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Article

Behavioral Heterogeneity and Excessive Volatility of RMB Exchange Rate

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Abstract: The paper develops a two-type behavioral heterogeneous agent model including fundamentalists and chartists. It examines whether investors' behavioral heterogeneity is related to the excessive volatility of RMB exchange rate. We use the deviation of the real exchange rate from the fundamental exchange rate as a measure of excessive exchange rate volatility. The fundamental value is calculated by the revised RMB fundamental exchange rate model with cointegration technology. After estimating the behavioral heterogeneous agent model using the monthly RMB exchange rate data from October 2006 to November 2020, we find that the heterogeneity of traders in price and trading strategies can significantly explain excess volatility of the RMB exchange rate. Our analysis of two significant fluctuations in 2015-2016 and 2018-2019 further corroborates our key finding that investors' behavioral heterogeneity plays an important role in explaining excess volatility of RMB exchange rate.

Keywords: Exchange Rate Volatility; Behavioral Heterogeneity; Agent-Based Model

1. Introduction

The exchange rate is considered as a "barometer" of national economic development, reflecting the stability of economic growth and serving as a link between the country's economy and the world economy. The RMB exchange rate maintained a small fluctuation within roughly 1% per month (except for the 2008 financial crisis) before the reform of China's foreign exchange system in 2015. After the reform, the RMB exchange rate had been increasing volatile. For example, it hit its maximum monthly volatility of 3.84% in July 2018. A large body of literature considers macroeconomic factors as the main factors which resulted in the RMB exchange rate volatility. However, as one of the typical characteristics in the formation of the exchange rate mechanism, the forex traders' heterogeneity was underappreciated in existing studies. Our study attempts to explain the RMB exchange rate volatility with the behavioral heterogeneity of forex traders.

In the empirical study of Richard and Rogoff (1983) [1], the traditional model of the exchange rate has been difficult to explain various abnormal foreign exchange phenomena, which is no match for the simple random walk model in terms of out-of-sample prediction. De Grauwe and Grimaldi (2005, 2006) [2, 3] and De Grauwe and Markiewicz (2013) [4] use behavioral heterogeneity models to simulate the process of excessive exchange rate volatility. These models assume two types (fundamentalists and chartists) of traders in the foreign exchange market, which have heterogeneous beliefs about exchange rate expectations and determine the current trading strategy (including strategies of fundamentalists and chartists) based on the profitability of the previous trading strategy. The simulation results show that the investor's behavioral heterogeneity can significantly explain the excess volatility in the foreign exchange market. Therefore, based on these studies, we try to provide the empirical evidence from the RMB foreign exchange market.

The measurement of RMB fundamental exchange rate is vital in an empirical analysis of exchange rate fluctuations. Li and Chen (2010) [5] construct a model of the RMB fundamental exchange rate, if the RMB fundamental exchange rate depends on macroeconomic factors that consistent with economic fundamentals. The RMB fundamental exchange rate is empirically measured by cointegration technology. Our study calculates the RMB fundamental exchange rate from October 2006 to November 2020 by using cointegration technology based on the revised model according to the work of Hu (2014) [6].

Our paper has two contributions. First, it enriches the empirical literature on the relationship between traders' behavior heterogeneity and excess volatility in the foreign exchange market. There is a great deal of theoretical research that consider traders' behavior heterogeneity as an essential factor to explain excessive exchange rate volatility (see Manzan and Westerhoff (2007) [7]; Bauer et al. (2009) [8]; De Jong et al. (2010) [9]; Buncic and Piras (2016) [10]; Li and Wu (2018) [11]), however, few articles focus on empirical research to support the above theoretical studies. Furthermore, the previous studies concern the foreign exchange markets of developed economies such as Japan, the United States and Europe, whereas our study provides empirical evidence from an emerging market by testing the link between traders' behavior heterogeneity and the RMB exchange rate volatility. Second, our study endogenously explains the excessive fluctuation of the RMB exchange rate. There are many articles which study the exogenous factors that affect the volatility of the RMB exchange rate (see Chen et al. (2020) [12]; Zhou et al. (2020) [13]; Lucey et al. (2020) [14]; Liu and Lee (2020) [15]; Tian et al. (2021) [16]), however few articles consider endogenous factors of RMB exchange rate fluctuations (see Li and Chen (2010) [5]; Hu (2014) [6]). Our study builds a nonlinear heterogeneous agent model to endogenously explain the RMB exchange rate fluctuations.

