# The Chinese Collectibles Bubble

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**ABSTRACT**

Using novel, hand-collected data from the largest Chinese collectibles exchange, we examine the asset price bubble in the collectibles market in the 2010s. Because the collectibles securitized on the exchange were also widely traded off the exchange, we are able to observe the fundamental price of the traded securities (i.e., the retail price of the securitized collectible). This feature of our data, combined with plausibly exogenous shocks to the trading environment, allows us to examine bubble theories in ways typically possible only in laboratory experiments. Our results are broadly consistent with resale-option theory and provide support for the external validity of several key findings from the experimental bubble literature.

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## 1. Introduction

Highlighted by the Gamestop and AMC bubbles and the demand for cryptocurrencies, speculative assets have seen a recent surge in retail interest. While boosters of these assets say that this is the result of "the remarkable example of the power of the internet and electronic trading to democratize capital markets"[1], critics argue that prices have become unmoored from their fundamental economic value.[2]

One manifestation of this phenomena is the resurgence in the market for collectibles - both traditional and new (e.g., non-fungible tokens).[3] In just the first half of 2021, "Action Comics #1" sold for US$3.25 million via ComicConnect.com setting the record for the price of a single comic book. Moreover, the digital artist Beeple, who had never previously sold a print for more than $100 USD, had a non-fungible token (NFT) of his work sold at Christie's for $69 million.

Prior studies of the collectibles markets (Anderson (1977), Baumol (1986), Dimson and Spaenjers (2011), Goetzmann (1993), Mei and Moses (2002), and Stein (1973)) largely focus on the (under) performance of collectibles with respect to equities and bonds. But such eye-popping numbers as these raise another important yet under-explored question: are there bubbles in the collectibles market? While periods of rapid appreciation are plausibly consistent with a price bubble, as discussed in Lovo and Spaenjers (2018), collectibles owner enjoys a private "emotional dividend", which could explain seemingly too-high prices.[4] The unobservable private utility individuals receive makes the study of collectibles bubbles empirically challenging, since such factors are not generally observable to researchers. For instance, US$3.25 million for the "Action Comics #1" might be just about right if the collector receives a high enough emotional dividend.

[1] Wall Street Journal, "The Long and Short of the Gamestop Bubble," Feb 5, 2021

[2] Wall Street Journal, "Gamestop Is a Bubble in Its Purest Form," January 27, 2021

[3] In 2020, the global collectibles market in fine art, stamps, coins, comic books, and sports cards is estimated at $370 billion (see https://techcrunch.com/2020/03/25/the-future-of-collectibles-is-digital/.

[4] In another theoretical study, Mandel (2009) models art investment as a conspicuous consumption good so that collectors get direct utility from (paying) higher prices for the collectibles.

Indeed, empirical research into bubbles in general has proven difficult due to the fact that the fundamental value of an asset is rarely observable. While many scholars apply the colloquial expression "I know it when I see it" to asset bubbles, recent work challenges the idea that even famous historical episodes such as the Dutch Tulip Mania (Garber 2000) or the Dotcom Bubble (Fama 2014) were in fact bubbles. This controversy exists in part because, in the absence of data on the true value of assets, empirical analysis of whether an episode even constitutes a bubble is a joint test of a specific model of bubbles and the existence of a bubble (Giglio, Maggiori and Stroebel 2016). Given the inherent difficulty in measuring an asset's fundamental value, most empirical analyses of asset bubbles have been carried out in the lab where fundamental asset values are known to the experimenter.[5]

In this paper, we examine China's recent "collectibles bubble" using data that allows us to overcome this empirical challenge. During the 2010s, art and collectibles were securitized and then traded on electronic exchanges similar to the current crop of exchanges for cryptocurrencies and NFTs. Then, as now, these exchanges were popular with retail investors and lauded by their supporters as an example of the power of technology to democratize financial markets.

Our data was collected from the Nanjing Cultural Products Exchange (NCPE) and includes daily data for all 196 collectibles traded on the exchange for the life of the exchange. With a daily trading volume in excess of 1.5 billion yuan, the NCPE was the largest of the many collectibles exchanges that operated in China during the 2010s. The NCPE opened on October 21, 2013 and eventually closed on June 30, 2017 as part of a nation wide ban on collectible exchanges. Before its closure, the NCPE securitized large sets of identical collectibles, mostly commemorative coins produced by the People's Bank of China and commemorative stamps produced by the China Post, on a one-to-one basis, with each security giving the holder the right to one whole unit of the collectible. A unique feature of this market was that

[5]A notable exception is Xiong and Yu (2011), who examine a set of put warrants so far out of the money that their fundamental value can reliably be set to zero. In related work Lee, Shleifer and Thaler (1990) and Lamont and Thaler (2003A, 2003B) document general mispricing in financial markets.

the securitized collectibles themselves were not particularly rare and available for purchase throughout the country at various retail locations and online. As such, collecting data on the off-exchange retail price of the collectibles themselves enables us observe the fundamental value of the traded securities.[6]

A typical example of a listing was the 1,759 shares of a lot containing 1,759 mint condition "2009 China S10Y Silver 1oz Panda Coins", where each share of the security gave the holder the rights to a single 2009 Panda coin. The Agricultural Bank of China minted 10,000 copies of the Silver Panda Coin, of which less than 18% were securitized on the NCPE. At the same time, the coin itself was widely available for purchase from multiple vendors in variousof physical collectibles markets throughout China, as well as on online. Thus, both the econometrician and individual traders could learn, with some effort, the asking price for the coin by visiting a market or calling a dealer.

The observable nature of the fundamental value of the traded securities allows us to not only test for the existence of a bubble in a model free way, but also to directly test the predictions of various bubble theories using real-world data. In addition, changes implemented by the NCPE and the China Securities Regulatory Commission during our study period provide several natural experiments which enable us to further explore various bubble theories. These exogenous shocks to the trading environment include the publication of the retail price of the collectible by the exchange, changes to the ability of traders to arbitrage, and the scheduled closure of all collectibles markets throughout China. Together, these unique features allow us to examine a real-world bubble in ways normally possible only in the lab.

Using this data, we find that securities traded on the exchange exhibit the classic three-stage plateau pattern of an asset bubble: the price of the listed securities starts close to their fundamental values, then jump to and stay at a price level substantially above both their initial price and the contemporaneous retail

[6]For expositional simplicity, we hereafter refer to the average off-exchange retail asking price of a single unit of a collectible as both its "retail price" and the "fundamental value" of the associated NCPE security.

price of the collectible, and finally drop in price back to their fundamental value. At its peak, the price of a security listed on the NCPE was over *10 times higher* than the average retail price of the underlying collectible.[7] This large divergence between the retail price and the NCPE security price lasted nearly 4 years, with security prices converging to the retail price only after the government ordered the closure of all collectibles exchanges in China. While such deviations between the price of a security and the underlying asset may be due to differences between the security and the securitized asset (Lamont and Thaler (2003)), to the extent that such factors do not generate a value several times higher than the asking price of the securitized collectible itself, this divergence serves as clear and direct evidence of an extremely large and long lasting pricing bubble. The next question to be answered is why so many investors traded so often at such inflated prices for such a long period of time.

To answer this question, we examine the relationship between various factors and the size of the bubble, and compare the results to the predictions of several key bubble models. We find that the size of the bubble is highly responsive to the yield curve, exhibiting a strong and negative relationship with short term, but not long term, interest rates. This result is the opposite of that predicted by purely speculative bubble models (including the classic rational bubble (Gali (2014)), which predicts that the size of the bubble should increase with interest rates. However, this finding is consistent with resale-option bubbles where some individuals knowingly buy into a bubble and aim to resell the asset at an even more inflated price relative to someone else (Harrison and Kreps (1978), Scheinkman and Xiong (2003), Simsek (2010)). In this latter class of models, increases in the interest rate decrease the value of the re-sale option, thus reducing the size of the bubble. We further show that the size of the bubble is positively related to both contemporaneous turnover and volatility, and negatively related to the number of outstanding shares - a result

[7]The market price of a collectible is calculated by averaging the daily asking price of merchants at the two largest physical collectibles markets in China, along with the listed price among major on-line collectibles sellers.

again consistent with resale-option bubbles.

Next, we examine the market response to several events that provide plausibly exogenous changes to the trading environment. The first of these natural experiments is the introduction of retail prices for the securitized collectibles on the NCPE official website on August 21, 2014. Worried that the collectibles market was experiencing an unsustainable bubble after the initial run up in prices during the summer of 2014, the exchange started collecting and displaying the asking prices for the collectible by vendors at the Beijing collectibles marketplace, the Shanghai collectibles marketplace, and a set of online retailers. This information was prominently displayed along with other information about the security (i.e., open, ask, volume, etc.) on the exchange's website. The addition of this information did not appear to have a significant effect on either asset prices or trading volume. This finding is consistent with one of the key (and most surprising) findings of the experimental literature (see Smith, Suchanek and Williams (1998), Haruvy, Lahav and Noussair (2007), and Hussam, Porter and Smith (2008), among others): that bubbles can exist even when asset fundamentals are publicly (and costlessly) observable. Indeed, given that the information was collected and disseminated by the exchange itself, once the change was made it would require traders to exert effort to avoid knowing the fundamental price. In the spirit of the resale option hypothesis, we interpret the result as agents' belief that prices may not track the fundamental value due to psychological biases of others. This suggests that when each investor believes that others are irrational, the fundamental value of an asset becomes of secondary importance.

Our second natural experiment involves a change to the exchange listing rules on September 17, 2014 that greatly reduced the barriers to arbitrage. The newly introduced rule effectively allowed traders to securitize additional units of a collectible, thereby enabling them to arbitrage differences between the price of the security and the price of the underlying collectible. Unlike the publication of the retail price of the underlying collectibles, this change had a huge impact on the

exchange. Indeed, the announcement of this new rule leads to such a precipitous drop in the price of listed securities that the exchange quickly reversed itself and rescinded the rule change. The drop in prices was also positively related to the supply of the collectible outside of the exchange (i.e., the supply of the collectible not already securitized by the exchange and thus available to arbitragers). While the average security fell by nearly 60% in 8 days before the exchange rescinded the rule change, the two securities for which the majority of the underlying collectibles were already securitized increased in value by 77% and 84% respectively. This behavior is consistent with another key finding of the experimental bubble literature - short-sales constraints are pivotal to maintaining asset price bubbles. This result also provides empirical support for the decision of many bubble theories to focus on the role of short sale constraints (see for example Ackert et al. (2006),DeLong et al. (1990), Haruvy and Noussair (2006), and Shleifer and Vishny (1997)).

