CESifo Working Papers
www.cesifo.org/wp

Exchange Rate Misalignment – The Case of the Chinese Renminbi

Yin-Wong Cheung

CESIFO WORKING PAPER NO. 3797
CATEGORY 7: MONETARY POLICY AND INTERNATIONAL FINANCE
APRIL 2012

CESifo *Working Paper No. 3797*

Exchange Rate Misalignment – The Case of the Chinese Renminbi

Abstract

Assessing exchange rate misalignment is not an easy task. With reference to the debate on the value of China's currency, the renminbi (RMB), this article highlights a few challenges in properly assessing the extent of currency misalignment. The results derived from the fundamental equilibrium exchange rate (FEER) approach and the Penn effect regression are used to illustrate the sensitivity of misalignment estimate to assumptions of the key parameters in a given model, sampling uncertainty, serial correlation adjustment, and data revision. It is shown that both the sign and the magnitude of a misalignment estimate could be dramatically affected by these factors.

JEL-Code: F310, F410.

Keywords: FEER, Penn effect, sampling uncertainty, serial correlation, data revision.

Yin-Wong Cheung
Department of Economics
University of California
USA – Santa Cruz, CA 95064
Cheung@ucsc.edu

The article is prepared for *The Handbook of Exchange Rates*, edited by Jessica James, Ian W. Marsh and Lucio Sarno. It draws on joint work conducted with Menzie Chinn and Eiji Fujii. Eiji kindly provided most of the figures.

1. Introduction

Exchange rates are a key macroeconomic price in international economics. And, exchange rate misalignment is perceived to be the culprit of both domestic and global economic ills including inflationary pressures, trade imbalances, and misallocation of resources within an economy and across trading partners (Hinkle and Montiel, 1999). Since the 1970s, the debate on currency valuation and misalignment has recurred several times and has involved different currencies. The recent contentious debate on the Chinese currency valuation vividly exemplifies the complexity of assessing the extent of misalignment.

During the 2000s, the meteoric rise in China's trade surpluses has put its foreign exchange policy under close scrutiny. One common view is that China has intentionally depressed the value of its currency, the renminbi (RMB), to gain unfair advantages in the global market. As a result, China has built up huge trade surpluses in the 2000s. In addition to global imbalances, the RMB misalignment induces chronic inflationary pressure on the Chinese economy. There are repeated calls from the international community urging China to ease global imbalances by revaluing its currency.

In the subsequent sections, the recent debate about the RMB valuation is used to illustrate the difficulty of determining the degree of misalignment. The theme is not to argue whether the RMB is overvalued or undervalued. Instead, the theme is to highlight a few selected factors that could make assessing the exact level of misalignment difficult.

To assess the RMB misalignment, we have to determine whether the RMB is misaligned or not and, if so, by how much. The assessment has to overcome some theoretical and empirical hurdles. First, standard results in exchange rate economics suggest that it is quite difficult to determine the right, or in economic jargon the equilibrium, exchange rate. Since misalignment is

a measure of deviation from the equilibrium exchange rate, an inability to pin down the equilibrium rate implies that it is hard to exactly evaluate the related misalignment.

Even if a theoretical specification is chosen to model the equilibrium exchange rate, the ability to infer the actual level of misalignment is hindered by some practical statistical considerations. For instance, alternative ways to make the theoretical framework operational could lead to different misalignment estimates. The preciseness of the misalignment is also affected by the usual statistical caveats including sampling uncertainty, serial correlation, and estimation robustness. Indeed, as illustrated in the subsequent sections, empirical estimates of the RMB misalignment could spread across a wide range.

The next section outlines the background of the RMB valuation debate. Section 3 uses the RMB case to illustrate the complexity of evaluating exchange rate misalignment. Specifically, the fundamental equilibrium exchange rate (FEER) approach and the Penn effect regression are used to illustrate the sensitivity to assumptions of the key parameters in a given model, sampling uncertainty, serial correlation adjustment, and data revision. Some concluding remarks are offered in Section 4.

2. Background

Over the past three decades, China has been one of the fastest growing countries in the world. A few years into the 21st century, the world has no doubt that China is a prominent trading country, a popular foreign direction investment destination, and a major manufacturing center in the global economy.

The RMB valuation received scant attention for most of the modern China's history. Since 1993, China has maintained a stable exchange rate against the US dollar. Its ballooning

trade surplus and level of international reserves have put China's *de facto* peg policy in the limelight. Questions have recently been raised as to whether China's foreign exchange policy has led to an undervalued currency that gives Chinese exporters an unfair advantage over their competitors. The valuation of RMB has become the center of economic and political rows between China and its trading partners.

For instance, the 2010 IMF Article IV Consultation Staff Report (IMF, 2010) assesses that the RMB "remains substantially below the level that is consistent with medium-term fundamentals." However, the Chinese authorities offered alternative interpretations of evidence that the Staff used to draw the undervaluation assessment. The Staff assessment was also not agreed by several Directors of the IMF Executive Board (IMF, 2010). Further, as recent as October 2011, the US Senate passed a bill which was interpreted as a possible legislation against the "undervalued" RMB. Indeed, some US officials hold the view that, by holding down the value of the RMB, China directly or indirectly triggered the 2007-8 global financial crisis and prevented a proper global rebalancing after the crisis.

Given its growing economic prowess, the extent of RMB misalignment and its implications are of great relevance to policy makers and financial institutions. For economists, the RMB is undervalued when it can be exchanged for a lower amount of, say, the US dollar than what economic fundamentals indicate it should be worth. Before we can define the level of misalignment, the overarching issue is how to define, in economic jargon, the equilibrium value of the RMB. A related question on the link between misalignment and the trade balance will be briefly commented on in the next section.

