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Speculation Spillovers

Yu-Jane Liu, Zheng Zhang, Longkai Zhao
Guanghua School of Management, Peking University, Beijing 100871, China
{yjliu@gsm.pku.edu.cn, zheng86@gsm.pku.edu.cn, lzhao@gsm.pku.edu.cn}

This paper demonstrates that speculative activities can be contagious and spill over across markets. Specifically, we test the hypothesis that during China's warrants bubble period, speculative activities in the warrants market grabbed investors' attention and caused them to trade more speculatively in the underlying stocks. Consistent with this hypothesis, we find that turnover and return volatility of the underlying stocks are positively associated with the warrants' unexpected turnover and price deviation from their fundamental values during the previous day, controlling for information-driven trading and hedging motives, and that such a spillover effect is more pronounced when warrants attract more investor attention.

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1. Introduction

The field of finance is missing an important chapter that examines whether thoughts and behaviors in assets markets are contagious (Hirshleifer and Teoh 2008). This paper aims to test whether speculative trading in one market is contagious to other markets. As highlighted by Odean (1998), investors may engage in trading that is unrelated to either information discovery or hedging motives; that is, each investor believes that his belief is more informed than others' and he can profit from trading against others. Trading induced by such speculative motives is particularly relevant for understanding asset bubbles (e.g., Harrison and Kreps 1978, Scheinkman and Xiong 2003). Thus, analyzing whether speculative trading in one market is contagious across different markets sharpens our understanding of speculative activities and price bubbles in asset markets.

Specifically, we test an attention-grabbing hypothesis. Huberman and Regev (2001) find that when a *New York Times* article reported a potential cancer research breakthrough and mentioned EntreMed, the biotechnology company with licensing rights to the breakthrough, the enthusiasm spilled over to other biotechnology stocks—even though there was no genuinely new information in the article. They attribute this example of contagious speculation to investors' inattention. Barber and Odean (2008) provide systematic evidence that individual investors are likely to be caught by attention-grabbing events because of their limited attention in searching for alternative investment choices. Motivated by these studies, we hypothesize that salient speculative activities in one market may grab investor attention and induce speculative trading in other markets.

We take advantage of the speculative behavior documented by Xiong and Yu (2011) during the Chinese warrants bubble in 2005–2008 to examine whether speculation in a warrant can spill over to the underlying stock market. This warrants market is unique for studying bubbles and speculative trading because the warrants' fundamental values can be reliably determined by the publicly observable prices of their underlying stocks. Indeed, as shown by Xiong and Yu, investors in this market engaged in maniacal speculation and generated a spectacular price bubble in a set of put warrants despite the fact that their fundamental values were virtually zero. We focus on examining whether intensified speculative trading in a warrant is accompanied by intensified speculative trading in its underlying stock on the subsequent day. We call such a positive association *speculation spillover*. By measuring speculative activities in the underlying stock measured by stock turnover and return volatility, we show that speculation spillover exists.

Our main sample covers complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. We adopt unexpected warrant turnover (turnover controlling for liquidity and the time-series pattern of warrant turnover) and warrant overpricing (the implied price difference (IPD)) as proxies for warrant speculation, and we use the Black–Scholes option pricing model and the generalized autoregressive conditional heteroskedasticity (GARCH) option model to derive IPD. We find strong evidence that stock turnover is positively associated with the previous day's unexpected turnover of warrants. The results are robust when we replace stock turnover with stock volatility as the dependent variable or when we replace the previous day's unexpected warrant turnover with the previous day's IPD as the independent variable in the regression models. Our results remain the same after controlling for a host of other variables such as warrant characteristics, stock market capitalization, stock liquidity, market turnover, market volatility, and industry effect.

We also control for information-driven motives for trading and hedging-induced trading in stocks (Back 1993, Chakravarty et al. 2004, Cho and Engle 1999, Figlewski 1989). We adopt the probability of information-based trading (PIN) measure developed by Easley et al. (2002) as a proxy for private information arrival and use the change in each warrant's hedge ratio as a measure of hedge-induced trading (Black 1989, Harris and Shen 2003). Our results are robust after controlling for these variables.

For a robustness check, we adopt a matching sample of stocks that do not have warrants written on them, and we find that speculation spillover is higher for stocks with warrants than those without warrants. Our findings are also robust in the subsample of only deep-out-of-the-money put warrants, in the same manner as those of Xiong and Yu (2011). In addition, we use the A-B and A-H share premiums as alternative measures of stock market speculation.[1] The results again confirm the existence of contagious speculation between warrants and the underlying stocks.

Furthermore, we find that the spillover effect is stronger for stocks with fewer outstanding shares and when the stock market is driven by optimistic beliefs. This is consistent with the prediction of Hong et al. (2006) that stock price bubbles induced by heterogeneous beliefs and short-sale constraints decrease with asset float, and it thus suggests that speculation spillover might impart a bubble component in the stock price.

We also identify the channel through which the spillover effect is realized. Specifically, we empirically investigate whether speculative activities in the warrants markets grab the attention of investors and attract them to trade in the underlying stocks. We use warrant media coverage, extreme price change, and extreme trading yuan volume in warrants to measure the attention-grabbing effect. Our findings indicate that when attention to warrants is high, the speculation spillover effect is more pronounced.

Taken together, the results of this study corroborate the existing literature on investor attention as an important driver of asset market dynamics, e.g., Sims (2003), Hirshleifer and Teoh (2003), and Peng and Xiong (2006) on the theoretical side and Barber and Odean (2008), Hou et al. (2009), and Yuan (2012) on the empirical side. In particular, Menkulasi (2009) develops a theory about the volatility of aggregate economic activity, and Brandt et al. (2010) provide empirical evidence to show that attention-grabbing behavior has a significant effect on changes in asset price volatility. Our study shows that the effect of investor attention is not limited to one market but can be contagious to other markets as well.

The rest of the study proceeds as follows. In the next section, we describe the institutional background of China's warrants market. Section 3 presents the theories on speculation spillovers and related hypotheses on potential causes of spillovers. Section 4 describes the empirical models, variables, and data. Section 5 shows the empirical analysis. Section 6 checks for the robustness of our analysis, and §7 concludes this paper.

2. Institutional Background

China's stock market was established around 1992, but equity derivatives appeared much later. Equity warrants were briefly introduced in China in 2005–2008. The first Chinese warrant, the BaoGang call warrant, was issued in August 2005. As the first equity derivative product in China's financial markets, warrants quickly became a favorite financial instrument for speculators. In less than three months, the total daily trading volume of warrants reached 10.18 billion yuan on December 6, 2005, with only six warrants issued. The total trading volume of more than 1,300 listed stocks was just 7.89 billion yuan on the same day. In the first year after being issued, the NanHang put warrant had a trading volume of 2,391.2 billion yuan, which was nearly 10% of China's gross domestic product.

China's warrants market is highly speculative. Most of the investors in this market are retail and are inexperienced in warrant trading. In our sample, the median daily warrant turnover is 0.540, or 10,800% annually. This is much higher than the median daily stock turnover of 0.025, or 500% annually.

Another unique feature of China's stock market and warrants market is its rigid short-sale restrictions. Short sales of stocks and warrants were not allowed during our sample period in 2005–2008.[2] Short-sale restrictions

[1] A-shares, which can only be held by domestic investors, and B-shares, which can only be traded by foreigners, have identical rights. Therefore, the A-B share premium largely captures the nonfundamental component. The A-B share premium can also help explain speculative motives of trading (Hwang et al. 2006, Mei et al. 2009). Therefore, the A-B (A-H) premium (the price difference between the dual-class A-B (A-H) shares) provides additional evidence along this line of speculation.

[2] Note that the Shanghai Stock Exchange introduced a limited shorting mechanism by allowing a set of securities firms to issue covered warrants. Short sales of stocks were launched in 2010 for a limited number of stocks.

and the lack of other financial instruments make it extremely difficult, if not impossible, for rational arbitrageurs to arbitrage on the divergence between the market prices of warrants and their fundamental values. With short-sale constraints, pessimistic investors stay out of the market. Instead, market prices are mainly determined by the trading of optimistic investors. As highlighted by the theories of Harrison and Kreps (1978), Scheinkman and Xiong (2003), and Hong et al. (2006), short-sale constraints and investors' speculative motives led to price bubbles. Indeed, Xiong and Yu (2011) document that these features led to a speculative bubble in China's warrants market. This warrants bubble provides an opportunity to study the impact of warrant speculation on speculative trading in the underlying market.

3. Hypothesis

We focus on analyzing whether speculative activities in the warrants market can spill over to the underlying stock markets.[3] Specifically, we hypothesize that investors' attention-grabbing behavior may cause speculation in the warrants market to spill over to the underlying stocks. The literature has shown that investors have difficulty absorbing relevant information when attention-grabbing stimuli compete for their attention. For example, Barber and Odean (2008) propose that individuals are limited in searching for alternative investment choices and therefore simply buy stocks that catch their attention. Consistent with their prediction, they document that individual investors are net buyers of attention-grabbing stocks, i.e., stocks that make news, stocks with abnormal trading dollar volumes, and stocks that realize extreme one-day returns.