The remaining structure of this paper is arranged as follows. Section 2 describes the RMB exchange rate model with two behavioral heterogeneous agents. Section 3 calculates the RMB fundamental exchange rate from October 2006 to November 2020. In section 4, we estimate the exchange rate model and analyze the results. Section 5 is Conclusions.

2. The Model

2.1. Model Assumptions

-There are two types (fundamentalists and chartists) of traders in the exchange market (Kurihara, 2013) [17]. Fundamentalists trade based on mean-reversion, while chartists trade based on trend-following.

-The limited rational traders in the exchange market only know the past information about relevant variables in the model.

-The expectation rules of traders in the foreign exchange market are dynamically adjusted based on the performance of the previous trading rules.

2.2. Fundamental Exchange Rate

Models to calculate the RMB fundamental exchange rate according to Li and Chen (2010) [5] are as follows:

$$lns_t^* = c_0 + c_1 \times (m_t - m_t^*) + c_2 \times (y_t - y_t^*) + c_3 \times \left(i_t^s - i_t^{s^*}\right) + c_4 \times \left(i_t^l - i_t^{l^*}\right) + c_5 \times (p_t - p_t^*) + \varepsilon_t \tag{1}$$

where lns_t^* is the natural logarithm of the fundamental exchange rate, m_t is domestic money supply, and y_t is national output. i_t^s measures domestic short-term interest rate, while i_t^l measures domestic long-term interest rate, and p_t measures national inflation rate. The variabls with * on the right of the equation represent variables corresponding to United States. Therefore, the RMB fundamental exchange rate is determined by the divergences in the money supply, output, short-term interest rates, long-term interest rates, and inflation rates between China and the United States.

We find multiple collinearities between short-term and long-term interest rates in our analysis, which is consistent with Hu (2014) [6]. Thus, we delete the expected inflation rate difference variable (i_t^l) and use Hu's RMB fundamental exchange rate model as follows:

$$lns_t^* = c_0 + c_1 \times (m_t - m_t^*) + c_2 \times (y_t - y_t^*) + c_3 \times \left(i_t^s - i_t^{s^*}\right) + c_4 \times (p_t - p_t^*) \tag{2}$$

It is difficult to determine whether c_1 is positive or negative. According to the elastic price currency analysis method, the relative growth of a country's money supply will lead to an increase in domestic inflation in the same proportion, which ultimately depreciate the local currency. But according to the vicious price currency analysis method, there is an "overshoot" in the exchange rate market that increased domestic money supply will lead to excessive depreciation. We define c_2 and c_3 negative, while c_4 positive. China is an export-oriented economy, which makes exports a significant role in supporting the economy. When the domestic output increases, the national surplus will increase too, which contributes to more foreign currency assets held by our nation. Under the foreign exchange settlement and sale system, the foreign currency supply in the foreign exchange market will increase, leading to the depreciation of the foreign currency. Similarly, the domestic currency attraction increases as the domestic short-term interest rate rises, leading to a growing domestic currency demand in the foreign exchange market, so the local currency appreciates (Lu et al., 2020) [18]. For c_4, rise in domestic inflation will theoretically lead to a decline in the attractiveness of the local currency and a depreciation of the domestic currency.