In exchange rate economics, there is very limited consensus on which is the right exchange rate model. Further, different models might be relevant for economies with different

economic structures and over different time horizons. China has undergone rapid structural changes, transitioning from central planning to greater market orientation over the last couple of decades. Even now China can be characterized as a hybrid economy, with strong elements of both 'planned' and 'market' systems. Though it is an integral part of a financially globalized world, China still retains a wide array of capital controls.

The well-known Dornbusch overshooting model is a useful setting to expound the role of time horizon in interpreting an exchange rate trajectory. Under the overshooting framework, the exchange rate in the short run can be different from its long-run equilibrium value and, at the same time, is consistent with market fundamentals. That is, the equilibrium path of the exchange rate can deviate from its long run value in the short run, and observed misalignment does not necessarily imply a dis-equilibrium scenario. These special attributes and considerations heighten concerns regarding the appropriate model for determining RMB's equilibrium value.

In the absence of a consensual exchange rate model, we should interpret any currency misalignment estimates with great care. Undervaluation, overvaluation, or currency misalignment in general could be in the eye of the beholder. Whether there is misalignment or not depends upon which economic model or what time horizon one has in mind. In addition to theoretical considerations, the complexity of valuing the RMB is compounded by the usual difficulties affecting empirical exercises. Some of these difficulties are discussed in the context of RMB valuation in the next section.

3. Undervalued or Overvalued

The inability of structural macro and time series models to explain exchange rate movements is well documented by Meese and Rogoff (1983). Their result that these models

cannot out-perform a naive random-walk specification has proven robust. For many years researchers have found it difficult to reject the hypothesis that major country exchange rates follow a random walk under floating exchange rate regimes; see, for example, Meese and Rogoff (1983), Rogoff (1996) and, Cheung *et al*., (2005). An implication of this finding is that the prospect of having a commonly agreed framework to assess exchange rate misalignment is pretty unpromising.

3.1 The FEER Misalignment Estimate

There is no shortage of RMB misalignment estimates, which vary considerably from one study to the other. Table 1 updates the list of recent estimates of the degree of RMB misalignment in Cheung *et al*. (2010a). One striking observation is the dispersion of these misalignment estimates, ranging from a 44 per cent undervaluation to an over 100 per cent overvaluation.

Table 1. Some Recent RMB Misalignment Estimates

Estimate	As of	Source
+49%	July, 2011	The Economist (2011), Big Mac Index
+33%;	March 2009	Cline and Willamson (2010), FEER
+31%*	2005	Subramanian (2010), Penn Effect
+21%**	end of 2008	Goldstein and Lardy (2009), External Balance
+17.5 **	2009	Wang and Hu (2010), FEER, external balance
+10%	2010Q1	Tenengauzer (2010), external balance
+2.56%	2009Q4	Stupnytska *et al.* (2009), BEER
-5%	2008	CCF (2010a)

-13.4%	2008Q4	Hu and Chen (2010), FEER
-16.8%	September 2009	CCF(2010a), relative PPP, real US exchange rate
-36%	December 2009	CCF(2010a), real PPP, trade-weighted exchange rate
- (>)100%		Schnatz (2011), FEER

Undervaluation (+), overvaluation (-)

* the average of estimates from adjusted data.

** the average of estimates

The differences in the estimates come not only from different model specifications but also from models with similar theoretical underpinnings. Even if we drop the extreme overvaluation cases, the remaining estimates are still spread over a rather wide range. These vastly different estimates allow individuals to pick and select the one that is consistent with their own agenda. Most studies, surprisingly, did not explicitly address the notorious difficulty of determining the extent of RMB undervaluation.

These estimates were obtained from typical theoretical frameworks including relative purchasing power parity, the Penn effect, the behavioral equilibrium exchange rate model, the FEER approach, and the macroeconomic balance effect approach. Cheung, Chinn and Fujii (2010b), for instance, offer some discussions and comments on these approaches while Cenedese and Stolper (forthcoming) present an extensive review of the equilibrium exchange rate models that are commonly used to assess exchange rate misalignment.

Conceivably, it is not unreasonable to expect different estimates from different theoretical settings. It is quite perplexing, however, to obtain different misalignment estimates from models that have a similar theoretical underpinning. We use the FEER approach, which is quite