Other studies document similar attention-based buying behavior. For example, using a sample of the Chinese stock market, Seasholes and Wu (2007) find that individual investors are net buyers for stocks that hit their upper price limit on the previous day. Huddart et al. (2009) find that an extreme stock price attracts more buy-initiated orders than sell-initiated orders, particularly for small transactions. Brandt et al. (2010) provide empirical evidence that during the rise and the fall of idiosyncratic volatility levels over the past two decades, volatility changed around "attention-grabbing events."[4]

Because of the extremely speculative behavior in the warrants market (Xiong and Yu 2011), we expect the intensive speculation in the warrants market to attract investor attention. In particular, because warrants and the underlying stocks share the same first two Chinese characters in their trading tickers, media coverage of the warrants market may attract investors who usually trade only in the stock market. For example, when a warrant's name—such as Wu Liang Warrant—appears in a news title, investors will not only pay attention to the warrant but also to the underlying stock. Thus, we hypothesize that by grabbing investors' attention, intensive speculation in the warrant can spill over to the underlying stock.

The literature has used media coverage, extreme price changes, and extreme trading volume to measure investor attention (Barber and Odean 2008, Hou et al. 2009, Yuan 2008). We adopt these variables and specifically test the following hypothesis.

Hypothesis 1 (Attention-Grabbing Channel). *Speculation spillover is more pronounced when there is more investor attention, measured by media coverage, extreme warrant volume, and extreme warrant price range, on the warrants market.*

It is worth noting that information-driven and hedging motives may also cause the correlation between trading in the underlying stocks with trading in their warrants (Back 1993, Stein 1987). Informed traders might take advantage of the high leverage and low trading costs associated with trading derivatives. Thus, stock trading may be affected by information disseminated from trading in warrants. We use the PIN measure developed by Easley et al. (2002) to control for information trading in stocks. If trading in the stocks is driven by private information held by some investors, we should expect the stock trading to be positively related to the coefficient of the PIN measure.

Additionally, investors may use stocks to hedge their warrant holdings. If so, they may need to rebalance their stock positions as the required hedge ratios change over time. Therefore, we measure this hedging motive by calculating the absolute value of the daily change in hedge ratio. If stock trading is induced by such a hedging motive, we expect to see a positive association between stock trading and the change in hedging ratio.

4. Empirical Design

In this section, we first describe the empirical model used to examine contagious spillovers from warrants to the underlying stocks, the measurement of the attention-grabbing channel, and our data. Then, we present summary statistics of our data.

4.1. Empirical Model Specifications

We follow the literature (Galbraith 1997, Hong and Stein 2007, Hong and Yu 2009, Scheinkman and Xiong 2003) to use stock turnover to measure stock speculation.

[3] Different from previous literature that focuses on the introduction effect of derivatives on the underlying assets, we focus on the impact of warrant speculation on stock trading behavior. See Mayhew (2000) for a survey.

[4] Evidence from behavioral literature also suggests that people often fail to incorporate all relevant information when they make decisions (DellaVigna and Pollet 2009, Hirshleifer and Teoh 2008, Hirshleifer et al. 2009).

Because speculation tends to increase price volatility, we also use return volatility as another measure of stock speculation.[5] The following equation specifies our pooling regression:

$$\begin{aligned}&\mathit{Unexpected\ Turn}_{it}^{\text{stock}}(\mathit{Vol}_{it}^{\text{stock}})\\&=\beta_0+\beta_1\mathit{Unexpected\ Turn}_{it-1}^{\text{warrant}}(\mathit{Unexpected\ IPD}_{it-1})\\&\quad+\beta_2\mathit{Put}_i+\beta_3\mathit{Covered}_{it}+\beta_4\mathit{Duration}_{it}+\beta_5\mathit{Stockcap}_{it}\\&\quad+\beta_6\mathit{Liquidity}_{it}+\beta_7\mathit{Market\ Turnover}_{it}(\mathit{Market\ Volatility}_{it})\\&\quad+\beta_8\mathit{Industry\ dummy}_i+\varepsilon_{it}.\end{aligned}\tag{1}$$

The dependent variables are daily stock turnover rate ($\mathit{Turn}^{\text{stock}}$) and daily stock volatility ($\mathit{Vol}^{\text{stock}}$), which measure speculative trading in stocks. Stock turnover ($\mathit{Turn}^{\text{stock}}$) is the trading volume in shares divided by the total outstanding shares, whereas stock volatility ($\mathit{Vol}^{\text{stock}}$) is the difference between the highest and the lowest intraday prices divided by the closing price. The one-day lagged $\mathit{Turn}^{\text{warrant}}$ and *IPD* are our measures of warrant speculation, where $\mathit{Turn}^{\text{warrant}}$ is the warrant turnover rate, and *IPD*, as shown in Equation (2), is the difference between the daily warrant market price and the warrant theoretical price:

$$\mathit{IPD}=\log\left(\frac{\mathit{warrant\_market\_price}}{\mathit{warrant\_theoretical\_price}}\right).\tag{2}$$

We choose two models to calculate the warrants' fundamental values. The first one is the Black–Scholes option pricing model. Most of the warrants are nominally Bermudan, but they are essentially European options, because they can only be exercised within five days of their maturity. Thus, we use the Black–Scholes option pricing formula to calculate their fundamental values. We define volatility as the standard deviation of daily stock returns in a 250-trading-day period ending 10 days before the warrant announcement.[6] We also consider stochastic volatility in China's stock market and use an option GARCH model (Duan 1995)[7] to estimate the theoretical prices of warrants. IPD^{BS} is the IPD based on the Black–Scholes pricing model, whereas $\mathit{IPD}^{\text{GARCH}}$ is based on the GARCH model. Any observation with a theoretical price below 0.05 is excluded from our sample.

The average warrant's IPD^{BS} value is 1.36 in our sample, which means that, on average, warrants are traded at prices 290% higher than their theoretical Black–Scholes prices. The median warrants are still 99% overpriced compared to their Black–Scholes prices. On average, $\mathit{IPD}^{\text{GARCH}}$ is higher than IPD^{BS}. $\mathit{IPD}^{\text{GARCH}}$ shows more extreme values on both ends. The correlation between IPD^{BS} and $\mathit{IPD}^{\text{GARCH}}$ is 0.852. In summary, warrants are extremely overpriced relative to their fundamental values regardless of the pricing model used, which is consistent with the findings of Xiong and Yu (2011).

As turnover and volatility (or IPD) can be persistent, we detrend stock turnover (volatility), warrant turnover, and IPD by constructing the unexpected terms of $\mathit{Turn}^{\text{stock}}$, $\mathit{Vol}^{\text{stock}}$, $\mathit{Turn}^{\text{warrant}}$, and *IPD*. The objective of detrending these variables is to capture the unpredictable component of the warrant turnover, IPD, stock turnover, and stock volatility. If there is speculation spillover, we expect β_1 in Equation (1) to be positive.

In the microstructure literature, turnover is used as a proxy for liquidity. Therefore, we also control for liquidity in the regression. We use the following steps to calculate unexpected warrant turnover ($\mathit{Unexpected\ Turn}^{\text{warrant}}$) for each day. First, we calculate warrant turnover ($\mathit{Turn}^{\text{warrant}}$) by dividing trading volume in shares by the outstanding warrants shares. Then we regress $\mathit{Turn}^{\text{warrant}}$ against the daily warrant bid–ask spread and the one- and two-day lagged warrant turnovers in a 50-day window before the day the warrant is mentioned by the media. The residual of the regression above is $\mathit{Unexpected\ Turn}^{\text{warrant}}$. This measure controls for the liquidity component embedded in turnover and also considers the time-series pattern of warrant turnovers. The results are not sensitive to the choice of lags. Stock turnover (volatility) is adjusted in similar ways. Regarding IPD, we perform an autoregression with a one-day lag for each measure of IPD and denote the residuals as $\mathit{Unexpected\ IPD}^{\text{BS}}$ and $\mathit{Unexpected\ IPD}^{\text{GARCH}}$.

To control for information trading, we use the PIN measure developed by Easley et al. (2002) as a proxy for the presence of private information among investors. The likelihood function of the microstructure model in Easley et al. is estimated across every month using intraday stock data. The estimation of the model's structural parameters can be used to calculate the PIN. We also control for hedging motive by calculating the absolute value of the daily change in hedge ratios ($\Delta\mathit{Hedge\ Ratio}$) using the Black–Scholes formula.

[5] Regarding volatility, Baele (2005) investigates volatility spillover from the aggregate European and U.S. markets to 13 local European equity markets and finds evidence for a contagion from the U.S. markets to some European financial markets during periods of high world market volatility. Christiansen (2007) finds that there is strong statistical evidence of volatility spillover from the U.S. and aggregate European bond markets.

[6] Other trading periods are also used to calculate the volatility. The results are similar in scale and do not change our subsequent results.

