10. PURCHASING POWER PARITY IN CHINA: AN EMPIRICAL INVESTIGATION BASED ON BOOTSTRAP ROLLING-WINDOW TEST

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Abstract

This paper aims to assess whether the purchasing power parity (PPP) holds by examining the dynamic link between nominal exchange rate (NER) and relative consumer price (RCP) in China. Because of existing economic transitions and structural breaks, we discover that there is no relationship between NER and RCP to support the PPP by using full sample data. Hence, we employ the rolling window causality method to reexamine the causal relation and the results show that PPP sets up only for a short period of time. Exchange rate reform, trade cost, restrictions and imperfect competition can be utilized to explain the deviations in most time of the sample. Therefore, this empirical result has important implications for stakeholders to distinguish` factors that bring about the PPP deviations and further offers policy suggestions for the Chinese monetary authority.

Keywords: Consumer Price Index; exchange rate; rolling window; bootstrap; time-varying causality
JEL Classification: C32, E31, F31

1. Introduction

The aim of this paper is to investigate whether the purchasing power parity (PPP) fits for China. In the past decades, considerable efforts have been put into examining the validity of the PPP. Studies on this issue are essential not only for empirical researchers but also for policy-makers. The PPP is indicative of a long-run link between the nominal exchange rate (NER) and relative consumer price (RCP) of a particular economy. When PPP exists, it can then be used to determine the equilibrium exchange rate, but if it does not hold, any

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monetary approach in intervening exchange market is invalidated. Therefore, it offers the basis for evaluating the effectiveness of foreign exchange market (Lu and Chang, 2011). With the development of the globalization of the world economy and the depeening of China's foreign trade, the role of RMB exchange rate on its economy and inflation is further enhanced (He *et al*., 2015). China announces a series of exchange rate regime reforms especially in July, 2005 and August, 2015, and RMB exchange rate flexibility gets a moderate increase (Dixon *et al*., 2016). Since reforms, the NER, RMB against per U.S. dollar, falls from 8.27 to 6.80 in June 2017, resulting in the cumulative appreciation of about 17.75%. The expection of NER appreciation stimulate the influx of "hot money", and exert an significant influence on China's monetary policy and the development of its economy and industry (He *et al*., 2015). Meanwhile, China has suffered several identifiable stages of inflation especially the recent heightened fluctuations during the mid- to late- 2000s. Zhao (2011) shows that excess liquidity holds the most important predictive power on inflation in China. Yi (2013) demonstrates that there is significant pass-through effect from exchange rates and import prices to domestic inflation. The changes in domestic inflation would further impact RCP. Hence, NER and RCP have interactions, which provide motivation to examine whether the PPP fit for China. If that holds true, it does not offer a basis for the evaluation of the effectiveness of monetary policy but offers as well suggestions to promote RMB exchange rate regime reform.

The internal and external economic environments that China faces in recent years have changed greatly. Hence, China provides an interesting case to study in terms of following reasons. First, China has made remarkable economic progress over the past decades. Its average annual economic growth rate in past 11 years (2006-2016) is 8.711% and per capita real Gross Domestic Product (GDP) reaches US$8865 in 2016. Second, China has become the world's first and largest trading country with the foreign exchange reserves estimated at US$2.62 trillion at the end of 2010 (Chang, 2012). Third, People's Bank of China (PBOC) announces a series of exchange rate revolutions such as "7.21" and "8.11" reforms in 2005 and 2015 respectively, to construct market-determined pricing mechanism (Ning *et al*., 2017). Fourth, China also accelearates the process of RMB internationalization (Wu *et al*., 2010) and it has been included in Special Drawing Rights (SDR) by International Monetary Fund (IMF) in 2016. The last, Central government starts open policy in the late 1970s, thus sufficient data are available for studies to evaluate the effect of economic liberalization on economic phenomenon. All incidents mentioned above may bring structural changes in NER and result in NER deviating from the PPP. Consequently, there is an imminent concern regarding whether the PPP still fits for China. If the PPP holds, the higher domestic inflation rate will result in RMB exchange rate depreciation in the future. Meanwhile, keeping price stability is one of the main goals for the PBOC, which is greatly motivated to pursue an investigation, related to the PPP condition between RCP and NER in China. Combining with corresponding results, we provide suggestions for reforming NER mechanism and implementing discreet monetary policy.

