Advances in Economics and Business 2(7): 249-260, 2014 http://www.hrpub.org
DOI: 10.13189/aeb.2014.020701

Impacts of Securities Transaction Tax Adjustments in Stock Market in China

Tong Fu*, Kennedy K. Abrokwa, Keshab R. Bhattarai

Economics Department, Business School, University of Hull. Hull, HU6 7 RX, United Kingdom
*Corresponding Author: canjianft@hotmail.com

Abstract In 2007, the security transaction tax was adjusted suddenly in the stock market by the Chinese government. The impacts of these adjustments are found here by analysing the real data of daily prices and trading volumes before and after these adjustments. Results of a vector error correction model confirm that, the long and short run relationships between price and trading volume were distorted fundamentally. A seasonal ARIMA model on stock price and trading volume was employed to predict prices or volumes with and without STT adjustments to quantify the impacts of the adjustment on prices and trading volumes. The results show that, the adjustment reduces the stock price by 890.46 points and trading volume by 972 million of hundred units. Two GARCH (1,1) models used to assess the volatility changes of trading volumes indicate to the significance of price effects in reduction of volatility in the Chinese stock market.

Keywords: Securities Transaction Tax Adjustment, Stock Market, VEC and SARIMA Models

1. Introduction

Even though the debate surrounding the adjustment of Securities Transaction Tax (STT) in stock market has received attention in recent literatures, the consensus about the impact of the adjustment is far away. In this paper, we argue that the increase of STT could distort the long-run and short-run relationships in the stock market when there is a bubble. Through the analysis over relationships, we also explain the adjustment of STT for avoiding infinite bubble expansion. Moreover, to give a clear picture about the impact of STT adjustment, we quantify the impact of the adjustment comparing the real data after STT adjustment and forecasted one based on the data before STT adjustment. The impact of the STT increase in Chinese stock market in 2007 is modelled and investigated with time series data before and after the STT adjustment.

Our paper is motivated by the figures of the adjustment of STT in Chinese stock market in 2007. Firstly, the decision time of the adjustment of STT in Chinese stock market was so special that no stockholder had time to react immediately; the corresponding direct influence could be tested without noise. In the early morning of 30/5/2007, the China government adjusted the STT upward by 2%, from 1% to 3%. Due to this sudden government interruption, the Chinese stock market experienced a sharp decrease on the first day with new STT, e.g. A-shares 1 in Shanghai Securities Composites Index, the main stock market in China, fell from 4334.91 to 4053.09, by 281.81 points on 30/5/2007. Secondly, the Chinese stock market has a very clear trend of bubble. According to Andrade et al. (2013), before the adjustment of STT, the Chinese stock market had a typical bubble deriving from a dramatic surge in transaction that is strongly correlated with price levels. In particular, a huge number of novice investors entered the stock market during that bubble period.

The two specific features of the STT adjustment in 2007, to some extent, derives from the background of Chinese stock market. Firstly, Chinese stock market is dominated by retail investors (Andrade et al 2013). By contrast with institutional investors holding the control right of listed companies, retail investors pursue the profit of transaction in stock market. The short-run target determines the sensitivity of retail investors towards market situation or government policy. This property of market gets reflected clearly two facts. The first one is there is a dramatic surge in transaction in Chinese stock market before STT adjustment with the entrance of a huge number of novice investors (Andrade et al 2013). The second one is that the trends of price and trading volume change after STT adjustment. The change could be seen in Figure 1 in following. For the price and trading volume before STT adjustment (P0 and Q0 in Figure 1, respectively) have a clear upwards trend. However, after the STT adjustment, the price and trading volume after STT adjustment (P1 and Q1 in Figure 1, respectively) fluctuates basically above and down some level.

1 China stock market has A-share and B-share for domestic Chinese citizens and foreign investors.

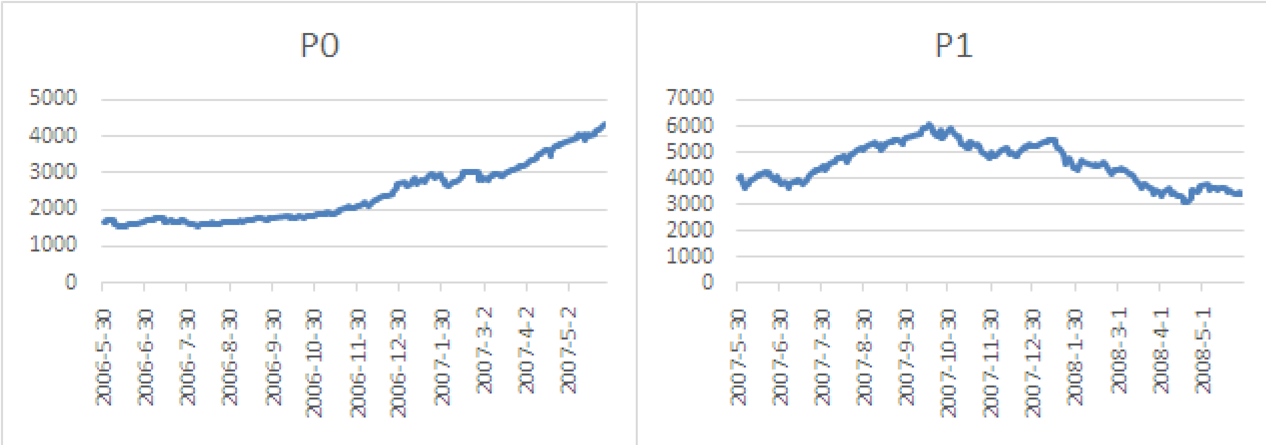
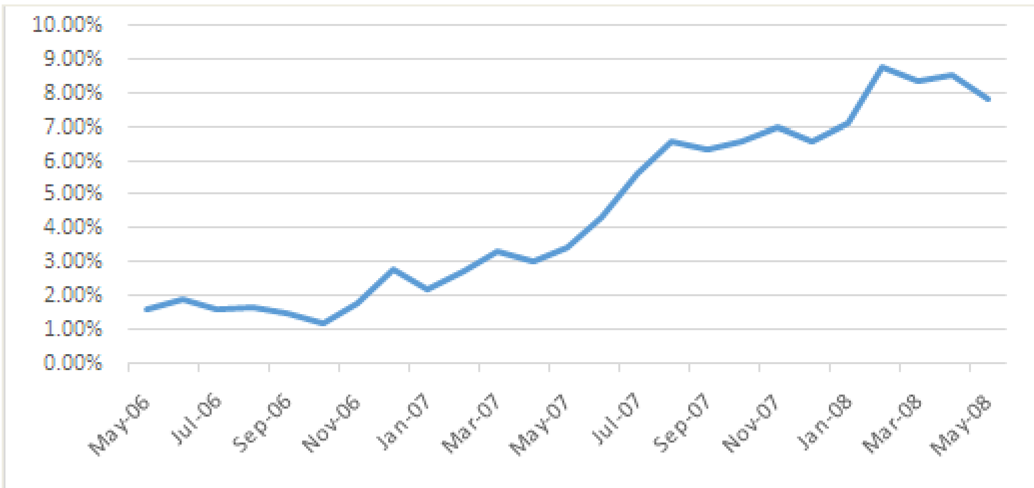


Figure 1. Indices of price and trading volume before and after STT adjustment



Source: China Statistics.