[7] The option GARCH model in Duan (1995) relaxes the constant volatility assumption in the Black–Scholes model and considers the changes in the conditional volatility of the underlying stocks. A GARCH(1, 1) process is estimated for the stock returns. For each day, the estimation is done in a window of $[-200, -1]$. Then the option GARCH model is applied for the theoretical prices of warrants. If the option GARCH model fails to converge, we extend or shorten our estimation window (no less than 100 days) to obtain an option price.

Other control variables are specified as follows. The covered dummy (*Covered*) is equal to 1 if the stock has a covered warrant (i.e., the warrant is traded on the Shanghai Stock Exchange, which allowed issuance of covered warrants by designated securities firms) and 0 otherwise. We include this variable to control for the possibility that covered warrants may ease speculative trading in these warrants. The put dummy (*Put*) is equal to 1 if the stock has a put warrant and 0 otherwise. Put warrants provide an opportunity for investors to trade on negative information. Given the restrictions on short selling stocks, put warrants may reduce speculation in the underlying stocks. Warrant duration (*Duration*) is the time left to maturity for warrants (days/365). Stock market capitalization (*Stockcap*) is calculated as the product of the price and the total number of tradable A-shares. Chordia et al. (2001) provide evidence of a positive correlation between share turnover, firm size, and liquidity. This suggests that stock market capitalization is related to liquidity. Stock liquidity (*Liquidity*) is measured by the bid–ask spread or the Amihud (2002) illiquidity measure. These variables have been found to be an effective measure of market liquidity (Goyenko et al. 2009, Lesmond et al. 1999). The bid–ask spread is the daily average of intraday percentage-quoted spreads. The Amihud illiquidity measure is defined as the absolute daily stock return divided by the daily trading value in RMB billions. Finally, we also control for stock market characteristics and industries. *Market Turnover* is the total stock turnover of the market. *Market Volatility* is the median of the stock market volatilities. Industry dummies (*Industry*) are included. All the variables are measured on a daily basis.

4.2. Measurements of Investor Attention

Our direct attention measure is media coverage. In addition, we also use extreme volume and extreme price change as indirect measures (Barber and Odean 2008). The definitions of these variables are as follows:

Media coverage. We use the popular Chinese Internet search engine Baidu News to search media coverage.[8] For each warrant, we note the date on which the warrant name appears in any news title. Baidu News includes media coverage from traditional media such as newspapers and magazines, as well as Web-based news media. In our sample, we find 620 warrant days with media coverage. We consider the day of media coverage as the event day, and we define the media coverage window as the period $[0, 1]$ and the no coverage window as $[-2, -1]$. In a robustness check, we exclude any date when the underlying stock name also appears in a news headline. The results remain the same.

Extreme warrant volume. In general, warrants have high trading yuan volume. To highlight the attention effect, we focus on whether there are extreme changes in warrant trading yuan volume. For each day, we examine the difference between the previous day's warrant yuan volume and the maximum daily warrant yuan volume in the previous week. Next, we sort the stocks by this extreme warrant volume to compare the speculation spillover effect in the top 30% group with that in the bottom 30% group.

Extreme warrant price change. Extreme intraday price changes may also attract investors' attention. We calculate the daily warrant price range, which is the difference between the highest and lowest intraday prices divided by the daily closing price, and sort the underlying stocks using the same method we use to sort extreme warrant yuan volume.

Note that the use of extreme volume and price change to measure attention is based on an implicit assumption that investor attention is nonlinear and likely to be grabbed by salient events such as extreme outcomes. In our analysis, media coverage provides a direct measure of investor attention, whereas extreme warrant volume and extreme warrant change provide indirect measures.

4.3. Data

We obtain the warrant data from WIND, a commercial financial data provider.[9] The information available includes the trading code of the underlying stocks, the date of warrant listing (or issuance), the expiration date of the warrant, whether the warrant is an equity warrant or a covered warrant, the call/put feature, the exercise price, and the stock exchange listed. Stock data are collected from the China Center for Economic Research (CCER) database. Our sample covers the period between August 2005 and June 2008.

Panel A of Table 1 shows that 41 firms issued warrants on their stocks, among which 23 firms issued only call warrants, 12 firms issued only put warrants, and 6 firms issued both call and put warrants. There are three firms that issued two call warrants. In panel B, the data set consists of the complete observations of 50 warrants that are listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange during our sample period. There are 32 equity warrants and 18 covered warrants in total. For equity warrants, there are more call warrants (25) than put warrants (7). There are 18 covered warrants, and 7 of them have a call feature.

[8] See http://news.baidu.com/. Baidu provides Internet search services similar to Google. It is the most dominant Internet search engine in China.

[9] We verify the data using other data providers such as the CCER and China Stock Market and Accounting Research databases. The data are consistent.

Table 1 Sample Distribution

Panel A: The number of sample firms with warrants issued	Number of sample firms
With call warrants issued	23
With put warrants issued	12
With call and put warrants issued	6
Total number of sample firms	41

Panel B: The number of warrants	Covered warrant	Equity warrant
Call warrants	7	25
Put warrants	11	7
Total number of warrants	18	32

Notes. We collect complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. The 50 warrants were written on 41 firms. "Equity warrant" is a standard warrant issued by a listed company. "Covered warrant" is a warrant that can be issued by investment banks.

In Table 2, we report the descriptive statistics of the variables used in our study. Normally, warrants issued by Chinese companies have one- or two-year maturities. Panel B of Table 2 shows that the average maturity of the warrants in our sample is 1.3 years. Warrants exhibit a high turnover rate. On average, 65.4% of the outstanding warrants are traded every day, whereas the daily turnover rate of the underlying stocks is only 2.4%. Warrants also appear to be more volatile. We present two measures of volatility in Table 2: the standard deviation of daily stock (or warrant) returns in the sample period and the daily price range normalized by the daily closing price. In both measures, the volatility in warrants is much higher than the volatility in stocks.

We also examine the change in stock turnover (volatility) around the introduction of warrants (see Table 3). We choose the listing date as the event date and find that the *industry-adjusted turnover* of warranted stocks increases significantly in postevent periods. In comparing the pre- and postevent periods, we observe that stocks are traded more frequently and are more volatile after the introduction of warrants.

5. Empirical Results

The purpose of our empirical analysis is twofold: (1) to ascertain the existence of speculation spillovers and (2) to examine whether speculation spillovers occur through the attention-grabbing channel.

Table 2 Summary Statistics

Panel A: Statistics of stocks

	Stockcap (million ¥)	$Turn^{stock}$	*Volatility* (standard deviation)	*Volatility* (daily price range)	*Shares outstanding* (million share)	*Liquidity* (bid–ask spread)	*Liquidity* (Amihud illiquidity)	*PIN*
Mean	21,452	0.024	0.035	0.049	1,389	0.002	0.022	0.102
Median	12,574	0.025	0.034	0.049	845	0.002	0.017	0.096
Max	113,434	0.050	0.041	0.062	5,084	0.004	0.092	0.323
Min	1,631	0.008	0.027	0.038	208	0.001	0.002	0.014
P25	7,886	0.017	0.033	0.046	459	0.001	0.010	0.072
P75	24,385	0.028	0.037	0.051	1,467	0.002	0.028	0.123

Panel B: Statistics of warrants

	Duration (year)	IPD^{BS}	IPD^{GARCH}	$Turn^{warrant}$	*Volatility* (standard deviation)	*Volatility* (daily price range)	*Hedge Ratio*
Mean	1.3	1.360	1.701	0.654	0.086	0.069	0.550
Median	1.0	0.689	0.833	0.540	0.080	0.068	0.550
Max	2.0	6.215	8.863	1.689	0.185	0.119	1.000
Min	0.5	−0.119	−0.438	0.062	0.041	0.051	0.001
P25	1.0	0.250	0.284	0.417	0.059	0.059	0.336
P75	2.0	1.668	1.326	0.829	0.106	0.076	0.962

Notes. We collect complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. The 50 warrants were written on 41 firms. We collect the variables of the warrants' characteristics and the warranted stocks' information on a daily basis. In panel A, *Stockcap* is the A-share market capitalization calculated as the stock price multiplied by the total tradable shares. $Turn^{stock}$ is the trading share volume divided by the total tradable shares. *Volatility* is defined in two ways: the first is the standard deviation of stock returns for the life of warrants; the second is the daily price range defined as (the highest price − the lowest price)/the closing price. *Shares outstanding* is the number of outstanding A-shares in the stock market. *Liquidity* is measured by the bid–ask spread or Amihud (2002) illiquidity measure. Stock bid–ask spread is the daily average of intraday percentage quoted spreads. Stock Amihud illiquidity is defined as the absolute daily stock return divided by the daily trading value in RMB billions. *PIN* is the probability of informed trading. We estimated the *PIN* variable every month using the stock intraday data following the method developed by Easley et al. (2002). In panel B, *Duration* is the time left to maturity for warrants (days/365). *IPD* is defined as log (warrant market price/warrant theoretical price), where the warrant theoretical price is calculated using the Black–Scholes model with volatility as the standard deviation of stock returns in a 250-day trading period ending 10 days before the listing of a warrant (IPD^{BS}) or the GARCH option model in Duan (1995) (IPD^{GARCH}). Warrant turnover ($Turn^{warrant}$) is the warrant trading volume divided by the total warrants outstanding. *Hedge Ratio* is derived from the Black–Scholes model and reports the absolute value. The mean, median, maximum, minimum, 25th percentile (P25), and 75th percentile (P75) of the variables are reported.