Substantial studies have been undertaken with focus on the PPP. However, the empirical researches have not reached a consensus on whether the PPP holds or not. Lin *et al*. (2011) indicate that PPP does not hold for most transition countries such as Bulgaria with Fourier stationary test. Huang and Yang (2015) find weaker evidence for PPP following the launch of the Euro in European countries with the panel unit root test. Vasconcelos and Júnior (2016) examine the PPP in the context of unit root tests and find that deviations exist for most of Latin American countries. Ma *et al*. (2017) argue the PPP hypothesis is not strongly supported for Japan, Korea and China through the conventional unit root test. However,

many researchers argue the PPP is valid. Chang *et al*. (2012) indicate the PPP holds for most East-Asian countries including Japan and South Korea. Su *et al*. (2012) and Peng *et al*. (2017) examine the PPP in BRICS countries and find it holds true for all countries. Cuestas and Regis (2013) apply the linearity test and the nonlinear unit root test to examine PPP in OECD countries and find most countries support it. Lee and Chou (2013) imply that PPP hold true for all Group of 20 countries by applying the Panel SURADF test. Bahmani-Oskooee *et al*. (2015, 2016) find PPP is effective for most major exporting countries and emerging economies through sequential panel selection method. Jiang *et al*. (2016) employ non-linear threshold unit root test to investigate the validity of PPP and find it holds true for seven Central Eastern European countries.

Because of China's "immunological strength" to global financial contagion and also the ever-growing economy under a strictly managed exchange regime. Chen *et al*. (2011) apply the threshold to test the validity of PPP in China and Taiwan and find PPP holds true for the two areas. Arize (2011) uses KPSS and KSS tests to examine the PPP and prove it is valid, which is suitable guide for exchange rate determination and exchange rate policy reform in China. Lu and Chang (2011) provide evidence to support PPP in China with threshold cointegration test. Chang (2012) provides strong support for the PPP in China relative to the major trading partner countries with nonlinear unit root test. Ma *et al*. (2017) indicate that the PPP hypothesis holds for China at certain levels under the quantile-based approach. However, Lee (1999) finds that there is no long run relationship between exchange rate and price ratio in Taiwan using dynamic error correction model. Zhang (2010) indicates that there are no economic relations between PPP and nominal exchange rate of RMB with Engle-Granger test. Dai *et al*. (2015) show the fluctuations of RMB exchange rate cannot meet the PPP based on empirical results from panel test. These previous studies only consider full-sample causality, being susceptible to misleading results in the presence of parameter instability due to structural breaks in relationships. Therefore, this paper proposes a bootstrap Granger full-sample causality test and subsample rolling-window estimation to revisit the link in China. It is distinct from most conventional mathematical methods, which can identify full and sub-sample linkage between time series or reveal how such relation change over time.

This paper examines the linkage between RCP and NER with regard to Sino-U.S., which is based on following reasons: First, USD is still the most important international currency. This is true for its public and private roles, whether it is measured as unit of account, medium of exchange or standard of deferred payment-the three traditional roles of money (Williamson, 2013). Second, although the RMB has been managed with reference to a basket of currencies since 2005:M07, but it still pegs to USD to some extent (Coudert and Couharde, 2008). Third, China has run up a large current account surplus and accumulated foreign exchange reserves exceed 3.7 trillion USD at the end of 2015Q1 and 63.6% of its reserves are dollar assets such as Treasury bonds (Shi and Nie, 2017). Finally, U.S. and China are top two economies and have close economic and trade ties. Bilateral trade reaches about 0.58 trillion dollars in 2016 and China is largest exporter for U.S., which accounts for 21.1% of total import. Thus, in terms of USD status and tight economic relation, U.S. is considered as relative country rather than other countries.

The major contributions of this study to the existing literature is that we take into account the time variation in the PPP condition between RCP and NER. Commonly, the previous researches just investigate the causal link under the full-sample, which is liable to get inaccurate conclusions since the parameters may present instability when faced with structural changes. Furthermore, the nonlinear relationship makes shocks to real factors

(Taylor *et al*., 2001). China experiences obvious economic reconstruction and structural changes from 2005:M07 to 2017:M06, producing a deep ripple effect reaching down to its economic fundamentals. All incidents may result in structural changes in time series, which further indicates that such dynamic linkage exists among the two series would clearly display instability varying across sub-samples (Balcilar *et al*., 2010). Therefore, the bootstrap Granger full-sample causality test and sub-sample rolling-window estimation are applied to revisit the PPP condition between RCP and NER. The bootstrap rolling-window method is different from previous methods which cannot distinguish full-sample and sub-sample relationship changes over time. When meeting structural changes, the causal linkage between these two variables may not be accurate in previous studies (Balcilar and Ozdemir, 2013). This can be solved by assuming a time varying causal link with single causality holding in every sub-interval. The time-varying character may exist in the causal nexus, which has been taken into account in this paper. The test for causality on the full sample is carried out under the assumption that the causal relationship is fixed. We test for causality on the rolling sample, which captures structural changes in the model and the evolution of causality between sub-periods. The results show that there is a bilateral causal relationship between RCP and NER in certain subsamples with rolling-window estimation.

