Measuring Capital Mobility in China: 1999 - 2005

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Abstract

This paper examines the level of capital mobility in China during Jan. 1999 to Apr. 2006 by estimating the covered interest rate differentials during this time period. This study was made possible by data from the fairly newly established offshore RMB Nondeliverable Forward market. It concludes that China had not been enjoying perfect capital mobility during the sample period of this study. Furthermore, capital controls were mainly placed on capital outflow before 2003 and inflow afterward. Comparison with previous research confirms the assertion.

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1 Introduction

As the recent news announcements regarding more liberal foreign exchange policies suggest, China has been more than ever integrating itself into the international financial markets. How much progress has China made? And how do we quantify this progress? These are the questions this paper is trying to answer. To do so, the level of Chinas capital mobility is going to be measured as a means to test its degree of international financial market integration. I am going to show that the *covered interest rate differential* is the most appropriate proxy to measure capital mobility. I conclude that China currently cannot be considered a perfectly open economy, largely due to the fairly heavy capital controls that the government has been implementing.

As we will see from the institutional details introduced in the Background section, China has taken large steps over the past two decades to liberate its financial system. Indeed, it has been transformed from a strictly planned economy to a more and more market-oriented one. One the other hand,

restrictions and capital controls can still be seen in many aspects of the economy. This places China in a situation where the country's degree of capital mobility cannot be immediately determined. Hence a thorough and rigorous measurement is in order.

Much work of measuring capital mobility has been done in the past. Feldstein and Horioka (1980) examine the data on average investment-to-GDP and saving-to-GDP ratios from 16 industrial countries over the period 1960-74 and conclude that high correction between national savings and investment indicated low capital mobility. Frankel (1991) surveys 25 countries in terms of their capital mobility measured by the covered interest rate differentials. Obstfeld (1996) presents an alternative way of calculating covered interest rate differentials, in which he compares the interest rate differentials between domestic deposit rates and Eurocurrency deposit rates. Finally, Montiel (1994) describes and evaluates five different approaches to measure capital mobility in developing countries.

Despite the large literature in capital mobility measurement, very little empirical work can be found that directly targets the Chinese financial market. I suspect that this is partially due to the difficulty of obtaining relevant data and until recently, the lack of a foreign exchange forward market. Fung, Leung and Zhu (2004) are the first to discuss the RMB NDF market. In their paper, the authors give a brief introduction to the market and compute the forward premiums during the sample period from 1999 to 2003. Fung et al., however, do not go much more beyond a factual overview of the market,

and little of what can be implied from the RMB NDF market is discussed. In other words, the relevant research that currently exists constitutes of two separate sides that either provides the theoretical framework or introduces the institutional background of this study. A gap thus exists between the theoretical and empirical aspects of the research. My study is an attempt to fill in this gap by tying the two sides of the literature together. Specifically, I measure China's capital mobility over the past six years using one of the most popular methods – thanks to the recent establishment of a foreign exchange forward market, the data crucial to this study are now available. I conclude that during the sample period of my study, China had not been enjoying free capital mobility. Furthermore, capital controls were mainly placed on capital outflow before 2003 and inflow afterward. I see the value of my study in two ways. First, it provides a quantitative measurement of Chinas degree of international financial market integration. With the knowledge of China's financial policies during the sample period, the theoretical framework in turn is tested by this measurement.

The remainder of the paper is organized as follows. Section 2 introduces the institutional background related to this paper. Section 3 provides a literature review. Two branches of the literature will be covered, namely, papers regarding capital mobility measurement and papers analyzing the structure of the Chinese financial market and its capital controls. Section 4 describes the theoretical framework on which this study depends. Alternative methods will be briefly mentioned but the focus will be the covered interest rates

differential measurement. Section 5 describes the data used in this study. Section 6 lays out how capital mobility in China is empirically estimated. Section 7 summarizes the findings in this study.

2 Background

The results of this study can be of little value without understanding the current state of the Chinese financial markets. The following few paragraphs provide a brief overview of China's foreign exchange market and major capital controls.