Figure 2. The inflation index in China

In spite of the domination of retail investors, Chinese stock market witnesses an increasingly severer inflation in the whole Chinese market during the history of our observation (see Figure 2). Our observation (and then data) could be divided into two periods[2], before STT adjustment (29/05/2006-29/05/2007) and after STT adjustment (30/05/2007-30/05/2008). Seen from Figure 2, inflation index increases consistently between Oct 2006 and Feb 2008, then it fluctuates but still at high level between March 2008 and May 2008. Before STT adjustment, the increasing severer inflation, to some extent, contributes to the bubble expansion in stock market. After STT adjustment, the unreduced inflation index indicates a similar market background as before except the STT adjustment. Given the clear trend of inflation in the whole China market, the background of STT adjustment in stock market does not change.

To confirm the impact of the adjustment of STT in Chinese stock market in 2007, we present firstly a simple but efficient theory based on probabilities to assess the potential effects of STT adjustment in a market with bubble. At the same time, we also explain the inevitability of government intervention when there is a consistent expansion of bubble.

We test the implications of our theory on real life data of daily prices and trading volumes before and after the adjustment of STT. The long-run and short-run relationship between price and volume before the adjustment of STT is confirmed with a Vector Error Correction (VEC) model. We discover the inexhaustible impulse response for the explanation over government intervention of STT adjustment. After that, due to the inexistence of cointegration, the long run relationship is rejected between the price and trading volume of stocks after the adjustment. Finally, with a Seasonal ARIMA model, we forecast the price and trading volume after the adjustment based on the real data before the adjustment and then compare forecasted data with the real data realized after the adjustment. Finally, we use GARCH model to consider the effect of random walk and then the price effect, thereby exposing the volatility change of trading volume and also finding out the significance of price effect

2 The corresponding data during these two periods are especially collected for later regression.

on the change.

There is no consensus in the literature about the impact of STT adjustment the prices and trade of stocks. Umlauf (1993) found that an introduction of, or increase in the STT in Swedish stock market had reduced stock prices, market turnover and market volatility. Then Jones and Seguin (1997) reported that the reduction of STT bring about a decline in the stock return volatility by examining the effects of the lower and negotiated commissions that were introduced on the U.S. national stock exchange in May, 1975. However, Hau (2006) concluded that a STT increase like an increase of transaction cost leads to a significant increase instead of reduction in market volatility. Su and Zheng (2011) also confirmed that the volatility increases after an increase in STT. To our best information, the impact of STT adjustment is studied for the market volatility involving price, trading volume or turnover, but none of these studies have examined the impact with the focus on the long-run and short-run relationships and quantified the impacts of these adjustments as we do in this paper. Relative to previous literatures on the impact on relevant variables (e.g. price, trading volume or turnover), we explain the impact with the focus on the change of market trend.

The rest of the paper is organized as follows. In section 2, we provide the empirical strategy and data. Three models, VEC, SARIMA and GARCH model are illustrated successively in section 3, 4 and 5. Finally, conclusion is given in Section 6.

2. Empirical Strategy and Data

Our empirical strategy is to show how STT adjustment distort the long and short run relationship between prices and trading volumes. After that, we will quantify the reduction of price and trading volume due to the STT adjustment in China stock market. Furthermore, we will also find out volatility process is also changed due to the STT adjustment. All of these three analyses derive from our understanding about STT adjustment in stock market. At first, a consistent expanded bubble in stock market will lead to government intervention, of which STT adjustment is the most common tool. Secondly, an STT increase could reduce the trading volume and then constrain or spoil the bubble, namely, it is rational at least for constraining bubble expansion. These two points come from our theoretical exploration, which could be seen in Appendix.

We employ unit root test, Vector-Error Correction (VEC) and SARIMA model to analyze the prices and trading volumes before STT adjustment in the China stock exchange market. Seen from Figure 1. P0 and Q0 have intercepts and trend while P1 and Q1 may have only an intercept. In particular, VEC model is used to examine the long run and short run relationships, SARIMA model is for the forecast of price and trading volume. Moreover, for exploring effect of the potential volatility change on trading volume, two GARCH models with the effect of random walk and with the effect of price effect would be used, respectively.

2.1. Data

Our data comes from historical price and transaction (trading volume)[3] in China. Two groups of daily price and trading volume data are collected. One group cross 29/5/2006 to 29/5/2007 while the other one starts from 30/5/2007 towards 30/5/2008. The former include one year data before STT adjustment while the latter consists of one year after STT adjustment. Because the STT adjustment is adopted at the early morning of 30/5/2007 when stock transaction is not open yet, so no data is at the point of STT adjustment. For convenience, P0 (endprice0) and Q0 (transaction0) represents the end price[4] and trading volume in period before STT adjustment; meanwhile, P1 (endprice1) and Q1 (transaction1) are used for THE corresponding data series after STT adjustment. In particular, the trading volume is measured with hundred unit in data.

2.2. VEC Model

This section mainly illustrates the regression procedure and explains the reason for chosen models and tests. The result and discussion are given in next section. In the first step of our model, we check for the existence of unit root in our series, knowing that most macroeconomic variables are non-stationary. We employ the Dickey-fuller (DF), the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests. It is important for our VEC model to identify the potential existence of a long-run relationship between price and trading volume. In effect, if we find that, prices and trading volume before STT adjustments are integrated of the same order, then there may be a link in long run. In the second step, we apply the Johansen (1988) and Johansen and Juselius (1990) maximum likelihood procedure to test for cointegration.

In the third step, we figure out the relationship with VEC model. When there exist cointegration, then the VEC can be written as:

$$\Delta P_t = \phi_{10} + \sum_{i=I} \phi_{11i} \Delta P_{t-1} + \sum_{i=I} \phi_{12i} \Delta T_{t-1} + \gamma ECT_{t-1} + \varepsilon_{1t} \tag{12}$$

$$\Delta \mathrm{T_t} = \varphi_{10} + \sum_{i=I} \varphi_{11i} \Delta \mathrm{T}_{t-1} + \sum_{i=I} \varphi_{12i} \Delta \mathrm{P}_{t-1} + \gamma \mathrm{ECT}_{t-1} + \varepsilon_{1t} \tag{13}$$

ECT represents the error term given by the long-run cointegrating equation. The short-run effects are derived from the joint significance of coefficients ϕ_{11i} and ϕ_{12i}. We find the VEC model appropriate due to its strong nature of tracing out the dynamic impacts of random disturbances of the systems on the variables. By this way, we are able to tell the effects of shocks in prices on trading volumes in the stock

3 Transaction is actually trading volume in stock market, the following will mainly use 'trading volume' for empirical work.
4 Stock market has start price and end price, we use end price for regression. Comparing with the start price, end price could reflect the stock market.

market and the vice-versa.

