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Abstract

This paper provides an application of the FEER model to the real exchange rate of the Chinese Yuan against the US Dollar. An important contribution is that we incorporate into the sustainable current account fundamentals that reflect the unique features of the Chinese economy but have not been employed by previous studies. Another contribution is the construction of a unique data set of consistent time series for economic fundamentals and trade-related variables, which allow us to carry out an econometric investigation of trend and sustainable current accounts and compute the FEER for both pre- and post-reform periods. The empirical results show that both the sustainable and trend current account surpluses have been steadily rising since the early 1990s. Chinese exports appear to be more price elastic, while imports are more income elastic. The misalignment rates suggest that the RMB was overvalued against the USD during the pre-reform period and has been undervalued for most of the post-reform period, particularly since 2003. However the misalignment rates are not as large as suggested by previous studies.

Key Words: Fundamental equilibrium exchange rate; Real CNY/USD; Misalignments; China

JEL Classification: F31, F32, C51 C52

1. Introduction

The growing USA trade deficit with China has caused considerable debate among politicians and academics about China's international competitiveness and the value of its currency, Renminbi (RMB)[1]. A few studies have addressed this subject by investigating the equilibrium real exchange rate between the RMB and the US dollar, with the majority showing substantial undervaluation in the real RMB since the middle of the 1990s[2]. Most of these papers use either some version of the Purchasing Power Parity framework (e.g. Zhang, 2002; Frankel, 2005; Coudert and Couharde, 2007), or the Behavioural Equilibrium Exchange Rate model (e.g. Zhang, 2001; Bénassy-Quéré *et al*, 2004).

In this paper we apply the Fundamental Equilibrium Exchange Rate (FEER) model which considers the whole economy and provides more information about the determination of the equilibrium exchange rate. To our knowledge, the only studies that have applied the FEER model to China are Jeong and Mazier (2003), Wang (2004), Wren-Lewis (2004a) and Coudert and Couharde (2007). However, only Coudert and Couharde (2007) applied the model to the real bilateral CNY/USD exchange rate, and only for two years (2002-2003).

We make two important contributions to the existing literature. First, in previous studies the sustainable current account is either based on assumptions (i.e. Wren-Lewis, 2004a), or estimated following the savings-minus-investment norm of Debelle and Faruquee (1998) and Chinn and Prasad (2000) (i.e. Jeong and Mazier, 2003;

[1] Renminbi (RMB) is the name of the Chinese currency. Yuan is the unit of the currency. In the foreign exchange market, the exchange rate is measured as CNY against other currencies (e.g. US dollar). But when Chinese authorities refer to appreciation, depreciation, overvaluation, undervaluation and equilibrium value of the currency, they are referring to the RMB.

[2] For an extensive review of the empirical literature on China's equilibrium exchange rate, using alternative models, see You (2008).

Wang, 2004)[3]. Assuming the sustainable account to be a certain percentage of GDP may seem feasible for a single year (i.e. 2002 in Wren-Lewis (2004a)), but would not be applicable for a data span of several decades as the sustainable account evolves overtime. Furthermore, the savings-minus-investment norm in Debelle and Faruquee (1998) is developed for industrial countries. It's unlikely that the fundamentals that are significant for the sustainable current account in industrial countries will be identical to the ones that are significant for China and *vice versa.* If the fundamentals that make the distinction between China and other countries are not included, the conclusions drawn on the misalignments are likely to be less convincing. Therefore, we contribute to the existing literature by incorporating into the sustainable current account fundamentals that reflect the unique characteristics of the Chinese economy but have not been employed by other studies.

The second contribution lies in the sample period and data set that we use. Existing FEER applications to China focus on the post-reform period only, or selected years after 2000. By restricting their time spans, previous studies miss the opportunity to provide a comparative analysis of the misalignments not only between the centrally-planned pre-reform period and the market-oriented post-reform period, but also amongst different periods of nominal exchange rate adjustments[4]. To address this limitation, we cover both pre- and post-reform periods (1960-2005). We have constructed a unique set of consistent time series for a variety of economic fundamentals and trade-related variables, which allows us to carry out econometric estimation of the sustainable and trend current account, and calculate the FEER for both pre- and post-reform periods.

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[3] Note that Coudert and Couharde (2007) use the sustainable current account estimated in Jeong and Mazier (2003).

[4] For a summary of China's exchange rate regimes since the 1950s, see You and Sarantis (2008c).

The paper is organised as follows. Section 2 outlines the FEER model for China. Section 3 presents the empirical estimates for the trend and sustainable current accounts. Section 4 calculates the FEER for the real bilateral CNY/USD exchange rate and analyses the misalignments. Section 5 draws conclusions.

2. The FEER Model for China

The Fundamental Equilibrium Exchange Rate (FEER), an equilibrium concept developed by Williamson (1994), can be calculated in two alternative ways. The first approach uses a complete macroeconomic model and generates the FEER as a solution. The second approach uses a partial equilibrium model (Driver and Wren-Lewis, 1998; Wren-Lewis, 2003, 2004a, 2004b; Barisone, Driver and Wren-Lewis, 2006). The partial equilibrium approach attempts to estimate part of the complete macroeconomic system and treats the rest as an exogenous input based on judgement. The motivation is mainly simplicity and clarity[5]. There are three steps in estimating the FEER using the partial equilibrium approach. The first step is to estimate the trend current account that is consistent with the internal balance. The second step is to calculate the sustainable current account—the current account that matches medium term structural capital flows. The trend current account in the first step is estimated keeping the real exchange rate unchanged. However, the real exchange rate must move to clear the balance of payments and simultaneously drive the trend current account to match the sustainable current account. The third step is to calculate the FEER that delivers this match.

[5] The model rules out any feedback from the estimated exchange rate to exogenous variables. If there is feedback from the real exchange rate to trend output or savings and investment decisions, there may be inconsistencies between the off-model assumptions and the solution for the real exchange rate.

2.1. The Real Exchange Rate

Following Barisone, Driver and Wren-Lewis (BDW) (2006), we define the real exchange rate, E, as

$$E = N \times \frac{WXP}{P} \tag{1}$$

where N, WXP and DP denote, respectively, the nominal exchange rate of the Chinese Yuan against the US Dollar (CNY/USD), world export prices (in USD) and domestic output price (in CNY). An increase in E implies depreciation of the RMB and *vice versa*.

2.2. Trend Current Account

The trend current account is the current account that is consistent with internal balance. In this chapter we estimate the trend current account following the two-country trade model from BDW (2006) where the trend current account has three components: the trend trade balance, trend interest, profits and dividends (IPD) flows and the trend net transfer. The two countries in our study are China and the rest of the world.

2.2.1. Trend Trade Balance

The trend trade balance is endogenous and is different from the actual trade balance in two perspectives. First, the actual trade balance contains the effect of temporary shocks while those shocks are stripped out in the trend trade balance. Trade balance is called the predicted trade balance when shocks are removed. Secondly, the trend trade balance is the balance that would have prevailed if output equals potential output

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However, Driver and Wren-Lewis (1999) examine the sensitivity of FEERs to feedback from the real exchange rate to output and conclude that the effects are relatively small.

(zero output gap). The derivation of trend trade balance involves estimation of trade volume and trade prices equations for exports and imports respectively.

Following BDW (2006), the predicted real net trade (RNT) is determined by export volume (X), real export price (RXP), import volume (M) and real import price (RMP)[6] as follows:

$$X = (WT, XCOM) \Rightarrow X = X(\underset{+}{WT}, \underset{+}{E/RXP}) \qquad \textit{export volume equation} \quad (2)$$

$$RXP = RXP(\underset{+}{E}, \underset{+}{RCXP}) \qquad \textit{real export price equation} \quad (3)$$

$$M = (Y, MCOM) \Rightarrow M = M(\underset{+}{Y}, \underset{-}{RMP}) \qquad \textit{import volume equation} \quad (4)$$

$$RMP = RMP(\underset{+}{E}, \underset{+}{RCMP}) \qquad \textit{real export price equation} \quad (5)$$

$$RNT = X(\underset{+}{WT}, \underset{+}{E/RXP})RXP(\underset{+}{E}, \underset{+}{RCXP}) - M(\underset{-}{Y}, \underset{+}{RMP})RMP(\underset{-}{E}, \underset{-}{RCMP}) \quad (6)$$

where WT, $RCXP$, Y and $RCMP$ denote world export volume, real commodity export price, real output and real commodity import price respectively. RXP and RMP are measured as export and import prices divided by domestic output price. $RCXP$ and $RCMP$ are measured as commodity export price and commodity import price divided by the world export prices.

As discussed by BDW(2006), the trade volume equations (2) and (4) embody the traditional "demand curve" approach (i.e. Goldstein and Kahn, 1985). The real domestic output of China (Y) measures the total demand for imports which captures the impact of the domestic activity on China's imports, while the world export volume

[6] Details on the specification of the trade volume and price equations can be found in Wren-Lewis (2003, 2004a) and BDW (2006). Some studies further divide trade into trade in goods and trade in services (i.e. Hristov, 2002). Due to limited data availability for China, we use data for aggregate exports and imports.

(WX) measures the total demand for Chinese exports which captures the impact of the world's activity on China's exports. Export and import competitiveness, measured by E/RXP and RMP respectively, act as relative prices of exports and imports. In particular, the import competitiveness, measured by RMP, can be further written as $E/(WXP/MP)$, where MP denotes China's import prices.