The third and final natural experiment was the surprise March 16, 2017 announcement by the China Securities Regulatory Commission (CSRC) ordering the closure of all collectible exchanges by June 30 of 2017. While the collectibles market had for some time been expecting the CSRC to begin to take a more active role in regulating the industry, the announcement that all collectibles exchanges were to close was largely unexpected.[8] The price of the securities listed on the NCPE began falling shortly after the announcement and continued to do so until the security prices converged with their fundamental values. This pattern is consistent with the resale bubble theory according to which the bubble component of the price should be an increasing function of future resale opportunities. The fact that this convergence happened, despite the presence of short-sale constraints and no known change in other factors that might create a wedge between the security and securitized collectible (e.g., storage costs), provides further evidence to support the importance of resale options in price bubbles.

One potential concern with the Chinese collectibles market is that it might

[8]See https://www.sohu.com/a/153172151_262784?p=wechat for a report. Accessed on June 15, 2022.

have been subject to market manipulation. Though we cannot directly rule out this alternative hypothesis, there are two pieces of evidence that suggest our results are not driven by such manipulation. First, to the best of our knowledge, there have been no lawsuits against either the NCPE or market investors for market manipulation in a country where such lawsuits are not uncommon. Second, assuming that market manipulation is easier in more concentrated markets, a positive relationship between ownership concentration and bubble size is expected. Instead, when we find a negative and statistically insignificant relationship between the two variables.

Overall, our results are difficult to reconcile with rational bubbles and bubble models with symmetric information. The fact that the fundamental value of the securities was public information also makes it unlikely that the bubble was driven by disagreements over fundamental values. Instead, consistent with anecdotal evidence,[9] we find the most support for the idea that the Chinese collectibles bubble was driven by heterogeneous beliefs about the value of the resale option, combined with limited arbitrage. That is, the Chinese collectibles bubble was caused by differences in beliefs about what other people may be willing to pay for an asset in the future *independent* of the asset's fundamentals. Or to quote Harrison and Kreps (1978), the collectibles bubble of the 2010s may be an example of "a *speculative phenomenon*... (where) an investor may buy the stock now so as to sell it later for more than he thinks it is actually worth".

Our paper contributes to a growing literature on collectibles as investments. Previous studies have investigated the relative performance of collectibles investment (compared to stock and bond investment) and the correlation between collectibles returns and stock market returns or other social and economic factors.[10] Building upon this literature we explore whether there exist collectibles bubbles,

[9] See for example https://www.sohu.com/a/45281542_335475, accessed on Aug 15, 2022

[10] Baumol (1986) shows underperformance of art investment, which is also confirmed in Pesando (1993) and Goetzmann (1993). Goetzmann (1993) finds a positive correlation between stock market and art investment returns. Mei and Moses (2002) construct a new data set of repeated sales of art paintings, estimate an annual index of art prices for the period 1875-2000 and find underperformance relative to stocks. Dimson and Spaenjers (2011) study investment performance

and what factors plausibly contribute to bubbles in the collectibles market. Our unique data allows us to estimate a plausible market price for the collectibles - something that, as made clear in Lovo and Spaenjers (2018) and Mandel (2009), is not generally possible for collectibles (and assets more generally).[11]

Our paper is also closely related to Xiong and Yu (2011), which examines a speculative bubble that occurred in China's warrant market between 2005-2008. Many of these warrants were so deep out of the money that they were "almost certain to expire worthless", thus their fundamental price was observable (i.e., zero). Specifically, the paper examines the market dynamics of 18 put warrants, with an average zero-fundamental value period of 48 days, to test the predictions of a number of different of bubble theories. The authors do not find empirical support for theories based on hedging need, rational bubbles, or agency problems. Instead, the results "highlight the joint effects of short-sale constraints and heterogeneous beliefs in explaining the price bubble across warrants and across time-to-maturity". We extend Xiong and Yu (2011) in several ways. First, the long lasting nature of the bubble (i.e., nearly 4 years), combined with the size and richness of our dataset allows us to directly test the impact of factors like the yield curve on bubble size. Second, we utlilize several natural experiments to more directly test the predictions of bubble models, including information frictions from the exchange's introduction of retail prices and the importance of short sale constraints.

The rest of the paper proceeds as follows. The subsequent section provides a history of the Nanjing collectibles Exchange and a description of the data used in the paper. Section 3 provides an overview of the collectibles price. Section 4

on stamps and find stamps offer higher return than bonds but lower return than equities, although after-cost returns on stamps might be comparable to equity investment for individual investors. Goetzmann, Renneboog and Spaenjers (2011) show both equity market and income inequality affect art prices. Luc Renneboog and Christophe Spaenjers (2012) show art collections offer similar returns to that of high-risk corporate bonds between 1957 and 2007. Lovo and Spaenjers (2018) build a dynamic auction model to explain trading and returns in the art auction market where art owner enjoys a private "emotional dividend" and they further provide empirical evidence consistent with their model predictions.

[11]Pesando (1993) compares prices of alternate copies of the same prints sold at Sotheby's and Christie's in New York and finds substantial evidence of violation of the "law of one price" during the period 1977-1992. Using more detailed data, Mei and Moses (2002) provide mixed evidence that the "law of one price" is violated in the New York art auction market.

describes the market dynamics. Section 5 analyzes the natural experiments present in the data. Section 6 concludes.

## 2. Nanjing Collectibles Exchange

Starting in October 2013, the Nanjing Cultural Products Exchange (NCPE) was the largest and best known of the many collectibles exchanges that operated in China during the 2010s. While there are no official statistics on the number and size of this collectibles market, contemporaneous newspaper reports suggest that the collectibles market was quite large with approximately 168 alike exchanges operating in China during the 2010s.[12] Collectibles trading was popular and widespread among Chinese retail investors - the NCPE opened over 3,500 retail locations for individuals to open and manage their accounts. In theory, exchanges like the NCPE are under the jurisdiction of the China Securities Regulatory Commission (CSRC). In fact, these exchanges were initially only lightly and jointly regulated by local governments and the Bureau of Finance (a subunit of the People's Bank of China).

The collectibles exchanges exhibited considerable variations in their business models. Specifically, some exchanges served as intermediaries connecting individual sellers with buyers, while others, most notably the Tianjin Cultural and Art Exchange, would divide unique artwork into millions of shares. In contrast, the NCPE focused exclusively on liquid and divisible assets belonging to one of the following categories: coins and banknotes issued by Chinese banks, stamps and collectible pre-stamped postcards issued by China Post, and collectible calling cards issued by China Telecom. To differentiate itself from the many physical and online marketplaces for collectibles, the NCPE styled itself after more traditional securities exchanges, going so far as to call the initial listing of securitized collectibles as an initial public offering (IPO) and the securitization of additions units as a secondary equity offering (SEO).

To list on the exchange, an individual would provide the NCPE with a set of

[12] https://www.tianfucaijing.com/news/106806.html, accessed on Aug 15, 2022

identical collectibles with a combined market value of at least two million RMB for banknotes (at least one million RMB for other collectible types). The exchange would then have the collectibles set appraised and authenticated, at a cost of no more than 2% of the collectibles' retail price. If the listing were approved, the exchange would store the collectibles in a secure location and issue the owner of the collectibles securities equal in number to the number of collectibles stored by the exchange. The collectible set would then go through an "IPO," after which the securities could be bought and sold on the exchange. Essentially, the exchange combined storage service with a platform that allowed individuals to buy and sell collectibles stored by the exchange. In addition to a one-time listing fee, the exchange made money by charging a one-time fee for secure storage of the collectibles in perpetuity, as well as a small transaction fee for trades conducted on the exchange.[13] While traders could redeem securities for units of the underlying collectible at any time fee free, such redemptions were quite rare.[14] Similar to Shanghai Stock Exchange, NCPE sets the daily price ceiling and price floor at 10% and -10%, respectively (the number is 30% for any security on its IPO day).

### *2.1. Natural Experiments*

During the operation of the NCPE, there were three events that provide insights regarding the economic mechanisms behind the collectibles bubble. The first was the addition of the retail price of the securitized collectibles to the exchange's website. Starting on August 19, 2014, the exchange began collecting and disseminating this information through its website. Even though the price of the securitized collectibles was public information, this change greatly reduced investors' cost of searching for this information.

[13]The listing fee, which includes the cost of authentication, varied between 0.5% to 5% of the IPO value (i.e., initial price of the security times the number of securities). The storage fee varied depending on the collectible, but never exceeding 2% of the IPO value. Transaction fees, which are discussed in detail in section 4.3, varied between 0% and 0.3% of the sale price.

[14]While we do not have transaction level data for redemptions, we analyze the decreases in the outstanding shares of each security across trading days. In our data, there are a total of 462 occasions where the number of units of a security drops from one day to the next out of a total of 130,059 security by day observations.

The addition of the retail price of the securitized collectibles was implemented in response to an increase in both the trading volume and the price of the securities. The exchange was concerned that they were at the start of an unsustainable bubble, which could harm the long term prospects of the market and potentially lead to undesired attention by the CSRC. Consequently, (off-exchange) retail prices were introduced to the site to help "cool" the market and prevent prices from rising too far above the retail price.

Prices were collected daily by NCPE at both physical retail markets and online. Specifically, the NCPE would collect the average asking prices for the collectible among sellers at the Lu Gong Coin and Stamp market in Shanghai, the Madian Coin and Stamp market in Beijing, and from several popular Chinese websites for purchasing collectibles (e.g., JD.com and taobao.com). The prices at each of these three locations, as well as a "reference price" of 130% of the average of the Shanghai, Beijing and online prices, were displayed on the website along with other information about the security (e.g., most recent transacted price, volume, etc.). We highlight that NCPE adds the 30% "markup" onto the average retail price to reflect the appraisal cost, authentification costs, storage costs and IPO costs. In addition, if the 5-day average price of a security was more than double the reference price, the exchange would flag the security with a "risk warning".

