Analysis of

Price-Volume Relationship

In 2014-2016 Bull and Bear Markets

By

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An honors thesis submitted in partial fulfillment

of the requirements for the degree of

Bachelor of Science

Business Honors Program

NYU Shanghai

May 2017

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Abstract

Several important researches show that price is sensitive to volume to some extent. This paper seeks to further investigate the sensitivity of price to volume in a bull market and in a bear market. In particular, the paper is interested in the bull market before the 2015 Chinese stock market crash and the bear market after the crash, and the price-volume relationship in both market. I find that price is more sensitive to volume in a bull market than in a bear market. In other words, a rise of 100% in volume would have a stronger effect on price in a bull market. I also find that this relationship may result from the fact that there in bull market, there are more investors who trade based on wrong signals like price-volume pattern. It is not conclusive whether high-volume return premium may account for this relationship. Besides, since there are more shocks in bear market, the paper fails to conclude that larger visibility may have a larger impact on the price-volume relationship.

Acknowledgements

First and foremost, I would like to thank my thesis advisor, Professor David Yermack, for your guidance, patience and encouragement. Without your continuous support, this thesis would not have been possible. Thank you for sharing with me your valuable thoughts on the direction and analysis of the paper.

Professor Marti Subrahmanyam and Professor Jiawei Zhang, thank you very much for your commitment to the honors program. I really appreciate this great opportunity to conduct my research project and have weekly seminars on higher-level knowledge.

My fellow honors students, it is my great pleasure to study with you for a whole academic year. Thank you for all your support on my research project.

My mother, thank you for giving me the inspiration on my thesis. Without your interest in this area, I would not have considered doing research on my current topic.

My father, thank you for bolstering my courage when I faced difficulty during my research.

Price-volume relationship has long been a controversial topic. Theoretically price is not affected by volume, but only by risk, as indicated by many efficient market hypotheses (ex. CAPM). However, in the real market, research shows that price is in fact sensitive to volume to some extent. For example, the downward-sloping demand curve hypothesis (Shleifer 1986) pointed out that stock returns could be consistent with supply and demand affecting the value of a stock.

This paper is to investigate the sensitivity of price to volume in a bull market and in a bear market. Because of different market features in bull and bear market, the effect of volume to price should not be the same. I am particularly interested in the bull market before the 2015 Chinese stock market crash and the bear market after the crash, and the price-volume relationship in both market. I find that price is more sensitive to volume in a bull market than in a bear market. In other words, a rise of 100% in volume would have a stronger effect on price in a bull market. Moreover, the sensitivity is almost twice stronger in a bull market, meaning that given the same volume change, the price change in the bull market is nearly twice of that in the bear market.

I postulate that a higher sensitivity of price to volume in a bull than in a bear market is due to the fact that there are more positive shocks (i.e. a gain of 5% in value) in a bull market. However, result shows that there are indeed more positive shocks in a bear market, which failed to accept Millar (1977) and Mayshar (1983)'s claim that positive shocks should entail the price to increase. I also assume that high-volume return premium can explain the different price-volume relationship in bull and bear market. Gervais, Kaniel and Mingelgrin (2001) introduced a high-volume return premium that exists in the stock prices. They state that an abnormally high volume would cause the stock to outperform the ones that have a normal volume, and vise versa. My result reveals that in a bull market the average volume is higher than in a bear market, but the

difference is not so great. Hence the higher average volume may have caused the bull market to outperform the bear market but it is not conclusive whether the current volume difference is large enough to create such an impact. Finally, I presume that a larger number of irrational investments made by more investors in bull market would potentially caused the price-volume relationship to be stronger. Statistics of the real market and De Long, Shleifer and Summers (1990)'s opinion on, who they called, "noise traders" suggest that there are more irrational investors in bull market which would trade according to wrong signals like price-volume pattern, and thus leading to a stronger price sensitivity to volume.

The paper is organized as follows. Section I of the paper gives a general background of the 2014-2016 path of Chinese equity market. Section II describes the main hypotheses and the data. Section III presents the main result on price-volume relationship in bull and bear market. Section IV provides a conclusion.

