Market Manipulation Monitoring Model and Its Application to Chinese Market

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Abstract

This report explores a new model and methodology for detecting price manipulations in a financial market with large traders. This method is first tested using public stock data on known historical cases of market manipulations. Its effectiveness is then further examined using the private data obtained from the Shanghai Stock Exchange. Based on our preliminary findings, further research topics are presented at the end of the report. [1]

[1]We would like to take this opportunity to thank Xinghai Fang, Ruyin Hu, Zhigang Liao, Yigen Tian, Fenghua Wang, Gang Zeng, Congjiu Zhu for their generous support and help throughout the project. We thank also Qi Chen, Bin Fu, Lie Lou, Liuyi Pi, Bo Que, Gang Wei, Xiaojing Zhang, and Xiaoping Zhao for kindly providing valuable data and research assistance.

1 Introduction

In a financial market, it is known that a large trader can influence the market price of an asset. If his/her holding is significant enough, the large trader can in fact manipulate the market. (See Jarrow(1992,1994) [10, 11]). In China, there have been quite a few market manipulation cases reported, such as the case of LuJiaZhui(600663) from September 8, 1996 to October 31, 1996, and the case of YiAnKeJi(000008) from October 5, 1998 to February 5, 2001. All these cases have had profound negative effect on the development of a healthy Chinese stock market.

Moreover, market manipulations can potentially damage the construction of the Chinese market as well, in particular the derivatives market. This is because losses from the market manipulation with derivatives could be up to hundreds times more than those without. In other words, the negative effect by larger traders' manipulations can be magnified in a market with derivatives. Indeed, theoretic studies by Jarrow [10, 11] pointed out that the manipulator can in fact have arbitrage opportunity by manipulating a market with derivatives.

In order to prevent the market manipulation, it is critical to monitor the manipulation in the first place. Although experienced investigators or financial analysts generally have a feel about the existence of manipulations from real-time trading prices and volumes, the accuracy of their detection is unknown, and a systematic quantitative method is highly desirable.

Clearly, a reasonable detection method should be based on analyzing large trader's virtual holding with information that is easy to obtain. There was an earlier attempt along this line by monitoring a particular stock holding in traders' registered accounts. Unfortunately, this method is complicated and does not fit for the Chinese market where a large trader can disguise himself by illegally obtaining several, even over hundreds of trading accounts registered under different names. Thus, he/she in general can create the illusion of a high demand for a particular stock and an inflated stock price by trading among his/her own accounts. Therefore, monitoring a registered account will not be sufficient to estimate accurately large trader's actual holdings, and an alternative tractable and simple method is required.

In response to this need, in this report we provide a simple monitoring method which is based on estimating both the change of volumes and the change of prices.

Outline of the report: We will first explain why it is more difficult to monitor market manipulations in the Chinese market than in US; We will then review some recent research on the topic of market manipulations; Next, we will present our model and test its performance based on the public data. We further test this model with the private data. Finally, we will discuss the limitations of our model and present some future research topics.

2 Comparison between Chinese and US markets

As we will see, both China and US have similar laws regarding market manipulations. However, there is a huge difference in terms of their efficiency between the two markets. In this section, we will attempt to resolve this myth by looking at these differences between the two countries from a social perspective.

2.1 Comparing the definitions for price manipulations

By comparing term by term the definitions of price manipulations between US and China, (see Table 1), it is clear that they are very similar. However, while there has been rarely any case of large scale price manipulations in US since the establishment of Security Exchange Act and SEC, there were more than twelve [2] manipulation cases reported by CSRC in China from year 1996 to year 2005. Fundamentally, we believe that this discrepancy is due to the lack of an efficient social system in China that is compatible with the rapidly-growing market.

2.2 Comparing factors that prevent manipulation in China and US

2.2.1 Factors that prevents manipulation in China

- $T + 1$ rule:
  In China $T + 1$ was established in order to prevent manipulations. Although this rule enjoyed some degree of success, it nonetheless reduces

[2] The actual number could be higher.

the efficiency of the market. Moreover, some traders, such as Nibo trader, did succeed in exploiting this rule to achieve manipulations.

- 10 percent price change limit:
  10 percent price change limit has historically succeeded in controlling the range of manipulation within a day. However, it too has clearly a negative effect on the efficiency of the Chinese market.

- One side market:
  One side market without the mechanism of short on one hand efficiently prevents manipulators from using the short-and-dump strategy. Nevertheless, this restriction on the market effectively reduced the market efficiency as wll.

In summary, all these market controlling mechanisms in China do help to prevent market manipulations to a certain degree, yet at the cost of the market efficiency.

2.2.2 Factors that prevent manipulations in US

In contrast, US seems much more successful thus far in preventing price manipulations while avoiding damaging the market efficiency. Here are some factors that may have contributed to this success.

- Maturity of investors:

  Since the establishment of US stock market in 1802, the US market has significantly matured, especially since the famous 1929 market crash. An indicator of this maturity is that over 80 percent of US market capital has been managed by financial institutions since 1960s.

  In China, in contrast, most of the capital is controlled by small investors, who could easily fall into the trap of manipulators.

- Social Security System:

  In US, the Social Security System (SSS) was established in 1933. And it has since helped to stop manipulations enormously. Under this SSS, everyone is required to have a Social Security number to be a legal employee. This social security number keeps the record of its holder's credit history, and helps to prevent manipulators from utilizing other people's accounts. Because very few people would be willing to risk his own credit to help the manipulator, it has effectively prevented anonymous tradings by making manipulations both costly and risky.

In China, due to the lack of a corresponding SSS, almost every manipulation involves up to thousands individual accounts. For instance, the case of Yian Tech in 2001 involved an illegal trading with 627 individual accounts.

In short, despite the similarity between China and US laws, there are significantly different factors that make manipulation prevention inefficient in China. As such, the most realistic way is to develop a more advanced technique, in compensation for the lack of support from its social system. And this is the main focus of our current effort and report.

3 Research on market manipulations

Although market manipulations could be dated back as early as the 18th century, academic research on this topic started only in 1990s. The reason is that there was virtually no large scale manipulation in US security market since the establishment of SEC and SEC law and before 1980s. However, since the 1980s, with the introduction and the rapid growth of the derivatives market, [3] chances of market manipulations have increased dramatically. For example, it is known that, unlike the the traditional manipulation methods, a clever combination of derivatives and their underlying securities will enable a manipulator to make huge profit at relatively low cost and very little risk. Naturally, this new manipulation method with derivatives attracts the attention of academic researchers.