Table 3 Comparison of Turnover and Volatility Before and After Listing of the Warrants

	Adjusted turnover			Adjusted volatility		
Window	Pre-event	Postevent	Difference	Pre-event	Postevent	Difference
			Panel A: Full sample			
(−45, −15) vs. (15, 45)	−0.0055	−0.0022	0.0034***	−0.0063	0.0027	0.0092***
(−90, −30) vs. (30, 90)	−0.0068	−0.0019	0.0049***	−0.0106	0.0040	0.0149***
(−180, −30) vs. (30, 180)	−0.0059	−0.0030	0.0027*	−0.0095	0.0044	0.0141***
			Panel B: Call and put			
With call						
(−45, −15) vs. (15, 45)	−0.0061	−0.0032	0.0031***	−0.0047	0.0029	0.0079***
(−90, −30) vs. (30, 90)	−0.0083	−0.0018	0.0069***	−0.0094	0.0054	0.0151***
(−180, −30) vs. (30, 180)	−0.0085	−0.0028	0.0057***	−0.0089	0.0053	0.0144***
With put						
(−45, −15) vs. (15, 45)	−0.0046	−0.0009	0.0037*	−0.0085	0.0024	0.0109***
(−90, −30) vs. (30, 90)	−0.0047	−0.0022	0.0025*	−0.0123	0.0023	0.0146***
(−180, −30) vs. (30, 180)	−0.0025	−0.0032	−0.0007	−0.0104	0.0034	0.0138***
			Panel C: Covered and noncovered			
Covered						
(−45, −15) vs. (15, 45)	−0.0050	−0.0026	0.0025*	−0.0066	0.0023	0.0089***
(−90, −30) vs. (30, 90)	−0.0051	−0.0028	0.0023*	−0.0116	0.0031	0.0147***
(−180, −30) vs. (30, 180)	−0.0033	−0.0033	0.0000	−0.0104	0.0040	0.0144***
Noncovered						
(−45, −15) vs. (15, 45)	−0.0057	−0.0020	0.0038***	−0.0062	0.0029	0.0094***
(−90, −30) vs. (30, 90)	−0.0076	−0.0015	0.0064***	−0.0101	0.0046	0.0149***
(−180, −30) vs. (30, 180)	−0.0072	−0.0028	0.0043***	−0.0091	0.0047	0.0139***

Notes. We collect complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. The 50 warrants were written on 41 firms. For each warrant, we identify its listing date as the event date. Around the event date 0, we construct three pre-event windows, (−45, −15), (−90, −30), and (−180, −30), and three symmetrical postevent windows, (15, 45), (30, 90), and (30, 180). Turnover is the trading share volume divided by the A-shares outstanding. Adjusted turnover is defined as the turnover subtracted by the industry median. Stock volatility is the average daily price range calculated as the difference between the highest intraday price and the lowest intraday price divided by the closing price. Adjusted volatility is defined as the volatility subtracted by the industry median. For each window, we report the mean. We also report the differences of means for two symmetric pre- and postevent windows. A t-test is used to report significance. Panel A reports the comparisons in the full sample. Panel B reports the results in the subcategories of the call and put warrants. Panel C reports the comparisons in the subcategories of covered and noncovered warrants.

*Significant at the 10% level; ***significant at the 1% level.

5.1. Has Speculation Spilled Over?

To examine whether speculation spillovers exist, we investigate whether the previous day's unexpected turnover or overpricing in a warrant has a positive impact on the turnover and volatility of the underlying stock. The results are presented in Table 4.

Panel A reports the results where the dependent variable is $Unexpected\ Turn^{stock}$; panel B reports results for the dependent variable $Unexpected\ Vol^{stock}$. In panel A, the coefficients of $Unexpected\ Turn^{warrant}$ are significantly positive in all specifications, suggesting that unexpected stock turnover is positively associated with lagged unexpected warrant turnover. For example, the coefficient of unexpected warrant turnover is 0.011 with a t-statistic of 3.420 in specification (1). The inclusion of control variables in specifications (4) and (7) does not change the result. Similarly, the coefficients of $Unexpected\ IPD^{BS}$ ($Unexpected\ IPD^{GARCH}$) are significantly positive in all specifications. Since the results are not sensitive to the option pricing model used, we only report the results of $Unexpected\ IPD^{GARCH}$ later. In panel B, we replace unexpected stock turnover with unexpected stock return volatility as the dependent variable and find that $Unexpected\ Vol^{stock}$ is positively associated with both $Unexpected\ Turn^{warrant}$ and $Unexpected\ IPD^{BS}$ (IPD^{GARCH}). In other words, when the warrants have higher unexpected turnover rates, the underlying stocks exhibit higher unexpected daily volatility. This is consistent with the results of panel A. We adopt the Newey–West estimator to cope with the autocorrelation and heteroskedasticity in the error terms in all of the regressions.[10]

In regard to the control variables, the coefficients of the control variable *Covered* are not statistically significant in all of the specifications, implying that covered warrants do not have a material impact on stock speculation. The coefficient of *Put* is positively significant in panel B but insignificant in panel A, indicating that the put feature could partly increase stock volatility. If investors are rational, the put feature provides a better way to materialize negative information. This

[10] The Newey–West estimator corresponds to the Bartlett kernel with bandwidth parameter $L+1$, where L is the maximum lag length. We set L equal to 4.

Table 4 Speculation Spillovers: Results of Regression Specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Panel A: *Unexpected Turn*$_t^{\text{stock}}$					
Intercept	−0.088***	−0.088***	−0.088***	−0.152**	−0.152**	−0.152**	−0.025	−0.019	−0.015
	(−10.064)	(−10.106)	(−10.043)	(−2.370)	(−2.367)	(−2.370)	(−0.410)	(−0.309)	(−0.249)
Unexpected Turn$_{t-1}^{\text{warrant}}$	0.011***			0.011***			0.010***		
	(3.420)			(3.278)			(3.027)		
Unexpected IPD$_{t-1}^{\text{BS}}$		0.018***			0.018***			0.018***	
		(4.544)			(4.378)			(4.526)	
Unexpected IPD$_{t-1}^{\text{GARCH}}$			0.016***			0.016***			0.016***
			(5.587)			(5.396)			(5.680)
Put$_t$				0.001	0.000	0.000	−0.001	−0.002	−0.002
				(0.267)	(0.076)	(−0.050)	(−0.111)	(−0.327)	(−0.471)
Covered$_t$				−0.002	−0.002	−0.001	−0.002	−0.003	−0.002
				(−0.321)	(−0.373)	(−0.290)	(−0.465)	(−0.507)	(−0.413)
Duration$_t$				−0.006	−0.005	−0.005	−0.004	−0.003	−0.003
				(−1.174)	(−1.121)	(−1.030)	(−0.764)	(−0.700)	(−0.612)
Stockcap$_t$				0.003	0.003	0.003	−0.002	−0.002	−0.002
				(1.202)	(1.194)	(1.187)	(−0.733)	(−0.828)	(−0.890)
Liquidity$_t$ (bid–ask spread)				−5.003	−4.769	−4.498			
				(−1.582)	(−1.508)	(−1.424)			
Liquidity$_t$ (Amihud illiquidity)							−0.686***	−0.699***	−0.703***
							(−7.457)	(−7.570)	(−7.688)
PIN$_t$	0.186***	0.185***	0.185***	0.196***	0.197***	0.197***	0.183***	0.184***	0.184***
	(4.684)	(4.707)	(4.686)	(4.729)	(4.798)	(4.787)	(4.449)	(4.522)	(4.526)
Δ*Hedge Ratio*$_t$	1.654***	1.688***	1.669***	1.744***	1.776***	1.754***	2.055***	2.093***	2.074***
	(11.987)	(12.396)	(12.436)	(12.294)	(12.700)	(12.737)	(12.006)	(12.378)	(12.443)
Market Turnover$_t$	1.403***	1.385***	1.383***	1.330***	1.320***	1.324***	1.203***	1.186***	1.186***
	(9.592)	(9.498)	(9.462)	(8.618)	(8.565)	(8.579)	(7.814)	(7.714)	(7.701)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	6,305	6,305	6,305	6,305	6,305	6,305	6,305	6,305	6,305
Adj. R^2	0.063	0.064	0.066	0.064	0.065	0.067	0.073	0.075	0.077
				Panel B: *Unexpected Vol*$^{\text{stock}}$					
Intercept	−0.272***	−0.276***	−0.279***	−0.536***	−0.534***	−0.531***	−0.340***	−0.329***	−0.316***
	(−19.575)	(−19.865)	(−19.969)	(−4.192)	(−4.173)	(−4.146)	(−2.929)	(−2.839)	(−2.731)
Unexpected Turn$_{t-1}^{\text{warrant}}$	0.015***			0.014***			0.014**		
	(2.819)			(2.632)			(2.520)		
Unexpected IPD$_{t-1}^{\text{BS}}$		0.025***			0.021***			0.021***	
		(3.764)			(3.261)			(3.149)	
Unexpected IPD$_{t-1}^{\text{GARCH}}$			0.034***			0.031***			0.030***
			(5.987)			(5.673)			(5.549)
Put$_t$				0.041***	0.040***	0.038***	0.037***	0.036***	0.034***
				(4.845)	(4.737)	(4.519)	(4.454)	(4.332)	(4.098)
Covered$_t$				0.007	0.007	0.008	0.010	0.010	0.011
				(0.789)	(0.769)	(0.871)	(1.065)	(1.050)	(1.163)
Duration$_t$				−0.005	−0.005	−0.004	−0.008	−0.008	−0.006
				(−0.666)	(−0.647)	(−0.466)	(−0.974)	(−0.955)	(−0.787)
Stockcap$_t$				0.010*	0.009*	0.009*	0.002	0.001	0.001
				(1.802)	(1.758)	(1.706)	(0.402)	(0.288)	(0.151)
Liquidity$_t$ (bid–ask spread)				17.381***	17.628***	18.413***			
				(2.761)	(2.801)	(2.927)			
Liquidity$_t$ (Amihud illiquidity)							−0.096	−0.119	−0.131
							(−0.584)	(−0.733)	(−0.810)
PIN$_t$	0.235***	0.241***	0.245***	0.148***	0.154***	0.157***	0.198***	0.205***	0.211***
	(3.630)	(3.747)	(3.818)	(2.204)	(2.303)	(2.358)	(3.099)	(3.227)	(3.325)
Δ*Hedge Ratio*$_t$	2.966***	3.013***	2.985***	2.870***	2.907***	2.868***	3.026***	3.075***	3.048***
	(14.708)	(15.162)	(15.188)	(13.760)	(14.132)	(14.099)	(13.221)	(13.633)	(13.647)
Market Volatility$_t$	4.810***	4.871***	4.918***	5.032***	5.082***	5.119***	5.077***	5.129***	5.169***
	(24.868)	(25.092)	(25.255)	(25.223)	(25.460)	(25.603)	(24.803)	(25.079)	(25.244)