2.3. SARIMA Model

To assess the precise influence of the STT adjustment, the final step in our estimations involves the use of Seasonal ARIMA (SARIMA) models to forecast the stock prices and quantities after STT adjustment based on the data before STT adjustment. We note that, in real life, most of the financial time series encountered have not only autoregressive (AR) structure but also moving average (MA) structure. We also detect some seasonality element in the series. By employing SARIMA, we are able to include more realistic dynamics and in particular, account for non-statioarity in mean and capture seasonal behaviours of the series. SARIMA model is formulated from ARIMA as:

$$\phi(B)\Delta^d X_t = \theta(B)\varepsilon_t \tag{14}$$

where B is the lag operated or backshift, ϕ and θ the lag operator polynomials and Δ^d the difference $(1-B)^d$. Then for searn s and time t, ε_t is such that:

$$\Phi(B^s)_s \Delta_s^D \varepsilon_t = \Theta(B^s)_s \varepsilon_t \tag{15}$$

Then, the SARIMA can be specified of the form:

$$\Phi(B)_s \Phi(B^s)\Delta_s^D \Delta^d X_t = \theta(B)_s \Theta(B^s)\varepsilon_t \tag{16}$$

Δ_s^D is defined as the seasonal difference and Δ^d as the non-seasonal difference. θ, ϕ, Θ and Φ are the lag operator polynomials. We then write $X_t \sim ARIMA(p,d,q)*(P,D,Q)_s$, thus, the idea is that SARIMA are ARIMA (p, d, q) models whose residuals ε_t are ARIMA (P, D, Q). The notion is that, with ARIMA (P, D, Q), the operators are defined on the successive powers and B^s. For ARIMA (p, d, q), p stands for autoregressive order, d order of integration and q the moving average order. In this case then, ARIMA (2, 1, 1) means that, there are 2 AR variables, differenced once for stationarity and 1 MA variable. For $SARIMA(p,d,q)*(P,D,Q)_s$, p stands for non-seasonal autoregressive order, d represents the non-seasonal order of integration and q for the non-seasonal moving average order. P stands for the seasonal autoregressive order, D for seasonal integration order and Q for seasonal moving average order.

We use SARIMA model instead of VEC for forecast because (1) VEC model involves more than one series in estimation and there could be more estimation errors and (2) the forecast based on VEC model could transfer forecast error of one to another series. Therefore, we use the single series model for the forecast. In principle, most of theory based econometric models are too restrictive in nature and simple time series models such as ARIMA tend to outperform such econometric models especially in short-run forecasting due to the absence of such restrictions on the ARIMA (see Stockton and Glassman 1987; Nadal-De Simone 2000). Moreover, because P0 and Q0 are only stationary after the first difference, ARMA cannot be used unless difference is used. In addition, either adopting ARIMA or SARIMA for forecast depends on the data property. To maximize the coefficient of determination, we find SARIMA method better for our data.

2.4. GARCH Models

Simply speaking, GARCH model has mean equation and variance equation. It is always used for the volatility examination. In our GARCH model, the trading volume after the first difference is used as dependent variable in mean equation. The GARCH models with random walk actually only use only one-period ahead trading volume is used in mean equation, namely, there is following:

$$y_t = y_{t-1} + \varepsilon_t \tag{17}$$

Where y_t is trading volume for the model before or after STT adjustment and ε_t the white noise of the process.

The GARCH models with price effect need to use price as independent variable in mean equation, at the same time, the autoregressive terms of price and trading volume could be used if those are significant. Namely, there is following:

$$y_t = \sum_1^m y_{t-i} + \sum_1^n x_{t-j} + \varepsilon_t \tag{18}$$

Where y_t is the trading volume before and after STT adjustment. y_{t-i} is the i-periods ahead trading volume and x_{t-j} is the price j-periods ahead.

After the regression of mean equations, the residual series is regressed by ARCH and GARCH item. We use the most common version of GARCH model, GARCH(1,1) as following:

$$\sigma_t^2 = \omega + \alpha\omega_{t-1}^2 + \beta\sigma_{t-1}^2 \tag{19}$$

Where σ_t^2 is the conditional variance because it is one-period ahead forecast variance based on the past information, ω is the constant, ω_{t-1}^2 is the ARCH item and σ_{t-1}^2 is the GARCH item for estimate of ε_t. Sometime, (19) could also add exogenous variable. Our GARCH model with random effect and price effect would have the same design for the regression of σ_t^2, namely, for the conditional variance, we use the same function of (19) for random effect and price effect.

3. Empirical Results of VEC Model

This section includes two parts. The first part proves the long run relationship between price and trading volume before STT adjustment. The relationship disappears after the adjustment. Hence, the influence of government intervention on stock market could be identified without doubt. Considering the relationship between price and trading volume in long run or short run is changed, the influence of STT adjustment should be qualitative. The second part assesses the quantitative influence of STT adjustment, namely, it finds out how much price or trading volume unit would be higher than the real one, if there is no STT adjustment.

To have robust test of unit root, an intercept is assumed when either of DF, ADF or PP method is used. ADF or PP method is adopted especially when trend is included. Hence, we have three tests with only intercept (under DF, ADF and PP) and two tests with intercept and trend under ADF and PP, respectively. The result could be seen in Table 1. When the original series are not stationary, the unit root is tested again after the first difference of the relevant series.

Seen from Table 1, P0 and P1 are non-stationary at level but they become stationary after the first difference, which are supported by all tests. Basically, Q0 has the same property as P0 and P1; the only difference is PP method which reject the unit root at level for Q0. Moreover, all tests reject the null hypothesis of unit root for Q1 except DF method (with only intercept assumption); namely, Q1 basically is stationary at level. To be concluded, P0, Q0 and P1 are integrated at first difference while Q1 is stationary at level. Namely, $P0{\sim}I(1), Q0{\sim}I(1), P(1){\sim}I(1)$ and $Q1{\sim}I(0)$. Therefore, price and trading volume quantity may have a long run relationship before STT adjustment while there is no potential one after that. For illustrating the data property, all series after the first difference could be seen in Figure 3, though original Q1 will be used in later regression.