The second event we examine was a change to the SEO process that greatly decreased the arbitrage barriers. Originally, only current shareholders with the approval of 60% of the existing shares could initiate an SEO. On September 17, 2014, the NCPE announced that anyone could issue SEO without approval from existing shareholders as long as the 5-day average trading price is 50 percent higher than the reference price. After the announcement, the exchange index dropped for seven consecutive trading days for a cumulative loss of 32.8% until September 25, when the NCPE announced that the Sep 17, 2014 rule was rescinded. On the day of the annoucement, the market index increased in value by 10% and by more than 9% the following trading day.

The final event we examine is the scheduled shutdown of all collectible exchanges in China. On January 9, 2017, a meeting to discuss the clean-up and rectification of exchanges (mainly collectibles exchange this time) was held by the China Securities Regulatory Commission in Beijing. Although it was suspected that Beijing might put more stringent regulations on the collectibles exchange, no formal regulatory files were released from this meeting. On March 16, 2017, the CSRC formally released the "No. 31 file" in which they announced that all collectible exchanges in China were to stop operating by June 30, 2017.[15] After the announcement, prices on the exchange fell with security prices converging to the average retail price of the associated collectible in early June, before rising during last few weeks of the market operation.

## 3. Data on China's Collectibles Bubble

The core of our data was collected from the NCPE website. For each trading day, we have screen shots of the information screens for the NCPE index and for each security traded on the NCPE. We then manually process the data using two pass verification. The data consists of all 196 collectibles traded on the exchange throughout the exchange's entire operations from October 21, 2013 to June 30, 2017. The data includes opening price, closing price, daily high, daily low, trading volume, number of shares listed, and retail prices of the securitized collectible starting on August 19, 2014. In addition, the information on the securitized collectibles includes producer, total number of units produced, and the collectible type. Further, the data on the yield curve is obtained from the China Stock Market and Accounting Research Database (CSMAR).

Summary statistics for the traded securities are presented in Table 1. There are four types of collectibles listed on the exchange: coins and banknotes (N=62), stamps (N=60), collectible pre-stamped postcards (N=61), and collectible telephone cards (N=13). During the period for which collectible price data are available,

[15] See https://www.waizi.org.cn/law/19748.html for the full text of this regulation. Accessed on May 25, 2022

securities listed on the exchange traded for nearly 4 times the average retail price of the underlying collectible. Daily turnover for securities on the exchange averaged 7.4%, or approximately fifteen times greater than that of stocks listed on the New York Stock Exchange and three times more than A-share stocks on the Shanghai stock exchange (Mei, Scheinkman, and Xiong (2009)).

Figure 1 plots the daily closing price and trading volume of the NCPE index for the life of the exchange. The index stayed relatively flat for the first nine months, increasing in value by "only" 56.5%. Then, starting in July 2015 the index rapidly increased in value with gains in excess of 3,000% over the next year. The high levels of daily volatility exhibited by the index, indicates that the market responds to something other than changes in asset fundamentals. That is, because information with the potential to significantly affect the value of the underlying collectibles occurs infrequently (e.g. a large number of stamps destroyed by fire or a previously unknown cache of collectible coins were found), the observed volatility in prices are difficult to reconcile with the efficient market hypothesis.

### *3.1. Table Tennis Commemorative Coin*

To illustrate a security traded on the exchange, we discuss the history of NCPE security number 802001. On Nov 8, 2002 the Bank of China released a one ounce sterling silver coin to commemorate the 50th anniversary of the establishment of the Chinese national table tennis team (see Figure 2). 50,000 pieces were minted by the Shenzhen National Treasury Gold Coin Manufacturing Factory and distributed by the China National Gold Coin Corporation at an initial price of 200 RMB. On October 21, 2013, security 802001 was listed on the NCPE with 2013 shares, where each share gives the holder the right to one of the 2013 one ounce sterling silver commemorative coin.

Figure 3 plots the daily closing price of security 802001, and the daily retail ask price for a single Table Tennis Commemorative Coin at retailers in Beijing, Shanghai and online. As is typical for the collectibles in our data, the retail asking price for

the Table Tennis Commemorative Coin is very similar across the three markets (Beijing, Shanghai and online), with the online market price usually slightly lower than that at brick-and-mortar sellers. Physical market and online prices are also much sticker than the securities price, changing on average once every 2-3 weeks.

Close to a year after it was initially listed, the security was sold at a value very similar to the retail price of the Table Tennis Commemorative Coin. However, starting in August 2014, the price of the security rapidly increased and to a level several times higher than the asking price of the identical item outside the exchange. The price of security 802001 eventually peaked on March 8, 2016 at 98,000 RMB per share, or well over 20 times the average contemporaneous retail price of a Table Tennis coin outside the exchange. The overvaluation lasted for a period of three years, falling back to the retail price of the coin after the CSRC ordered the closure of all collectible exchanges. The price of the collectible then continued to trade close to the retail price until the exchange permanently closed on June 30, 2017. The observed pattern closely matches the time series aspect of asset price bubbles in lab experiments (e.g., Smith, Suchanek and Williams (1998)): an initial boom phase, followed by an extended period during which the security price greatly exceeds the fundamental value, and then followed by a collapse in price.

The difference between the price of the security and underlying collectible is striking not only due to its size and duration, but also because the ease of locating the fundamental value from public information (i.e., the retail price of the collectible). This simplicity is in stark contrast to other financial assets, where valuing of an asset from publicly available information requires considerable effort, needs sophistication, and involves uncertainty.[16]

In the following section, we analyze the daily data on the table tennis coin and the 195 other securities traded on the NCPE.

[16]For example, Xiong and Yu (2011) note that "Although investors can observe the current stock prices, valuing the deep-out-of-the-money put warrants requires a nontrivial assessment of the stocks' future tail distribution."

## 4. Market Dynamics and Bubble Size

In this section, we first explore the existence of a price bubble and then examine the extent to which the market dynamics are consistent with the predictions of different bubble models.

The price of asset at time $t$ can be expressed as

$$p_t = v_t + b_t, \tag{1}$$

where $v_t$ is the assets fundamental value and $b_t$ is the bubble component of price. This equation demonstrates the difficulty of empirically testing for bubbles in the field. Specifically, when the fundamental value $v_t$ is not observed, any empirical test becomes a joint test a model of a model of fundamental value ($v$) and the bubble ($b$).

To date, there are only two papers have attempted to directly tackle this empirical concern in the field. First, Xiong and Yu (2011) examine a small number of Chinese put warrants that are so far out of the money, thus the fundamental value (based on stock prices) can be reliably determined to be effectively zero. Second, Giglio, Maggiori and Stroebel (2016), use differences in prices between houses with extremely long run, but finite maturity, leaseholds and perpetual leaseholds (i.e., freeholds) to eliminate the fundamental value component of price. Specifically, the authors argue that given the extreme length of the leaseholds (e.g., in excess of 700 years), the fundamental value of the asset post leasehold expiration is effectively zero. Hence, to the extent that one can match houses based on other observable characteristics, any difference observed in prices between leaseholds and freeholds can be attributed to the present value of the bubble component (i.e., failures of the "transversality condition:" $lim_{n\to\infty} b_t = 0$.)

In our case, since the market price of the securitized collectible is observable, we have a reliable measure of the fundamental value of the associated security. Specifically, we assume that the fundamental value of a security on the exchange is

given by the equation

$$v_t = m_t + \xi_t, \tag{2}$$

where $m_t$ is the contemporaneous (off-exchange) retail price of the collectible and $\xi_t$ are pricing differences caused by differences in trading frictions, storage costs, etc. associated with holding a security vs. a physical asset. The bubble component of price $b_t$ can then be written simply as

$$b_t = p_t - m_t - \xi_t. \tag{3}$$

Since we observe both $p_t$ and $m_t$, the only unobservable in the equation is $\xi_t$, which can be decomposed into fixed and time varying components:$\xi_t$=$\xi_{fixed}$+$\varepsilon_t$ .While we cannot control for all the possible differences between an collectible and its securitized equivalent, in this instance, $\xi_t$ is likely to be both small relative to $m$ and also slow to change. For example, one potential component of $\xi_t$ is the authentication and storage costs charged by the exchange. Though we are unable to measure the average market price of those services during the sample period, the NPCE charged a one-time fee of no greater than 2% to authenticate and list the collection, and no more than 2% of the *initial* price of the security for perpetual secure storage. Thus in comparision to the price of the security, the value of $\xi$ due to these fees is small (2%) and essentially fixed.

Under the assumption that the differences in a security price and the price of the securitized collectible is fixed (i.e., $\xi_t$=$\xi_{fixed}$), we test the existence of a bubble using the following regression:

$$Bubble_{i,t} = \alpha + FE_i + \epsilon_{i,t}, \tag{4}$$

where $Bubble_{it}$ is the difference between the closing price of security $i$ on date $t$ minus the average retail price of the associated collectible divided by the average retail

price of the collectible, and $FE_i$ are security fixed effects to absorb the time-invariant component of $\xi$. Standard errors are two-way clustered on date and security.

The regression results are presented in Table 2. We find that during the sample period, the bubble component made up nearly 75% of the total security price (i.e., the security price was four times higher than fundamntal price). Given the magnitude of this result, both $\xi$ and the variation in $\xi$ over time are likely to constitute a negligible component of the difference in price between the traded securities and the price of the securitized collectible.

We next aim to understand the nature of this bubble by examining the response of $Bubble_{i,t}$ to cross sectional and time series variations in a number of factors central to varies theoretic models of bubble formation.

### *4.1. Interest Rates*

A key prediction of the bubble models documents the relationship between the size of a bubble and interest rates. The purely speculative bubbles, such as the classic rational case (Gali (2014)), predict that bubble size increases with interest rates, while models analyzing a resale-option bubble predict the opposite (Harrison and Kreps (1978), Scheinkman and Xiong (2003), Simsek (2010)). Intuitively, bubbles based on pure speculation increase with interest rates, as such bubbles grow in expectation together with the interest rate. In contrast, according to a resale-option bubble, the bubble is caused by the belief of some investors that they will be able to sell an overpriced asset to someone else at an even higher price later on. The value of the asset is then tied to future resale cash flows, so the size of a resale-option bubbles will be decreasing with increased interest rates due to the diminished value of the future cash flows.