Table 4 (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	6,305	6,305	6,305	6,305	6,305	6,305	6,305	6,305	6,305
Adj. R^2	0.196	0.197	0.202	0.205	0.206	0.210	0.204	0.204	0.209

Notes. We collect complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. The 50 warrants were written on 41 firms. $Turn^{stock}$ is the stock turnover rate measured by the trading share volume divided by the total tradable shares. *Unexpected* $Turn^{stock}$ is the residual of the regression where $Turn^{stock}$ is regressed on the daily stock bid–ask spread and the one-day lagged stock turnover using the previous 50 trading-day observations. Vol^{stock} is the daily price range calculated as the difference between the highest intraday price and the lowest intraday price divided by the closing price. *Unexpected* Vol^{stock} is the residual of the regression where Vol^{stock} is regressed on the daily stock bid–ask spread and the one-day lagged stock turnover using the previous 50 trading-day observations. $Turn^{stock}$ and Vol^{stock} have been multiplied by 100. *Unexpected* $Turn^{warrant}$ is the residual of the regression where $Turn^{warrant}$ is regressed on the daily warrant bid–ask spread and the one-day lagged warrant turnover. *IPD* is defined as log (warrant market price/warrant theoretical price), where the warrant theoretical price is calculated using the Black–Scholes model, with the volatility as the standard deviation of stock returns in a 250-day trading period ending 10 days before the listing of a warrant (IPD^{BS}), or the GARCH option model in Duan (1995) (IPD^{GARCH}). Two measures of *IPD*s are adjusted by taking the residual in the autoregression with a one-day lag and are denoted as *Unexpected* IPD^{BS} and *Unexpected* IPD^{GARCH}. The covered dummy (*Covered*) is set to be 1 if the stock has a covered warrant and 0 otherwise. The put dummy (*Put*) is set to be 1 if the stock has a put warrant and 0 otherwise. Warrant duration (*Duration*) is the time left to maturity for warrants (days/365). Stock market capitalization (*Stockcap*) is the A-share market capitalization calculated as the stock price multiplied by the total tradable shares. Stock liquidity (*Liquidity*) is measured by the bid–ask spread or the Amihud (2002) illiquidity measure. Here, the bid–ask spread is the daily average of intraday percentage-quoted spreads. Amihud illiquidity is defined as the absolute daily stock return divided by the daily trading value in RMB billions. *PIN* is the probability of informed stock trading. We estimate the *PIN* variable every month using the stock intraday data following the method developed by Easley et al. (2002). Δ*Hedge Ratio* is the absolute value of the difference of the daily hedge ratios calculated using the Black–Scholes model. *Market Turnover* is the total stock turnover of the market. *Market Volatility* is the market median of stock volatilities. Industry dummies (*Industry*) are included. The variables are measured on a daily basis. Newey–West *t*-statistics (with four lags) of coefficients are reported in parentheses.

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

could result in less speculation in the underlying stocks. Our result suggests the opposite.

Duration is not significant in either panel. The coefficients of stock market capitalization are positive in many cases, supporting the previous empirical studies (Chordia et al. 2001) on liquidity trading. However, the results of the other two liquidity measures are somewhat inconsistent. Both liquidity measures show negative signs in panel A, and the coefficients of the Amihud (2002) illiquidity measure are also negative in panel B. However, the results of the bid–ask spread measures are positive in panel B.

Stock trading could also result from information dissemination or hedging motives. Table 4 reports the results after we control for information-induced trading or hedging motives. As shown in panels A and B, when we incorporate control variables in the regressions, stock PIN is significantly positive. Notably, in all specifications, the coefficients of *Unexpected* $Turn^{warrant}$, *Unexpected* IPD^{BS}, and *Unexpected* IPD^{GARCH} remain significantly positive. The average stock PIN in our sample is 10.2%, whereas the average PIN in the U.S. stock market is around 20%. Information-induced trading is a significant factor in explaining stock trading in our sample. Still, the speculation spillover is significant after controlling for it.

With regard to the potential hedging motives, panels A and B of Table 4 show that the coefficients of Δ*Hedge Ratio* are positive and statistically significant in all cases. *Unexpected* $Turn^{warrant}$ (*Unexpected* IPD^{BS}) remains significantly positive after controlling for hedging motives. This implies that even if the hedging motives have affected stock trading, warrant speculation could still have spilled over to the underlying stock market.

To further examine whether speculation spillovers are caused by warrant trading, we construct a matching sample of firms that do not have warrants issued. For each stock with warrants, we select firms in the same industry whose market capitalizations are within ±15% of the stock with warrants. Out of these firms, we then choose the one with the smallest difference in bid–ask spread from the stock with warrants. Finally, we calculate *Adjusted* $Turn^{stock}$ and *Adjusted* Vol^{stock}, which are the differences of *Unexpected* $Turn^{stock}$ and *Unexpected* Vol^{stock}, respectively, between the firms with warrants and their matched firms. The results are presented in Table 5. *Unexpected* $Turn^{warrant}$ and *Unexpected* IPD^{GARCH} are significantly positive, showing that the difference between stocks with warrants and the matched stocks in $Turn^{stock}$ (Vol^{stock}) can be explained by warrant trading.

Whether speculation spillovers impart a bubble component in stocks is an important issue. Hong et al. (2006) argue that when investors have heterogeneous beliefs and short-sale constraints exist,[11] the resale option component in stock prices decreases with the asset float. Therefore, if warrant speculation has spilled over to the stock market, we expect the spillover effect will be stronger when the asset float, measured

[11] Harris and Raviv (1993) and Kandel and Pearson (1995) show that heterogeneous beliefs occur when investors use different economic models, which could result in different interpretations of the same news.