I. Background

Starting from 1990 when Shanghai Stock Exchange and Shenzhen Stock Exchange were established, the Chinese stock market has experienced market cycles for nearly a dozen times. Figure I[1] is an overview of the Chinese stock market. It is quite clear on the graph that the market started to grow in 2014. It went to a peak in mid 2015, and crashed at an incredible speed. The 2015 bull market was thought to be the 11th bull market (Figure II[2]). From Mar 12, 2014 when Shanghai Stock Exchange Composite Index (SSECI[3]) closed at 1997.692 (with the lowest price of the day at 1974.382), the stock market experienced a relatively continuous growth, which since then never went below 1974. On July 22, 2014, SSECI closed at 2075.481, which was considered as the

[1] Figure from finance.sina.com.cn
[2] Figure from finance.sina.com.cn
[3] All SSECI information from finance.sina.com.cn

official starting point of 2014-2015 bull market, as it has broken the decreasing tendency since 2009 market crash. On Dec 8, SSECI closed at 3020.258, which broke through the 3000-line for the first time in 5 years. On Mar 17, 2015, SSECI went back to 3502.847. On Apr 10, SSECI closed at 4034.310, exceeding the 4000-line. On Jun 12, SSECI reached to its peak at 5166.350 (highest 5178.191). Compared to the price on Mar 12, 2014, SSECI obtained a gain of 158.6%.

Figure I

Figure II

As summarized by Junhui Qian, four major factors accounted for the bull market:

1. The policy was easing. The China Securities Regulatory Commission (CSRC) has loosen many financial related regulations to free up more money for trading.

2. The stimulation of economic activities by rising stock price.

3. There are an unprecedented number of investors. More than 30 million new accounts went into the stock market in early 2015.

4. Most importantly, there is "an unchecked building up of leverage".

Too much leverage inflated a huge stock market bubble in China, which later brought the market to turbulence (Figure III[4]). From Jun 12, 2015, SSECI lost almost one third of the value within only one month. The price dropped from 5166 to 3507.192 on Jul 8, 2015. Half of the listed companies filed for a trading halt to avoid more losses. Because of the government's direct investment in the market – the intervention of the so-called "National Team", SSECI has been stabilized for 3 weeks. However, the market continued to drop in late August 2015. SSECI closed at 2964.967 on Aug 25, revealing the failure to hold the "defense line" of 3000 points.

Figure III

Up to April 2017, the market went back and has been stable to 3000 points. The stock market bubble has been reduced.

II. Methodology

A. Hypotheses

My first objective is to figure out whether price is more sensitive to volume in a bull market. I intend to see whether the change of price is greater in a bull market or in a bear market with the same amount of change in volume. The null hypothesis here is

[4] Figure from finance.sina.com.cn

that price sensitivity to volume is the same in both markets.

As predicted by efficient market hypothesis, price should not have any relationship to volume since price is affected by risk. Howeverm, from mid 20th century, studies on price-volume relationship have shown that there is a correlation between change in price and change in volume. Ying (1966) made the point that prices and volumes should not be isolated because they are joint products of one single market mechanism. A larger/smaller volume is usually accompanied by and results in a rise/fall of stock price, and a large increase in volume would cause a large change in price. Shleifer (1986) examined DS Hypothesis, stating that the demand curve for stocks slopes down. Millar (1977) and Mayshar (1983) took another approach to see the investor's behaviors. They introduced the concept of visibility, indicating that any shock that attracts the investors' attention to one stock should result in a subsequent price increase. In other words, some investors may be interested in buying a stock if the change in volume of the stock does attract enough attention. Based on their theory, Gervais, Kaniel and Mingelgrin (2001) suggested a High-volume return premium, that is, "the stocks that experienced unusually high (low) trading volume outperform (are outperformed by) the stocks which had normal trading volume." Therefore, there are reasons to believe that price in some way is connected to trading activity.

So far the studies on price-volume relationship has taken all markets into consideration. However, it is inconclusive whether the relationship holds the same or different in different market conditions. One major market difference is the bull and the bear market. Bainbridge finds that there are several disparate market conditions in bull and bear market. Share prices are highly volatile in bull market. There are more investment activities. Such high volatility would also provide more opportunities for insider trading. In addition, not all the investors are rational. Day and Huang (1990)

separate the investors into α-investors and β-investors. They find that the majority of investors are within the β-investor's group, who are "market sheep" that flock into the market as it goes up, and vise versa. De Long, Shleifer and Summers (1990) state that many investors, typically the individual investors, fail to diversify their portfolio based on sophisticated research. They tend to enter the market by signals like price/volume pattern and past investment success rather than the risk of the stocks. Daniel, Hirshleifer and Subrahmanyam (1998) also discover that investor overconfidence about their information and biased self-attribution causes a market under- or overreaction.

