diagonal terms of the $\boldsymbol{A^0}$ matrix are scaled to 1. We need one extra restriction on $\boldsymbol{A^0}$ to achieve identification. The key identification condition we consider is that $\boldsymbol{NI_t}$ is contemporaneously exogenous to $\boldsymbol{\Delta B_t}$, i.e., $\boldsymbol{A^0}$ has the following structure

$$\boldsymbol{A^0 = \begin{pmatrix} 1 & 0 \\ a_{21} & 1 \end{pmatrix}}. \quad \text{(b)}$$

The assumption that bubble growth has no contemporaneous effect on $\boldsymbol{NI}$ is reasonable, because new investors need time to decide whether to enter the market or not. Moreover, we use high-frequency data, making the identification restriction even weaker. Again, we use five-minute data and include twelve lags, as we did in the single equation regression (4). Our main results are robust to various choices of lags.

[Figure 5 about here.]

Panel A and B of Figure 5 plot impulse responses of one standard deviation shocks to bubble growth ($\boldsymbol{\Delta B}$) and new investors ($\boldsymbol{NI}$). One can see from the Panel B that the shock is

followed by a sizable but transitory increase in $\boldsymbol{NI}$, suggesting that new investors immediately flow into the market as a reaction to the positive price move. Interestingly, such a positive response disappears quickly. This might be due to the absence of persistency (or momentum) of $\Delta\boldsymbol{B}$ shown in Panel A. Although an increase in $\Delta\boldsymbol{B}$ encourages the inflow of new investors, they are perhaps disappointed by observing no further price increase and therefore reluctant to purchase the warrant afterwards, resulting in a decrease of $\boldsymbol{NI}$. Panel C and D of Figure 5 plot impulse responses of a one standard deviation shock to $\boldsymbol{NI}$. The response of new investors is relatively persistent, whereas the positive response of $\Delta\boldsymbol{B}$ is only statistically significant for the 10 minutes after the shock. The cumulative effect of such a shock (about one percentage increase in $\boldsymbol{NI}$) increases the bubble by 0.002 Yuan in 10 minutes, a magnitude consistent with that implied by the estimation in Table 7.

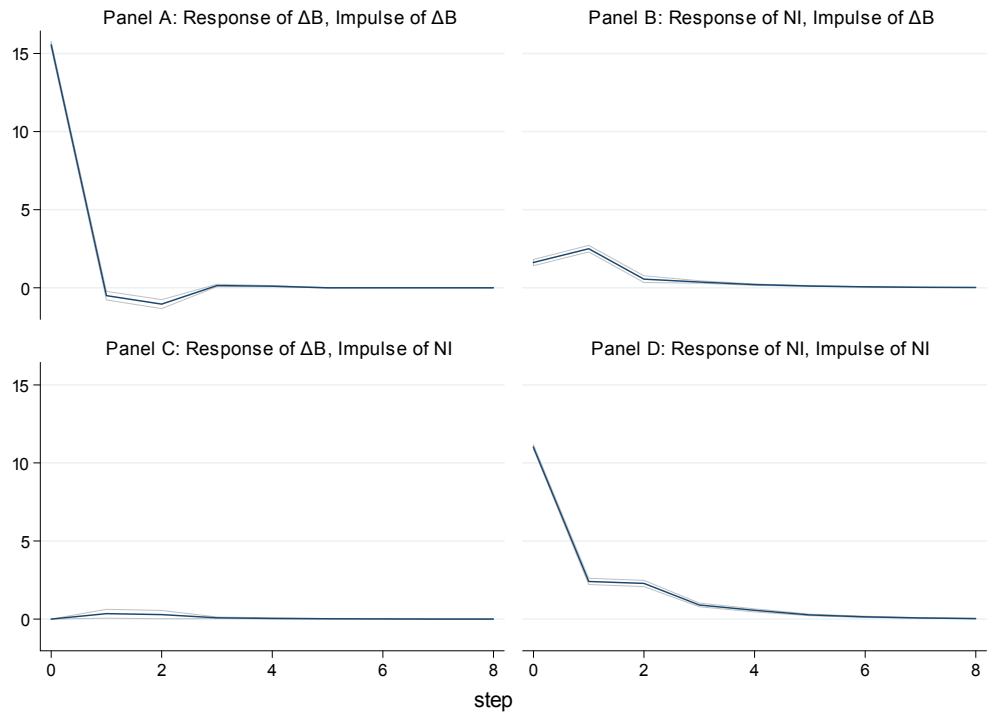

Figure 5: Impulse Response of New Investor and Bubble Growth. This figure graphs impulse-response of the SVAR system of $\Delta \boldsymbol{B}$ and $\boldsymbol{NI}$ stands for bubble growth and new investors. The shaded parts indicate 95% confidence intervals.