The rest of this paper is organised as follows: Section 2 introduces purchasing power parity. Section 3 provides the methodology. Section 4 describes the data. Section 5 analyses the empirical results and gives policy implications. Section 6 drives conclusions.

2. Purchasing Power Parity

According to Cheung and Lai (1993), the PPP is the cornerstone for any model examining the long-run exchange rate movements and is written as:

$$s_t = c + \alpha_1 p_t - \alpha_2 p_t^* + \mu_t \tag{1}$$

where: c is a constant, s_t is logarithm of NER. p_t and p_t^* represent logarithms of the domestic and foreign price indices respectively. μ_t is an error term. The long-run proportionality between exchage rates and prices infers $\alpha_1 = \alpha_2 = 1$. The PPP can be motivated by the presence of measurement errors in prices (Taylor, 1988). We assume the PPP fits for the following Equation:

$$s_t = c + g_t - g_t^* + \varepsilon_t \tag{2}$$

where: ε_t is a stationary process. g_t and g_t^* represent domestic and foreign consumer price index, repectively. Following above equation, s_t is determined by $g_t - g_t^*$, and the PPP condition is thus a simple no-arbitrage condition. It is central in understanding inflation, international trade and monetary policy. Therefore, deviations in the parity condition here would mean foreign market is effcient.

3. Methodology

3.1 Bootstrap Full-sample Causality Test

Granger causality statistics rely on the stationarity of time series. If this precondition cannot hold, the time series may not follow standard asymptotic distributions, making it difficult to evaluate the vector autoregression (VAR) models (Sims *et al*., 1990; Toda and Phillips, 1993, 1994). The modified Wald test is estimated by using Monte Carlo simulations (Shukur and Mantalos, 1997a), but gives unreliable results especially in small- and medium-sized samples. Compared with the modified Wald test, critical values can be improved by using

the residual-based bootstrap (RB) method (Shukur and Mantalos, 1997a, 1997b) which has been proven to perform well in standard asymptotic tests through Monte Carlo simulation (Mantalos and Shukur, 1998). However, Shukur and Mantalos (2010) further show that the likelihood ratio (LR) test performs even better in small samples. Combining with above conclusions, this paper chooses the RB-based modified-LR statistic to revisit causal relationship between RCP and NER. In terms of the RB-based modified-LR causality test, the bivariate VAR (*p*) process can be constructed as follows:

$$\begin{bmatrix} RCP_{1t} \\ NER_{2t} \end{bmatrix} = \begin{bmatrix} \varphi_{10} \\ \varphi_{20} \end{bmatrix} + \begin{bmatrix} \varphi_{11}(L)\varphi_{12}(L) \\ \varphi_{21}(L)\varphi_{22}(L) \end{bmatrix} \begin{bmatrix} RCP_{1t} \\ NER_{2t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}, \ t = 1, 2 \cdots T \quad (3)$$

where: $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t})$is a zero mean, independent, white noise process with nonsingular covariance matrix Σ. Schwarz Information Criteria (SIC) is selected to determine the optimal lag length *p* in this paper. $\varphi_{ij}(L) = \sum_{k=1}^{p+1} \varphi_{ij,k} L^k, \ \ i, j = 1, 2$ and *L* is the lag operator defined as $L^k X_t = X_{t-k}$. From Equation (3), we assume the null hypothesis that NER does not Granger cause RCP and is tested with the restriction, $\varphi_{12,k} = 0$ for $k = 1, 2 \cdots p$. In the same way, the null hypothesis that RCP does not Granger cause NER is tested with the restriction, $\varphi_{21,k} = 0$ for $k = 1, 2 \cdots p$. As previously debated, the RB-based modified-LR statistic is utilized to investigate the causal link under the full-sample. If one of the null hypotheses is rejected, which shows there is a unidirectional causality. When both hypotheses are rejected, the two variables can affect each other. However, no causal link would exist while the hypotheses are accepted.

3.2. Parameter Stability Test

The assumption that parameters in the VAR model are fixed may be false when meeting structural changes in the full-sample occur, leading to causal link instability (Balcilar and Ozdemir, 2013). Granger (1996) has emphasized the importance of solving the precondition of constant parameters. Based on this, Andrews and Ploberger (1994) utilize *Sup-F*, *Mean-F* and *Exp-F* to investigate the short-term parameters in every sub-interval. In generally, the VAR model can only be constructed by underlying variables that are cointegrated in levels. Regardless, underlying variables that are cointegrated in levels, require the VAR model to allow for error correction in order to be correctly specified. Therefore, it is essential to take into consideration and parameter stability. These methods are proposed to verify whether exists structural breaks exist in time series and whether they can lead to parameters instability. Andrews and Ploberger (1994) utilize parametric bootstrap procedure to estimate critical values and *p*-values. Andrews (1993) also points out that statistics require a 15 percent trimming from both ends of the sample. To test the stability of parameters in the short-run, the fraction of the sample in (0.15, 0.85) is needed.

