Intraday periodicity, long memory volatility, and macroeconomic announcement effects on China Treasury bond market

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Abstract: In this paper, we provide a detailed characterization of the volatility in China Treasury bond market using a sample of 5-min excess return from January, 4, 2000 to February, 28, 2002. We use two-step regression procedure and multivariate GARCH model to show that macroeconomic announcements is an important source of the volatility in China Treasury Bond market. Among the various announcements, we identify GDP, consumer price index (CPI), retail price index (RPI), People Bank of China benchmark interest rate, Shanghai Security Exchange (SSE) A-share index as having the greatest effects, which explain the observed high degree of volatility persistence on China Treasury bond market. Our analysis also uncovers striking long-memory volatility dependencies in China Treasury bond market, which is consistent with the finding in developed Treasury bond markets.

Keywords: China Treasury Bonds; High-frequency data; Intraday periodicity; long-memory volatility; macroeconomic announcements effects

1. Introduction

Contrary to stocks and corporate bond markets, there is hardly any asset-specific or private information regarding Treasury bonds. Instead, most of the information of direct relevance for the Treasury bond market are likely related to macroeconomic news. There appears to be little, if any, asset-specific information concerning Treasury bonds. Accordingly, macroeconomic announcements affect the Treasury bond market. It is well known that the return volatility of financial assets, for example foreign exchange, are autocorrelated and highly persistent over time, for a review, cf, Bollerslev et al. (1992). Hence, it has been suggested that the announcements of macroeconomic news could explain observed high degree of volatility persistence on the Treasury bond market.

Consistent with this view, a number of prior studies have documented in the finance literature a significance bond market impact from numerous macroeconomic announcements. Ederington and Lee (1993) examine the impact of monthly economic announcements on 5-min Treasury bond futures returns and find that the return volatility is much higher between 0830 and 0835 Eastern Standard Time (EST) than during any other 5-min trading period. Similarly, Fleming and Remolona (1997, 1999) report significant announcement effects in the return volatility, bid-ask spread, and trading activity of the 5-year US Treasury note. Jones et al. (1998) study the effects of announcements of employment and PPI figures on the conditional volatility of the excess returns of three different U.S. government bonds using daily data. The conditional variance is assumed to evolve according to a univariate Generalized Autoregressive Conditional Heteroscedasticity (GARCH) process, which is extended to include level as well as persistence differences on announcement and non-announcement days.

In a framework similar to Jones et al. (1998), Li and Engle (1998) study the effects of macroeconomic announcements (Consumer Price Index, PPI, and Employment situation reports) on the volatility of the U.S. Treasury bond future. Using a univariate GARCH framework, they find that announcement shocks are not persistent, that positive and negative announcement shocks are significantly different, and the persistence is stronger after bad news is released than after good news. But they do no discover significant increases in the returns on announcement days (i.e. there is no risk premium for macroeconomic news.) Balduzzi et al. (1999) study the impact of macroeconomic announcements on the price, trading volume, bid-ask spread, and volatility of both short- and long-term US interest rate instruments.

However, little attention has been paid to the case in which Treasury bonds in emerging markets may be stark contrast to those in developed markets. To the author's knowledge, no methodical studies have examined the effects of macroeconomic announcements on the excess return of Treasury bond in emerging markets. A high frequent data of Treasury bond in these emerging markets are not easily accessible, the issue of Treasury bond volatility is left as a virgin soil. The research on Treasury bond is just at the beginning in China. The recent availability of high frequent data has dramatically increased the power to identify and estimate such announcement effects. To uncover the systematic volatility patterns of Treasury bond Market in China, a few economists have made some researches on China Treasury bond market. The China Bond market is known as the emerging and active financial markets in the world. From this perspective a practical question arises: is there anything to be gained by including Treasury bond in emerging markets in studies of Treasury bond market? Furthermore, only by including all possible Treasury bond markets can compliments the current research on high-frequent volatility in financial market. The aim of this paper is to answer the questions of "what characteristics of volatility patterns in China Treasury bond market?" and "what main macroeconomic announcements will affect the degree of volatility of excess return in China Treasury bond market?" by posing them together within the context of a single model.

Building on the methodology in Andersen and Bollerslev (1997a,b, 1998), this paper offers a comprehensive study of the intraday patterns in the volatility for the China Treasury bond market in a coherent framework. Our analysis is based on a sample of 5-min excess return from January, 4, 2000 to February, 28, 2002. Our main findings are as follows. First, there exist two spikes in the intraday volatility. Secondly, there is an overall U-shape pattern in the volatility across the day, although this pattern is much less pronounced than what is typically observed in equity markets. Third, we find that excess returns in the China Treasury bond market are readily linked to the release of macroeconomic announcements.

