DOES HOT MONEY IMPACT STOCK AND EXCHANGE RATE MARKETS ON CHINA?

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ABSTRACT

This study investigates the impact of hot money on stock and exchange rate markets and the returns and volatility spillover between the stock and exchange rate market in China by using the monthly data covering the period from July 2005 to June 2013. This paper also uses the quantile approach to determine whether the hot money influences the stock and exchange rate markets. The results first reveal the long-run equilibrium relationship that is exhibited between the stock and exchange rate market. Second, hot money has an impact on the stock market but has no effect on the exchange rate market, according to the VECM-BEKK model. Third, regarding the volatility spillover effects on the stock and exchange rate markets, there is a spillover effect on the Shanghai stock and exchange rate markets. Hot money has an impact on the stock and exchange rate markets. Finally, we apply the quantile regression to determine the impact of hot money on low quantiles of the exchange rate and high quantiles of the Shanghai and Shenzhen stock market.

Keywords: hot money, stock market, foreign exchange rate, BEKK model, quantile approach

INTRODUCTION

As the financial markets have become liberalised and international, the relationship between the stock market and the exchange rate market has become a popular issue for the economic literature to investigate and discuss. Currently, the analysis of the relationship between the stock market and the exchange rate market is more interesting and important in emerging markets such as the Chinese market. The Chinese government implemented the fixed peg exchange rate policy before 2005. As the financial markets were liberalised, the Chinese government released the exchange rate policy reform in July 2005, abolishing the fixed nominal exchange rate system for the U.S. dollar. Foreign governments had pressured the Chinese government to make their exchange rate more flexible and floating. As a result, the Chinese government shifted their system to a version of a currency basket system.

Over the past several decades, numerous studies have investigated the relationship between the stock market and the exchange rate market. These two markets are essential to the financial market. Prior studies often used the Johansen cointegration test to identify the relationship between the stock and exchange rate markets. Pan, Fok and Liu (2007) utilised the Johansen cointegration test to find the long-run equilibrium relationship between exchange rates and stock prices for the East Asian markets and found the long-run relationship between the markets was at least at a 10% level for Hong Kong, in the two sub-periods before the Asian financial crisis. Some studies have indicated that the linkage between the stock and exchange rates is a short-run relationship; Zhao (2010) used the Johansen cointegration method to determine the relationship between the stock and exchange rate market and used the GARCH method to study a short-term dynamic relationship between stock prices and exchange rates in China. Nevertheless, few studies have explored the relationship between Chinese stock prices and the exchange rates. One of the aims of our study is to investigate this relation in the Chinese market. Our finding is that there is a long-run equilibrium relationship between the markets.

To investigate the relationship between stock prices and exchange rates, there are two models for examining the casualty relationship of both markets. The international trading effect theory was formulated by Dornbusch and Fisher (1980), in reference to the goods market. The fluctuations of exchange rates have a direct influence on the profitability of a business and a firm's international competitiveness. The appreciation of exchange rates will decrease the exporters' sales, earnings, and stock prices, and vice versa. The portfolio balance effect (Frankel, 1983) was necessary for investors for hedging and the diversification

of portfolios. Because the previous relationship was changed, it provided a unidirectional causality from stock prices to exchange rates.

The hot money issue is quite an interesting topic in the financial market currently (Kim & Iwasawa, 2017; Fuertes, Phylaktis, & Yan, 2016; Tsai, Chiang, Tsai, & Liou, 2014). Because of globalisation, hot money[1] can spread around the world, especially in emerging markets. This study focused on the Chinese market, which is the biggest emerging market, and investigated their flow of hot money. After 2005, the Chinese government began the exchange rate policy reform, and the inflow and outflow of hot money became more frequent, as shown in Figure 1. Few papers have investigated how hot money has affected the stock and real estate markets (Guo & Huang, 2010; Xu & Chen, 2012). This paper investigates the impact on the stock and exchange rate markets as hot money flows into the Chinese market. A few studies have investigated the impact of hot money on the exchange rate and stock market. This study further examines the influence of hot money on the stock and exchange rate market after China implemented financial liberalisation in 2005.