3.1 Some literature review

In 1992 and 1994, R. Jarrow wrote two papers that are perhaps the earliest to study manipulations systematically. The first paper [10] studies the arbitrage strategy for a large trader in the futures market; and the second

[3] This is largely attributed to the Black-Scholes-Merton' pioneering work on derivative pricings.

one [11] deals with the arbitrage strategy for a large trader in the options market. Along the line of Jarrow's earlier research, Bank and Baum(2004) [2] consider hedging from the perspective of a large trader. One of their main (and curious) conclusions is that a large trader is in a dis-advantageous position compared to small traders. This seems unrealistic, at least for a Chinese market. Cvitanic and Ma (1996) [6] consider the pricing problem in the presence of a large trader. Recently, Jarrow and Protter(2005) [12] investigate the problem of how a small investor can make a profit when there is a large trader in the market. Another recent paper by Aggarwal and Wu (2004) [1] analyze some small cap OTC stocks that could have been manipulated and conclude that manipulation does damage the market efficiency. Finally, a very recent paper by a Chinese researcher Lin studies the relation between the number of large share holders and manipulations based on studying the Chinese market.

3.2 Our model and its application to Chinese market

In this section, we present a model of price dynamics and apply this model to detect manipulation on some stocks that were historically known to have been manipulated. The goals of our detection methods are:

- (A), to provide an estimation of the time period when the large trader switches from buying to selling the stock.
- (B), to enable us to identify the pump phase of dump-and-pump manipulation.

3.2.1 Models for price dynamics

We first present a general price dynamic model of the following form:

$$S_t = S_0 \exp(h(X_t) \exp((\mu - \frac{\sigma^2}{2})t + \sigma W_t), \tag{1}$$

where S_t represents the price of a stock at time t, with S_0 being the current stock price (at time 0); $h(\cdot)$ is an increasing function with $h(0) = 0$ that represents the large trader's influence on the stock price; X_t is a nonnegative random process representing the large trader's holdings, μ and σ are the mean return and the volatility of the stock. W_t is a standard Brownian motion as the underlying uncertainty driving the stock price.

Note that when X_t increases, so does the stock price; when the large trader short sells the stock, the price decreases. In particular, when $X_t = 0$, i.e., the large trader holds no shares, then the stock price follows the well-known Black-Scholes-Merton model for a complete market where there are no market manipulations. Therefore, the incorporation of X_t into the classical Black-Scholes-Merton model underlines the larger trader's influence on the stock price.

Obviously, one focus of our research is to determine the particular form of $h(\cdot)$. We start by assuming that $h(\cdot)$ is a linear function. In the future we hope to test this linear assumption by analyzing financial time series data.

Now, we are to analyze on some historically manipulated stocks listed in Shanghai Stock Exchange for our model (2) where h is linear, i. e.

$$S_t = S_0 \exp(\lambda X_t) \exp((\mu - \frac{\sigma^2}{2})t + \sigma W_t). \tag{2}$$

3.2.2 Manipulation and switch time detection using linear h and public data

Recall that our goal for detecting manipulation is (A) to determine the switch time from buy to sell, and (B) to identify the dump phase. Now, given this linear model of (2), the basic idea is to detect the change of λ, and use this λ change as our basis to estimate the switch time.

In addition, we are going to test if manipulation is implied in a period when there are both price increase and volume increase, via comparison of λ at different time periods. The motivation for this test is to determine whether prices and volumes increases are the result of a market manipulation or they are simply from the influence of the general market .

we first report some results from our analysis on the Stock 600878 using the public data in Section 3.2.2. Note that this part of the analysis was carried out without any prior knowledge from the private data. For comparison, we will re- examine the results with those obtained based on the private data in Section 3.2.3.

The public data sets We collect the public data of manipulated stocks including stocks with IDs 600878, 600718 and 600758, respectively. The relevant information includes the trading time, the stock ticker, the open price, the close price, the maximum price and the minimum price. We have collected additionally the corresponding fundamental information of each stock, such as its dividend payoff and split.

We chose these data sets because of their manipulation cases according to the disclosure by CSRC from 1996 to 2003. For example, according to the report by CSRC, South Security used their own account, two institutional accounts and 15 individual accounts to trade 600878 continuously. The stock price rocketed from 8.86 Yuan a share on October 17, 1996 to 16.25 Yuan/share on October 31, 1996, with more than 80 percent price increase. On October 21, 22 and 23, South Security purchased respectively 2.23, 1.27 and 1.64 million shares, each of which accounting for 35.93, 35.58 and 49.04 percent of the total market trading volume.

By December 31, 1997, the holding by South Security increased up to 17 million shares, or 60.61 percent of the total outstanding shares of stock 600878. Meanwhile, South Security did match sale between its 18 accounts. For instance, on November 5, 1996, there were 14 match sales of total $700,000$ shares, or 20.73 percent of the trading volume; and on January 14, 1997, there were 27 match sales of about $400,000$ shares, or 33.16 percent of the market trading volume. Table 2 shows the hourly total holding by South Security from October 18, 1996, to April 25, 1997.

Determine the switch time With only public data sets available, it seems impossible to directly estimate λ for detecting manipulations. We thus use an approximation method, postulating that the large trader's holding is equal to the total volume times a certain constant.

However, this method is only valid during the large trader's buy-in period of time, and it fits best when stock price increases with the increase of the trading volume.

Statistical analysis, compared to CSRC report First, as revealed in the report by CSRC, South Security bought large volume of 600878 from October 21, 1996 to January 23, 1997/23/1997.

In Chart 1, the first picture represents the daily return of the stock, with the line in black for the virtual return of this stock and the line in light for the return from the regression method according to Eq. (2); the second picture displays the actual stock price, with the black line representing the virtual stock price and line in light color representing the price by the regression analysis.

From Chart 2 we see that our approximation method fits the actual situation fairly well.

Secondly, according to the report of CSRC, South Security started to sell the stocks from March 24th, 1997, to April 25, 1997. But the report does not specify the activity of the South Security from January 24, 1997 to March 24, 1997. If South Security kept buying the stock until March 24, 1997, then our regression analysis should fit well the actual price and return. However, clearly Chart 3 shows the opposite, implying that South Security in fact started selling its holdings before the date of March 24th.

