A Study of RMB Exchange Rate Fluctuation Influence on China’s Tea Export Value

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Abstract. It is an empirical analysis of whether RMB real effective exchange rate (REER) can influence China’s tea export value and how, using least square method and error correction model to establish long-term and short-term equilibrium relationships among variables on the basis of unit root test, autocorrelation test and co-integration test. The empirical results show that RMB appreciation can increase China’s tea export value in the short term, but decrease in the long term; the average price rise of China’s tea export can increase the tea export either in the long term or short; US consumer price index (CPI) rise can increase China’s tea export in the long term, but decrease in the short term; China’s manufacturing purchasing managers index (PMI) for China economic climate can also accelerate China’s tea export. But all the influences are not significant.

1. Research Proposal and Literature Review

On July 21, 2005 the People’s Bank of China officially announced the implementation of a market-based, managed floating exchange rate system with reference to a basket of currencies. RMB appreciated against USD by 2\% from 8.2765 to 8.11 on nominal terms. From then on, RMB exchange rate increased its floating range with frequent fluctuation and escalating flexibility. RMB was in appreciation almost all the way. Up to June 31, 2006, RMB against USD spot rate reached 7.9956, breaking through integral juncture of 8 within less than one year. To May, 2008 RMB equivalent to USD at the end of the period was 6.9472, and RMB against USD spot rate broke through the juncture of 7. In 2008 international financial crisis, RMB stayed strong and slowed down its appreciation. From the breakthrough of 7 in May, 2008 to May, 2010, RMB against USD exchange rate stayed strong for 2 years. In order to adapt to market development, consolidate market-determined exchange rate, and establish market-based, managed floating exchange rate system, the People’s Bank of China decided to expand RMB against USD exchange rate floating range in foreign exchange market. From March 17, 2014, in the inter-bank spot foreign exchange market RMB against USD floating range increased from 1 to 2, strengthening RMB exchange rate two-way floating flexibility. Figure 1 shows that RMB against USD nominal exchange rate has dropped all the way since 2005, and RMB continues appreciating to 6.1238 in 2008. In 2015, RMB against USD exchange rate increased a little. There were signs of RMB depreciation, but the range was very small.
China has a long history of tea production and consumption. Recent years, supported by national industry policies, China’s tea industry maintained a sustained and rapid development momentum. Over the last ten years, tea export developed rapidly. To 2014, China’s tea export value reached 1,272.979 million dollars, 2.63 times as much as 484.306 dollars of 2005. Although China’s tea export increased year by year, the yearly annulus growth fluctuated, up to 23.07% in 2011 and down to 1.84% in 2014. See figure 2 and table 1 in detail.

Table 1. China’s Tea Export Value Annulus Growth Rate.

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annulus Growth Rate</td>
<td>12.93</td>
<td>11</td>
<td>12.41</td>
<td>3.31</td>
<td>11.24</td>
<td>23.07</td>
<td>7.76</td>
<td>20.19</td>
<td>1.84</td>
</tr>
</tbody>
</table>

Data source: Calculation on the figures from the website of the Foreign Trade Department of the Ministry of Commerce of the people’s Republic of China.

The above analysis shows the constant appreciation and fluctuation of RMB exchange rate on the one hand and the constant increase and volatility of China’s tea export value on the other hand. Whether RMB exchange rate fluctuation can influence China’s tea export value and how is the focus of the study.
There are many researches concerning RMB exchange rate change influence on China’s certain agricultural products import and export trade. Chen Wei [1], Gao Weixin [2] analyzed respectively RMB exchange rate change influence on aquatic products with qualitative analysis, concluding RMB appreciation can benefit China aquatic import and restrain export. Kong Fanling [3], Li Jinglei [4], Sun Li [5], Zhang Kun [6], Zhang Jiashe [7] and others analyzed empirically RMB REER influence on some agricultural products import and export such as wheat, cotton, corn, aquatic products etc. Long Zhijun [8] analyzed empirically RMB nominal exchange rate influence on aquatic export. But all these previous studies lack special research on tea. Methodically, there are more empirical analyses and less qualitative. Their subjects cover RMB REER fluctuation influence on some kind of agricultural products trade and nominal exchange rate change impact on the trade. This paper does not study RMB exchange rate fluctuation influence on China’s tea export to a certain country, so cannot take the bilateral nominal exchange rate, but REER that is figured out on sample currencies of representative countries to reflect RMB comprehensive external value in international trade. The paper analyzes RMB REER fluctuation influence on China’s tea export.