Figure 1. The inflow and outflow of hot money

The quantile regression model is used to estimate the relation of these two markets under different market conditions (different quantiles of exchange rates, stock prices, and hot money). In this research, using the quantile regression method, we observe the impact of hot money on markets under various conditions. This study tests the impact of hot money on both the stock and exchange rate markets under different quantiles to determine the effect of hot money on both markets in declining or in rising markets.

This study has three objectives. First, this paper uses the cointegration method based on the Johansen cointegration model to identify the long-run relationship between the stock and exchange rate markets. Second, this study further examines the influence of hot money on the return and volatility on the stock and exchange rate markets. Finally, there is a lack of literature on the use of

quantile regression methods; therefore, this paper is intended to provide evidence of the impact of hot money on two markets in different quantiles.

DATA AND METHODOLOGY

This research mainly examines the impact of hot money on the stock and exchange rate markets in China. Our empirical data are from the monthly frequency time series dataset of the stock and foreign exchange markets in China covering the period from July 2005 to June 2013.[2] The information is collected from several resources:

1. Indices in China, including the Shanghai composite index and the Shenzhen composite index (hereafter, SH and SZ);

2. the foreign exchange rate in China and foreign direct investment monthly data from the *China Statistical Yearbooks Database*;

3. foreign exchange reserves and trade surplus in China from TEJ (Taiwan Economic Journal Database).

Following the studies from Zhang and Fung (2006) and Guo and Huang (2010), this paper defines the calculation of hot money (HM) as follows:

$$HM = FER - TSB - FDI \qquad (1)$$

where FER, TSB and FDI denote the change in foreign exchange reserves, trade and service balance and foreign direct investment. The rates of change of the data series are calculated as:

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \qquad (2)$$

where $P_{i,t}$ is the price level of the market i ($i = e$ for exchange rate, $i = s$ for stock price) at the time, t. $R_{e,t}$ denotes the change of exchange rate; $R_{s,t}$ denotes the return on stock prices.

Johansen (1988) noted that the cointegration procedure is based on an unrestricted vector autoregressive (VAR) model for the ($n \times 1$) vector Y_t:[3]

$$\Delta Y_t = \prod Y_{t-1} + \sum_{i=1}^{k-1} \Gamma \Delta X_{t-i} + \Phi D_t + \varepsilon_t \qquad (3)$$

where Y_t explores the vectors of all the economic variables, the model (~I(1)) includes n variables, the Π, Γ, and Φ are parameter matrices to be estimated, D_t

contains deterministic terms (constant, trend, seasonal dummy) and ε_t denotes the white noise, which is the variable of I(0). There are two tests for the reduced rank of Π, which are the trace test and the maximum eigenvalue test and are shown as follows:

$$\lambda_{trace} = -T\sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right) \tag{4}$$

$$\lambda_{max}\left(r, r+1\right) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right) \tag{5}$$

where λ_i denotes the characteristic estimation values, and T is the number of the effective observations after the lag adjustment. The trace test illustrates the existence of any vector of cointegration, $r = 0$, implies that $\lambda_1 = \lambda_2 = \ldots = \lambda_n = 0$, that is, $\lambda_{trace} = 0$; if there are a number of distinct cointegrating vectors $(r), \lambda_1 \neq 0, \lambda_2 \neq 0, \ldots, \lambda_r \neq 0$, but $\lambda_{r+1} = \lambda_{r+2} = \ldots = \lambda_n = 0$, then the value of $\lambda_{trace} = -T\sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right)$ is nearly equal to zero. The maximum eigenvalue tests the null hypothesis that the cointegration vector is r, against the alternative of $r + 1$ cointegrating vectors.

This section introduces the VECM-BEKK model that incorporates spillover volatility effects and enables us to examine the relationship between stock indices and exchange rates. This research utilises a bivariate conditional mean equation of the VECM-BEKK model, i.e., the VECM process:

$$R_{e,t} = \alpha_{e,0} + \sum_{i=1}^{n} \alpha_{e,i} R_{e,t-i} + \sum_{i=1}^{n} \alpha_{s,n+j} R_{s,t-i} + \varphi_e hm_t + \pi_e Z_{t-1} + \varepsilon_{e,t} \tag{7}$$

$$R_{s,t} = \alpha_{s,0} + \sum_{i=1}^{n} \alpha_{s,i} R_{s,t-i} + \sum_{i=1}^{n} \alpha_{s,n+j} R_{e,t-i} + \varphi_s hm_t + \pi_s Z_{t-1} + \varepsilon_{s,t} \tag{6}$$

