

# On the Relationship between stock return and exchange rate: evidence on China

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## Abstract

The purpose of this paper is to investigate the relationship between RMB exchange rate and A-share stock returns in China, in particular in Shanghai stock market. We find that both stock returns and RMB nominal exchange rate are integrated of order 1. The Engle–Granger cointegration test is then performed, suggesting that there is not a long-run equilibrium relationship between stock returns and RMB exchange rates at 5% significance level. However, there is strong evidence suggesting that there is a short-run uni-directional causality relationship from the nominal exchange rate to the stock returns.

*Keywords:* cointegration; Granger causality; RMB exchange rate; stock return; unit root test.

## 1. Introduction

The China's exchange rate policy has recently emerged as one of major issues in the trade between the PR of China and the United States of America. The controversy is fuelled by China's pegging of RMB to USD. Since a major devaluation of the RMB in 1994, the Chinese currency's exchange rate vis-a-vis USD remained more or less unchanged until 21 July 2005, and has fluctuated from RMB 8.22 to 8.11 per dollar since then. The Chinese Authority has recently announced that "RMB will be no longer pegged to the US dollar" and that "China will reform the exchange rate regime by moving into a managed floating exchange rate regime based on market supply and demand with reference to a basket of currencies" (People's Bank of China. Public announcement([www.pbc.gov.cn/english/](http://www.pbc.gov.cn/english/))). With the appreciation of the RMB exchange rate, stock returns increase in the Chinese A-share markets of Shenzhen and Shanghai. The question is: does the appreciation of the RMB exchange rate lead to the increase of stock returns? In the paper, the relationship between stock returns and RMB exchange rates is investigated. This paper employs daily data and considers a more recent sample period after Chinese exchange rate reform.

The relationship between stock returns and foreign exchange rates has drawn much attention of economists, for theoretical and empirical reasons, because they both play crucial roles in influencing the development of a country's economy. In addition, the relationship between stock returns and foreign exchange rates has frequently been utilized in predicting the future trends for each other by investors.

Macroeconomic fundamentals are seen by economists as providing the robust media to link stock returns and foreign exchange rates. Among all the monetary models of exchange rate determination, money supply, interest rate, return level, and inflation are taken into account to

predict the exchange rate movement. See e.g. Frenkel (1976), Bilson (1978), Dornbusch (1976), Frankal (1979), Dornbusch and Fisher (1980), and Hooper and Monton (1982). Branson, et al.'s (1977) portfolio-balance model further incorporates assets of portfolios to describe the "stock-oriented" exchange rate movement. Among empirical studies, Meese and Rogoff (1983), Wolff (1988), Baillie and Selover (1987), and Ghartey (1998) have found certain relationships among macro-fundamentals and exchange rates, whereas the empirical evidence for the relationships among macro-fundamentals and stock returns are found in Bailay (1990), Sadeghi (1992), and Kwon and Shin (1999).

The existing finance literature is inconclusive on the relationships between exchange rate movements and macroeconomic variables (see Aggarwal, 1981; Edison, 1991; Frenkel, 1983; Gandolfo, Padoan, & Paladino, 1990; Giovanni & Jorion, 1987; Hardouvelis, 1988; Wasserfallen, 1990). Solnik (1987) contends that the major reason is the poor quality of the macroeconomic data used. Most of such data, he argues, suffer from significant measurement errors while some are not even measurable directly. He further suggests stock returns as surrogates for macroeconomic data, contending that stock returns reflect expected changes in future economic activity, and that returns can be measured directly and accurately. He employs monthly and quarterly data for eight industrial countries from 1973-1983 to examine the relationship between real stock return differentials (RSR) and changes in real exchange rates (RER) and reports a negative relation between RSR and RER for monthly and quarterly data over his sample space. However, using monthly data over the 1979-1983 sub-periods, he observes a weak positive relationship between the two variables. In arriving at the above conclusions, Solnik modeled the exchange rate as a function of interest rate and stock return differential. Soenen and Aggarwal (1989) re-assess the Solnik model using 1980-1987 data for the same eight industrial countries. They report a positive correlation between stock returns and exchange rates for three countries and negative correlation for five. Other researchers, however, examine stock returns as a function of exchange rates (see Aggarwal, 1981; Ma & Kao, 1990; Soenen. & Hennigar, 1988). Employing monthly data, Aggarwal (1981) examines the relation between U.S. stock market indexes and a trade-weighted value of the dollar for the period 1974-1978. He finds that the stock returns and exchange rates are positively correlated. In contrast, Soenen and Hennigar (1988), also using monthly data, report a strong negative correlation between U.S. stock indexes and a fifteen currency-weighted value of the dollar for the period 1980-1986.