On July 21, 2005, the Chinese government abandoned the more-than-decade-long peg of its currency, the RMB, to the US dollar, revalued the RMB by 2.1% against the dollar, and adopted a more liberal exchange rate regime. Until then, the RMB was pegged to the dollar at an 8.28 RMB/USD exchange rate. The Peoples Bank of China (PBC, the Chinese central bank) published a daily reference rate against the dollar and allowed a 0.3% trading band. In the new exchange rate regime, the RMB is instead pegged to a basket of at least 11 internationally traded currencies[1] . The weight of each of the components in the basket was not disclosed. Each day the PBC announces a central parity against the US dollar according to the previous days closing price of the RMB, and allows the currency to fluctuate within a 0.3% band around the central parity the following working day.

[1]Main currencies: USD, EUR, JPY, KRW; secondary currencies: SGD, MYR, AUD, CAD, RUB, THB

Since its July 21st, 2005 announcement, the PBC has taken several additional steps to bring more flexibility into its foreign exchange market. Among the more noticeable is the introduction of an onshore foreign exchange forward market. Until Oct. 19th, 2005, all forward transactions of the RMB were taken outside of the country, mostly in the Singapore and Tokyo markets, in the form of nondeliverable forward (NDF) contracts. On Sept. 27th, 2005, Hong Kong was set to launch retail RMB NDF contracts in order to expand its role as a financial hub for the RMB business. Standard documents are used in setting out the contract agreements, which is a new feature of the RMB NDF. Those traded in the past were on an individually-negotiated basis, where two parties agreed on the terms of the contract.

Nondeliverable forward contracts are a common instrument to hedge currency risks for countries under heavy capital controls, which is especially true for the emerging markets. For the RMB, the offshore NDF market was setup to meet the increasing need of foreign enterprises that engage in business activities in China. The lack of a domestic RMB forward market catalyzed the establishment of its offshore counterpart. Unlike the traditional forwards, the NDF is a cash settlement contract. The net difference, determined by the principal amount of the contract, the forward rate and the spot exchange rate on the day of maturity, is settled by a cash payment in US dollars, i.e. there is no actual delivery of the RMB. This feature allows parties to hedge the currency risk without engaging in RMB transactions directly, which oftentimes are highly regulated by the Chinese government (Fung, Leung, &Zhu,

2004). The RMB NDF contracts are traded over-the-counter.

There has been much talk lately of China's liberalizing its capital account. Indeed, China has long been implementing heavy controls over its capital flows. Some of the key elements of Chinas capital control include the universal requirement for registration and the tight control over foreign exchanges. For example, investing in the Chinese stock market by foreign investor using the RMB is prohibited. Chinese residents are not allowed to invest in foreign securities of any kind, nor are they allowed to borrow internationally without prior government approval. Opening personal foreign exchange accounts abroad by Chinese residents is also prohibited. Some exceptions can be made for large enterprises or financial institutions that engage in international transactions, but government approval must be obtained before the removal of any restrictions (Yu, 1999). In terms of the offshore NDF market, only non-Chinese residents are allowed to participate.

3 Literature Review

The literature relevant to this study can be roughly split into two parts, namely, theoretical works proposing a variety of methods to test a country's degree of capital mobility and surveys that overview the development of the Chinese financial markets. The theoretical papers, oftentimes backed by empirical evidence, are rarely found to include China as one of the sample countries largely due to its long-absence of a developed foreign exchange market. The market-oriented surveys, on the other hand, are not accompanied

by in-depth quantitative analyses. As China has only recently been taking large steps to liberalize its financial markets, policy-related discussions seem to attract more attention than thorough quantitative analyses[2].

Feldstein and Horioka (1980) survey 16 industrial countries in terms of their investment-to-GDP and saving-to-GDP ratios and found a large correlation (0.887) between national savings and investment. The authors argue that under free capital mobility, there should be no correlation between these two values, hence concluded that their findings implied low capital mobility. Since its publication, the Feldstein-Horioka conclusion has received two major criticisms. First of all, in order for free capital mobility to imply zero correlation between savings and investment, savings and investment must be affected by independent factors. Yet this assumption may not hold in reality. Thus, a correlation between savings and investment may not be due to imperfect capital mobility but rather an event that shifts both the saving and the investment schedules. Secondly, the Feldstein-Horioka criterion ignores large country effects, in which world interest rate changes due to shocks in the country that consequentially affects both S and I regardless of what the shock alones has to do with either schedule.

