CURRENCY CONVERTIBILITY AND LINKAGE BETWEEN CHINESE OFFICIAL AND SWAP MARKET EXCHANGE RATES

JIAN YANG and DAVID J. LEATHAM*

This article investigates the impact of currency convertibility under the current account on the informational linkage between official and swap market exchange rates for Chinese currency (renminbi). Findings indicate that currency convertibility increased the informational connection between the government’s official exchange rate and the swap market exchange rate, exclusively traded by foreign investors, and thus improved the information content of renminbi exchange rates. Moreover, the results also suggest that more complete currency convertibility was needed for more informed renminbi exchange rates. (JEL F31, F32, G14, G15)

I. INTRODUCTION

After unifying the dual exchange rates of the Chinese currency renminbi (RMB) and implementing a managed-float system on January 1, 1994, China formally committed itself to partial currency convertibility, that is, currency convertibility under the current account, in December 1996. Partial currency convertibility means that any domestic or foreign agent in China has the right to convert freely the domestic currency into a foreign currency at the official exchange rate to complete a current account transaction. A current account transaction is typically the purchase of goods or services from abroad, including the remittance of profits earned on direct investment. Partial currency convertibility is partial in its nature in that it does not permit conversion of the domestic currency into a foreign currency for the purpose of a capital account transaction, such as capital exporting. However, partial currency convertibility was an unprecedented step in the liberalization of China’s foreign exchange system. It should have significant effects on China’s foreign exchange market performance.

Little empirical work has been done previously to examine how currency convertibility affects performance of financial markets in developing countries. This article addresses the impact of partial currency convertibility on the informational efficiency of Chinese foreign exchange markets. Specifically, this article empirically investigates the informational linkage between official and swap market exchange rates in China before and after partial currency convertibility was implemented. The RMB official exchange rates were based on rates of the interbank market where Chinese firms made their foreign exchange transactions during the study period. Hence, official exchange rates over the sample period depended primarily on domestic transactions. In contrast, swap markets were foreign exchange markets traded exclusively by foreign-invested enterprises (FIEs) in China during the study period, though FIEs could also get access to the interbank market after China allowed partial currency convertibility. Thus, swap market exchange rates reflect information provided by foreign investors. The underlying

*The authors thank David A. Bessler and two anonymous reviewers for their helpful comments.

Yang: Assistant Professor, Department of Accounting, Finance and Information Systems, P.O. Box 638, Prairie View A&M University, Prairie View, TX 77446. Phone 1-936-857-4011, E-mail jian.yang@pvamu.edu

Leatham: Professor, Department of Agricultural Economics, 2124 Texas A&M University, College Station, TX 77843-2124. Phone 1-979-845-5806, Fax 1-979-862-1563, E-mail d-leatham@tamu.edu

ABBREVIATIONS

ADF: Augmented Dickey-Fuller
AIC: Akaike Information Criteria
ECM: Error Correction Model
FIE: Foreign-Invested Enterprise
IMF: International Monetary Fund
RMB: Renminbi
WS: Weighted Symmetric

Contemporary Economic Policy
ISSN 1074-3529

© Western Economic Association International

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
assumption is that Chinese domestic investors and foreign investors on the foreign exchange markets may have differential access to information if they are legally separated in two completely segmented markets.

The existence of information asymmetry (i.e., different information sets) on values of domestic assets between foreign investors and domestic investors has been well recognized in finance literature (Kang and Stulz, 1996; Brennan and Cao, 1997). However, the issue of whether foreign investors have more information than domestic investors is controversial. The controversy also applies to studies on Chinese stock markets (i.e., A shares and B shares markets), which was characteristic of complete market segmentation, and similar to the Chinese foreign exchange markets before partial currency convertibility. Chui and Kwok (1998) argue that foreign investors may be better informed than Chinese domestic investors about the value of financial assets, because of the Chinese government’s control of mass media and the more advanced technology for processing and analyzing information by foreign investors. In contrast, Chakravarty et al. (1998) argue that foreign investors have less information on Chinese stocks than domestic investors due to language barriers, different accounting standards, and lack of reliable information about the local economy and firms. This article may shed more light on the information asymmetry issue.

The empirical results herein address the following questions. First, does partial currency convertibility help produce more informed RMB official exchange rates, at least in the long run? It was expected that official and swap market exchange rates are more likely to be linked after currency convertibility because more information regarding RMB valuation may be assimilated from foreign investors into the official exchange rates. Second, do swap markets, under the partial currency convertibility system, provide valuable information? There was no clear time schedule on how and when the swap centers would be eliminated. As of this writing, the two swap markets under study are still in operation. There was also a popular argument that the current convertibility system would make the swap centers unnecessary (Stevenson-Yang, 1996; House and Lehner, 1996). However, if major swap markets were still effective in collecting and providing relevant RMB valuation information during the early period of currency convertibility, any plan to formally close all major swap markets in the near future should be assessed prudently. Third, was there any indirect evidence of the effectiveness of Chinese foreign exchange management under the managed-float system and of the associated trade system reforms since 1994? Although China has claimed unification of the RMB dual exchange rates and partial currency convertibility in recent years, the effects of these liberalization policies could be jeopardized by the continuation of heavily rooted broad administrative intervention and discretion under the managed-float system. In addition, the substance of currency convertibility could be denied de facto if an abolition of exchange control were accompanied by an intensification of trade restrictions (Williamson, 1991, 377). Thus, the existence of informational linkage between official and swap market exchange rates was conditional on and in favor of the effective market-oriented foreign exchange market management under the managed-float system, which would imply that the market force was really in place to value RMB exchange rates. Similar arguments can be made regarding the progress in liberalization of China’s trade system.