Using the estimated coefficients from equations (2)-(5) and the actual values of the variables, we calculate the predicted trend balance (equation (6)) that is not affected by the shocks. To obtain trend current account, the internal balance condition (zero output gap) must be satisfied. To achieve such a condition, we apply the HP (Hodrick-Prescott)-filter to the actual value of domestic real output, Y. By replacing the actual value of Y by its smoothed values in equation (6), we obtain the real trend trade balance $\overline{RNT}$.

2.2.2. Trend IPD Flows

Following BDW (2006), we regard IPD flows as exogenous while taking into account the effect of exchange rate revaluation and smoothing the series using the HP-filter. To take into account the effect of currency revaluation, Hristov (2002) models the currency revaluation as the gap between FEER and actual real bilateral exchange rate divided by the actual real exchange rate and incorporates it into the IPD flows[7]

$$IPD = \left(1 + \frac{FEER - E}{E}\right)(IPDC - IPDD) \tag{7}$$

[7] In Hristov (2002), the net IPD flow is measured as $IPD = \left(1 + \rho \frac{FEER - E}{E}\right)(IPDC - IPDD)$, with ρ measured the proportion of the revaluation effect and is it assumed that $\rho = 1$. For simplicity, in our study we also assume the proportion of the revaluation effect equals unity.

where $\frac{FEER-E}{E}$ measures the revaluation effect, $IPDC$ and $IPDD$ denote overseas assets held by domestic residents and domestic assets held by overseas residents, respectively. To obtain the smoothed IPD flow, we apply the HP-filter to $(IPDC-IPDD)$

$$\overline{IPD}=\left(1+\frac{FEER-E}{E}\right)\overline{(IPDC-IPDD)} \tag{8}$$

with the smoothed series denoted by " $^{-}$ ".

2.2.3. Trend Current Account

Net transfer is regarded as exogenous and it is smoothed by the HP-filter to get the trended value. The trend current account is the sum of trend trade balance, trend IPD and trend net transfer. Differences between the actual and trend current account generally reflect either cyclical movements in output, or persistent deviations in actual trade balance (trade volumes or prices) from their predicted levels.

2.3. Sustainable Current Account

There are two approaches for estimating the sustainable current account. One derives measures of sustainable (structure) capital flows, which finance current account imbalances (Williamson and Mahar, 1998). Another approach equates the current account to the savings minus investment in the economy. This methodology was developed by Masson (1998) and applied by Debelle and Faruqee (1998) to industrial countries and by Chinn and Prasad (2000) to developing countries. We model the sustainable current account for China as savings minus investment. However, for reasons discussed in Section 1, in our study the determinants of the sustainable current account include fundamentals that matter for China and have not been employed by existing studies. The sustainable current account/GDP ratio (CAY) is given by

$$CAY = S - I = CAY(Z) \tag{9}$$

$$\text{where } Z = (\underset{+}{TFP}, \underset{-}{CREP}, \underset{-}{DEP}, \underset{+}{RULC}, \underset{-}{RRC}, \underset{+}{r'}, \underset{+}{B}, \underset{+}{\tau}, \underset{-}{GI},) \tag{9a}$$

where TFP, $CREP$, DEP, $RULC$, RRC, r', B, τ and GI denote, respectively, total factor productivity, financial liberalisation, dependency ratio, relative unit labour cost, relative rate of return to capital, US real interest rate (as an approximation of world real interest rate), relative real price of capital, taxation rate and government investment. The signs under fundamentals indicate their effects on the sustainable current account[8].

3. Empirical Results

As argued by BDW (2006), the FEER describes a medium term equilibrium, hence the concern is not the short run dynamics of trend and sustainable current account equations, but their longer term properties. Therefore, we employ the Johansen cointegration method to test for the long-run properties of the equations. We also look at the adjustment factor in the error-correction model to evaluate the stability of the equations. The sample period is 1960-2005. A detailed description of the data is given in Appendix B.

Before we carry out the cointegration estimation, we apply the ADF (augmented Dickey-Fuller) unit root test in order to test for the stationarity of the variables. The number of lags in the ADF test is chosen using the general to specific procedure suggested by Campbell and Perron (1991). The ADF statistics, reported in Table 1,

[8] The specification of the savings and investment functions is discussed in You and Sarantis (2008a). The derivation of equation (9) and signs of each fundamental are discussed in Appendix A.

cannot reject the null of a unit root for all variables. For the USR the null of a unit root cannot be rejected at 1% and for all other variables at 5%. ADF tests for the first difference of the non-stationary variables show that all of them are $I(1)$ processes so they can enter into a cointegration relationship. We also report ADF statistics with lags chosen by the AIC criterion for comparison. These statistics confirm the results obtained by the Campbell and Perron method.

3.1. Trend Current Account

A time trend (T) and a constant are incorporated in equations (2)-(5)[9]. In terms of the trade price equations, freely estimated parameters of the real commodity prices for the whole sample period are implausibly high. According to BDW (2006), the commodity composition of trade shares could have been used to impose the coefficient on prices, although it is unclear which year to choose. Therefore we fix the coefficients on the commodity prices to the average commodity composition of trade between 1980-2005, which are 0.24 and 0.20 in real export and import price equations respectively. We choose the average of 1980-2005 rather than average of the whole sample as in the pre-reform period the composition of commodity could be distorted by the centrally-planned trade pattern of exporting food and textile and import machinery. We also had to fix the coefficient on the trend in the export price equation as the freely estimated coefficient was implausible. For the import price equation, there is no significant cointegrating vector when we estimate it for the whole sample period. Therefore, we had to exclude the pre-reform period and estimate only the sub-period

[9] When no trends are incorporated, the variables in the trade equations are correctly signed but they are either implausible or statistically insignificant. When trends are incorporated variables remain correctly signed and turn to be statistically significant and plausible. Wren-Lewis (2004a, b) also incorporate trends in the trade equations.

1980-2005, when there is one significant cointegrating vector, and apply the estimated coefficients to the whole sample period.

In order to choose the lag length of the VAR, we started with a maximum lag of 3 and tested downwards using the AIC criterion. For all trade equations, VAR (1, 2) was chosen. The results for the Johansen cointegration are reported in Table 2. The max-eigenvalue statistic suggests one CV at 5% significance level for all four trade equations. The trace statistic suggests one CV at 5% for all equations except two CVs for the export price equation. We chose the results based on the max-eigenvalue statistic as Banerjee *et al* (1986, 1993) suggest that the max-eigenvalue statistic is more reliable in small samples. Therefore, there is one significant cointegrating vector for all four trade equations. The adjustment factors are all negative and significant at 1% (except at 10% for the import price equation), ensuring the stability of all trade equations in the long-run. All estimated coefficients are correctly signed and statistically significant at 5% (except the coefficient of import competitiveness that is significant at 10%). The coefficients are shown in Table 3.

Looking at the export volume equation, the export competitiveness elasticity and the world activity elasticity are 1.05 and 0.26 respectively, which implies that export volume is more responsive to changes in relative prices than to changes in foreign demand. In other words, the large expansion in China's exports is mainly due to improvements in its competitiveness. In the case of the import volume, the import competitiveness elasticity and the domestic activity elasticity are -0.24 and 0.36 respectively. This implies that China's demand for imports is more income elastic than price elastic. The sum of the absolute values of export and import competitiveness is 1.29, which is greater than unity. This suggests that the Marshall-Lerner condition is satisfied in China, mainly due to the high export prices elasticity, and hence currency devaluation can have a positive effect on the trade balance. Both trade volume equations have positive trends of 0.128 and 0.098 respectively[10].

The coefficients on the real exchange rate (relative price of world exports to domestic output in same currency) are 0.79 and 0.85 in the real export and import price equations respectively. This implies that more than three quarters of the real trade prices are determined by the real exchange rate. One interesting feature of the trade prices estimates is that they suggest the trade prices of China are dependent mainly on the world export prices. Decomposition of the estimated coefficients in the real trade prices (see Table 4) reveal that 72% and 81% of the export and import prices respectively are determined by the world export prices, and only 28% and 19% are determined by the domestic output price. This supports the exogeneity of the terms of trade for China.

Based on the coefficients in Table 2 and actual values of the variables, we are able to compute the predicted trade volumes and prices and therefore obtain the predicted exports and imports, which are illustrated in Figures 1 and 2. We apply the HP-filter to output (real GDP) to obtain the potential output[11]. By imposing the condition of internal balance we obtain the trend net trade. The actual, predicted and trend net trade are plotted in Figure 3. We also apply the HP-filter to net IPD flows and net transfers to obtain the trend net IPD flows and trend net transfers (Figures 4 and 5). The sum of the tend net trade, trend net IPD flows and trend net transfers yields the trend current account. The latter is plotted against the real current account (as a percentage of real GDP) in Figure 6.

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[10] Existing studies on the price elasticity of China's foreign trade (or the effect of real exchange rate on China's real exports and imports) reach no consensus. For a literature review, please refer to Cheung, Chinn and Fujii (2005). The estimates in our study, namely for export and import prices (competitiveness) elasticities, and activity (world demand and domestic income) elasticities, are overall within the range suggested by the existing studies.

Looking at Figures 1 and 2, for both exports and imports the predicted values were fairly close to the actual values, except for the 1960s and 1970s when the predicted imports were persistently higher than the actual values. Figure 3 shows that there were little gaps between predicted and trend net trade. It is noticeable that both trend and predicted net trade were lower than the actual values before early 1980s and higher than the actual values for most of the years since middle 1980s, especially for the last three years of the sample period, 2003-2005. Looking at Figure 6, before 1984 the trend real current account/ GDP ratio was below the actual values while for the period 1999-2005, the trend value had been higher than the actual value. During 1985-1998, the trend values were less volatile than the actual values and the two series were fairly close to each other.