where $R_{e,t}$ is the change of exchange rates and $R_{s,t}$ is the return on stock index. $Z_{t-1} = (S_{t-1} - \alpha - \beta EX_{t-1})$ is error correction term. S_{t-1} and EX_{t-1} are the prices of the stock index and the exchange rate, respectively. $\varepsilon_t = [\varepsilon_{e,t}, \varepsilon_{s,t}]$ represents a vector of the random error at time t, which indicates that the market has been affected at that time, $\varepsilon_t|I_t-1 \sim N(0, H_t)$, H_t is a 2×2 variance-covariance matrix, and I_{t-1} is the information collection of time $t-1$. The 2×1 vectors $\alpha = [\alpha_{e,0}, \alpha_{s,0}]$ are the long-run float coefficients. The parameter $\alpha_{e,n+j}$ and $\alpha_{s,n+j}$ denote the mean spillovers effect, $\alpha_{e,i}$ ($\alpha_{s,i}$) indicates the exchange rate (stock return) is affected by its lag value, $\alpha_{e,n+j}$ is the mean of the spillovers from the stock indices to the RMB exchange rate, $\alpha_{s,n+j}$ is the mean of the spillovers from the RMB exchange rate to the stock indices, and hm_t denotes the influence of hot money between the stock

and the exchange rate. According to the MGARCH model by Engle and Kroner (1995), the conditional variance equation of VECM-BEKK model is

$$\varepsilon_t = H_t^{1/2} v_t \tag{8}$$

$$H_t = A'A + B'\varepsilon_{t-1}\varepsilon'_{t-1}B + C'H_{t-1}C + D'DHM_t \tag{9}$$

where v_t denotes the white noise process and A and D represent the 2×2 triangular matrix. B_{ij} is the 2×2 matrix B and reveals the ARCH effect of volatility, which is the volatility impact of market i on market j; the element C_{ij} indicates the impact of volatility persistent between market i and market j.

$$H_t = \begin{pmatrix} h_{ee,t} & h_{es,t} \\ h_{se,t} & h_{ss,t} \end{pmatrix} = \begin{pmatrix} a_{11} & 0 \\ a_{21} & a_{22} \end{pmatrix}' \begin{pmatrix} a_{11} & 0 \\ a_{21} & a_{22} \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \varepsilon_{t-1}\varepsilon'_{t-1} \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix}$$

$$+ \begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix} H_{t-1} \begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix} + \begin{pmatrix} d_{11} & 0 \\ d_{21} & d_{22} \end{pmatrix}' \begin{pmatrix} d_{11} & 0 \\ d_{21} & d_{22} \end{pmatrix} hm_t \tag{10}$$

The Equation (10) for H_t, further expanded by matrix multiplication, takes the following form:

$$h_{ee,t} = a^2_{11} + b^2_{11}\varepsilon^2_{e,t-1} + 2b_{11}b_{21}\varepsilon_{e,t-1}\varepsilon_{s,t-1} + b^2_{21}\varepsilon^2_{s,t-1} + c^2_{11}h_{ee,t-1}$$
$$+ 2c^2_{11}c_{21}h_{es,t-1} + c^2_{21}h_{ss,t-1} + d^2_{11}hm_t \tag{11}$$

$$h_{es,t} = a_{11}a_{21} + b_{11}b_{12}\varepsilon^2_{e,t-1} + (b_{21}b_{12} + b_{11}b_{22})\varepsilon_{e,t-1}\varepsilon_{s,t-1} + b_{21}b_{22}\varepsilon^2_{s,t-1}$$
$$+ c_{11}c_{12}h_{ee,t-1} + (c_{21}c_{12} + c_{11}c_{22})h_{es,t-1} + c_{21}c_{22}h_{ss,t-1} + d_{11}d_{21}hm_t \tag{12}$$

$$h_{ss,t} = a^2_{21} + a^2_{22} + b^2_{12}\varepsilon^2_{e,t-1} + 2b_{12}b_{22}\varepsilon_{e,t-1}\varepsilon_{s,t-1} + b^2_{22}\varepsilon^2_{s,t-1} + c^2_{12}h_{ee,t-1}$$
$$+ 2c_{12}c_{22}h_{es,t-1} + c^2_{22}h_{ss,t-1} + (d^2_{11} + d^2_{22})hm_t \tag{13}$$