The paper is organized as followings: Section 2 discusses the data and preliminary results. Section 3 sets up research model. Section 4 examines the empirical results from China Treasury bond market. Finally, concluding remarks are found in Section 5.

2. Data

2.1 *Excess Return of Treasury bond*

China issued the first Treasury bond in 1950, and it issued Treasury bond each year after 1981. In fact, Treasury bond market at China is still at the exploring period and there still exist two desperate Treasury bond markets that include *Inter-bank Treasury bond market* and *Stock Exchange Treasury bond market*. As we do not have access to high frequent data in *Inter-bank Treasury bond market*, we choose *Stock exchange Treasury bond market*. Since the Treasury bond market at *Shanghai Stock Exchange* (SSE) began earlier than *Shenzhen Stock Exchange* (SZE), the Treasury bond market at SSE far surpasses the SZE. So we collected the data of SSE Treasury bond market as our research population. The intraday China Treasury bond data are collected from Treasury bond online data system provide by SSE China, and cover the period from January, 4, 2000 to February, 28, 2002. The sample being examined are six different Treasury bonds (696, 010,896, 9704 9905, 9908) traded on SSE, China. All of them require delivery of a China Treasury bond with 6 or more years to maturity. The intraday time series is partitioned into 5-min intervals. During each 5-min interval, the last recorded price for the nearby futures contract is employed to calculate the 5-min risk return. The daily time interval covers the period from 0900 to 1300 Beijing Standard Time (BST), corresponding to the trading hours of the SSE, thus resulting in a total of 72 5-min yield risk for each trading day. Occasionally, there can be no trading for more than 10 min. In these cases, the missing futures prices are determined by linear interpolation, leading to identical excess return over each of the intermediate intervals. With 507 trading days, each consisting of 72 intraday 5-min returns, this leaves us with a total of 219,024 observations, say $REB_{i,k,t}$, where $i = 1,2,\cdots,6$, $k = 1,2,\cdots 72$, $t = 1,2,\cdots,507$.

We determined the excess return rates of each 5-min interval using the function:

$$REB_{ikt} = [(P_{i,k,t} - P_{i,k,t-1}) / P_{i,k,t-1}] - R_0 \quad (1)$$

where REB_{ikt} is the excess return for the i th Treasury bond at the k th 5-min interval on the t th trading day ; P_{ikt} is the trading price for i th Treasury bond at the k th 5-min interval on the t th trading day, $P_{i,k,t-1}$ is the trading price for the i th Treasury bond at the $k-1$ th 5-min interval on the t th trading day ; R_0 is the no-risk yield rate on the t th trading day. As the most paper did, we assumed that no-risk yield rate adopted the 3-month short-term Treasury bond rate.

The macroeconomic announcements included in the present study are inflation rate, POBC benchmark rate, foreign exchange rate, consumer price index (CPI), SSE A-Share Index Consumer Price Index (CPI), GDP, Shanghai Stock Exchange A-Share (SSE A-Share) (Yield rate curve of China Treasury bond is introduced after 2002, as a result, we chose SSE A-Share, not Treasury bond yield rate), Consumer Retail Price Index (RPI), inflation rate, Import & Export Index, etc.

2.2 *Preliminary analysis*

Before we turn to the estimation of a multivariate GARCH model, we take a quick look at the sample moments of the data. Figure 1 show us the basic statistic of bond risk yield for six Treasury bonds. It is evident that the trends of risk yield for six different Treasury bonds are similar, which suggests that there maybe some correlations among them. The sample means of excess return are between -0.0032% and 0.0048%. At the 400mins, there is a big breakdown.

Table1 includes summary statistics for correlations and covariance for six different Treasury bonds. As we would expected, the correlation between 9905 and 9908 is very significant (p<0.000) and the convariance analysis supports this significant relationship. Except this significant correlation, there is not one Treasury bond that is significant correlated with other five Treasury bonds. Since 9905 and 9908 were issued in the same year, they have same macroeconomic announcements, which may explain their significant correlation.

Table1: Correlations and Covariance between each two Treasury bonds: (696, 010, 896, 9704, 9905, 9908)

	696	010	896	9704	9905
010	-0.046				
	(0.436)				
896	0.004	0.018			
	(0.921)	(0.753)			

9704	1.000	-0.046	0.004		
	*	(0.436)	(0.921)		
9905	0.039	0.061	-0.019	0.039	
	(0.381)	(0.297)	(0.674)	(0.381)	
9908	0.037	0.071	-0.009	0.037	0.181
	(0.404)	(0.227)	(0.845)	(0.404)	(0.000)

Cell Contents: 1.Pearson correlation

2. (P-Value)