As mentioned earlier, I predict that price is more sensitive to volume in a bull market. This may because visibility has a bigger impact in bull market. Based on Millar (1977)'s theory, if there are more shocks and these shocks attract more investors' attention, it may cause a larger price change. This may also because volume is generally larger in a bull market. As high-volume return premium states, the unusually higher volume in a bull market would result in a subsequent larger change of stock price. The third hypothesis is based on De Long, Shleifer and Summers (1990)'s theory. If there are a lot more investors in a bull market and these investors behave irrationally according to wrong signals like "price-volume pattern", the price may be more sensitive to volume. Therefore, these investors can potentially cause a stronger price-volume relationship.

Thus in generally the hypothesis to test are the following four:

I. Price is more sensitive to volume in bull market.

II. There are more positive shocks in a bull market.

III. The volume is higher in a bull market.

IV. There are more investors in a bull market.

B. Data

I started from testing whether price is more sensitive to volume in a bull market. The sample includes 100 company stocks trading only in Shanghai Stock Exchange[5]. In order to avoid the potential bias brought by the difference in stock exchange centers, the stocks in Shenzhen Stock Exchange are excluded from the sample. The 100 company stocks chosen are the stocks from the top one hundred companies that rank in market value. To examine the price change according to volume change, I conducted a daily sample of the price change and volume change for both the bull and the bear market. For each market, the time interval of the data is one year so as to get enough exposure to the data and to prevent from too much noise. The turning point is the day the market crashed, which is Jun 12, 2015. Therefore, for bull market I chose to observe the price and volume change from Jun 16, 2014 to Jun 12, 2015, and for bear market I chose to observe from Jun 15, 2015 to Jun 14, 2016. Eventually I got 24,544 observations for the bull market and 24,331 observations for the bear market.

C. Model

1. Regression of price change against volume change

My test on hypothesis begins from running a simple regression of price change against volume change separately for bull and bear market, in order to get a first glance to the price-volume relationship:

$$VolChange_{it} = log\ (Vol_{it}/Vol_{it-1})$$

$$PrcChange_{it} = log\ (Prc_{it}/Prc_{it-1})$$

Table I shows the result for the bear market. The coefficient of change in volume is

[5] Historical stock price data from finance.sina.com.cn

0.979% for bear market. This indicates that a rise of 100% in volume would affect the price by 0.979%. Such result means that there is indeed a price-volume relationship in Chinese stock market. The R-square is 2.27%, which is quite small. This is acceptable, because there are a lot of factors besides volume that can affect the stock returns.

Table I

Model Summary (Bear Market)					
S	R-square	R-sq(adj)	R-sq(pred)		
0.0298613	2.27%	2.27%	2.25%		
Coefficients					
Term	Coef	SE Coef	T-value	P-value	VIF
Constant	0.027277	0.000191	142.46	0.000	
Vchange	0.009794	0.000412	23.79	0.000	1.00
Regression Equation PriceChange = 0.027277 + 0.009794 VolumeChange					

Table II shows the result of the regression for the bull market. In this regression, R-square is 7.99%, still a quite small number for a similar reason to that in a bear market. However, the coefficient of change in volume is 1.64%, which means a rise of 100% in volume would affect the price by 1.64%. Compare to that in a bear market, which is 0.979%, the price is significantly more sensitive to volume in a bull market than in a bear market. The sensitivity is almost twice stronger in a bull market.

Table II

Model Summary (Bull Market)					
S	R-square	R-sq(adj)	R-sq(pred)		
0.0248207	7.99%	7.99%	7.97%		
Coefficients					
Term	Coef	SE Coef	T-value	P-value	VIF
Constant	0.019819	0.000146	135.43	0.000	
Vchange	0.016455	0.000356	46.16	0.000	1.00
Regression Equation PriceChange = 0.016455 + 0.015502 VolumeChange					

In order to test whether the coefficients of change in volume in the two regressions are significantly different from each other, or in other words, the volume change has significantly different impact on price in bull and bear market, I did a two-sample t test. I used bull and bear market as two samples, the two coefficients as mean, and the SE coefficients as standard deviations. Table III is the two-sample t-test result. The t-value is -1911.74, which rejects the null hypothesis that the difference is 0. Therefore, the coefficient of bear market is significantly different from that of bull market. This implies that change in volume in bear market has a different effect on price from that in a bull market.

