

The Big Mac Index and the Valuation of the Chinese Currency

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Abstract

The Big Mac index has been used as one of the justifications for the claim that the Chinese currency, the Renminbi (RMB), is undervalued at the current exchange rate of 8.28 yuan to the dollar. This note intends to evaluate the Big Mac index as a guide for currency valuation and analyze the value of the RMB. Since the Big Mac index fails to account for the non-tradable component in its pricing, it is a misleading measure for currency valuation for countries whose income levels are lower than the benchmark currency countries. The RMB is being overvalued by the index since China's per capita income is significantly lower than that of the United States.

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In 1986 the Economist magazine began publishing a survey of prices of Big Macs in a number of countries as “a rough-and ready guide to whether a currency is under- or over-valued,” in the hope of making economic theory more digestible (Economist 1991). The survey started to cover China in 1992 (with 1996 as an exception). The survey has shown consistently that the RMB has been undervalued (See Table 1). In 2003, the Big Mac exchange rate between the RMB and the U.S. dollar was 3.65 yuan/dollar versus the actual exchange rate at 8.28 yuan/dollar, implying that the Chinese currency was undervalued by 56% against the dollar.¹ While the Big Mac index is only a “medium-rare guide to whether currencies are trading at the right exchange rates (Economist, 1986),” it has been regarded as “a pretty good indicator,” and has the added benefit of being a measure that “lay people can understand (Bender 2003).” Policy makers and business executives do use the index to support their recent claims that the Chinese currency is undervalued.

Table 1 Valuation of RMB Based on Big Mac Prices

Year	Prices RMB (Yuan)	Prices in dollars	Actual exchange rate	PPP Implied exchange rate	RMB under (-) / over(+) valuation %
1992	6.3	2.19	5.44	2.88	-47
1993	8.5	1.50	5.68	3.73	-34
1994	9.0	1.03	8.70	3.91	-55
1995	9.0	1.05	8.54	3.88	-55
1997	9.7	1.16	8.33	4.01	-52
1998	9.9	1.20	8.28	3.87	-53
1999	9.9	1.20	8.28	4.07	-51
2000	9.9	1.20	8.28	3.94	-52
2001	9.9	1.20	8.28	3.90	-53
2002	10.5	1.27	8.28	4.22	-49
2003	9.9	1.20	8.28	3.65	-56

Note:

Sources: *The Economist*, various issues

There was no data for China for the 1996 survey.

¹ One should note that the reference for the Big Mac index – the price of a Big Mac in the United States – varies significantly even within the United States. The 1989 Economist survey found that the price of a Big Mac varied much more in America than within other countries. The price (\$2.48) in Manhattan was about 23% higher than the average of four U.S. cities (\$2.02), or the average dollar in the four U.S. cities was undervalued by about 18.5% against the dollar in Manhattan.

How good is the Big Mac index as a guide for currency valuation? As the price of a Big Mac must cover not only the cost of ground meat and buns, which are supposed to be tradable, but also the cost of non-tradable local services such as labor, rent, and electricity, one has to dichotomize the ingredients in the analysis of the Big Mac index. The price of a Big Mac in the United States can be specified as follows:

$$P_{\$} = P_{T,\$} T_{US} + W_{\$} L_{US} \quad (1)$$

Where

- T: Ingredients that can be traded across countries.
- L: Labor and other local inputs required preparing and serving the Big Mac.
- $P_{T,\$}$: Prices of traded ingredients in the United States.
- $W_{\$}$: Cost of local inputs (mainly wages) in the United States.

Similarly, the price of a Big Mac in China is specified as

$$P_{RMB} = P_{T,RMB} T_{China} + W_{RMB} L_{China} \quad (2)$$

The Big Mac is presumably a homogeneous product across countries and it is sensible to assume that the tradable ingredients, T_{US} and T_{China} , are the same. For simplicity, we normalize them as 1. Labor inputs should represent the main portion of the non-tradable ingredients, L_{US} and L_{China} . Labor productivity in preparing and serving the Big Mac should not be much different in the United States and China. This assumption, while intuitively plausible, is also evidenced in Balassa (1964) and Samuelson (1964). In their reappraisal of the purchasing power parity doctrine, Balassa (1964) and Samuelson (1964) highlighted the importance of non-traded goods (services) in the relationship between prices and exchange rates. They assumed that the labor forces of poor countries are less productive than those of rich countries in the tradables sector but that international productivity differences in nontradeables are negligible. Given this assumption, we again normalize the non-tradable inputs for the Big Mac in both countries as 1. Thus equations (1) and (2) become

$$P_{\$} = P_{T,\$} + W_{\$} \quad (3)$$

$$P_{RMB} = P_{T,RMB} + W_{RMB} \quad (4)$$

The exchange rate (expressed as yuan to the dollar) based on Big Mac prices can then be expressed as:

$$E_{Big\ Mac} = \frac{P_{RMB}}{P_{\$}} = \frac{P_{T,RMB} + W_{RMB}}{P_{T,\$} + W_{\$}} \quad (5)$$