where the $h_{ee,t}$ variable symbolises the change of RMB's exchange rate; $h_{es,t}$ represents the covariance combined with the change rate of the RMB exchange rate and the stock price return; and $h_{ss,t}$ stands for the variance of the stock return. This study tests the coefficients b_{12} and c_{12} to determine if there are significant effects based on the volatility of spillover from the exchange rate market to the stock market (H$_0$: $b_{21} = c_{21} = 0$) and investigates the coefficients b_{21} and c_{21} (H$_0$: $b_{12} = c_{12} = 0$) to determine if there are significant effects based on the volatility of the spillover from the stock market to the exchange rate market. If there is no volatility spillover effect between two markets, the elements of b_{21}, c_{21}, b_{12} and c_{12} of matrices B and C have insignificant effects (H$_0$: $b_{21} = c_{21} = b_{12} = c_{12} = 0$). H$_0$: $\varphi_e = \varphi_s = 0$ and H$_0$: $d_{11} = d_{21} = 0$ test the hot money impact on the stock and exchange rate markets in the mean and volatility equations, respectively.

Several studies have used the quantile approach to analyse the conduct of dependent variables, given the information contained in a set of explanatory variables. In this section, this paper use quantile regression approach to investigate the impact of hot money on the stock market and exchange rate markets, from different quantiles. First, this paper use the quantile regressions of $R_{s,t}$ and $R_{e,t}$,

$$R_{e,t,\tau} = \alpha_{e,\tau} + \beta_{e,\tau} hm_{t,\tau} + \varepsilon_{e,t,\tau} \tag{14}$$

$$R_{s,t,\tau} = \alpha_{s,\tau} + \beta_{s,\tau} hm_{t,\tau} + \varepsilon_{s,t,\tau} \tag{15}$$

where $R_{e,t,\tau}$ is the change of the RMB exchange rate at the τ quantile and $R_{s,t,\tau}$ is the stock return at the τ quantile on the Shanghai and the Shenzhen composite indices. $\beta_{e,\tau}$ and $\beta_{s,\tau}$ are the coefficients of the model that this paper estimated. The model estimates $\beta_{e,\tau}$ and $\beta_{s,\tau}$ for different conditional quantile functions, and $\varepsilon_{s,t}$ and $\varepsilon_{e,t}$ are error terms. The variable HM_t denotes the impact of hot money on the stock and the exchange rate markets. Then, this paper assumes the conditional mean of R is $\mu(X) = X'\beta$, and the ordinary least squares approach suggests the mean, $\min\limits_{\beta \in R} \sum_{t=1}^{n} (E_t - \mu)^2$, which can be showed as $\min\limits_{\beta \in R^P} \sum_{t=1}^{n} (E_t - X'_t \beta)^2$.

EMPIRICAL RESULTS

Table 1 presents the summary statistics of the returns on the stock indices and the change of foreign exchange rates and hot money for the sample period from July 2005 to June 2013. The means of the returns on the stock indices and hot money are greater than 0. The means of the returns on $R_{SH,t}$ and $R_{SZ,t}$ are 0.6347 and 1.3152, and the standard deviation of $R_{SH,t}$ and $R_{SZ,t}$ are 9.4459 and 10.3365, respectively. A higher return on stock indices indicates a higher risk, which suggests that the Shenzhen composite index has a higher risk in the market. The average change of exchange rates is negative, which means that the currency depreciates during the sample period. The exchange rates and SH stock returns of Jarque-Bera statistic show the significant results for the null hypothesis of normal distribution.

To examine the degree of the integration of the variables, this paper applied the unit root test to ensure the stationarity of the time-series data. The variables should be conducted for each level and for the first difference if the variables are significant by using the unit root test. The Phillips-Perron (PP) test is used to search for the existence of unit roots. The results for the Phillip-Perron test, as shown in Table 2, illustrates that the change of the foreign exchange rate and the returns on the stock market are non-stationary, with the exception of hot money. The variables that are non-stationary data become stationary in the first difference at the 1% level. After the first difference degree, this paper found that all

of the variables are significant. Then, this paper is going to test the cointegration method to investigate the long-run equilibrium.

