Working Paper No. 413

Anomaly in China’s Dollar–RMB Forward Market

by

Yi David Wang

February 2010

Stanford University

579 Serra Mall @ Galvez, Landau Economics Building, Room 153

Stanford, CA 94305-6015
Anomaly in China’s Dollar–RMB Forward Market

Yi David Wang*

February 2010

Abstract

Newly-established data on onshore deliverable US dollar–RMB forwards and SHIBOR from October 2006 to April 2009 reveal significant violations of covered interest rate parity. This paper explains the cause of this anomaly. Deviations in the forward market are caused by an increase in US dollar-to-RMB conversion restrictions. Given that Chinese monetary authorities want to prevent market participants from taking advantage of the predictable appreciation of the RMB, China’s State Administration of Foreign Exchange has to tighten up the control on US dollar-to-RMB conversions. Under the tightened conversion restrictions, similar deviations will resurface in the forward market whenever hot money inflow increases. One way to avoid covered interest rate parity violations in the forward market is to decrease hot money inflow into China by maintaining a stable and credible exchange rate policy.

Key words: China, foreign exchange, covered interest rate parity, deliverable forward
JEL codes: F31, F42

* Yi David Wang, PhD candidate, Department of Economics, Stanford University, Stanford, USA. Email: dyiwang@stanford.edu. The author is grateful for the guidance and advice of Professor John Taylor and Professor Ronald McKinnon on this paper. All remaining errors are solely the author’s.
I. Introduction

Since China removed its decade-long currency peg to the US dollar in July 2005, its interbank foreign exchange market has undergone many reforms and has evolved into a highly active market. For example, under the pegging regime (fixed exchange rate at 8.28), forward contracts between the RMB and the US dollar were absent in China’s interbank foreign exchange market. After China moved away from its fixed-exchange-rate regime, the new uncertainty regarding China’s exchange rate generated a demand for forward contracts. Although offshore nondeliverable retail forward contracts between the RMB and the US dollar have been around since December 1998, deliverable forward contracts did not come into existence in the interbank market until 19 October 2005.

The current paper focuses on onshore deliverable forward contracts. In particular, it introduces new data, such as daily prices of forward contracts of different maturities from October 2006 to mid-April 2009, along with China’s interbank (lending/borrowing) offering rate over the same period. The current paper commences with a basic question: Does covered interest rate parity (CIP) hold in China’s interbank foreign exchange market?

Combining two new series of interbank forward rates and borrowing/lending rates with some more readily available data, such as the historical RMB/US dollar spot rates and the US dollar London Interbank Offered Rate (LIBOR), the question above can be readily answered. Detailed description of the data will be presented in Section III. To convince the reader that this is indeed an interesting question, Figure 1 depicts the deviation of 1-year actual forward rate from the CIP-implied forward rate.\(^1\)

---

**Figure 1. Deviation from Covered Interest Rate Parity (CIP) (1-year Forward)**

![Chart showing deviation from CIP](chart.png)


---

\(^1\) This is the actual forward rate divided by implied forward rate minus 1.
It is evident from Figure 1 that there were significant deviations from CIP. It appears that CIP deviations were relatively small and stable up to May 2007, by which point actual forward rates started deviating further from the CIP implied forward rate. The magnitude of deviation increased for nearly 1 year until it peaked around April 2008. What caused this apparent anomaly? What is preventing arbitrage forces from eliminating the deviations? The present paper attempts to provide some answers for these questions.

This paper argues that the anomaly originated from an increase in foreign exchange conversion restrictions by Chinese authorities starting from May 2007. In particular, evidence suggests that Chinese authorities tightened US dollar-to-RMB conversion restrictions from May 2007 in an effort to prevent hot money inflow, which led to the increase in CIP deviations. The economic implications of the anomaly in the forward market make interesting research topics. However, before examining the potential implications of the forward market anomaly, it is important to identify its cause first.

To convince the reader that an increase in the difficulty of converting the US dollar into RMB through official channels is indeed the reason for the anomaly, it is necessary to exonerate other usual suspects by refuting some seemingly obvious reasons. For instance, when CIP violations are present, one should always first check the reliability of the data series involved before looking for more subtle causes. Therefore, this paper first examines and exonerates the usual suspects of forward rates, spot rates and US dollar and RMB interest rates. Finally, it incriminates an unusual suspect: the tightening of conversion monitoring by the State Administration of Foreign Exchange (SAFE).

This paper is organized as follows. Section II covers some relevant institutional background on China’s interbank foreign exchange market and interbank borrowing and lending market. Section III describes data used for the research. Section IV details the anomaly in the China’s forward market. Section V first eliminates other relevant explanations for this anomaly and then defends the conversion restriction explanation in detail. Finally, Section VI concludes the paper and proposes further research work.