The question is: When exactly?

Below we show how to estimate this actual selling date. Recall that we approximate the large trader's holding by using the actual total trading volume times a certain constant, and this approximation method is valid if and only if the large trader is longing the stock and the price is increasing. So, if the large trader has instead already been shorting the stock, the method applied above would present an underestimated λ. Therefore, by observing the change of λ, we can effectively detect when the large trader is selling the stock. Chart 4 shows the regression analysis from October 23, 1996 to April 23, 1997. Note that there is a significant decease of λ on March 7, 1997, implying a possible earlier switch day of March 7, instead of March 24.

Remark 1 *After analysis using the private data, we find remarkably consistent results indicating that the actual switching day was March 5th, and that the major selling started on March 7.*

The same method can be applied to detect the switch time of manipulation of 600718 and 600758. As Chart 5 and Chart 6 illustrate. For example, our analysis shows that switch dates are March 7, 1997 for stock 600718, (see Chart 5) and February 17. 1997 for stock 600758, (see Chart 6), respectively.

Detecting manipulations As aforehand mentioned, an experienced practitioner may detect the existence of market manipulations of large traders by his/her intuition. But this intuition can be both unreliable and inaccurate. Moreover, in a bull market, it is more difficult to tell if the price and volume increase is due to the general benign market environment or if there is an additional market manipulation.

We will illustrate, via case studies, how to use our model to differentiate these two scenarios.

Recall again that the λ obtained through the regressed analysis corresponds effectively the to actual λ in Equation (2) times a certain constant. This constant is the ratio of shares traded by the large trader to the total market volume. Therefore, the larger the regressed λ, the higher the probability that there is a manipulation.

Table 2 list all dates when the stock prices of 600878,600718 and 600758 increase, with their corresponding λ's during the time periods. The red marks of λ indicate the time periods for which an existence of manipulation was known, and the yellow marks of λ suggest some possibility of a manipulation, because of a relatively large value of λ.

For example, for stock 600878, its value of λ reached it maximum during the period of May 18, 1999 and August 4, 1999. However, it is not immediately obvious that there WAS a market manipulation in spite of a big value of λ, because this period coincides with the event May 19 when the general market enjoyed a significant bull run. To exclude the possibility that the increment of λ is due to the effect of a bull market, we estimate the λ's for stocks 600718 and 600758 in the same period of time. Both stocks of 600718 and 600758 enjoyed trading volume and price increases during this period. Nevertheless, their λ were all within normal ranges. From this comparison, there is a strong suspicion of market manipulations for stock 600878. In fact, there was additional information with which this suspicion is confirmed.

Remark 2 *In Chart* 5 *there is also a suspicion of market manipulation for stock 600718 from December 16, 1997 to January, 8, 1998, which has yet to be verified.*

3.2.3 Re- Examining the model with private data

The private data we gather for analysis and comparison are from the historically manipulated stocks traded Shanghai Stock Exchange, including stock ID 600878. We collect the stock data in terms of minutes, and the information we have gathered includes the trading time interval, the stock ticker, the last trading price, the average trading price within a minute, the trading volume, and the number of outstanding shares. Most of the manipulations were disclosed by CSRC from 1996 to 2003. We also collect the corresponding fundamental information of the stock, such as the dividend payoff and stock split.

In addition, we include the entire record of intra-day trading. This consists of the trading time, trading record code, trading price, trading volume, the account number of the buyer, and the account number of the seller.

We identify the manipulator's account numbers of the Manipulator (South Security) based on the reports from CSRC and the intra-day data. Based on the accounts, we treat match sales between their own accounts as a buy. We generate the daily holding volume of South Security in the Chart below.

Re-Examine the result in Session 3.2.2 Recall that in Section 3.2.2 we have concluded, based on analysis with model (2) with the public data that South Security started to sell their stock at around March 7, 1997. Our analysis with the private data (shown in Chart 7) shows that South Security in fact started to sell earlier, on March 5th, 1997, and large amount of sell occurred on March 7, 1997. This new finding is consistent with our earlier effort, only more accurate with the help of additional privately-held data.

Re-Examine Model (2) Recall that in the model (2), we assume the stock price dynamics follows

$$r_t = lnS_t - lnS_0 = \lambda \Delta X_t + u + \epsilon_t \tag{3}$$

Notice that this model applies to the case when the stock is under a price manipulation. To exclude the influence of other factors, such as the release of stock split plans on Jan. 16, 1997 and on April 14, 1997, we remove one week's data after the release of the plans. Table 3 and Chart 8 below show detailed results based on the regression analysis. It shows that the value of F test is 23.16 with $p < 0.0001$, implying a 99.99 percent confidence that the assumption of linearity is valid. The relation is

$$r_t = \Delta X_t \times 1.6053 \times 10^{-8} + 0.00362. \tag{4}$$

3.3 Future work

The main focus of our future research is to explore further the assumption of the linearity of $h(\cdot)$. With more stock data, we hopefully can compare and screen out the effect of irrelevant factors and test the linearity of the relation between return and holdings by a large trader. If successful, a complete method can be formulated to detect manipulation in all period of time.

4 Conclusion

In this report we have discussed the motivation and urgency of developing a more advanced technique in the Chinese market to prevent market manipulations. A price dynamics model is presented. Its effectiveness is tested with sample stock data, and further cross-tested with the private data. So far it can be applied only to the price-up-volume-up period. Our future research effort is to complete the model for all phases so that it that can be applied to detect manipulations at any given time.

