基于混合 GJR-GARCH 模型的中美证券市场
信息传播速度研究

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摘 要: 本文利用包含信息传播速度的 GJR-GARCH(1,1)模型估算中美证券市场的信息传播速度。发现信息传播速度对上证指数波动率有明显的影响，而对道琼斯指数波动率影响很弱。表明上海证券市场消化新信息的速度明显低于纽约证券市场。实证结果较好地刻画了中美证券市场信息流动的基本特征。

Information Transmission Speed in Chinese the US Stock Markets

1 Introduction

Clark(1973),Epps and Epps(1976) argue that positive price-volume relation involves the mixture distribution hypothesis model. In Clark's mixture model, trading volume is a proxy for the speed of information flow, a latent common factor that affects contemporaneous stock returns and volume. Copeland(1976,1977) analyzed asset trading with sequential information arrival model. Jennings, Starks and Fellingham(1981) suggested a positive causal relation between stock prices and trading volume in either direction. Noise trader models (Delong, Shleifer, Summers, and Waldmann,1990) also provide an explanation for a positive price-volume relation.

There is a vast amount of literature on the price-volume relation,see, for Karpoff's(1987) , Hong and Stein(2007).

The goal of this study is to examine the effect of information transmission speed (ITS) on the conditional volatility of daily stock returns in Shanghai and New York stock markets. The GJR-GARCH(1,1)model is modified to capture the effect of ITS on the volatility clustering of financial time series. Different empirical results have been gotten when the new model is applied to Shanghai Shcomp and Dow Jones indices.

2 Trade volume

2.1 Trade motives

Under asymmetric information framework, the motives of investors to trade can be divided into two classes (Andersen,1996). (1) Liquidity need: investors keep the balance of their total assets between currency and risk assets such as stocks. (2) Arbitrage need: investors adjust their portfolios according to the new information (public information, private information) in order to manage risk.

The informed trader's trading motive mostly comes from the second one.

The volume generated by the first motive and the second

motive as $Q_{L,t}$ and $Q_{I,t}$, respectively. So the total trading volume of t day is

$$Q_{T,t} = Q_{L,t} + Q_{I,t}$$

We use t day move average volume as a proxy for $Q_{L,t}$

$Q_{I,t}$ is generated as investors receive new information.

So $Q_{I,t}$ is positive relative to the quantity of new information

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$Q_{I,t}$ is positive relative to the quantity of new information,

which is a proxy variable for the quantity of new information at t day.

Let $\Delta Q_{I, t} = Q_{I, t} - Q_{I, t-1}$

If $\Delta Q_{I, t} = 0$,

the quantity of new information of t day is as much as the quantity of new information of t-1 day

If $\Delta Q_{I,t} \neq 0$,

the quantity of new information is not equal to one another for consecutive intervals.

The signals of each interval value of $\Delta Q_{I,t}$ have two typical cases:

$$\{\cdots,+,-,+,-,\cdots,+,-,\cdots-,+,-,+,\cdots\} \qquad (1)$$

$$\{\cdots,+,+,+,+,\cdots,-,+,\cdots,+,+,+,+,\cdots\} \qquad (2)$$

The first case shows the quantities of new information at each interval are not equal, they have no orderliness. This is consistent with efficient market hypothesis, under which different intervals information has no relation with each other

The second case presents same signal for continuing intervals.

Under asymmetric information framework, when new information arrives, there is a process in which the new information is transmited among investors.

Another explanation is based on noise trader model under which noise trader will adversely select according to informed traders action.