The article is organized as follows. First, the evolution of China’s exchange rate policy is briefly reviewed. Second, the data used in the study and its time series property is described. Third, the econometric methodology and the hypotheses of interest are presented. Fourth, the empirical results are discussed. Finally, the conclusions are made.

II. EVOLUTIONARY POLICY TOWARD CURRENCY CONVERTIBILITY

China’s RMB was inconvertible at its inception in 1949. Until the start of economic reform in 1978, the central government directly planned RMB exchange rates and foreign exchange allocation for a handful of foreign trade companies with little reference to market conditions. Since then, as part of the reform process, the foreign exchange system and foreign trade system have been progressively liberalized. Lardy (1992) gives
an excellent account of liberalization process in the foreign trade system and the foreign exchange system, spanning from the late 1970s to late 1980s and focusing on specific important policy changes (such as the use of the internal settlement rate) in the early stage of China's economic reform.

In 1986, China introduced a dual RMB exchange rate system. During 1986–93, China maintained this system, with an artificially high official exchange rate that was adjusted periodically, and a more depreciated market-determined swap market exchange rate set in the Foreign Exchange Adjustment Centers. Black market rates were very near to swap market rates prior to 1994. The centers, known as swap centers or swap markets, were quasi-official markets on which foreigners could trade for foreign currency and RMB. Under this dual rate system, domestic enterprises were required to surrender their export receipts at the official exchange rate but received retention quotas equivalent to a portion of their export earnings. These retention quotas entitled the owner to purchase foreign exchange at the official exchange rate. It could also be traded on swap markets. FIEs were allowed to retain all of their export earnings and to transact directly in foreign exchange on swap markets. However, these operations were considered a privilege rather than a right, and the authorities had broad discretion as to whether they would allow a particular transaction to be completed (Genzberger et al., 1994). By 1993, there were 109 swap centers in China, and nearly 80% of all foreign exchange activity was already occurring on these swap markets. The swap markets in Shanghai and Shenzhen were the most active ones, whereas most other swap markets operated infrequently and at lower levels of activity (Genzberger et al., 1994). Huang and Wong (1996) find evidence of linkage among swap market rates from major swap markets during 1992–93. Tseng et al. (1994) give more details about the dual exchange rate system in China.

On January 1, 1994, China replaced the dual exchange rate system with a market-oriented managed-float system. Under this system, the previous retention quotas were abandoned, and RMB exchange rates were primarily determined by market supply and demand conditions. Official exchange rates were initially pegged to an average of the swap market exchange rates. After the opening of a national interbank foreign exchange trading center in Shanghai in early April 1994, official exchange rates were based on rates of the interbank market. The purpose of establishing this interbank market, which was a national network connected via satellite and telecommunication systems, was to make Chinese financial markets operate more efficiently. The exchange rate was allowed to fluctuate in the interbank market, but only within a small daily range, such as 0.3% of the opening rate. The opening rate was set by the Chinese central bank according to the weighted average of the previous day's rates. However, the interbank market was only for Chinese domestic firms and not for FIEs until China took the final major step to be qualified for partial currency convertibility on July 1, 1996. There was some conditional currency convertibility for the current account transactions during this period.

The convergence of the dual rates was regarded as the first big positive step toward partial currency convertibility. The change eliminated much of the distortion in China's exports and direct foreign investment inflows, which had previously been hindered by the need to make conversions at the artificially high official exchange rate (Asiamoney, 1996). Unification of the dual rate helped form a more rational foreign exchange market. It also may have increased significantly the efficiency of foreign exchange management by the Chinese government. However, under the unified rate system, RMB was still far from a convertible currency, and many disincentives still applied. Particularly, FIEs were not allowed to make foreign exchange transactions on the interbank market; they could only do so on swap markets after receiving government permission. Chinese firms also had to sell all export receipts and handle all currency trading with designated Chinese banks. It might not be expected that the official exchange rates would be well linked with swap market exchange rates in the long run because of three things: the existence of two functionally separate foreign exchange markets running during this unified exchange rate system, the important role of FIEs in the Chinese economy (which approximately covered one third of China's GNP.
in recent years), and the many remaining constraints on currency trading for Chinese firms.