3.2. Sustainable Current Account

The sustainable current account (equation (9)) is estimated by applying the Johansen cointegration method. Due to the large number of fundamentals, we adopted the same strategy as in You and Sarantis (2008c), i.e. keeping the core variables (factor productivity, dependency ratio, financial liberalisation) in all equations and dropping the ones that were not significant. Regarding the lag length of VAR, we started with a maximum lag of 3 and tested downwards using the AIC. For all experiments, VAR (1, 1) was chosen. Johansen cointegration estimations often suggest two CVs at 5% and one CV at 1% using the trace statistic, and one CV at both 5% and 1% using the max-eiganvalue statistic. We rely on the max-eigenvalue statistic as Banerjee *et al* (1986,

[11] Following BDW (2006), the world trade volume and real commodity prices are also smoothed using HP-filter.

1993) suggest that the max-eigenvalue statistic is more reliable in small samples. The results of the Johansen cointegration estimations are shown in Table 5.

For all three equations in Table 5[12], the max-eigenvalue statistic suggests one CV at both 1% and 5%. The adjustment factors are all negative and significant at 1%, implying the long-run stability of the equations. All coefficients are significant at 5% except RRC in equation A which is significant at 10%. In each equation, most of the fundamentals have the expected signs. In all three cases, the world real interest rate (USR) is wrongly signed and highly significant. However, sustainable current account computed from the coefficients in equations B and C are abnormally low during the 1960s and extremely high after 2000 compared with the actual values[13]. This may due to the relative large constants in equations B and C. Therefore, we decided to compute the sustainable current account based on the cointegrating vector A. The long-run equilibrium equation is given by

$$CAY=1.1628TFP1 - 0.1680CREP - 0.1719DEP + 2.5394RULC + 0.0969RRC - 0.3577USR + 7.57 \qquad (10)$$

In equation (10), all coefficients are significant at 5% significance level (except RRC at 10%). Though RRC and USR are wrongly signed, the core variables, namely TFP1, CREP, DEP and RULC, are all correctly signed and highly significant.

Based on the coefficients in equation (10) and HP-filtered fundamentals, we obtain the sustainable current account (SCAY). This is plotted against the actual (CAY) and trend (TCAY) current accounts, all measured as a percentage of real GDP, in Figure 6. Overall, SCAY has been stable though there are some shifts for certain periods. It

[12] When we incorporated TFP2 instead of TFP1, we also found one significant CV for most of the combinations, the adjustment factors were also negative and statistically significant and most of the fundamentals were significant and correctly signed. However, the sustainable current account turned out to be positive before the mid-1980s and negative after that, which is the opposite of the actual current account and seems to be implausible. Therefore we only report cointegrating results based on TFP1.

was negative until 1964 and has been positive since 1965. For the period 1965-1992, the SCAY was very stable within 1% of GDP. Since 1993, it has been increasing, though gradually from 1% to 5.5%. Compared with the CAY, the SCAY is much smoother with the former varying around the latter. However, the volatility of the gap between these two CAYs has been relatively higher during 1986-2005 compared with that during 1960-1985. Compared with the TCAY, the SCAY was higher during the period 1961-1985, and then became smaller for most of the years in the period 1986-2005. Such a relationship between TCAY and SCAY suggests that depreciation and appreciation of the RMB were needed during the periods 1960-1985 and 1986-2005 respectively, to match TCAY with the SCAY.

4. FEER and Misalignments

The trend current account was estimated by treating the real exchange rate as exogenous. However, the real exchange rate must move to clear the balance of payments and simultaneously drive the trend current account to match the sustainable current account. The third step is to calculate the FEER that delivers this match. As TCAY is a function of FEER and SCAY is known, we solve for the FEER by equating TCAY to SCAY. Figure 7 plots the FEER against the actual real exchange rate, while Figure 8 exhibits the misalignment rates. Table 6 summarises the findings on misalignment rates[14].

Comparison between the FEER and the actual real bilateral CNY/USD exchange rate suggests that the RMB had been persistently overvalued during the pre- and early post-reform periods. From 1960 to 1985, in 24 out of 26 years, the real bilateral

[13] For instance, based on equation C, the sustainable current account is -19.4% of GDP in 1960 and 14.0% of GDP in 2005, which are implausible.

[14] ADF tests show that the misalignment rates in Figure 8 are stationary at 10%.

CNY/USD exchange rate was lower than the FEER. The misalignment rates show that the real RMB was on average overvalued by 24%, with its peak undervaluation of 39% in 1969. However, the overvaluation had been less severe towards the end of pre- and beginning of post-reform period 1974-1985 when there had been some adjustment in the nominal exchange rate of CNY/USD by the Chinese government. The average overvaluation during 1974-1985 was 12% compared with 34% during 1960-1973.

During the post-reform period 1986-2005, in 12 out of 20 years the real exchange rate was above the FEER. The misalignment rates suggest the RMB was undervalued at an average rate of 5%. For the other 8 years, there was overvaluation with an average rate of 5%. Compared with the persistent overvaluation period 1961-1985, misalignment rates in this period were not only spread on both sides of under and overvaluation, but were also much more modest. We further divide this period into 3 sub-periods: 1) 1986-1996, undervaluation; 2) 1997-2002, overvaluation; 3) 2003-2005, undervaluation. This general picture is drawn by the relationship between TCAY and SCAY that is determined by fundamentals., and coincides with the development of exchange rate policies in China and the US.

Over the period 1986-1996, the USD had been depreciating against major currencies following the Plaza Agreement in 1985. Meanwhile, the Chinese government depreciated RMB by increasing the nominal exchange rate of CNY against the USD several times. The comparison between FEER and the real bilateral CNY/USD rate suggests that the RMB had been undervalued in 9 out of 11 years at an average rate of 4%. The undervaluation could have been more severe had the difference between the nominal and real exchange rates, i.e., the ratio of world export prices to domestic

GDP price deflator (equation 1), not been reduced owning to a faster growth in the domestic GDP price deflator.

The overvaluation during the period 1997-2002 was related to the appreciation of the USD and a fixed nominal exchange rate of CNY/USD. There had been 6 years of consecutive overvaluation at an average rate of 6% with its peak rate of 7% in 1998. Meanwhile, the ratio of world export prices to the domestic GDP price deflator kept on falling due to the decline of the former and the rise of the latter, which may also have contributed to the overvaluation.

With regards the period 2003-2005, it is interesting to notice that not only the RMB had been undervalued, but also that there was an upward trend in this undervaluation. The average undervaluation was 10% with a peak of 14% in 2005. Undervaluation in this period was related to the depreciation of the USD against major currencies and a fixed nominal rate of CNY/USD. At the same time the ratio of world export prices to the domestic GDP price deflator had been relatively stable.

We compare our study with Zhang (2001), one of the few studies of the bilateral real exchange rate of China that covered both post- and pre-reform periods (1954-1997). Based on the BEER model, Zhang (2001) finds relatively large overvaluation before 1978, while the real exchange rate is generally in line with the BEER between 1979-1007. Our results suggest a similar picture for the pre-reform period, but not the post-reform period.

For the period 1998-2005, which was not covered by Zhang (2001), we compare our results with the literature analysing the real bilateral CNY/USD exchange rate for the post-reform period. Most of recent studies suggest undervaluation of the RMB, though with various magnitudes. The average magnitude of undervaluation we found for the period 1986-2005 is much smaller than those reported by most previous studies (i.e. 44-54% in year 2003 by Coudert and Couharde (2007); 36-45% in year 2000 by Frankel (2005); 47% in 2003 by Bénassy-Quéré et al. (2004)).

Next we compare our study with other applications of FEER to China (Table 7). We notice that, despite the different measures of the exchange rate used, the trend current account estimates (measured as a percentage of GDP) are quite similar across these studies (within the band of 2-4%); the differences in misalignments stem primarily from the differences in the sustainable current account estimates (measured as a percentage of GDP) that vary from -2.8% to +3.1%. Basically, the wider the gap between trend and sustainable current account, the larger is the misalignment. The trend current account in our study is similar with existing studies for same years. However, our study suggests a much smaller misalignment than Jeong and Mazier (2003) and Coudert and Couharde (2007), implying a smaller gap between trend and sustainable current account. We believe our estimates of the sustainable current account, which are based on fundamentals that capture the unique features of the Chinese economy that have not been employed by other studies, are more realistic than those of previous papers, some of which are based on assumptions and not on econometric estimations.

5. Conclusions

This paper provides an application of the FEER model, based on the partial equilibrium approach, to the real bilateral exchange rate of the Chinese Yuan against the US Dollar. It is the first FEER application that covers both the pre and post-reform periods. A second contribution is that we incorporate into the sustainable current account fundamentals that reflect the unique features of the Chinese economy but have not been employed by previous studies. Another contribution is the construction of a unique data set of consistent time series for a range of economic fundamentals and trade-related variables, which allows us to carry out econometric investigation of sustainable and trend current accounts for both pre- and post-reform periods. Based on the trend and sustainable current accounts we compute the FEER that closes the gap between them and then we calculate the misalignments.