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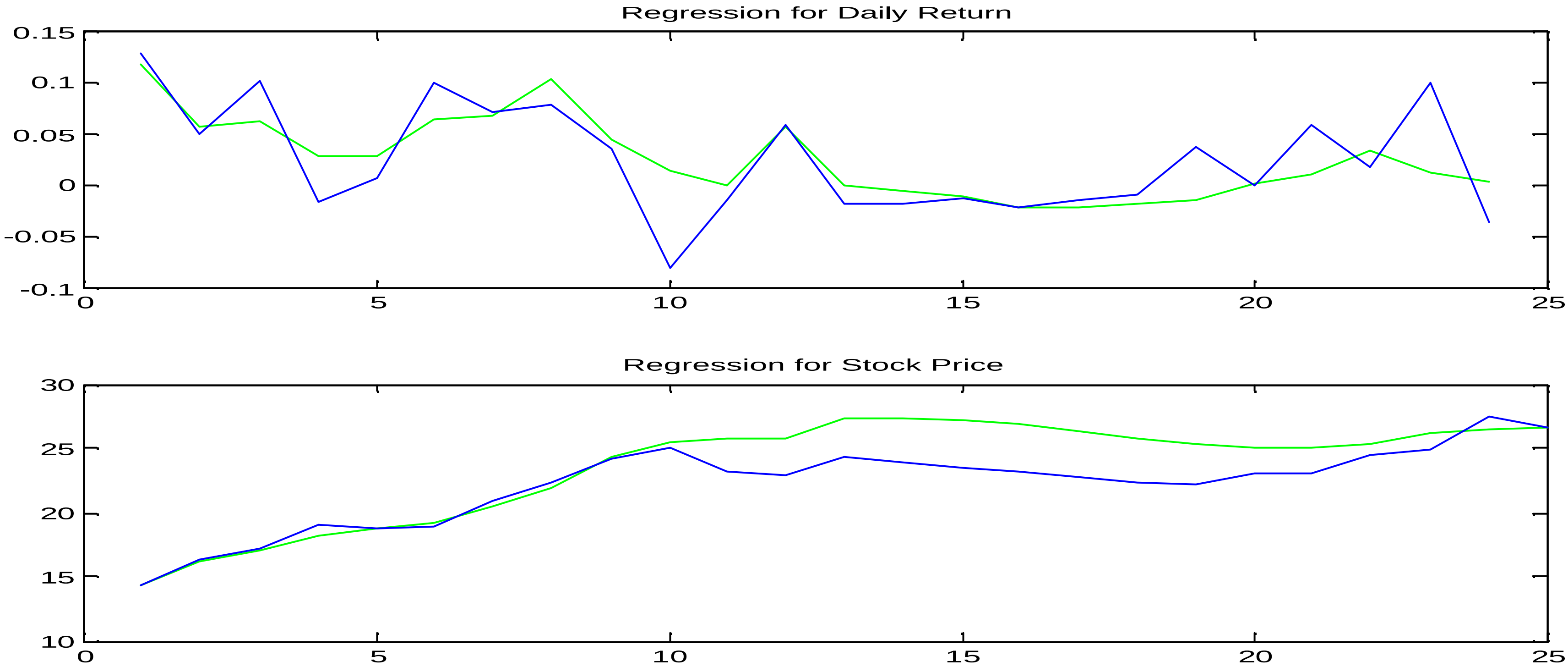


Chart 1:Regression of 600878 (10/21/96-01/23/97)

a. The upper picture displays the return, with blue line for the original, Green line from the regression.

b. The lower picture displays the stock price, with blue line for the original , green from the regression.

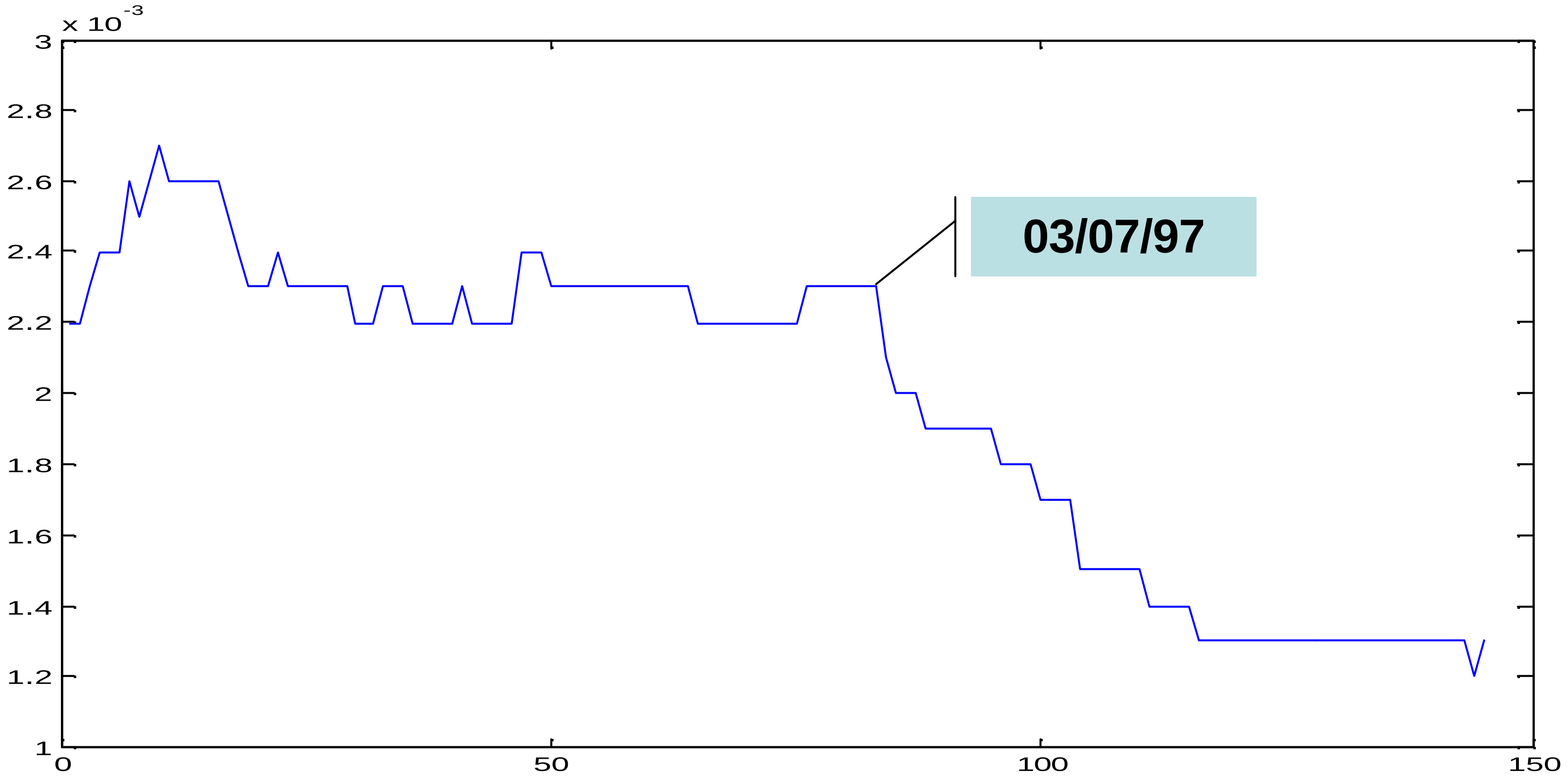
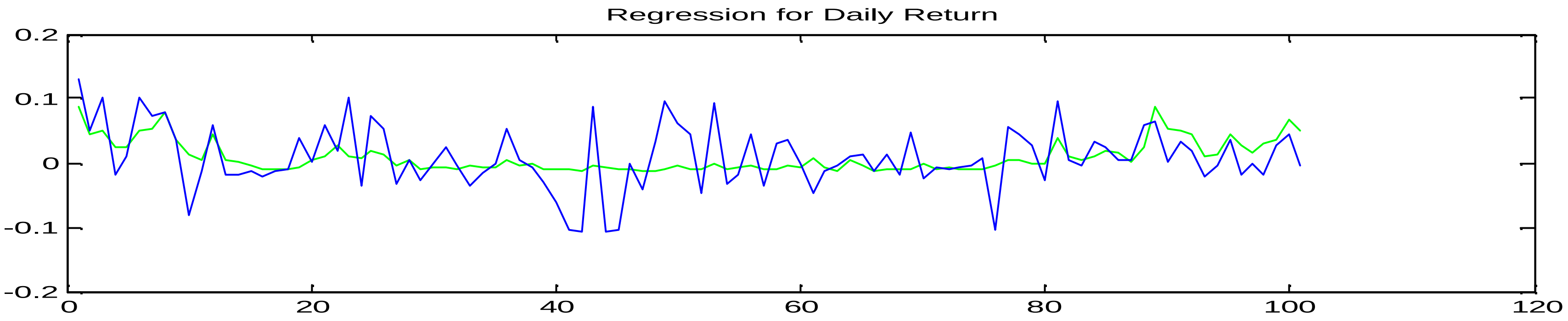