Using T days average trade volume to indicate $Q_{L,t}$

$$Q_{L,t} = \frac{1}{T}\sum_{i=1}^{T} Q_{T,t-T+i}$$

$$Q_{I,t} = Q_{T,t} - \frac{1}{T}\sum_{i=1}^{T} Q_{T,t-T+i}$$

$Q_{I,t}$ is a measurement of t day's quantity of new information coming to market, can measure the quantity change of new information from t day to t-1 day. a standard form of $Q_{I, t}$

$$\upsilon_t = \frac{\Delta Q_{I,t}}{Q_{I,t}}$$

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2.2 Information transmission speed (ITS)

Define γ_t as following

$$\gamma_t = \begin{cases} \gamma_{t-1} + 1 & if \quad \upsilon_t > tip \quad and \quad \upsilon_{t-1} > tip \\ 0 & else \end{cases}$$

γ_t can be seen as a proxy variable of the new information transmission speed. Define

$P^+ = P\{\upsilon_t > tip\}, \quad P^- = P\{\upsilon_t \le tip\}$

Then the distribution of γ_t is

$$P\{\gamma_t = n\} = \begin{cases} P^-P^+ + P^+P^- + P^-P^- & n = 0 \\ P^-P^+P^+ & n = 1 \\ P^-(P^+)^3 & n = 2 \\ \cdots & \\ P^-(P^+)^{i+1} & n = i \\ \cdots & \end{cases}$$

3 Model

The GJR-GARCH model introduced by Glosten, Jagannathan and Runkle(1993) offers an alternative method to analyze the asymmetric effects.

The extension of the GJR-GARCH referred as the mixture GJR-GARCH model is

$$y_t = f(x_t) + \varepsilon_t \qquad (1)$$

$$\varepsilon_t = z_t\sqrt{h_t} \qquad (2)$$

$$h_t = \alpha_0 + \exp(\phi\gamma_t)(\alpha_1\varepsilon_{t-1}^2 + \delta D_{t-1}\varepsilon_{t-1}^2) + \beta h_{t-1} \qquad (3)$$

where y_t is the log return, x_t is a vector with p lags of y_t,
z_t is a white noise with mean zero and variances one, and h_t is the conditional variance of ε_t.

γ_t is a proxy variable for ITS and used here as a mixing variable under the mixture distribution hypothesis. D_{t-1} is a dummy variable.

The standard GJR-GARCH(1,1) follows if ϕ is zero

The mixture GJR-GARCH model has a similar appearance with OGARCH proposed by Liu and Morimune (2006), and the difference is in the definition of Information Transmission Speed (ITS) , which is defined by the trade volume in this paper, not by the return rate as in OGARCH. Therefore, the mixture GJR-GARCH model is simultaneously modeling the daily trade volume and the return ratio data.

4 Estimation results

The Empirical analysis is to verify the effect of ITS in two stock markets.
Daily trade volume data of Shcomp index (A price index of Shanghai Stock Exchange market) and Dow Jones index (A price index of New York Stock Exchange market).
The sample period extends from first trade day of 2005 to final trade day of 2009 (Data come from Wind system).