To determine the relationship between bubble size and interest rates, we regress the size of the bubble on the yield of China Government Bonds (CGB) for different

maturities, using the regression equation below:

$$Bubble_{i,t} = \alpha + CGB\ Yield_t\beta_1 + X_{i,t}\gamma + FE_{i,t} + \epsilon_{i,t}. \tag{5}$$

$Bubble_{it}$ is defined as the closing price of security $i$ on date $t$ minus the average retail price of the associated collectible on date $t$ divided by the average retail price of the collectible. $CGB\ Yield_t$ is the yield for CGB bonds on date $t$. $FE_{it}$ are security, day-of-week, week-of-year, and year fixed effects. Standard errors are 2-way clustered on date and security.

The results of this regression are shown in Table 3. Column 1 regresses the overnight bank lending rate against the size of the bubble component of the price and shows a significantly negative relationship. The magnitude of the coefficient indicates that a one percent increase in the overnight lending rate is associated with a decrease in the size of the bubble of 0.17 standard deviations. We find similar coefficient estimates when using the one-quarter, half-year, one-year, ten-year and 30-year yields for Chinese government bonds, though the results are not statistically significant for the ten-year and 30-year rates (columns 2-6). Overall, the negative relationship between interest rates and the size of the price bubble is inconsistent with speculative bubbles, but consistent with resale bubbles.

Given the correlation between interest rates at different maturities, in column 7 we regress the size of the bubble simultaneously against the bond rates at all maturities. While we again find a negative relationship between short maturity yields and bubble size, the role of maturity in this relationship become even stronger. While in unitary regressions the relationship survived for maturities up to one year, here the significant relationship only exists for the two shortest maturity periods. Overall, the pattern is the opposite of what one would expect with speculative bubbles, in which the value of the bubble component would be dominated by the long run interest rate. With respect to resale theory, the results imply that the relevant (resale) time horizon is quite short and on the scale of days to weeks and not months or years.

### 4.2. *Turnover, Volatility, and Floatation*

Next, we examine the relationship between bubble size and several factors that play a prominent role in bubble models. Specifically we examine the relationship between bubble size and turnover, volatility and floatation by running the following regression:

$$Bubble_{i,t} = \alpha + \beta_1 Turnover_{i,t} + \beta_2 Volatility_{i,t} + \beta_3 Flotation_{i,t} + FE_t + \epsilon_{i,t}. \quad (6)$$

$Bubble_{it}$ is the difference between the price of the security $i$ on date $t$ and the contemporaneous retail price of the associated collectible, scaled by the retail price, $Turnover_{it}$ is the number of shares of $i$ traded on date $t$ divided by the number of outstanding shares in this exchange, $Volatility_{it}$ is the daily price volatility of security $i$ on date $t$, $Floatation_{it}$ is the number of tradable share of security $i$ on date $t$, and $FE_t$ are security, day-of-week, week-of-year, and year fixed effects.. Standard errors are 2-way clustered on date and security.

Columns 1-3 of Table 4 examine the relationship between bubble size and turnover, volatility, and flotation respectively, while in column 4 we combine all three into a single regression. The relationship between these three variables and bubble size were previously examined in Xiong and Yu (2011) where the authors test the predictions of the resale option hypothesis. We replicate the analysis in Xiong and Yu (2011) to examine whether the size of the bubble is positively correlated with trading volume and price volatility, and is negatively related to the number of tradable shares, as predicted by Scheinkman and Xiong (2003) and Hong, Scheinkman, and Xiong (2006) respectively.

We find that the relationship between bubble size and turnover is positive (column 1) and is largely unaffected by the inclusion of volatility and flotation (column 4). These results are similar to those of Xiong and Yu (2011), who finds a positive and statistically significant relationship between turnover and bubble size, consistent with models of heterogeneous belief bubbles (Scheinkman and Xiong

(2003)). Turning to volatility, and again consistent with resale theory, we find a positive relationship between volatility and the size of the asset price bubble (column 2) and this relationship is robust to the inclusion of turnover and flotation (column 4). Finally, columns 3 documents a negative relationship between the number of outstanding shares and the size of the bubble, though the coefficient is only statistically significant at the 10% level. This result is again consistent the predictions of models of resale bubbles.[17]

### *4.3. New Investor Flow*

The idea of non-common knowledge of rationality is central to some theories of bubble (Smith, Suchanek and Williams (1998)). Given that the collectibles bubble lasted for years and only burst when the government announced the closure of the market, an obvious question is why learning by investors did not burst the bubble over such a long time horizon. One possibility suggested by the literature is the importance of inflows of new investors in maintaining the price bubbles.

As data on the number of new investors are not available, we collect data on the number of new retail locations opened by the NCPE to proxy new investor flows. Specifically, the data, collected from documents released by the NCPE, contain the number of newly opened physical retail locations every month.[18] During the 42 month period for which the data is available, the NCPE opened an average of 84 retail locations each month. While the retail offices assisted existing customers with some service related issues, the main purpose was to assist individuals with opening new individual trading accounts. As such, we believe that the number of new offices opened in a given month is a plausible proxy for the number of new NCPE traders.

We examine the relationship between turnover and the number of new office openings to assess the suitability of new retail locations as a proxy for new investors.

[17]The difference in statistical significance between Xiong and Yu (2011) and our results might be due in part to the different econometric framework. Specifically, when we adjust our standard errors for heteroskedasticity and date as in Xiong and Yu (2011), we generate P-values of $<0.001$ for our coefficients of interest.

[18]For the first three trading months of the exchange, we are unable to find the monthly number of newly opened retail locations.

If newly opened retail locations proxy for new (and on average more naive) investors, they should be associated with an increase in turnover. To check if this relationship holds, we run the following regression:

$$Turnover_{i,t} = \alpha + \beta_1 Newbranch_t + FE_i + \epsilon_{i,t}, \tag{7}$$

where $Turnover_{i,t}$ is the total turnover of security $i$ in month $t$, $Newbranch_t$ is the number of new retail locations opened by the exchange in month $t$, and $FE$ are security fixed effects. Standard errors are clustered by security and month.

The regression results are shown in columns 1 and 2 of Table 5, and confirm that there is indeed a positive and statistically significant relationship between the number of new retail locations and turnover. In terms of magnitude, for every 10 additional retail locations opened per month, the monthly trading volume increase varies between 2.9% and 4.6%, depending on the specification. To the extent that new customers ought to increase trading volume, this result provides supporting evidence for the use of new retail office openings as a proxy for the number of new investors. Column 2 repeats the analysis, but includes the number of newly opened retail locations in previous month and two months prior. Again we find a significant increase in trading volume associated with new retail locations. But there is no significant relationship between the previous month openings and trading volume, suggesting that increases in trading volume due to retail location openings are relatively short lived.

We next turn to the relationship between our proxy for the number of new investors and bubble size by repeating the regression in column 1, but with monthly returns as the dependent variable. The results of this analysis are presented in columns 3 and 4, and indicate that the number of new branches is positively related to monthly returns. Again this relationship is limited to concurrent openings, as the coefficient for lagged number of openings is negative and statistically insignificant.

Finally, in columns 5 and 6, we compare the size of the bubble to the number of new retail locations. The results indicate that the number of new branches is

positively related to the size of the asset price bubble, though the relationship is again limited to concurrent openings.

Taken together, these results indicate that new traders are an important factor in the creating and maintaining the collectibles bubbles. Moreover, the fact that lagged openings do not contribute to either trading volume or bubble suggests that the effect of new users is most pronounced in the period immediately after opening their accounts.

### *4.4. Momentum and Riding the Bubble*

We next turn to examining whether investors could have profitably exploited momentum strategies during the collectibles bubble. We test this by examining the performance of a portfolio made up of buying past winners (or losers) for different holding periods by running the following regression:

$$RET_{i,t} = \alpha + \beta Winner_{i,t-1} + \epsilon_{i,t}, \tag{8}$$

where $Winner_{i,t}$ takes a value of one if the returns for security $i$ for period $t$ are higher than the median return for that period. The coefficient $\beta$ can then be interpreted as the returns from buying previous winners, while $\alpha$ is the return from buying previous losers. Standard errors are two-way clustered on period and security.

Table 6 reports the results of this regression for return horizons of a day, week, month, quarter-year and half-year, respectively. The coefficient for $Winner_{i,t-1}$ is positive and statistically significant for holding periods of a month or less. While the presence of positive momentum profits does not completely rule out the presence of rational arbitragers choosing to ride a bubble (Abreau and Brunnermeier (2003)), it does indicate that it would have been profitable for additional momentum traders to ride the bubble for those shorter return horizons.

The coefficient estimate of the regression constant $\alpha$, which is the performance of the loser portfolio, is negative and statistically significant only for a holding

period of a day, indicating that shorting losers would have been profitable only for the shortest holding period. We note that given the inability to short securities on the exchange, the fact that shorting the loser portfolio was not profitable for holding periods of a week or more is not due to short selling, but is instead a feature of the bubble itself.

### *4.5. Ownership Concentration*

In October 2016, three years after establishment, the NCPE began releasing information on ownership concentration. Each quarter, securities are classified into 6 groups based on the share of each security owned by the ten largest shareholders: less than 30%, 30 to 40%, 40 to 50%, 50 to 60%, 60 to 70% and more than 70%. As ownership concentration affects factors such as coordination that plays a role in some bubble theories, we examine the relationship between concentration and bubble size, returns and turnover using the following regression:

$$Outcome_{i,t} = \alpha + \beta_1 Concentration\ Rank_{i,t} + FE_{i,t} + \epsilon_{i,t}, \tag{9}$$

where $Outcome_{i,t}$ is either the average size of the bubble, total return, or total turnover for security $i$ in quarter $t$, $Concentration\ Rank_{i,t}$ is a number from 0 to 5 corresponding to increasing levels of ownership by the top 10 largest shareholders (e.g., 0 if the category is less than 30% and 5 if the category is greater than 70%), and $FE$ are security fixed effects. Standard errors are clustered by security and quarter.