The main empirical findings are as follows. First, we found one cointegrating vector for each trade equation and for the sustainable current account equation. Second, the estimates of the trend current account suggest that: a) the increase in China's export volume is due mainly to improvements in its price competitiveness; b) China's demand for imports is more income elastic than price elastic; c) the Marshall-Lerner condition holds in China, which implies that currency devaluation (revaluation) can improve (deteriorate) the trade balance; and d) China's trade prices are mainly determined by world trade prices, thus supporting the assumption of exogenous terms of trade for China.

Third, in the estimation of the sustainable current account we found: a) the significant fundamental determinants of the equilibrium real CNY/USD exchange rate are total factor productivity, dependency ratio, financial liberalisation, relative unit labour cost, relative rate of return to capital and world real interest rate; b) the estimated sustainable current account (measured as a percentage of GDP) is negative until 1964, positive but very stable within 1% during 1965-1992, positive and increasing gradually from 1% to 5.5% during 1993-2005.

Fourth, comparing FEER and the actual real bilateral exchange rate, we found that the real RMB had been persistently overvalued for the period 1961-1985, with the misalignment rates during 1961-1973 significantly larger than those during 1974-1985. During 1986-1996, the RMB was undervalued but with an average misalignment rate of only 4%. The most interesting results are those for the last 9 years. During 1997-2002, when there was appreciation of the USD against major currencies and the CNY was fixed against the USD, the RMB had been overvalued, albeit at a modest average misalignment rate of 6%. For the period 2003-2005, when the CNY was still fixed against the USD, the real RMB had been persistently undervalued against the USD at an average rate of 10%, with the highest undervaluation occurring in 2005 at 14%. Nevertheless, the overall undervaluation, especially in the last 3 years, is not as large as suggested by some previous studies.

Appendix A. The Sustainable Current Account

The saving and investment functions, specified in You and Sarantis (2008c), are:

$$s = y(k;TFP) + r'F - C(k,F;CREP,DEP) = S(k,F;TFP,r',CREP,DEP) \quad (11)$$

$$+ \; - \; + \; + \; - \; -$$

$$I = I(I_{DPI}, GI, FDI) = I(k,F;TFP,c,GI,RULC,RRC) \quad (12)$$

$$+ \; + \; + \; - \; + \; - \; +$$

where k, F, TFP, r', $CREP$, DEP, c, GI, $RULC$ and RRC are, respectively, capital stock per effective labour, net foreign assets per effective labour, total factor productivity, real world interest rate (approximated by US real interest rate), financial liberalisation, dependency ratio, user cost of capital, government investment/total fixed assets investment, relative unit labour cost and relative rate of return to capital. Therefore the current account is given by[15]

$$CA = S - I = CA(k,F;TFP,CREP,DEP,RULC,RRC,r',B,\tau,GI) \quad (13)$$

where B denotes relative price of capital (p_k) to price of output (p): $B = p_k/p$.

In long-run equilibrium the two stock variables (*k* and *F*) themselves are functions of the economic fundamentals (see You and Sarantis, 2008c), so the current account/GDP ratio (CAY) can be written as

$$CAY = S - I = CAY(Z) \quad (9)$$

$$\text{where } Z = (TFP, CREP, DEP, RULC, RRC, r', B, \tau, GI,) \quad (9a)$$

$$+ \quad - \quad - \quad + \quad - \quad + \quad + \quad + \quad -$$

Equation (9) implies that the sustainable current account/GDP ratio is purely determined by economic fundamentals. As fundamentals evolve over time, the

[15] Note that $c = [p_k(r+\delta)]/[p(1-\tau)]$, where r is the domestic interest rate and δ is the depreciation rate. As $r = (r', F)$ -see You and Sarantis (2008a)- and δ is assumed constant, this can be written as $c = (B, \tau, r', F)$, where $B = p_k/p$.

sustainable current account also evolves in a way that is consistent with the effects of changes in fundamentals.

Total Factor Productivity: higher total factor productivity stimulates investment; on the other hand, it increases output and hence savings. We assume that higher total factor productivity will have a larger positive effect on savings than on investment, and, therefore a positive effect on sustainable current account.

Dependency Ratio and Financial Liberalisation: A higher dependency ratio implies more consumption and less savings. Higher financial liberalisation suggests easing of liquidity constraints and better access to credit to finance consumption. Both events will lead to lower savings and a reduction in the sustainable current account.

Relative Unit Labour Cost and Relative Rate of Return to Capital (between China and the USA)*:* Higher relative unit labour cost discourages FDI to China. With savings unchanged, this will have a positive effect on the sustainable current account. On the contrary, higher relative rate of return to capital encourages FDI to China and hence have a negative effect on sustainable current account.

Relative Price of Capital to Output and Taxation Rate: Both higher relative price of capital to output and taxation rate lead to higher user cost of capital and consequently discourage domestic investment. Lower investment, with savings unchanged, implies a higher sustainable current account. Therefore, both fundamentals have a positive effect on sustainable current account.

Government Investment: Higher government investment leads to higher aggregate investment and hence lower sustainable current account.

World Real Interest Rate: A higher world real interest rate leads to higher interest income, since China is a net creditor. It also increases the user cost of capital which discourages investment. Both will have a positive effect on the current account.

Appendix B. Data Sources and Variable Measurement

The main data sources for this paper are the *50 Years of New China* (*50YNC*), *China Statistical Yearbook* (*CSY 2006)* of China National Statistical Bureau (NBS), the *IMF International Financial Statistics* (*IFS*), and the *United Nations Conference on Trade and Development* (*UNCTAD*). The data span is 1960-2005. All indices are with 2000 as their base year, unless stated otherwise.

Nominal Exchange Rate (N): The nominal exchange rate of CNY per USD is collected from *IFS* (line 924.RF.ZF). It is then converted into an index.

World Export Price (WXP): The world export price index (unit value of world export) (in USD) is collected from *IFS* (line 74. DZF).

GDP Price Deflator (P) *and Real Output* (Y): The construction of these variables is explained in You and Sarantis (2008c).

The Real Exchange Rate (E): The real exchange rate is defined in equation (1) as the nominal exchange rate times world export prices and divided by the GDP price deflator.

Export and Import Values: Data are collected from *IFS* (lines 70.DZF and 71.DZF) and then converted into domestic currency using the nominal exchange rate, N .

Export (XP) and Import (MP) Prices: The construction of export and import prices indices (in USD) is discussed in You and Sarantis (2008c). But here we convert the export and import prices indices into domestic currency using the nominal exchange rate, *N*.

Export (X) and Import (M) Volumes: By dividing export and import values by the export and import prices indices (all in domestic currency) respectively and multiplying by 100, we obtain the export and import values at constant prices.

Real Export (RXP) and Import (RMP) Prices: The real export and import prices indices are defined as the export and import prices indices in domestic currency divided by the domestic GDP price deflator and multiplied by 100.

World Export Volume (WT): World export volume is derived by dividing world export value by the world export prices index and multiplying by 100. World export value (in USD) is collected from *IFS* (line 70.DZF).

Commodity Export (CXP) and Import (CMP) Prices: In BDW (2006), the commodity export price is defined as a weighted average of the following commodity prices: oil prices, world food prices, world beverage prices, world agricultural non food prices, and world metals and minerals prices, with the weights based on the relevant shares of world commodity exports and imports in total trade. *UNCTAD* provides price indices for a) all food (which includes i) beverages ii) vegetable oil seeds and oils iii) agriculture raw materials), b) mineral, ores and metals, c) crude petroleum (average of Dubai/Brent/Texas equally weighted ($/barrel)). *UNCTAD* also provides price of all food which includes the first 3 categories.

Since 1980, *CSY* provides disaggregated trade data. Trade in commodity is disaggregated into a) food and live animals chiefly for food, b) beverages and tobacco, c) animal and vegetable oils, d) fats and waxes non-edible raw materials mineral fuels, e) lubricants and related materials. By dividing trade value of each category by sum of the five categories gives the share of each category. However, data before 1980 are not available.

UNCTAD also provides shares of 4 categories, which are a) all food (includes food, beverages and vegetable oil seeds and oils), b) agricultural raw materials, c) mineral, ores and metals, d) crude petroleum, for some developed countries and developing areas that go back to 1960. One of the areas covered by *UNCTAD* is the Developing

Countries: Other Asia, which includes China. For the period 1960-1979, we will use the shares for the latter region to approximate the shares for China[16] .The matching between shares reported by *CSY* and *UNCTAD* is shown in Table 8.

For years prior to 1980, we apply an adjustment factor to shares collected from *UNCTAD*. For each category, the adjustment factor is defined as the 23 years (1980-2002) average of China's shares from *CSY* divided by same 23 years average of shares from *UNCTAD*. Then original shares from *UNCTAD* before 1980 are multiplied by the adjustment factor, hence called the "adjusted shares", to obtain the approximations of shares for China. The adjusted shares are then normalised so that the sum of them for each year is 100%. Therefore, for the years prior to 1980, shares of China are approximated by adjusted shares from *UNCTAD* and for the period 1980-2005, the shares are obtained from data provided by *CSY*.

Real Commodity Export (RCXP) and Import Prices (RCMP): These are derived by dividing commodity export and import prices by the world export prices index and multiplying by 100.

Nominal and Real Net Trade: IFS provides data for goods exports (line 78AADZF), services credit (line 78ADDZF), goods imports (line 78ABDZF) and service debit (78AEDZF) for China from 1982 to 2005 in USD. The sum of the first pair gives exports in goods and service and the sum of the second pair gives imports in goods and services. *IFS* also provides export and import values for China in USD from 1960 to 2005 (lines 70DZF and 71DZF)[17]. We compared export and import values with

[16] We used shares of Developing Countries: Other Asia to approximate the shares of China for two reasons. First, China is included in the group of developing countries: other Asia. Second, compared with shares of other countries or regions provided by *UNCTAD*, developing countries: other Asia have shares that are closest to shares of China for the period 1980-2005. The only exception is import of fuel. USSA has the closest import shares of fuel compared with China for the years after 1980 and hence we use import shares of fuels of USSA to approximate that of China.