II. Institutional Background

1. China’s Foreign Exchange Trade System
The official interbank foreign exchange market in China is called the China Foreign Exchange Trade System (CFETS). It is the only legal market for interbank foreign exchange activities in China, and participation is restricted to members only. It was initially founded in February 1994, which marked the unification of the fragmented interbank foreign exchange markets in China.

---

2 As an interesting side note, the period when the CIP was violated also coincides with the violation of open interest rate parity (OIP) (McKinnon and Schnabl, 2009). The OIP is not the primary focus of the present paper, and OIP is less empirically robust than CIP. However, whether or not the violations of these two interest rate parities are caused by common factors can be a potentially interesting and important extension of this paper.

3 Members are composed of financial institutions. Individuals are not allowed to participate in the interbank market.
The CFETS headquarters are located in Shanghai, with backup headquarters in Beijing. In addition, the CFETS has 18 sub-centers. It is a sub-department of the People’s Bank of China (PBOC), and is also regulated by SAFE (see Figure 2).

Figure 2. China Foreign Exchange Trade System’s Relationship to Other Government Agencies

Note: PBOC, People’s Bank of China.

All foreign exchange transactions must be carried out in CFETS during its market hours. Currently, the products traded on CFETS include spot trades, deliverable forward contracts between RMB and US dollars, and currency swaps between RMB and other foreign currencies. For the spot market, the major currencies involved are the RMB, the US dollar, the pound sterling, the Hong Kong dollar, the yen and the euro. Forward contracts between the RMB and the US dollar were first introduced in October 2005, less than 3 months after China ended its decade-long pegging regime to the US dollar. At the point this paper was written, more exotic products such as futures and options were not traded in CFETS.

Participation requires membership. A financial institution needs to apply at the main market in Shanghai or at one of the sub-markets for a seat. In most cases, for a bank with many branches, only the main branch and a few designated sub-branches have seats at one of the CFETS trading centers. Nonmember financial institutions that wish to access CFETS need to go through a member bank. Different products require separate membership applications. In June 2009, there were 262 members in the spot market, but only 67 of them were allowed to participate in the forward market (CFETS, 2009). Out of the existing members, there are 16 that serve as primary market makers in both spot and forward markets.

Chinese authorities intervene heavily in the foreign exchange spot market. Take the US dollar–RMB spot market for example. The PBOC sets the opening quote based on the previous day’s closing price and allows a narrow range of daily fluctuation. When supply

---

4 The 18 cities are Guangzhou, Shenzhen, Tianjin, Jinan, Dalian, Nanjing, Xiamen, Qingdao, Wuhan, Chongqing, Chengdu, Zhuhai, Shantou, Fuzhou, Ningbo, Xi’an, Shenyang and Haikou.

5 Market hours: from 09.30–15.30 hours Monday through Friday with the exception of holidays.

and demand forces require the market clearing price to go beyond the fluctuation range, the PBOC will buy or sell US dollars to maintain the exchange rate within the band. Another method of intervention is through SAFE’s monitoring. All interbank foreign exchange transactions require SAFE’s approval prior to their completion. SAFE’s role in approving foreign exchange transactions will be discussed in detail in Section V.

Forward contracts in this market are deliverable with standardized maturities. A forward contract in the wholesale market can be settled in two ways: gross settlement or net settlement. Under gross settlement, full notional amounts of the RMB and the US dollar are exchanged on delivery date (i.e. contract maturity date). Under net settlement, counterparties only settle the difference between the forward rate and the settlement rate. The net settlement can be settled in either US dollars or RMB, which is agreed upon in advance. The settlement rate is defined as the closing rate 2 days prior to the maturity date. Settlement method is agreed in advance by the two counterparties on signing a contract.

Counterparties in the forward contracts can require collateral from each other. The collateral amount, delivery date and return date are determined by the two counterparties on a case-by-case basis. The CFETS can provide a safekeeping service and hold collateral if the two counterparties agree. However, CFETS does not require the posting of collateral. Collateral can be denominated in any currency as long as the two parties agree.

2. China’s Interbank Borrowing and Lending Market
The official interbank borrowing and lending market is the National Interbank Funding Center (NIFC). The NIFC was established in January 1996, under a mandate by the PBOC that required all interbank borrowing and lending activities to be carried out through the NIFC. On 3 January 1996, NIFC and CFETS became a single de facto market, with the NIFC and CFETS locating in the same physical location and using the same operating system. Both of them are regulated by the PBOC and have been formally treated as one entity since 27 January 1997.