2. Analysis Model Setting and Data Selection

2.1 Analysis model setting

According to the international economy and trade theory, in the modern open economy era the factors that can influence international trade are still price and income, and the trade price concerns domestic price and international price of trade goods. If the domestic price of some kind of trade goods is higher than the international price, it will result in export decrease and import increase of the goods. On the contrary, if lower, export increase and import decrease. Necessarily, trade goods price concerns exchange rate; depreciation of domestic currency can lead to export increase and import decrease and appreciation lead to import increase and export decrease. The same, Income consists of domestic income level and international income level of the trade goods. If domestic income level rises, it will bring about import increase of the trade goods; if international rises, export increase.

Containing the above factors, an analysis model as equation (1):

$$\ln EX_t = \beta_0 + \beta_1 \ln REER_t + \beta_2 \ln PMI_t + \beta_3 \ln AP_t + \beta_4 \ln UCPI_t + \mu_t$$

Log in equation (1) is processed data to eliminate different variances. In it $EX_t$ is for China’s tea export value; $\beta_0$ denotes intercept; $REER_t$ denotes RMB real effective exchange rate; $PMI_t$ denotes China’s manufacturing purchasing managers index; $AP_t$ denotes China’s tea export average price; $UCPI_t$ denotes US consumer price index; $\beta_1$ denotes China’s tea export value flexibility to RMB real effective exchange rate fluctuation; $\beta_2$ denotes China’s tea export flexibility to China’s manufacturing purchasing managers index; $\beta_3$ denotes China’s tea export value flexibility to US consumer price index change; $\mu_t$ denotes random error term. Based on the above theoretical analysis, inferences can be made as follows:

- Inference 1: with RMB appreciation, China tea export value will decrease. i.e. $\beta_1 < 0$;
- Inference 2: the higher China’s manufacturing PMI is, indicating the increase of Chinese national income, the lower China’s tea export value should be. i.e. $\beta_2 < 0$;
- Inference 3: China’s tea export average price rise can cause the drop of China’s tea export value. i.e. $\beta_3 < 0$;
- Inference 4: US CPI rise, possibly indicating the rise of international tea export price, can increase China’s tea export. i.e. $\beta_4 > 0$.

2.2 Data selection

From 2008 to 2018, RMB stayed strong in the international financial crisis and made great contribution to alleviation of the crisis. From then, RMB fluctuation increased to meet the market demand. So this paper selects the monthly data from Jan. 2011 to Dec. 2014 after the crisis as the
study objects. China’s tea export value monthly data are from the website of the Foreign Trade Department of the Ministry of Commerce of the people’s Republic of China. The unit is million dollars. As for RMB, it selects RMB real effective exchange rate. The reason of this selection, but not the RMB nominal exchange rate, is that the RMB REER is obtained through weighting the bilateral nominal exchange rates of homeland and trade partners on the basis of a certain weight and it can meet the need of the study on China’s multilateral tea trade better. RMB REER data are from Bank for International Settlements. Because of no access to the monthly data of Chinese national income, manufacturing PMI for China’s economic climate is adopted instead of Chinese national income to show the macroeconomic trend of China, and the data are from China National Bureau of Statistics website. China’s tea export average price is used to represent China’s tea price level, and the data are from the website of the Foreign Trade Department of the Ministry of Commerce of the People’s Republic of China with the unit of dollar/ton. US CPI can show the international tea price and international income level, and the data are from US Department of Labor.

3. Empirical Analysis

3.1 Variable stability test (ADF test)

Since the non-stationary feature of data can bring about spurious regression, the data of empirical analysis in the paper are all macroeconomic data. Because most macroeconomic time series tend to produce non-stationary phenomena, it is necessary to carry variable stability test, i.e. unit root test to prevent spurious regression. Given more than two variables in the model, ADF test is used.

