ESTIMATION OF THE FUNDAMENTAL MISALIGNMENT OF THE CHINESE RENMINBI

THE CHINA CURRENCY COALITION
(July 2008)

I. EXECUTIVE SUMMARY

During the 18-month period of September 2006 – February 2008, the Chinese Renminbi ("RMB") was undervalued by an average of 35 percent, relative to the U.S. dollar, and remained undervalued by 30 percent in February 2008, the most recent month for which data are available. The RMB will need to appreciate to a value of 5.02 RMB/US$ in order to reach an equilibrium level consistent with economic fundamentals.[1]

This paper describes, in detail, the calculations involved in obtaining the estimates reported above. The undervaluation of the RMB was calculated using two approaches that economists generally employ to measure exchange rate misalignment, the macroeconomic balance approach and the reduced form real exchange rate approach. For each approach, the undervaluation of the RMB is calculated first in real effective terms ("REER"),[2] and then converted into real bilateral terms ("RER"). The results are as follows:[3]

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[1] The estimate of the equilibrium nominal exchange rate – 5.02 RMB/US$ – assumes that all adjustment in the real RMB/US$ exchange rate will take place in the nominal exchange rate. Adjustment in the real exchange rate could also be brought about by changes in price levels in China and the United States.

[2] Real effective exchange rates are trade-weighted multilateral exchange rates, which provide an overall indicator of the competitiveness of a country's currency. Undervaluation in the bilateral RMB/dollar rate can then be extracted from the level of undervaluation in the REER.

[3] These results are based on official Chinese current account data. In the past several years, China's official trade data have shown current account surpluses that are significantly smaller than those based on the trade data of China's trading partners. This discrepancy persists even after adjusting for trade routed through Hong Kong and adjusting for the inclusion of transport costs in import value data. To the extent that China's current account surplus is understated by China's official data, the result is a conservatively lower estimate of the RMB's undervaluation.

Undervaluation of the RMB – 18-Month Average: September 2006 – February 2008

Approach	Macroeconomic Balance	Reduced Form	**Simple Average**
Overall Under-valuation (REER)	14.1%	13.6%	**13.9%**
Undervaluation Relative to US$ (RER)	35.6%	34.4%	**35.0%**

Undervaluation of the RMB – Most Recent Month: February 2008

Approach	Macroeconomic Balance	Reduced Form	**Simple Average**
Overall Under-valuation (REER)	14.1%	9.6%	**11.8%**
Undervaluation Relative to US$ (RER)	35.6%	24.2%	**29.9%**

II. METHODOLOGICAL BACKGROUND

A. Basic Comments

The estimates presented in this paper reflect what is believed to be the most appropriate and accurate application of each of the two approaches mentioned above. To the degree possible, reliance has been placed on the guidelines followed by the Coordinating Group on Exchange Rate Issues (hereafter "CGER"), which is the division of the International Monetary Fund ("IMF") charged with currency surveillance.[4] In addition, alternative strategies are

[4] Two publications describe the guidelines followed by CGER in exchange rate surveillance: Lee, Jaewoo, Gian Maria Milesi-Ferretti and Lucia Ricci, "Methodology for CGER Exchange Rate Assessments," IMF Research Department (2006) (hereafter "Lee"), and Isard, Peter, Hamid Faruqee, G. Russell Kincaid and Martin Fetherston, "Methodology for Current Account and Exchange Rate Assessments," International Monetary Fund Occasional Paper 209 (2001) (hereafter "Isard). As discussed below, the empirical strategies employed here for the macroeconomic balance and reduced form real exchange rate approaches are the same as those employed by CGER. The differences arise from the exclusion of certain variables, for which

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described that could be used within each of the two approaches, and the effects these changes might have on the calculations are noted. The data used are from the World Bank's World Development Indicators and the IMF's International Financial Statistics. Both of these datasets are publicly available and trustworthy sources that are used extensively by CGER in its own measurement of potential exchange rate misalignment.

Each of the approaches described below measures exchange rate misalignment from a different perspective, and each has distinct strengths and weaknesses. By employing the results of two different approaches, the goal is to obtain a more reliable and accurate estimate of exchange rate misalignment than if either approach was relied upon by itself.