2.3. Heterogeneity Expectations

Based on the previous assumption, two types of traders using different expectation rules are considered in our model. E_t^f, E_t^c are heterogeneous beliefs of fundamentalists and chartists (Neuberg et al., 2004) [19]. The fraction of fundamentalists is n_t^f, whereas the fraction of chartists is n_t^c. According to Flaschel et al. (2015) [20], the exchange rate expectation $E_t^f(s_{t+1})$ for the fundamentalists is given by:

$$E_t^f(s_{t+1}) = s_{t-1} + \alpha \times (s_{t-1} - s_{t-1}^*),\ -1 < \alpha \le 0 \tag{3}$$

where α reflects traders' sensitivity to the deviation between the exchange rate and its fundamental values. According to Frankel and Froot (1991) [21], the chartists' expectation of exchange rates is given by:

$$E_t^c(s_{t+1}) = s_{t-1} + \varphi \times (s_{t-1} - s_{t-2}),\ \varphi > 0 \tag{4}$$

where φ is the extrapolation coefficient.

The dynamic fractions n_t^f and n_t^c are updated as shown below:

$$n_t^f = exp(\beta \times U_{t-1}^f) \Big/ exp(\beta \times U_{t-1}^f) + exp(\beta \times U_{t-1}^c) \tag{5}$$

$$n_t^c = 1 - n_t^f \tag{6}$$

where β is the intensity of choice, reflecting the degree to which traders switch between different expectation rules. U_{t-1}^i is traders' risk-adjusted profitability in period $t-1$.

Inconsistent rules adopted by traders to gain will create uncertainty, so the traders should adjust the corresponding risk when calculating and selecting returns from the different expected rules (Teräsvirta, 1994) [22]. Given risk $\sigma_{i,t-1}^2$, and the traders' risk aversion coefficient $\mu = 1$, risk-adjusted profit is given by:

$$U_{t-1}^i = \pi_{t-1}^i - \mu \times \sigma_{i,t-1}^2 \tag{7}$$

where π_t^i is the realized profit on the investment at $t-1$ and the maturity of t period, as shown below:

$$\pi_{t-1}^i = (s_{t-1} - s_{t-2}) \times plus[E_{t-2}^i(S_{t-1}) - s_{t-1}] \tag{8}$$

where $plus[x] = \begin{cases} 1, for\ x > 0 \\ 0, for\ x = 0 \\ -1, for\ x < 0 \end{cases}$, $i = c, f$.

According to De Grauwe and Grimaldi (2005) [2], the risk $\sigma_{i,t-1}^2$ is measured by the square of the prediction error as follows:

$$\sigma_{f,t-1}^2 = [E_{t-2}^f(s_{t-1}) - s_{t-2}]^2 \Big/ 1 + (s_{t-2} - s_{t-2}^*)^2 \tag{9}$$

$$\sigma_{c,t-1}^2 = [E_{t-2}^c(s_{t-1}) - s_{t-2}]^2 \tag{10}$$

where $(s_{t-2} - s_{t-2}^*)$ is the misalignment. As the misalignment increases, fundamentalists attach less importance to the short-term volatility measured by the one-period forecast error. They become increasingly confident that the exchange rates will revert to their fundamental values (Stanek and Kukacka, 2018) [23].

Combined with Equations (3) to (10), the expectation of the exchange rate is the weighted average of the expectation of the two types of heterogeneous traders:

$$E_t(s_{t+1}) = s_{t-1} + n_t^f \times \alpha \times (s_{t-1} - s_{t-1}^*) + n_t^c \times \varphi \times (s_{t-1} - s_{t-2}) \tag{11}$$

So, the estimation model in this paper can be expressed as:

$$s_t = s_{t-1} + n_t^f \times \alpha \times (s_{t-1} - s_{t-1}^*) + n_t^c \times \varphi \times (s_{t-1} - s_{t-2}) + \varepsilon_t \tag{12}$$

where ε_t is independent and identical distributed shock with a Gaussian distribution of $N \sim (0,1)$.