Table 1. Unit root test on model variables

Level	DF	ADF	PP	ADF (trend)	PP (trend)
P0	4.2313	2.6225	2.8918	-0.7688	-0.6914
Q0	-0.1813	-0.5129	-2.0123	-2.8431	-3.4224*
P1	-0.8054	-0.7181	-0.7800	-1.3432	-1.3492
Q1	-0.1453	-3.7489***	-4.4960***	-4.0430***	-5.4219***
Differenced					
P0	-3.8190***	-16.2093***	-16.2079***	-16.8594***	-16.8613***
Q0	-3.2726***	-9.0692***	-24.5042***	-9.2839***	-24.9116***
P1	-1.6350*	-8.8325***	-15.2216***	-12.2134***	-15.3374***
Q1	×	×	×	×	×

Series are significant at *** (1%), **(5%) and *(10%).

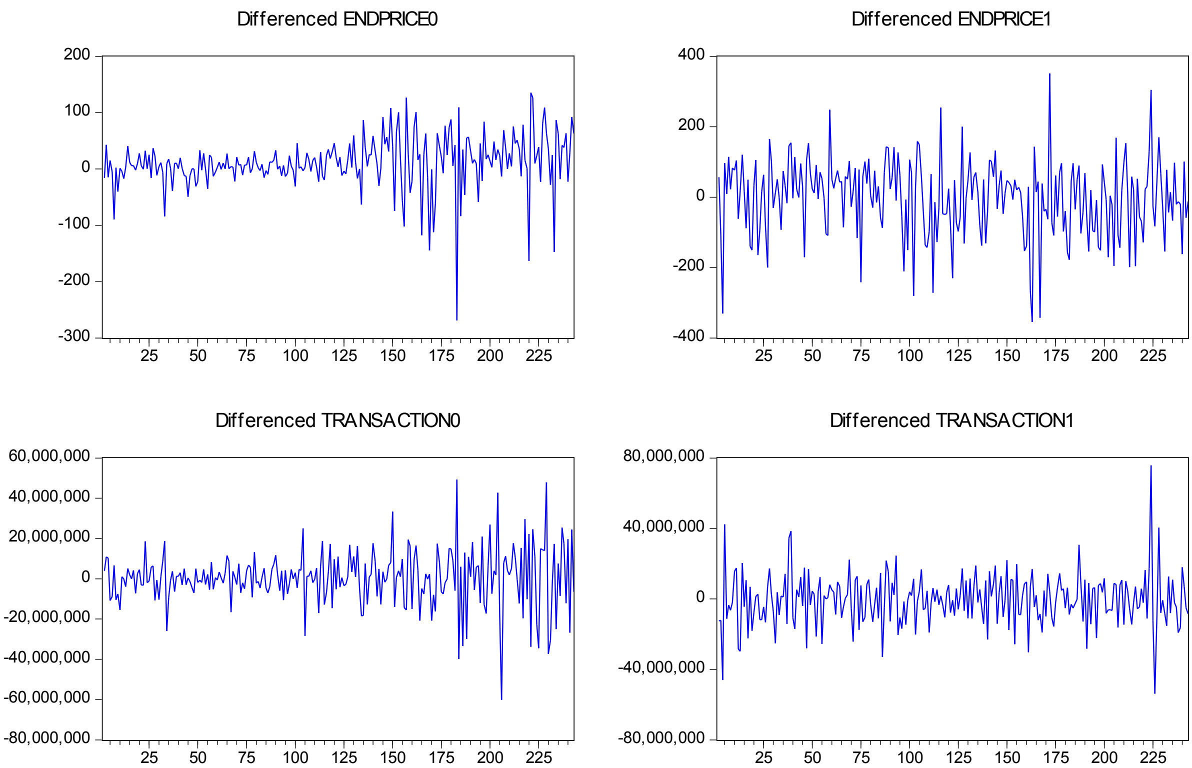


Figure 3. Plots of model series after the first difference

After unit root test, the lag length should be identified for Johansen test and VEC estimation. The common procure for that is to construct a VAR model with potential lags (that should be bigger than the potentially best lag length) and then test the lag length. According to AIC and SIC standard, E-views suggests that 2 is the best lag for our data. Therefore, for the Johansen test and VEC model, only one lag is used since those two need use p-1 lag(s) for estimation5.

The long run relationship between $P0$ and $Q0$ could be identified by Granger test or Johansen test. Considering that the latter could not only identify the potential relationship and also give precise cointegrating equation, we prefer Johansen test. More practically, VEC model in later regression need to know the precise cointegrating equation, Johansen test is obviously better for this paper.

All of potential model assumptions for cointegration are included for Johansen test there exists at least one cointegrating vector. According to the corresponding result, we will choose the best model assumption on the basis of Akaike Information Criterion (AIC) and Schwarz Criterion (SC). The second step is to do the Johansen test with the chosen model assumption. The final result of Johansen test is presented in Table 2.

The final result of VEC model for the data before STT adjustment is presented in Table 3. From the result, it could be seen that the long-run relationship between price and trading volume is positive. In the short run, price and trading volume will have a positive relationship with derivative from VEC item.

Table 2. Cointegration Test

		Trace			Maximum Eigenvalue		
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.177048	47.25022	18.39771	0.0000	46.96063	17.14769	0.0000
At most 1	0.001201	0.289599	3.841466	0.5905	0.289599	3.841466	0.5905

Trace/ Max-eigenvalue testindicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 3. The result of VEC model

Long-run Results						
Variable	Coefficient		Stand. Error		t-statistics	
P0(-1)	1.000000					
Q0(-1)	-1.84E-05		-11.5155		1.6E-06	
Trend	-0.391182					
C	-896.1644					
Short-run Results						
Dependent Variable	D(P0)			D(Q0)		
	Coefficient	Stand. Error	t-statistics	Coefficient	Stand. Error	t-statistics
D(P0(-1))	-0.103464	0.06685	-1.54771	103022.2	16253.0	6.33867**
D(Q0(-1))	4.47E-07	2.4E-07	1.86576	-0.007637	0.05826	[-0.13108
ECM_{t-1}	0.016661	0.01274	1.30801	21285.29	3096.90	6.87309**
C	-5.001607	5.94480	-0.84134	10950.90	1445343	0.00758
Trend	0.139903	0.04315	3.24239*	-5305.202	10490.5	-0.50572
R-squared	0.060551			0.366787		
Adj. R-squared	0.044628			0.356054		
F-statistic	3.802743			34.17553		
SIC	45.98636					

* Significant at 1% level; **significant at 0.1%.

Moreover, in above VEC model, impulse response indicates any shock in stock market will have an irrational influence for ever. This could be identified in Figure 4. Any shock from price or trading volume towards itself or the counterpart will not disappear. Seen from Figure 4, though some point may have zero response, most of those almost stay one non-zero level.

5 p of p-1 denotes the value of best lag length for relevant estimation.