B. The Macroeconomic Balance Approach

The macroeconomic balance approach measures the level of exchange rate misalignment as the change in the REER required to move from a country's "underlying" current account balance to its "equilibrium" current account balance. For purposes of this approach, the equilibrium current account balance is defined as the current account balance that would bring about equilibrium in the balance of payments. The underlying current account balance, on the other hand, is the observed current account balance, with adjustments made to account for past changes in the REER and the business cycle.[5] Trade elasticities are employed to calculate the

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data were unavailable. Specifically, this analysis excludes a banking crisis variable in the estimation of the equilibrium current account balance in the macroeconomic balance approach and excludes the trade restriction and administered prices variables in the reduced form real exchange rate approach. As these variables are employed relatively infrequently in studies of exchange rate misalignment, their omission should not greatly affect the results.

[5] The approach described herein follows CGER by obtaining estimates of the underlying and equilibrium current account balances using econometric models.

percentage change in the REER needed to move from the underlying to equilibrium current account balance.

C. The Reduced Form Real Exchange Rate Approach

The reduced form real exchange rate approach defines exchange rate misalignment as the difference between the observed REER and the REER predicted by an econometric model employing some of the theoretical determinants of exchange rate levels as independent variables. Following CGER, the equilibrium level of the REER has been estimated using a dynamic ordinary least squares specification, which accounts for time trends in the independent variables.

D. Conversion from REER to RER

Because real effective exchange rates are generally thought to be a better indicator of a country's competitiveness than any bilateral exchange rate, it is appropriate to identify fundamentally misaligned currencies based on the REER, as described above. However, it is the misalignment in the bilateral exchange rate that should be used to calculate an ad valorem subsidy rate in countervailing duty ("CVD") proceedings or to make adjustments to U.S. price in antidumping ("AD") proceedings.

There are two reasons that the level of misalignment in the bilateral exchange rate — rather than in the REER — should be used to account for exchange rate misalignment in unfair trade cases. First, it is mathematically inconsistent to apply the misalignment of the REER, which is implicitly defined in terms of an index of currencies, to a price based on a bilateral transaction between firms in two countries. Second, employing the misalignment of the REER in AD or CVD proceedings would not account for the fact that levels of misalignment in bilateral exchange rates can vary greatly from country to country. Extracting the level of bilateral

misalignment from the misalignment of the REER allows one to address these differences in misalignment across countries.[6]

E. A Note On Some Criticisms of These Approaches

Some have argued that the approaches described in this paper yield estimates that are too inexact to be used in AD and CVD cases. In particular, one concern that has been voiced is that results can vary based on the approach(es) used and on the assumptions made within each approach. While these criticisms correctly observe that these approaches do not yield a flawless measure of currency misalignment, no economic model is capable of producing such an estimate. This does not mean, however, that a reasonable estimate of exchange rate misalignment cannot be made using the tools at hand. These two approaches to measuring exchange rate misalignment represent the best techniques available and arrive at results that the IMF considers reliable for its currency surveillance operations. Moreover, while the results of an individual approach might be somewhat inexact, the quality of the estimate of overall misalignment is significantly improved by taking the simple average of the outcomes of the two approaches.

F. Alternative Methodologies

The macroeconomic balance and reduced form real exchange rate approaches are the most widely accepted techniques employed by economists to measure exchange rate misalignment. This preference is apparent from the reliance of the IMF on these approaches[7] as well as from the sheer number of studies produced by researchers in reliance upon these

[6] The technique used to extract the level of bilateral misalignment from the misalignment in the REER is described in detail below.

[7] See Isard, Lee.

techniques.[8] There are, however, other methodologies that have sometimes been employed to measure exchange rate misalignment. Perhaps best known among these other methodologies is the purchasing power parity approach. As next discussed, this approach has significant shortcomings and so has not been used to generate the estimates described herein.