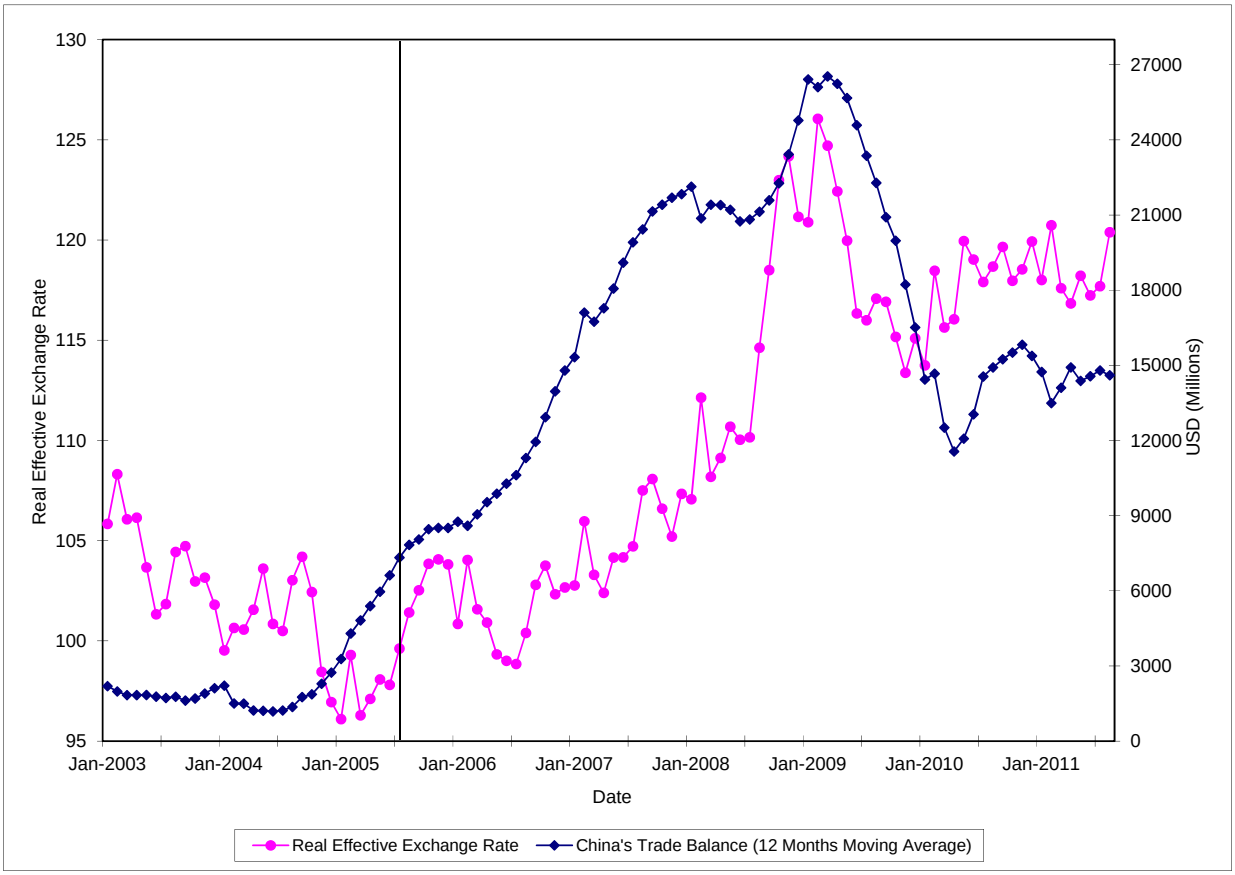
commonly referred to in discussions on exchange rate misalignments in emerging economies including China to illustrate the sensitivity of misalignment estimation. It is noted that the FEER approach is quite closely related to other fundamental or fair value models including the macroeconomic balance effect approach.

Schnatz (2011) succinctly illustrates the limitations and sensitivity of the FEER framework. The FEER approach postulates that current account balance could be non-zero in the medium-term. The determination of the equilibrium exchange rate involves a two-step procedure. First, the "normal" current account balance is identified. The norm could be determined on a judgmental basis that depends on researchers' priors or via an empirical approach. In the second stage, trade elasticities are used to back out the "equilibrium" exchange rate that would generate the normal current account balance. Thus, the FEER equilibrium exchange rate depends on, among other things, the values assigned to the current account norm and the trade elasticities.

What is China's current account norm? Sieving through the literature, the value could range from a low of a 2.8% of GDP deficit (Williamson and Mahar, 1998) to a high of a 8.4% surplus (Medina *et al*., 2010). The norm of 8.4% is a projected value for 2014 (Medina *et al*., 2010, Table 4). A large norm is usually driven by data from the post-2000 period during which China experienced substantial current account surpluses. The extent of RMB undervaluation is inversely related to the size of China's current account norm, *ceteris paribus*; see, for example, Wang and Hu (2010). It is noted that China's current balance surplus was 5.23% in 2009 and 5.19% in 2010. If the norm is assumed to be near or at the high end of 8.4%, then the RMB is likely to be *overvalued* or, at least, the case for undervaluation is very weak! Apparently, this possibility is not well articulated in, say, the media coverage.

The estimation of China's trade behavior presents a quite formidable empirical task. In general, Chinese export and import price elasticities are not very precisely and robustly estimated. These estimates tend to be quite sensitive to the inclusion of time trends and control variables in the regressions.[1]

Figure 1. China's real effective exchange rate and trade balance



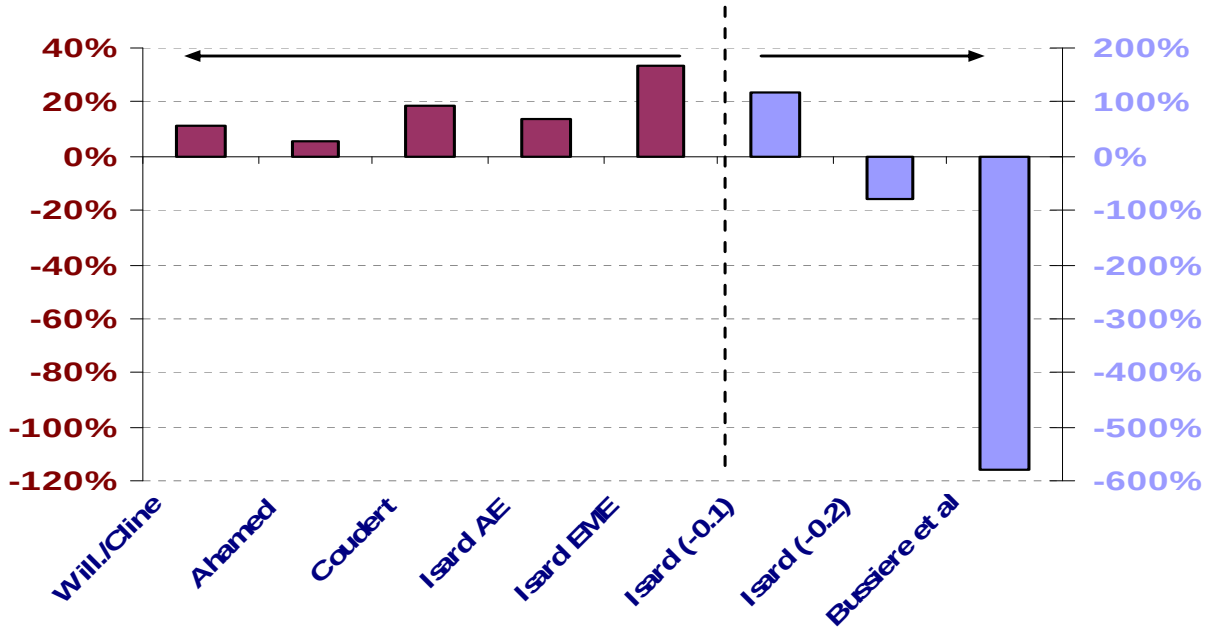
A problematic phenomenon is that some of these estimates do not satisfy the Marshall-Lerner condition and, for these cases, an increase in trade surplus can follow a RMB appreciation. Such a possibility is illustrated by Figure 1 which plots China's real effective