Table 5 Matching-Sample Comparison

	Adjusted $Turn_t^{stock}$		*Adjusted* Vol_t^{stock}	
	(1)	(2)	(3)	(4)
Intercept	−0.071**	−0.074**	0.014	0.011
	(−2.551)	(−2.611)	(0.580)	(0.447)
Unexpected $Turn_{t-1}^{warrant}$	0.026***		0.015*	
	(3.000)		(1.817)	
Unexpected IPD_{t-1}^{GARCH}		0.023***		0.020**
		(2.864)		(2.596)
Put_t	0.020	0.021	−0.100***	−0.100***
	(1.189)	(1.277)	(−6.596)	(−6.584)
$Covered_t$	−0.056***	−0.058***	0.032**	0.032**
	(−3.544)	(−3.638)	(2.191)	(2.185)
$Duration_t$	0.040**	0.037**	−0.044***	−0.043***
	(2.327)	(2.146)	(−3.124)	(−3.016)
PIN_t	−0.208	−0.210	0.168	0.172
	(−1.356)	(−1.472)	(1.591)	(1.637)
Δ*Hedge* $Ratio_t$	2.766***	2.751***	3.067***	3.074***
	(7.551)	(7.523)	(8.818)	(8.797)
Market $Turnover_t$/	−1.711***	−1.581***	−1.463***	−1.410***
$Volatility_t$	(−3.854)	(−3.530)	(−5.104)	(−4.969)
Industry	Yes	Yes	Yes	Yes
No. of obs.	4,004	4,004	4,004	4,004
Adj. R^2	0.151	0.149	0.047	0.047

Notes. Reported are the results of the regression specifications where the dependent variables are *Adjusted* $Turn^{stock}$ and *Adjusted* Vol^{stock}. We collect complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. The 50 warrants were written on 41 firms. For each stock with warrants, we first select firms in the same industry during the same period that have a market cap within ±15% of the warranted stock. Then, from among the surviving candidates we choose the one with the smallest difference in bid–ask spread from the warranted stock. *Adjusted* $Turn^{stock}$ and *Adjusted* Vol^{stock} are calculated as the differences of *Unexpected* $Turn^{stock}$ and *Unexpected* Vol^{stock}, respectively, between the stocks with warrants and their matching firms. The other variables are defined in Table 4. Newey–West t-statistics (with four lags) of coefficients are reported in parentheses.

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

by the number of tradable shares (*Float*), is smaller. We construct an interaction term between *Float* and *Unexpected* $Turn^{warrant}$ (*Unexpected* IPD^{GARCH}) and expect a negative coefficient for the interaction term. In Table 6, the results show that *Unexpected* $Turn^{warrant}$ (*Unexpected* IPD^{GARCH}) is positively associated with *Unexpected* $Turn^{stock}$ (*Unexpected* Vol^{stock}), and the effect is reduced when the stock has a larger asset float. As expected, all the coefficients of the interaction terms have negative signs and are significant in specification (2) of the *Unexpected* $Turn^{stock}$ regression and in specification (4) of the *Unexpected* Vol^{stock} regression. However, *Float* is not significant in all specifications.[12]

Furthermore, speculation spillover is likely to be more pronounced when investor sentiment is high.[13] Therefore, we expect spillover effects are stronger in bull markets than in bear markets. China's stock market experienced a historical bull run from 2005 to mid-2007. During this period, the Shanghai Composite Index increased from 998 to 6,124 and reached its historical high on October 16, 2007. The market quickly dropped after that, and by the end of our sample period in 2008, the index was around 2,736. We define a *Bull dummy* variable as 1 for the period before October 16, 2007 and 0 afterward; we expect a positive coefficient for the variable. The results reported in Table 7 indicate that for the *Unexpected* $Turn^{stock}$ regression, the interaction of *Bull dummy* and *Unexpected* IPD^{GARCH} is positive. The interaction shows that the coefficient of *Unexpected* IPD^{GARCH} in a bull market period is significantly larger than the coefficient in a bear market; the difference is 0.034. Most of the coefficients of the interaction terms are statistically significant. We have similar findings in the *Unexpected* Vol^{stock} regression. In sum, we find evidence of stronger speculation spillover effects in a bull market, suggesting that optimistic beliefs could magnify the spillover effect.

5.2. Attention-Grabbing Channel

To determine the attention-grabbing channel of speculation spillover, we first identify situations in which attention to warrants is either very high or very low. Then we rerun our regression models in both situations. Finally, we compare the effects of speculation spillover across the two levels of attention.

Table 8 presents the results. In panel A, we choose media coverage as the measure of attention. We consider that attention to warrants is high on the day and one day after the warrants are covered by the media. Then, we compare the speculation spillover effect on those two days to the effect on the two days before the media coverage. The results show that the coefficients of the interactions between *Unexpected* $Turn^{warrant}$ (*Unexpected* IPD^{GARCH}) and *Media Coverage dummy* are significantly positive except for one case in *Unexpected* Vol^{stock}. For example, in the *Unexpected* $Turn^{stock}$ regression, the interaction of *Unexpected* $Turn^{warrant}$ and *Media Coverage dummy* has a coefficient of 0.044. Our finding indicates that the speculation spillover effect is stronger in the period with media coverage.

The results from panel A of Table 8 suggest that the speculation spillover effect is stronger when warrants draw more attention because of media coverage.

[12] This does not contradict the prediction in Hong et al. (2006) because the dependent variable is the unexpected value. When the dependent variable is $Turn^{stock}$ (Vol^{stock}), we find *Float* to be significantly negative, and the interactions are still significantly negative.

[13] Harrison and Kreps (1978) show that in a dynamic setting, an optimistic investor is willing to pay more than an asset's fundamental value. This shows that the investor anticipates the possibility of reselling the asset in the future to even more optimistic investors.

Table 6 Difference of Opinions: Float Shares

	Unpexpected $Turn_t^{stock}$				*Unexpected* Vol_t^{stock}			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Intercept	−0.169**	−0.165**	−0.169**	−0.170***	−0.531***	−0.530***	−0.527***	−0.531***
	(−2.600)	(−2.549)	(−2.606)	(−2.627)	(−4.138)	(−4.128)	(−4.093)	(−4.117)
Unexpected $Turn_{t-1}^{warrant}$	0.010***	0.031***			0.014***	0.022		
	(3.241)	(2.985)			(2.632)	(1.400)		
Unexpected $Turn_{t-1}^{warrant} \times Float_t$		−0.067**				−0.026		
		(−2.245)				(−0.561)		
Unexpected IPD_{t-1}^{GARCH}			0.016***	0.032**			0.031***	0.073***
			(5.455)	(2.413)			(5.671)	(3.499)
Unexpected $IPD_{t-1}^{GARCH} \times Float_t$				(−0.046)				(−0.124)**
				(−1.268)				(−1.975)
$Float_t$	−0.049**	−0.047**	−0.050**	−0.048**	0.015	0.016	0.013	0.019
	(−2.072)	(−1.987)	(−2.114)	(−2.029)	(0.390)	(0.416)	(0.359)	(0.499)
Put_t	0.004	0.004	0.002	0.002	0.040***	0.040***	0.037***	0.037***
	(0.672)	(0.674)	(0.375)	(0.367)	(4.573)	(4.577)	(4.259)	(4.249)
$Covered_t$	−0.002	−0.002	−0.002	−0.002	0.007	0.007	0.008	0.008
	(−0.406)	(−0.386)	(−0.377)	(−0.377)	(0.804)	(0.810)	(0.885)	(0.886)
$Duration_t$	−0.006	−0.006	−0.006	−0.006	−0.005	−0.005	−0.004	−0.004
	(−1.296)	(−1.322)	(−1.154)	(−1.156)	(−0.640)	(−0.646)	(−0.443)	(−0.448)
$Stockcap_t$	0.005	0.004	0.005	0.005*	0.009*	0.009	0.009	0.009
	(1.647)	(1.583)	(1.645)	(1.657)	(1.690)	(1.677)	(1.600)	(1.612)
$Liquidity_t$ (bid–ask spread)	−4.623	−4.738	−4.110	−4.077	17.344***	17.285***	18.379***	18.465***
	(−1.462)	(−1.498)	(−1.301)	(−1.293)	(2.751)	(2.743)	(2.917)	(2.937)
PIN_t	0.207***	0.207***	0.208***	0.206***	0.146**	0.146**	0.156**	0.152**
	(4.919)	(4.921)	(4.977)	(4.947)	(2.162)	(2.159)	(2.317)	(2.278)
$\Delta Hedge\ Ratio_t$	1.780***	1.774***	1.791***	1.795***	2.861***	2.858***	2.860***	2.870***
	(12.277)	(12.184)	(12.717)	(12.712)	(13.599)	(13.576)	(13.928)	(13.939)
Market $Turnover_t/Volatility_t$	1.382***	1.388***	1.376***	1.375***	5.036***	5.037***	5.123***	5.130***
	(8.935)	(8.984)	(8.906)	(8.900)	(25.233)	(25.245)	(25.612)	(25.608)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	6,305	6,305	6,305	6,305	6,305	6,305	6,305	6,305
Adj. R^2	0.065	0.066	0.068	0.068	0.206	0.210	0.204	0.204

Notes. Reported are the results when difference of opinion is considered as a mechanism for speculation spillover. We collect complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. The 50 warrants were written on 41 firms. *Float* is the log of the number of the A-shares outstanding. The other variables are defined in Table 4. The variables are measured on a daily basis. Newey–West t-statistics (with four lags) of coefficients are reported in parentheses.

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

We acknowledge the possibility that the news about warrants could be due to news about the underlying stocks. We verify that most of the media coverage is exclusive to warrants and not about the underlying stocks. In an unreported robustness test, we exclude the days when there is media coverage of both the warrants and the underlying stocks. Only a few observations are dropped, and the results do not change materially.