Purchasing power parity (hereafter "PPP") is one of the oldest and most straightforward of the theories that address the concept of an "equilibrium" exchange rate. Under the PPP approach, exchange rate misalignment is defined as the difference between the observed REER and the REER that would equalize prices for a basket of goods across countries, once prices have been converted into a common currency. This level of misalignment can be calculated using the PPP conversion factors reported in the World Bank's World Development Indicators ("WDI"), which provide a measure of misalignment in absolute bilateral terms. The varying price of non-tradable goods across countries can then be controlled for by regressing the PPP conversion factors on per-capita income.[9]

There are, however, a number of flaws in the PPP approach that cast doubt on the results it produces. First, the IMF does not employ the PPP approach in its exchange rate surveillance activities.[10] This is a particularly important drawback for purposes of this study, because great effort has been taken to follow the IMF's methodologies whenever possible. Second, the PPP

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[8] See e.g. Isard; Lee; Goldstein, Morris, "Adjusting China's Exchange Rate Policies," Institute for International Economics (2004); Coudert, Virginie and Couharde, Cecile, "Real Equilibrium Exchange Rate in China," CEPI (2005); Wang, Tao, "Exchange Rate Dynamics," in Prasad, Esward, ed., *China's Growth and Integration into the World Economy: Prospects and Challenges*, International Monetary Fund Occasional Paper 232 (2004);

[9] The PPP approach has been used in the past to measure the misalignment of the Chinese RMB, including by Frankel, Jeffrey, "On the Renminbi: The Choice Between Adjustment Under a Fixed Exchange Rate and Adjustment Under a Flexible Rate," National Bureau of Economic Research Working Paper 11274 (2005).

[10] See Lee.

approach relies on international price surveys to generate PPP exchange rates. These international surveys create problems, because different preferences and consumption patterns across countries make it impossible to gather prices for an identical basket of goods. Finally, in contrast to the macroeconomic balance approach and the reduced form real exchange rate approach, the PPP approach does not consider changes in current account balances when it is used to measure exchange rate misalignment. These recognized deficiencies so undermine the PPP approach as to make it unreliable in the measuring of a currency's fundamental misalignment.[11] After careful consideration, therefore, this study does not incorporate in its calculations the PPP approach.

III. THE MACROECONOMIC BALANCE APPROACH

A. Background

The macroeconomic balance approach is the primary approach employed by the IMF in its currency surveillance activities.[12] As described above, this approach measures exchange rate misalignment by comparing the "underlying" current account balance to the "equilibrium" current account balance and determining the change in the REER required to equalize the two. The percentage change in the REER that equalizes the underlying and equilibrium current account balances is the level of measured misalignment. In full, therefore, the macroeconomic balance approach consists of four steps:

[11] In the case of China, for instance, the PPP methodology applied with the most recent data available (including the World Bank's prices from 2006 for a basket of goods across countries) yields the conclusion that the RMB through February 2008 was undervalued by 11.4 percent on a REER basis and by 7.5 percent relative to the U.S. dollar on a RER basis. These results, due in significant part to their not taking into account the rapid growth in China's current account surplus over the past ten years, are strikingly inconsistent with the results obtained from the macroeconomic balance approach and the reduced form real exchange rate approach.

[12] See Isard (2001), p. 24.

Step 1: Determination of the "underlying" current account balance, which is the observed current account balance, adjusted for the business cycle and past changes in the REER;

Step 2: Determination of the "equilibrium" current account balance, which is the current account balance that brings about some concept of equilibrium in the balance of payments;

Step 3: Determination of the change in the REER required to move from the underlying current account balance to the equilibrium current account balance; and

Step 4: Extraction of the level of misalignment in the RER from the misalignment of the REER calculated in Step 3.

Naturally, each of these steps requires decisions on the part of the researcher as to how they should be implemented. Whenever possible, calculations contained herein follow the guidelines established by CGER, which tend to be among the most appropriate and unbiased techniques for calculating misalignment based on the macroeconomic balance approach.[13] Estimates that coincide with the recommendations of CGER are marked in the tables below with an asterisk (*).

B. Step 1 – Determining the "Underlying" Current Account Balance

The underlying current account balance is the observed current account balance, adjusted for deviations from potential gross domestic product ("GDP") (the business cycle) and the effects of past changes in the REER.[14] There are two primary ways to calculate the underlying

[13] More specifically, the econometric approach used is identical to that employed by CGER. The difference is due solely to data availability and consists of the omission of a banking crisis variable from the estimation of the equilibrium current account balance.

