A research on RMB exchange rate based on big mac index empirical analysis

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Abstract

Based on the Theory of Purchasing Power Parity (PPP), the Big Mac Index is widely used to measure whether a country's currency is at its "correct" level since it is easy to understand and clear and also is considered to be one of the important indices for evaluating a country's currency real exchange rate. This paper performed empirical study on the Big Mac index of Australia, Britain, Japan and Singapore by adopting regression analysis model. The test results show that the regression analysis results support the PPP theory, namely the big MAC index is an effective tool to determine exchange rate equilibrium. On this basis, this paper analyzed the RMB exchange rate level evaluated by Big Mac index, and considered that RMB exchange rate is a certain degree undervalued, and will be at a slowly rising trend consistently.

Keywords: Big Mac index, RMB exchange rate; theory of purchasing power parity

1 Introduction

1.1 BIG MAC INDEX PROPOSAL

Big Mac index is proposed by The Economist of Britain in Sept. 1986. Thereafter, the index is widely used to measure whether a country's currency is at its "correct" level in economics, and is considered as an important indicator to evaluate the national currency exchange rate level. The theoretical basis of Big Mac index is Theory of Purchasing Power Parity (Purchasing Power Parity, shortened form PPP) [1-4]. According to the theory, Big Mac index assumes that the same dollar has the same purchasing power in each country and then investigate the trading value of Big Mac. At McDonald's fast-food chain in more than 120 countries around the world, and compare them with the price of the Big Mac in the United States so as to evaluate whether the exchange rate of the currency of other countries is reasonable.

The reason why The Economist selects Big Mac is that along with the expansion of McDonald's chain stores in the world, the hamburgers are sold in most countries of the world. Since the production specification, process of Big MAC hamburger are consistent, and the price is determined by the responsible local McDonald's dealer [5], the index evaluation price of currencies has strong objectivity.

1.2 THEORETICAL BASIS OF BIG MAC INDEX-THEORY OF PURCHASING POWER PARITY

The Theory of Purchasing Power Parity (PPP) proposed by Gustav Cassel, a Swedish economist in the early 20th century, is one of the main theories to determine the exchange rate. The theory believes that the ratio of the purchasing power of currencies between the countries is the basis of exchange rate determination [6-9]. Therefore, from the long-term trend, the amount of monetary value between any two countries to buy the same set of goods or services cost will tend to be consistent. The exchange rate and currency exchange rate between the two countries namely will move in that direction, and eventually make the buyer pay the same price.

Therefore, according to the PPP theory, the big MAC index assumes that the prices of big MAC prices around the world are the same. Converse the big MAC price of each country into dollars by exchange rate conversion; you can compare the purchasing power level difference from country to country. The calculation method is that a country's Big MAC hamburger native currency price is divided by the Big MAC hamburger native currency price of the other country, and then compares the quotient and the actual exchange rate between the two countries. If the quotient is lower than the actual exchange rate, it means that the exchange rate of the former country is underevaluated; on the contrary, if is higher than the actual exchange rate, the exchange rate of the former country is overevaluated.

For example, if the selling price of a Big MAC in the United States is 3 USD, and 2 pounds in Britain, then the purchasing power parity exchange rate is 3/2=1.5. If the exchange rate for pound sterling into dollar is 1.65 (namely 1 pound can purchase 1.65USD), then according to Big Mac index, the exchange rate for pound sterling into dollar is overevaluated by 10% ((1.65-1.5)/1.5×100%). Another example, if the selling price of a Big MAC in China is 15RMB, then the purchasing power parity exchange rate is 15/3=5. If the exchange rate for RMB sterling into dollar is 6 (namely 1 USD can purchase 6RMB), then according to Big Mac index [10], the exchange rate for RMB sterling into dollar is underevaluated by 20%.

Of course, to measure the purchasing power level by using the Big MAC index has certain limitation, such as tax, business competition will have an effect on prices. However, because it is simple and easy to understand, since form its date of birth, Big MAC index has been widely used in academia, and has been considered as the main indexes to evaluate the exchange rate of each country at present.