3.3. Sub-sample Rolling-window Causality Test

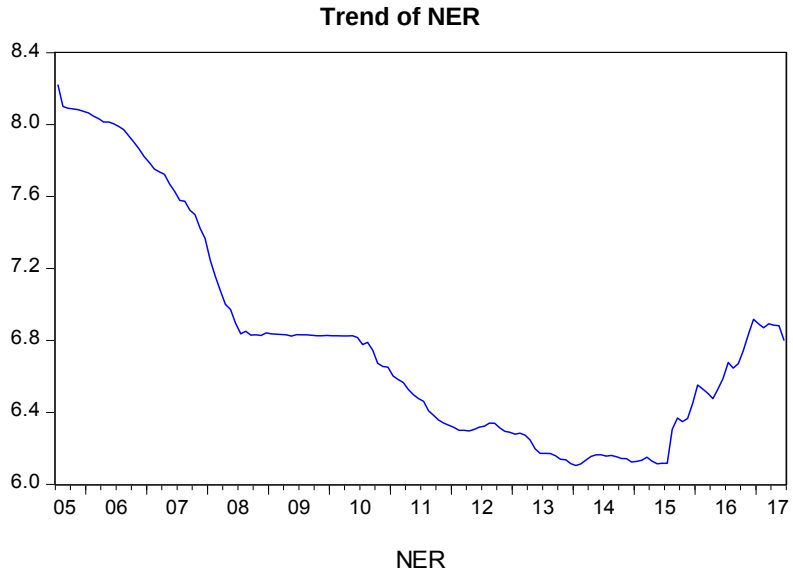
In terms of the above analysis, it is necessary to use the rolling-window bootstrap method proposed by Balcilar *et al*. (2010). Two advantages of using this method should be noticed. First, a rolling window is applicable when the casual link between variables is time varying. Second, since structural changes exist, a rolling method is unstable in different sub-samples. The rolling-window bootstrap method is grounded on fixed-size sub-samples rolling unceasingly from start to end of the full sample. In particular, when given a fixed-size rolling window including *m* observations, the full sample is constituted with *T-m* sub-samples that includes τ *-m*+1, τ *-m*, ..., *T* for τ *=m, m*+1, ..., *T*. Then, every sub-interval can be investigated by RB-based modified-LR causality test. Potential changes can be distinguished through computing the *p*-values of observed LR statistics. $N_b^{-1} \sum_{k=1}^{p} \varphi_{21,k}^*$ and

$N_b^{-1}\sum_{k=1}^{p}\varphi_{12,k}^{*}$ represent influence from RCP and NER, separately. $\varphi_{21,k}^{*}$ and $\varphi_{12,k}^{*}$ are bootstrap estimates from Equation (3). N_b shows the bootstrap repetitions. The 90% confidence intervals are also estimated, for which the lower and upper limits equal the 5th and 95th quantiles of each of the $\varphi_{21,k}^{*}$ and $\varphi_{12,k}^{*}$, respectively. The main problem of the sub-sample rolling-window causality test is the determination of an optimal window size. On one hand, to ensure accuracy the window size needs to be large enough; one the other hand representativeness requires a small window size. Since the two objectives are contradictory, it is essential to choose a suitable number of observations to achieve balance between them. The optimal window size should be relied on the persistence and size of the structural breaks Pesaran and Timmerman (2005).

4. Data

To perform the analysis, monthly data is used, covering the period from 2005:M07 to 2017:M06. According to Equation (2), the following variables are chosen. First, the spot RMB exchange rates per U.S. dollar on behalf of NER is used, extracting the data from the National Bureau of Statistics of China (NBSC). Second, the Chinese CPI (based on 2010 = 100) for the domestic price level is considered, and the data is taken from the PBOC. Third, we choose U.S. CPI (based on 2010 = 100) as the foreign price level, and we extract the data from IMF. From Figure 1, the NER is obviously influenced by incidents.