Table III

Two-Sample T-Test (VolChange)				
Sample	N	Mean	StDev	SE Mean
Bear	24331	0.009794	0.000412	0.0000026
Bull	24544	0.016455	0.000356	0.0000023
Difference = μ (1) - μ (2)				
Estimate for difference:		-0.006661		
95% CI for difference:		(-0.006668,-0.006654)		
T-Test of Difference = 0 (vs ≠0):				
T-Value	P-Value	DF		
-1911.74	0.000	47745		

2. Regression of price change against abnormal volume

The model indicated above is truly the very first step to a conclusion. Hence, I began to see whether the result could still be held in a more sophisticated model. As indicated by the Gervais, Kaniel and Mingelgrin (2001), the price and volume relationship derive from the unusually high or low volume, in other words, the abnormal volume. Meulbroek(1992) introduced a model to detect abnormal volume, and abnormal return. Her estimation of abnormal volume is shown in Figure IV. She regresses log volume against the log of the total market volume on the day and the log volume for the stock on the two previous days, four dummy variables for days of the week, one for public announcement day, one for insider trading day and J dummy variables for "confounding interim news announcements. The lagged firm volumes are used to adjust for the serial correlation, and the dummy variables are used to adjust for day-of-the-week patterns in volume.

Figure IV

$$\begin{aligned}\log(v_{it}) = {} & \alpha_i + \beta_i \log(v_{mt}) + \lambda_1 \log(v_{it-1}) + \lambda_2 \log(v_{it-2}) + \delta_1 \mathrm{Mon}_{it} \\ & + \delta_2 \mathrm{Tues}_{it} + \delta_3 \mathrm{Weds}_{it} + \delta_4 \mathrm{Thurs}_{it} \\ & + \gamma_i \mathrm{Announce}_{it} + \eta_i \mathrm{Inside}_{it} + \sum_{j=1}^{J} \mu_{ij} \mathrm{News}_{ijt} + \varepsilon_{it} \qquad (6)\end{aligned}$$

I set up the model based on hers to calculate the abnormal volume in my case. I got rid of the variables that are not necessary in my calculation (i.e. the dummy variables for public announcement day, insider trading day and news announcements). Instead, I introduced a new dummy variable to indicate whether there is a trading suspension day before that trading day. This is because it is quite normal for a stock to stop trading for one day due to reasons like company announcement in the Chinese market. Therefore, my final model to estimate the abnormal volume is shown below:

$$log(v_{it}) = \alpha_i + \beta_i log(v_{mt}) + \lambda_1 log(v_{it-1}) + \lambda_2 log(v_{it-2}) + \delta_1 Mon_{it} + \delta_2 Tues_{it} + \delta_3 Weds_{it} + \delta_4 Thurs_{it} + \gamma_i Suspension_{it-1}$$

where:

1. *v represents trading volume in shares,*
2. *i subscripts the individual firm,*
3. *t subscripts days,*
4. *m represents the market (represented by the total shares traded on SSE),*
5. *Mon_{it} is a dummy that equals one on Mondays and zero otherwise, etc.*
6. *$Suspension_{it-1}$ is a dummy that equals on if there is a suspension day before the trading day, and zero otherwise.*

I included the data of both bull and bear market in one regression to get the abnormal volume, which consists of more than 48,000 observations. Table IV is the model summary of the regression. The R-square is 91.59%, which is high enough to justify the result. So I took the residuals gained from the regression. These residuals indicate the "abnormal volume" for each stock on each day.

Table IV

Model Summary (Abnormal Volume Calculation)					
S	R-square	R-sq(adj)	R-sq(pred)		
0.408563	91.59%	91.59%	91.58%		
Coefficients					
Term	Coef	SE Coef	T-value	P-value	VIF
Constant	-2.6191	0.0812	-32.26	0.000	
Log Vol(mt)	0.15382	0.00372	41.40	0.000	1.25
Log Vol(it-1)	0.67466	0.00431	156.55	0.000	10.80
Log Vol(it-2)	0.26244	0.00428	61.35	0.000	10.65
IsMonday	0.08035	0.00591	13.6	0.000	1.62
IsTuesday	0.01342	0.00586	2.29	0.022	1.65
IsWednesday	0.00876	0.00586	1.49	0.135	1.64
IsThursday	-0.0175	0.00591	-2.96	0.003	1.62
w/ suspension(t-1)	-0.4082	0.0562	-7.27	0.000	1.00
Log Vol(it) = -2.6191 + 0.15382 Log Vol(mt) + 0.67466 Log Vol(it-1) + 0.26244 Log Vol(it-2) + 0.08035 IsMonday + 0.01342 IsTuesday +0.00876 IsWednesday - 0.01750 IsThursday					

III. Data Analysis

A. Result on Hypothesis I

With the abnormal volume, I regressed the price change against the abnormal

volume separately for the bear market and the bull market, in order to see the coefficient on the abnormal variables in the two regressions.