For unsecured lending and borrowing among financial institutions, the relevant interest rate is the Shanghai Interbank Offered Rate (SHIBOR), which is conceptually the same as the LIBOR. In particular, it is a simple no-guarantee wholesale interest rate calculated by arithmetically averaging all the interbank RMB lending rates offered by the price quotation group of banks with a high credit rating. There are currently 16 banks in the quoting group. SHIBOR is calculated by removing the top 2 and bottom 2 rates and averaging the remaining 12 rates. Currently, the SHIBOR survey banks are required to provide rates on the following eight maturities: overnight, 1 and 2 weeks, 1, 3, 6 and 9 months and 1 year. In addition to the required rates, reporting banks also have the option to report any of the following eight maturities: 3 weeks and 2, 4, 5, 7, 8, 10 and 11 months.

---
7 Forward contracts of 1 week, 1, 3, 6 and 9 months and 1 year are traded. Forwards with longer maturities do exist, but are less liquid.
III. Data Description

The basic structure of China’s interbank foreign exchange and money market has been discussed above. This section focuses on the data to answer the questions posed in the Introduction. Given that the primary focus of the paper is to identify the reason for CIP violations in the forward market, a natural place to start would be data series involved in CIP calculation. The CIP can be expressed by the following equation:

\[ F = S \frac{1+i_{RMB}}{1+i_s}, \]  

(1)

where \( F \) and \( S \) are forward and spot rates (measured in unit of RMB per US dollar), and \( i_{RMB} \) and \( i_s \) are RMB and US dollar interest rates.

Only four data series are needed to examine whether the CIP holds for China’s onshore deliverable RMB–US dollar forwards: the forward rate, the spot rate and proxies of relevant RMB and US dollar interest rates. Given that China’s onshore deliverable forward market did not come into existence until 19 October 2005, one can argue that it is only now that there is enough data for meaningful academic study. The SHIBOR is the appropriate proxy for \( i_{RMB} \) and the US dollar LIBOR rate for \( i_s \).

Given that both the LIBOR and the SHIBOR are based on surveys rather than actual market rates, justifications for their accuracy should be examined before using them as proxies. The LIBOR’s accuracy over the sample period under study is justified by Taylor and Williams (2009). The current paper examines differences between the LIBOR (a survey rate) and the rates on term Fed funds (a transaction rate). The difference is small.

To verify the SHIBOR’s accuracy, the same method of comparing the survey rate to a transaction rate is adopted in the present paper. In particular, the 3-month SHIBOR is compared to the 3-month China Interbank Offer Rate (CHIBOR), which is an interbank rate index based on actual transaction rates in China’s interbank money market. Both rates are illustrated in Figure 3.

Figure 3. 3-month SHIBOR versus 3-month CHIBOR

---

\(^9\)There might be an onshore dollar rate in China that is different from LIBOR. However, such a rate (if it exists) is not readily available. Furthermore, for multinational banks, such as HSBC, Citi, and Royal Bank of Scotland, the relevant rate for dollar borrowing is more likely the LIBOR US dollar rate than any other rate.
As Figure 3 demonstrates, the SHIBOR tracks the CHIBOR fairly well. However, the CHIBOR exhibits greater volatility. The difference should not be surprising because the SHIBOR’s smoothness is the result of it being the average of 12 rates, whereas the CHIBOR is the transaction rate involving different counterparties. In addition, throughout 2008, when deviations from CIP were most noticeable according to Figure 1, the discrepancies between the two rates are small. Therefore, the SHIBOR is a fairly accurate survey.

As mentioned in the Introduction, there are two new data series. Forward rates between RMB and the US dollar from 2006 to mid-April 2009 are obtained from the CFETS. SHIBOR from October 2006 to mid-April 2009 are obtained from the NIFC. For reasons unidentified, SHIBOR prior to October 2006 are beyond the scope of public access and are not included in this research. Hence, the present paper focuses on the time interval of October 2006 to April 2009.

**Figure 4. Sport Rates and Forward Rates**
Figure 4 illustrates daily forward rates for RMB/US dollar forwards of six maturities: 1 week, 1, 3, 6 and 9 months and 1 year. It also includes the RMB/US dollar spot rate, which is obtained from the official archive of SAFE. As Figure 4 indicates, the RMB was appreciating against the US dollar throughout most of the sample period until a somewhat abrupt stop around July 2008. Some scholars have attributed this stop in RMB appreciation to the arguably unexpected appreciation of the US dollar (e.g. McKinnon et al., 2010).

Figure 5 illustrates historical SHIBOR, with the same maturities as the forward contracts.

Figure 5. SHIBOR and Lending Rate of the People’s Bank of China

Sources: SAFE (2009) and CFETS (2009a).
Figure 6 illustrates the corresponding LIBOR rates over the same period from Bloomberg. In addition to the LIBOR of different maturities, Figure 6 includes the Fed Funds rate.