Chien-Chung Nieth & Cheng-Few Lee (2001) explore the dynamic relationships between the stock returns and the exchange rates for each of the G-7 countries. Both the Engle-Granger (EG) two steps and the Johansen maximum likelihood cointegration tests are employed. Their empirical work rejects most of the previous studies that suggest a significant relationship between stock returns and exchange rates. The result supports Bahmani-Oskooee and Sohrabian's (1992) finding that there is no long-run equilibrium relationship between these two financial variables. Nonetheless, from vector error correction model, significant short-run findings show the one-day predicting power of the two financial assets for certain countries. Issam; Abdalla and Victor (1997) investigate interactions between exchange rates and stock returns in the emerging financial markets of India, Korea, Pakistan and the Philippines to establish the causal linkages between leading returns in the foreign exchange market and the stock market. The results show uni-directional causality from exchange rates

to stock returns in all the sample countries, except for the Philippines.

So far, the research thus far has extended the inquiry into the stock market and exchange rate relations across developed and emerging economies to bring a broadly-based insight into the issue and to fill the gap in the literature. However, the China's market is rarely included into the existing literature. The purpose of this paper is to investigate the relationship between stock returns and exchange rates in China.

The rest of the paper is organized as follows. Section 2 is devoted to the data and variables used in the analysis. In Section 3 we perform analysis and then reports the empirical results. Finally Section 4 provides discussion and conclusions.

## 2. Data and variables

We collected the daily nominal RMB exchange rate against the USD. The exchange rate series were the daily middle exchange rate obtained from the State Administration of Foreign Exchange in China. Daily closing stock market index in China's stock market index, Shanghai Stock Exchange Composite, and daily closing stock market index, US's S&P500, were obtained from <http://finance.cn.yahoo.com>. All data sets were from 21 July 2005 to 18 January 2008 without covering the observations on Saturday and Sunday, as well as some major holidays in China and US. The reason start date is on 21 July 2005 that China revalued the Renminbi and officially modified the exchange rate regime from that time.

The following variables are used in the model.  $H_t$  represents nominal Exchange rate (it is defined as domestic currency units per unit of U.S. dollar) in day  $t$ .  $R_t$  represents China's Stock return in day  $t$ , where we use daily closing stock market index in China's stock market index, Shanghai Stock Exchange Composite in this paper.  $RM_t$  represents U.S. stock return in day  $t$ , where we use daily closing stock market index: US's S&P500. Let  $S_t = R_t - RM_t$  be the difference of the stock returns between China and U.S.

Fig. 1 and Fig. 2 show time series plot of RMB nominal exchange rate and Difference of the stock returns between China and U.S.



Fig. 1. RMB nominal exchange rate

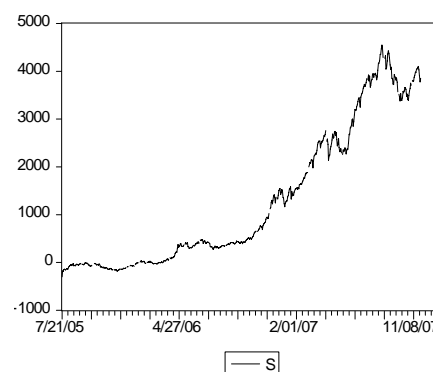


Fig. 2. Difference of the stock returns between China and U.S.

## 3. Methodologies and analysis

This section is devoted to the methodologies this paper incorporates to explore the

relationship between stock returns and exchange rates in China and the relevant data analysis. In 1969 Granger proposed the Granger causality to test whether one economic variable can help forecast another economic variable (Granger, 1969). Specifically, Granger causality from  $X$  to  $Y$  is established when the coefficients of the lagged difference of  $X$  are found to be jointly statistically significant and therefore help explain and predict  $Y$ , over and above what the lagged differences of  $Y$  can predict. To confirm that the Granger causality results will not generate any spurious inferences, the unit root and cointegration tests are performed before conducting the Granger causality test to measure the changes in the existence and directions of causality (see Enders, 1995; Phillips, 1986, 1987).

### 3.1. Unit root tests

To determine the stationarity of each variable for each subsample, we employ the augmented Dickey–Fuller (ADF) test. The ADF model used is given as follows:

$$\Delta H_t = \alpha_0 + \gamma H_{t-1} + \sum_{i=1}^p \beta_i \Delta H_{t-i} + \varepsilon_t, \quad (1)$$

where  $H_t$  represents nominal exchange rates against USD,  $\alpha_0$  is the intercept term,  $\gamma$  is the coefficient of interest in the unit root test,  $\beta_i$  is the parameter of the lagged first difference of  $H_t$  to better represent the  $p$ th-order autoregressive process, and  $\varepsilon_t$  is the white noise error term. Time trend is not included in the model since exchange rates do not exhibit time trend (Mills & Taylor, 1989). To ensure that the exchange rate series are not integrated of more than 1, the ADF unit root test is also run using the first difference exchange rate series as follows:

$$\Delta^2 H_t = \alpha_0 + \gamma \Delta H_{t-1} + \sum_{i=1}^p \beta_i \Delta^2 H_{t-i} + \varepsilon_t. \quad (2)$$