Table 1
Summary statistics

	$R_{e,t}$	HM_t	$R_{SH,t}$	$R_{SZ,t}$
Mean	−0.2933	37.7681	0.6347	1.3152
Maximum	0.8898	814.8607	24.2526	25.4171
Minimum	−1.7419	−1202.1900	−28.2779	−26.8091
Standard Deviation	0.4619	384.2920	9.4459	10.3365
Skewness	−0.9456**	−0.4462	−0.6549*	−0.5495*
Kurtosis	1.4379**	0.7619	1.0587	0.3317
Jarque-Bera	22.3416**	5.5079	11.2069**	5.2163

Notes: $R_{SH,t}$, $R_{SZ,t}$ represent the return of variables at time t. $R_{e,t}$ denotes the exchange rates of RMB; HM_t denotes variables of the hot money. $R^m_{SH,t}$ and $R^m_{SZ,t}$ denote the equally weighted sum of each stock return on Shanghai and Shenzhen stock markets. This table indicates the descriptive statistics for the change of RMB foreign exchange rate, hot money, stock index return for SH and SZ during the period from July 2005 to June 2013. * and ** signify the significant level at 5% and 1% respectively.

Table 2
Unit root test

Variables	Index level		First difference	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept
EX	−0.9976	−1.3946	−8.2296**	−8.2407**
HM	−7.8825**	−7.9047**	−20.436**	−20.325**
SH	−2.3758	−2.0721	−9.1427**	−9.3176**
SZ	−2.5177	−2.0119	−9.1437**	−9.2866**

Notes: This table shows the results of unit root test for stationary of the individual time series of hot money (HM), RMB exchange rate (EX), Shanghai composite indices and Shenzhen composite indices (SH and SZ). Intercept denotes the test of unit root only for intercept term. Trend & Intercept denote the unit root test for trend term and intercept term. ** denotes the significant at the 1%.

The result of the Johansen trace and maximum eigenvalue cointegration tests in Table 3 display evidence of a cointegration system.[4] The test results show that the exchange rates and the stock prices are cointegrated. At the 5% confidence level, the results show that cointegration exists between the prices of the stock indices and the exchange rates, as the trace and maximum eigenvalue tests are statistically significant. Consequently, based on the evidence in Table 3, this paper concludes that there exists a cointegration relationship between the stock prices and the exchange rates.

Table 3
Johansen cointegration approach

Variables	SH		SZ	
	Trace	Max-Eigen	Trace	Max-Eigen
H_0: $r = 0$	43.2670**	42.5671**	42.5671**	34.6513**
H_1: $r = 1$	8.5760	7.0329	7.0329	8.5785

Notes: r denotes the number of cointegrating vectors. This table shows the Johansen cointegration test for the trace test and the maximum eigenvalue test on Shanghai composite index and Shenzhen composite index (SH and SZ). The model of trace and eigenvalue test were showed as $\lambda_{trace} = -T\Sigma_{i+r+1}^{n} \ln\left(1 - \hat{\lambda}_i^2\right)$ and $\lambda_{max}(r,r+1) = -T\ln(1-\lambda_{r+1})$. ** denotes the significant at the 5%.

This section applies the VECM-BEKK model to explore the dynamic relationship between the RMB foreign exchange rates and stock prices, as shown in Table 4. On panel A in Table 4, the coefficients of the stock return, $\alpha_{s,1}$ and $\alpha_{s,2}$, are not significant on the SH and the SZ stock markets, but the coefficients of the change of the exchange rate $\alpha_{e,2}$ are significant. This finding shows that the stock market is an efficient market, but the exchange rate market is not an efficient market. In term of the return spillover effect between the stock and exchange rate markets, we can find the results of $\beta_{e,1}$, $\beta_{e,2}$, $\beta_{s,1}$ and $\beta_{s,2}$ are not significant. The results of Panel D in Table 4 investigates the monthly return and volatility spillover effects between stock and exchange rate markets and hot money effect on two markets. The statistics show H_0: $\beta_{e,1}$, $= \beta_{e,2} = \beta_{s,1} = \beta_{s,2} = 0$ is 4.110 (5.6680) between the SH (SZ) stock and exchange rate markets and the insignificant return spillovers.