Table 2. Variable Stability Test Results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test form(c,t,k)</th>
<th>ADF value</th>
<th>1%critical value</th>
<th>5%critical value</th>
<th>10%critical value</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnEX</td>
<td>(c,0,1)*,<strong>,</strong>,**</td>
<td>-3.923973</td>
<td>-3.581152</td>
<td>-2.926622</td>
<td>-2.601424</td>
<td>stable</td>
</tr>
<tr>
<td>lnREER</td>
<td>(c,t,1) ***</td>
<td>-3.312534</td>
<td>-4.170583</td>
<td>-3.510740</td>
<td>-3.185512</td>
<td>stable</td>
</tr>
<tr>
<td>lnPMI</td>
<td>(c,0,1)<strong>,</strong>,**</td>
<td>-3.546617</td>
<td>-3.581152</td>
<td>-2.926622</td>
<td>-2.601424</td>
<td>stable</td>
</tr>
<tr>
<td>lnAP</td>
<td>(c,t,1) <strong>,</strong>,**</td>
<td>-3.748720</td>
<td>-4.170583</td>
<td>-3.510740</td>
<td>-3.185512</td>
<td>stable</td>
</tr>
<tr>
<td>lnUCPI</td>
<td>(c,t,1) *,<strong>,,</strong></td>
<td>-4.345625</td>
<td>-4.170583</td>
<td>-3.510740</td>
<td>-3.185512</td>
<td>stable</td>
</tr>
</tbody>
</table>

Note: in test form, c denotes intercept, t denotes trend, k denotes lag order; in test results, *** are for series stable on the critical value 1%, 5%, 10%.

In the unit root test of variables, lag phase is determined by Akaike Information Criterion (AIC) and Schwarz Criterion (SC) least value, and whether each variable has intercept and trend is judged by each variable graph. From table 2 we can see the test results of time series on horizontal sequence, the ADF values of original series lnEX and lnUCPI are all smaller than the critical value of any test level and their unit root hypothesis is refused, indicating the original series lnEX and lnUCPI are stable time series. When original series lnPMI and lnAP are under the confidence level of 5% and 10%, their ADF test value is smaller than given test critical value, indicating original series lnPMI and lnAP are stable time series. When original series lnREER is under confidence level of 10%, its ADF value is smaller than its test critical value and the original series lnREER is also stable. So all the original series of time series are stable and the next test can be managed.

3.2 Autocorrelation test (LM test)

To be an effective equation, whether there is autocorrelation in the random errors should be tested. Below, Lagrange multiplier test (LM test) is used to judge it and its order.

After test, LM (1) (lag phase 1) = 0.230426, and its probability $p = 0.6312$; LM (2) (lag phase 2) = 1.848131 and its probability $p = 0.3969$; on the significance level of 5%, probabilities are all larger than 0.05. So there is not autocorrelation of order 1 and 2 in the empirical model.
3.3 Johansen co-integration test

Following variable stability test and autocorrelation test, a co-integration test is necessary to judge whether there is long-term stable equilibrium relationships among series.

Table 3 lists the co-integration test results. Under the significance level of 5%, when co-integration relationship number is assumed 0, trace statistic 114.4458 is greater than trace critical value 69.81889, refusing the original assumption of no co-integration equation, at least there is 1 co-integration equation; when co-integration relationship number is assumed 1, trace statistic 59.26388 is greater than 47.85613, refusing the original assumption of 1 co-integration equation at most, there are at least 2 co-integration equations; When co-integration relationship number is assumed 2, trace statistic 29.89544 is greater than 29.79707, refusing the original assumption of 2 co-integration equations at most, there are at least 3 co-integration equations. The above results support the conclusion that there are long-term stable equilibrium relationships among variables.