The first part of equation (5) is exactly how the Economist magazine formulates its “implied PPP of the dollar.” Following Balassa (1964), we argue that, in the absence of trade restrictions, the market (or actual) exchange rate equates the prices of traded goods, with allowance made for transportation costs. Thus,

$$P_{T,RMB} = E_T P_{T,\$} \quad (6)$$

Where E_T is the exchange rate (yuan/\$) that is determined in the traded goods market. Then Equation (5) becomes

$$E_{Big\ Mac} = E_T \frac{P_{T,\$} + (W_{RMB}/E_T)}{P_{T,\$} + W_{\$}} \quad (7)$$

Equation (7) yields an important comparison between the Big Mac implied exchange rate and the exchange rate determined by the traded goods market. The conformity between the two exchange rates hinges crucially on (1) the proportion of the cost of traded ingredients in the total dollar cost of the Big Mac, $P_{T,\$} / (P_{T,\$} + W_{\$})$, and (2) the difference between the wages rates (costs of nontradable ingredients) as measured in dollars, (W_{RMB}/E_T) as compared with $W_{\$}$. As the proportion of cost of the tradable ingredients approaches 1 (That is, all ingredients are tradable – no local services involved), the two exchange rates will converge. On the other hand, if all the ingredients are nontradable, the conformity of the two exchange rates depends entirely on the convergence of the wage rates (or costs of the nontradable ingredients) in the two countries. When the wage rates are equal, so are the two exchange rates. But as long as $(W_{RMB}/E_T) < W_{\$}$, we have

$$\frac{P_{T,\$} + (W_{RMB}/E)}{P_{T,\$} + W_{\$}} < 1 \quad (8)$$

And

$$E_{Big\ Mac} < E_T \quad (9)$$

That is, as long as the wage rates in China are lower than that in the United States, the Big Mac estimated exchange rate is smaller than the exchange rate determined in the goods market.

It is known to all that China, despite its rapid economic growth in the past two decades, its per capita income is still among the lowest in the world. According to the World Bank, per capita income in the United States in 2002 was \$35,060 while that for China was \$940. That is, the U.S. per capita income was 37.3 times as much as that of China. Even based on the World Bank's estimate of China's PPP adjusted per capita income - \$4,390 in 2002, the U.S. per capita income is still about 8 times as high as that for China. Table 2 presents the quarterly and hourly wage rates for workers employed in different types of enterprises in China. The average hourly wage in the first quarter of 2003 was only \$.77 for Chinese workers. One should note that the rural workers (farmers) – the majority of China's population - cannot even earn that rate on average. For comparison, the average hourly wages were \$15.46 in October 2003, about 20 times that for Chinese workers.²

² The average hourly wages for the private sector in the United States is obtained from the U.S. Department of Labor, The Employment Situation: October 2003, available at <http://www.bls.gov/news.release/empisit.nr0.htm> (accessed November 9, 2003).

According to McDonald's 2002 financial report, tradable ingredients (food and paper) were about 25% of total sales.³ That is, out of the average price of \$2.71 for a Big Mac in the United States in 2003, about \$0.69 represented tradable ingredients and \$2.02 for non-tradable ingredients. Assume that the tradable ingredients in China cost the same but the non-tradable ingredients were a quarter of the U.S. costs, not an unreasonable assumption as discussed above, then the Big Mac should have sold for \$1.19! This estimate is strikingly close to the Economist survey price - \$1.20 in China.

Table 2 Workers' Compensation in China: First Quarter 2003

Type of Enterprises	Number of People Employed		Average Compensation		
			Quarterly		Hourly
	000	%	in Yuan	In USD	In USD
Total	108,343	100.00%	3,139.00	379.11	0.73
State-owned Enterprises	70,702	65.26%	3,243.00	391.67	0.75
Township Enterprises	10,884	10.05%	1,883.00	227.42	0.44
Other	26,757	24.70%	3,379.00	408.09	0.78

Notes:

Other enterprises include joint ventures with foreign enterprises and large privately owned enterprises. Hourly compensation is based on 40 hour/week and 13 weeks in the quarter. The prevailing exchange rate of 8.28 yuan/USD is used for conversion.