[1] See, for example, Ahmed (2009), Aziz and Li (2008), Kwack *et al.* (2007), Thorbecke and Zhang (2009), Mann and Plück (2007), and Marquez and Schindler (2007). Some earlier studies are reviewed in Cheung, *et al.* (2010c).

exchange rate (an increase implies appreciation) and trade balance. It is quite apparent that the RMB exchange rate moves with China's trade surplus in a "procyclical" manner – specifically, the RMB appreciation after the 2005 policy change was met with an increase in the trade surplus.

Figure 2, which is adopted from Schnatz (2011), depicts the dramatic change in the misalignment estimate across different China's trade elasticity estimates found in the literature. The RMB misalignment estimate could go from an undervaluation of 40% to an overvaluation of over 500%! While the extreme overvaluation estimate is implausible, the exercise vividly illustrates the fragility of the exchange rate misalignment estimation. Either the magnitude or the sign of misalignment estimate crucially depend on the assumed values of the current account norm and trade elasticities.

Figure 2. FEER sensitivity to changes in the trade elasticities (Schnatz, 2011)



Undervaluation (+), overvaluation (-)

The variability of the FEER misalignment estimate is also documented by, say, Dunaway, Leigh and Li (2009), Hu and Chen (2010) and Wang and Hu (2010). These studies demonstrates that equilibrium RMB real exchange rate estimates exhibit substantial variations in response to small perturbations in model specifications, explanatory variable definitions, and sample periods. In other words, inferences regarding currency misalignment could be very sensitive to small changes in the way the equilibrium exchange rate is estimated.

3.2 The Penn Effect Regression

In this subsection, results from the Penn effect regression are used to illustrate the implications of sampling uncertainty, serial correlation adjustment, and data revision. The basic Penn effect regression equation is given by

$$r_i = \beta_0 + \beta_1 y_i + u_i \qquad (1)$$

where r_i and y_i are, respectively, country *i*'s national price level and real *per capita* income in logs and relative to the corresponding US variables. The national price level indeed is the reciprocal of the PPP-based real exchange rate - an increase in r_i means an appreciation of the currency.[2] Henceforth, we call r_i the real exchange rate for brevity.

The Penn effect is based on the acute observation that price levels vary with income levels. That is, a high income country tends to have a high real exchange rate. The empirically robust positive association between national price levels and real per capita incomes is

---

[2] The term national price level is potentially confusing for those who are not familiar with the Penn effect regression using PPP-based data. In this context, the national price level is in fact a relative price with the US price level as the reference and, thus, is equivalent to the inverse of the real exchange rate.

documented by a series of Penn studies (Samuelson, 1994; Kravis and Lipsey; 1983, 1987; Kravis, et al., 1978; Summers and Heston, 1991). In passing, we note that, after taking income levels into consideration, the so-called Big Mac Index approach will suggest the RMB was 3% overvalued in July 2011 instead of 44% undervalued as stated in Table 1 (The Economist, 2011).

The Penn effect framework has been adopted in the recent debate on RMB misalignment (Frankel, 2006; Cheung, *et al.*, 2007; Coudert and Couharde, 2007). The inference of currency misalignment based on equation (1) hinges upon the robust positive Penn effect and the implicit assumption that real exchange rates may be overvalued or undervalued, but they are at the equilibrium level on average. Specifically, for a given currency, the empirical degree of misalignment is given by its estimated residual from (1). To ensure data compatibility, the empirical analysis is typically conducted with PPP-based real exchange rates and GDP measures.

Using the PPP-based data from the *World Development Indicators* downloaded in 2006, Cheung, *et al.* (2007) reported the panel regression result

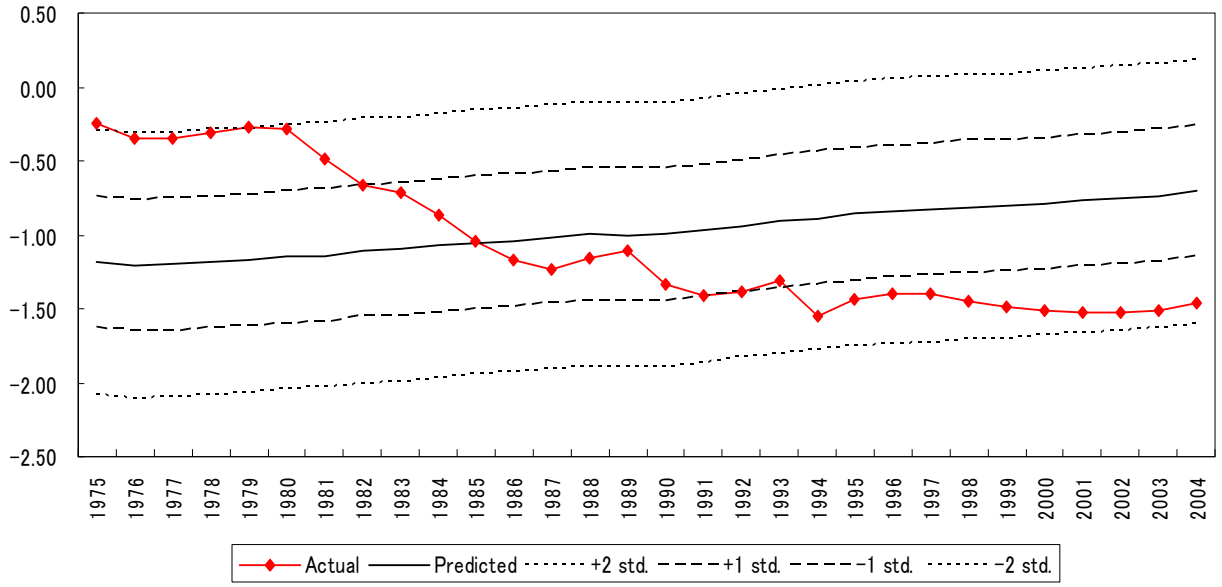
$$r_i = -0.134 + 0.299 y_i + \hat{u}_i; \qquad (2)$$

the coefficient estimates are statistically significant. The pooled least squares result is based on data from 160 countries for the period 1975 to 2004. The estimated level of undervaluation for China in 2004 is a stunning 53.3%.