3. Data

This paper uses monthly data of the RMB exchange rate from October 2006 to November 2020, with 170 samples in total, which was obtained from the National Bureau of Statistics of China. The RMB exchange rate $\mathrm{s_t}$ is the average monthly exchange rate against the dollar under the direct price method. The broad money supply M2 represents the money supply of China and the United States. The unit of China's broad money supply $\mathrm{m_t}$ is RMB 1 billion, and the unit of the U.S. money supply

m_t^* is \$ 1 billion. The outputs of China and the United States are expressed in broad terms of total domestic production, which are converted from quarterly data to monthly data. The unit of China's GDP y_t is RMB 1 billion, and the unit of US GDP y_t^* is Dollars 1 billion. The above-mentioned data was all derived from the Wind. China's short-term interest rate i_t uses the Shanghai Interbank Offered Rate, and the U.S. short-term interest rate i_t^* uses the U.S. three-month Treasury bill interest rate, which comes from the ECIC. In the cointegration analysis, it is found that the difference between the monthly consumer price index and producer price index between China and the United States is stable from October 2006 to November 2020. Therefore, our paper uses industrial producers' monthly ex-factory price index that comes from the ECIC to measure the two countries' inflation levels. The index forms a fixed base of 100 in 2005.

We use model (2) to calculate the dynamic RMB fundamental exchange rate, which can be divided into three steps. First, the monthly exchange rate of RMB against the U.S. dollar and the macroeconomic variables in the model are used to establish a long-term cointegration equation. Second, we perform an H-P filtering analysis on the macroeconomic variables in the cointegration equation to obtain the long-term values of the macroeconomic variable, because the RMB fundamental exchange rate depends on the long-term values of macroeconomics. Third, we calculate fundamental exchange rate based on the estimated cointegration equation and the long-term values of the macroeconomic variable.

The ADF unit root test is performed on the variables in the formula (2) of the model, and the test results are shown in Table 1. The variables $\ln s_t^*$, $(m_t - m_t^*)$, $(y_t - y_t^*)$, $(i_t^s - i_t^{s^*})$, $(p_t - p_t^*)$ are all first-order unit covariates.

Table 1. The unit root test of the variables.

Variable	The type of test	Pro-check value			ADF statistics	P value
		1%	5%	10%		
$\mathbf{lns_t^*}$	(c, t, 13)	-4.0136	-3.4368	-3.1425	-2.4230	0.3664
$\mathbf{d(lns_t^*)}$	(c, 0, 13)	-3.4695	-2.8786	-2.5760	-7.1821	0.0000***
$\mathbf{(m_t - m_t^*)}$	(c, t, 13)	-4.0133	-3.4366	-3.1425	0.8853	0.9998
$\mathbf{d(m_t - m_t^*)}$	(c, 0, 13)	-3.4695	-2.8786	-2.5760	-9.8527	0.0000***
$\mathbf{(y_t - y_t^*)}$	(c, t, 13)	-4.0172	-3.4385	-3.1436	-2.6961	0.2398
$\mathbf{d(y_t - y_t^*)}$	(c, 0, 13)	-3.4720	-2.8797	-2.5765	-3.2586	0.0185**
$\mathbf{(i_t^s - i_t^{s^*})}$	(c, t, 13)	-4.0133	-3.4366	-3.1425	-2.5226	0.3169
$\mathbf{d(i_t^s - i_t^{s^*})}$	(c, 0, 13)	-3.4695	-2.8786	-2.5760	-11.2959	0.0000***
$\mathbf{(p_t - p_t^*)}$	(c, t, 13)	-4.0176	-3.4387	-3.1437	-2.024	0.5678
$\mathbf{d(p_t - p_t^*)}$	(c, 0, 13)	-3.4723	-2.8798	-2.5766	-3.5005	0.0092***

Note: The variables include $\ln s_t^*$, $(m_t - m_t^*)$, $(y_t - y_t^*)$, $(i_t^s - i_t^{s^*})$ and $(p_t - p_t^*)$. The test types (c, t, l) represent constants, trend items, and lag items. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Therefore, there may be cointegration relationships among variables $\ln s_t^*$, $(m_t - m_t^*)$, $(y_t - y_t^*)$, $(i_t^s - i_t^{s^*})$ and $(p_t - p_t^*)$. The results of the Johansen cointegration test are shown in Table 2 and Table 3.