The result is shown in Table V. In a bear market, the coefficient of abnormal volume is 0.95%, which means that a rise of 100% in abnormal volume affect the price by 0.95%. Because of other factors that also affect price change, the R-square is still quite small.

Table V

Model Summary (Abnormal Volume-Bear Market)					
S	R-square	R-sq(adj)	R-sq(pred)		
0.0285363	1.98%	1.98%	1.96%		
Coefficients					
Term	Coef	SE Coef	T-value	P-value	VIF
Constant	0.027092	0.000183	148.05	0.000	
AbnormalVol	0.009548	0.00043	22.19	0.000	1.00
Regression Equation PriceChange = 0.027092 + 0.009548 AbnormalVol					

While in a bull market, as shown in Table VI, the coefficient is 1.7%, meaning that a rise of 100% in abnormal volume affect the price by 1.7%. Therefore, price is still more sensitive to volume in bull market, and the sensitivity is also nearly twice strong. Comparing to the result in the simpler model discussed earlier, the results are in fact almost identical.

Table VI

Model Summary (Abnormal Volume-Bull Market)					
S	R-square	R-sq(adj)	R-sq(pred)		
0.0217345	8.73%	8.72%	8.71%		
Coefficients					
Term	Coef	SE Coef	T-value	P-value	VIF
Constant	0.019859	0.000139	143.1	0.000	
AbnormalVol	0.01719	0.000335	48.44	0.000	1.00
Regression Equation					
PriceChange = 0.019859 + 0.01719 AbnormalVol					

Similar as what I have done for the previous regression, I did a two-sample t-test to test whether the coefficient difference is significant. I also used bull and bear market as two samples, the coefficients as means, and SE coefficients as standard deviation. The results are shown in Table VII. The t-value is now -2190.43, which also rejects the null hypothesis that the difference is 0. Hence, there is still a significant difference in coefficients of the two markets, implying that change in volume in bear market has a different effect on price from that in a bull market.

Table VII

Two-Sample T-Test (Abnormal Volume)				
Sample	N	Mean	StDev	SE Mean
Bear	24331	0.009548	0.000430	0.0000028
Bull	24544	0.017190	0.000335	0.0000021
Difference = μ (1) - μ (2)				
Estimate for difference:		-0.007642		
95% CI for difference:		(-0.007649,-0.007635)		
T-Test of Difference = 0 (vs ≠0):				
T-Value	P-Value	DF		
-2190.43	0.000	45931		

The results I got in both models are in the same general range as that found by Meulbroek (1992) in the US market, indicating that the result is quite reasonable. Compare the results of the two models, it shows that the results are actually similar. In

the second model when regressing price change against abnormal volume, price shows a slightly stronger sensitivity to volume in bull market and a slightly weaker one in bear market, which increases the difference between the markets. Overall price is more sensitive to volume in a bull market, and such sensitivity is about twice stronger.

B. Result on Hypothesis II

With such a preliminary conclusion, my next step is to figure out whether price is more sensitive to volume in bull market because of more positive shocks and more visibility. As suggested by Millar (1977), although volume in theory does not affect price, a positive shock may become good news for the stock, attracting lots of attention, and thus entailing the price to rise.

I defined a positive shock as a gain by 5% in one day, and accordingly, a negative shock as a loss by 5% in one day. I calculated the number of positive and negative shocks separately for bull market and bear market. The results showed in Table VIII. In the bull market, there are 1387 positive shocks. Among them, 420 are limit-ups, meaning that the gain of the day has reach to a daily limit of 10% in value. In a bear market, however, there are 1716 positive shocks and 563 of them are limit-ups. Although there is fewer trading days included in my observations for bear market, there are more positive shocks and more limit-ups. Thus it is hard to conclude that more positive shocks cause the bigger sensitivity of price to volume in bull market, as the mathematical result is the opposite way. I also calculated the number of negative shocks and limit-downs (i.e. the loss of the day has reach to a daily limit of 10% in value). There are 2392 negative shocks (790 are limit-downs) in a bear market, while only 628 negative shocks (96 limit-downs) in a bull market. The number of negative shocks and limit-downs are also greater, and is in fact almost 4 times of that in bear market, while

the number of positive shocks is less than 1.3 times. In fact, the theory seems to apply more in a bear market than in a bull market. Thus it is inconclusive whether shocks has an impact on price-volume relationship.