The foreign exchange system with partial currency convertibility under the current account was applied on a trial basis in four locations—Jiangsu province, Shanghai, Shenzhen, and Dalian (Wang, 1996; Asiamoney, 1996)—beginning in March 1996. Beginning in July 1996, China began fulfilling all International Monetary Fund (IMF) requirements for currency convertibility under the current account, as defined in Article 8 of IMF’s Article of Agreement. On December 1, 1996, China formally announced a nationwide implementation of partial currency convertibility. Partial currency convertibility was trade-related and covered payment of goods and services as well as repatriation of profits from operations by foreign companies in China. Most notably, under this new system, FIEs were able to buy and sell foreign exchange in banks since July 1996, just as Chinese firms had been able to do since April 1994. FIEs still could obtain foreign exchange on swap markets. There was evidence that many FIEs continued to rely on the swap markets for foreign exchange transactions because of the remaining restrictions on their access to the interbank market (Euromoney, 1997). Foreign banks had also been allowed to participate in a larger part of the business involving foreign exchange settlements for FIEs.

The new system removed much of the uncertainty and greatly accelerated the previous liberalization process of the Chinese foreign exchange market. Wang (1996) presents new rules of the partial currency convertibility system in China in more details. There were still many restrictive foreign exchange rules and ambiguities embedded in the new currency convertibility system. For example, FIEs had to sell all hard currency earnings in excess of a state limit, which was set by the government, to authorized banks (Euromoney, 1997). Early analysis of the new system could not ensure that the foreign companies’ RMB earnings would be convertible (Stevenson-Yang, 1996). Foreign investors’ skepticism of the new system reflected their concern that it was not being implemented as well as it should have been. The practical effects of currency convertibility were not clear. Furthermore, even if currency convertibility under the current account was fully implemented, it was still not clear whether it would impose a significant positive impact on the foreign exchange market performance and foreign exchange management by the Chinese authority, due to RMB inconvertibility under the capital account. It was also expected that China would not allow RMB full convertibility under the capital account for some 15–20 years (Westlake, 1997). Furthermore, Mexico’s financial crisis plus the most recent Asian financial crisis might even postpone full currency convertibility under the capital account well into the next century (Westlake, 1997; Johnson and Smith, 1997).

III. THE DATA

The available data consists of daily official exchange rates for RMB against the U.S. dollar (US$/RMB) and against the Hong Kong dollar (HK$/RMB), and daily swap market exchange rates for US$/RMB from the Shanghai market and for HK$/RMB from the Shenzhen market, from January 1, 1994, to March 31, 1997. Datastream International provided the data. All exchange rates are denoted in the form of yuan (RMB currency unit) per U.S. dollar or per HK dollar. Note that January 1, 1994 marks the day of unification of the dual rates and the day the market force were introduced to determine the official exchange rate. The sample period is further divided into two subperiods, that is, 564 observations in the first subperiod from January 1, 1994, to February 29, 1996, and 282 observations in the second subperiod from March 1, 1996, to March 31, 1997. The first and second subperiods correspond to the time before and after partial currency convertibility, respectively. The cutoff point of March 1, 1996, was chosen because partial currency convertibility had been applied since March 1996 in the Shanghai and Shenzhen swap markets. As noted before, these two markets are the most active. The Shanghai market deals mostly in U.S. dollars. The Shenzhen market trades in a wider variety of currencies, but deals mostly with HK dollar transactions (Genzberger et al., 1994). Thus, the study uses US$/RMB swap market rates from the Shanghai market and the HK$/RMB swap market rates from the
Shenzhen market, which can be expected to be the most active and representative of the market-determined RMB exchange rates with regard to these currencies. Huang and Wong (1996) documented cointegration among swap market rates from Shanghai and Shenzhen with those from other swap markets in their regions during 1992–93. This implies that the swap rates in the Shanghai and Shenzhen markets contain the same long-run information on exchange rate movement as other swap markets.

Following the literature, all the data used in the following sections were converted to natural logarithms. The empirical evidence suggests that the exchange rate time-series data is nonstationary. Melvin and Zhou (1989) documented the nonstationary property [i.e., I(1)] of RMB official foreign exchange rates, using monthly data from 1978–89. To test for this possibility, this study applied augmented Dickey-Fuller (ADF) tests (with a nonzero mean) (Dickey and Fuller, 1979, 1981) with and without a deterministic time trend. The ADF test models are specified as follows:

Model 1: \[ \Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta y_{t-j} + e_t \]

\[ H_0 : \alpha_1 = 0 \text{(ADF without trend);} \]

Model 2: \[ \Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 t + \sum_{j=1}^{p} \gamma_j \Delta y_{t-j} + e_t \]

\[ H_0 : \alpha_1 = 0 \text{(ADF with trend).} \]

The null hypothesis states that the variable under investigation (y) has a unit root. If the calculated test statistic is a substantially negative value and less than the appropriate critical value (−2.86 for the ADF without trend and −3.41 for the ADF with trend, respectively), the null hypothesis should be rejected. The tests are performed sequentially as recommended in Johansen (1992) and Dickey et al. (1991). Johansen (1992, 393–394) argued that the unit root test statistics should be calculated for cases with and without a trend to decide which model best fits the data. The null hypothesis of a unit root can be rejected only if the null hypothesis was rejected in both cases. Note that this procedure is a special case of the Johansen (1992) sequential hypothesis testing procedure to determine cointegration rank as discussed in the next section. Table 1 reports ADF test results both for levels [I(1) versus I(0)] and for first differences [I(2) versus I(1)]. The optimal lags were determined by the minAIC+2 rule; the lags were determined by the lags selected by the minimum Akaike information criterion (AIC) plus two. Pantula et al. (1994) pointed out that the minAIC+2 rule corrects the problems of size distortion of ADF tests.