In general, the magnitudes of undervaluation estimates reported here and in the subsequent discussion are quite robust to various sensitivity tests, which include a) grouping countries according to their stages of development, income levels, and geographical locations, b) splitting the sample into two subsample periods 1975-1989 and 1990-2004, and c) allowing for the effects of various combinations of control variables such as demographics, government policy, financial development, corruption, capital controls, and trade balances.

To what extent we could treat the estimated level as the actual level of the RBM undervaluation? Are the data informative enough for conducting a definite statistical inference? Figure 3 traces out the Chinese currency's time path, its equilibrium values estimated from the Penn effect regression, and the associated standard error bands. The standard error bands are the usual statistical device to capture sampling uncertainty associated with an estimator and are indicative of the possible range in which the true value of the variable of interest could be found.

Figure 3. Actual and predicted RMB values, the 2006 vintage data



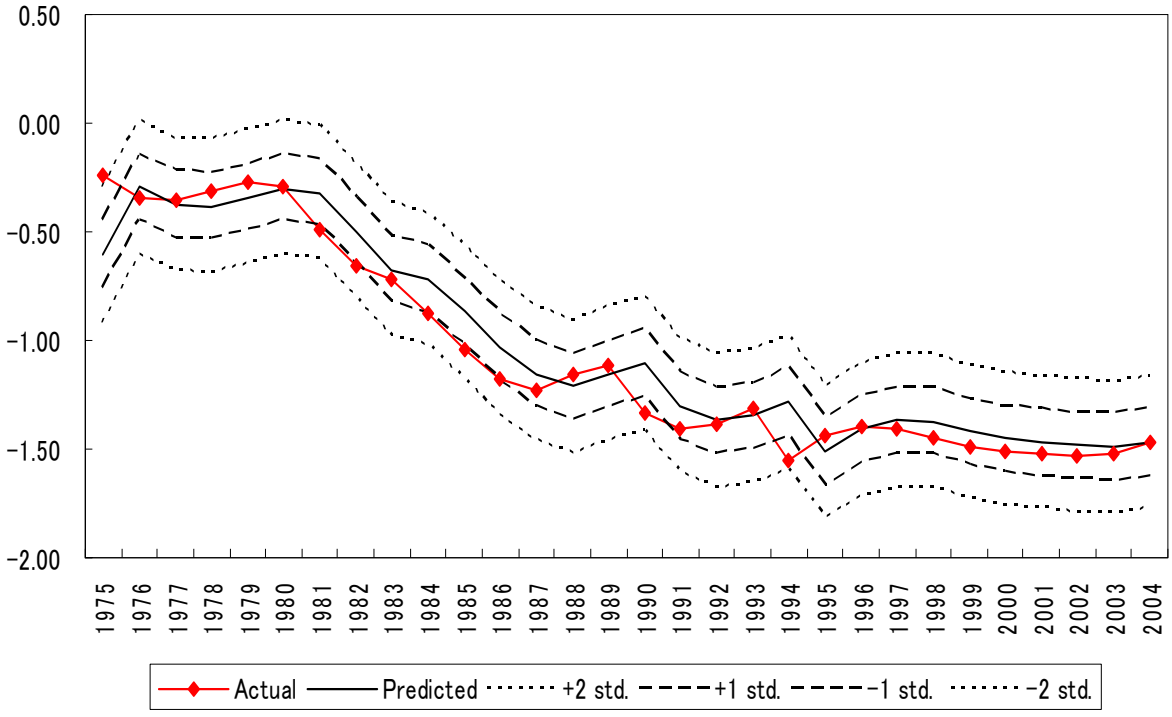
According to the point estimates, the RMB started its devaluation trend in the mid-1980s. Nevertheless, the actual RMB rate is always within the two standard errors band. That is, if we apply the usual statistical inference approach, the Chinese currency's level of undervaluation is not statistically significantly different from zero. Another way to interpret the result is that the data are not sufficiently informative to tell the predicted and the actual exchange rate values apart.

In regression analysis, the presence of serial correlation could affect both the estimation and inference results. Indeed, the adjustment for serial correlation in regression analysis is a common and relevant practice. It turns out that the estimated residuals in (2) display substantial serial correlation. Using the Prais-Winsten method to control for serial correlation, the estimated regression becomes

$$r_i = -0.026 + 0.147\, y_i + \hat{u}_i; \qquad (3)$$

the two coefficient estimates are again statistically significant though the Penn effect as given by the slope coefficient is weaker. The implication of controlling for serial correlation is illustrated by Figure 4. The predicted RMB values and their standard errors bands are based on the Penn effect regression using the Prais-Winsten method.

Figure 4. Actual and predicted RMB values, the 2006 vintage data (Prais-Winsten)



The impact of serial correlation adjustment on the current misalignment analysis is non-trivial. The standard errors bands in Figure 4 are, as expected, noticeably narrower than those in Figure 3. A striking result is that, in 2004, the RMB is not undervalued but is 0.2% overvalued. Even though the misalignment estimate is again not statistically significant, the sheer shift in the magnitude and the direction of the estimate itself should make us re-assess our ability to precisely estimate the degree of misalignment.