Chart 2:

l from regression from 10/17/97 to 04/25/97.



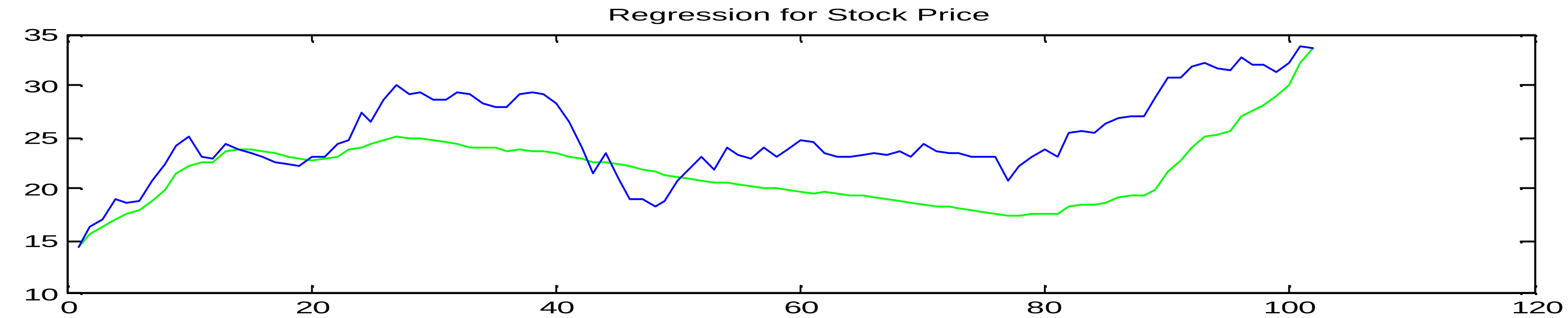
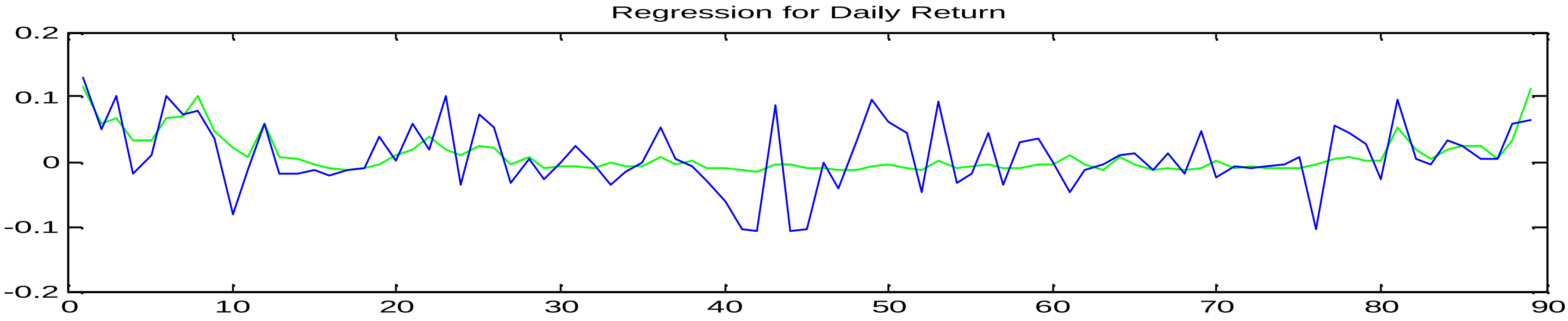


Chart 3:Regression of 600878 (10/21/96-03/25/97)

a. The upper picture displays the return, with blue line for the original, Green line from the regression.

b. The lower picture displays the stock price, with blue line for the original , green from the regression.