Figure 1

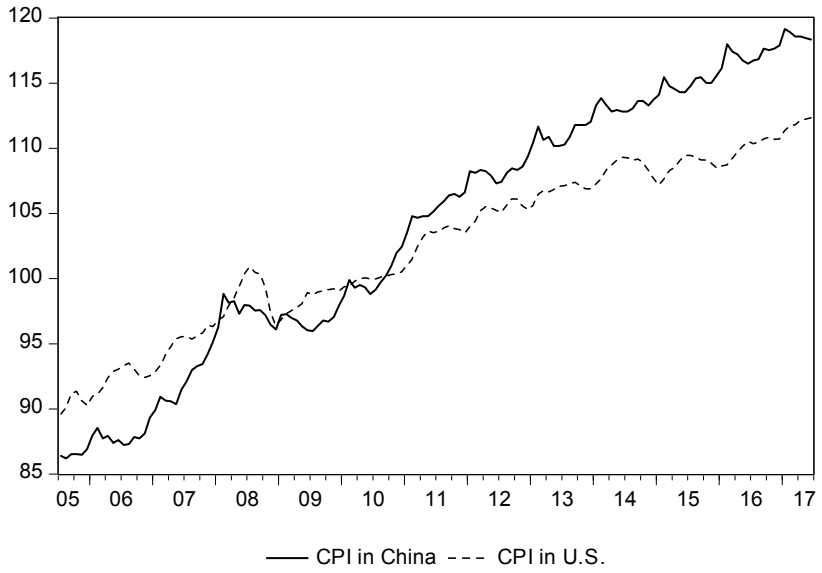


In 2005:M07, the People's Bank of China (PBOC) announces that RMB regime has changed from a de facto peg to the U.S. dollar to a basket of currencies for more flexibility. Since then, the RMB against USD falls from 8.27 to 7.01 in 2008:M04, resulting in the cumulative appreciation of about 15.2%. In time of 2008:M05-2010:M06, in order to cope with financial crisis, the PBOC announces that the RMB keeps a relative stable level and shrink fluctuation

range. The PBOC further undertakes the second RMB regime reform and enhances RMB exchange rate flexibility in 2010:M06 and it started to appreciate again. In 2015:M08, the third round of foreign exchange reform is carried out, which is known as the "8.11" reform. This reform is regarded as a historical move toward a market-determined exchange rate reform (Ning *et al*., 2017). Figure 2 indicates the followings: First, both Chinese and U.S. CPIs rise during the sample. Second, both CPIs suffer sharp rise and fall during the global financial crisis that burst in 2008. Third, Chinese CPI is higher after 2010 and the gap becomes bigger. That can be explained by follows. The Chinese government launches four trillion RMB government stimulus plan, which activate China's economic growth but the negative impact on inflation becomes prominent after 2010 (Yang, 2017). Besides, due to U.S. QE policies and its slow economic growth, the "hot money" flows into China and burst domestic asset prices (Bouvatier, 2010).

Figure 2

Trend of Chinese and U.S. CPI



5. Empirical Results

Following Equation (3), the bivariate VAR model is constructed by RCP and NER. The optimal lag length of the VAR model is 2 based on SIC. Table 1 shows the full-sample causality results from the RB-based modified-LR method. RCP does not Granger cause NER, and vice versa through bootstrap *p*-values. That is to say, the movements in RCP cannot lead to NER fluctuation, and NER has no influence on RCP based on the full-sample causality test. This finding is consistent with some of the existing literature that there is no causal link between these two variables (Dai *et al*., 2015). However, the conclusion is contentious because other researchers have reached opposite conclusions, specifically that RCP and NER can affect each other (Bahmani-Oskooee *et al*., 2016; Vasconcelos and Júnior, 2016).

Table 1

Full-sample Granger-cause Tests

	H_0: RCP does not Granger cause NER	H_0: NER does not Granger cause RCP
Bootstrap LR test	1.891	0.371

Table 2

Parameter Stability Tests

	RCP Equation	NER Equation
Sup-F	30.671***	60.253***
Mean-F	19.083***	13.431***
Exp-F	12.392***	29.513***

Note: We calculate *p*-values using 1,000 bootstrap repetitions. Hansen-Nyblom Parameter stability test for all parameters in the VAR jointly. *** denotes significance at the 1% level.

Nevertheless, the above conclusion is based on a default assumption. It does not take structural changes into consideration and believes that a causal link does or does not exist in the full-sample (Balcilar *et al*., 2010). When the structural breaks are emerging, the parameters are no longer constant. They would change with time passing, which shows the causal linkage between these two variables is unstable. Hence, this paper tests parameter stability and pursues the purpose of confirming or denying the existence of structural breaks. As previously mentioned, the *Sup-F*, *Mean-F* and *Exp-F* tests are applied to test whether the parameters are stable or not and Table 2 shows the corresponding results of above tests. For the *Sup-F* test, the null hypothesis is that parameters have no one-time sharp shift. The hypothesis is rejected at 1% significance level, which means one-time sharp shift exists in RCP and NER equation. The null hypothesis for *Mean-F* and *Exp-F* test is that the parameters follow a Martingale process. The hypothesis is also rejected at 1% significance level, which indicates equations from RCP and NER might evolve gradually. The parameters submit to a random walk process and these provide enough evidence to reject the hypothesis that parameters are fixed in long-run relationship.