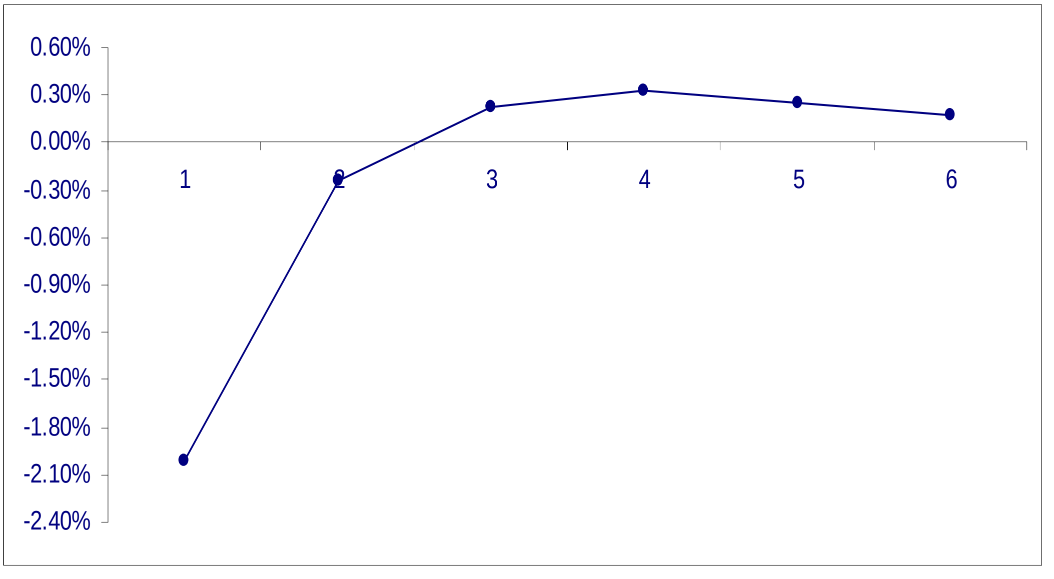
4.1 The summary statistics

The summary statistics of the two log return series are tabulated in Table 1.

Table 1 Summary Statistics of Data

Index	*T*	Max	Min	Mean	Kurtosis	Skewness	Std Dev
Shcomp	1214	9.03	-9.26	0.08	2.42	-0.34	2.04
DowJones	1269	10.51	-8.20	0.00	10.33	0.05	1.39

Data: 2005-2009; Resource: Wind system



Note: Horizontal axis represents ITS .（Tip=0.01）Vertical axis represents the frequency difference of ITS between two stock markets (viz. the frequency difference of ITS between Shcomp and DowJones)

Figure 1. The frequency difference of Information transmission speed between two stock markets

4.2 Estimation results

The mixture GJR-GARCH (1, 1) model is estimated by the quasi-maximum likelihood (QML) method that z_t is a standard normal random variable. The quasi log likelihood function is

$$L_T(\theta) = \sum_{t=1}^{T} -\frac{1}{2}\log(2\pi) - \frac{1}{2}\log(h_t) - \frac{\varepsilon_t^2}{2h_t}$$

where T is the sample size. The QML method is usually applied to the ARCH class models since the distribution of disturbance term is unknown but known to be nonormal.

Table 2 and 3 present the estimation results of the GJR-GARCH(1,1) and mixture GJR-GARCH model respectively

Table 2. The GJR-GARCH(1,1) estimation

Index	T	μ	α_0	α_1	δ	β	Likelihood
Shcomp	1214	0.14^{**}	0.04^{*}	0.06^{**}	0.02	0.92^{**}	-2487.63
		(2.85)	(2.09)	(4.24)	(1.12)	(64.80)	
DowJones	1269	0.01	0.01^{**}	0.00	0.13^{**}	0.92^{**}	-1756.32
		(0.56)	(3.93)	(0.00)	(6.36)	(83.37)	

Note: The t values are in parentheses. * and ** indicate significant coefficient at 5% and 1%.

Table 3. The mixture GJR-GARCH(1,1) estimation

Index	T	μ	α_0	ϕ	α_1	δ	β	Likelihood
Shcomp	1214	0.13^{**}	0.05^{*}	0.30^{**}	0.04^{**}	0.05^{**}	0.91^{**}	-2484.32
		(2.78)	(2.17)	(2.95)	(3.07)	(2.58)	(60.81)	
DowJones	1269	0.01	0.01^{**}	0.00	0.00	0.13^{**}	0.92^{**}	-1756.32
		(0.56)	(3.93)	(0.00)	(0.00)	(6.36)	(83.37)	

Note: same as Table 2. Tip=0.01

There is a big difference between the estimation of likelihood functions value in mixture GJR-GARCH (1,1) model and GJR-GARCH (1,1) model for Shcomp.The information transmission speed coefficient ϕ is significant in Shcomp case, which means it has significant affect on Shcomp and the mixture GJR-GARCH(1,1) fits the information transmission process of Shcomp properly.