3.3 Data Revision

The reliability of Chinese data has been a subject of concern among academic researchers; especially applied researchers. Instead of questioning the quality of official Chinese data, we consider an instance of data revision initiated by a World Bank project. The PPP-based data used to generate results presented in the previous subsection were based on price information obtained from the 1993 International Comparison Program benchmark. In 2008, the World Bank, in cooperation with the Asian Development Bank, reported new estimates of output and price level data measured in PPP terms, which are based on new benchmark data on prices generated by the 2005 International Comparison Project (Asian Development Bank, 2007; International Comparison Program, 2007; World Bank, 2008a, b). These data are believed to be more accurate than those previously available.

These new PPP-based data are quite different from the corresponding ones in the previous version. An often cited example is that the 2005 China's PPP-based *per capita* GDP is 39% smaller than previously estimated. Some countries, indeed, have their 2005 *per capita* GDPs revised up or down by 50% or more (World Bank, 2008c). What is the implication of these drastic data revisions for assessing currency misalignment?

The result of fitting (1) using the updated data is given by

$$r_i = -0.295 + 0.174 y_i + \hat{u}_i . \qquad (4)$$

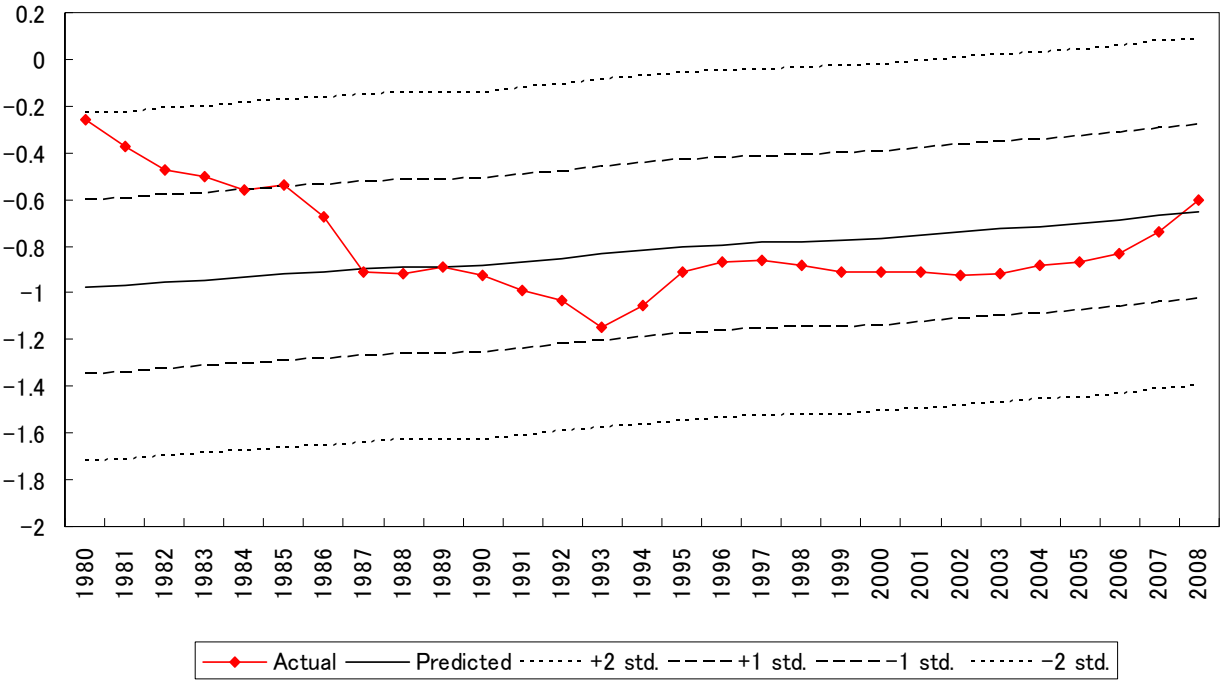
The updated data on 176 countries for 1980-2008 were downloaded from the World Development Indicator dataset in 2010. Using the Prais-Winsten method to account for serial correlation, the result is modified to

$$r_i = -0.018 + 0.160 y_i + \hat{u}_i . \qquad (5)$$

The coefficient estimates in (4) and (5) are all statistically significant.

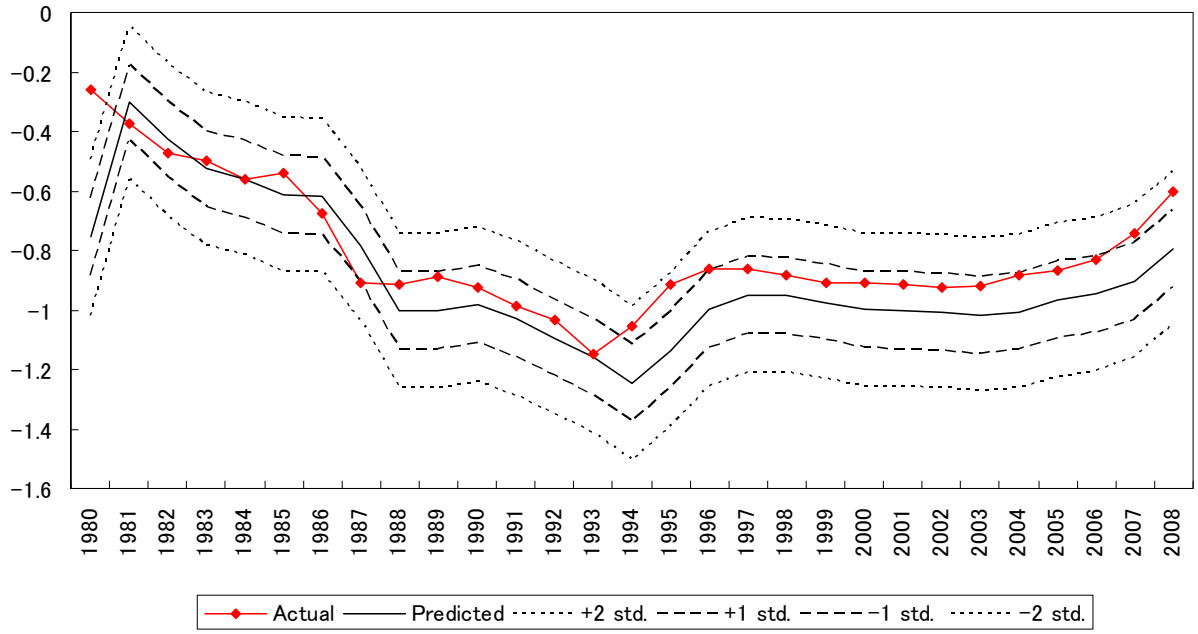
Apparently, the empirical Penn effect survives the data revision and, indeed, the magnitudes of the Penn effect are comparable to those derived from the previous data set. While the robustness of the Penn effect is asserted, the same cannot be said for misalignment estimates.