Figure 6. US LIBOR

From Figure 6, it is evident that the Fed Funds rate was declining toward zero over the sample period, which also dragged down the US dollar LIBOR rate. It is interesting to note that the spread between the LIBOR and the Fed Funds rate increased dramatically from March 2008 and peaked around October 2008, reflecting an increase in counterparty...
risk in the interbank dollar market. In comparison, China’s interbank money market (see Figure 5) appeared more stable during the same period, with longer maturity SHIBOR tracking closely the PBOC lending rate. There was a drop in the SHIBOR in October 2008, which was probably the result of US interest rates dropping toward zero and the stable US dollar–RMB exchange rate.

Given that all of the required data have been introduced and described, in what follows we will use Chinese data to examine the empirical robustness of the CIP.

IV. “Money on the Table” in the Forward Market

Covered interest rate parity is based on the concept of no arbitrage. It states that in the absence of transaction costs, default risks and other frictions such as capital controls or conversion restrictions, converting a US dollar into RMB in the spot market and earning RMB interest rates should yield the same return in 1 year as saving that same US dollar to earn US dollar interest and locking in the conversion rate in RMB 1 year down the road using a forward contract. Any deviations from Equation (1) will be driven by arbitraging forces, and any deviation from Equation (1) must be explained by transaction costs or frictions generated by capital controls, which can either be observable or unobservable to an academic bystander but acutely noticeable by market participants.

Given that the world is not frictionless, CIP might not hold all the time. However, CIP is empirically robust when currencies are freely convertible (Frankel and Levich, 1975). Therefore, with the data from the previous section in hand, our academic investigation of the RMB–US dollar forward market involves checking whether the forward contracts trading in CFETS violate the CIP, and, if so, determining the causes of these deviations.

With interest rate and exchange rate data, Equation (1) can be used to calculate the forward rate implied by the CIP, which is called the CIP-implied forward rate. Figures 7–10 depict the CIP-implied forward rate and actual forward rate for forward contracts of different maturities.

Figure 7. 1-week Forward
**Sources**: CFETS (2009a), NIFC (2009a), British Bankers’ Association (2009), and SAFE (2009).

**Figure 8. 1-month Forward**

![1-month Forward Graph](image1.png)

**Sources**: CFETS (2009a), NIFC (2009a), British Bankers’ Association (2009) and SAFE (2009).

**Figure 9. 6-month Forward**

![6-month Forward Graph](image2.png)

**Sources**: CFETS (2009a), NIFC (2009a), British Bankers’ Association (2009) and SAFE (2009).

**Figure 10. 1-year Forward**

![1-year Forward Graph](image3.png)

**Sources**: CFETS (2009a), NIFC (2009a), British Bankers’ Association (2009) and SAFE (2009).
Sources: CFETS (2009a), NIFC (2009a), British Bankers’ Association (2009), and SAFE (2009).

For shorter maturity forwards, such as 1-week or 1-month forwards, it appears that implied forward rates and actual forward rates are not far apart. As Figures 7 and 8 indicate, although CIP deviations exist for these forward contracts, the magnitudes are relatively small and might not justify further investigation. As maturity increases, the magnitude of deviations increases as well. However, forwards with longer maturities exhibit CIP deviations. For 6-month and 1-year forwards, the deviation is noticeable (see Figures 9 and 10).

The data shows that during most of the sample period, actual forward rates are less than CIP-implied forward rates \( F < S \frac{1 + i_{RMB}}{1 + i_S} \). In theory, in the absence of capital controls, a trader will seek unlimited profit by repeating the strategy of borrowing US dollars at \( i_S \), convert it into RMB in the spot market, save the RMB proceeds to gain \( i_{RMB} \), and lock in the rate of converting the RMB back into US dollars using the forward market.\(^{10}\) This particular strategy will be referred to as the arbitrage strategy for the remainder of this paper. What is causing these deviations? What prevented the market participants, which included financially savvy multinational banks fully aware of the empirical robustness of CIP, from arbitraging away these deviations? These questions are answered in detail in the next section.

V. Solving the Puzzle

1. Exonerating the Usual Suspects

As discussed in the previous section, CIP should hold for freely convertible currencies, and, according to the IMF (1996), the RMB has been a freely convertible currency since 1996. Therefore, the hypothesis of convertibility restrictions as the cause of the observed

\(^{10}\) This procedure can be hindered if there are restrictions on converting US dollars into RMB. Yet, according to the IMF’s *Annual Report on Exchange Arrangements and Exchange Restrictions* (2008), there were no exchange restrictions reported.
anomaly should not be the first point of investigation. Instead, a more natural starting point is to consider the accuracy and reliability of the four variables in Equation (1).