Table 2. Johansen Trace Test Results (Trace) of the variables.

The original assumption	Eigenvalue	Trace statistics	5% threshold	P-value
Note	0.322697	141.0014	69.81889	0.0000***
At most 1	0.172072	75.54238	47.85613	0.0000***
At most 2	0.133366	43.81904	29.79707	0.0007***
At most 3	0.076086	19.77175	15.49471	0.0106**
At most 4	0.037819	6.476917	3.841466	0.0109**

Note: The variables include $\ln s_t^*$, $(m_t - m_t^*)$, $(y_t - y_t^*)$, $(i_t^s - i_t^{s^*})$ and $(p_t - p_t^*)$. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 3. Johansen Max Feature Test Results of the variables.

The original assumption	Eigenvalue	Trace statistics	5% threshold	P-value
Note	0.322697	65.45902	33.87687	0.0000***
At most 1	0.172072	31.72334	27.58434	0.0138**
At most 2	0.133366	24.04729	21.13162	0.0189**
At most 3	0.076086	13.29483	14.26460	0.0707*
At most 4	0.037819	6.476917	3.841466	0.0109**

Note: The variables include $\ln s_t^*$, $(m_t - m_t^*)$, $(y_t - y_t^*)$, $(i_t^s - i_t^{s^*})$ and $(p_t - p_t^*)$. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

A cointegration equation is estimated, and the standardized cointegration coefficients are shown in Table 4.

Table 4. Standardized cointegration equation.

Variable	$\ln s_t^*$	$(m_t - m_t^*)$	$(y_t - y_t^*)$	$(i_t^s - i_t^{s^*})$	$(p_t - p_t^*)$	Constant items
Estimate	1.000000	-2.285026	2.389038	0.004184	-1.615043	-1.165414
Standard Deviation	-	0.30603	0.31853	0.01423	0.97248	-

Note: Using cointegration technology, we obtain an equation of cointegration. The variables include $\ln s_t^*$, $(m_t - m_t^*)$, $(y_t - y_t^*)$, $(i_t^s - i_t^{s^*})$, and $(p_t - p_t^*)$.

The cointegration equation is as follows:

$$\ln s_t^* = 1.165414 + 2.285026 \times (m_t - m_t^*) - 2.389038 \times (y_t - y_t^*) - 0.004184 \times (i_t^s - i_t^{s^*}) + 1.615043 \times (p_t - p_t^*) \tag{13}$$

To calculate the RMB fundamental exchange rate, we performed the H-P filtering analysis on the economic variables in the cointegration equation. The long-term values of the RMB fundamental exchange rate are given by substituting the long-term values of these variables into the model (13). According to Figure 1, the RMB exchange rate always fluctuates around its fundamental values from October 2006 to July 2018. Since August 2018, the deviation has continued to increase. Although the

RMB appreciated relatively to the US dollar before the reform, the change was relatively small compared to the change in its fundamental value. The pressure of the continuous appreciation of the RMB should not be neglected although it developed slowly, which led to a gradual increase in the deviation of the RMB exchange rate from 2006 to mid-2007. There were two reasons as following. On the one hand, the RMB was under pressure to appreciate as China's domestic economy was growing rapidly and commodity prices were falling (Şengül, 2021) [24]. On the other hand, the United States economy was in the doldrums and called for a rapid appreciation of the RMB (Hu, 2014) [6]. For a longer period after mid-2007, the RMB exchange rate was overvalued. More seriously, since the end of 2018, the deviation of the RMB exchange rate has continued to increase.