[17]According to notes in *IFS*, export and import values cover merchandise trade. Therefore, services are not included in these two series. This explains the gaps between export/import values and export/import in goods and services. However, in the early and mid-1980s, export/import values and

exports and imports in goods and service for the overlapping period (1980-2005) and found they are very close. Hence we construct the adjustment factors based on the three overlapping years 1982-1984, and multiply the export and import values before 1982 by the adjustment factors. Therefore, for the period 1960-1981, exports and imports in goods and services are approximated by adjusted export and import values; for the period 1982-2005, actual data are used. Then the nominal net trade is the gap between the two series and is converted into CNY using the nominal exchange rate N. The real trade balance is obtained by dividing the nominal trade by the GDP price deflator.

Nominal and Real Net IPD Flows ($NIPD$) *and Net Transfer* (NTR): *IFS* provides IPD credit and debt (lines 78AGDZF and 78AHDZF) and current transfer credit and debt (lines 78AJDZF and 78AKDZF) for China from 1982 to 2005 in USD. The sum of the first pair gives the net IPD flows and that of the second pair gives the net transfer. They are converted into CNY using the nominal exchange rate N.

For the period prior to 1982, data are not available. For the period 1982-2005, when data is available from *IFS*, we convert current account, balance in goods and service (line 78AFDZF), net IPD flows and net transfer into CNY using nominal exchange rate N and then calculate the ratios of current account, balance in goods and service, net IPD flows and net transfer to GDP. Before 1994, the fluctuation of current account/GDP ratio was mainly represented by the net trade/GDP ratio; on the other hand, net IPD/GDP and net transfer/GDP ratios (especially the latter) were very smooth, fluctuating within the narrow bands of -0.21%-0.51% and 0.06%-0.24% respectively. Based on their relative stable and small ratios, we use the averages of the

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export/import in goods and services are almost identical, implying trade in services are negligible. For the years prior to 1982, we expect that trade in service carries even smaller weights due to China is economically more closed. Therefore, during 1960-1982, export/import values are very close approximations to export/import in goods and services.

net IPD/GDP and net transfer/GDP ratios for the period 1982-1994, which are 0.12% and 0.13% respectively, to approximate the ratios before 1982. For years prior 1982, by multiplying the two ratios by GDP we obtain the nominal values of net IPD flows and net transfer in CNY respectively. Real net IPD flows and net transfer in CNY are obtained by dividing their respective nominal values by the GDP price deflator.

Nominal and Real Current Account: For the period 1982-2005, nominal current account in USD is collected from *IFS* (line 78ALDZF) and is converted into CNY by using the nominal exchange rate N. For the period 1960-1981, the sum of nominal net trade, net IPD flows and net transfer, all in CNY, gives the nominal current account. The real current account is derived by dividing the nominal current account by the GDP price deflator.

Real Current Account/GDP Ratio (CAY): The real current account/GDP ratio is derived by dividing the real current account by real GDP and then multiplying by 100.

Relative Price of Capital to Output (B): This is measured by the price index of capital (p_k), which is constructed in You and Sarantis (2008b, c), divided by the GDP price deflator.

Chinese Economic Fundamentals $(TFP, CREP, DEP, RULC, RRC, r', B, \tau, GI,)$: See You and Sarantis (2008c) for a detailed description of the measurement of these variables and data sources.

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Table 1. Unit Root Tests (ADF)

	General to Specific					AIC				
Sample Period: 1960-2005		Level		1st Difference			Level		1st Difference	
Variables	Lag Length	ADF	p-value	ADF	p-value	Lag Length	ADF	p-value	ADF	p-value
E	0	-1.01	0.7424	-6.15	0.0000	0	-1.01	0.7424	-6.15	0.0000
X	0	3.12	1.0000	-6.71	0.0000	0	3.12	1.0000	-6.71	0.0000
WT	0	-0.02	0.9517	-6.26	0.0000	0	-0.02	0.9517	-6.26	0.0000
XCOM	0	-0.59	0.8625	-7.09	0.0000	0	-0.59	0.8625	-7.09	0.0000
M	2	1.87	0.9997	-4.98	0.0002	3	2.34	0.9999	-4.23	0.0018
Y	2	1.17	0.9975	-6.14	0.0000	2	1.17	0.9975	-6.14	0.0000
MCOM	0	-1.06	0.7226	-6.01	0.0000	0	-1.06	0.7226	-6.01	0.0000
RXP	0	-1.58	0.4837	-6.91	0.0000	0	-1.58	0.4837	-6.91	0.0000
RCXP	2	-1.30	0.6216	-4.56	0.0007	2	-1.30	0.6216	-4.56	0.0007
RMP	0	-1.06	0.7226	-6.01	0.0000	0	-1.06	0.7226	-6.01	0.0000
RCMP	2	-1.16	0.6837	-4.23	0.0018	2	-1.16	0.6837	-4.23	0.0018
CAY	0	-2.26	0.1877	-6.44	0.0000	0	-2.26	0.1877	-6.44	0.0000
DEP	1	0.82	0.9932	-3.09	0.0351	1	0.82	0.9932	-3.09	0.0351
CREP	1	-0.74	0.8262	-4.32	0.0013	1	-0.74	0.8262	-4.32	0.0013
RULC	0	-0.29	0.9183	-5.79	0.0000	0	-0.29	0.9183	-5.79	0.0000
RRC	0	-2.73	0.0774	-7.58	0.0000	0	-2.73	0.0774	-7.58	0.0000
B	1	-1.32	0.6105	-4.07	0.0027	1	-1.32	0.6105	-4.07	0.0027
TFP1	2	0.44	0.9827	-5.22	0.0001	3	0.86	0.9941	-3.94	0.0037
TFP2	2	0.99	0.9959	-4.60	0.0005	2	0.99	0.9959	-4.60	0.0005
GI	1	-0.61	0.8587	-4.24	0.0016	3	-0.59	0.8628	-2.78	0.0691
USR	1	-3.01	0.0415	-5.71	0.0000	1	-3.01	0.0415	-5.71	0.0000
TAX	0	-2.25	0.1923	-6.40	0.0000	0	-2.25	0.1923	-6.40	0.0000

Note: (a) E=real exchange rate; X=export volume; WT=world trade volume; XCOM=E/RXP=export competitiveness; M=import volume; Y=real GDP; MCOM=RMP=E/(WXP/MP)=import competitiveness; RXP=real export price; RCXP=real commodity export price; RMP=real import price; RCMP=real commodity import price; CAY=real current account/GDP ratio; DEP=dependency ratio; CREP=financial liberalisation; RULC=relative unit labour cost (between China and the USA); RRC=relative return to capital (between China and the USA); B=relative price of capital to output; TFP1=total factor productivity 1; TFP2=total factor productivity 2; GI=government investment/total investment ratio; USR=US real interest rate; TAX=tax rate.

(b) TFP1and TFP2 are based on two alternative measures of capital stock: K1 that is calculated by employing the methodology of Chow and Li (2002), but using updated data from CSY 2006 and extended from 1998 to 2005; K2 obtained from Bai *et al* (2006). See You and Sarantis (2008b) for details about the measurement of the two capital stock series, the estimation of the production function and the calculation of total factor productivity.

(c) All variables are measured in natural logarithm except RRC and USR as they are rates of returns. Also CAY is not measured in natural logarithm as it contains negative values.

Table 2. Johansen Cointegration Results of Trade Volumes and Prices Equations

	Hypothesized No. of CE(s)	Trace Statistic	5% Critical Value	1% Critical Value	p-value	Max-Eigen Statistic	5 % Critical Value	1% Critical Value	p-value
Export Volume Equation	None	58.48*	47.86	54.68	0.0037	34.47*	27.58	32.72	0.0056
	At most 1	24.02	29.80	34.46	0.1998	12.04	21.13	25.86	0.5437
Import Volume Equation	None	55.12*	47.86	54.68	0.0090	29.43*	27.58	32.72	0.0286
	At most 1	25.68	29.80	34.46	0.1384	18.59	21.13	25.86	0.1094
Real Export Prices Equation	None	71.88*	47.86	54.68	0.0001	40.86*	27.58	32.72	0.0006
	At most 1	31.02*	29.80	35.46	0.036	17.72	21.13	25.86	0.1406
Real Import Prices Equation	None	57.12*	47.86	54.68	0.0053	30.35*	27.58	32.72	0.0215
	At most 1	26.77	29.80	35.46	0.1074	17.71	21.13	25.86	0.1409

Normalized cointegrating coefficients (std.err. in parentheses)

Export Volume Equation	X	WT	XCOM	T	C
	1.0000	-0.2603	-1.0490	-0.1281	2.0959
		(0.0724)	(0.1278)	(0.0050)	
	Adjustment coefficient (std.err. in parentheses)				
	D(X)	-0.5270			
		(0.1699)			
Import Volume Equation	M	Y	MCOM	T	C
	1.0000	-0.3580	0.2388	-0.0975	-3.0123
		(0.1433)	(0.1256)	(0.0129)	
	Adjustment coefficients (std.err. in parentheses)				
	D(M)	-0.5145			
		(0.1631)			
Real Export Prices Equation	RXP	RCXP	E	T	C
	1.0000	-0.24	-0.7895	0.01	0.0904
		(0.0000)	(0.0758)	(0.0000)	
	Adjustment coefficients (std.err. in parentheses)				
	D(RPX)	-0.3598			
		(0.1057)			
Real Import Prices Equation	RPM	RCMP	E	T	C
	1.0000	-0.20	-0.8538	0.0124	0.1921
		(0.0000)	(0.1183)	(0.0045)	
	Adjustment coefficients (std.err. in parentheses)				
	D(RMP)	-0.3168			
		(0.1746)			

Note: "*" denotes rejection of the hypothesis at the 5% level. Critical values are taken from MacKinnon *et al* (1999).