[14] Adjustments are made based on the business cycle to take into account the impact of an overheating (or recessionary) economy on the current account balance. In an overheating (or recessionary) economy, the volume and price of imports are driven up (or down), leading to an overstated (or understated) current account balance. Adjustments are made based on lagged

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current account balance. The first option is to employ the results of an econometric model that explains variation in the current account deficit based on lagged values of the REER and countries' output gaps. The second option is to simply average the ratio of the current account balance to GDP over previous years. The values for China associated with each of these options are reported in Table 1.

Table 1

Options for Calculating Underlying Current Account Balance

Option	Underlying Current Account for China, % GDP
World Economic Outlook Estimates*	10.9%
Average of Past Three Years (Wang, 2004)	6.7%

Virtually every researcher in the field bases the estimate of the underlying current account on the results of an econometric model. That approach is followed in the calculations in this paper as well. Specifically, the underlying current account balance is defined as the projected current balance for China reported in the IMF's World Economic Outlook ("WEO").[15] This is the same approach employed by CGER in its currency surveillance activities. The underlying current account balance for China reported in the World Economic Outlook is 10.9 percent of GDP.[16]. This figure is above the observed current account balance of 9.4 percent [17]

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values of the REER, because the effect of recent depreciation or appreciation of the REER may not yet be reflected in the current account balance.

[15] See International Monetary Fund, *World Economic Outlook, Housing and the Business Cycle*, 2008, available online at http://www.imf.org/external/pubs/ft/weo/2008/01/index.htm.

[16] Id.

[17] Id.

due to past depreciation in the REER of the RMB, as well as China's rapidly expanding economy.

In contrast, Wang (2004)[18] — the only study that finds no undervaluation of the RMB — uses the average of China's current account balance in the three years preceding the year of analysis as the measure of the underlying current account balance. This definition of the underlying current account balance is less appropriate than one based on the econometric framework described above. First, it does not control for either of the most important adjustments for the underlying current account balance — lagged changes in the REER and the business cycle. Second, the reliance on historical data ignores that adjustments to the observed current account balance should be forward-looking. Because there does not appear to be any theoretical support for basing an estimate of the underlying current account balance on past values, that technique has not been included in this analysis.

C. Step 2 – Determining the Equilibrium Current Account Balance

The equilibrium current account balance is the current account balance associated with some concept of balance of payments equilibrium. The concept of equilibrium chosen, of course, greatly affects the level of measured misalignment, and there are many options from which to choose. In general, however, these options can be separated into two categories: those based on some aspect of the capital account; and those estimated using econometric models of savings and investment. Two potential estimates of the underlying current account balance for China falling under each of these categories are reported in Table 2.

[18] See Wang, Tao, "Exchange Rate Dynamics," in Prasad, Esward, ed., *China's Growth and Integration into the World Economy: Prospects and Challenges*, International Monetary Fund Occasional Paper 232 (2004).

Table 2

Options for Calculating Equilibrium Current Account Balance

Option	Equilibrium Current Account Balance for China, % GDP
IMF Saving-Investment Model*	1.52%
Stabilized NFA (Net Foreign Assets)/GDP at 2001 Levels[19]	0.98%

Estimates of the equilibrium current account balance based on capital account measures are the most straightforward to obtain. Examples include setting the equilibrium current account balance equal to the negative of the total capital account, the level that maintains net foreign assets at some constant share of GDP, or the level that stabilizes the debt to GDP ratio. These options are all legitimate measures of the equilibrium current account balance. While not selected for this analysis, any of these proxies for the equilibrium current account balance would yield comparable measures of the undervaluation of the RMB.