A more direct, and perhaps more convincing, approach to measure capital mobility is to look at arbitrage conditions. Frankel (1991) examines the covered interest rate differentials in 25 countries as a means of capital mo-

[2]The large literature on China's currency revaluation is an exception, although this is not directly related to this study.

bility measurement. Covered interest rate differential is calculated as the difference between the domestic interest rate and the world interest rate, minus the forward discount. The idea behind this method is that under little capital flow barriers, a unit invested domestically should yield the same return as invested abroad, otherwise arbitrage opportunities would occur. Yet, merely comparing domestic and world interest rates are not enough, because even under perfect capital mobility discrepancies between the two interest rates might still exist due to expectations of changes in exchange rate or as a compensation for exchange rate risk. Covered interest rate differential incorporates both these aspects into the measurement.

Obstfeld (1995) presents an alternative way of calculating covered interest rate differentials, in which he compares the interest rate differentials between domestic deposit rates and Eurocurrency deposit rates.

Several alternative approaches to measure capital mobility have been proposed. Montiel (1994) describes and evaluates five different approaches geared towards emerging markets, namely, to measure the magnitude of capital flows, interest rate parity conditions, tests of monetary autonomy, saving-investment correlations, and the Euler equation test. According to this empirical findings using some of these methods, the author concludes that a substantial number of developing countries could be considered financially open. China is not included in his study.

Fung, Leung and Zhu (2004) are the first to study data from the RMB NDF market. The authors give an introduction to the NDF market in general

and present some empirical analysis of the RMB NDF market in particular. They find that the foreign exchange forward premium against the US dollar becomes a discount starting on November 13, 2002, and attributed the change to the increasing China-US trade deficit and Chinas large foreign reserves. In terms of policies, Zhang andYu (1999), in two separate papers, both give a thorough overview of some of these issues. The former provides a detailed summary of the evolution of the Chinese foreign exchange regime, while the latter outlines China's capital controls in recent years.

In the context of the literature, my study can be viewed as an attempt to fill in some of the gap regarding quantitative analyses of Chinese financial policies besides currency revaluation. Specifically, it provides a quantitative measurement of China's degree of international financial market integration, which has not been previously done. In doing so, I hope to tie the two seemingly unrelated sides of research together.

4 Theoretical Framework

Frankel (1991) presents four distinct criteria to identify perfect capital mobility. The first one is a result from a provoking paper by Feldsteain and Horioka in the early 80s relating a country's national savings to its rates of investment, and the rest revolve around the idea that arbitrage opportunities due to interest rate differentials across borders should not exist in a world of perfect capital mobility.

1. The Feldstein-Horioka definition: exogenous changes in national saving

(both in the private and public sector) can be easily financed by borrowing from abroad at the going real interest rate, and thus need not crowd out investment in the originating country (provided the country is small in world financial markets)

2. Real interest rate parity: international capital flows equalize real interest rates across countries

3. Uncovered interest rate parity: capital flows equalize expected rates of return on countries bonds, despite exposure to exchange risk

4. Covered interest rate parity: capital flows equalize interest rates across countries when contracted in a common currency.

I will adopt the fourth definition in this paper to measure China's capital mobility, and the following shows why this is the most appropriate among the four.

Feldstein-Horioka: consider the identity $CA = SI$, where CA stands for Current Account, S for National Savings and I for Investment. In a closed economy with no capital mobility, CA is always zero. In this situation, $S = I$, and savings and investment are 100% correlated. On the other hand, for a *small* open economy with full access to the international capital market, the domestic interest rate is exogenously determined by the world interest rate, hence the correlation between savings and investment is *zero so long as they are affected by independent factors*. Feldstein and Horioka thus conclude that

high (low) correlation between S and I indicates low (high) capital mobility. This conclusion receives at least two major criticisms. First of all, the assumption that savings and investment are affected by independent factors may not hold in reality. Thus, a correlation between S and I may not be due to imperfect capital mobility but rather an event that shifts both the saving and the investment schedules. Secondly, the Feldstein-Horioka criterion ignores large country effects, in which world interest rate changes due to shocks in the country that consequentially affects both S and I regardless of what the shock alone has to do with either schedule (Schmitt-Grohé, & Uribe, 2005).