(1) Forward Rate
It is important to ensure that the onshore deliverable forward rates are accurate. In particular, there are some unobservable factors (maybe latent regulations) specific to China that prevents its onshore deliverable forwards from trading at market clearing prices. Therefore, it is possible that the forward prices obtained from CFETS are not prices on which market participants can actually transact.

If there exists an offshore interbank deliverable forward market between the RMB and the US dollar, then comparing the prices of forwards in the two markets would offer an indication on whether the onshore forward rates are off. Unfortunately, there is no such deliverable forwards traded offshore, but offshore retail nondeliverable forwards exist. The offshore nondeliverable forwards between the RMB and the US dollar have been around for quite some time, dating back to December 1998. Two rates should not be exactly the same because of the interbank versus retail nature of the contracts. However, if the offshore rates are much closer to the CIP-implied rates than the onshore rates, then there is reason to believe that the onshore forward rates are not true transactional rates. If the two rates are comparable or offshore rates are farther from CIP-implied rates than onshore rates, then the onshore forward rate is less suspicious.

The 1-year offshore nondeliverable forward rates over the same sample period can be obtained from Bloomberg, which reports daily forward trading prices from the Hong Kong nondeliverable forwards market. Figure 11 illustrates rates of the onshore deliverable forward and the offshore nondeliverable forward.

Figure 11. 1-year Forward Rate: Deliverable versus Nondeliverable

Sources: CFETS (2009a) and Hong Kong Nondeliverable Forward Market (2009).

As Figure 11 indicates, although the two rates do not equal each other, they demonstrate significant degrees of comovement. In addition, it appears that for most of the sample period, especially for most of 2008 when the anomaly was most noticeable, offshore rates were even farther from the CIP-implied rate than onshore rates. If the
CFETS were indeed providing nontransactional or false forward rates to the public, the CFETS could just as easily release rates that are consistent with CIP. Therefore, it is more likely the case that the forward rates obtained from CFETS are indeed transactional rates and their deviations from CIP are caused by other factors.

(2) Spot Rate
Despite the unpegging of the RMB to the US dollar from July 2005, the PBOC still exerts great control over the spot rate between the US dollar and the RMB. The smooth appreciation of the RMB from July 2005 to July 2008 reveals that China’s government is very active in regulating the spot rate. Is the PBOC’s heavy and frequent intervention in the spot market the source of the deviations observed in the forward market?

According to Equation (1), only the spot rate on the contracting date of the forward matters for the calculation of the forward rate. For the spot rate to be the cause of the deviations, at least one of the following might be true: the Chinese Government is restricting the amount of US dollars, a CFETS member can convert into RMB at the quoted spot rate (i.e. conversion restrictions), or member banks for some reason expect the spot rate to be different from the observed spot rate when they actually try to carry out the arbitrage strategy (false or uncertain spot price).

For the first possibility, it is necessary to argue convincingly that the spot rates observed are indeed transactional rates rather than a misreport by SAFE, either intentional or unintentional. A trader who believes that the spot rate he or she observes is a result of PBOC intervention also has reason to believe that the spot rate he or she will transact on might be different from the one he or she observes.\(^{11}\) Therefore, the forward deviations observed in the previous section can occur when the trader’s expectation for the spot rate on which he or she will transact is different from the spot rate he or she observes.\(^{12}\)

Based on the above analysis, one can calculate this “expected spot rate” using Equation (1) as follows:

\[
E[S] = F \frac{1 + i_s}{1 + i_{RMB}}. \tag{2}
\]

One testable implication of this possibility is that \(E[S]\) should be independent of forward maturity. Put another way, using 1-year forward rates and 1-year interest rates in Equation (2) should generate the same \(E[S]\) as using the 6-month forward rates and interest rates.\(^{13}\) Figure 12 shows estimates for \(E[S]\) using 1-year and 6-month data. Obviously, the two series are not identical, especially during the period of CIP violations. Therefore, it is unlikely that the anomalies in the forward market are caused by the false or uncertain spot prices.

\(^{11}\) It is important to note that transacting at a different rate than the spot rate observed is different from conversion restriction. In the former case, the spot conversion can be carried out for certain and the main uncertainty is the transacting price. In the case of conversion restriction, it is uncertain whether a spot transaction can be carried out at any price.

\(^{12}\) Once again, it is important to emphasize that the trader does not assign a positive probability to not being able to sell his or her US dollars through the official channel at any price (i.e. no conversion restriction), so the only uncertainty is the spot rate volatility over a strictly positive domain.