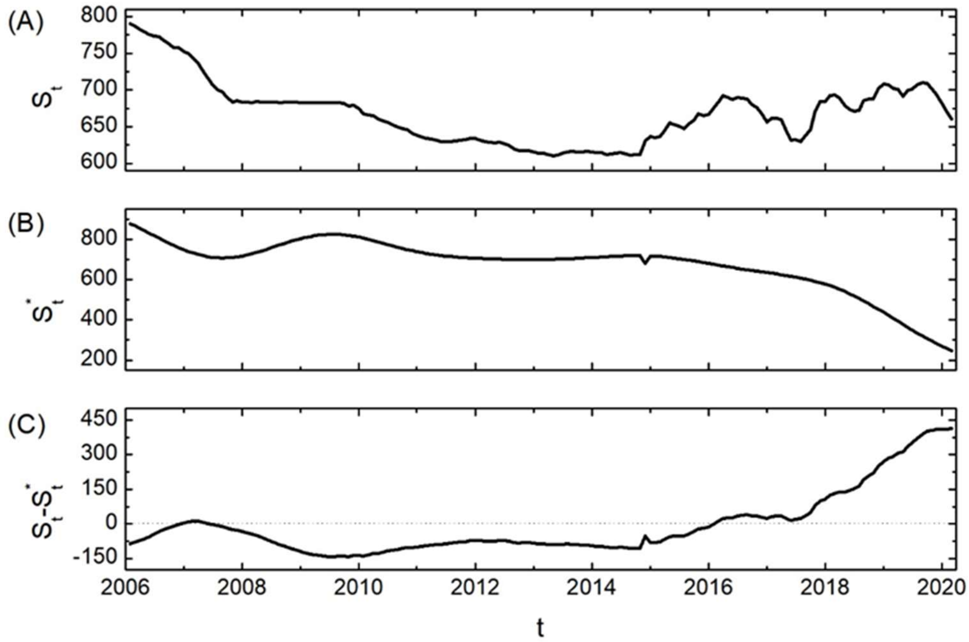

Figure 1. Panel (A) is the RMB exchange rate, panel (B) is the RMB fundamental exchange rate, and panel (C) is the deviation between the RMB exchange rate and its fundamental value from October 2006 and November 2020.

4. Estimated Results

This section presents results of the estimation of the model (12). We estimate the model by the nonlinear least squares method (NLLS), and the parameter estimation results are shown in Table 5.

Table 5. Estimation results of the model.

Parameter	Numeric value	Standard deviation	t-value	P-value
α	-0.02892	0.01261	2.292	0.0232**
φ	1.19516	0.19945	5.992	0.0000***
β	0.00113	0.00095	1.186	0.2375

Note: This table shows the estimation results of the behavioral heterogeneous agent's model given in equation (3) – (13) that, which includes the belief coefficient of fundamentalists (α), the belief coefficient of chartists (φ), and the intensity of choice (β). *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

The results show that the two belief coefficients α and φ are significant and differ at the 5% confidence level, which means there are two distinct types of expectorants of heterogeneity in the RMB foreign exchange market. The belief coefficient of fundamentalists α is -0.02892, while the belief coefficient of chartists (φ) is 1.19516, which complies with the economic theory hypothesis mentioned above. We also found that the estimated result of the intensity of choice β is not significant because our sample size is too small, as explained by Hommes and in't Veld (2017) [25]. If it exists a significant heterogeneity in the estimated mechanism, it should not be worrisome if heterogeneity indicators are not significant in the estimation.