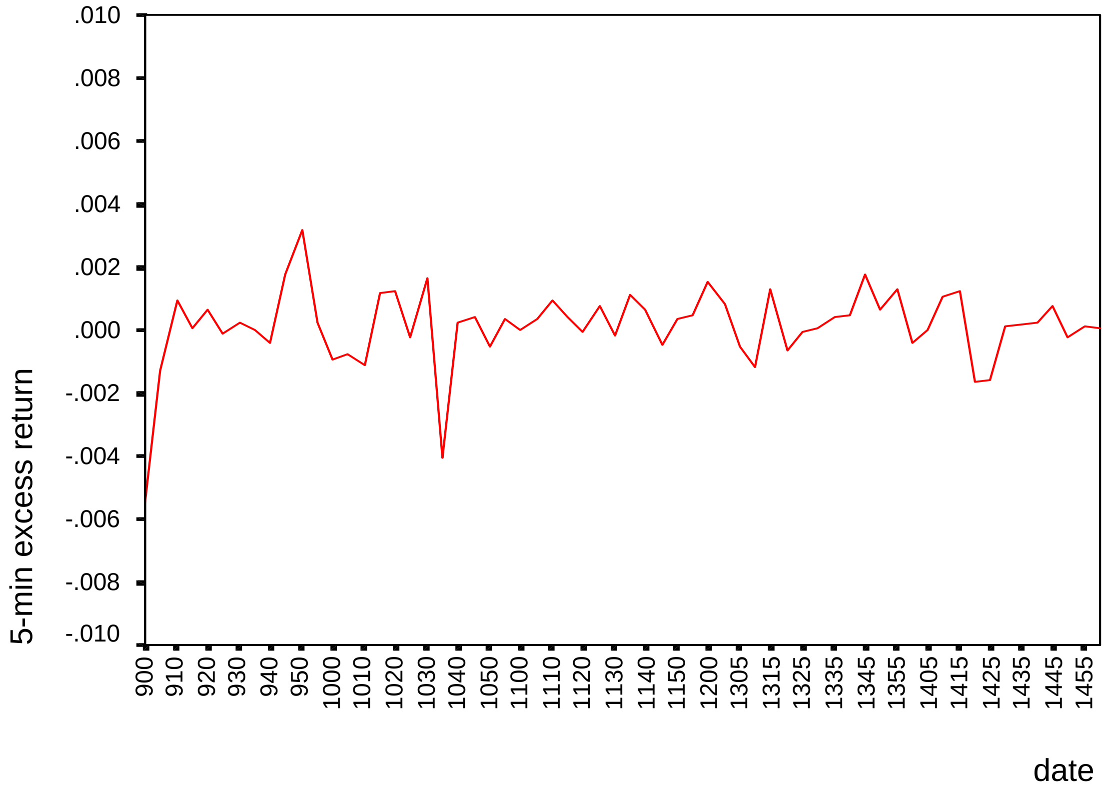
Covariance

	696	010	896	9704	9905	9908
696	0.00002099					
010	-0.00000038	0.00000369				
896	0.00000009	0.00000016	0.00002191			
9704	0.00002099	-0.00000038	0.00000009	0.00002099		
9905	0.00000041	0.00000026	-0.00000020	0.00000041	0.00000530	
9908	0.00000040	0.00000029	-0.00000009	0.00000040	0.00000097	0.00000540

2.3 *Intradaily Pattern*

Fig. 2 shows that the average raw excess return across the day are centered around zero with little evidence for any systematic pattern. The sample mean of the 5-min excess return equals 0.0011. Meanwhile, the sample skewness of -10.8 and the sample kurtosis of 156.59 both suggest that the returns are not normally distributed.

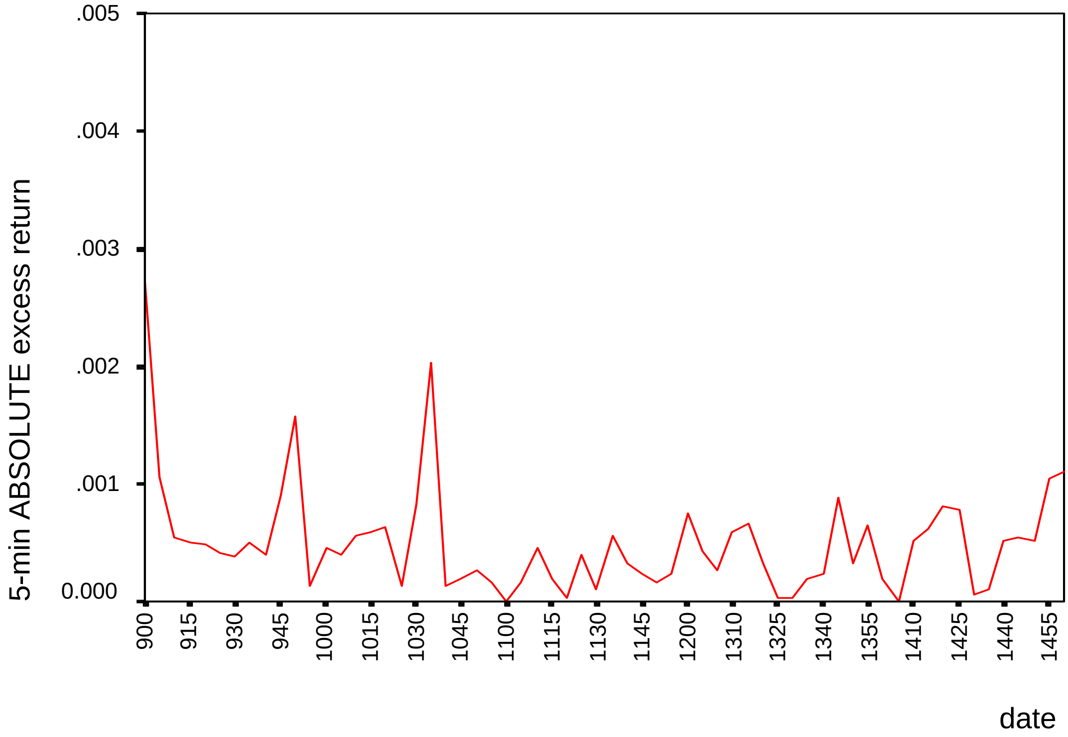
Figure 2: Treasury bond risk yield intraday 5-min volatility pattern