Figure 5. Actual and predicted RMB values, the 2010 vintage data



Figures 5 and 6 plot the time path of the Chinese currency, its estimated equilibrium values based on (4) and (5), and their standard error bands. Note that in these two Figures, the PPP-based real RMB exchange rate is the one from the updated dataset and is quite different from the "old" one depicted in Figures 3 and 4.

Figure 6. Actual and predicted RMB values, the 2010 vintage data (Prais-Winsten)



The implication of the data revision for the RMB misalignment debate is quite apparent. The sample uncertainty associated with equilibrium exchange rate estimates is similar to the one observed in previous cases. The magnitude of misalignment estimates, however, changes in a discernable manner. Before adjusting for serial correlation, the 2004 estimate is reduced to a

15.32% undervaluation from the previously estimated 53.3%. By 2008, the revised data indicate that the RMB is overvalued!

After controlling for serial correlation, the RMB is estimated to be 13.26% overvalued in 2004. Indeed, the RMB is overvalued during most of the sample period in Figure 6. The previous finding of substantial misalignment is not robust to the data revision following the 2005 International Comparison Project. The use of updated data alters not just the magnitude of the misalignment estimate but also the direction of misalignment.

4. Concluding Remarks

The current study draws on the seemingly unending debate on the value of the RMB to illustrate a few difficulties affecting a typical exchange rate misalignment assessment exercise. The debate on exchange rate misalignment has recurred, albeit with varying degrees of intensity, in the international community over the last few decades. To what extent could the debate be grounded in firm economic theory? Standard results in exchange rate economics do not offer a consensual model to determine the equilibrium exchange rate. Without a commonly agreed upon model, it is hard to assess the extent of exchange rate misalignment. The RMB case is of no exception.

Our discussion focuses on the susceptibility of misalignment estimates to a few selected factors including the values assigned to the key parameters in a given model, sampling uncertainty, serial correlation adjustment, and data revision. The implications of these factors are illustrated using results derived from the fundamental equilibrium exchange rate (FEER) approach and the Penn effect regression, which are commonly used in assessing exchange rate misalignment.

Comparing results from some plausible scenarios, it cannot be ignored that the empirical evidence on RMB undervaluation is weaker than the one commonly posited in the media. The RMB misalignment estimate is quite sensitive to variations in the selected factors listed in the previous paragraph. In addition to the estimates suggesting severe undervaluation that mirror the one reported in, say, the financial press, there are empirical results suggesting the RMB is quite fairly valued or is overvalued. It is important to emphasize that our theme is not to argue whether the RMB is undervalued or not – the point is that the evidence on the inability to precisely estimate exchange rate misalignment is quite pronounced, and hence we have to exercise considerable caution in interpreting any misalignment estimates.

At first glance, our discussion seems unhelpful to, say, policymakers and financial professionals, who conduct their operations here and now in the real world. The inability to pin down the precise level of misalignment, however, should be interpreted positively. The imprecision of a misalignment estimate in fact is in accordance with the well-known result that it is quite difficult to model exchange rates in general. Ignoring what we do not know does not help analyze the actual degree of misalignment. Given these considerations, it is prudent to avoid making a hasty policy decision based on a typical misalignment assessment exercise. Specifically, it is not advisable to make a particular drastic and swift exchange rate move without taking the uncertainty surrounding a misalignment estimate into consideration.

References

Ahmed, Shaghil, 2009, "Are Chinese Exports Sensitive to Changes in the Exchange Rate?" International Finance Discussion Paper No. 987 (Washington, D.C.: Federal Reserve Board, December).

Asian Development Bank, 2007, Purchasing Power Parities and Real Expenditures (Manila, Philippines: Asian Development Bank, December).

Aziz, Jahangir and Xiangming Li, 2008, "China's Changing Trade Elasticities," China and the World Economy 16(3): 1 – 21.

Cenedese, Gino and Thomas Stolper, forthcoming, Currency Fair Value Models, Chapter 6 in Jessica James, Ian W. Marsh and Lucio Sarno, eds, The Handbook of Exchange Rates.

Cheung, Yin-Wong, Menzie Chinn and Antonio Garcia Pascual, 2005, "Empirical Exchange Rate Models of the Nineties: Are Any Fit to Survive?" Journal of International Money and Finance 24, 1150-1175.

Cheung, Yin-Wong, Menzie D. Chinn and Eiji Fujii, 2007, The Overvaluation of Renminbi Undervaluation, Journal of International Money and Finance 26(5) (September): 762-785.

Cheung, Yin-Wong, Menzie D. Chinn and Eiji Fujii, 2010a. Measuring Renminbi Misalignment: Where Do We Stand? *Korea and the World Economy* 11: 263-296.