In the case without a time trend, the reported test statistics indicate that the null hypothesis cannot be rejected for any level variable at a 5% level. In the case with a time trend, the test statistics for all level variables are also insignificant at a 5% level, except for the HK$/RMB swap market rate (HK Swap2) and the US$/RMB official exchange rate (US Official2) in the second subperiod. Another type of unit root test, the weighted symmetric (WS) test, is also employed. Unlike the ADF test, the WS test employs a maximum likelihood estimator instead of the ordinary least square estimator. This method has the advantage of higher power and was recommended over the ADF test (Pantula et al., 1994, 459). The WS test statistics are also subject to a distribution. The WS test yielded insignificant test statistics for these two series at the 5% level (−2.52 for HK Swap2 and −2.61 for US Official2, compared to the same critical values as ADF tests). Hence, the hypothesis that each of the exchange rate series contains at least a unit root appears not to be rejected.

All the ADF test statistics for the first differences of variables are less than the corresponding critical values and statistically significant at 5% level. Thus, the null hypothesis of a unit root for each first difference of variables [i.e., the order of integration is not lower than I(2) for all variables] is rejected. The WS test results (not reported here) draw similar conclusions. Combining all the findings, this study concludes that there is a unit root for all variables under investigation [i.e., the order of integration is I(1)], though two of them may not have the time trend that the others have.

Finally, due to the concern of low power of the above ADF-type tests, a new procedure of testing stationary is used to double-check the validity of nonstationarity results (Hansen...
<table>
<thead>
<tr>
<th>Currency</th>
<th>Exchange Rate</th>
<th>ADF without Trend</th>
<th></th>
<th></th>
<th>ADF with Trend</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Levels</td>
<td>First Differences</td>
<td>Levels</td>
<td>First Differences</td>
<td></td>
</tr>
<tr>
<td>Hong Kong dollar</td>
<td>SWAP 1</td>
<td>-1.33</td>
<td>-6.42*</td>
<td>-0.93</td>
<td>-6.48*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Official 1</td>
<td>-1.50</td>
<td>-5.18*</td>
<td>-0.29</td>
<td>-5.36*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SWAP 2</td>
<td>-0.20</td>
<td>-8.01*</td>
<td>-3.45*</td>
<td>-8.04*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Official 2</td>
<td>-1.01</td>
<td>-8.58*</td>
<td>-3.00</td>
<td>-8.57*</td>
<td></td>
</tr>
<tr>
<td>United States doll</td>
<td>SWAP 1</td>
<td>-1.34</td>
<td>-6.07*</td>
<td>-0.78</td>
<td>-6.17*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Official 1</td>
<td>-0.56</td>
<td>-27.15*</td>
<td>-1.70</td>
<td>-27.12*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SWAP 2</td>
<td>-0.79</td>
<td>-8.45*</td>
<td>-1.69</td>
<td>-7.51*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Official 2</td>
<td>-2.59</td>
<td>-8.27*</td>
<td>-11.31*</td>
<td>-8.24*</td>
<td></td>
</tr>
</tbody>
</table>

*The ADF tests were performed with p* lags of the dependent variable. p* was determined by application of an AIC+2 principle (Pantula et al., 1994). The critical values of the ADF without trend and with trend are -2.86 and -3.41, respectively.

1 and 2 denote the first and second subperiods.

*Indicates a significant statistic at the 5% level.

and Juselius, 1995). Different from the above ADF-type tests, where the null hypothesis is nonstationarity, this procedure has stationarity as the null hypothesis. Specifically, the Johansen’s (1991) likelihood ratio tests are applied to test whether any one of the two economic variables (i.e., the official and swap market exchange rates) does not enter the cointegrating vector. This is equivalent to testing the possibility that one cointegrating vector might arise simply because one of the underlying series is itself stationary. If there is no cointegration between two variables, it immediately implies that both variables are nonstationary. Hence, this article only needs to be concerned with the cases of finding cointegration. The results (to be discussed later) also confirm that each series is integrated of order one, either with or without linear trend.2