The results of this analysis are shown in Table 7, and show that increased ownership concentration is not correlated with the size of the bubble (column 1), is positively correlated with returns at a marginal level of statistical significance (column 2), and is strongly and negatively correlated with turnover. These results suggest that while ownership concentration may decrease overall trading volume, it is at best weakly correlated with the size of the bubble. Even though high ownership concentration increases the ability of a small number of traders to influence the

price either directly or by coordinating their actions, these results suggest that such behavior is not a significant contributing factor in the size or persistence of the collectibles bubble. This finding is also consistent with the idea that the collectibles bubble is driven by a large number of retail investors, and not caused by the actions of a small number of large investors.

## 5. Natural Experiments

A key limitation of any analysis of market dynamics, including those done in the previous sections, is the difficulty in establishing causal relationships between the variables of interest. To mitigate these concerns, we exploit three natural experiments that provide plausibly exogenous changes to the trading environment.

### *5.1. Provision of Security Fundamentals*

On August 21, 2014, the NCPE began disseminating retail price information for collectibles traded on the exchange, in response to the concern that the rapid rise in prices represented a bubble that would be detrimental to the long term stability of the exchange. The exchange collected prices from a number of vendors in Beijing, Shanghai and online on a daily basis, and published the average retail asking price at each of these locations on the exchange website.

While the information on retail prices was publicly availably prior to the change, the inclusion of the information on the NCPE website reduced the cost of information acquisition. Indeed, one could reasonably argue that once the retail prices of collectibles were incorporated into the exchange's website, it took more effort for a trader to avoid learning the retail price of a collectible than to learn it. Consequently, if disagreements about the fundamental value of securities resulting from differences in information acqusition costs were a significant driver of the bubble, the publication of retail prices by the NCPE should help deflate the bubble.

Figure 4 plots the daily closing price of the NCPE index around the time that the exchange began displaying the market value of the collectibles. At the

time the exchange began disclosing retail price information, the average security on the NCPE was trading at 1.8 times the retail price of the underlying collectibles, indicating the presence of a substantial bubble. And while the sudden increase in prices prompted the exchange to include retail prices is evident, the disclosure of retail prices appears to engender no change in the price trajectory. As benchmark prices prior to their collection by the NCPE are available, we cannot directly test whether there was a change in the size of the bubble following the introduction of benchmark prices to the site. But the relatively infrequent changes to retail prices of collectibles during the period immediately following the publication of retail prices, combined with the lack of a break in the pricing pattern around August 21, 2014, indicates that a discrete drop in bubble size subsequent to the disclosure of retail prices did not exist. Moreover, in the weeks following the introduction of benchmark prices, the average ratio of exchange price to retail price increased on each trading day growing from 1.80 to 2.02.

Consistent with Figure 4, the local linear regression discontinuity estimates show no evidence of a discrete change in prices, volatility, or trading volume around the introduction of benchmark prices (Appendix Table 1). This lack of response indicates that the knowledge of the fundamental price was an inconsequential factor in investor decision-making.

Notably, and unlike in most situations, the incorporation of publicly observable information into the value of the security in our setting is trivial[19] (e.g., Xiong and Yu (2011) note the inherent complexity in pricing far out of the money options). As such it is unlikely that the variations in investor sophistication result in different beliefs arising from common information. Together with the response (or lack thereof) to the introduction of retail prices of the securitized collectibles, the result indicates that the bubble was not driven by differences in beliefs about the fundamental value of the traded securities.

[19]Indeed, with the exception of transportation and storage costs, the two should have a one-to-one correspondence.

### 5.2. *Changes to Barriers to Arbitrage*

Given the large wedge between the prices of the listed securities and the underlying collectible, one obvious question to ask is why these differences were not arbitraged away. First, as is generally the case in China, short selling was not allowed on the NCPE, preventing investors from directly short the exchange traded securities. In addition, exchange listing rules prevented most investors from arbitraging the difference between the price of a security and the retail price of the underlying collectible by purchasing the collectibles on the open market (i.e. from brick-and-mortar dealers or online sellers) and then listing them on the exchange (i.e., conducting a secondary equity offering or SEO). Specifically SEOs were only allowed if the 5-day average security price exceeded the fundamental price (the average of the price of the commodity in Beijing, Shanghai and online) by at least 95%, and if new shares to constitute less than 30% of outstanding shares. The key restriction though was that SEOs required the approval rate of 60% from existing shareholders, which blunted the arbitrage incentive by increasing supply, since the option was only available to the investors who would have to bear the cost of correcting the mispricing.

The second natural experiment we utilize is a change in SEO policy implemented by the exchange that greatly increased the ability of investors to arbitrage exchange traded securities. In late summer of 2014, the exchange decided to remove the restrictions on SEOs, allowing anyone to issue additional shares of a traded security without the supermajority approval from existing shareholders. This change effectively allowed all traders to arbitrage the overvaluation of securities by purchasing collectibles in the open market and then converting collectibles to exchange traded securities.

The change was first announced to the public without much fanfare via the exchange's press release "No. 2013243: A circular on SEOs of trading products". The press release was issued in the afternoon of September 17, 2014. The market index, which had previously been trading at an all time high, promptly crashed

6.4% on the day of announcement and over 9.1% the next trading day. The market index continued to fall for seven consecutive trading days until September 25, when the exchange announced it was repealing the rule changes made on September 17, 2014.

Figure 4, which plots the daily closing price of the index, clearly shows the drop in price that occurred immediately after the rule was announced and the increase in price once the rule was rescinded. Appendix Figure 1a and Appendix Table 2 panel A show the result of a regression discontinuity analysis on daily return for securities around the rule change. In the figure, the large and statistically significant drop in average daily returns pre vs post announcement is apparent. Appendix Figure 1b and Appendix Table 2 panel B repeat this analysis around the rescindment, and find a large discrete positive increase in average daily returns. Significantly, no SEOs occurred between the announcement of the rule change and its rescindment, suggesting that investors were responding purely to the threat of arbitrage, and not to an actual increases in supply.

To further test the effects of arbitrage on bubble size, we exploit the fact that in order to arbitrage overvalued NCPE listed securities, traders need to acquire additional units of the securitized collectible. As an extreme example, if the entire supply of a collectible is already securitized on the NCPE, then no threat of arbitrage exists post the rule change. We then explore the variation in external supply to test whether the drop in price is in fact related to the threat of arbitrage engendered by the rule change. Specifically, the impact of the rule change should be positively related to the supply of the commodity available on the open market. While we do not know the exact number of collectibles available for purchase at that point in time, for all but one of the collectibles listed on the exchange during this transition period, we have data on the total number of each collectible produced. We then combine this number, which is the upper bound of the total number of collectibles available for purchase, and the number of units already securitized on the exchange to construct a measure of the supply of collectibles available to potential arbitragers.

To analyze the interaction between the supply of a commodity outside the exchange with the price crash, we run the following regression

$$Bubble_i = \alpha + \beta_1 Supply_i * Post_t + \beta_2 Post_t + \gamma Supply_i + FE_{i,t} + \epsilon_i, \qquad (10)$$

where as before $Bubble_{i,t}$ is defined as the closing price of security $i$ on date $t$ minus the average retail price of the associated collectible on date $t$, divided by the average retail price of the collectible, $Supply_i$ is the share of the collectible not securitized on the exchange ((total quantity produced - total quantity securitized on exchange)/total quantity produced), $Post$ is a dummy equal to one if the date is on or after September 17, 2014, and $FE_{i,t}$ are security and date fixed effects. Standard errors are clustered by security and date. The post-period consists of the seven trading days between the new SEO rule was announced and the rule was rescinded, while the pre-period consists of the seven trading days before the annoucement. In results not tabulated, we find that increasing the length of the pre-period does not meaningfully affect the main results.

The regression results with and without different sets of fixed effects are shown in Table 8 Across all three specifications, $\beta_1$ is negative, indicating that the attenuation of the price bubble was larger when collectibles were readily available for purchase outside the exchange. That is the easier a security was to be arbitraged, the more the bubble would burst. We also find that the coefficient estimate is largely unaffected by the inclusion of date fixed effects or when date and security fixed effects are included in the regression (column 3). This indicates that, following the rule change that allowed individuals to effectively arbitrage listed securities, collectibles that were readily available outside of the exchange experienced bigger losses of value.

The coefficient for the Post dummy itself though is positive in Column 1, indicating a price increase for securities that already represent a high share of the total existing collectible supply. Epitomizing this relationship was the case of the two of the securities for which a super majority of the produced collectible

(84% and 95% respectively) were securitized on the exchange. Given that there were not likely many units of either collectible available on the open market, these two securities were largely unaffected by the threat of arbitrage even after the rule change. As such, while the average NCPE listed security saw the bubble component of their price drop by over 59% between September 16 and September 24, these two securities experienced gains of 77% and 84% respectively. Indeed, the extreme size of these gains is suggestive of a "flight to safety," with investors demanding exchange traded securities that were essentially immune to this form of arbitrage.

Together, these findings provide strong evidence of the important role of arbitrage plays in asset bubbles, as changes to the ability to arbitrage lead to large and immediate effects on asset price bubbles in the direction predicted by theories.

### *5.2.1. Closure of Exchange*

The final natural experiment we examine is the unexpected announcement by the China Securities Regulatory Commission (henceforth CSRC) on March 16, 2017, ordering the closure of all collectible exchanges in China by June 30, 2017.[20] Prior to this regulatory announcement, traders could have reasonably assumed that the opportunity to trade collectibles securities would last indefinitely. Afterwards, investors were aware that trading would end on June 30th, 2017, and securities owned would be converted to the underlying collectibles. Thus, this change in trading horizon provides another opportunity to better understand both investor beliefs and the economic mechanism behind their trading behavior.

Specifically, while trading physical collectibles entails high transaction and storage costs, and these costs are relatively low compared to the fundamental value of the collectible. As such, if the exchange prices reflected investor's beliefs about the true fundamental price of the collectible, the closure of the exchange should have only modest effects on the size of the bubble. That is if the bubble was an artifact of stale or incorrect collectibles prices, the conversion of the security to the underlying

[20] See https://www.waizi.org.cn/law/19748.html for the full text of this regulation. Accessed on May 25, 2022

asset should not have a significant effect on the price of the security. Alternatively, as posited by resale theory, investors buy overvalued securities to resell the security for a profit, then prices should fall to the fundamental value when the number of resale opportunities decreases.