\(^{13}\) The selection of 1 year and 6 months is completely arbitrary.
(3) **US Dollar LIBOR**

There is a view out there that the deviations from CIP during 2008 were caused by liquidity constraints in the US dollar interbank borrowing/lending market, which greatly restricted banks’ ability to borrow US dollars. The direction of the observed CIP deviations indicates that the arbitrage strategy initiates with borrowing of US dollars, and deviations from CIP in the forward market can indeed persist if there are liquidity constraints in the US dollar interbank money market. In particular, if there is a disconnection between the US dollar LIBOR and the actual rate that clears the interbank money market (i.e. the US dollar LIBOR is actually lower than the true market clearing rate), then the result that actual forward rates are less than the CIP-implied forward rates (i.e. $F < S \frac{1 + i_{\text{RMB}}}{1 + i_s}$) is unsurprising. The cause of this disconnection could be a market failure in the interbank dollar market during 2008. Furthermore, there is also the conjecture that banks were purposely underreporting the LIBOR relative to their true borrowing rate (Mollenkamp, 2008). However, this conjecture has been refuted by Taylor and Williams (2009).

It seems convincing that a failure in the US dollar money market indeed appeared during 2008. However, it is difficult to imagine that a well-established market such as the interbank dollar market could have a market failure of such magnitude and duration to generate the type of deviations reflected in Figures 1 and 10. It is definitely possible that there were temporary disturbances in the US dollar money market during 2008, which could have caused violations of CIP in the forward markets and this could partly explain the deviations observed in the US dollar–RMB forward market, especially around the time when Lehman Brothers declared bankruptcy.

First, the timing appears off. According to Figures 1 and 10, the discrepancy in the US dollar–RMB forward market started as early as May 2007, reached a peak around April 2008, and started to disappear after then. By October 2008, when the spread between the LIBOR and the Fed Funds Rate skyrocketed (see Figure 6), the deviation...
from CIP in the US dollar–RMB forward market had already returned to a relatively low level of less than 1 percent. Therefore, the timing appears to be off mark.

Second, the claim that the LIBOR being too low is the cause of the puzzle also lacks empirical support. If there were disconnects between the LIBOR US dollar rate and the true US dollar borrowing rate during 2008, then we should expect to see similar deviations from CIP in forward markets between the US dollar and other major currencies. With this hypothesis in mind, 1-year forward rates over the same time period between the US dollar and the pound sterling are analyzed and the results are depicted in Figure 13. In addition, one would expect that the time of the deviations to match between the US dollar–sterling forward market and the US dollar–RMB forward market.

Figure 13 shows the percentage deviations of actual forward rates from the CIP-implied forward rate using 1-year US dollar–sterling forwards from October 2006 to April 2009. For the calculation of Figure 13, the sterling 1-year LIBOR is from the British Bankers’ Association. The sterling–US dollar spot rate is obtained from the Federal Reserve Board of Governors. The actual 1-year forward rates between the two currencies are the Bloomberg-reported rates (October 2006–April 2009).

![Figure 13. Deviation from Covered Interest Rate Parity in US Dollar–Sterling Forward Market (1-year Forward)](image)

**Figure 13. Deviation from Covered Interest Rate Parity in US Dollar–Sterling Forward Market (1-year Forward)**

*Sources:* Federal Reserve Board of Governors (2009), British Bankers’ Association (2009) and Bloomberg (2009).

From Figures 1 and 13, it is evident that for the first half of 2008, when deviations in the RMB market were expanding, there do not appear to be any significant deviations from the CIP in the Sterling market. Although deviations in the US dollar–sterling market did increase around September 2008, the US dollar–RMB market had already exhibited a return to CIP by then, so the timing did not match up. In other words, the CIP deviations

---

\[15\] Given that the convention of quoting the exchange rate between the US dollar and the pound sterling has the US dollar in the numerator, as opposed to the dollar–RMB quoting convention, which has the US dollar in the denominator, the LIBOR US dollar rate being too low should result in actual dollar–pound sterling forward rates being greater than the CIP-implied forward rates.
in the US dollar–sterling market might be the result of disturbances in the US dollar money market around October 2008, but the CIP deviations in the US dollar–RMB market were probably caused by something else. Hence, the LIBOR US dollar rate being too low during 2008 was probably not the primary cause of the deviations in the US dollar–RMB forward market.

(4) **SHIBOR**
What if the SHIBOR was too high? To bring the observed forward rates in line with CIP, the Chinese interest rate should be much lower. Figure 14 depicts the 1-year SHIBOR versus the CIP-implied rate.

**Figure 14. 1-year SHIBOR versus CIP-implied Rate**

To verify the forward rates, observe that the CIP-implied Chinese 1-year interest rate was negative between November 2007 and July 2008, a level that is impossible (see Figure 14). Combining this impossibility with the information reflected in Figure 3 that SHIBOR already appears to be a bit lower than the transaction-rate-based CHIBOR, it is difficult to attribute the observed CIP deviations to the SHIBOR being too high.