IV. ECONOMETRIC METHODOLOGY

It is well known that nonstationarity can give rise to the possibility of a spurious relationship among the levels of economic variables. The seemingly high correlation between two economic variables (for example, the official and swap market exchange rates in this study) may be misleading when exploring the stable relationship between levels of the two variables. The cointegration analysis developed by Engle and Granger (1987) is suitable for retrieving the possible long-run stable relationship among levels of nonstationary economic variables while allowing for flexible short-run dynamic specification. The empirical methodology in this article employs the maximum likelihood estimator for cointegration analysis developed by Johansen (1991) and Johansen and Juselius (1990, 1992, 1994). Given two series, X_{1t} (representative of the swap market exchange rate) and X_{2t} (representative of the official exchange rate), each of which is not stationary in levels but stationary in first differences, that is, I (1), a linear combination of these two series is generally also stationary in first differences. However, if a unique linear combination of these two series is stationary in levels, then the two series are considered cointegrated. Generally, let X_t denote a vector that includes p variables (p = 2 in this study). If variables in X_t are cointegrated, a vector autoregressive model with k lags can
meaningfully express it:

\[ H_0: X_t = \sum_{i=1}^{k} \Pi_i X_{t-i} + \mu + \epsilon_t \quad (t = 1, \ldots, T); \]

or it can be reproduced as a reduced form error correction model (ECM):

\[ H_0: \Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \mu + \epsilon_t \quad (t = 1, \ldots, T). \]

The first hypothesis of interest in this study relates to cointegration between the swap market and the official exchange rates before and after partial currency convertibility. Cointegration between the two rates implies that there is linkage between the swap market and the official exchange rates in the long run, which is crucial to the argument that the official RMB exchange rate adequately contains the relevant information from swap markets where foreign investors trade. The a priori expectation is that commitment to partial currency convertibility might help the Chinese government improve its collection and assimilation of information from the freer and better-functioned foreign exchange market, particularly the market information from foreign investors. Thus, it may be expected that the swap market and the official exchange rates are more likely to be cointegrated after partial currency convertibility. This can be tested by examining the number of cointegrating vectors between two rates in two subperiods. The number of cointegrating vectors, \( r \), is equal to the rank of \( \Pi \) and can be formulated as the following statistical hypothesis:

\[ H_1(r) : \Pi = \alpha \beta', \]

where \( \alpha = \binom{\alpha}{\alpha} \) and \( \beta' = (\beta_1 \beta_2 \beta_0) \) in the case of no linear trend, which will be shown to apply in this study. The trace test was employed to determine the \( r \). The null hypothesis of the trace test is that there are at most \( r (0 \leq r \leq p) \) cointegrating vectors, where \( p \) was the dimension of the vector. The trace test statistics is:

\[ \text{Trace} = -T \sum_{i=r+1}^{p} \ln(1 - \lambda_i), \]

where \( T \) is the number of observations, \( p \) is the vector dimension, \( \lambda_i \)'s are the \( p - r \) smallest squared canonical correlations of \( X_{t-1} \) with respect to \( \Delta X_t \) corrected for lagged differences.

Testing the rank of \( \Pi \) requires one to explicitly make clear how \( \mu \) enters into the ECM—either as a constant in the cointegrating vector or as a time trend in the original levels representation. To deal with this problem, Johansen (1992) proposed a sequential hypothesis testing procedure with respect to the rank of \( \Pi \). If there is a linear trend in the model, this hypothesis is labeled \( H_1(r) \), which is restricted. The sequential hypothesis testing procedure suggests testing hypotheses in the following order: \( H_1(0) \), \( H_1(0) \), \( H_1(1) \), \( H_1(1) \), \( H_1(p) \), \( H_1(p) \). Testing is stopped and the associated hypothesis is accepted after the first failure of rejection. Note that the decision on inclusion or exclusion of a linear trend here may be different from that in unit root tests because cointegration tests are performed on multiple time series rather than on the univariate time series. The optimal lags in trace tests and ECM estimations are selected by minimizing the AIC in this study. Minimization of the Schwarz Bayesian information criterion was also employed to select alternative lags and double-check robustness of the empirical findings.

Additional testing of the long-run relations between the cointegrated swap market and official exchange rates requires exact identification of the \( \alpha \) and \( \beta \) matrix. There are two more hypotheses of interest with respect to the \( \alpha \) and \( \beta \) matrix. The second hypothesis tests whether the cointegrated swap market rate and the official exchange rate were equal in the long run. If the market force plays a crucial role in determining the RMB exchange rate, equality of the swap market and the official exchange rates is expected in the long-run equilibrium. Note that the hypothesis testing is not affected by the short-run deviation of the managed official exchange rate from the market fundamental. Mathematically, the hypothesis testing can expressed as

\[ H_2|H_1 : R \beta = 0, \]
where \( R' = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \) and \( \beta' = (\beta_1 \beta_2 \beta_3) \) for the second hypothesis. The appropriate likelihood ratio test statistics are generally as follows:

\[
LR = T \sum_{i=1}^{r} \ln\left(\frac{(1 - \lambda_{i,1})}{1 - \lambda_{i,2}}\right).
\]

The third hypothesis is whether the swap market exchange rate or the official exchange rate was not responsive (i.e., weakly exogenous) to the deviation from long-run relations. This is a test for weak exogeneity of an exchange rate series. A weakly exogenous rate is a primary source of information in the long run. The hypothesis testing can be framed as follows:

\[
H_3 : H_1 : \beta' \alpha = 0,
\]

where \( \alpha = (\alpha_{11}) \), and \( \beta' = (\beta_1 \beta_2 \beta_3) \) if \( X_{1t} \) (or \( X_{2t} \)) is a weakly exogenous rate. The similar likelihood ratio test statistics as indicated in equation (6) can be employed.