In both cases, the null hypothesis of the unit root test is  $\gamma = 0$ , i.e., the  $\{H_t\}$  sequence contains a unit root process (nonstationarity) while the alternative hypothesis indicates that the series is a stationary process. We reject the null hypothesis of the unit root if the  $t$ -statistic of  $\gamma$  is smaller than the 95% Dickey–Fuller critical value, given by MacKinnon (1991).

We also consider the ADF model for stock return as follows:

$$\Delta S_t = \alpha_0 + \alpha_1 t + \gamma S_{t-1} + \sum_{i=1}^p \beta_i \Delta S_{t-i} + \varepsilon_t, \quad (3)$$

$$\Delta^2 S_t = \alpha_0 + \alpha_1 t + \gamma \Delta S_{t-1} + \sum_{i=1}^p \beta_i \Delta^2 S_{t-i} + \varepsilon_t, \quad (4)$$

where  $S_t$  represents stock return differentials,  $\alpha_1$  is the trend term. Time trend is included in the model. Note that stock return differentials  $S_t$  are expressed as the difference between stock returns of China and the U.S. stock returns. This definition is based on the fact that the U.S. market accounts for a substantial share of the world's equity market capitalization and is consistent with our definition of exchange rates as domestic currency units per unit of U.S. dollar (Richard A. Ajayi, Joseph Friedman and Seyyed M. Mehdian, 1998).

The ADF test results in Table 1 clearly show that both the variables are not stationary at the 5% level of significance; however, ADF statistics reject the null hypothesis of non-stationarity at the 5% level of significance after the variable have been first differenced. Thus, the variables are integrated of order 1.

Table 1

ADF unit root test

Variable	lag	ADF	$I(d)$
$H$	4	3.760189	$I(1)$
$\Delta H$	4	-12.63499 *	$I(0)$
$S$	4	-0.880999	$I(1)$
$\Delta S$	4	-9.245137 *	$I(0)$

\* Significant at the 5% level for ADF test.

Note: Lag length  $p$  is selected based on the smallest number of AIC (Akaike's Information Criterion) and SC (Schwartz criterion)

### 3.2. Cointegration test (Engle–Granger cointegration test)

The Engle–Granger procedure consists of estimating the cointegrating regression by ordinary least square, obtaining their residuals, and applying unit root tests for the residual (Engle & Granger, 1987). Thus, if the time series is found to be nonstationary and integrated of the same order from the ADF test, the Engle–Granger cointegration test is performed. To obtain the residual, the following cointegrating regressions are performed:

$$H_i = \beta_0 + \beta_1 S_i + e_{hi}, \quad (5)$$

$$S_i = \beta_0 + \beta_1 H_i + e_{si}, \quad (6)$$

and the ADF test is as follows:

$$\Delta \hat{e}_i = \alpha_1 \hat{e}_{i-1} + \sum_{t=1}^k \alpha_{t+1} \Delta \hat{e}_{i-t} + \varepsilon_i, \quad (7)$$

where  $\Delta \hat{e}_i$  include  $e_{hi}$  or  $e_{si}$  sequence and with the null hypothesis of  $H_0: \alpha_1 = 0$  (no cointegration). The value of optimal lag length  $k$  is selected by the smallest Akaike information criterion (AIC) and Schwartz criterion (SC). Since the residual series is calculated from a cointegrating equation, an intercept or time trend is omitted from the equation (Enders, 1995). Table 2 shows that the exchange rate and stock return are not found to be cointegrated at 5% significance level. This means that there is no long-run equilibrium relationship between stock returns and RMB exchange rates at 5% significance level (Enders, 1995).

Table 2

Engle–Granger cointegration test

Cointegrating regressions	Residual	ADF	5% Critical Value
$\hat{H}_i = 803.4391 - 0.0157S_i$	$\hat{e}_{hi} = H_i - \hat{H}_i$	-0.8447	-1.9401
$\hat{S}_i = 47870.37 - 59.474H_i$	$\hat{e}_{si} = S_i - \hat{S}_i$	-0.8333	-1.9401