Namely, any tiny increase of price or trading volume would have an infinite impact in future unless there is structural change (such as the STT adjustment), More practically, during one year before STT adjustment, most of days have a price increase. Considering the positive long run relationship confirmed from VEC model, the stock holders have an expectation of increase of price and trading volume in future. The bubble in stock market of China before STT adjustment will be expanded continuously, hence the STT adjustment is, at least, efficient to constrain the bubble expansion. (Shiller 2013), Good Society encourages actual human behaviour into an effective and congenial whole. Government intervention in stock market (generally STT adjustment) is inevitably adopted when bubble expansion cannot stop by economic system.

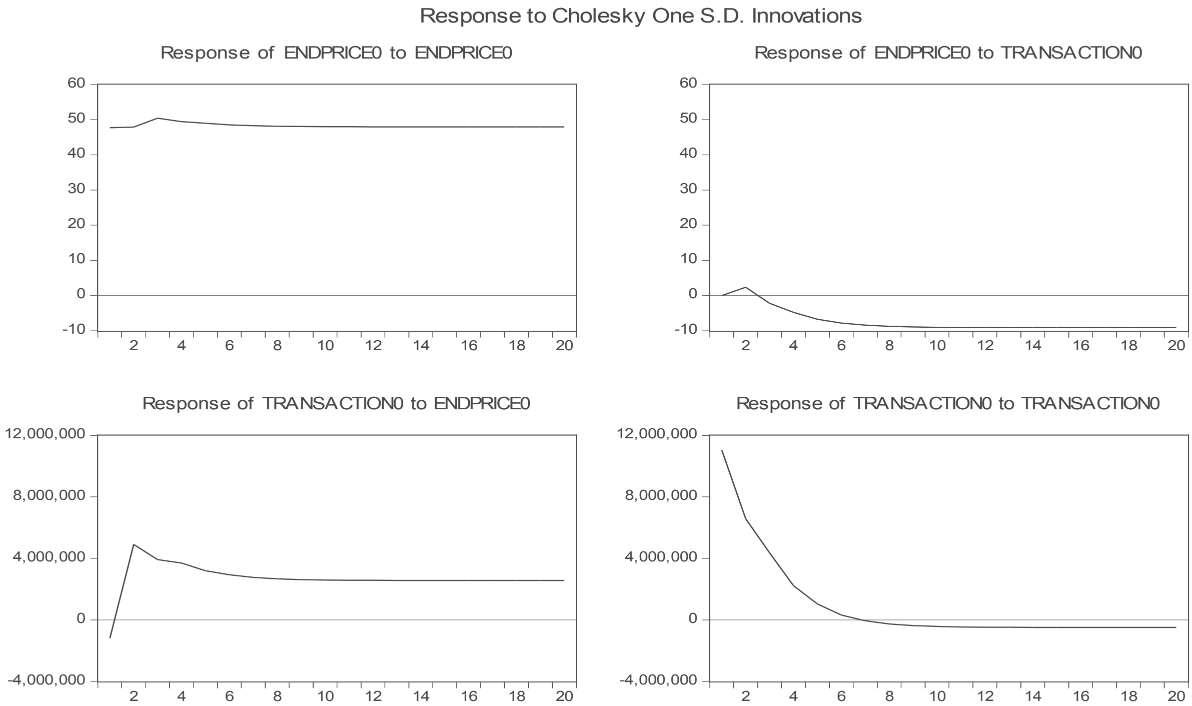


Figure 4. Response to Cholesky One S.D Innovations

After STT adjustment, there is no relationship between price and trading volume. The price and trading volume are at I(1) and I(0), respectively. Then the condition of cointegration between P1 and Q1 cannot be satisfied and then these two series cannot be co-integrated anymore. Consequently, VAR model cannot be used for P1 and Q1. It illustrates that the STT adjustment breaks the link between two elements in stock market. This is the good side of the government intervention.

4. Empirical Results of SARIMA Model

If the length of STT adjustment influence could be identified, we could use data to make corresponding forecast. After that, the direct influence of STT adjustment could be given a precise quantitative result by comparing forecast with real number after STT adjustment. The potential corresponding difference will be the quantitative influence of STT adjustment. Unfortunately, recalling the above conclusion that the response cannot disappear before tax, we cannot identify the length of influence from a shock. However, with another perspective, it seems to tell us the influence of STT adjustment is infinite in theory. Simply speaking, the persistent response will either lead to a government intervention or spoil economic system.

Though we cannot give a precise assessment of STT adjustment, we could give numerical examples. According to the stock price after STT adjustment, at the forty-second day, it reaches the level before STT adjustment at the first time. In other words, after STT adjustment, stock price level gets recovered after forty-two days. Forty-two is the length of forecast.

As mentioned before, SARIMA model is used for the forecast6 instead of VEC model. The best SARIMA model for P0 is given as $\mathrm{ARIMA}([19, 38, 47, 52, 66], 1, [1, 38])(2, 1, 1)^{13}$; the results is following.

$$(1 - 0.1262B^{19} - 0.1585B^{38} - 0.1902B^{47} + 0.2698B^{52} - 0.0760B^{66})(1 + 0.1393B^{13} - 0.1925B^{26})(1 - B)(1 - B^{13})P0_t = (1 - 0.1261B - 0.8736B^{38})(1 - 0.9571B^{13})\varepsilon_t$$

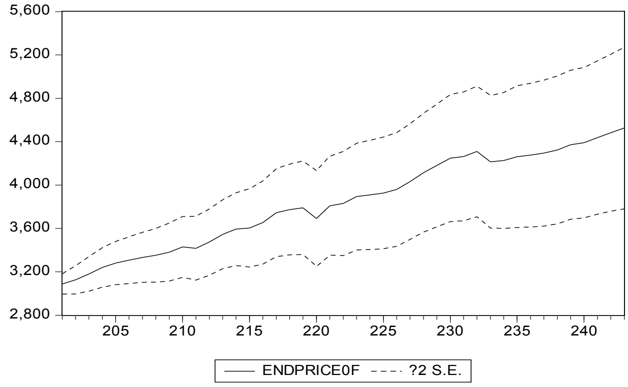
6 SARIMA model is used for the better data-fitting and then later forecast instead of explanation. Though the data has no clear trend of seasonality, we indeed find spikes in the correlogram diagram.

Similarly, the SARIMA model for Q0 is identified as $\mathrm{ARIMA}([3,6,15,22,32],1,[1,3,5,22,33])(1,1,1)^{13}$ and the results is following.

$$(1-0.4584B^{3}-0.1507B^{6}-0.1123B^{15}+0.0762B^{22}-0.1794B^{32})(1-0.3680B^{23})(1-B)(1-B^{23})Q0_{t}=(1-0.0642B+0.3022B^{3}-0.2672B^{5}-0.2660B^{22}+0.5647B^{33})(1-0.8729B^{23})\varepsilon_{t}$$

Considering out-of-sample forecast is needed for this article, dynamic forecast instead of static forecast is adopted. To test the ability of SARIMA model for our forecast, in-sample forecast should be compared with the real data. The later out-of-sample forecast need use 42 working days after STT adjustment, hence we adopt in-sample forecast for 42 working days before STT adjustment. In particular, for the sake of consistence, in-sample forecast also use dynamic method. The in-sample forecast for P0 could be seen in Figure 5.