Finally, the fourth hypothesis is a supplementary test of unit roots, as explained previously. Assuming one cointegrating vector found, the hypothesis testing can expressed as

\[
H_4 : H_1 : \beta' \beta = 0,
\]

where \( \beta' = (\beta_1 \beta_2 \beta_3) \), \( R' = (1 0 0) \) when testing (non)stationarity of \( X_{2t} \), or \( R' = (0 1 0) \) when testing (non)stationarity of \( X_{1t} \). The similar tests were also conducted for the models with linear trend.

V. EMPIRICAL FINDINGS

This section discusses empirical results from implementation of the econometric methodology described previously. The findings reported here are qualitatively robust against alternative lags, inclusion or exclusion of a linear trend in the cointegration analysis, and omission of the observations from 94.1.1 to 94.3.31 when the interbank had not yet been in operation.

The first test involves cointegration between the official exchange rates and their respective swap market rates for US$/RMB and HK$/RMB markets during two subperiods. This provides information on whether partial currency convertibility affects the long-run informational linkage pattern between the official and swap market exchange rates as well as China foreign exchange market efficiency. The Johansen trace tests were performed on the official and swap market exchange rates for US$/RMB and HK$/RMB in two subperiods, respectively.

The trace test results are listed in Table 2. Following Johansen (1992), the table for each trace test should be read from left to right and from top to bottom. The first hypothesis that cannot be rejected should be accepted when the calculated test statistic is smaller than the critical value. In the case of US$/RMB in the first subperiod, the null hypothesis \( r = 0 \), (i.e., no cointegration between US$/RMB official and swap market exchange rates in the first subperiod) cannot be rejected in both cases with or without a linear trend at a 5% level of significance. In contrast, the US$/RMB official and swap market exchange rates are cointegrated in the second subperiod. The hypothesis of \( r = 0 \) can be rejected, but \( r \leq 1 \) cannot be rejected in both cases with or without a linear trend at the 5% level. It was indicated that the US$/RMB official exchange rate did not incorporate the expected information from foreign investors for the relative value of RMB against the US dollar in the long run before partial currency convertibility, but it did assimilate the information under partial convertibility system. Additionally, one may also conclude that there was no linear trend in the cointegrated exchange rate movement under the second subperiod.

The trace test results for the HK dollar exchange rates are also listed in Table 2. This study finds that the hypothesis of \( r = 0 \) can be rejected, but \( r \leq 1 \) cannot be rejected in both cases with or without a linear trend at

3. A reviewer suggested that the general to specific test procedure developed in Johansen (1994) should be employed to determine whether the final model may be no linear trend, as determined by the specific to general test procedure developed in Johansen (1992). A sequence of likelihood ratio tests were conducted by testing the degree of deterministic trend reduction, beginning with the least restrictive model and reducing the deterministic components toward the most restrictive model until further reduction is rejected. The model specification of no linear trend has been confirmed in all cases concerned. The final model specification is also consistent with the argument that a constant term in the cointegrating vector may be a proxy for (relatively stable) risk premium differential between the official and swap exchange rate markets.
TABLE 2
Trace Tests on Swap Market and Official Exchange Ratesa

<table>
<thead>
<tr>
<th></th>
<th>Without Linear Trend</th>
<th>With Linear Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T$</td>
<td>$C(5%)$</td>
</tr>
<tr>
<td>USS/RMB—first period</td>
<td>11.25</td>
<td>20.17</td>
</tr>
<tr>
<td></td>
<td>5.20</td>
<td>9.09</td>
</tr>
<tr>
<td>USS/RMB—second period</td>
<td>11.47</td>
<td>20.17</td>
</tr>
<tr>
<td></td>
<td>5.56</td>
<td>9.09</td>
</tr>
<tr>
<td>HK$S$/RMB—first period</td>
<td>55.00</td>
<td>20.17</td>
</tr>
<tr>
<td></td>
<td>5.13</td>
<td>9.09</td>
</tr>
<tr>
<td>HK$S$/RMB—second period</td>
<td>26.83</td>
<td>20.17</td>
</tr>
<tr>
<td></td>
<td>7.58</td>
<td>9.09</td>
</tr>
</tbody>
</table>

aThe critical values are from Tables A1 and A3 in Johansen and Juselius (1990). $r$ was the number of cointegrating vectors. $T$ was the trace test statistics. $C$ was the trace test critical values. $R$ indicates that we reject the null hypothesis that the number of cointegrating vectors was less than or equal to $r$ (when $T$ was greater than $C(5\%)$). $F$ indicates that we fail to reject the null hypothesis that the number of cointegrating vectors was less than or equal to $r$ (when $T$ was less than $C(5\%)$).