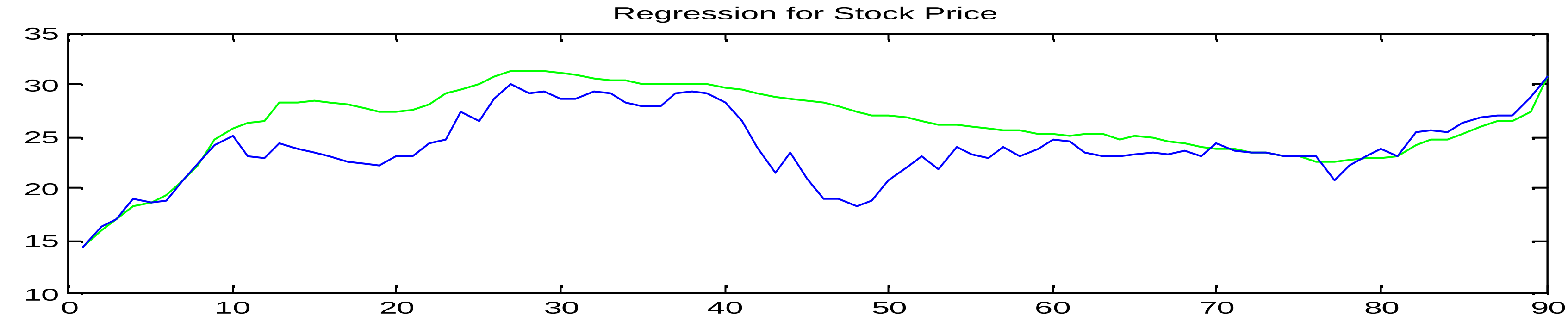
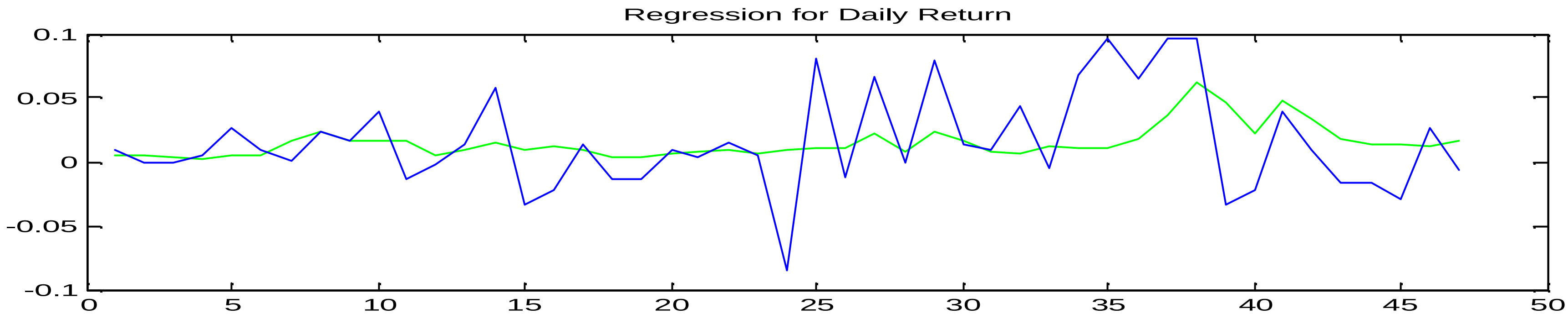


Chart 4:Regression of 600878 (10/21/96-03/07/97)

a. The upper picture displays the return, with blue line for the original, Green line from the regression.

b. The lower picture displays the stock price, with blue line for the original , green from the regression.



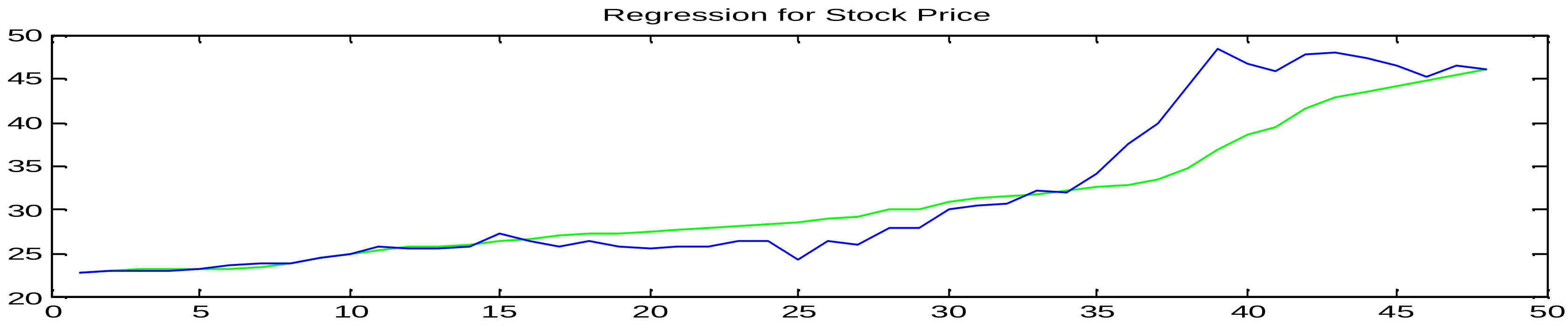


Chart 5:Regression of 600718 (01/02/97-03/07/97)

a. The upper picture displays the return, with blue line for the original, Green line from the regression.

b. The lower picture displays the stock price, with blue line for the original , green from the regression.