Figure 5 reflects the dynamic SARIMA model give a good forecast. Then dynamic SARIMA model could be used safely for out-of-sample forecast. According to our result, the forecast of P0 in 42nd working day after STT adjustment could reaches reach 5236.92. At the same time, the price level before STT adjustment is 4346.46. Namely, STT adjustment reduces directly price by 890.46.



Forecast: ENDPRICE0F	
Actual: ENDPRICE0	
Forecast sample: 201 243	
Included observations: 43	
Root Mean Squared Error	173.5135
Mean Absolute Error	157.3920
Mean Abs. Percent Error	4.146254
Theil Inequality Coefficient	0.022919
Bias Proportion	0.822809
Variance Proportion	0.126773
Covariance Proportion	0.050418

Figure 5. In-sample forecast for P0

In particular, for illustrating the effect of STT adjustment, the real price level before STT adjustment (P0 in Figure 6), the forecasted price level without STT adjustment and real price level after STT adjustment for next forty-two periods (PF and P1 in Figure 6), these three lines are combined together as following. Seen from Figure 6, for one thing, the upward trend of price disappears due to STT adjustment since PF increases while P1 moving around about the level of 4000. For another, the price level has a sudden and sharp decrease at the day of STT adjustment; there is a gap between PF and P1 at the point of 243.

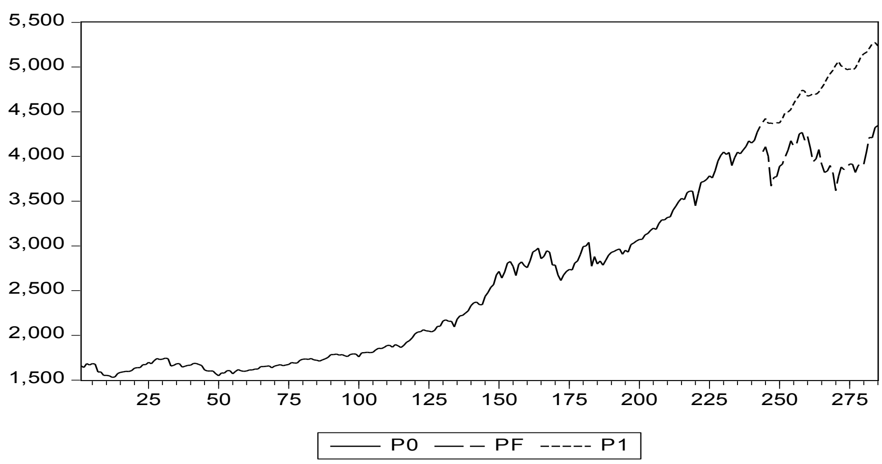


Figure 6. The effect of STT adjustment on price

Similarly, in spite of the sharp decrease at the first day after STT adjustment (whose value is 14 million), trading volume gets reduced by STT adjustment (see Figure 7). The direct reduction is 97.2 million unit since the forecasted one along the trend before STT adjustment is 196 million of hundred unit while the real one at the forty-second day is 99.2 million of hundred unit.

In particular, total trading volume reduced by STT adjustment will be the sum of difference between above tow lines of QF and Q1 during 42 days after STT adjustment. The precise value is 353 billion unit.

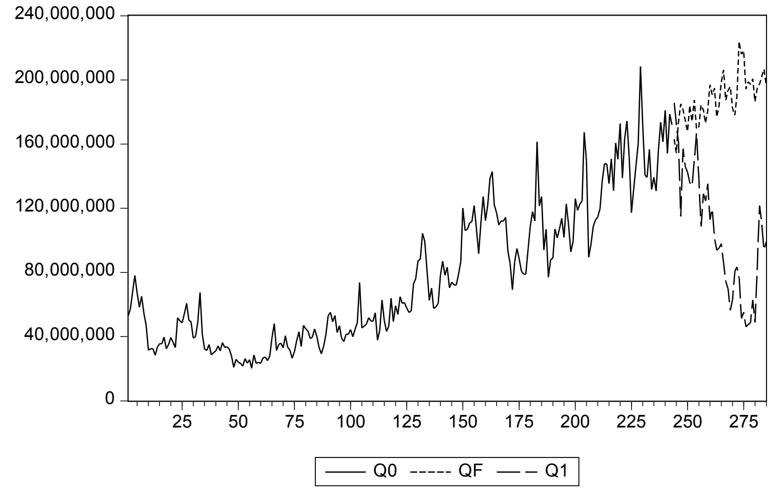


Figure 7. The effect of STT adjustment on transaction

5. Empirical Results of GARCH Models

The results of GARCH model indicate the STT adjustment indeed change the volatility in stock market. However, the change of volatility disappear if the price effect is also considered when we examines the volatility of trading volume. This unilateral change in volatility supports the previous finding that the relationship between price and trading volume did change after the STT. It seems also to have a shift effect over trading volume with price together.

The volatility change due to the STT adjustment could be reflected by the result of GARCH model with the effect of random walk, in which only one-period ahead trading volume is used in the mean equation. Seen from Figure 8, the conditional variance before STT adjustment has an increasing trend clearly; however, after STT adjustment, it witnesses a decreasing trend. This change of trend of conditional variance uncovers the STT adjustment indeed reduced the volatility in the Chinese stock market.