<table>
<thead>
<tr>
<th>Hypothesis of cointegration numbers</th>
<th>Eigen value</th>
<th>Trace-statistic (5% significant level)</th>
<th>Trace-critical value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.698687</td>
<td>114.4458</td>
<td>69.81889</td>
<td>0.0000</td>
</tr>
<tr>
<td>at most 1</td>
<td>0.471887</td>
<td>59.26388</td>
<td>47.85613</td>
<td>0.0030</td>
</tr>
<tr>
<td>at most 2</td>
<td>0.290027</td>
<td>29.89544</td>
<td>29.79707</td>
<td>0.0487</td>
</tr>
</tbody>
</table>

3.4 Establishment of long-term stable model

The above tests have shown the stability of variables, no autocorrelation in random error of equation, and the existence of long-term equilibrium model among variables through co-integration. Below, through estimating regression model by least square method, long-term equilibrium relationships formulae can be achieved.

\[
\ln EX_t = -2.598207 - 0.644881 \ln REER_t + 0.462159 \ln PMI_t + 1.123925 \ln AP_t \\
\hspace{1cm} (-0.162879) \hspace{1cm} (-0.745660) \hspace{1cm} (0.3424180) \hspace{1cm} (1.980386)
\]

\[
+ 0.770457 \ln UCPI_t \\
\hspace{1cm} (0.20690)
\]

\[
R^2 = 0.447131; \ F = 8.694027 \ (F \text{ probability value of statistic test is 0.000031}); \ DW = 2.096582
\]

Equation (2) is the long-term equilibrium relationships formulae achieved after regression. Model goodness of fit is average. The equation has been through F test and DW value shows no autocorrelation.

3.5 Error correction model (ECM)

After the establishment of long-term equilibrium equation among variables through co-integration test, error correction model is established by residual term of lag phase 1 to judge short-term equilibrium relationships among variables. See equation 3 for results.

\[
\Delta \ln EX_t = 0.01 + 0.223795 \Delta \ln REER_t + 0.710615 \Delta \ln PMI_t + 0.416395 \Delta \ln AP_t \\
\hspace{1cm} (0.353976) \hspace{1cm} (0.101277) \hspace{1cm} (0.948801) \hspace{1cm} (0.432882)
\]

\[
-7.411423 \Delta \ln UCPI_t - 1.104188 \text{ECM}_{-1} \\
\hspace{1cm} (-1.024392) \hspace{1cm} (-6.876486)
\]

\[
R^2 = 0.574295; \ F = 11.06215 \ (F \text{ probability value of statistic test is 0.000001}); \ DW = 1.686695
\]

Equation (3) shows the goodness of fit of error correction model is average, and through F test and DW test the estimation coefficient of error correction term \( \text{ECM}_{-1} \) of lag phase 1 of short-term equilibrium relationships error correction model is -1.104188, conforming to reverse
correction mechanism and the reverse correction is significant on the level of 1%, which shows error correction term will make a reverse adjustment with the force of 1.104188 to recover equilibrium from disequilibrium state of variables.

4. Conclusions

Through above analysis, we can get the following conclusions:

First, empirical results validate the inference that RMB appreciation can decrease China’s tea export value in the long term. In the long term, RMB appreciation of 1% can decrease China’s tea export value by 0.64488%; in the short term, RMB appreciation of 1% can increase by 0.223795%. The different influences of RMB exchange rate fluctuation in the long term and short term on China tea export, of which the long-term impact is stronger than the short-term, shows the lag effect in RMB exchange rate fluctuation influence on China’s tea export.

Second, empirical results show that Chinese economic development increasing China’s manufacturing PMI either in the long term or in the short term can accelerate China’s tea export, though not significantly. However, it does not cohere with the inference 2. It is mainly because China’s tea production quantity and quality have strong advantage in the world, Chinese economic development and income rise can expand domestic tea consumption as well as tea export.

Third, empirical results prove that the average price rise of China’s tea export either in the long term or in the sort term can cause more China tea export, but not significantly. The conclusion is inconsistent with the anticipation of inference 3. But it can prove further China as a major tea production and consumption country has high-quality tea of which many kinds are international famous brands in dependence on geographic advantage; with the brand effect and geographic advantage China’s tea export price fluctuation does not influence tea export value significantly.

Fourth, empirical results prove that the rise of US CPI for international tea price and international income can accelerate China tea export in the long run. It validates inference 4. But the acceleration is not significant, and even there is deceleration in the short term though not significant either. It is because China tea export with strong geographic advantage is influenced by price little on the one hand, and normally, US CPI, that is not international tea price, rise and economic drop thereby will decrease tea export in the short term on the other hand.

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