2. **Main Cause: Spot Market Conversion Restrictions**

(1) **General Intuition**
Based on the above analysis, the hypothesis of US dollar-to-RMB conversion restriction as the cause of CIP violations in the forward market now deserves more attention. Since China removed its US dollar-pegging regime, the RMB has smoothly and predictably appreciated against the US dollar. Naturally, speculators might want to take advantage of this appreciation by converting US dollars into RMB. However, Chinese authorities have not welcomed such speculative “hot money.” In fact, SAFE has repeatedly announced the desirability of maintaining a balance between US dollar inflow and outflow since the removal of the pegging to the US dollar. In an effort to decrease the demand for RMB in the spot market by discouraging the inflow of speculative hot money, SAFE increased its monitoring efforts on US dollar–RMB spot conversions.
As the major agency in charge of regulating China’s foreign exchange market, SAFE has the authority and responsibility of reviewing interbank foreign exchange transactions. For example, if two member banks of CFETS want to complete a spot transaction between US dollars and RMB, and have agreed on the amount, the spot rate and the delivery/settlement logistics, the transaction needs to be approved by SAFE before it can be executed. Normally, the two parties would provide documents and justifications to prove that their needs for RMB or US dollars are current account transactions associated with ordinary business rather than capital account transactions. SAFE then reviews the transaction and makes a decision on whether to approve or block the transaction. Transactions associated with exchange rate speculation are a primary target of SAFE monitoring, and, once identified, such transactions are denied. Not surprisingly, during periods of anticipated RMB appreciation against the US dollar, speculators would want to convert US dollars into RMB under the disguise of legitimate current account transactions. If such transactions were carried out unmonitored, they would apply downward pressure on the exchange rate, forcing the PBOC to step in and function as a buyer of US dollars in the spot market. Whenever the PBOC deems that it is buying up too much US dollars, it is SAFE’s job to slow down this process by increasing its monitoring effort for speculative hot money, which often results in an increase in spot transaction denial, with some legitimate current account transactions being incorrectly denied.\textsuperscript{16}

Given that SAFE is far from omniscient, it is not surprising that even legitimate current account transactions sometimes run the risk of misclassification and denial during periods of intensified monitoring. Consequently, because the period under study overlaps with periods of predictable RMB appreciation and, hence, speculative capital inflow into China, any US dollar-to-RMB transaction in the spot market during the sample period faced a strictly positive probability of such a transaction being denied by SAFE. Such conversion restrictions and uncertainties in the spot market would transfer into the forward market, causing CIP violations as unintended byproducts. Furthermore, whenever SAFE increases its monitoring effort, denial probability increases, which in turn would enlarge the deviations in the forward market. Therefore, deviations from CIP in the forward market can be viewed as measures of conversion restrictions imposed by SAFE.

(2) Primary Source Evidence
This subsection presents publicly available primary source evidence to show that SAFE indeed increased its monitoring effort during the sample period. First, notice that the anomaly in forward market first started around May 2007. Indeed, it turns out on 18 May 2007, SAFE hosted a conference focusing on “the monitoring and inspection of foreign currency inflow and conversion.”

According to a press release by SAFE, the reversal to the “easy in” policy on foreign currency conversions was under way and would continue.\textsuperscript{17} The ultimate goal of this reversal is to achieve balance between currency inflow and outflow. Consistent with this

\textsuperscript{16} In theory, if authorities believe that too much capital is flowing out of the country, SAFE can also deny certain RMB-to-dollar transactions. However, during my sample period, capital flight is less of a concern.

\textsuperscript{17} “Easy in” policy refers to the practice of allowing the US dollar to be converted into RMB in the spot market with relatively little monitoring and denial.
press release, violations of CIP in the forward market started to increase in magnitude. The sentiment of achieving a balance between US dollar inflow and outflow was reemphasized by another SAFE press release on 29 January 2008. Referring to Figure 1, deviation from CIP increased once again shortly after this announcement.

The forward rate’s eventual return to the CIP was probably a result of the stabilization of the spot rate around July 2008. Such stabilization could be the result of a conscious effort by the Chinese Government. In other words, this stabilization could be an “accident” caused by the unexpected appreciation of the US dollar against other currencies, to mitigate the pressure of the RMB to further appreciate against the US dollar. As the stabilization gained credibility, hot money inflow slowed down. With the slowing down of hot money inflow, it was likely that SAFE also relaxed their monitoring effort on the spot market, leading to a restoration of CIP. Consequently, it appears that one way to avoid CIP violations in the forward market would be to have a credible and stable exchange rate, which would decrease hot money inflow into China.