The results reported in this paper are based on an equilibrium current account balance that has been estimated using an econometric model that is highly similar to that employed by CGER in its exchange rate surveillance activities. The model employed here explains variation in the current account balance as a function of government fiscal balance, age dependency ratio (the ratio of retired persons to working-age persons), population growth rate (a measure of the share of youth in the population), growth rate of per-capita income, energy balance, and an

[19] This is the benchmark employed in Wang (2004).

indicator variable for the Asian financial crisis.[20] Specifically, the following equation is estimated with data collapsed to four-year averages and country fixed effects:

$$cur_{it} = \alpha + \hat{\beta}_1 FiscBal_{it} + \hat{\beta}_2 AgeDep_{it} + \hat{\beta}_3 PopGrowth_{it} + \hat{\beta}_4 Growth_{it} + \hat{\beta}_5 EnergyBal_{it}$$
$$+ \hat{\beta}_6 AsiaCris_{it} + \gamma_i + \varepsilon_{it}$$

where countries are denoted by the subscript i, and time is denoted by subscript t. This estimation yields the following results, which are generally consistent with those reported by the IMF:

Table 3

Regression Results for Equilibrium Current Account Balance Model

	Current Account (% GDP)
Fiscal Balance	-.029 -0.14
Age Dependency Ratio	-2.108 -0.21
Population Growth	-2.243 -2.15**
Per-Capita GDP Growth	-0.083 -0.40
Energy Balance	5.53 1.84*
Asian Crisis	2.482 1.67*
Constant	0.933 2.95***
Observations	177
Number of countries	51
R-squared	0.17

T statistics based on robust standard errors are reported.
* significant at 10%; ** significant at 5%;
*** significant at 1%

[20] Following CGER, government fiscal balance, age dependency ratio, population growth rate and growth rate of per-capita income are measured in deviations from the average of trading partners. See Lee (2006), p. 25.

On this basis, an equilibrium current balance of 1.52 percent of GDP is estimated for China, which is simply the predicted value based on the econometric model discussed above.

D. Step 3 – Determining Change in the REER Needed for Equilibrium

The next step in the macroeconomic balance approach is to determine the change in the REER required to move the underlying current account balance in line with its equilibrium level. This step requires estimates of trade elasticities, which give the percentage change in imports and exports that would result from a one-percent change in the REER.

The trade elasticities employed in these calculations are the same as those utilized by CGER, as described in Isard.[21] These elasticities are constant across countries. That is, the same percentage change in the REER will cause the same percentage change in the volume of imports and exports in all countries. The impact on the ratio of the current account balance to GDP, however, will vary from country to country based on each country's openness to trade. This methodology leads to a finding that the REER of the Chinese RMB would need to appreciate by 14.1 percent in order to move from an underlying current account surplus of 10.9 percent of GDP to an equilibrium current account surplus of 1.52 percent of GDP.

E. Step 4 – Extracting Bilateral Levels of Misalignment

As mentioned above, calculations made in CVD and AD proceedings that account for the fundamental misalignment of exchange rates should employ the bilateral misalignment in the RER, which is extracted from the level of misalignment in the REER. Using the misalignment

[21] See Isard (2001), p. 14. These elasticities are in the upper range of those observed in the literature concerned with estimation of trade elasticities. As a result, the level of undervaluation reported herein is conservatively lower than would be the case if lower trade elasticities were used.

of the RER is necessary in order to be mathematically consistent and account for variation in bilateral levels of misalignment across countries.

Once one has calculated the REER required to bring about balance of payments equilibrium, it is necessary to consider an appropriate allocation of changes in bilateral exchange rates that would yield the desired change in the REER. The calculations contained in this paper are based on the methodology developed by Cline (2005).[22] Under this methodology, a desired change in the REER is allocated among bilateral exchange rates based on the overall current account balances of China's trading partners. For example, if the desired change in the REER is appreciation, larger portions of that appreciation would be allocated toward currencies of countries with overall current account surpluses. For simplicity, the conversion of the REER to RER is based on China's top 10 trading partners, which collectively account for nearly two-thirds of China's total trade.

The calculations in this paper adapt Cline's methodology — which was based on allocating the required depreciation of the U.S. dollar — to the required appreciation of the RMB. As mentioned above, this means that countries with overall current account deficits will experience larger depreciations in their currencies relative to the RMB than those with current account surpluses. In Cline's calculations, even countries with current account deficits are expected to experience depreciations in their RERs with the dollar, by an amount that yields a change in current surplus of 0.35 percent of GDP.

[22] See Cline, William, *The United States as a Debtor Nation*, Institute for International Economics and Center for Global Development, Washington, DC (2005), at pp. 219-252 (hereafter "Cline").