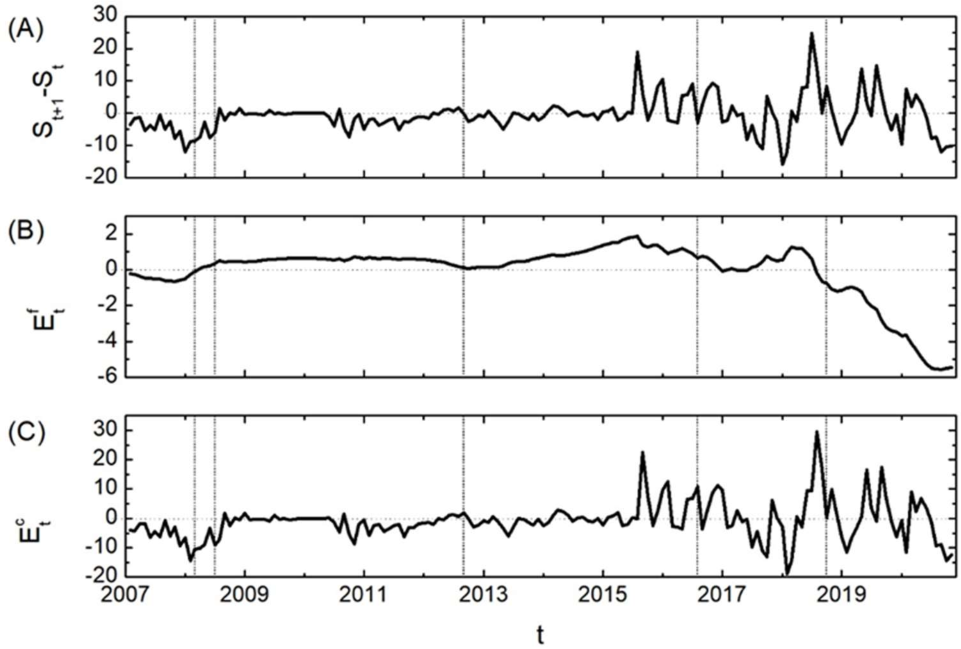

Figure 2. Panel (A) shows the changes of the RMB exchange rate, Panel (B) is the exchange rate expectations of fundamentalists, and Panel (C) is the exchange rate expectations of chartists from February 2007 to November 2020.

Figure 2(B) and Figure 2(C) show the exchange rate expectations of fundamentalists and chartists. Fundamentalists have obvious regression expectations: during the period when the RMB currency was undervalued, that is, before February 2008, and after July 2018, fundamentalists expected the RMB to appreciate. As the RMB exchange rate approached its fundamental values, the exchange rate expectations of fundamentalists decreased gradually. When the RMB exchange rate was overvalued, especially from September 2012 to August 2016, fundamentalists expected the RMB to depreciate. Besides, as the exchange rate deviated from its fundamental values, the expected depreciation of fundamentalists was getting bigger and bigger. Furthermore, comparing the trend of the exchange rate expected by chartists in Figure 2(C) with the trend of the RMB exchange rate in Figure 2(A), we discover that the expected trend of the exchange rate by chartists lags the RMB exchange rate. According to historical change trends, the expected method of chartists has inferred expectations.

Figure 3 shows the ratio changes between fundamentalists and chartists during the sample period. Before March 2008, the RMB exchange rate was undervalued, and the proportion of fundamentalists increased gradually. The fundamentalists' mean-reversion expectations further increased the appreciation of the RMB exchange rate. During this period, both types of traders expected the exchange rate to appreciate in the foreign exchange market. However, the proportion of fundamentalists did not continue to rise. On the one hand, as the RMB exchange rate appreciated significantly, the deviations decreased gradually, so as their profitability. On the other hand, both types of traders believed that the RMB exchange rate would appreciate, the herding effect led to an overvaluation of the RMB exchange rate. As a result, the proportion of fundamentalists declined from March to November 2008, coupled with the impact of the financial crisis.