As for Dow Jones, the estimation results of these two models are almost the same. The information transmission speed coefficient ϕ is insignificant in mixture GJR-GARCH (1,1) model, which means mixture GJR-GARCH (1,1) cann't capture the effect of information transmission process on the volatility.

4.3. News impact curves

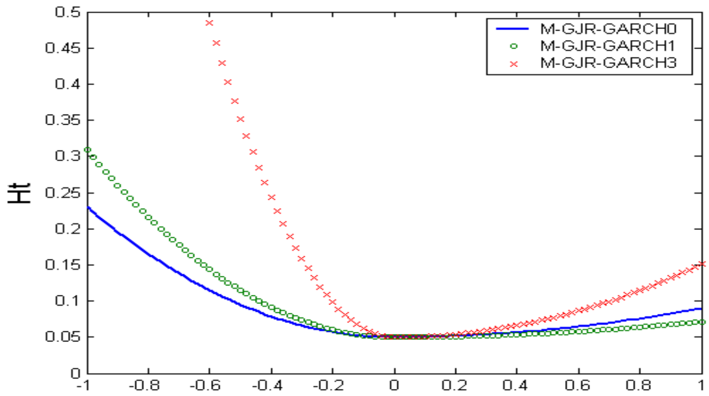
The news impact curve function of standard GARCH(1,1) model is $h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta\sigma^2$

The news impact curve of the mixture GJR-GARCH (1, 1) is

$$h_t = \alpha_0 + \exp(\phi\gamma_t)(\alpha_1\varepsilon_{t-1}^2 + \delta D_{t-1}\varepsilon_{t-1}^2) + \beta h_{t-1}$$

The impact curve is plotted in Figure 2 with the estimates in Table 2 and Table 3

Figure 2. News impact curves



Note: M-GJR-GARCH0-3 denote the mixture GJR-GARCH

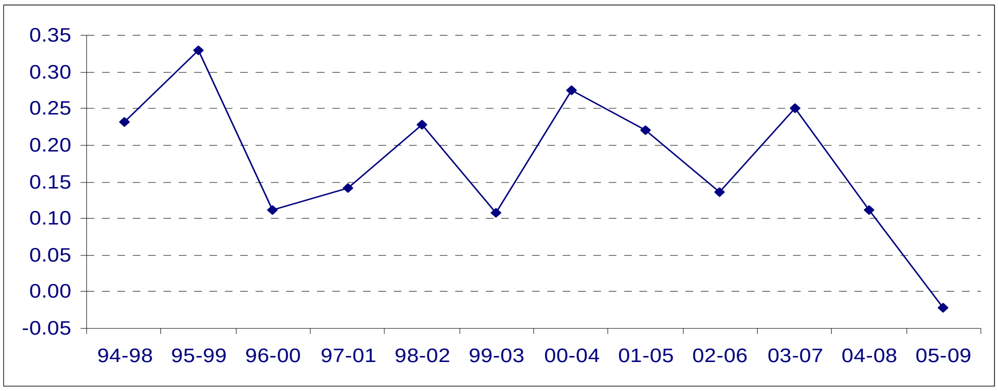
Table 4. The mixture GARCH(1,1) rolling windows estimation

Period	93-97	94-98	95-99	96-00	97-01	98-02	99-03
DowJones	0.21*	0.12	0.00	0.23*	0.14	0.17	0.31**
	(2.15)	(.)	(.)	(2.16)	(1.16)	(1.73)	(3.12)
Shcomp	0.22*	0.35**	0.33**	0.34**	0.28**	0.40**	0.42**
	(2.48)	(5.09)	(2.80)	(6.02)	(3.84)	(5.89)	(6.50)
Period	00-04	01-05	02-06	03-07	04-08	05-09	
DowJones	0.29**	0.28**	0.32**	0.09	0.13	0.14	
	(3.23)	(3.49)	(3.73)	(0.70)	(1.35)	(1.5)	
Shcomp	0.56**	0.50**	0.45**	0.34**	0.24**	0.12	
	(7.60)	(6.46)	(6.01)	(4.4)	(3.15)	(1.35)	

Note: The estimations are coefficients on Information transmission speed .