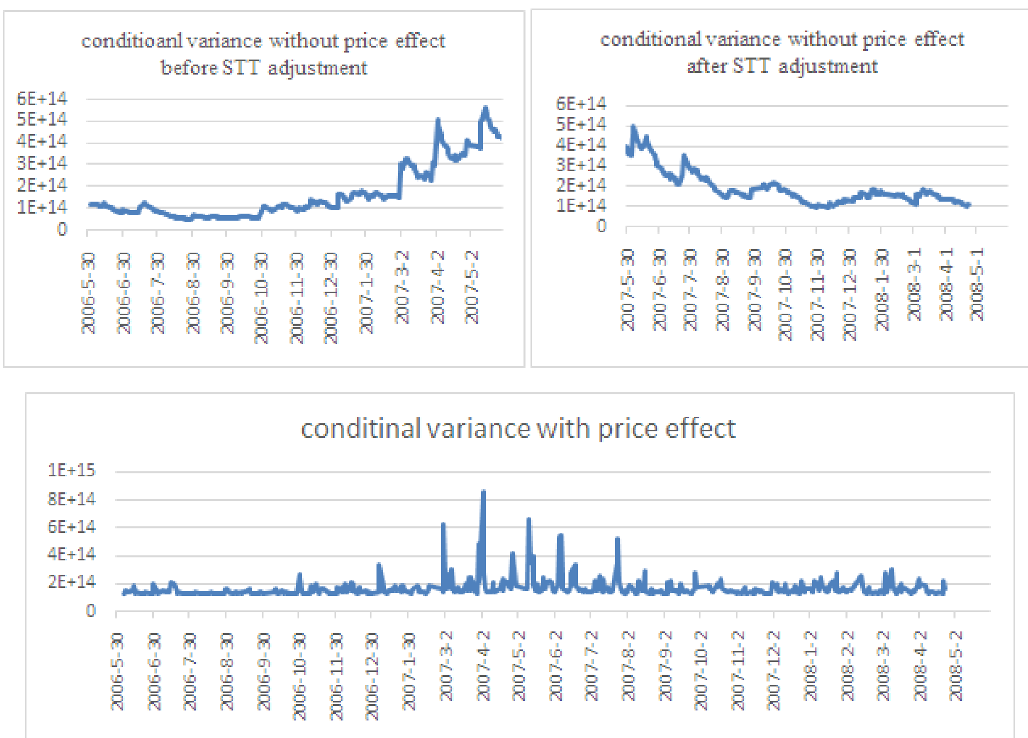


Figure 8. conditional variance with and without price effect

The volatility change disappearance could be found from the GARCH model with the effect of price for trading volume. By contrast with GARCH model with the effect of random walk, the GARCH model with price effect includes one-period ahead price and the first three trading volumes ahead since other price/trading-volume items are not significant. It is clearly seen from Figure 8, the volatility of trading volume during the whole observation periods (before STT adjustment and after STT adjustment) has no clear trend.

To sum up, there is indeed volatility changes on trading volumes, however, the change could be explained more by the price effects. To some extent, this discovers the rationality of STT adjustment, which is aimed to affect the price directly. This finding could explain the real consequences of STT adjustments in Chinese stock markets in 2007. When the STT is increased by government, the intuitive phenomenon is that many of transacting parties stop buying or selling equity. The potential buyer exit from the market while the seller could only hold the stock. However, the change of trading volume could be well explained by the price element because most of transacting parties are retail investors in the Chinese stock market and then the price element would determine the trading volume and the corresponding volume volatility.

6. Conclusion

The STT adjustment to Chinese stock market on 30/05/2007 breaks the bubble starting from one year ago. Though the tax at stock market increased very little from 1‰ to 3‰ at that time, in spite of a sharp decrease (whose value is 243 for price level and 1.4×10^7 hundred unit (14 million) for trading volume) at the first day after STT adjustment, the long run relationship does not exist anymore. If there is no STT adjustment and the stock market remains as before, any changes (of price or trading volume) in market could lead to influence the volatility in prices and trade, which cannot disappear under the long run relationship.

After the STT adjustment, at the 42nd day, the price level reached and exceeded a little more than the one before STT adjustment. If there is STT adjustment, according to our forecast, price and trading volumes should reach 5236.92 and 1.96×10^8 (196 million), respectively. Hence, comparing the original situation before STT adjustment, the increase of price and the trading volume were avoided by 890.46 and 9.92×10^7 (99.2 million) hundred unit, respectively. These increase avoided by STT adjustment could be regarded as the direct influence at China stock market.

There is volatility change on trading volume, however, the change derives from by the price under the effect of STT. The volatility disappearance after the consideration of price effect reflects the fact that the Chinese stock market is dominated by retail investor before and after STT adjustment.

Appendix: The Theoretical Model

This appendix presents a theoretical model to explain the cause effect of the STT adjustments over trading volume of stocks. The model draws on works of Shiller (2013), Umlauf (1993), Hau (2006), Su and Zheng (2011) and Jones and Seguin (1997).

Assuming there are i potential buying transactions and j potential selling transactions in the stock market. Without loss of generality, every potential buyer/seller could buy/sell one unit of stock at the market; hence, there are also *i/j* pair of potential buying/selling transactions in the market. Expected positive profit leads potential entrant to enter really into the stock market; similarly, positive expected profit could keep stockholders stay in the market. Let $\bar{V}$, $\underline{V}$ be the higher price level and lower level in future, respectively; while V_0 denotes the current price level of stock.

For potential buying transactions, let P_r^b be the probability of price increase after buying; similarly, P_r^s denotes the probability of price increase for potential selling transactions. Both groups observe the price and transaction in stock. Let α denote the historical ratio of price increase for the potential buyers while β represents the corresponding ratio for potential seller. In particular, $\alpha \lesseqgtr \beta$.

The history affects the price in future and probability of price increase. Precisely, the higher price level in future would be determined by the historical ratio of price increase for buyer and seller, namely, $\bar{V} = \bar{V}(\alpha)\ or\ \bar{V}(\beta)$. Similarly, the lower level of price in future will face the same situation, $\underline{V} = \underline{V}(\alpha)\ or\ \underline{V}(\beta)$. Moreover, the probability of price increase in future should be also updated by latest ratio of price increase for buyer or seller. Hence, there are $P_r^b = P_r^b(\alpha)$ and $P_r^s = P_r^s(\beta)$. Finally, assuming c is the STT adjustment mechanism for transaction at stock market. The expected profit for potential buying transaction or selling transaction is expressed as:

$$\begin{cases} g_b = \bar{V}(\alpha)P_r^b(\alpha) + \underline{V}(\alpha)\left(1 - P_r^b(\alpha)\right) - V_0 - c, \\ g_s = \bar{V}(\beta)P_r^s(\beta) + \underline{V}(\beta)\left(1 - P_r^s(\beta)\right) - V_0, \end{cases} \tag{1}$$

It is worthwhile to mention three natural assumptions. At first, $\bar{V}(b) \geq V_0 + c, \underline{V}(b) \leq V_0 + c, b = \alpha, \beta$; otherwise, nobody wants to buy or sell the stock. Moreover $\frac{\partial \bar{V}(b)}{\partial b} \geq 0, \frac{\partial \underline{V}(b)}{\partial b} \geq 0, b = \alpha, \beta$. Namely, when the higher historical ratio of price increase leads to a higher expectation of stock value; either $\bar{V}$ or $\underline{V}$ will be expected to increase. Finally, there is also $\frac{\partial P_r^\rho(b)}{\partial b} \geq 0, \rho = i, j, b = \alpha, \beta$. The corresponding reason is that the transacting party should expect the high value of stock with a bigger probability after observing a higher historical ratio of price increase.

In particular, the decision making functions is as following for potential buying transaction,

$$x = \begin{cases} 1, if\ g_b \geq 0; \\ 0, otherwise.\end{cases} \tag{2}$$

Similarly, for potential selling persons, there is the following,

$$y = \begin{cases} 1, if\ g_s \leq 0; \\ 0, otherwise. \end{cases} \quad (3)$$

when $g_\rho = 0, \rho = i, j$, α and β are actually at the minimum level to buy or sell stock in market. For later analysis, we use $\dot{\alpha}$ and $\dot{\beta}$ to represent the minimum level for α and β.