Figure 5 plots the average ratio of security price to retail price for the period shortly before the announcement that all art and collectibles exchanges were to close (March 16, 2017) to the required closing date of the exchange (June 30, 2017). In the weeks prior to CSRC closure announcement, the average security on the NCPE was trading at approximately two and a half times the retail price of the underlying commodity. Starting shortly after the announcement, that ratio dropped steadily until June 9 when it reaching an all time low of 0.79, after which the ratio began to steadily increase reaching a value of 1.54 on June 30, 2017 - the last day of trading. The convergence of the price of the security to the average retail price of the security is consistent with resale theory, as the investors appear to know the fundamental value of security (i.e., the value of the securitized collectible). [21]

To further test the resale hypothesis, we compare the abovemented crash to the one caused by changes to ability to arbitrage by investors. The resale hypothesis predicts that the closure of the market would affect all securities equally, and not be related to the supply of collectibles outside the exchange. Thus, if this crash is triggered by closure of the market which would mandate all investors to redeem their securities, and that investors' beliefs that the retail price was approximately the true market value of the collectible, then the share of the collectible securitized on the market should not differentially drive the decrease in prices. That is, in response to forced conversion of the securities to the physical collectibles, the price of the security is expected to converge to the price of the collectible.

We re-estimate regressions in Table 8 using security prices from January 1, 2017 to the market's last day of trading on June 30, 2017, with the *Post* dummy

[21] The increase in security prices in late June was likely due to the fact that traders became increasingly uncertain as to whether the NCPE would in fact close. See for instance, `https://www.sohu.com/a/153172151_262784?t=1501855609587`.

equal to one for dates after March 16, 2017 (i.e. the date on which the CSRC announced the closure of the exchange). The results of this analysis are presented in Table 9. Consistent with the resale hypothesis, they show a markedly different pattern of results from the analysis of the SEO rule change. Specifically, while the coefficient estimate of $Supply_i * Post_t$ was negative and statistically significant across all three regression specifications in Table 8, in Table 19, the coefficient estimates are statistically insignificant across all specifications. Overall, the results indicate that the crash following the change in the SEO rules was mediated by the supply of the collectibles available to arbitragers, but the supply had no significant impact on the crash caused by the announced closure of the exchange.

## 6. Conclusion

In this paper, we use a unique hand-collected dataset from the largest Chinese collectibles exchange to study Chinese Collectibles bubble in the 2010. The existence of a robust collectibles market outside the exchange allows us to overcome a key obstacle in the empirical study of real-world bubbles by enabling us to observe the fundamental price of the traded securities (i.e., the market price of the securitized asset). Moreover, we exploit several quasi-experimental shocks to investigate a real world bubble in a manner typically only feasible in laboratory experiments.

Our findings also help inform the theoretical efforts to model bubbles in general, and collectibles bubbles in particular. First, the negative relationship between interest rates and bubble size serves as evidence against purely speculative bubbles, including the canonical rational bubble and the workhorse model for much of macroeconomics. The finding supports the assertion made by Giglio, Maggiori and Stroebel (2016) that fields such as macroeconomics should move away from rational bubbles and move "towards... other, more empirically-plausible models of bubbles".

Second, our results are largely consistent with resale option theory - the idea

that individuals buy overvalued assets and expect the asset can be sold at an even higher price later. Specifically, we find that the bubble component of a security's price is positively correlated with its trading volume and price volatility and negatively related to the number of shares (Scheinkman and Xiong (2003) and Hong, Scheinkman, and Xiong (2006), and Xiong and Yu (2011)). In addition, since the value of selling a security in the future is negatively related to the discount rate, resale theory predicts our finding that bubble size is negatively related to interest rates. The fact that this documented relationship is driven by the yield on short term government bonds suggests that the relevant resell time-horizon for most investors is on the order of days to weeks.

Finally, we find support for two of the key findings from laboratory experiments on asset bubbles: 1) bubbles can occur even when asset fundamentals are publicly observable; 2) the importance of short sale constraints in driving asset bubbles. Along with Xiong and Yu (2011), our findings provide some of the best evidence to date supporting the external validity of laboratory based studies of asset price bubbles, and highlight that the insights gained through lab experiments apply to real-world bubbles.

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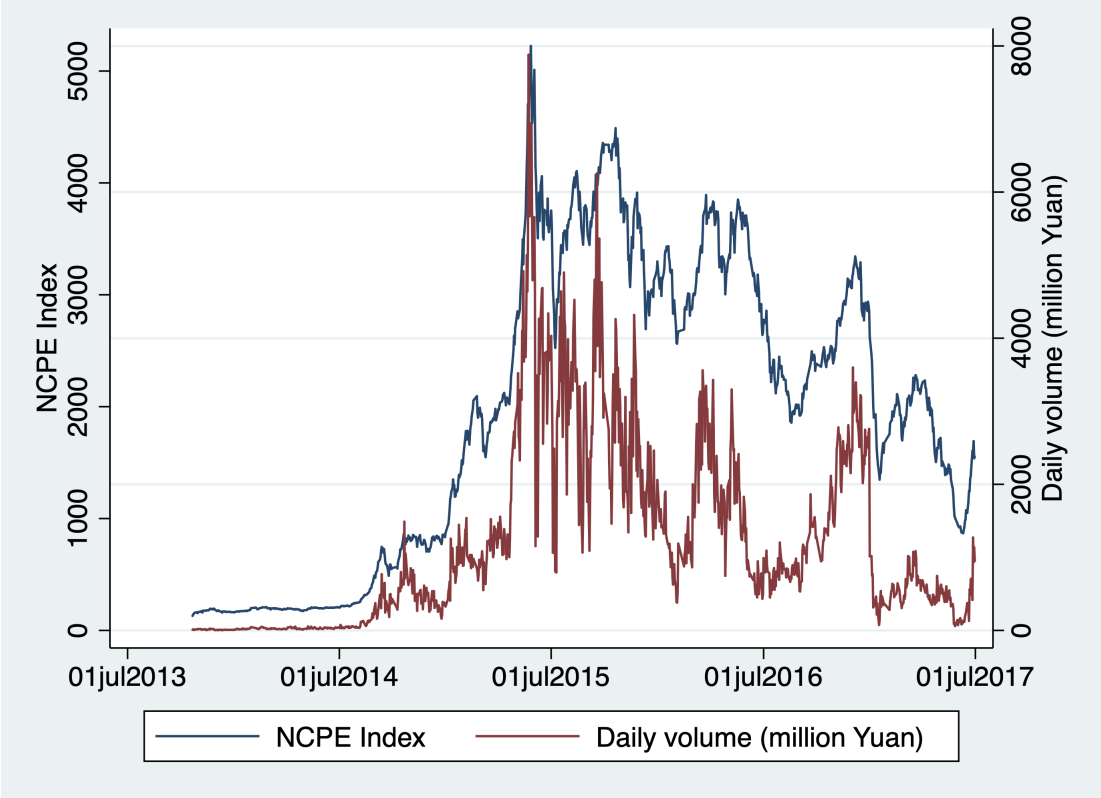
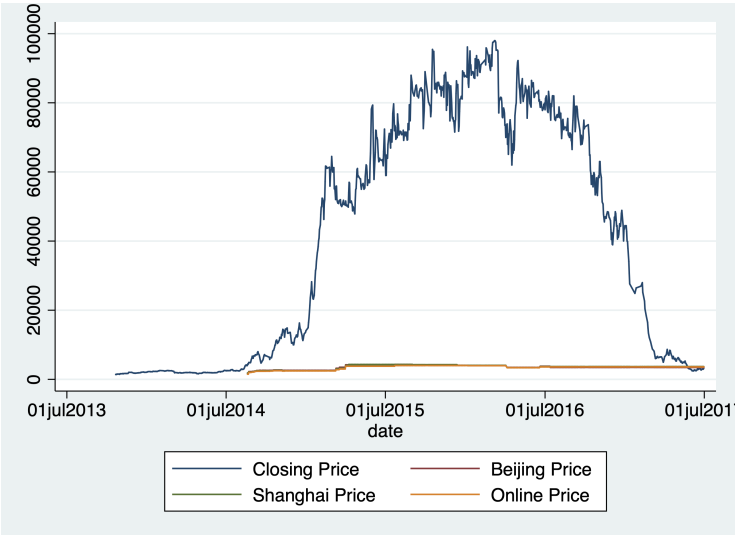
Figure 1. NCPE Index Daily Price and Volume




Notes: This figure plots the daily price and trading volume for the NCPE index for the life of the exchange.