The error correction coefficients of π_e and π_s measure the speed of adjustment in response to deviations from the long-run equilibrium, and we found that the two coefficients are significant negatively on panel A of Table 4. We generally expect $\pi_e < 0$ and $\pi_s > 0$, but it is also possible that the error correction coefficient of the two markets have the same negative sign (Bohl, Salm and Schuppli, 2011). Bohl, Salm and Schuppli (2011) suggest that $|\pi_e| > |\pi_s|$ is only required to restore the long-run equilibrium, and our result is $|\pi_e| > |\pi_s|$

On Panel A of Table 4, the results of φ_e and φ_s are significant for the effect of hot money on the stock and exchange rate markets, indicating the hot money impact on the stock return and the change of exchange rate markets in China.

In Panel B of Table 4, a_{11}, b_{12}, b_{22}, c_{11}, c_{21}, c_{22} and d_{11} (a_{11}, b_{11}, b_{21}, b_{22}, c_{21}, c_{22}, d_{11} and d_{21}) are significant in the volatility equations between SH (SZ) stock and exchange rate markets. The estimated parameters of b_{22}, c_{11} an d c_{22} (b_{11}, b_{22} and c_{22}) are all statistically significant, which indicates a strong GARCH (1, 1)

process between the SH (SZ) stock market and the exchange rate markets. The results of d_{11} and d_{21} are significant in the volatility equation, indicating the hot money impact on the volatility of the stock and exchange rate markets in China.

The results in Panel D of Table 4 investigate the monthly volatility spillover effects between the stock and the exchange rate markets. The value of H_0: $b_{21} = c_{21} = b_{12} = c_{12} = 0$ is 30.2700 (26.0900) between the SH (SZ) stock and the exchange rate markets and the significant volatility spillovers. We further test the volatility spillovers from the stock market to the exchange market (H_0: $b_{12} = c_{12} = 0$) and the volatility spillovers from the exchange market to the stock market (H_0: $b_{21} = c_{21} = 0$). The values of H_0: $b_{12} = c_{12} = 0$ and (H_0: $b_{21} = c_{21} = 0$) are 10.9550 and 17.8400, respectively, and they are significant on the SH stock and exchange rate markets, indicating the volatility spillover shows a bi-causality effect between the Shanghai stock and exchange rate markets. However, the value of H_0: $b_{21} = c_{21} = 0$ is 20.3610 and significant for the SZ stock market, indicating the volatility spillovers from exchange market to Shenzhen stock market.

Finally, we investigate hot money impact on the stock and exchange rate markets on the mean of H_0: $\varphi_e = \varphi_s = 0$ and the volatility equation H_0: $d_{11} = d_{21} = 0$ by the VECM-BEK model in Panel D of Table 4. The values of H_0: $\varphi_e = \varphi_s = 0$ and H_0: $d_{11} = d_{21} = 0$) are 98.4610 and 13.5000 (17.0980 and 32.1660) and are significant on the SH (SZ) and exchange rate markets, indicating that hot money has a significant impact on the change of exchange rates and stock returns.

Examining the standardised residuals and square standardized residuals using the Ljung-Box Q statistic as shown in Table 4 on Panel C, the Ljung-Box Q statistics of the standardised residuals of the SH and the SZ are 3.5310 and 3.8390, respectively, denoting that there is no autocorrelation to the standardised residuals in the SH and the SZ; the Ljung-Box Q statistics of the standardised residuals exchange rate is 8.6320, denoting that there is no significant autocorrelation with the standardised residuals in the exchange rate. Consequently, the Ljung-Box Q^2 statistic shows no evidence of linear and non-linear dependence in the square standardises residuals; thus, the VECM-BEKK models can sufficiently describe the dynamic relationship.

The quantile regression method is used to examine the influence of hot money on the exchange rate and the Shanghai and Shenzhen composite stock markets. The result illustrates the impact of hot money on the SH and SZ markets under different quantile regressions, as shown in Table 5. The coefficients acquired from the different quantiles are clearly shown. The coefficients of the impact of hot money on the exchange rate market are negative and are significantly evident in the higher quantiles. In other words, the estimated statistics suggest statistical