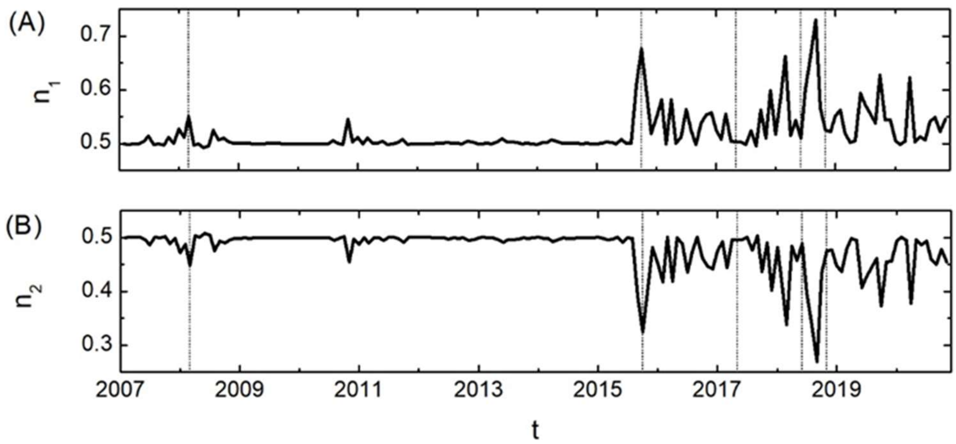

Figure 3. Panel (A) shows the ratio of fundamentalists, and Panel (B) shows the ratio of chartists from February 2007 to November 2020 in the foreign exchange market.

Influenced by the financial crisis, the two types of traders in the foreign exchange market have been in a stable state for a long time. Since the belief value of fundamentalists is much lower than the value of chartists, the exchange rate expectations of chartists will significantly influence the changes in the RMB exchange rate. Thus, although the RMB exchange rate has been overvalued from November 2008 to August 2015, it was still slowly appreciating. This is mainly due to the rapid development of the Chinese economy after the financial crisis. While the RMB exchange rate has appreciated, its fundamental value has also appreciated at a higher rate. However, since late 2013, there has been an economic “bubble” and there was a stock market crash in August 2015. The impact of the stock market crash also spread to the foreign exchange market, so the RMB exchange rate began to fall. As the deviation in the exchange rate decreased, the proportion of fundamentalists decreased accordingly. As a result, fundamentalists played a dominant role in the foreign exchange market from October 2015 to May 2017, but their dominant power diminished as deviations decreased. After the stock market crash, the social economy returned to normality, and the foreign exchange market entered a short-term stable situation. The RMB fundamental exchange rate has entered a state of appreciation, and the proportion of fundamentalists has increased gradually. However, the proportion of fundamentalists will not remain at a high level for a long time. As the deviation decreases, the proportion of fundamentalists will decrease.

As we all know, the United States has imposed several rounds of large-scale economic sanctions against China since 2018 (Feng et al., 2021) [26]. Figure 1 shows that the deviation continued to increase after June 2018. At the same time, the proportion of fundamentalists has risen rapidly in the foreign exchange market. The fundamentalists' mean-reversion expectations led to an appreciation of the RMB exchange rate. However, the United States continues to increase sanctions against China, which led to an increase in the proportion of Chartists. As a result, since then, the fluctuations in the foreign exchange market have appeared in two directions. On the one hand, the increased United

States sanctions against China will cause the RMB exchange rate to depreciate. On the other hand, the RMB exchange rate has been stayed under its fundamental value for a long time and there will be expectations of appreciation. The fundamentalists believe that the RMB exchange rate will appreciate, while the chartists believe that the RMB exchange rate will not appreciate due to the strong pressure from the United States. As a result, the ratio of fundamentalists to chartists fluctuates during this period, with the ratio of fundamentalists slightly higher than the ratio of chartists.

5. Conclusions

Our study examines whether the excessive volatility of RMB exchange rate is associated with investors' behavioral heterogeneity. Consistent with the heterogeneous agent model prediction, results show that investors' heterogeneity in price trends and trading strategies leads to RMB exchange rate volatility. This finding is further confirmed by our analysis of the two significant fluctuations of RMB exchange rate in 2015–2016 and 2018–2019. The switching of investors with heterogeneous beliefs contributed to the excess volatility of RMB exchange rate.

Our results offer an important implication. Our evidence provides insights into the underlying sources that can explain the excess volatility of RMB exchange rate. We find empirical evidence that there is a strong linkage between investors' heterogeneity and the fluctuation of the RMB exchange rate. Thus, reducing the degree of heterogeneity in investors' behavior is conducive to maintaining the stable development of the RMB foreign exchange market.

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