Note: The horizontal axis represents 5-min interval during the daytime; the vertical axis represents risk yield rate of Treasury bond (unit： E-04）

On the other hand, the plot for the average absolute excess returns in Fig. 3 suggests an interesting regular pattern. The autocorrelations for the 5-min raw returns are numerically small, and resemble the realizations of a white noise. The average absolute 5-min returns start at nearly -0.005% early in the morning, rise to a higher lever of 0.004% in the middle of the day, and drop to about 0.001% towards the close. There are two distinct spikes at 0950 and 1040 BST, which is different from those of Bollerslve et al. (2000), whose two spikes are 0830 and 1000 EST, respectively. However, compared to bond markets in developed markets, the general U-shape pattern over the trading day is much weaker.

Figure 3: Treasury bond absolute excess return futures intraday 5-min volatility pattern

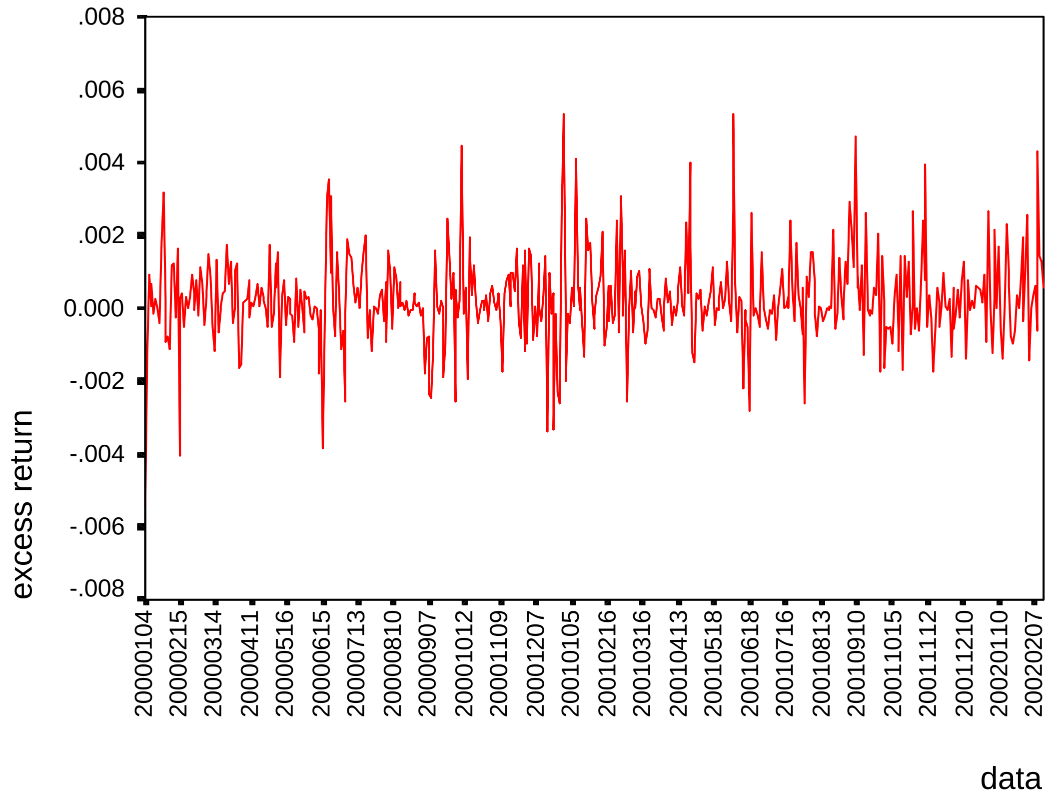


Note: The horizontal axis represents the each 5-min interval during the daytime, the vertical axis represents the absolute excess return rate of Treasury Bond (unit: E-04), the absolute excess return rate is the absolute value of excess return of Treasury bonds.