In terms of above analysis, the long-run link between RCP and NER is no longer credible. With existing structural changes, the rolling-window bootstrap method is performed to revisit the causality between RCP and NER. This approach takes a time-varying character into account that makes empirical results more accurate. The LR test is utilised to reexamine the PPP condition between these two variables in sub-intervals. The hypotheses for these tests are rejected meaning that RCP does not Granger cause NER and vice versa. After iterating the test several times, the 15-month[5] window size is selected as optimal. The *p*-values of LR test can be obtained from Equation (3) using this window size. When cutting 15 observations from the beginning, the remaining samples cover the period from 2006:M10 to 2017:M06.

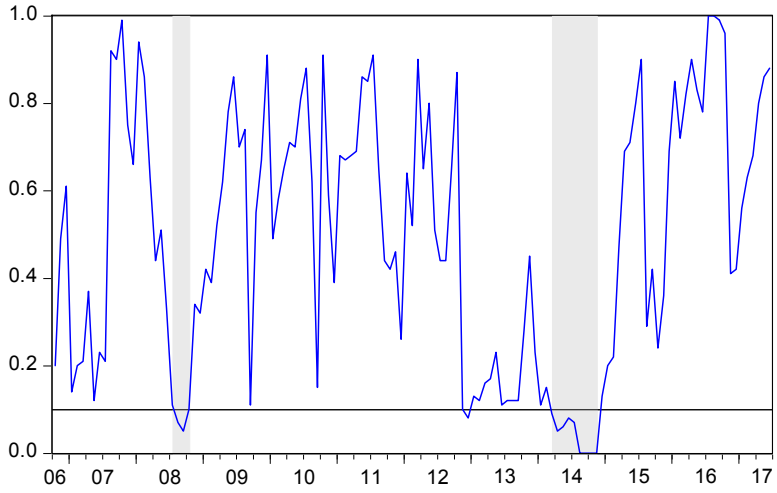
From Figure 3, it can be observed that the null hypothesis can be rejected in 2008:M07-2008:M10 and 2014:M03-2014:M11. Figure 4 further indicates that RCP has a negative influence on NER in above periods. However, we should pay more attention that the PPP

[5] *We wonder whether the results are sensitive to the choice of window size. Thus, we select different window size (e.g. 12, 24, 36 months) to test and find the results are affected, but very little.*

does not hold in most time of sample. This phenomenon can be explained by the following arguments: Cheung and Lai (1993) notice that the link can be weakened by trade cost, trade restrictions and imperfect competition. Since joining the World Trade Organization (WTO), the trade cost between China and U.S. has been reduced from 35.57% to 27.32%, but this still violates the foundation of the PPP (Kim, 2014). U.S. carries out export control and abandons high-tech product to China, meanwhile, China also implements trade quota, which results in commodity not being exchanged freely. Qiu (2006) indicates that the PPP does not hold true based on the differences in economic development level, trade condition and labor productivity. Yin (2008) attributes PPP deviations to economic imbalance and strong unilateral RMB appreciation expectation. Dai *et al*. (2015) argue that the law of one price and Balassa-Samuelson effect can be utilized to illustrate the invalid of the PPP. Cheng and Niu (2016) regard productivity, interest rate and money supply as possible omitted variables that impact the PPP.

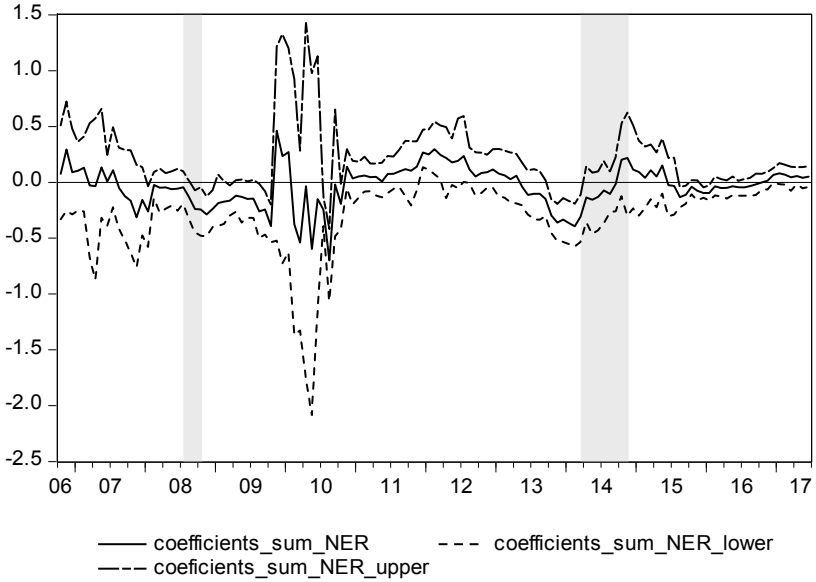
Figure 3

Bootstrap *p*-value of Rolling Test Statistic Testing the Null that RCP Does Not Granger Cause NER.



p-value: RCP does not Granger cause NER

Figure 4
Bootstrap Estimates of the Sum of the Rolling Window Coefficients for the Impact of RCP on NER.