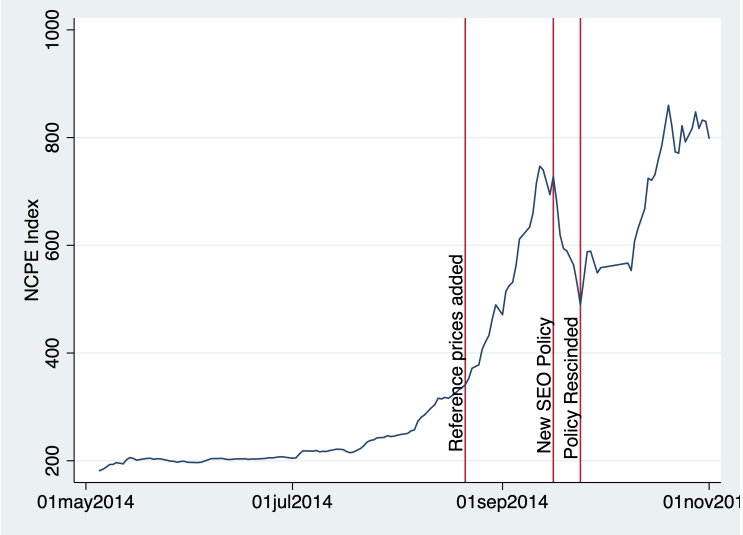
Figure 2. Bank of China Coin to Commemorate the 50th Anniversary of Men's Table Tennis Team

Figure 3. Table Tennis Coin Daily Security Closing Price and Retail Prices



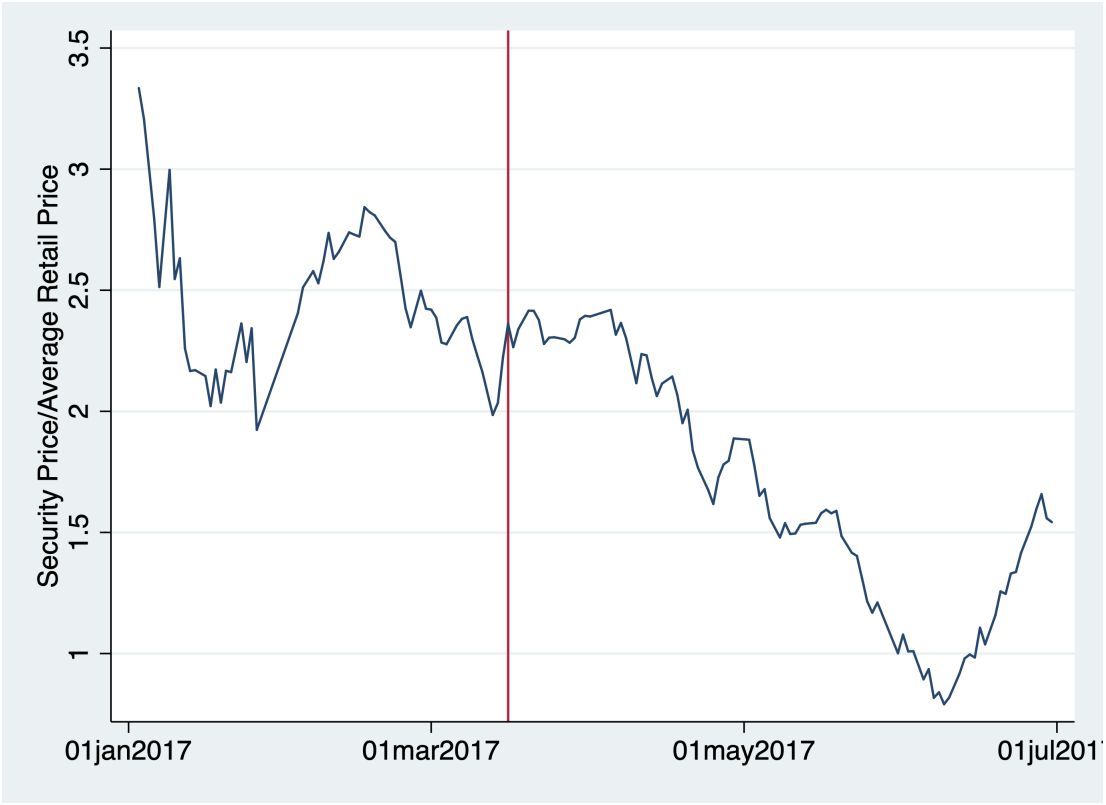

Notes: The Beijing and Shanghai retail prices are the average asking price for the coin shown in Figure 2 by brick-and-mortar vendors in their respective cities. The online price is the average asking price for the coin on several online sites that sell collectibles.

Figure 4. NCPE Index: Key Events




Notes: The figure shows the daily closing price of the NCPE Index around the dates of three key events. The first is the inclusion by the index of a reference price for a securities underlying collectible. The reference price was calculated as 130% of the average retail price of the collectible in Shanghai, Beijing and online. The later two events were the announcement and recision of a policy that increased the ability of traders to arbitrage the difference between the retail price of a collectible and its associated security.

Figure 5. Ratio of Security Price vs. Retail Price




Notes: The blue line shows the average daily ratio of the closing price of a security and the retail price of the underlying collectible from January 1, 2017 till the closure of the exchange on June 30, 2017. The red line corresponds to the date on which the China Securites Regulatory Commission ordered the closure of all collectibles exchanges in China on June 30, 2017.

**Table 1: Sample Statistics**

| Variable Name | Observation | Mean | StdDev | Min | Max |
|---|---|---|---|---|---|
| *Closing Price* | 130509 | 4095.042 | 14296.969 | 0.940 | 4.07e+05 |
| *Volatility* | 130508 | 3.07e+05 | 9.72e+06 | 0.000 | 2.94e+09 |
| *Volume* | 130509 | 69310.914 | 5.11e+05 | 1.000 | 4.13e+07 |
| *Turnover* | 130509 | 0.074 | 0.135 | 0.000 | 15.447 |
| *Flotation* | 130509 | 6.70e+05 | 3.44e+06 | 230.000 | 5.95e+07 |
| *Bubble* | 126371 | 2.924 | 7.927 | -0.995 | 152.947 |
| *Supply* | 123270 | 0.706 | 0.293 | -3.956 | 1.000 |

Notes: *Closing Price* denotes the average closing prince in RMB. *Volatility* is defined as the square of the difference between opening and closing price. *Volume* is the number of shares traded in a day. *Turnover* is the fraction of total shares traded in a day. *Flotation* is the number of outstanding shares/number of securitized collectibles. *Bubble* is the ratio of the difference between the security price and the fundamental price divided by the fundamental price. *Supply* is the share of the collectible not securitized on the exchange ((total quantity produced - total quantity securitized on exchange)/total quantity produced).

**Table 2: Bubble Size**

| | (1) |
|---|---|
| Constant | 2.924*** |
| | (0.048) |
| Security FE | Yes |
| Observations | 126371 |
| R-Squared | 0.562 |

Notes: The regression results show the ratio of the difference between the security price and the fundamental price divided by the fundamental price. Numbers in parentheses are standard errors clustered by date and security. Significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 3: Bubble Size and Interest Rate**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| $Yield: Overnight$ | -1.344*** | | | | | | -0.710*** |
| | (0.273) | | | | | | (0.256) |
| $Yield: 3Months$ | | -1.416*** | | | | | -1.269* |
| | | (0.342) | | | | | (0.734) |
| $Yield: 6Months$ | | | -1.364*** | | | | 0.805 |
| | | | (0.358) | | | | (1.263) |
| $Yield: 1Year$ | | | | -1.369*** | | | -0.375 |
| | | | | (0.328) | | | (0.748) |
| $Yield: 10Years$ | | | | | -0.521 | | 0.685 |
| | | | | | (0.777) | | (0.756) |
| $Yield: 30Years$ | | | | | | -1.157 | -0.377 |
| | | | | | | (0.827) | (0.666) |
| Security FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Date FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 106798 | 106798 | 106798 | 106798 | 106798 | 106798 | 106798 |
| R-Squared | 0.592 | 0.592 | 0.592 | 0.592 | 0.589 | 0.589 | 0.592 |

Notes: Regression results of the relationship between the size of the bubble and the yield of China Government Bonds of different maturies. Numbers in parentheses are standard errors clustered by date and security. Date fixed effects include dummies for day-of-week, week-of-year and year. Significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 4: Bubble Size and Turnover, Volatility, and Outstanding Shares**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Turnover* | 1.627*** | | | 1.619*** |
| | (0.618) | | | (0.613) |
| *Volatility* | | 0.714** | | 0.714** |
| | | (0.333) | | (0.333) |
| *Flotation* | | | -1.055* | -0.981* |
| | | | (0.562) | (0.565) |
| Security FE | Yes | Yes | Yes | Yes |
| Date FE | Yes | Yes | Yes | Yes |
| Observations | 126371 | 126371 | 126371 | 126371 |
| R-Squared | 0.590 | 0.597 | 0.589 | 0.598 |

Notes: Table 4 documents the daily relationship between bubble size and various characteristics of the traded securities. *Turnover* is the fraction of total shares traded in a day. *Volatility* is defined as the square of the difference between opening and closing price of a security divided by its opening price. *Flotation* is the number of outstanding shares of the security. Numbers in parentheses are standard errors clustered by date and security. Date fixed effects include dummies for day-of-week, week-of-year and year. Significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 5: New Investor Inflow**

| | (1) | | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dependent Variable | *Turnover* | | *Return* | | *Bubble* | |
| *New Branches* | 0.0029** | 0.0046** | 0.0017*** | 0.0027*** | 0.0087*** | 0.0102** |
| | (0.0011) | (0.0020) | (0.0005) | (0.0004) | (0.0023) | (0.0039) |
| *New Branches* $t-1$ | | -0.0006 | | -0.0004 | | -0.0026 |
| | | (0.0014) | | (0.0006) | | (0.0028) |
| *New Branches* $t-2$ | | -0.0020 | | -0.0012** | | 0.0009 |
| | | (0.0013) | | (0.0004) | | (0.0021) |
| Security FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 5197 | 5167 | 5197 | 5167 | 5077 | 5077 |
| R-Squared | 0.2199 | 0.2267 | 0.0929 | 0.1207 | 0.5983 | 0.5985 |

Notes: *NewBranches* is defined as the number of new brick-and-mortar retail locations opened by the exchange in a given month. *Turnover* is the fraction of total outstanding shares of a security traded in a given month. *Return* is the monthly return of a security. *Bubble* is the average difference between the security and fundamental price of a security divided by its fundamental price. Numbers in parentheses are standard errors clustered by month and security. Significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

## Table 6: Momentum

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| period | Day | Week | Month | Quarter | Half Year |
| *Winners* | 0.0120*** | 0.0333*** | 0.1171*** | 0.0002 | 0.0014 |
| | (0.0008) | (0.0051) | (0.0365) | (0.0005) | (0.0033) |
| Constant | -0.0036*** | 0.0006 | -0.0073 | 0.0001 | 0.0028 |
| | (0.0013) | (0.0085) | (0.0352) | (0.0003) | (0.0025) |
| Observations | 130312 | 23152 | 5204 | 1540 | 813 |
| R-Squared | 0.0109 | 0.0084 | 0.0089 | 0.0005 | 0.0003 |

Notes: Table 6 documents the relationship between returns and a dummy equal to one if the returns for a security are higher than the median as described in equation (9). The unit of observation is defined by the time unit at the top of each column. Numbers in parentheses are standard errors clustered security and the time period defined at the top of each column. All regressions include security fixed effects and time fixed effects at the level defined at the top of each column. Significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