3. Modeling Analysis

In order to validate our model, the daily excess returns of six different Treasury bonds are examined and they have the similar properties which are showed graphically in Fig4. The graphs suggest that a model including heteroscedasticity is required to describe the evolution of the Treasury bond excess return as there are signs of volatility clustering. And we use $Jarque-Bera$ Statistics to test whether the series is normally distributed and use $Ljung-Box\ Q$ Statistics to test if the series is white noise.

Figure 4: Daily excess return of Treasury bonds volatility pattern



Note: the horizontal axis represents the everyday segment from January, 4, 2000 to February, 28 2002, the vertical axis represents the daily excess return rate of Treasury bonds (unit: E-02)

Consequently, we investigated the effect of these macroeconomic announcements in a heteroscedastic multivariate model of the excess returns of six China Treasury bond with different maturities. The model should be formulated such that we can make interesting conclusions as to the impacts of macroeconomic announcements on excess return of six Treasury bonds. The multivariate GARCH model is suited for this object.

3.1 *Significant announcement effects*

To illustrate influential announcements, we use the Variance-covariance Matrix to evaluate the correlation between excess return and trading volume, the degree of volatility, inflation rate, POBC benchmark rate, foreign exchange rate, consumer price index (CPI), SSE A-Share Index in order to determine the main effects on excess return of Treasury bond of SSE, China.

$$COV=\begin{bmatrix} \text{cov}(\text{Re}b_{i,k},\text{Re}b_{i,k}) & & & \\ \text{cov}(\text{Re}b_{i,k},Rate_k) & \text{cov}(Rate_k,Rate_k) & & \\ \text{cov}(\text{Re}b_{i,k},Vol_{i,k}) & \text{cov}(Rate_k,Vol_{i,k}) & \text{cov}(Vol_{i,k},Vol_{i,k}) & \\ \text{cov}(\text{Re}b_{i,k},Cons_k) & \text{cov}(Rate_k,Cons_k) & \text{cov}(Vol_{i,k},Cons_k) & \text{cov}(Cons_k,Cons_k) \end{bmatrix} \quad (2)$$

where $\text{Re}b_{i,k}$ is the excess return for the ith Treasury bond at the kth 5-min interval on the tth trading day; $Rate_t$ is POBC benchmark interest rate on the tth trading day; $Vol_{i,t}$ is the trading amount for the ith Treasury bond; $Cons_k$ is the Consumer Price Index increasing rate;

3.2 Multivariate GARCH model

Among the control variables, we select the variables whose F_{cal} significant level less than critical value (0.05), and delete the variables whose F_{cal} significant level ≥ 0.10. We set up multivariate GARCH model to eliminate the Auto-Regressive Conditional Heteroscedasticity produced when regression model parameters are estimated by time series.

$$\begin{aligned} REB_k = {} & \Theta_0 + \Theta_1 Vol_k + \Theta_2 \text{Re}tail_k + \Theta_3 Rate_k + \Theta_5 Cons_k + \Theta_5 Diff_k + \Theta_6 GDP_k \\ & + \Theta_7 Shaser_k + \Theta_8 \text{Im}\&Export_k + \Theta_9 \text{Re}venue_k + \Theta_{10} REB_{k-1} + \varepsilon_t \end{aligned} \quad (3)$$

Where Θ_i $i=1,\cdots,10$ are parameter vectors, REB_t is the excess return for six different Treasury bonds on the tth trading day; Vol_t is the trading amount for Treasury bonds on the tth trading day; $\text{Re}tail_k$ is commodity retail price index; $Rate_t$ is PBOC benchmark interest rate on the tth trading day; $Cons_t$ is the Consumer Price Index increasing rate; $Diff_t$ is the degree of volatility for the six different Treasury bond on the tth trading day; GDP_t is the Gross

Domestic Product; $Shaser_t$ is SSE A-Share Index yield; $\mathrm{Im}\&Export_t$ is total import growth rate; $\mathrm{Re}venue_t$ is residents real revenue.