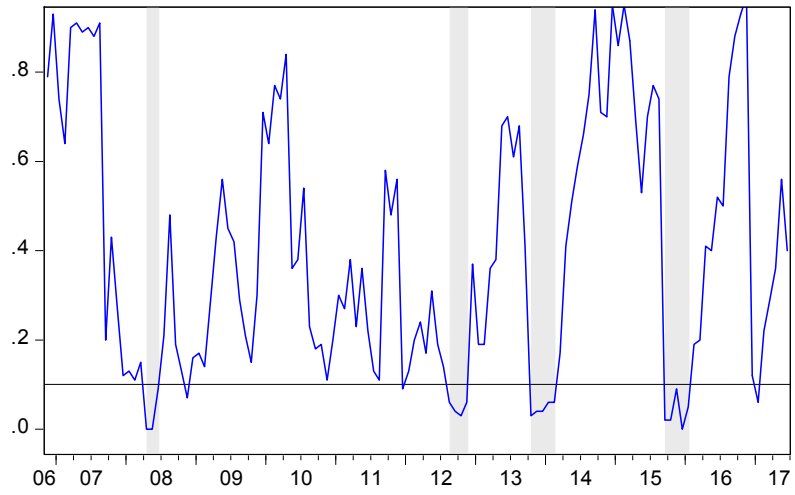


Ito (2017) argue that since capital controls are still in place, China could exercise autonomous monetary policy.However, the Chinese inflation rate turns out to be much more stable than other countries with similar exchange rate stability. Capital controls help prevent portfolio capital inflows that would have driven the economy toward overheating. Therefore, being impacted by above factors, the PPP is invalid in most time of sample and it cannot be employed to determine the equilibrium exchange rate.

Figure 5 points out that we can reject the null hypothesis in some sub-samples, which means NER has impact on RCP in the following periods 2008:M04-2008:M06, 2012:M08-2012:M11, 2013:M10-2014:M02 and 2015:M09-2016:M01. Figure 6 shows that in above periods, NER has a positive impact on RCP. In the first period 2008:M04-2008:M06, RMB is in the process of appreciating that attracting a mass of international short-term capital flowing into China, which results in excess liquidity and rising domestic prices (Zhao, 2011). Fannie Mae and Freddie Mac, the top two largest U.S. real estate companies, are taken over by the U.S. government and Lehman Brothers file for bankruptcy protection that sparks market panic and brings U.S. price down (Dua and Tuteja, 2016). In the second sub-interval 2012:M08-2012:M11, the appreciation of the RMB is expected to strengthen, which leads to inflation through the exchange rate pass-through effect (Li and Luo, 2013). Meanwhile, the fourth QE policy is carried out by Federal Reserve that result in ample liquidity for emerging markets, which would bring pressure for inflation and asset prices. In the time period 2013:M10-2014:M02, with the influence of global financial crisis wearing off and external financial environment stabilizing, the RMB exchange rate strengthens raising domestic prices (Gong *et al*., 2016).

Figure 5

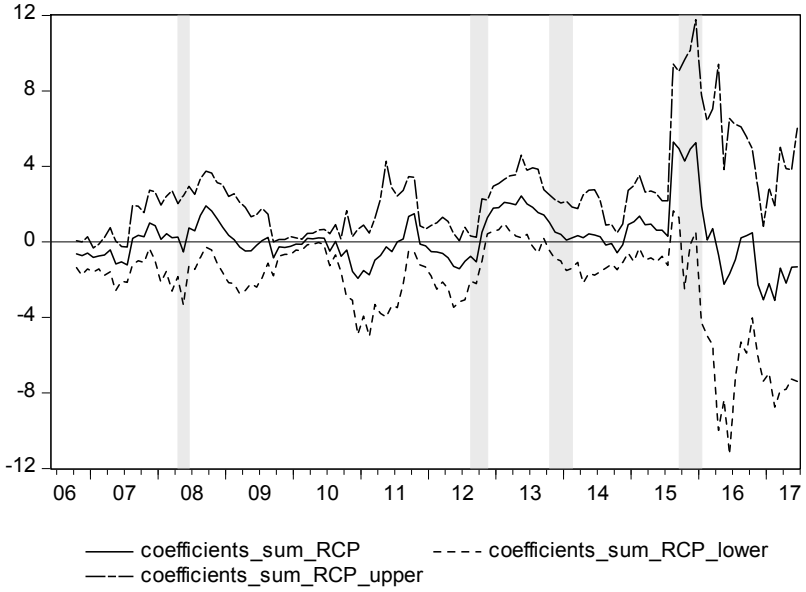
Bootstrap *p*-value of Rolling Test Statistic Testing the Null that NER Does Not Granger Cause RCP.