Table 3. Trade Volumes and Prices Equations

Export Volume (X)			Import Volume (M)		
World Activity (WT)	Competitiveness (XCOM)	Trend (T)	Domestic Activity (Y)	Competitiveness (MCOM)	Trend (T)
0.26	1.05	0.128	0.36	-0.24	0.098
Real Export Prices (RXP)			**Real Import Prices (RMP)**		
Relative Price (E)	Real Commodity (RCXP)	Trend (T)	Relative Price (E)	Real Commodity (RCMP)	Trend (T)
0.79	0.24^{F}	-0.010^{F}	0.85	0.20^{F}	-0.012

Note: Superscript "F" denotes the parameters are fixed. All equations are estimated for 1960-2005 except import prices equation is estimated for 1980-2005.

Table 4. Decomposition of Coefficients in Prices Equations

Export prices (XP)				Import prices (MP)			
World (WXP)	Domestic (P)	Commodity (CXP)	Trend (T)	World (WXP)	Domestic (P)	Commodity (CMP)	Trend (T)
0.72	0.28	0.24^{F}	-0.010^{F}	0.81	0.19	0.20^{F}	-0.012

Note: Trade price equations can be written as follows:

$$N \times XP = \left((N \times WXP)^{\gamma} P^{1-\gamma} \right)^{\alpha} (N \times CXP)^{1-\alpha} ,$$
$$N \times MP = \left((N \times WXP)^{\phi} P^{1-\phi} \right)^{\beta} (N \times CMP)^{1-\beta} ,$$

where N , XP , MP , WXP , P , CXP and CMP are, respectively, nominal exchange rate (domestic currency per USD), export price, import price, world export price, domestic output price, commodity export price and commodity import price.
The estimates of 0.72 and 0.81 are for the parameters γ and φ respectively.

Table 5. Johansen Cointegration Results for the Sustainable Current Account

	Hypothesized No. of CE(s)	Trace Statistic	5 % Critical Value	1% Critical Value	p-value	Max-Eigen Statistic	5% Critical Value	1% Critical Value	p-value
Equation A	None	158.75*	125.62	135.97	0.0001	60.27*	46.23	52.31	0.0009
	At most 1	98.48*	95.75	104.96	0.0320	30.59	40.08	45.87	0.3861
Equation B	None	252.38*	197.37	210.05	0.0000	86.24*	58.43	65.00	0.0000
	At most 1	166.14*	159.53	171.09	0.0207	47.07	52.36	58.67	0.1575
Equation C	None	123.37*	97.75	104.96	0.0002	55.74*	40.08	45.87	0.0004
	At most 1	67.63	69.82	77.82	0.0738	26.99	33.88	39.37	0.2636

Normalized cointegrating coefficients (std.err. in parentheses)

Equation A	CAY	TFP1	CREP	DEP	RULC	RRC	USR	C		
	1.0000	-1.1628	0.1680	0.1719	-2.5394	-0.0969	0.3577	-7.57		
		(0.1924)	(0.0287)	(0.0461)	(0.4967)	(0.0590)	(0.0776)			
	Adjustment coefficient (std.err. in parentheses)									
	D(CAY)	-0.5769								
		(0.1449)								
Equation B	CAY	TFP1	CREP	DEP	RULC	B	USR	GI	TAX	C
	1.0000	-2.8700	0.4888	0.4096	-2.4482	0.1718	0.4563	-0.1458	-0.5901	-36.3745
		(0.3256)	(0.0469)	(0.1444)	(1.0146)	(0.0675)	(0.1532)	(0.0457)	(0.1469)	
	Adjustment coefficient (std.err. in parentheses)									
	D(CAY)	-0.2226								
		(0.0759)								
Equation C	CAY	TFP1	CREP	DEP	RULC	USR	C			
	1.0000	1.9087	0.2829	0.2617	-3.3964	0.5969	-12.4563			
		(0.3245)	(0.0438)	(0.0782)	(0.8348)	(0.1343)				
	Adjustment coefficient (std.err. in parentheses)									
	D(CAY)	-0.3619								
		(0.0899)								

Note: "*" denotes rejection of the hypothesis at the 5% level. Critical values are taken from MacKinnon *et al* (1999).

Table 6. Summary of Findings—FEER for Real CNY/USD Exchange Rate

1960-1985 (Overvaluation occurred in 24 out of 26 years (except 1960 and 1976) with an AMR of 24%)		1986-2005 (Undervaluation occurred in 12 out of 20 years with an AMR of 5%)		
1960-1973[18] (Fixed nominal exchange rate)	1974-1985 (small adjustments of nominal exchange rate)	1986-1996[19] (large depreciation of nominal exchange rate)	1997-2002 (Fixed nominal exchange rate)	2003-2005 (Fixed nominal exchange rate)
There were relatively large MRs in this period. AMR for this period was 34% with the peak MR at 39% in 1969.	In this early post-reform period MRs were relative smaller. AMR for this period was 12% with peak MR at 26% in 1979.	There were 9 out of 11 years of undervaluation. AMR for this period was 4% with the peak MR at 6% in 1988.	There were 6 years of consecutive overvaluation. AMR for this period was 6% with the peak MR at 7% in 1998.	There were 3 years of consecutive undervaluation. AMR for this period was 10% with the peak MR at 14% in 2005.

Note: AMR and MR refer to average misalignment rate and misalignment rate respectively.

Table 7. Choice of Sustainable Current Account and Misalignments

Study	Exchange Rate	Trend Current Account (as a % of GDP)	Sustainable Current Account (as a % of GDP)	Results
Wang (2004)	REER	2.1 in 2000-2002	(1) 3.10%; (2)0.98%	(1) Modestly overvalued; (2) Modestly undervalued
Wren-Lewis (2004a)	NER	3.4% in 2002	(1) 1%; (2) 0%	(1) 20% undervalued (2) 28% undervalued
Jeong and Mazier (2003)	REER NER	2-4% in 1997-2000[20]	-1%— -1.5%	REER: 33% undervalued NER: 60% undervalued
Coudert and Couharde (2007)	RER	n.a.	(1) -2.8%; (2) -1.5%	(1) 57% undervalued (2) 44% undervalued
Our Study	RER	2.53% in 2002 1.85% in 2000-2002	3.7% in 2002 3.2% in 2000-2002	4% overvalued in 2002 6% overvalued in 2000-2002

Note: NRE, RER, and REER denote, respectively, nominal bilateral CNY/USD exchange rate, real CNY/USD exchange rate and real effective exchange rate.

[18] The nominal exchange rate had been fixed between 1960-1971. In 1972 and 1973 the nominal rate adjusted slightly. We broadly include 1972 and 1973 into the fixed nominal exchange rate period.
[19] The fixed nominal exchange rate of CNY/USD starts from 1994 but here for convenience we regard 1986-1996 as a period of large depreciation of RMB.
[20] The sample period of Jeong and Mazier (2003) is 1982-2000. However, before 1996, the trend current account was relatively volatile, varying between -4% – 4% and hence is not included here.

Table 8. Detailed Total Trade Disaggregation of *CSY* and *UNCTAD*

<table>
<tr><td colspan="3">Disaggregation of CSY</td><td colspan="2">Disaggregation of UNCTAD</td></tr>
<tr><td rowspan="6">Primary Goods</td><td rowspan="3">All Food</td><td>Food and Live Animals Chiefly for Food</td><td rowspan="3">All Food</td><td rowspan="6">Primary Goods</td></tr>
<tr><td>Beverages and Tobacco</td></tr>
<tr><td>Animal and Vegetable Oils, Fats and Waxes</td></tr>
<tr><td colspan="2" rowspan="2">Non-edible Raw Materials</td><td>Minerals, Ores and Metals</td></tr>
<tr><td>Agricultural Raw Materials</td></tr>
<tr><td colspan="2">Mineral Fuels, Lubricants and Related Materials</td><td>Crude petroleum</td></tr>
<tr><td colspan="3">Manufactured Goods</td><td colspan="2">Manufactured Goods</td></tr>
</table>

Figure 1. Predicted and Actual Exports (Billion CNY) (in Natural Log)[21]