(3) **Empirical Evidence**

In addition to primary source evidence presented above, there is empirical evidence consistent with the hypothesis that conversion restriction caused the CIP deviations observed in the US dollar–RMB forward market. Table 1 provides the summary statistics of the CIP deviations using 1-year data. In particular, the sample period is divided into two subgroups, using the SAFE announcement date of 18 May 2007 as the dividing line.

| Table 1. 1-year Forward Covered Interest Rate Parity Deviations (%) |
|------------------|------------------|------------------|------------------|------------------|
|                   | Mean             | Median           | Standard deviation | Minimum          | Maximum          |
| Before 18 May 2007| -0.32            | -0.30            | 0.50              | -1.89            | 1.04             |
| After 18 May 2007 | -3.48            | -2.74            | 3.36              | -11.18           | 1.00             |

Source: Calculated by the author using Figure 1 data

First, notice that the magnitude of the CIP deviations increased after SAFE announcement date. In particular, the absolute magnitude of mean deviation after announcement is more than 10 times of the pre-announcement mean. In addition, the absolute magnitude of the median deviation also increased by a factor of 9 after the announcement. The increase in standard deviation also reflects the fact that the CIP deviations became more volatile after SAFE announcement. All of the above mentioned empirical observations suggest that there is a structural change in the determination process of forward rates associated with SAFE’s announcement to tighten conversion restriction. More importantly, these observations are consistent with the hypothesis that the increase in US dollar–RMB conversion restrictions in the spot market causes the increase in CIP deviations in the forward market.

Figures 15 and 16 are scatter plots of actual forward rates vs. CIP-implied forward rates for 1-year forwards before and after 18 May 2007, respectively.

**Figure 15. Actual Forward Rate versus Covered Interest Rate Parity-implied Forward Rate (1-year Forwards, Pre-announcement)**
The structural change associated with SAFE’s announcement is evident by comparing Figures 15 and 16. As Figure 15 portrays, prior to the SAFE announcement regarding increasing conversion restriction, actual forward rates and CIP-implied forward rates demonstrated an almost linear relationship, making the CIP-implied forward rate an effective predictor of actual forward rates. However, this linear relationship broke down after the announcement, as reflected in Figure 16, rendering the CIP-implied forward rate a less effective predictor of the actual forward rate. Not surprisingly, the correlation between the two series dropped from 0.9255 prior to the announcement to 0.5746 after the announcement. The fact that this breakdown occurred after the SAFE announcement suggests that the increase in conversion restriction might have caused the intensified violations of CIP in the forward market. Although this statistical evidence alone does not guarantee that tightening of conversion restrictions in the spot market caused magnified deviations from CIP in the forward market, it is nonetheless consistent with such a hypothesis. Furthermore, combining the empirical evidence with the primary source evidence and the intuition presented in previous subsections, one naturally comes to the
VI. Conclusions and Future Work

Based on the above analysis, one should be convinced that the anomaly observed in the onshore deliverable interbank dollar–RMB forward market was caused by an increase in US dollar–RMB conversion restrictions resulted from SAFE monitoring of the spot market. In particular, given that Chinese monetary authorities wanted to prevent speculators from taking advantage of the predictable appreciation of the RMB, SAFE tightened up the control on US dollar–RMB conversions. The disappearance of the deviation in the latter half of 2008 was most likely a result of the spot rate stabilization to decrease hot money inflow, which in turn led to a loosening of conversion restrictions in the spot market. Therefore, the deviations in the forward market that appear to be “money on the table” are a result of “hot money” inflow and government policies in place to curb such inflow. The disturbance in the forward market was probably an unintended consequence.

In the present paper, the reason for CIP violations has been identified; the next step is to explain theoretically how forward prices are determined under these conversion restrictions or constraints. Given that forwards are the primary hedging tool for businesses facing US dollar–RMB exchange rate risk, having a defendable theoretical framework for the pricing of these forwards under the spot conversion restrictions would be important to both academic scholars and market participants.

Finally, anomalies of such magnitude and duration in the forward market must have had significant consequences for other sectors of the economy. Some of these consequences probably deserve further study.

In China’s case, the deviations observed imply that Chinese exporters with US dollar-denominated cash inflows faced a discount when selling their US dollars forward during most of 2008. Increase in hedging difficulty faced by exporters should have a negative impact on export volume, ceteris paribus. The deviations in the forward market discussed in this paper could help us understand empirically the impact of hedging costs on Chinese exports.

References


NIFC (National Interbank Funding Center), 2009b, “Historical 3-month Chibor” [online; cited 18 April 2009]. Available from Bloomberg: IBO03M <Index> HP.