An analogous approach is followed in the calculations herein in that even countries with current account surpluses are expected to experience moderate depreciations in the RER of their currencies relative to the RMB. Specifically, countries with current account surpluses are expected to experience depreciations in their RERs relative to the RMB such that their current account surpluses increase by 1.0 percent of GDP.[23] The remaining appreciation in the RMB is then divided evenly among countries with overall current account deficits, which among China's top 10 trading partners is only the United States.[24] Under this approach, the U.S. dollar is responsible for absorbing slightly over half of the overall appreciation of the RMB. Based upon this methodology, the level of bilateral misalignment of the RMB relative to the U.S. dollar is 35.6 percent.

F. Data

The equilibrium current account balance is estimated using data from the World Bank's World Development Indicators for the years 1973 to 2006. WDI is a publicly available and generally reliable data source that is well-suited to the measurement of exchange rate

[23] The selected increase in current account balances for surplus countries is set at 1.0 percent of GDP, rather than 0.35 percent as in Cline, in order to account for the fact that this analysis is based only on China's top 10 trading partners. Increasing the amount of current account balance change for surplus countries in this way conservatively decreases the bilateral misalignment of the RMB vis-à-vis the U.S. dollar.

[24] Note that, in Cline's analysis, countries with large current account deficits such as Australia were not expected to experience any appreciation in their RERs relative to the dollar. By having even countries with large current account surpluses, such as Singapore, experience appreciations in their RERs relative to the RMB, the amount of measured bilateral misalignment of the RMB relative to the U.S. dollar is conservatively decreased.

misalignment.[25] Estimates of the underlying current account balance are obtained from the IMF's World Economic Outlook, 2008 ("WEO").

G. Obtaining Contemporaneous Results

The estimation results used to derive China's equilibrium current account balance were based upon data from the World Bank's World Development Indicators from 1973 to 2006. In order to obtain more contemporaneous estimates of the RMB's misalignment, this equilibrium current account balance can be compared to estimates of the underlying current account balance obtained from the IMF's WEO.

Estimates of China's underlying current account balance for 2006 to 2008 are from the 2008 WEO. Following CGER, China's underlying current account balance for the current year, 2008[26], is defined as the furthest projection of the current account balance provided in the WEO. The next furthest projection of the current account balance is the underlying current account balance for 2007, and so on. Based upon this approach, the RMB is found to be undervalued by 14.1 percent in real effective terms and by 35.6 percent relative to the U.S. dollar for the 18-month period from September 2006 through February 2008, the most recent period for which data are available.

[25] WDI data are only as reliable as the raw data reported to the IMF and World Bank by national governments. As mentioned in footnote 2 above, China's official trade statistics appear to understate significantly its current account surplus. To the extent that China's current account surplus is understated in the WDI data, this will lead to a conservatively lower estimate of the undervaluation of the RMB's REER.

[26] The most recent monthly data available are for February 2008.

IV. THE REDUCED FORM REAL EXCHANGE RATE APPROACH

A. Background

The reduced form real exchange rate approach defines exchange rate misalignment as the difference between the observed REER and the REER predicted by an econometric model employing some of the theoretical determinants of exchange rates as independent variables. Estimation of the level of exchange rate misalignment under this approach is accomplished in four steps:

Step 1: Estimation of an econometric model where variation in the REER is explained by variation in a set of independent variables identified by economic theory as potential determinants of the REER;

Step 2: Derivation of a predicted REER for the country of interest, based on the results of Step 1;

Step 3: Measurement of misalignment by the difference between the observed REER and the predicted REER of the country of interest; and

Step 4: Extraction of the level of misalignment in the RER from the misalignment of the REER calculated in Step 3.

B. Empirical Strategy

1. Step 1 – Estimating the Model

In order to derive a predicted "equilibrium" REER under this approach, it is necessary to estimate an econometric model that explains variation in the REER based on variation in a set of independent variables. What makes the approach "reduced form" is that the regression equation is not based on a single theoretical model and can include many variables that might have an

impact on the REER. CGER has a preferred set of variables and an econometric approach for the reduced form approach, which is followed here as closely as data availability permits.[27]