Panel B of Table 8 reports the difference in speculation spillover between the top 30% and the bottom 30% of extreme warrant volume. The positive association between *Unexpected* $Turn^{stock}$ (*Unexpected* Vol^{stock}) and *Unexpected* $Turn^{warrant}$ is significantly stronger in the top 30% of the extreme warrant volume sample than in the bottom 30% of the sample (0.017 in $Turn^{stock}$, 0.031 in Vol^{stock}). *Unexpected* IPD^{GARCH} also shows similar results, and the coefficients are all statistically significant. Warrants allow day trading, making daily price range an important factor to consider in warrants trading. In the same way that we analyze extreme warrant turnover, we analyze extreme warrant price range as another way to separate the level of attention. The results are presented in panel C of Table 8. The conclusion drawn from panel C is similar to that drawn from panel B; that is, for the sample with a higher extreme warrant price range, both *Unexpected* $Turn^{warrant}$ and *Unexpected IPD* have a stronger impact on stock trading.

The above results indicate that the level of attention strongly affects the impact of warrant speculation on stock trading. When the attention level is high, the speculation spillover effect is more pronounced.

Table 7 Difference of Opinions: Bull vs. Bear Market

	Unexpected $Turn_t^{stock}$		*Unexpected* Vol_t^{stock}	
Intercept	−0.139***	−0.139***	−0.525***	−0.528***
	(−2.665)	(−2.651)	(−5.473)	(−5.502)
Unexpected $Turn_{t-1}^{warrant}$	0.019***		0.019**	
	(3.002)		(2.056)	
Unexpected $Turn_{t-1}^{warrant}$ × *Bull dummy*	−0.010		0.045***	
	(−1.369)		(4.089)	
Unexpected IPD_{t-1}^{GARCH}		−0.015		−0.008
		(−1.132)		(−0.387)
Unexpected IPD_{t-1}^{GARCH} × *Bull dummy*		0.034**		0.043**
		(2.521)		(1.954)
Put_t	0.003	0.001	0.041***	0.039***
	(0.706)	(0.260)	(6.377)	(6.048)
$Covered_t$	−0.002	−0.002	0.012*	0.012*
	(−0.472)	(−0.495)	(1.723)	(1.818)
$Duration_t$	−0.006	−0.005	−0.002	0.000
	(−1.574)	(−1.370)	(−0.399)	(−0.078)
$Stockcap_t$	0.003	0.003	0.009**	0.009**
	(1.295)	(1.304)	(2.210)	(2.183)
$Liquidity_t$ (bid–ask spread)	−6.258***	−5.938***	16.896***	18.122***
	(−2.171)	(−2.068)	(3.087)	(3.295)
PIN_t	0.195***	0.192***	0.182***	0.184***
	(5.884)	(5.876)	(3.612)	(3.689)
$\Delta Hedge\ Ratio_t$	1.699***	1.711***	2.897***	2.875***
	(12.510)	(13.123)	(14.448)	(14.486)
$Market\ Turnover_t/Volatility_t$	1.309***	1.269***	5.043***	5.121***
	(8.547)	(8.352)	(21.579)	(21.585)
Industry	Yes	Yes	Yes	Yes
No. of obs.	5,838	5,838	5,838	5,838
Adj. R^2	0.063	0.067	0.218	0.221

Notes. Reported are the results of the regression specifications in bull and bear markets. We collect complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. The 50 warrants were written on 41 firms. *Market Volatility* is the market median of stock volatilities. Industry dummies (*Industry*) are included. The variables are measured on a daily basis. We define a bull market as the days before October 16, 2007 (*Bull dummy* = 1) and a bear market as the days after that date in our sample (*Bull dummy* = 0). Newey–West *t*-statistics of coefficients are reported in parentheses.

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

In other words, by grabbing investors' attention, speculation in the warrants market can be contagious to the underlying stock market.

6. Robustness Check

In our previous analysis, we use the full sample of all warrants. Xiong and Yu (2011) analyze the price bubble in a sample of deep-out-of-the-money put warrants. As a robustness check, we use a sample similar to theirs to rerun the above analysis.[14] The advantage of their sample is that one cannot use either information- or hedging-based arguments to explain the trading of these fundamentally worthless put warrants at their highly positive market prices. In our analysis of this warrant sample, we nevertheless use the PIN and change in the hedge ratio as control variables in the regressions to account for any possible information- or hedging-induced trading.

In Table A.1 of the appendix, we replace lagged *Unexpected IPD* with the lagged *Warrant Close Price*. We find that *Unexpected* $Turn^{stock}$ is still positively associated with warrant speculation, yet the coefficients are not significant. *Unexpected* $Turn^{stock}$ and *Unexpected* Vol^{stock} are positively associated with the warrant price. Taken together, even when the linkage of information

[14] China imposes a 10% upward or downward limit in daily stock price. In our sample of deep-out-of-the-money warrants, we include warrants with Black–Scholes prices less than 0.05. However, if we consider the price limit on stock prices, the intrinsic value of the warrants is zero, since it is impossible for the warrant to be exercised with any value.

Table 8 Attention as a Mechanism for Speculation Spillover

	Unexpected $Turn_t^{stock}$		*Unexpected* Vol_t^{stock}	
	Panel A: Media coverage			
Intercept	−0.133 (−1.030)	−0.123 (−0.953)	−0.482** (−2.056)	−0.446* (−1.930)
Unexpected $Turn_{t-1}^{warrant}$	−0.006 (−0.875)		0.014 (0.973)	
Unexpected $Turn_{t-1}^{warrant}$ × *Media Coverage dummy*	0.044*** (4.857)		0.017 (1.019)	
Unexpected IPD_{t-1}^{GARCH}		0.021*** (2.678)		0.038*** (2.846)
Unexpected IPD_{t-1}^{GARCH} × *Media Coverage dummy*		0.022** (2.303)		0.027* (1.711)
Media Coverage $dummy_t$	0.011** (2.218)	0.013** (2.456)	0.014* (1.762)	0.014* (1.801)
Put_t	−0.007 (−0.769)	−0.012 (−1.340)	0.028** (2.030)	0.021 (1.523)
$Covered_t$	−0.005 (−0.605)	−0.007 (−0.823)	0.018 (1.278)	0.016 (1.164)
$Duration_t$	−0.018** (−2.096)	−0.014 (−1.646)	−0.020 (−1.465)	−0.014 (−1.056)
$Stockcap_t$	0.003 (0.513)	0.002 (0.407)	0.007 (0.720)	0.005 (0.535)
$Liquidity_t$ (bid–ask spread)	−7.468 (−1.210)	−5.542 (−0.903)	5.799 (0.505)	7.958 (0.701)
PIN_t	0.210*** (2.732)	0.200*** (2.720)	0.306** (2.591)	0.302*** (2.674)
Δ*Hedge* $Ratio_t$	2.008*** (9.788)	2.011*** (9.783)	3.043*** (7.912)	2.983*** (7.816)
Market $Turnover_t/Volatility_t$	1.469*** (5.890)	1.486*** (5.913)	5.289*** (15.143)	5.389*** (15.479)
Industry	Yes	Yes	Yes	Yes
No. of obs.	2,443	2,443	2,443	2,443
Adj. R^2	0.091	0.098	0.212	0.226
	Panel B: Warrant extreme volume			
Intercept	−0.288*** (−3.184)	−0.301*** (−3.354)	−0.266 (−1.538)	−0.276 (−1.594)
Unexpected $Turn_{t-1}^{warrant}$	0.002 (0.412)		−0.002 (−0.150)	
Unexpected $Turn_{t-1}^{warrant}$ × *Extreme Volume dummy*	0.017** (2.130)		0.031** (2.208)	
Unexpected IPD_{t-1}^{GARCH}		−0.005 (−1.262)		0.003 (0.382)
Unexpected IPD_{t-1}^{GARCH} × *Extreme Volume dummy*		0.022*** (3.153)		0.032* (1.932)
Extreme Volume $dummy_t$	0.017*** (2.889)	0.024*** (4.217)	0.002 (0.234)	0.010 (1.189)
Put_t	−0.021*** (−3.096)	−0.021*** (−3.103)	0.008 (0.780)	0.007 (0.658)
$Covered_t$	0.009 (1.436)	0.011* (1.677)	0.015 (1.287)	0.017 (1.525)
$Duration_t$	−0.001 (−0.203)	−0.003 (−0.393)	0.008 (0.734)	0.006 (0.557)
$Stockcap_t$	0.008** (1.990)	0.008** (2.169)	−0.001 (−0.170)	−0.001 (−0.113)
$Liquidity_t$ (bid–ask spread)	2.260 (0.473)	1.873 (0.393)	4.319 (0.526)	3.611 (0.434)
PIN_t	0.299*** (5.494)	0.291*** (5.281)	0.284** (3.611)	0.279** (3.508)

Table 8 (Continued)