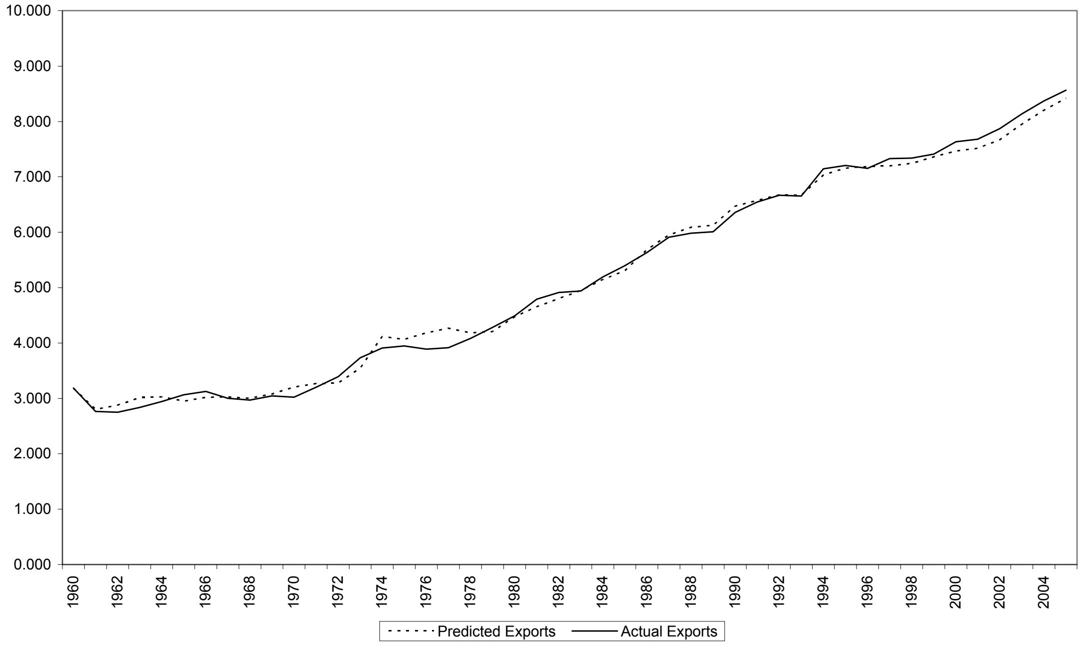
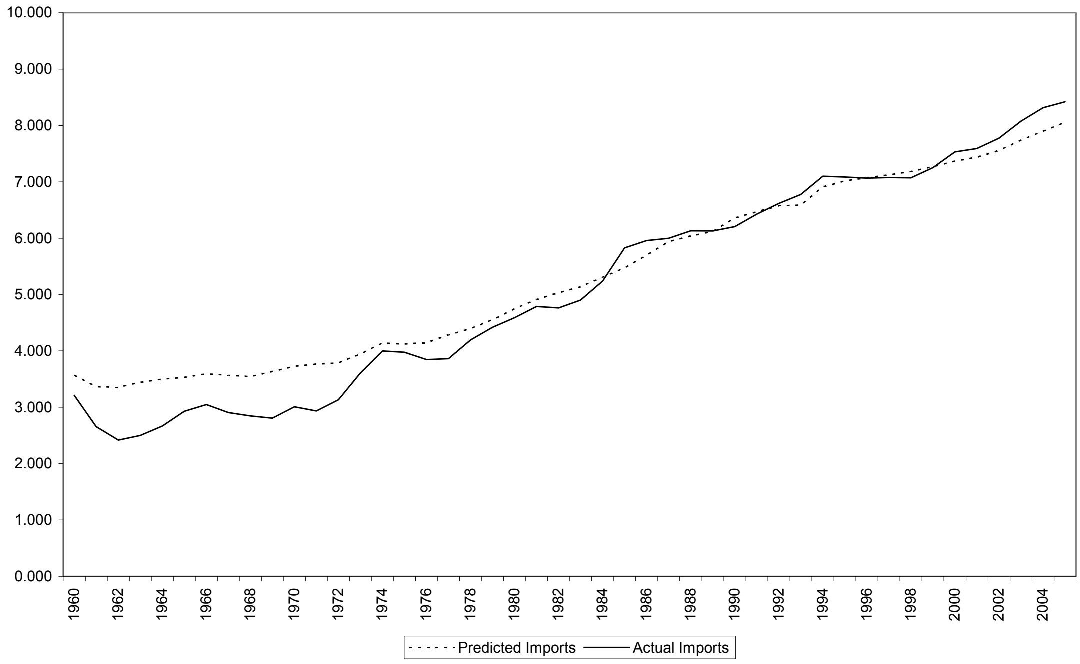


Figure 2. Predicted and Actual Imports (Billion CNY) (in Natural Log)



[21] Predicted Exports at constant prices= (Predicted Export Volume*Predicted Real Export prices)/100; Predicted Imports at constant prices= (Predicted Import Volume*Predicted Real Import Prices)/100.

Figure 3. Predicted, Trend and Actual Net Trade (Billion CNY) [22]

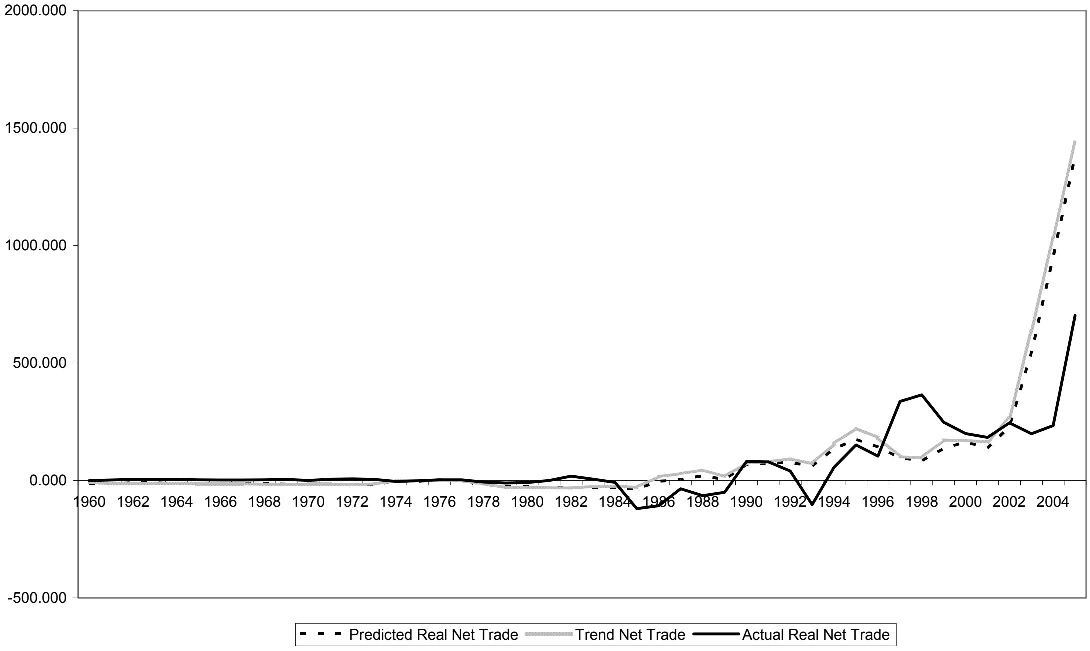
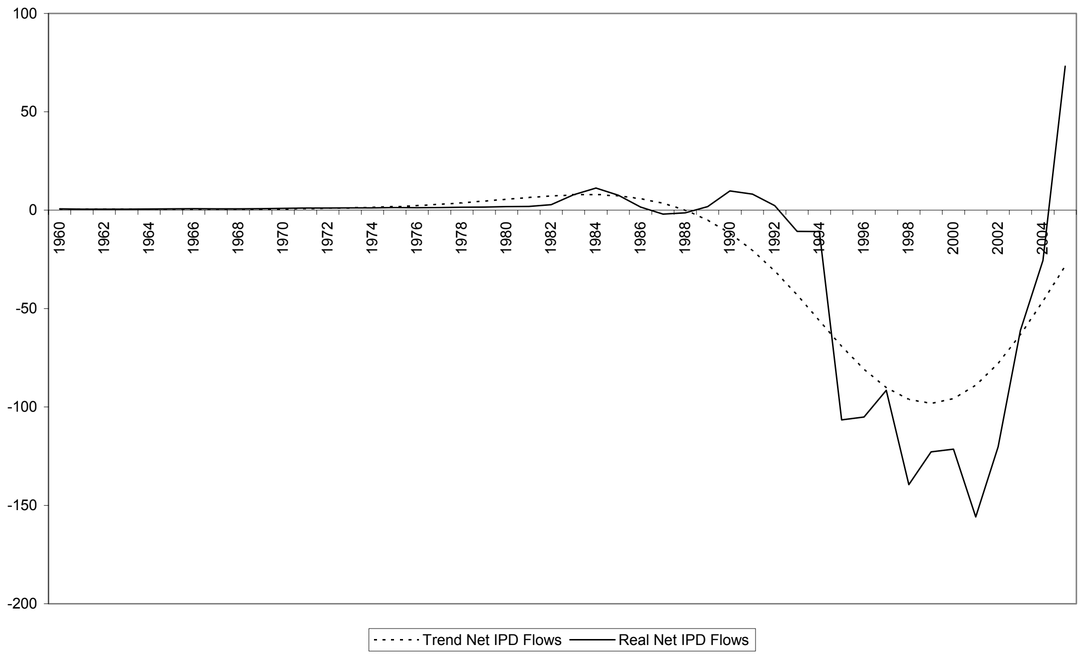


Figure 4. Potential and Actual Real Net IPD Flows (Billion CNY)



[22] Net trade, net IPD flows and net transfers are not in natural log as some of the values are negative.