The t values are in parentheses.* and ** indicate significant coefficient at 5% and 1%. Tip=0.01.

$h_t = \alpha_0 + \alpha_1 \exp(\phi\gamma_t)\varepsilon_{t-1}^2 + \beta h_{t-1}$



Note: Horizontal axis represents sample periods. （Tip=0.01） Vertical axis represents the frequency difference of Information transmission speed between two stock markets (viz. the frequency difference of Information transmission speed between Shcomp and DowJones)

Figure 3. The mixture-GARCH(1,1) rolling windows estimation of frequency difference of Information transmission speed between two stock markets

What's the reason inducing the big difference effect of information transmission speed on volatility between China and U.S.A?

We give two comments: The structure of Investors. The investors of Shanghai Stock

Market are limited to Chinese mainland. The QFII (Qualified Foreign Institutional Investors) are 94 and the amount of $16.770 billion, which is minor compared with A share market value of 11720 billion (RMB). The proportion of Institution investor is lower than Euramerican stock markets (Fig 4). The main participants are individual investors who run short of investment experience and capability of collection and disposal of information.

Figure 4 Securities Accounts of Shanghai and Shenzhen Stock Market (10000)

Their investment decisions are typically noise trader and their investment behavior is representation of Herd Behavior. Their investment purposes are obtaining the Bid-Ask spread which shortens the investment term. The turnover of Shanghai Stock market is higher than NYSE (Fig 5) which reflects the character of short-term investment manner of investors in Shanghai Stock market.

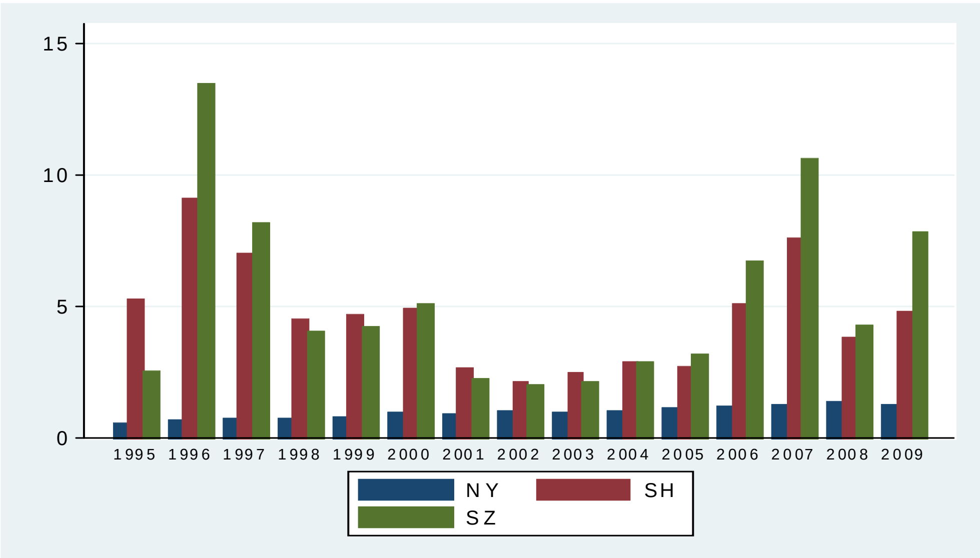


Figure 5 Turnover Velocity in New York, Shanghai and Shenzhen Stock Exchange

The Micro-structure of Market

Investors can't obtain the accurate fundamental information of enterprises because the requirement of information disclosure is insufficient by the laws and rules that they follow other investors like sheep. The stock market is not an information effective one since the information cannot be obtained by the majority investors.