Table 4
VECM-BEKK Model

	SH				SZ		
	Exchange rate		Stock market		Exchange rate		Stock market
Panel A: Mean equations							
Constant	−0.1830**	Constant	−1.8183**	Constant	−0.1709**	Constant	0.1941
	0.2241		0.9650		0.4044**		3.7733
	0.2010**		−1.1096		0.2041**		−2.4815
	0.0038		−0.0039		0.0027		0.0046
	−0.0041		0.0496		0.0014		0.1804
	−0.2469**		−12.5419**		−0.1908**		−8.3179**
	−0.0001		0.0080**		0.0001		0.0090**
Panel B: Variance equations							
	0.0962**	c_{11}	0.7272**		0.1530**	c_{11}	0.2243
	−0.2731	c_{12}	−0.3432		−0.4191	c_{12}	−4.6213
	0.0000	c_{21}	0.0072**		−1.3863	c_{21}	0.0066*
	0.1114	c_{22}	0.7888**		−0.3030**	c_{22}	0.9261**
	3.9235**	d_{11}	−0.0006**		−2.9647	d_{11}	−0.0009**
	0.0065	d_{21}	−0.0015		−0.0155**	d_{21}	−0.0074*
	−0.7028**	d_{22}	0.0000		0.3277**	d_{22}	0.0008
Panel C: Model Diagnostics							
LQ(5)	8.6320	LQ(5)	3.5310	LQ(5)	10.8300	LQ(5)	3.8390
$LQ^2(5)$	2.3710	$LQ^2(5)$	0.5460	$LQ^2(5)$	1.0570	$LQ^2(5)$	1.8780

Panel D: Test

	Return	Volatility		Return	Volatility
Spillover effect	4.1100	30.2700**	Spillover effect	5.6680	26.0900**
Stock market spillover to exchange rate	1.6970	10.9550**	Stock market spillover to exchange rate	0.8330	3.2320
Exchange rate spillover to stock market	1.9440	17.8400**	Exchange rate spillover to stock market	5.1490	20.3610**
Hot money impact on exchange rate and stock markets	98.4610**	13.5000**	Hot money impact on exchange rate and stock markets	17.0980**	32.1660**

Notes: ** and * denote the significant at the 1%, 5% level, respectively. LQ (*n*) and LQ² (*n*) denote the Ljung-Box Q statistic for the standardised residuals and square standardised residuals (lag = 5). The mean equations are shown as below:

$$R_{e,t} = \alpha_{e,0} + \sum_{i=1}^{n} \alpha_{e,i} R_{e,t-i} + \sum_{i=1}^{n} \beta_{e,i} R_{s,t-i} + \varphi_e hm_t + \pi_e Z_{t-1} + \varepsilon_{e,t}$$

and $R_{s,t} = \alpha_{s,0} + \sum_{i=1}^{n} \alpha_{s,i} R_{s,t-i} + \sum_{i=1}^{n} \beta_{s,i} R_{e,t-i} + \varphi_s hm_t + \pi_s Z_{t-1} + \varepsilon_{s,t}$.

The variance equations are exposed as below:

$$h_{11,t} = a^2_{11} + b^2_{11}\varepsilon^2_{1,t-1} + 2b_{11}b_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + b^2_{21}\varepsilon^2_{2,t-1} + c^2_{11}h_{11,t-1} + 2c_{11}c_{21}h_{12,t-1} + c^2_{21}h_{22,t-1} + d^2_{11}hm_t ,$$

$$h_{12,t} = a_{11}a_{11} + b_{11}b_{12}\varepsilon^2_{1,t-1} + (b_{21}b_{12} + b_{11}b_{22})\varepsilon_{1,t-1}\varepsilon_{2,t-1} + b_{21}b_{22}\varepsilon^2_{2,t-1} + c_{11}c_{12}h_{11,t-1} + (c_{21}c_{12} + c_{11}c_{22})h_{12,t-1} + c_{21}c_{22}h_{22,t-1} + d_{11}d_{21}hm_t$$

and

$$h_{12,t} = a^2_{21} + a^2_{22} + b^2_{12}\varepsilon^2_{1,t-1} + 2b_{12}b_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + b^2_{22}\varepsilon^2_{2,t-1} + c^2_{12}h_{11,t-1} + 2c_{12}c_{22}h_{12,t-1} + c^2_{22}h_{22,t-1} + (d^2_{21} + d^2_{22}) hm_t$$