### 3.3. Granger causality test

Next, the pairwise Granger causality test is used to examine whether the past value of a variable series,  $X_t$ , will help to predict the value of another variable series at present,  $Y_t$ , taking into account the past value of the  $Y_t$  (Granger, 1988). If the time series of a variable is stationary or  $I(0)$  from the ADF test, the Granger causality test is performed as follows:

$$H_t = \alpha_1 + \sum_{j=1}^n \beta_{1,j} H_{t-j} + \sum_{j=1}^n \gamma_{1,j} S_{t-j} + \varepsilon_{1,t}, \quad (8)$$

$$S_t = \alpha_2 + \sum_{j=1}^n \beta_{2,j} S_{t-j} + \sum_{j=1}^n \gamma_{2,j} H_{t-j} + \varepsilon_{2,t}. \quad (9)$$

If the time series of a variable is nonstationary,  $I(1)$  from the ADF test, and not cointegrated, they will be converted to a  $I(0)$  by first differencing, and the following Granger causality test can be applied:

$$\Delta H_t = \alpha_1 + \sum_{j=1}^n \beta_{1,j} \Delta H_{t-j} + \sum_{j=1}^n \gamma_{1,j} \Delta S_{t-j} + \varepsilon_{1,t}, \quad (10)$$

$$\Delta S_t = \alpha_2 + \sum_{j=1}^n \beta_{2,j} \Delta S_{t-j} + \sum_{j=1}^n \gamma_{2,j} \Delta H_{t-j} + \varepsilon_{2,t}, \quad (11)$$

where  $\Delta H_t$  is the first difference at time  $t$  of nominal exchange rate where the series is nonstationary and  $\Delta S_t$  is the first difference at time  $t$  of stock returns where the series is nonstationary.

Because the exchange rate and stock return are not found to be cointegrated at 5% significance level, we apply the equations (10) and (11) to test relationships of Granger-causality. The results from Granger-causality test is sensitive to the selection of lag length, so results are presented from VAR lag length selected by AIC. We tested for Granger-causality using the standard F-test computed from restricted and unrestricted versions of the variants of Equations (10) and (11). The results are reported in Table 3. The  $F$ -test results suggest we reject the null hypothesis that exchange rate does not Granger-cause stock return.

Table 3  
Pairwise Granger Causality Tests (Lags: 18)

Null Hypothesis ( $H_0$ ):	F-Statistic	Probability
$\Delta H$ does not Granger Cause $\Delta S$	1.82197	0.02596
$\Delta S$ does not Granger Cause $\Delta H$	1.53543	0.08282

The empirical results reveal that at at 5% significance level there is the uni-directional causality from the first difference of nominal exchange rate to the first difference of stock returns in our sample. Hence, there are short-run uni-directional causality relationships from the nominal exchange rate to the stock returns at 5% significance level.

#### 4. Conclusions

This paper sheds lights on the linkages between RMB exchange rates and A-share stock returns in China's stock market. Some econometric techniques are applied to a bivariate VAR model of stock returns and exchange rates in order to test for Granger-causality between the two variables. Essentially, we have performed the ADF tests with different autoregressive orders until we obtain individual series for  $H$  and  $S$  that are consistent with white noise error terms. Having established the order of integration of the individual series, we move to test for cointegration using the two-step Engle-Granger procedure. The results suggest that we have to proceed with a VAR. Taking the VAR model, we determine the optimum lag length of the bivariate VAR, then carry out diagnostics on the resulting equations, proceeding to test for inference of Granger-causality with these equations.

The interesting finding is that this paper rejects most of the previous studies that suggest a significant relationship between stock prices and exchange rates. Our time-series estimations support Bahmani-Oskooee & Sohrabian's (1992) and Chien-Chung Nieth & Cheng-Few Lee's (2001) finding that there is no long-run equilibrium relationship between these two financial variables for G-7 country. This finding is obtained from the EG two-steps. Another finding is that, based on the results from the pairwise Granger causality test, there are short-run uni-directional causality relationships from the nominal exchange rate to the stock returns. The conclusion support Issam; Abdalla and Victor's (1997) finding there are short-run uni-directional causality relationships from the exchange rate to the stock price index for Korea and Pakistan.

We find that there is no long-run equilibrium relationship between these two financial variables and there are short-run uni-directional causality relationships from the nominal exchange rate to the stock returns at 5% significance level. The main implications are that, in the case of Granger-causality from exchange rates to stock returns, changes in exchange rates affect stock returns in short-run. Thus, in terms of policy relevance, the findings of this paper suggest that the government should be cautious in their implementation of exchange rate policies since they affect stock markets in short-run. But It is not supported in statistics that the changes in exchange rates affect stock returns in long-run. As noted in Granger (1969), the daily data may be more desirable because a sampling frequency less than one day may introduce spurious statistical significance into the tests. For comparative purposes, we should run the tests on weekly data and monthly data, therefore it will be explored in our future research.

### **Acknowledgements**

We would like to express our gratitude to Biabing Li for valuable comments and suggestions on the manuscript. Any views expressed and all remaining errors are the responsibility of the authors.

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