Seen from (1), (2) and (3), the value of g_ρ and then the value of x or y depends on the historical ratios of price increase, namely, α and β. Potential buyers and sellers observing historical notes of price and trading transaction get the value of α or β value. When α reaches the value of $\dot{\alpha}$, in fact, the potential signal of buying transaction must be seen in the market while $\beta \geq \dot{\beta}$, potential stockholder will need a selling transaction to exit from market. In the common way, the number of people observing $\alpha \geq \dot{\alpha}$ or $\beta \geq \dot{\beta}$ is assumed to satisfy Bernoulli distribution within its own buyer/seller group.

For the Bernoulli distribution, let Pr^{in} be the probability of potential entrants observing $\alpha \geq \dot{\alpha}$ and Pr^{out} be the probability for potential exiting persons finding $\beta \geq \dot{\beta}$. When $\alpha \geq \dot{\alpha}$ and $\beta \geq \dot{\beta}$ are satisfied, the transaction of buying and selling of stock occurs. That is why we use in and out as the superscript. In mathematical term, they are as following:

$$\begin{cases} Pr^{in} = \{Pr|\alpha \geq \dot{\alpha}\} \\ Pr^{out} = \{Pr|\beta \leq \dot{\beta}\} \end{cases} \quad (4)$$

According to the definition of Pr^{in} and Pr^{out}, there are the following expressions:

$$\frac{\partial Pr^{in}}{\partial \dot{\alpha}} \leq 0, \frac{\partial Pr^{out}}{\partial \dot{\beta}} \geq 0. \quad (5)$$

According to the Bernoulli distribution, the dynamic equilibrium of stock market should satisfy $i \cdot Pr^{in} = j \cdot Pr^{out}$; the transaction bought equals transaction sold.

If the demand of buying transaction is bigger than the one of selling transaction, the stock market expands. Otherwise, the market will shrink. Namely, whether the market expand or shrink depends on the value of difference between buying demand and selling demand. When the stock market has a bubble, the buying demand dissatisfied should be as following.

$$f = i \cdot Pr^{in} - j \cdot Pr^{out} \quad (6)$$

Based on the above model set-up, there will be more entrants such that:

$$\frac{\partial f}{\partial \alpha} = i \cdot \frac{\partial Pr^{in}}{\partial \alpha} \geq 0, \quad (7)$$

$$\frac{\partial f}{\partial \beta} = -j \cdot \frac{\partial Pr^{out}}{\partial \beta} \geq 0. \quad (8)$$

Equations (7) and (8) give a very important insight; if there is a bubble in stock market, α and β must increase and then (6) will get a bigger value than before. Namely, in the end, the dissatisfied buying demand will become bigger. This means that, when there is bubble in stock market, a bigger demand of buying stock will take place. In other words, the bubble will continue and become bigger. So there is the need for an intervention.

Also, when $\alpha = \dot{\alpha}$, $\beta = \dot{\beta}$, the potential entrant start to buy transaction while potential exit person is prepared to exit from stock market. At that moment, (1) will be equal to zero. For convenience, let F be equal to the right side of (1), then there are following.

$$\begin{cases} \dfrac{\partial F}{\partial \dot{\alpha}} = \bar{V}' \cdot P_r^b + (P_r^b)' \cdot \bar{V} + \underline{V}'(1 - P_r^b) - (P_r^b)' \cdot \underline{V} \\ \dfrac{\partial F}{\partial c} = -1 \end{cases}$$

$$\rightarrow \frac{\partial \dot{\alpha}}{\partial c} = -\frac{\frac{\partial F}{\partial c}}{\frac{\partial F}{\partial \dot{\alpha}}} = \bar{V}' \cdot P_r^i + (P_r^i)' \cdot \bar{V} + \underline{V}'(1 - P_r^i) - (P_r^i)' \cdot \underline{V} = \bar{V}' \cdot P_r^i + (P_r^i)'(\bar{V} - \underline{V}) + +\underline{V}'(1 - P_r^i) \geq 0 \quad (9)$$

Similarly, there is also:

$$\frac{\partial \dot{\beta}}{\partial c} = -\frac{\frac{\partial F}{\partial c}}{\frac{\partial F}{\partial \dot{\beta}}} = \bar{V}' \cdot P_r^i + (P_r^i)' \cdot \bar{V} + \underline{V}'(1 - P_r^i) - (P_r^i)' \cdot \underline{V} \geq 0 \quad (10)$$

Therefore, when there is a bigger tax, there must be higher historical ratio of price increase. From (5), (9) and (10), there is the following expression:

$$\frac{\partial F}{\partial c} = i \cdot \frac{\partial Pr^{in}}{\partial \dot{\alpha}} \cdot \frac{\partial \dot{\alpha}}{\partial c} - j \cdot \frac{\partial Pr^{out}}{\partial \dot{\beta}} \cdot \frac{\partial \dot{\beta}}{\partial c} \leq 0 \quad (11)$$

Therefore, government could use the STT adjustment (precisely, a tax increase for transaction at stock market) to reduce the transaction at stock market.

To sum up, in our modelling, there are two conclusions. Firstly, based on (7) and (8), a bubble in stock market will lead to a bigger bubble and then government intervention is inevitable if there is no other structural change. Secondly, seen from (11), the increase of tax for transaction could reduce the transaction quantity and then constrain or spoil the bubble. The second conclusion guides the empirical investigation directly.

REFERENCES

[1] Andrade, S. C., Bian, J., & Burch, T. R. (2012). Analyst coverage, information, and bubbles. Journal of Financial and Quantitative Analysis, 1-64.

[2] Hau, H. (2006). The role of transaction costs for financial volatility: Evidence from the Paris Bourse. Journal of the European Economic Association, 4(4), 862-890.

[3] Johansen, S. (1988). Statistical analysis of cointegrating vectors. J. Econ. Dynamics Control 12, 231-254.

[4] Johansen, S., Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxf. Bull. Economics Statistics, 52: 169-210.

[5] Jones C. & Seguin, P. J. (1997). Transaction costs and price volatility: evidence from commission deregulation, American Economic Review, 84: 728–737.

[6] Nadal-De Simone, F. (2000). Forecasting inflation in Chile using state-space and regime switching models. IMF working paper WP/00/162.

[7] Shiller, R. J. (2013). Reflections on finance and the good society. The American Economic Review, 103(3), 402-405.

[8] Stockton, D. J. and J. E. Glassman. (1987). An evaluation of the forecast performance of alternative models of inflation, The review of economics and statistics, 69(1): 108 - 117.

[9] Su, Y., & Zheng, L. (2011). The impact of securities transaction taxes on the Chinese stock market. Emerging Markets Finance and Trade, 47, 32-46.

[10] Umlauf, S. R. (1993). Transaction taxes and the behavior of the Swedish stock market, Journal of Financial Economics, 33: 227–240.