	Unexpected $Turn_t^{stock}$		*Unexpected* Vol_t^{stock}	
Δ*Hedge Ratio*$_t$	1.441***	1.490***	2.870***	2.943***
	(6.487)	(6.975)	(9.358)	(9.986)
Market Turnover$_t$/*Volatility*$_t$	1.225***	1.210***	4.313***	4.349***
	(5.232)	(5.121)	(15.558)	(15.655)
Industry	Yes	Yes	Yes	Yes
No. of obs.	2,649	2,649	2,649	2,649
Adj. R^2	0.079	0.076	0.181	0.190
Panel C: Warrant extreme price change				
Intercept	−0.240***	−0.242***	−0.316**	−0.313**
	(−2.797)	(−2.817)	(−1.944)	(−1.910)
Unexpected $Turn_{t-1}^{warrant}$	0.001		−0.008	
	(0.242)		(−0.927)	
Unexpected $Turn_{t-1}^{warrant}$ × *Extreme Warrant Price Change dummy*	0.010*		0.036***	
	(1.819)		(2.837)	
Unexpected IPD_{t-1}^{GARCH}		−0.004		−0.003
		(−1.057)		(−0.311)
Unexpected IPD_{t-1}^{GARCH} × *Extreme Warrant Price Change dummy*		0.015**		0.041***
		(2.278)		(2.831)
Extreme Warrant Price Change dummy$_t$	0.023***	0.025***	0.004	0.006
	(4.417)	(4.736)	(0.446)	(0.700)
Put$_t$	−0.009	−0.009	0.015	0.012
	(−1.189)	(−1.280)	(1.349)	(1.145)
Covered$_t$	−0.009	−0.008	−0.004	−0.002
	(−1.457)	(−1.359)	(−0.342)	(−0.192)
Duration$_t$	−0.002	−0.002	0.002	0.001
	(−0.247)	(−0.318)	(0.172)	(0.133)
Stockcap$_t$	0.006	0.006	0.001	0.000
	(1.581)	(1.601)	(0.079)	(0.061)
Liquidity$_t$ (bid–ask spread)	4.600	4.563	15.509*	15.440*
	(1.009)	(1.000)	(1.861)	(1.831)
PIN$_t$	0.227***	0.225***	0.278***	0.277***
	(4.246)	(4.206)	(3.578)	(3.577)
Δ*Hedge Ratio*$_t$	1.728***	1.738***	2.419***	2.427***
	(8.650)	(8.884)	(8.584)	(8.733)
Market Turnover$_t$/*Volatility*$_t$	1.329***	1.329***	4.640***	4.663***
	(5.902)	(5.889)	(15.197)	(15.270)
Industry	Yes	Yes	Yes	Yes
No. of obs.	2,678	2,678	2,678	2,678
Adj. R^2	0.080	0.080	0.182	0.183

Notes. We collect complete observations of 50 warrants that were listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange between August 2005 and June 2008. The 50 warrants were written on 41 firms. The variables are measured on a daily basis. The T-statistics of coefficients are reported in parentheses. In panel A, we collect 620 warrant-days with media coverage. We consider the day of media coverage as the event day and define the media coverage window as the period of [0, 1] (*Media Coverage dummy* = 1) and the no coverage window as [−2, −1] (*Media Coverage dummy* = 0). In panel B, we define the *warrant extreme volume* as warrant yuan volume ($t-1$) − max [warrant yuan volume ($t-2$ to $t-6$)]. *Extreme Volume dummy* equals 1 if the warrant extreme volume is among the top 30% and 0 if the warrant extreme volume is among the bottom 30%. In panel C, *warrant extreme price change* is defined as the difference between the highest intraday price and the lowest intraday price. We then divide the difference by the daily closing price. We similarly define the *Extreme Warrant Price Change dummy*. Newey–West t-statistics (with four lags) are reported in parentheses.

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

or hedging between the two markets is irrelevant, we still observe a speculation spillover effect of the deep-out-of-the-money put warrants.

In another robustness test, we replace the dependent variable with A-B and A-H stock premiums. In China's stock market, firms can issue shares in the A-share market, the B-share market, or the H-share market. In our sample period, the B-share market is open to domestic investors. However, investors need to own a foreign currency account (i.e., USD account) to trade B-shares. The H-share market refers to the shares listed on the Hong Kong Stock Exchange. Mei et al. (2009)

consider the A-B share premium as a measure of stock speculation. We adopt a similar measure and also consider the A-H share premium as an alternative measure. The speculation spillover still exists. As shown in Table A.2 of the appendix, the coefficients of *Unexpected* $Turn^{\text{warrant}}$ (*Unexpected* IPD^{GARCH}) in the A-B and A-H premium regressions are positive and significant in two specifications.

There are some observations that have higher theoretical prices than the market prices and exhibit negative *IPD*s. In an unreported test, we exclude the sample with negative IPD^{BS} or IPD^{GARCH}. The results either remain the same or are even stronger than those reported above.

7. Conclusion

In this paper, we demonstrate that speculative activities can be contagious and spill over across markets. Specifically, we find that frenzied speculation during the Chinese warrants bubble had created some side effects on the trading and volatility of the underlying stocks—stock turnover (volatility) was positively associated with the lagged unexpected warrant turnover or warrant overpricing. This speculation spillover effect is robust after controlling for information or hedging-based trading motives and is particularly strong when the underlying stock has a small asset float or when the market is filled with optimistic investors. Furthermore, we find that warrant speculation spills over more intensively to the underlying stock market when the warrant attracts more investor attention, which identifies investor attention as a channel for the speculation spillover effect.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/mnsc.2014.1914.

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Appendix

Table A.1 Robustness Check: Sample with Deep-Out-of-the-Money Put Warrants

	Unexpected $Turn_t^{\text{stock}}$		*Unexpected* Vol_t^{stock}	
Intercept	−0.008	−0.028	−1.274	−1.167
	(−0.018)	(−0.065)	(−1.992)	(−1.877)
Unexpected $Turn_{t-1}^{\text{warrant}}$	0.006		0.006	
	(1.250)		(0.756)	
Warrant Close Price$_{t-1}$		0.015***		0.033***
		(4.986)		(5.445)
Covered$_t$	−0.001	0.000	−0.064**	−0.058**
	(−0.038)	(0.021)	(−2.411)	(−2.256)
Duration$_t$	0.041*	0.059**	0.083**	0.115**
	(1.746)	(2.503)	(2.148)	(3.004)
Stockcap$_t$	−0.005	−0.005	0.044	0.037
	(−0.259)	(−0.252)	(1.552)	(1.352)
Liquidity$_t$ (bid–ask spread)	2.227	4.075	62.938	63.806
	(0.215)	(0.406)	(2.513)	(2.492)
PIN$_t$	0.093	0.059	0.005	−0.048
	(0.811)	(0.526)	(0.026)	(−0.234)
Δ*Hedge Ratio*$_t$	4.858***	4.683***	3.515**	2.831**
	(4.002)	(3.670)	(2.214)	(1.986)
Market Turnover$_t$/*Volatility*$_t$	1.462***	1.394***	4.718***	5.269***
	(4.830)	(4.708)	(10.196)	(11.126)
Industry	Yes	Yes	Yes	Yes
No. of obs.	850	850	850	850
Adj. R^2	0.057	0.077	0.134	0.165

Notes. Reported are results of the regression specifications using a sample of deep-out-of-the-money put warrants. In this sample, we include only deep-out-of-the-money put warrants that have a Black–Scholes value less than 0.05. The variables are measured on a daily basis. Newey–West t-statistics (with four lags) are reported in parentheses.

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

Table A.2 Robustness Check: A-B or A-H Premiums

	A-B premium$_t$		*A-H premium*$_t$	
	(1)	(2)	(3)	(4)
Intercept	−12.187***	−12.408***	2.653***	2.630***
	(−13.199)	(−13.265)	(12.187)	(12.082)
Unexpected $Turn_{t-1}^{\text{warrant}}$	0.017***		0.002	
	(2.983)		(0.191)	
Unexpected IPD_{t-1}^{GARCH}		0.003		0.010*
		(0.638)		(1.930)
Put$_t$			0.056*	0.053*
			(1.793)	(1.712)
Duration$_t$	0.413***	0.417***	−0.032	−0.036
	(12.356)	(12.350)	(−1.380)	(−1.524)
Stockcap$_t$	0.544***	0.553***	−0.070***	−0.069***
	(14.177)	(14.226)	(−7.915)	(−7.781)
Liquidity$_t$	−4.612***	−4.582***	−1.705***	−1.701***
(bid–ask spread)	(−30.093)	(−29.675)	(−8.339)	(−8.343)
Market Volatility$_t$	−3.535***	−3.608***	−10.321***	−10.273***
	(−8.964)	(−8.985)	(−17.738)	(−17.682)

Table A.2 (Continued)

	A-B premium$_t$		*A-H premium$_t$*	
	(1)	(2)	(3)	(4)
Industry	Yes	Yes	Yes	Yes
No. of obs.	442	444	1,152	1,152
Adj. R^2	0.873	0.871	0.263	0.266

Notes. Reported are the results when the dependent variable is either an A-B or an A-H premium. We collect the subsample that has either a B-share or an H-share listed in the B-share market or on the Hong Kong Stock Exchange, respectively. *A-B premium* is log(A-price/B-price), and *A-H premium* is the log(A-price/H-price). B-price and H-price are adjusted by the exchange rate. The variables are measured on a daily basis. The *T*-statistics of coefficients are reported in parentheses.

*Significant at the 10% level; ***significant at the 1% level.

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