Table VIII

Number of Shocks		
	Bull Market	Bear Market
Positive shocks	1387	1716
Limit-ups	420	563
Negative shocks	628	2392
Limit-downs	96	790

C. Result on Hypothesis III

In order to test the volume effect on the sensitivity of price to volume, I calculated the average volumes in both markets, with the result shown in Table IX. In bear market, the average volume is approximately 29 billion, while in bull market, the average volume is 33.7 billion. Although this indicates that the volume is generally larger in a bull market, the difference is not so great. Therefore, high-volume return premium may be a reason for a stronger price-volume relationship in bull market. A larger volume in the bull market may cause the stocks outperform the one in the bull market. However, since the difference is not so great, it is still inconclusive whether the slightly higher volume in bull market in this case is strong enough to affect the price sensitivity to volume.

Table IX

Average Market Volume		
	Bull Market	Bear Market
Average Volume	33,709,880,595	29,245,461,174

D. Result on Hypothesis IV

The last hypothesis to test is the impact of the number of investors in both markets. Figure V[6] shows the number of new A-Share Accounts in Chinese stock market from 2003 - 2015. Several important information are shown on the graph. First, this graph has a very similar pattern to the stock market price pattern (Figure VI[7]). When in a bull market, the number of new A-share accounts increase significantly. In a bear market, there are clearly fewer new accounts. Second, the number of new individual accounts is far more than the number of new institutional accounts. In fact, statistics shows that in China, unlike other countries like US, 85% of the investors are individual investors. The trading activities are mainly made by these individuals. De Long, Shleifer and Summers (1990) believe that the individual investors are the typical traders who did not trade based on financial knowledge, and thus bring abnormal reactions to the market. They imitate other successful investors' investments or they rely on "pseudosignals". Day and Huang (1990) indicate that majority of the investors buy into a rising market, and sell out of a falling market. Given that China has such an enormous number of individual investors who lack of financial knowledge in the bull market, their trading activity may involve a lot of irrational deals. The market behaves more differently than it theoretically should do, and thus causes the price to have stronger sensitivity to volume.

Figure V

[6] Figure from Qian's paper (Reference [9])
[7] Figure from finance.sina.com.cn

Figure 5: Number of New A-Share Accounts

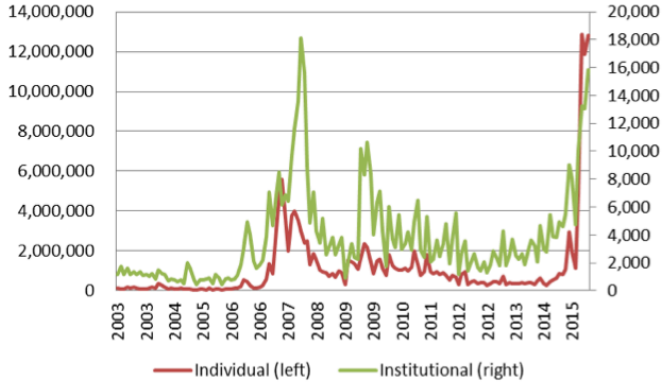

Figure VI

IV. Conclusion

Recent experience shows that in the Shanghai market, price is more sensitive to volume in a bull market than in a bear market. The relationship between price and volume is about twice stronger in a bull market. High-volume return premium may account for the stronger sensitivity of price to volume in bull market. It may also because a large number of individual investors behave irrationally in the market. In addition, it is not certain whether positive shocks and larger stock visibility also have a bigger impact on the price-volume relationship in a bull market.

This paper needs a stronger reason and explanation on why price is more sensitive to volume in bull market. Currently there is still a gap between the statistical result and the broader reasons behind the result. In other words, a detailed explanation or

calculation is necessary. The result of this paper also needs to be tested on an even more sophisticated model to avoid more noises and include more factors. Currently the paper only takes stocks in Shanghai Stock Exchange into consideration. Stocks trading in Shenzhen Exchange also need to be included in the sample, because these stocks are counted for the other half of the Chinese stock market. Finally, trading activities during other period of time is another sample that is necessary, in order to prove that the current price-volume relationship is not a market coincidence.

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