Source:

National Bureau of Statistics of China, Compensation for Employees in Urban Areas, <http://www.stats.gov.cn/tjsj/jdsj/1200305070150.htm>. Accessed June 11, 2003.

The conclusion that low per capita income countries' currencies tend to be undervalued based on purchasing power parity (PPP) has been well documented in the academic literature. Balassa (1964) points out that, since services (non-tradable) enter the calculation of purchasing power parities but do not directly affect exchange rate, the purchasing power parity based exchange rate, measured as currency units for the low wage country per unit of the currency for high wage country, will be lower than the equilibrium rate of exchange. Balassa points out further that the greater are productivity differentials in the production of traded goods between two countries, the larger will be the differences in wages and in the prices of services and, correspondingly, the greater will be the gap between purchasing power parity and the equilibrium exchange rate. Instead of relying on the differential productivity postulate, Bhagwati (1984) and Kravis and Lipsey (1983) resort to differences in endowments of capital and labor to explain the lower price levels of poor countries and the undervaluation of currencies for these countries.

³ McDonald's 2002 Financial Report, available at <http://www.mcdonalds.com/corporate/investor/financialinfo/investorpub/financial/page16/ada1/index.html>. Accessed November 21, 2003.

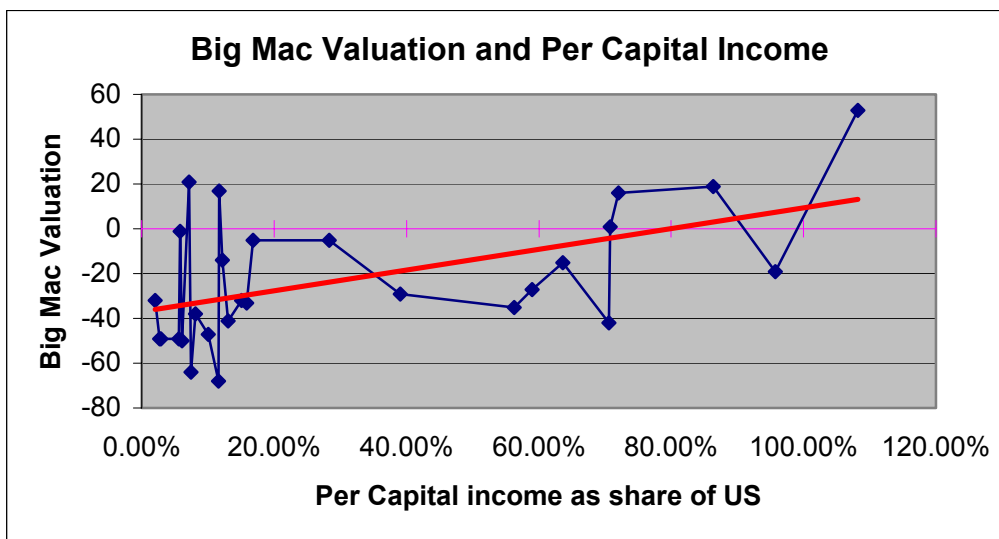
Table 3 Big Mac Valuation and Per Capita Income - 2002