p-value: NER does not Granger cause RCP

Figure 6

Bootstrap Estimates of the Sum of the Rolling Window Coefficients for the Impact of NER on RCP.



In last period 2015:M09-2016:M01, RMB is adopted as a composition currency of SDR by IMF, with 10.92%, ranking number 3 and surpassing the Japanese yen and Great Britain pound. Ito (2017) indicate that in projecting the growth of the Chinese economy relative to advanced countries, the weight of RMB in the financial markets will increase globally as well as regionally in the foreseeable future. Lu *et al*. (2017) demonstrate that RMB would also produce impacts on international commodity markets and further influences domestic prices. However, NER has no significant impact on RCP in the following periods. During 2006:M10-2008:M03, U.S. economic growth slows down and global energy prices fall, reducing the pressure of inflation (Kalian and Vega, 2008). The proportion of fiscal deficit to GDP decreases from 3.6%, the highest point, to 1.9%, which further stabilizes the U.S. price (Dockery *et al*., 2012). The Federal Open Market Committee (FOMC) announces it would keep the target interest rate at 5.25%, which means a tight monetary policy. In 2008:M07-2012:M07, the PBOC indicate that high CPI is tight with Chinese Spring Festival and natural disasters (e.g. snowstorm). The festival produces huge demand for food, clothes and transport. Snow disaster destroys the transport and agriculture and increases domestic prices. Meanwhile, with the subprime crisis becoming a global financial crisis, the FOMC take unprecedented losing monetary policy. It carries out two times QE policies separately in 2010:M04, 2010:M06. The FOMC also implements low interest rate policy, which reduces the interest from 5.25% to 0%. The above measures produce excess liquidity and rising U.S. price (Tu, 2011). In time 2012:M12-2013:M09, the FOMC implements the fourth QE policy, which results in ample liquidity and bring pressure for emerging markets' CPI and asset prices. In last period 2016:M02-2017:M06, the RCP is mainly influenced by "policy sequel". In order to get through the global financial crisis, the central government implements four trillion economic stimulus plan, and this triggers persistent inflation. At the same time, U.S. losing monetary policies weaken the dollar and have huge debt, which has damaged the U.S. economy (Tu, 2011).

This paper employs the sub-sample rolling-window method proposed by Balcilar *et al*. (2010) to examine the relationship between RCP and NER under the PPP condition in China. The main result is that the nexus presents unstable over time and even shows deviations from the positive link. It is suitable as in the past few decades China experienced domestic economic restructures and global economic fluctuation such as exchange rate regime reforms in 2005:M07 and 2015:M08. The major policy implication that emerge from our study is that the government in China cannot use the PPP to determine the equilibrium exchange rate and the unbounded gains from arbitrage in traded goods are possible. In most time of the sample, the empirical findings do not support the PPP, which imply that Chinese economy is not integrated with U.S. Meanwhile, if the country experiences difference between home and foreign inflation rates, the PBOC cannot act accordingly to PPP to appreciate RMB against USD. Hence, these have important policy implication on cross-border agreement for international trade and investment with U.S. Besides goods and services markets, financial markets should also be pronounced in the future. If we intervene this process and to some extent that it requires even more political engagement, the prospects for cooperation along a variety of dimensions are good.

6. Conclusions

This paper reexamines the PPP condition between RCP and NER with rolling window method. Considering the structural changes in the full-sample period, the PPP condition does not hold in the short run. Therefore, we perform the bootstrap sub-sample rolling-window causality test and find RCP has impact on NER in 2008:M07-2008:M10 and

2014:M03-2014:M11. However, in most time of sample, the PPP does not hold. Deviations from the PPP meet the realties that China experiences economic transition and structural changes over the past decade. Some suggestions can be offered for China. First, the PBOC should continue to promote the internationalisation of the RMB, which lays the foundation for the PPP. Second, the PBOC should notice the structural changes from home and abroad that may result in deviating from the PPP. Last, the monetary policy should be made under specific economic situation and reduce the negative influence from deviations. Through above, the PPP cannot act a "stabilizer" in foreign exchange market in current economic environment.

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