3.3 *Conditional variances*

We use GARCH(p,q), which was introduced by Bollerslev in 1986, to model the condition variance.

$$\varepsilon_t = \sqrt{h_t} * v_t; h_t = \omega + \sum_{j=1}^{p} \alpha_j h_{t-j} + \sum_{i=1}^{q} \beta_i \varepsilon^2{}_{t-i}; \qquad \{v_t\} \sim i.i.d.(0,1) \qquad (4)$$

Where w is the mean, $\varepsilon^2{}_{t-1}$ (the ARCH term) is the news about volatility from the previous period, measured as the lag of the squared residual from the mean equation, $h^2{}_{t-1}$ (the GARCH term) is the last period's forecast variance, p is the order of the GARCH terms and q is the order of the ARCH term. α, β are, respectively, lag period of the residues in the GARCH Model. There is not a unique way of measuring volatility persistence, however, one simple and often use metric is the sum of the ARCH parameter and GARCH parameter.

The multivariate GARCH set up above is estimated using a two-step estimation technique. In the first step, we employ a GARCH model to capture the daily volatility clustering. The result 5-min volatility estimator is given by standard deviation σ. The second step of the estimation involves estimating the parameters in Eq.3. The actual estimation is based on all 219,024 intraday 5-min returns.

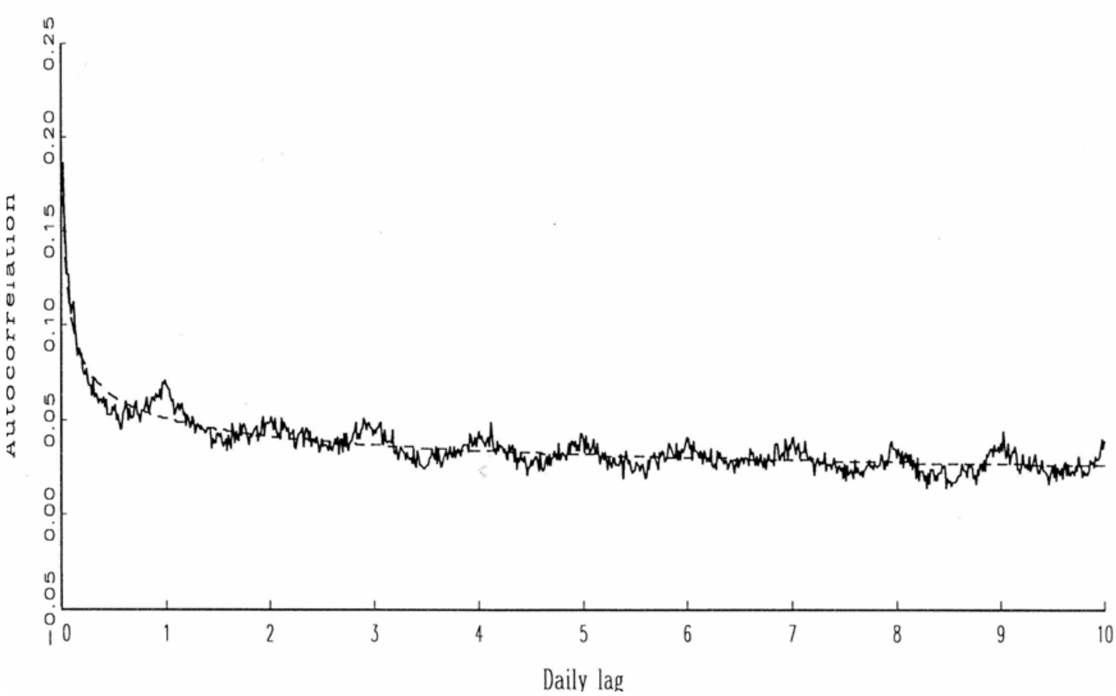
4. Empirical results from Treasury bond market

This section provides the empirical results from China Treasury bond market.

4.1 *Long memory volatility*

The intraday periodicity discussed in Fig3 gives rise to a striking repetitive pattern in the autocorrelations of the absolute excess return in Fig5. A rapid initial decay in the autocorrelation, is discernable, followed by an extremely slow rate of decay. The slowly declining U-shape occupies exactly a 1-day interval. Even at the 10-day, there is a clear U-shape in the autocorrelations. This shape indicates the presence of long-memory volatility dependencies in the China Treasury bond market. The GARCH model is well suited for modeling such patterns.

Figure 5: Daily lag of autocorrelation of absolute excess return



4.2 *Variance- Covariance Matrix*

Table 2: Covariances: yield, CPI, SSE A-Share, GDP, com retail, RPI, im&export

	yield	CPI	SSE A-Sh	GDP	com reta	RPI	im&export
yield	0.000014						
CPI	-0.000069	0.588016					
SSE A-Sh	0.000008	0.006433	0.003762				
GDP	0.000012	-0.000117	0.000005	0.000005			
com reta	-0.000028	0.141803	0.009307	0.000028	0.718946		
RPI	0.000022	0.121000	-0.000575	-0.000018	-0.274663	0.548793	
im&expor	0.000702	-1.844867	-0.026265	0.000039	-3.715695	0.909607	47.096285

Table 2 above lists the covariance between excess return of China Treasury bonds and other macroeconomic announcements. From Table 2, we can find out that GDP account for the largest absolute returns in the table, followed by CPI, and RPI. These results directly are consistent with the prior findings in the studies on the developed Treasury bond markets. And absolute return of China Treasury bonds has a weak negative correlation with SSE A-share index. Additionally, POBC benchmark interest rate and exchange rate have also some influences on excess return of China Treasury bonds.