Figure 5. Trend and Actual Real Net Transfers (Billion CNY)

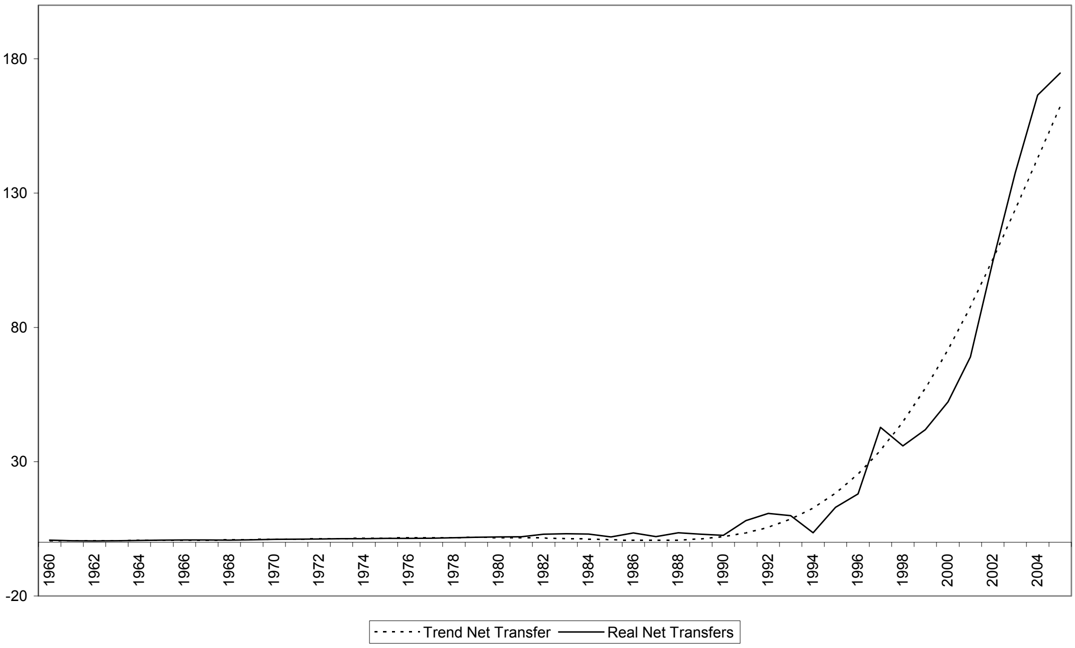


Figure 6. Trend (TCAY), Sustainable (SCAY) and Actual (CAY) Current Account (as a percentage of GDP)

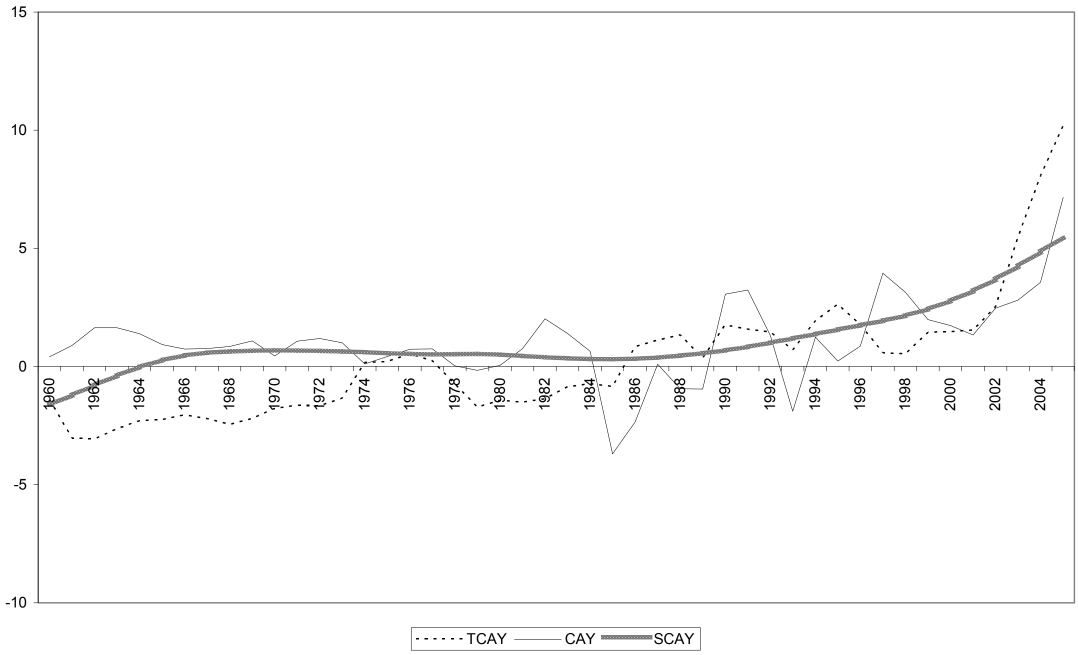


Figure 7. FEER and Actual Real CNY/USD Exchange Rate (E)

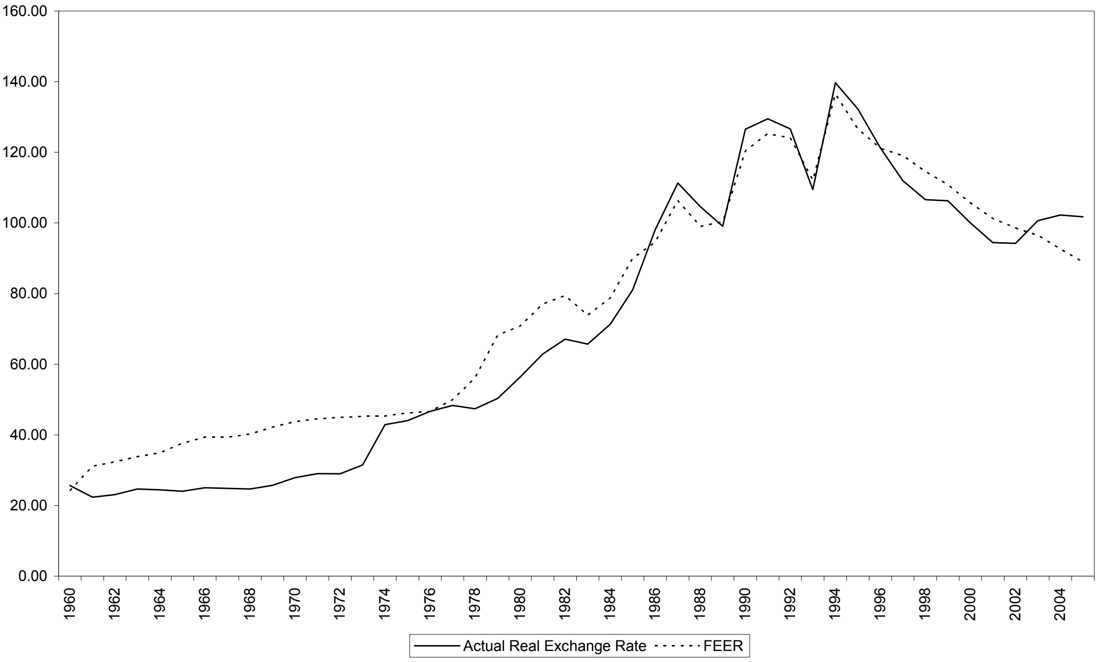
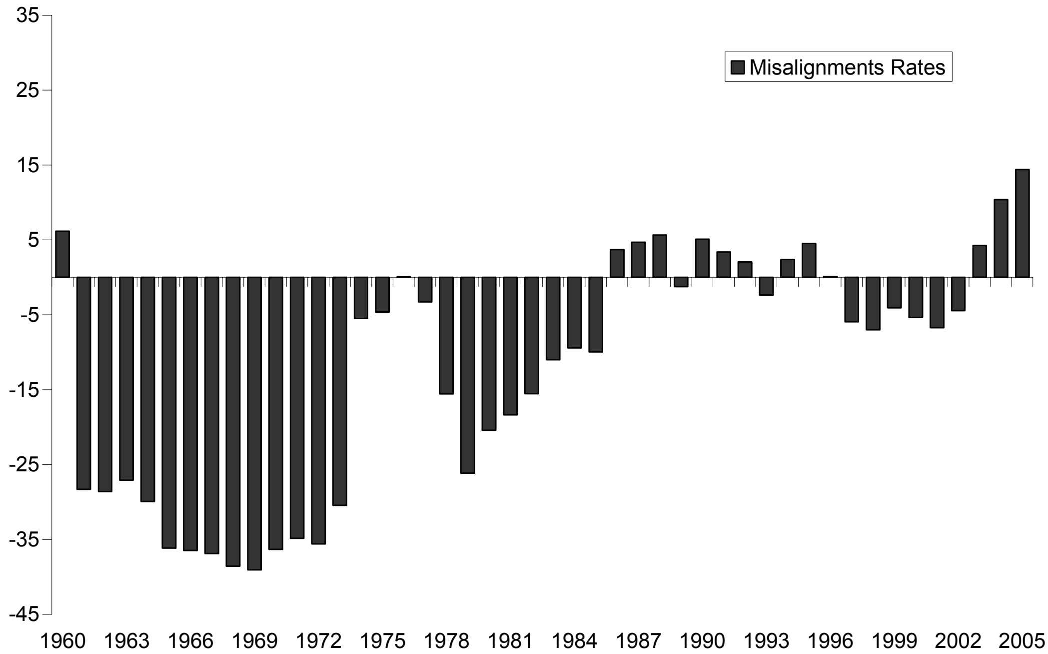


Figure 8. Misalignment Rates between Actual Real CNY/USD Exchange Rate and FEER (%)



Note: Misalignment rate=(E-FEER)/FEER*100%; a positive (negative) misalignment rate implies an undervaluation (overvaluation) of the RMB. E denotes the actual real CNY/USD rate (equation 1).