## Table 7: Ownership Concentration

| | (1) | (2) | (3) |
|---|---|---|---|
| Dependent Variable | *Bubble* | *Return* | *Turnover* |
| *Concentration* | -23.9130 | 0.0792* | -1.4022*** |
| | (28.7168) | (0.0410) | (0.4190) |
| Observations | 707 | 707 | 707 |
| R-Squared | 0.7852 | 0.3241 | 0.4863 |

Notes: *Concentration* is a measure of ownership concentration generated by the NCPE on a quarterly basis. The variable ranges from 0 to 6 where 0 indicates less than 10% of the security is owned by the 10 largest shareholders, and 6 indicates over 70% ownership. Time fixed effects dummies for each quarter. Numbers in parentheses are standard errors clustered by quarter and security. Significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 8: Outside Supply and the Effect of Increased Arbitrage**

| | (1) | (2) | (3) |
|---|---|---|---|
| $Supply * Post$ | -1.0579*** | -1.0575*** | -1.0884*** |
| | (0.2546) | (0.2520) | (0.3160) |
| $Post$ | 0.4566** | | |
| | (0.2021) | | |
| $Supply$ | 0.6386 | 0.6384 | |
| | (0.4719) | (0.4725) | |
| Security FE | N | N | Y |
| Date FE | N | Y | Y |
| Observations | 473 | 473 | 473 |
| R-Squared | 0.1435 | 0.1787 | 0.7154 |

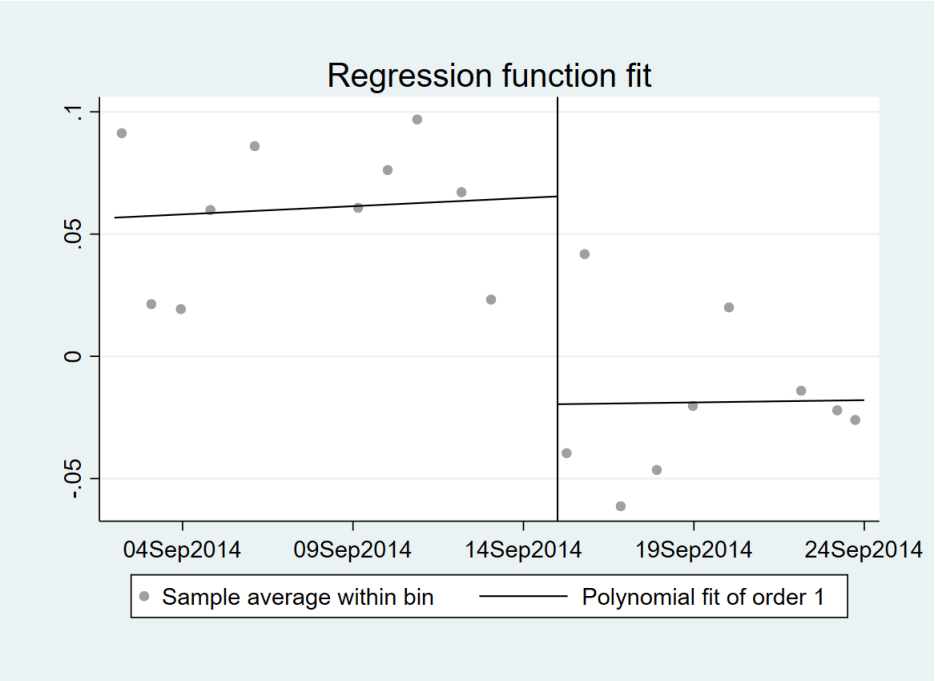
Notes: This table shows relationship between security price and the fraction of the produced units of a collectible securitized on the market (e.g., a value of 0.22 of the variable *Supply* indicates that 22% of the produced collectible has been securitized on the NCPE). *Supply* is the share of the collectible not securitized on the exchange ((total quantity produced - total quantity securitized on exchange)/total quantity produced). *Post* is a dummy equal to one if the date is on or after the announcement of the rule that increase the ability of traders to arbitrage the difference between the price of a security and the price of the underlying collectible. The sample is the 14 trading days around the announcement. Security and date fixed effects are dummies for security and date respectively. Numbers in parentheses are standard errors clustered by date and security. Significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 9: Supply Share and Ordered Closure**

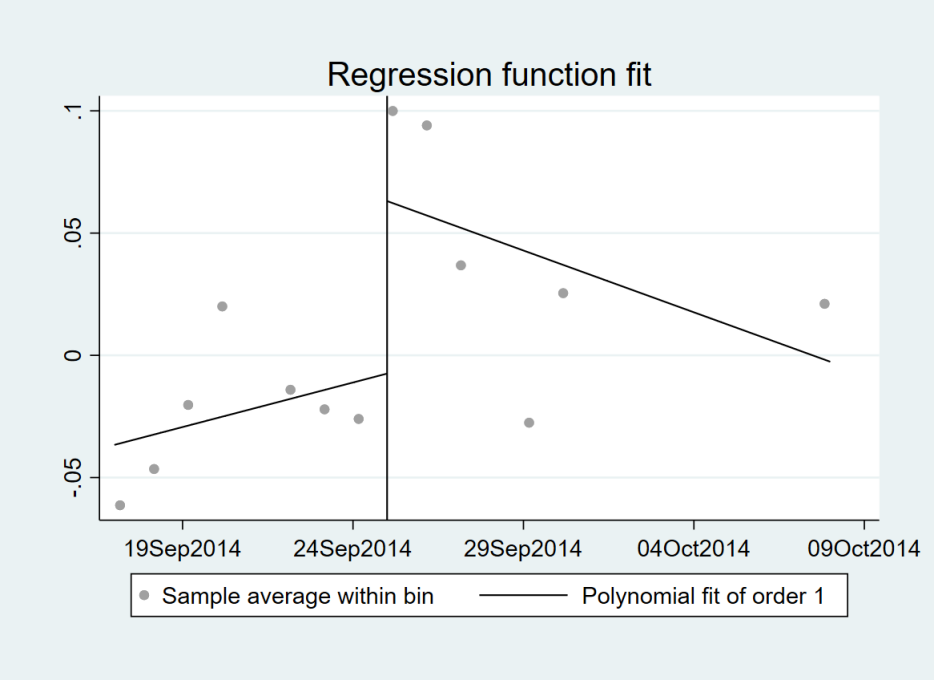
| | (1) | (2) | (3) |
|---|---|---|---|
| $Supply * Post$ | 0.4485 | 0.4612 | 0.1009 |
| | (1.0206) | (1.0246) | (0.9714) |
| $Post$ | -1.0644 | | |
| | (0.7755) | | |
| $Supply$ | -0.4718 | -0.4611 | |
| | (1.4378) | (1.4369) | |
| Security FE | N | N | Y |
| Date FE | N | Y | Y |
| Observations | 21563 | 21563 | 21563 |
| R-Squared | 0.0067 | 0.0151 | 0.7160 |

Notes: This table shows the relationship between security price and the fraction of the produced units of a collectible securitized on the market (e.g., a value of 0.22 of the variable *Supply* indicates that 22% of the produced collectible has been securitized on the NCPE). *Supply* is the share of the collectible not securitized on the exchange ((total quantity produced - total quantity securitized on exchange)/total quantity produced). *Post* is a dummy equal to one if the date is on or after the announcement by the China Securities Regulatory Commission requiring the exchange to cease operations by June 30, 2017. The sample period is January 1, 2017 till the closing of the exchange on June 30, 2017. Security and date fixed effects are dummies for security and date respectively. Numbers in parentheses are standard errors clustered by date and security. Significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

Online Appendix Figure 1A. Returns and SEO Rule Annoucement




Online Appendix Figure 1B. Returns and SEO Rule Recision




Notes: The figures show the effect on daily returns of the announcement (Panel A) and recision (Panel B) of a policy that increased the ability of traders to arbitrage securities. Plotted are the average (equal weighted) security return and the associated linear RD.

## Online Appendix Table 1. RD across addition of retail prices to site

Panel A: Closing Price

| Method | Coef. | Std.Err. | P>Z | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| *Conventional* | 167.747 | 709.016 | 0.813 | -1221.898 | 1557.392 |
| *Robust* | | | 0.944 | -1655.324 | 1779.052 |

Panel B: Price Volatility

| Method | Coef. | Std.Err. | P>Z | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| *Conventional* | 53258.891 | 98818.633 | 0.590 | -1.40e+05 | 2.47e+05 |
| *Robust* | | | 0.643 | -1.92e+05 | 3.11e+05 |

Panel C: Trading Volume (units)

| Method | Coef. | Std.Err. | P>Z | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| *Conventional* | 15886.772 | 30250.877 | 0.599 | -4.34e+04 | 75177.398 |
| *Robust* | | | 0.863 | -6.66e+04 | 79485.609 |

Panel D: Trading Volume (million RMB)

| Method | Coef. | Std.Err. | P>Z | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| *Conventional* | -8.15e+05 | 7.55e+05 | 0.280 | -2.29e+06 | 6.64e+05 |
| *Robust* | | | 0.123 | -3.06e+06 | 3.67e+05 |

Notes: This table shows local linear regression discontinuity estimates for the daily closing price, price volatility, and trading volume just after relative to just before the NCPE site began publishing the retail price of a security's underlying collectible.

## Online Appendix Table 2. RD across SEO rule change/recindment

Panel A: New SEO Rule

| Method | Coef. | Std.Err. | P>Z | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| *Conventional* | -0.028 | 0.013 | 0.034 | -0.054 | -0.002 |
| *Robust* | | | 0.039 | -0.054 | -0.001 |

Panel B: Rule Recindment

| Method | Coef. | Std.Err. | P>Z | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| *Conventional* | 0.140 | 0.020 | 0.000 | 0.100 | 0.180 |
| *Robust* | | | 0.000 | 0.075 | 0.192 |

Notes: This table shows local linear regression discontinuity estimates for the daily closing price just after relative to just before the announcement of the rule that significantly increased the ability of investors to arbitrage the price difference between NCPE securities and the retail price of the securitized collectibles.