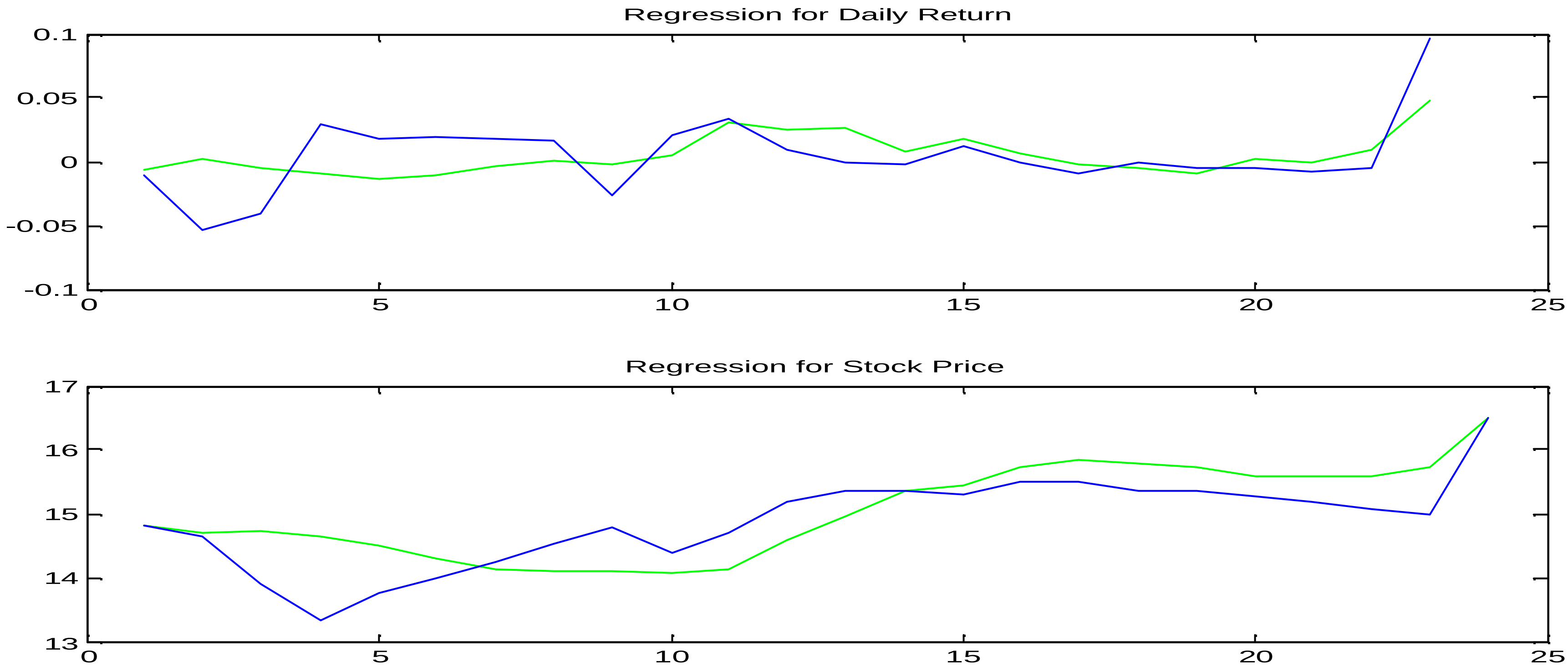


Chart 6:Regression of 600758 (01/02/97-02/17/97)

a. The upper picture displays the return, with blue line for the original, Green line from the regression.

b. The lower picture displays the stock price, with blue line for the original , green from the regression.

美国对价格操纵定义	中国对价格操纵定义
Section 9 of the Exchange Act : 1．To effect, alone or with one or more other persons, a series of transactions 2．Creating actual or apparent active trading in such security 3．For the purpose of inducing the purchase or sale of such security by others.	1.《禁止证券欺诈行为暂行办法》:以抬高或者压低证券交易价格为目的，连续交易某种证券。 2.《证券法》 ：第 71 条：连续买卖，相互委托，冲洗买卖，其他操纵行为。

Table 1: **中美法律对市场价格操纵定义比较**

Stock Number	Period	λ	Stock Number	Period	λ	Stock Number	Period	λ
600718	01/02/97-03/25/97(M)	0.0047	600878	10/23/96-03/07/97(M)	0.0023	600758	1/1/97-4/1/97(M)	0.0029
	05/12/07-06/02/97	0.0019		04/14/98-04/30/97	0.0013		01/08/98-02/18/98	0.0016
	10/21/97-11/18/97	0.0039		04/14/98-05/03/98	0.0013		05/18/98-08/04/98	0.00091
	12/16/97-01/09/98	0.0054		08/20/98-10/17/98	0.00079		09/16/98-10/15/98	0.00028
	03/13/98-04/13/98	0.0018		03/30/99-04/30/99	0.0014		03/08/99-03/22/99	0.00059
	05/18/99-08/09/99	0.0013		05/18/99-08/04/99	0.002		05/18/99-08/02/99	0.00036
	10/21/99-02/18/00	0.00058		01/21/00-02/21/00	0.00062		07/28/00-08/18/00	0.0016
	07/06/00-08/10/00	0.00097		04/12/01-05/29/01	0.0006		10/19/00-11/15/00	0.0013
	10/24/00-11/10/00	0.00013		02/27/02-03/14/02	0.00046		12/19/00-01/09/01	0.0011
	04/16/01-05/17/01	0.00013					07/09/02-08/27/02	0.0015
	06/21/02-06/28/02	0.00012					08/05/03-09/08/03	0.0013

Table 2: l from regression for 600878,600718 and 600758 in various price-up-volume-up periods from 01/01/97-12/31/03. Cells in red include the manipulation period disclosed by CSRC and corresponding l ; Cells in yellow include the detected manipulation period and corresponding l .