2002	Local currency units	Prices in local currency	Prices in dollars	Actual exchange rate 4/23/02	Implied PPP of the dollar	Local currency under (-) /over(+) valuation, %	GNP per Capita \$ (2002)	PPP GNP per Capita \$ (2002)	GNP per capita as compared with US	PPP GNP per capita as compared with US
United States	\$	2.49	2.49	-	-	-	35,060	35,060	1.00	1.00
Argentina	Peso	2.50	0.78	3.13	1.00	-68	4,060	9,930	0.12	0.28
South Africa	Rand	9.70	0.87	3.90	10.90	-64	2,600	9,870	0.07	0.28
Russia	Ruble	39.00	1.25	31.20	15.70	-50	2,140	7,820	0.06	0.22
China	Yuan	10.50	1.27	8.28	4.22	-49	940	4,390	0.03	0.13
Philippines	Peso	65.00	1.28	26.10	51.00	-49	1,020	4,280	0.03	0.12
Thailand	Baht	55.00	1.27	43.30	22.10	-49	1,980	6,680	0.06	0.19
Malaysia	M\$	5.04	1.33	2.02	3.80	-47	3,540	8,280	0.10	0.24
Hong Kong	HK\$	11.20	1.40	4.50	7.80	-42	24,750	26,810	0.71	0.76
Poland	Zloty	5.90	1.46	2.37	4.04	-41	4,570	10,130	0.13	0.29
Brazil	Real	3.60	1.55	1.45	2.34	-38	2,850	7,250	0.08	0.21
Australia	A\$	3.00	1.62	1.20	1.86	-35	19,740	26,960	0.56	0.77
Czech Rep	Koruna	56.28	1.66	22.60	34.00	-33	5,560	14,500	0.16	0.41
Hungary	Forint	459	1.69	184.00	272.00	-32	5,280	12,810	0.15	0.37
Indonesia	Rupiah	16,000	1.71	6426	9430	-32	710	2,990	0.02	0.09
New Zealand	NZ\$	3.95	1.77	1.59	2.24	-29	13,710	20,020	0.39	0.57
Singapore	S\$	3.30	1.81	1.33	1.82	-27	20,690	23,090	0.59	0.66
Japan	Yen	262.00	2.01	130.00	105.00	-19	33,550	26,070	0.96	0.74
Canada	C\$	3.33	2.12	1.34	1.57	-15	22,300	28,070	0.64	0.80
Chile	Peso	1,400	2.16	562.00	655.00	-14	4,260	9,180	0.12	0.26
Mexico	Peso	21.90	2.37	8.80	9.28	-5	5,910	8,540	0.17	0.24
S. Korea	Won	3,100	2.36	1304	1245	-5	9,930	16,480	0.28	0.47
Peru	New Sol	8.50	2.48	3.41	3.43	-1	2,050	4,800	0.06	0.14
Sweden	SKr	26.00	2.52	10.40	10.30	1	24,820	25,080	0.71	0.72
Britain	Pound	1.99	2.88	1.25	1.45	16	25,250	25,870	0.72	0.74
Venezuela	Bolivar	2,500	2.92	1004	857	17	4,090	5,080	0.12	0.14
Denmark	DKr	24.75	2.96	9.94	8.38	19	30,290	29,450	0.86	0.84
Turkey	Lira	4,000,000	3.06	1606426	1324500	21	2,500	6,120	0.07	0.17
Switzerland	SFr	6.30	3.81	2.53	1.66	53	37,930	31,250	1.08	0.89

Sources: Big Mac prices and valuation from *The Economist* (2002); Per capita GNP data from World Bank, *World Development Report*, 2003.

The relationship between wages/price levels and currency valuation is evident in the Big Mac prices and currency valuations based on these prices. Table 3 presents the Big Mac valuation data from the Economist survey for 2002 and data for per capita income. The correlation between the Big Mac valuation against the U.S. dollar and the normalized income level using the U.S. per capita income as the benchmark is positive (0.5248) and statistically significant.⁴ This relationship is plotted in Figure 1.

Figure 1 Correlation between Per Capita Income and Big Mac Valuation



Based on our analysis of the Big Mac standard, we conclude that, given that labor cost is lower in China than in the United States, PPP implied value of the dollar as measured in the Chinese currency should be less than the exchange rate determined by the traded goods market. In other words, the PPP implied value of the RMB should be higher than the value of the RMB determined in the traded goods market. To generalize, the exchange rates for currencies of low-income countries tend to be undervalued based on PPP standards. Or PPP standards tend to overestimate the value of currencies of low-income countries.

Given that China’s labor cost and rental are significantly lower than that of the United States, the relatively lower price of Big Mac in China and hence the derived under-valuation should not be a surprise. The under-valuation of the RMB or the overvaluation of the U.S. dollar, as judged by the Big Mac standard, is a natural result of the non-tradable nature of the product and the wages differences in the two countries. Samuelson (1964) pointed out about four decades ago that professors, “particularly cultured ones, are particularly prone to infer an overvaluation of the dollar by the cheapness abroad of personal services (maids, tenors, and Doctors of Philosophy).” By this reasoning, every prosperous region has a chronically overvalued currency. He illustrated the non-tradable nature of services by saying that, patently, he could not import cheap Italian haircuts, nor could Niagara-Falls honeymoons be exported. By the same token, American workers would not go to China in 2003 to buy Big Mac hamburgers for lunch, even though the Big Mac hamburger costs less than that of the United States in 2003.

⁴ Based on the PPP GNP per capita, this correlation is 0.4031, still positive and statistically significant. This smaller correlation is expected when the income levels are adjusted with PPP.

Thus, currency valuations based on such measures should not be taken as the basis for exchange rate policy recommendations. However, the RMB should revalue if the gap in productivity and labor compensation between the two countries narrows over time.

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