The 5% level for HK$S$/RMB in both periods. Hence, the conclusion is that there was one cointegrating vector and that there was no linear trend for the HK$S$/RMB official and swap market rates in both periods. Hence, in the case of the HK$S$/RMB, the official and swap market exchange rates were cointegrated before and after partial currency convertibility. A better understanding of the cointegrated HK$S$/RMB rates before partial currency convertibility may depend on the fact that the use of Hong Kong dollars was the only exception to the law that foreign currency cannot legally be used in China. HK dollars enjoy substantial circulation in southeastern China, and they can sometimes be used, though illegally, for retail purchases in this region (Genzberger et al., 1994, 311). Shenzhen is a major city and the regional financial center in southeastern China. Actually, Shenzhen has an exceptional privilege of pricing and circulating foreign currencies (Stevenson-Yang, 1996). Thus, there was de facto currency convertibility largely for HK$S$/RMB in this region around Shenzhen. However, further analysis of the $\alpha$ and $\beta$ matrix reveals that the formal commitment to currency convertibility still significantly affected the information flow pattern between the official and swap market exchange rates for the HK$S$/RMB market.

The impact of partial currency convertibility is further investigated utilizing the ECM representation. The following ECM estimation and hypothesis testing were conducted in the case of no linear trend, using the CATS in RATS software (Hansen and Juselius, 1995). All estimations were checked for autocorrelation problems. The results are reported in Table 3. Column one gives the unrestricted estimates of the $\alpha$ and $\beta$ matrix. Column two shows the hypothesis test concerning the $\alpha$ and $\beta$ matrix. Column three gives the restricted estimates of the $\alpha$ and $\beta$ matrix with imposition of any hypothesis in column two that cannot be rejected. The economic interpretation should be based on the quantitative relation identified in the restricted estimates, if any exists. Otherwise, the unrestricted estimates serve the purpose.

Testing the second hypothesis of the $\beta$ matrix, we are interested in whether the official and swap market exchange rates, though cointegrated, were equal in the long run. Inequality suggests the potential for profitable arbitrage if the current barrier to market entry was loosened and the arbitrage transaction can go through. In the case of the USS/RMB in the second subperiod, we reject the hypothesis of the equal swap market and official exchange rate. That is, the U.S. dollar
## Table 3

<table>
<thead>
<tr>
<th>Case</th>
<th>Unrestricted Estimates</th>
<th>Restriction Testing</th>
<th>Restricted Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta' = (1 - 1.02 \ 0.001)$</td>
<td>$H_1 : \beta_1 + \beta_2 = 0$</td>
<td>$\chi^2$</td>
</tr>
<tr>
<td></td>
<td>$\alpha = (-0.12 \ \ 0.13 )$</td>
<td>$H_0 : 0$</td>
<td>10.39</td>
</tr>
<tr>
<td></td>
<td>$H_1 : \alpha_1 = 0$</td>
<td>12.63</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$H_1 : \alpha_2 = 0$</td>
<td>16.49</td>
<td>1</td>
</tr>
<tr>
<td>HK dollar</td>
<td>$\beta' = (1 - 1.02 \ 0.002)$</td>
<td>$H_1 : \beta_1 + \beta_2 = 0$</td>
<td>$\chi^2$</td>
</tr>
<tr>
<td>(second period)</td>
<td>$\alpha = (0.02 \ \ 0.22 )$</td>
<td>$H_1 : \alpha_1 = 0$</td>
<td>4.08</td>
</tr>
<tr>
<td></td>
<td>$H_0 : 0$</td>
<td>19.01</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>$H_1 : \alpha_2 = 0$</td>
<td>107.37</td>
<td>2</td>
</tr>
<tr>
<td>U.S. dollar</td>
<td>$\beta' = (1 - 1.60 \ 1.282)$</td>
<td>$H_1 : \beta_1 + \beta_2 = 0$</td>
<td>$\chi^2$</td>
</tr>
<tr>
<td>(second period)</td>
<td>$\alpha = (0.05 \ \ 0.64 )$</td>
<td>$H_1 : \alpha_1 = 0$</td>
<td>10.66</td>
</tr>
<tr>
<td></td>
<td>$H_1 : \alpha_2 = 0$</td>
<td>106.60</td>
<td>1</td>
</tr>
</tbody>
</table>

*The notations $\alpha' (\alpha)$ and $\beta' (\beta, \beta_0)$ are those identified in equation (3). The $\chi^2$ test was performed at the 0.05 significance level. "n.a." denotes no restrictions can be accepted.*

The valuation of the RMB against the US dollar was equal to the valuation from the foreign investors' market in the long run.