Test of volatility spillover effects: H_0: $b_{21} = c_{21} = b_{12} = c_{12} = 0$ test the volatility spillovers between stock and exchange rate markets by the VECM-BEKK model; H_0: $b_{12} = c_{12} = 0$ test the volatility spillovers from stock market to exchange market; H_0: $b_{21} = c_{21} = 0$ test the volatility spillovers from exchange market to stock market. H_0: $\varphi_e = \varphi_s = 0$ and H_0: $d_{11} = d_{21} = 0$ test hot money impact on stock and exchange rate markets on mean and volatility equations, respectively.

significance of the coefficients in the higher quantiles and impacts to the exchange rate market from −0.0003 to −0.0005. The coefficients of the SH and the SZ are all positive and are statistically significant in the lower quantiles (from 0.05th to 0.5th). The results of quantile regression methods denote that hot money has an impact on the growth of the exchange rate market. In contrast, the impact of hot money on the stock returns is low or declining. According to the results, the findings show the negative significant evidence on exchange rate market in the higher quantiles and positive significant evidence on the Shanghai and Shenzhen stock markets in the lower quantiles.

Table 5
Quantile regression results from Chinese stock and RMB exchange rate

Quantile	EX	SH	SZ
0.05	−0.0004	0.0112*	0.0155***
0.1	−0.0003	0.0099***	0.0074*
0.25	−0.0005***	0.0061**	0.0081**
0.5	−0.0003**	0.0062**	0.0068**
0.75	−0.0003*	0.0024	0.0049
0.9	−0.0004**	0.0027	0.0002
0.95	−0.0004**	0.0011	0.0067

Notes: ***, ** and * denote the significant at the 1%, 5% and 10% level, respectively. This table denotes the quantile regression test for exchange rates and Shanghai composite index and Shenzhen composite index (EX, SH, and SZ). The equations of quantile regression can be showed as $R_{s,t} = \alpha_s + \beta_s hm_t + \varepsilon_{s,t}$ and $R_{e,t} = \alpha_e + \beta_e hm_t + \varepsilon_{e,t}$.

CONCLUSIONS

There have been enormous inflows and outflows of "hot money" to the Chinese market in recent years. As the biggest emerging country, China has become an interesting issue to investigate. Using our sample period from July 2005 to June 2013, this paper utilises monthly frequency data to explore the impact of hot money on the stock and exchange rate market. First, using the cointegration method, this paper explores a long-run equilibrium relationship between the stock and exchange rate markets. Second, the paper applies the VECM-BEKK model to identify the impact of hot money on the stock and exchange rate markets and examines the volatility of the spillover between the stock and the exchange rate market. Finally, this study uses the quantile approach to determine the influence of hot money on the stock and exchange rate markets.

To summarise the results, first this paper finds a long-run equilibrium relationship between the stock and exchange rate market based on the cointegration model. Second, hot money has an impact on the stock and exchange rate markets. Finally, the results of the quantile regression showed that hot money has an impact on the exchange rate market in the low quantiles and on the Shanghai and Shenzhen stock markets in the high quantiles. The quantile regression clarifies the impact of hot money on stock and exchange rate markets in the difference quantile regions. This finding could be very useful in investment decisions and policymaking.

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NOTES

1. Hot money is defined as the flow of funds (or capital) from one country to another in order to earn a short-term profit.
2. RMB exchange rate has changed its regime in 2005 after china release the financial liberalisation. China implemented a managed floating exchange rate regime in July 2005. Because of the monthly data of foreign direct investment, this study takes the same frequency data for all variables.
3. Because the non-stationary time-series data is uncertainly, this paper firstly examines the stationary by using the time-series data at the level and at their first differences to test the significant evidence of the relationship. If there is a significant relationship between the non-stationary variables, it will imply that the variables have the characteristics of the equilibrium in the long-run after the first differences adjustment. In other words, because of non-stationary time-series data of the stock indices and exchange rate in our data, cointegration method identifies the variables become the stationary variables after using the first difference. Consequently, after the cointegration test of the time-series data, this study can apply the time series data to examine.
4. This study utilises Johansen cointegration method to examine the cointegration between stock prices and exchange rates. Johansen (1988) suggested that the cointegration analysis and the consistent the causal relationship are analysed by estimating a vector error-correction model (VECM). Seeing as the time series data are integrated on the same order, cointegration methods can be used to clarify whether a stable long-run relationship exists between each variable.

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