2 Effectiveness analysis of big mac index reflecting market rate of exchange

Since from 1986, The Economist journal will issue a new big MAC index every year. The countries covered by it are increasing, from 15 in 1986 to 60 at present. It is worth noting that, among these countries, only Britain, Australia, Japan and Singapore have no great currency reform, and have been carrying on free exchange rate since from 1986 to now. Therefore, we performed regression analysis on the exchange rate and the big MAC index of the four countries separately to verify the effects of the big MAC on market exchange rates.

2.1 REGRESSION MODEL

$$A_t = \alpha P_{t-1} \quad (1)$$

Whereas in the Equation, A_t is the exchange rate of a country's currency at the t year. P_{t-1} is the big MAC index reduced the country's currency against the dollar at the year of t-1, α is the coefficient.

According to the above model, empirical tests on the 1986-2012 annual data of Britain, Australia, Japan, and Singapore are performed. The regression results are as follows.

TABLE 1 England

Regression Statistics	
Multiple R	0.994101
R Square	0.988237
Adjusted R Square	0.948237
Standard Error	0.067678
Observations	26

TABLE 1 England (continue)

ANOVA	df	SS	MS	F	Significance F
Regression	1	9.619827	9.619827	2100.285	7.01E-25
Residual	25	0.114506	0.00458		
Total	26	9.734333			

TABLE 1 England (continue)

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lagged PPP	0.868998	0.018962	45.82886	1.21E-25	0.829945	0.90805	0.829945	0.90805

TABLE 2 Australia

Regression Statistics	
Multiple R	0.981565
R Square	0.96347
Adjusted R Square	0.92347
Standard Error	0.270233
Observations	26

TABLE 2 Australia (continue)

ANOVA	*df*	*SS*	*MS*	*F*	*Significance F*
Regression	1	48.15149	48.15149	659.3734	5.77E-19
Residual	25	1.825653	0.073026		
Total	26	49.97714			

TABLE 2 Australia (continue)

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lagged PPP	1.269921	0.049455	25.67827	1.73E-19	1.168066	1.371776	1.16806625	1.371776

TABLE 3 Japan

Regression Statistics	
Multiple R	0.960403
R Square	0.922373
Adjusted R Square	0.882373
Standard Error	33.30151
Observations	26

TABLE 3 Japan (continue)

ANOVA	df	SS	MS	F	Significance F
Regression	1	329429.5	329429.5	297.0536	5.09E-15
Residual	25	27724.76	1108.99		
Total	26	357154.3			

TABLE 3 Japan (continue)

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lagged PPP	0.813093	0.047176	17.23524	2.19E-15	0.715932	0.910254	0.715932	0.910254

TABLE 4 Singapore

Regression Statistics	
Multiple R	0.984731
R Square	0.969695
Adjusted R Square	0.929695
Standard Error	0.292679
Observations	26

TABLE 4 Singapore (continue)

ANOVA	df	SS	MS	F	Significance F
Regression	1	68.5235	68.524	799.936	6.1E-20
Residual	25	2.14153	0.0857		
Total	26	70.66503			

TABLE 4 Singapore (continue)

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lagged PPP	1.238084	0.043775	28.283	1.7E-20	1.147928	1.328239	1.14793	1.3282

The empirical results of the four countries mentioned above are significant. The regression results support the Theory of Purchasing Power Parity. And at least 96% of the real exchange rate changes can be explained by the convert currency of the Big Mac index of the last year, namely, Theory of Purchasing Power Parity is the most important factor that affects the market exchange rate changes and market exchange rate will move to the big MAC index conversion rate. Therefore, from the point of the empirical test results, under the free exchange rate system, the big MAC index is still an effective tool to evaluate and decide market exchange rate.

3 Estimation of Big Mac index to China Yuan exchange rate

The big MAC index has included China to the index system since from 1992, and has published 21 years' data continuously until today. From the index, the RMB exchange rate has been underevaluated as shown below.