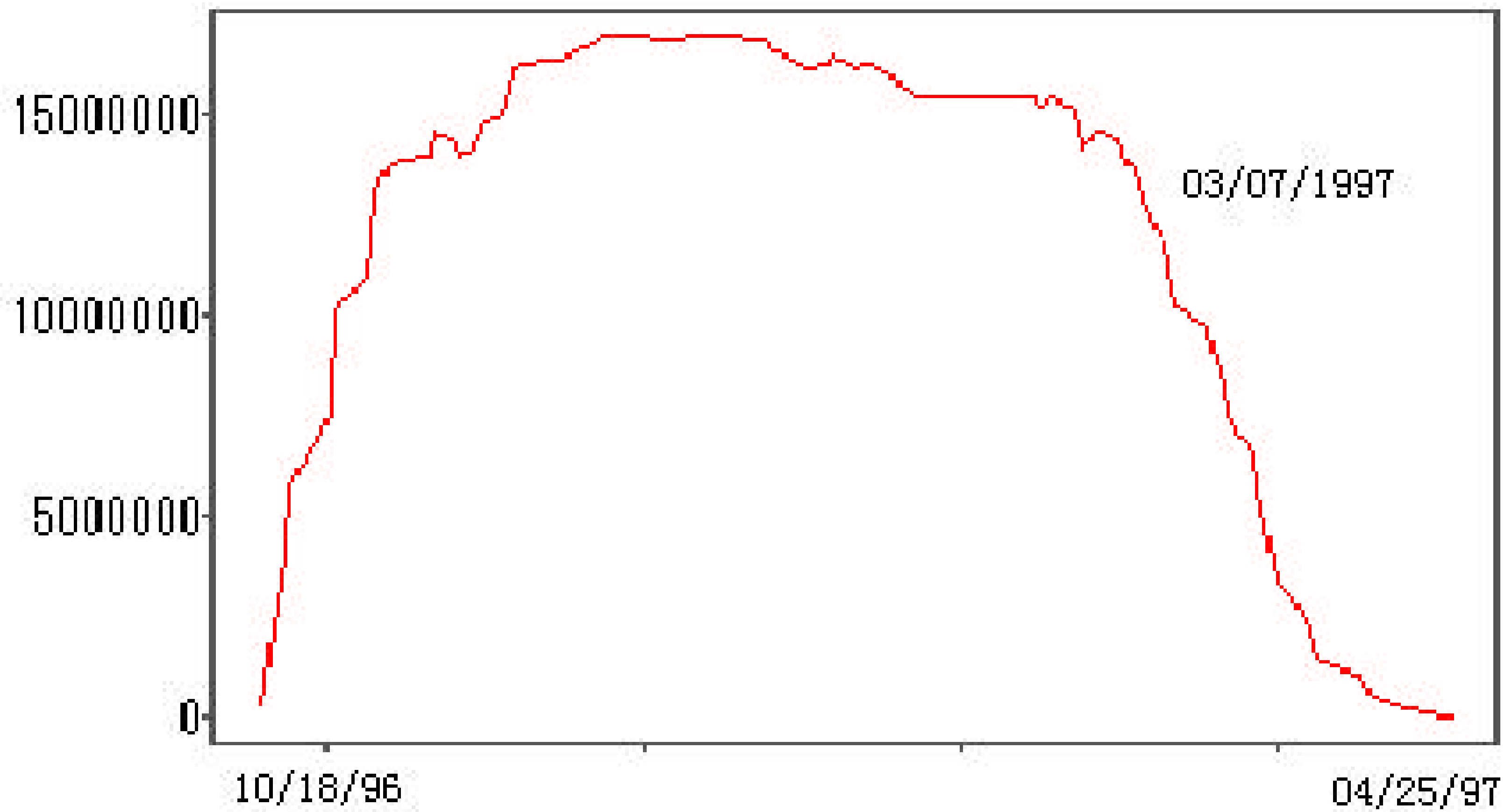


Chart 7: holding by South Security

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.00576	0.00576	23.16	<.0001
Error	377	0.09380	0.00024880		
Corrected Total	378	0.09956			

Root MSE	0.01577	R-Square	0.0579
Dependent Mean	0.00402	Adj R-Sq	0.0554
Coeff Var	392.03270		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	0.00362	0.00081461	4.44	<.0001
total	total	1	1.605333E-8	3.335538E-9	4.81	<.0001

Table 3: Linear Regression, return v.s. holding

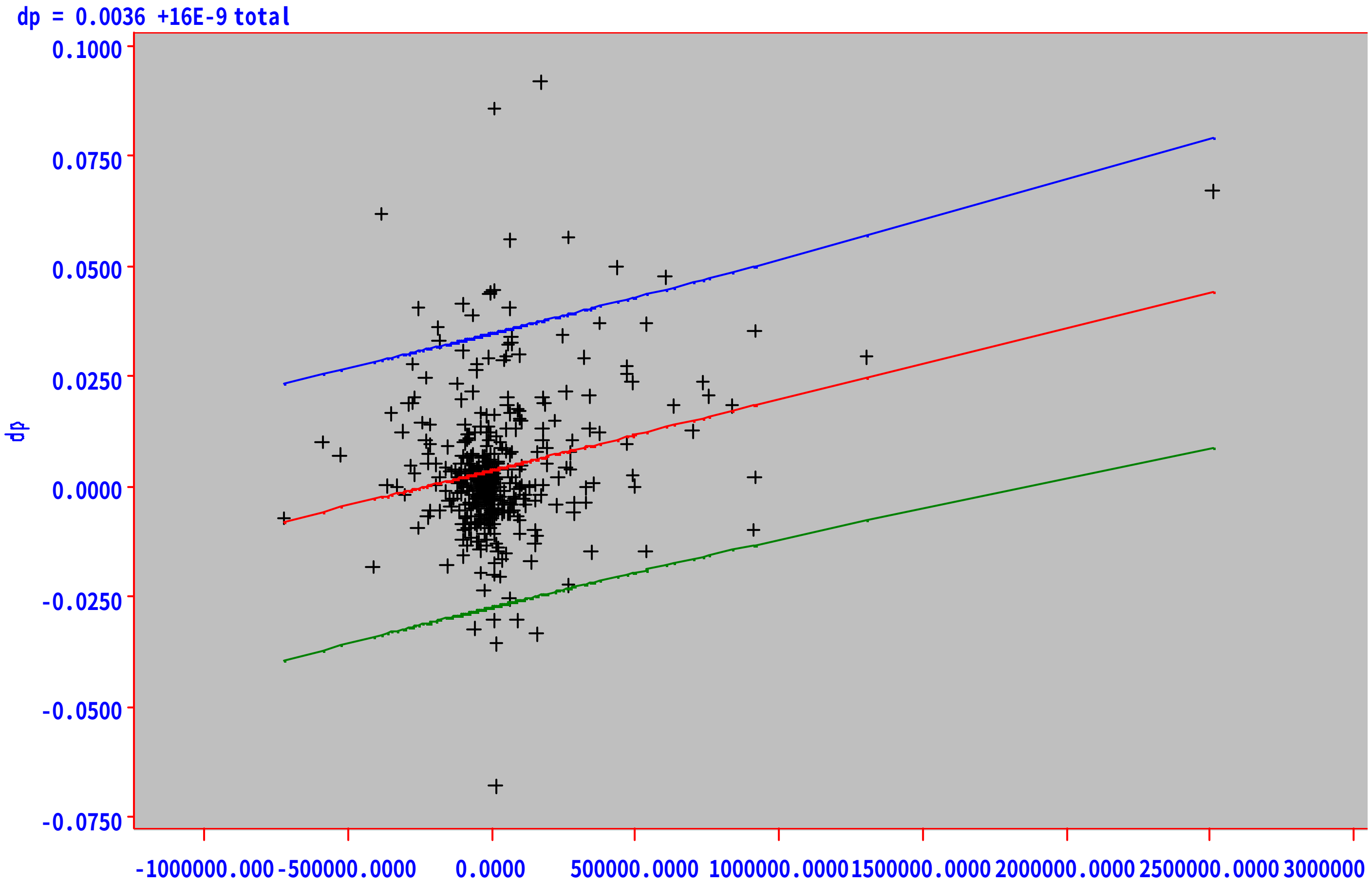


Chart 8: Linear Regression, return v.s. change of holding by the large trader