More specifically, the equilibrium REER is estimated based upon a set of determinants including per-capita income relative to the United States, net foreign assets, terms of trade (export price index divided by import price index) and the share of government consumption in GDP. As discussed by CGER in its guidelines, there are various potential econometric problems when estimating equations with time series components.[28] These concerns are addressed by estimating the model with dynamic ordinary least squares, which includes lagged and leading values of the first differences of the independent variables as additional regressors. That is, the following equation is estimated:

$$REER_{it} = \alpha + \hat{\beta}_1 GNIPerCap_{it} + \hat{\beta}_2 NFA_{it} + \hat{\beta}_3 TOT_{it} + \hat{\beta}_4 GY_{it}$$

$$+ \sum_{j=1}^{4} (x_{ijt-1} - x_{ijt-2}) + \sum_{j=1}^{4} (x_{ijt+1} - x_{ijt}) + \varepsilon_{it}$$

where i is an index of countries, t is an index of time, and j is an index of the four primary independent variables. The following results are obtained:

[27] See Lee (2006), pp. 27-31. The variables for trade restrictions and share of administered prices included in CGER's analysis have been omitted here. As mentioned above in footnote 3, this should not cause undue concern, as these variables tend to be used only infrequently when applying the reduced form real exchange rate approach. In addition, GDP per-capita has been used to account for the Balassa-Samuelson effect, rather than an explicit productivity measure.

[28] See Lee (2006), p. 29.

Table 4

Regression Results for Reduced Form Real Exchange Rate Model

	REER
Per-Capita Gross National Income	43.001 7.87***
Net Foreign Assets	-0.309 -1.22
Terms of Trade	0.403 2.84***
Government Consumption/GDP	2.206 2.96***
Constant	-17.684 -1.25
Observations	685
Number of countries	33
R-squared	0.26

T statistics based on robust standard errors are reported.
* significant at 10%; ** significant at 5%; *** significant at 1%

2. Step 2 – Calculating the Equilibrium REER

The "equilibrium" REER predicted by the model is the predicted value, based upon the estimated coefficients calculated in Step 1. The estimate can be based on either observed values of the independent variables or on their predicted medium-term values from the IMF's World Economic Outlook. Because country-specific, medium-term values for China are not publicly available, these predictions are based upon the observed values of the independent variables.

3. Step 3 – Measuring Exchange Rate Misalignment

The level of misalignment of the RMB is then calculated in real effective terms. The level of undervaluation is simply the percentage difference between the observed REER and the REER predicted by the reduced form dynamic model. Based on these calculations the level of misalignment in the REER of the RMB is 19.0 percent.

4. Step 4 – Extract Bilateral Levels of Misalignment

The bilateral level of misalignment between the RMB and the U.S. dollar is extracted from the misalignment of the REER of the RMB using the same technique described in step 4 of the macroeconomic balance approach. This leads to a measured undervaluation of 48.2 percent for the RMB relative to the U.S. dollar.

C. Data

All data are from the World Bank's World Development Indicators and the IMF's International Financial Statistics. Estimates of the equilibrium REER are based upon data for the period from 1980 through 2006. These public data are used extensively in CGER's application of the reduced form real exchange rate approach.

D. Obtaining Contemporaneous Results

The estimation results used to derive the equilibrium REER of the RMB were based upon data from the World Bank's WDI from 1980 to 2006. In order to obtain more contemporaneous estimates of the RMB's misalignment, the equilibrium REER can be compared to the most recent observed REER of the RMB reported in the IMF's International Financial Statistics. Based upon this approach, the RMB is found to be undervalued by 13.6 percent in real effective terms and by 34.4 percent relative to the U.S. dollar for the 18-month period from September 2006 through February 2008, the most recent period for which data are available.

V. CONCLUSION

In summary, it is submitted that the methodology followed in the computations underlying this paper arrives at a reasonable and fair estimation of the extent of the RMB's fundamental misalignment in both real effective and real bilateral terms. Application of the same methodology likewise would result in a reasonable and fair estimation of whether any other

country's currency was fundamentally misaligned. Reliance upon a simple average of the results of the macroeconomic balance approach and the reduced form real exchange rate approach — the two approaches most widely used by the IMF and recognized in the academic literature — and the use of publicly available data gathered by the IMF and the World Bank lead to as transparent and as accurate a quantification as is possible of the RMB's fundamental misalignment.