Table 3: Correlation coefficients Matrix

	REB	Consu	Shaser	Econ	Soc	Retail	Rev	Import
REB	1.000							
Consu	-0.368	1.000						
Shaser	-0.074	-0.013	1.000					
Econ	0.3525	0.337	0.378	1.000				
Soc	-0.217	0.206	0.352	0.26	1.000			
Retail	-0.137	0.149	-0.266	0.002	------	1.000		
Rev	0.0477	0.058	-0.343	0.216	------	------	1.000	
Import	-0.162	-0.155	-0.029	0.422	------	------	------	1.000

4.3 *Multivariate Model Estimation*

Table 4 provides us basic statistical characteristics of daily excess return of China Treasury bonds:

1、Considering the mean and variance: The average daily excess return of China Treasury bonds is low. And the Treasury bonds issued after 1999 have higher daily excess return, which presents a progressive market characteristic. The phenomenon is relative to that POBC reduced deposit interest rates in 1999. It shows that China’s Treasury bonds market is becoming more and more reasonable.

2、Considering the skewness and kurtosis: The probability distribution of average daily excess return of China Treasury bonds has severe leftward skewness and fat tail, which can be explained by the China’s investment behaviors in Treasury bonds market. In other words, when it is bull market, more people have higher return; and when it is bear market, more people lose money. This tendency has been greatly improved after 1999 Treasury bonds.

3、From the Jarque-Beta statistic data: The statistic value of each Treasury bond is significant, indicating the daily excess return of China Treasury bonds does not follow normal distribution. The significant test further supports the results of the skewness and kurtosis.

4、Q(5)、Q(10)、Q(30) are Ljung-Box adjusted statistics with $\alpha = 0.05$. Q(30) is highly significant at $\alpha = 0.05$ and we reject the null hypothesis that 30 terms yield are not series correlation, which means that there is series correlation among excess return series.

Table 4: Basic statistic characteristics of daily excess return of China Treasury bonds

	96Treasury bond (10)	96Treasury bond (7)	97Treasury bond(10)	99Treasury bond(8)	99Treasury bond(10)	00Treasury bond (7)
Sample	507	507	507	507	507	293
Equilibration (*E-05)	-7.7	-8.7	-4.3	10.9	10.4	2.9
Variance (*E-05)	2.63	2.19	2.10	0.53	0.54	0.37
Minimum	-0.08031	-0.07291	-0.06808	-0.03104	-0.03215	-0.02263
Maximum.	0.00597	0.00529	0.00619	0.00633	0.00740	0.00865
Skewness	-14.289	-14.754	-12.843	-9.288	-8.691	-5.486
Kurtosis	218.158	227.637	188.783	122.705	114.870	67.413
Jarque Beta	927995**	938674**	923145**	965821**	912548**	952633**
Q（5）	16.400	13.023	11.032	13.256	16.556	15.3214
Q（10）	23.021	29.123	22.369	20.361	30.694	29.456
Q（30）	40.369**	42.329**	49.251**	50.741**	64.021**	51.021**

Note:

1. Jarque-Bera is a test statistic for measuring the difference of the skewness and kurtosis of the series with those from the normal distribution. The statistic is computed as:

$Jarque - Bera = \frac{N-k}{6}\left(S^2 + \frac{(K-3)^2}{4}\right)$, where S is the skewness, K is the kurtosis, and k represents the number of estimated coefficients used to create the series.

2. Ljung-Box Q-statistics at lag k is a test statistic for the null hypothesis that there is no autocorrelation up to order k and is computed as: $Q_{LB} = T(T+2)\sum\sum_{j=1}^{k} \frac{\tau_j^{\ 2}}{T-J}$, where τ_j is the j^{th} autocorrelation and T is the number of observations. If the series is not based upon the results of ARIMA estimation, then under the null hypothesis, Q is asymptotically distributed as a with degrees of freedom equal to the number of autocorrelations.

3. ** represents that significant level $\alpha = 0.05$; 96 Treasury bond (7) is the 7-year Treasury bonds issued in 1996, the rest are in the analogy.

4.3 *Macroeconomic announcement effects*

Table 5 summaries the empirical results. The estimation is based on the Eq.3, which includes GDP, CPI, SSE A-Share, RPI, and residents real income, im&export, exchange rate, inflation rate.