The third hypothesis for the $\alpha$ matrix helps us identify the flow pattern of long-run information from the RMB exchange market and the impact of the current convertibility. These results are reported in Table 3. In the case of US$/RMB$ in the second subperiod, we rejected the hypothesis that either the swap market rate or the official exchange rate may lead the other in the long run. It appears that the information flow was not bidirectional between the official and swap market exchange rates. However, we note that the adjustment coefficient for the swap market rate ($\alpha_1 = 0.05$) was almost negligible, compared to the adjustment coefficient for the official exchange rate ($\alpha_2 = 0.64$), though $\alpha_1$ is statistically significant. It implies that even under partial currency convertibility the swap market rate in Shanghai adjusted very slowly toward the long-run equilibrium relation (as captured by the $\beta$ matrix), whereas the official US$/RMB$ rate adjusted much faster. The overall effect appears that, largely, the swap market rate led the official US$/RMB$ exchange rate in the long run.
TABLE 4
Likelihood Ratio Test Results of Variable Exclusion

<table>
<thead>
<tr>
<th>Case</th>
<th>Hypothesis</th>
<th>Without Linear Trend</th>
<th>With Linear Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\chi^2$</td>
<td>d.f.</td>
</tr>
<tr>
<td>HK dollar (first period)</td>
<td>$H_1: \beta_1 = 0$</td>
<td>43.70</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$H_1: \beta_2 = 0$</td>
<td>43.96</td>
<td>1</td>
</tr>
<tr>
<td>HK dollar (second period)</td>
<td>$H_1: \beta_1 = 0$</td>
<td>10.64</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$H_1: \beta_2 = 0$</td>
<td>11.18</td>
<td>1</td>
</tr>
<tr>
<td>U.S. dollar (second period)</td>
<td>$H_1: \beta_1 = 0$</td>
<td>86.34</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$H_1: \beta_2 = 0$</td>
<td>107.89</td>
<td>1</td>
</tr>
</tbody>
</table>

*The $\chi^2$ test was performed at the 0.05 significance level.

In the case of the HK$/RMB market, we found that neither the swap market exchange rate nor the official exchange rate led the other in the long run before partial currency convertibility, that is, $\alpha_1 \neq 0$ and $\alpha_2 \neq 0$ in the first subperiod. In contrast, we found that the HK$/RMB swap market exchange rate led the official exchange rate in the long run because $\alpha_1 = 0$ and $\alpha_2 \neq 0$ in the second subperiod. The finding of a weakly exogenous HK$/RMB swap market exchange rate indicates that information about the RMB value relative to the Hong Kong dollar from the Shenzhen swap market was the only indispensable source for the Chinese government to evaluate HK$/RMB rate in the long run. It justifies the unique function of the Shenzhen swap market as an information source under the currency convertibility system and casts doubt on any imprudent plan to close off all major swap markets in the near future.

Finally, Table 4 reports the supplementary unit root test results. The results show that the null hypothesis of stationarity can be rejected with a very low significance level for every case concerned, either with or without linear trend in the data. The case of US$/RMB in the first subperiod does not need to be examined here, because there is no cointegration found. The evidence verifies that cointegration analysis in this study is meaningful and valid.

VI. CONCLUSION

Using cointegration techniques, the authors examined the linkage between the RMB official and swap market exchange rates against the U.S. dollar and Hong Kong dollar before and after the RMB currency convertibility under the current account. The study found that partial currency convertibility did have a significant impact on Chinese foreign exchange markets. Specifically, the official and swap market exchange rates for US$/RMB were not linked before partial currency convertibility and were linked afterward in the long run. The official exchange rates for US$/RMB also seemed to be led largely by market information from foreign investors. However, the US$/RMB official exchange rate was not equal to the swap market exchange rate in the long run. This suggests that more effort should be exerted to improve the information content and rationality of the US$/RMB official exchange rates. In contrast, the HK$/RMB official and swap market exchange rates were linked in the long run before partial currency convertibility due to its high degree of de facto currency convertibility. But after partial currency convertibility, the HK$/RMB official exchange rate was equal to and led by the swap market exchange rate in the long run. These findings indicate that partial currency convertibility did improve the information connection between the official exchange rates and the foreign investors market as well as the information assimilation process.

The results also suggest that there was room for further improving the processing of crucial market information from foreign investors in China, which was important for a more rational RMB exchange rate and calls for more complete currency convertibility. China needs to further pursue full currency convertibility, that is, make the RMB convertible on the capital account.
The path toward full currency convertibility may take years and may be very challenging, but it is essential to China’s further integration with the world economy. In general, the RMB exchange rate under full currency convertibility may reflect the real value of scarce resources in China more accurately and help improve the optimal allocation of scarce resources in the production process. More specifically, for an example, the RMB exchange rate under full currency convertibility may help China attract more and cheaper foreign capital. Pursuit of full currency convertibility is much harder than that of partial currency convertibility, and particularly should be coordinated with the structural reform in other areas, such as monetary system, banking system, and state-owned enterprises. The determination of interest rates should be based more on market forces. State-owned banks should be transformed into commercial banks responsible for their investment and financing decisions, and state-owned enterprises into legal entities sensitive to their performance. This should be done gradually to avoid economic shocks associated with the process.

Only a preliminary analysis of the impact of currency convertibility on China foreign exchange markets was conducted in this study. One possible limitation involves the data. The data for the second subperiod, which was crucial in examining the impact of current currency convertibility, only covers the early period of the current convertibility system. Thus, one may expect that the reported quantitative relations between the official and swap market exchange rates could change when China continues its ongoing reform of its financial markets. The impact of the current convertibility in this study may be reexamined when more exchange rate data are available. Other interesting topics for future research may include the potential impacts of partial current convertibility on Chinese stock market and foreign exchange market volatility.

REFERENCES