Cheung, Yin-Wong, Menzie D. Chinn and Eiji Fujii, 2010b, Measuring misalignment: Latest estimates for the Chinese renminbi, in Simon Evenett (Editor), The US-Sino Currency Dispute: New Insights from Economics, Politics and Law, A VoxEU.org Publication, Chapter 10, 79-90,

Cheung, Yin-Wong, Menzie Chinn and Eiji Fujii, 2010c, "China's Current Account and Exchange Rate," in R. Feenstra and S.-J. Wei, editors, China's Growing Role in World Trade, Chapter 9, pp. 231-271 (U.Chicago Press for NBER).

Cline, William R. and John Williamson, 2010 "Notes on Equilibrium Exchange Rates: January 2010," Policy Brief PB10-2 (Washington, DC: Peterson Institute for International Economics, January).

Coudert, Virginie and Cecile Couharde. 2007. Real Equilibrium Exchange Rate in China: Is the Renminbi Undervalued? *Journal of Asian Economics* 18 (4): 568–594.

Dunaway, Steven, LAmin Leigh and Xiangming Li. 2009, How Robust are Estimates of Equilibrium Real Exchange Rates: The Case of China, *Pacific Economic Review* 14(3), 361-375.

The Economist, 2011, Currency comparisons, to go, http://www.economist.com/blogs/dailychart/2011/07/big-mac-index

Frankel, Jeffery, 2006, On the Yuan: The Choice between Adjustment under a Fixed Exchange Rate and Adjustment under a Flexible Rate, CESifo Economic Studies 52 (2), 246-75.

Goldstein, Morris and Nicholas Lardy, 2009, *The Future of China's Exchange Rate Policy*, Policy Analyses in International Economics 87 (Washington, DC: Peterson Institute for International Economics, July)

Hinkle, Lawrence E. and Peter J. Montiel, 1999, Exchange Rate Misalignment (Oxford University Press for World Bank, New York).

Hu, Chuntian and Zhijun Chen, 2010, Renminbi Already Overappreciated: Evidence from FEERs (1994-2008), China Economist 26, 64-78.

International Comparison Program, 2007, “Preliminary Results: Frequently Asked Questions,” mimeo. http://siteresources.worldbank.org/ICPINT/Resources/backgrounder-FAQ.pdf.

International Monetary Fund, 2010, *People’s Republic of China: 2010 Article IV Consultation – Staff Report*; http://www.imf.org/external/pubs/ft/scr/2010/cr10238.pdf.

Kwack, Sung Yeung, Choong Y. Ahn, Young S. Lee, Doo Y. Yang, 2007, “Consistent Estimates of World Trade Elasticities and an Application to the Effects of Chinese Yuan (RMB) Appreciation,” Journal of Asian Economics 18: 314–330.

Kravis, Irving B. and Lipsey, Robert E., 1983. Toward an Explanation of National Price Levels, Princeton Studies in International Finance No. 52, Princeton, NJ: International Finance Center, Princeton University, 1983.

Kravis, Irving B. and Lipsey, Robert E., 1987. The Assessment of National Price Levels," in Sven W. Arndt and J. David Richardson, eds., Real Financial Linkages Among Open Economies, Cambridge, MA: MIT Press, 97-134.

Kravis, Irving B., Alan Heston, and Robert Summers, 1978. International Comparisons of Real Product and Purchasing Power, Baltimore: The Johns Hopkins University Press.

Mann, Catherine and Katerina Plück , 2007, “The US Trade Deficit: A Disaggregated Perspective,” in Richard Clarida (ed.), G7 Current Account Imbalances: Sustainability and Adjustment (U. Chicago Press).

Marquez, Jaime and John W. Schindler, 2007, “Exchange-Rate Effects on China’s Trade,” Review of International Economics 15(5), 837–853.

Medina, Leandro, Jordi Prat and Alun Thomas, 2010, Current Account Balance Estimates for Emerging Market Economies, IMF Working Paper 10/43.

Meese, Richard and Kenneth Rogoff, 1983. Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?, Journal of International Economics 14, 3-24.

Rogoff, Kenneth, 1996. The purchasing power parity puzzle. Journal of Economic Literature 34, 647-668.

Samuelson, Paul, 1994. Facets of Balassa-Samuelson Thirty Years Later," Review of International Economics 2(3), 201-26.

Schnatz, Bernd, 2011, Global Imbalances and the Pretence of Knowing FEERs, *Pacific Economic Review* 16 (5), 604–615.

Stupnytska, Anna, Thomas Stolper and Malachy Meechan, 2009, "GSDEER On Track: Our Improved FX Fair Value Model," Global Economics Weekly No. 09/38 (Goldman Sachs Global Economics, October 28).

Subramanian, Arvind, 2010, "New PPP-Based Estimates of Renminbi Undervaluation and Policy Implications," Policy Brief PB10-18 (Washington, DC: Peterson Institute for International Economics, April).

Summers, Robert, Heston, Alan, 1991. The Penn World Table (Mark5): an expanded set of international comparisons. Quarterly Journal of Economics 106 (2), 327-368.

Tenengauzer, Daniel, 2010, "RMB: the People's currency," EM FX and Debt Spotlight (21 April 2010), Bank of America-Merrill Lynch.

Wang, Tao and Harrison Hu, 2010, "How Undervalued Is the RMB?" Asian Economic Perspectives (13 April 2010), UBS Investment Research.

Thorbecke, Willem and Hanjiang Zhang, 2009, "The Effect of Exchange Rate Changes on China's Labour-Intensive Manufacturing Exports," Pacific Economic Review 14(3), 398–409.

Williamson, John, and Molly Mahar, 1998, A Survey of Financial Liberalization (Princeton:Princeton Essays in International Finance no. 211).

World Bank. 2008a. Global Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program. International Comparison Program and International Bank for Reconstruction and Development. Washington, DC.

World Bank. 2008b. ICP 2003-2006 Handbook, http://go.worldbank.org/MW520NNFK0.

World Bank. 2008c. Comparison of New 2005 PPPs with Previous Estimates: Appendix G Revised: Global Purchasing Power Parities and Real Expenditures. Washington, DC.