TABLE 5 Big Mac index of China

Year	Big MAC convert against the dollar	The exchange rate for RMB sterling into dollar	Overevaluated (+)/underevaluated (-) rate %
1992	2.88	5.44	-47.06
1993	3.73	5.68	-34.33
1994	3.91	8.7	-55.06
1995	3.88	8.54	-54.57
1996	4.07	8.35	-51.26
1997	4.01	8.33	-51.86
1998	3.87	8.28	-53.26
1999	4.07	8.28	-50.85
2000	3.94	8.28	-52.42
2001	3.9	8.28	-52.90
2002	4.22	8.28	-49.03
2003	3.65	8.28	-55.92
2004	3.59	8.28	-57.00
2005	3.43	8.28	-59.00
2006	3.39	8.03	-57.78
2007	3.42	7.77	-55.98
2008	3.50	6.83	-48.76
2009	3.50	6.83	-48.76
2010	3.54	6.78	-47.79
2011	3.60	6.45	-44.19
2012	3.67	6.32	-41.90

From Figure 1 we can see that, the underevaluated rate of exchange rate for RMB sterling into dollar has been fluctuating around 50% in recent 20 years. And it presents obvious rapidly rising trend after the exchange reform in 2007. For the exchange rate, 6.32 in 2012, it is still underevaluated about 42%. But since 2013, it continues to break through the record of RMB exchange rate revaluation, and close to 6.14 at present. According to the exchange rate big MAC index, the underevaluated rate of exchange rate for RMB sterling into dollar is about 40%.

We can see from the model analysis results, that under the free exchange rate system, Big Mac index is an effective

measures monetary exchange rate. Thus it has a certain reference value to reflect the RMB equilibrium exchange rate. From the issued data of Big Mac index, RMB exchange rate has been undervalued. It is still underevaluated about 40% to USD at present. At the same time, from the perspective of the other major currencies purchasing power of the big MAC index, RMB is underevaluated by 35.1% to pound, and by 44% to Euro, and by 18.4% to Japanese yen. And has different degrees of underevaluated to Rouble, Korean won, Singapore dollar, Australian dollar, Canadian dollar and other free exchange rate currency.

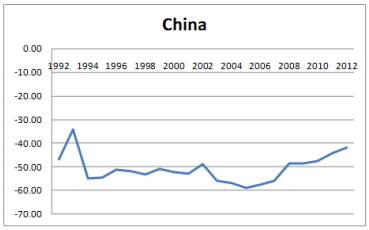

FIGURE 1 Underevaluated rate of exchange rate for RMB sterling into dollar

However, it is worth noting that a cheap Big MAC does not mean that the currency is seriously undervalued since the effectiveness of the theory of purchasing power parity (PPP) on market exchange rate has been controversial in academic circles. Meanwhile, the key factors of the exchange rate are very complex. A country's level of economic development, international status, such as labor costs will have an effect on its exchange rate. For example, the prices of commodities in developing countries are generally lower than that of developed countries since they have lower labor costs. In addition, the change of real exchange rate in the international market also depends on the change of currency supply and demands and a country's macroeconomic and financial policy adjustments. If introduce variables such as per capita GDP, inflation rate, the RMB equilibrium exchange rate into the model, the measured results will be different as well. It has certain limitations to use big MAC index to estimate the RMB real exchange rate.

4 Conclusions

Therefore, the author believes that the big MAC index is one of the more effective models under the condition of the free market to judge the exchange rate change trend. But it put too much emphasis on the influence of price on exchange rates. And it is only a kind of static analytical model. While the exchange rate of a country is under dynamic change. We should not only take Big Mac index to judge whether it is reasonable. Recently, the central bank continuously released the determination and signal to accelerate the RMB internationalization, marketization which further increased the appreciation of RMB. With the further deepening of China's exchange rate formation mechanism reform and maturing of RMB market exchange rate mechanism, the space of RMB exchange rate fluctuating will be bigger and bigger, the flexibility will be stronger and stronger, the RMB will further improve the international status, in the future it will also has certain appreciation of space, and gradually approaching the equilibrium level. It also requires regulatory vigilance on international speculative capital inflows to grasp the RMB appreciation, stable the exchange rate market, ensure that the RMB exchange rate appreciation and reach the equilibrium exchange rate stably, gradually and in a controlled manner.

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