Table 5: Estimation Results of two-Step Reversion Model

	96Treasury bond(10)	96Treasury bond (7)	97Treasury bond(10)	99Treasury bond (8)	99Treasury bond (10)	00Treasury bond(7)
a_1 (*E-10)	-0.128***(-5.363)	-0.128*** (-5.963)	-0.096** (-3.619)	-0.057**(-2.719)	-0.057** (-2.519)	-0.114**(-4.417)
b_1 (*E-2)	0.056** (-2.658)	0.056** (-2.958)	0.061* (-4.526)	0.063* (-2.982)	0.063* (-2.582)	0.181***(-8.218)
a_3 (*E-4)	-0.131***(-2.238)	-0.131*** (-2.638)	-0.090* (-3.698)	-0.043**(-2.982)	-0.043** (-2.942)	-1.91***(-2.238)
a_4 (*E-2)	0.0335** (2.046)	0.0335** (2.016)	0.038** (2.385)	0.043** (2.046)	0.043** (2.096)	0.145*** (7.245)
a_5	-0.010** (-2.139)	-0.010** (-5.362)	-0.0065* (-2.365)	-0.045**(-2.139)	-0.045** (-3.256)	-0.035**(-3.139)
$F_{cal\ c}$	5.003	5.123	4.012	5.698	6.343	7.325
F_{calc} significant level	0.000	0.000	0.000	0.000	0.000	0.000

Table 5 displays the 5-min excess return rate of six different China Treasury bonds. The results from estimating equation (3) are striking. Firstly, the estimated coefficient b_j values in all six Treasury bonds are distinctive in the sample period, indicating that there is positive series correlation among Treasury bonds excess return, but a little weak. The estimated coefficient a_4 is significant, which tell us that PBOC benchmark interest rate has a negative impact on excess return of China Treasury bonds. From the estimated parameter a_5, we can find that there is obvious negative correlation between Treasury bonds excess return and the fluctuation in the same period. The retention of the fluctuation is rather strong and slower with the time attenuation degree. Moreover the excess return rate of Treasury bond issued after 1999 the year when PBOC greatly reduced basic interest rate has more distinctive correlation.

In fact, GARCH models are estimated by the method of maximum likelihood, under the assumption that the errors are conditionally normally distributed. We estimated likelihood using 120 iterative algorithms. After 120 iterations and estimate converge, we get the following parameter estimates and conventional regression statistics. The output from Eq.4 estimation is divided into two sections—the upper part provides the standard output for the mean equation, while the lower part, labeled "Variance Equation" contains the coefficients, standard errors, z-statistics and p-values for the coefficients of the variance equation. From the estimated parameter k_0 in the GARCH model, volatility genes of different Treasury bonds term structures are different, which show that the inner volatility of different Treasury bond term structure are different.

Table 6: GARCH (p,q) model fit to the 5-min China Treasury bond excess return output

Dependent Variable: R

Method: ML - ARCH

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Convergence achieved after 120 iterations

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.005072	0.005167	-0.973479	0.2367
Variance Equation				
C	0.015701	0.00304	12.64622	0.0070
ARCH (α)	0.205969	0.03492	35.56064	0.0000
GARCH (β)	0.786126	0.03822	20.14789	0.0000

R-squared	-0.000632	Mean dependent var	-0.020818
Adjusted R-squared	-0.001154	S.D. dependent var	0.604167
S.E. of regression	0.604511	Akaike info criterion	1.597167
Sum squared resid	2102.443	Schwarz criterion	1.601694
Log likelihood	-4592.295		

The ARCH parameters correspond to α in equation (4) is 0.205969 and the GARCH parameters corresponding to β is 0.786126. And the sum of the ARCH and GARCH coefficients ($\alpha+\beta$) is very close to one, indicating that China Treasury bond volatility shocks are quite persistent.

4. Conclusion

This paper provides a detailed characterization of China Treasury bond excess return volatility based on a sample of 5-min excess return from 2000 to 2002. We have noticed that with the development and reformation during the last decade, China Treasury bond markets have grown into a new phase: market average yield level arises, while the market risk depresses greatly. The main finds of the empirical work can be summarized as follows: Consistent with previous findings, we find two spikes in the intraday absolute 5-min excess return. The volatilities at the open and close are higher than in the middle of the day, although the corresponding U-shape is less pronounced than the typical pattern in equity markets. The strong intraday periodicity leads to equally strong patterns in the autocorrelation of the absolute excess return. We have argued that the interdaily volatility of China Treasury bonds excess return rate has the obvious fat tail and clustering characteristics. The volatility has a long memory with the slow decreasing process and is independent of the interest rate term structure. Our analysis also details the impact of main macroeconomic announcements on excess return of China Treasury bonds. We investigate, the are by far the most important, followed by the . In contrast to prior results for developed Treasury bonds markets, we find that macroeconomic announcement effects constitute an important source of China Treasury bonds markets volatility.

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