Now, consider the real interest rate parity, $r = r^*$, where r = domestic interest rate and r^* = world interest rate[3]. According to definition 2, real interest rate parity holds under perfect capital mobility, i.e. *r - r*, the real interest rate differential*, is zero. Using the real interest rate differential as a measurement of capital mobility, we would expect open developed economies to have $(r - r^*)$ values close to zero. Empirically, however, this is not true. In the Frankel paper, 25 countries are observed from 1982 to 1988 and several industrial countries such as Switzerland had larger and more variable real interest rate differentials than many of the closed economies during that period. Intuitively, the real interest rate differential as a measurement of international capital mobility fails to take into consideration the changes in

[3]Unless noted otherwise, the starred variable refer to that in the foreign country or the rest of the world

relative price across countries and the nominal exchange rate uncertainty. A more rigorous approach is provided in the next paragraph.

Recall the Fisher equation,

$$r = i - \pi^{e4} \tag{1}$$

where i denotes the nominal interest rate and π^e the expected inflation. The same condition holds for the foreign country, i.e.

$$r^* = i^* - \pi^{*e} \tag{2}$$

Taking the difference between the two Fisher equations yields,

$$r - r^* = (i - i^*) + (\pi^{*e} - \pi^e) \tag{3}$$

Let S denote the spot nominal exchange rate between the domestic and foreign currency (i.e. the unit price of the foreign currency in terms of the domestic one), and let F denote the forward rate. Let $f = \ln F$ and $s = \ln S$, then manipulating Equation (3)[5] yields the following expression,

$$r - r^* = (i - i^* - fd) + (f - s^e) + (s^e - s + \pi^{*e} - \pi^e) \tag{4}$$

where fd is the *forward discount* defined as $f - s$. We have hence decomposed the real interest rate parity into three terms: $(i - i^* - fd)$, $(f - s^e)$ and $(s^e - s + \pi^{*e} - \pi^e)$. The second term $(f - s^e)$, the *exchange risk premium* as it is termed, calculates the difference between the forward rate and the

[4]Unless noted otherwise, the superscript e refer to expected

[5]Add and subtract $(s + s^e + f)$ to the left hand side of Equation (3) and use the fact that $f - s = fd$

expected spot rate on the day the forward is to be exercised. This is the amount one has to pay to compensate the counterparty for the risk assumed in agreeing to lock in the exchange rate at some specified point in the future (i.e. the forward rate)[6] . $(s^e - s + \pi^{*e} - \pi^e)$ is the *expected real depreciation*, which is the expected percentage change of the real exchange rate between the RMB and the USD[7]. Subtracting these two terms frees the real interest rate differential from factors that are not relevant to international capital mobility. We call the leftover term, $(i - i^* - fd)$, the *covered interest rate differential*.

To eliminate arbitrage opportunities, under free capital mobility it must be true that a unit invested domestically yields the same return as invested abroad, thus the following equality must hold,

$$1 + i = (1 + i^*)F/S \tag{5}$$

When i is small, which is the case in reality, $\ln(1 + i) \approx i$. Thus we can rewrite the above expression as

$$i = i^* + f - s \tag{6}$$

[6]Technically, this is the difference between the natural log of the two rates. The intuition nevertheless is the same.

[7]The real exchange rate, e, is defined as $\frac{S \cdot P^*}{P}$, where P is the RMB price of a US consumption basket and P^* is the dollar price of a Chinese consumption basket. The expected percentage change in e is $\ln e^e - \ln e = s^e - s + \pi^{*e} - \pi^e$. For a full derivation of the identity , see Schmitt-Grohé and Uribe (2005, p.90).

Substituting fd for $f - s$ and rearranging terms, we obtain the condition for covered interest rate parity

$$i - i^* - fd = 0 \tag{7}$$

A violation of the covered interest rate parity (i.e. a deviation of *covered interest rate differential*, $i - i^* - fd$, from zero) hence implies a violation of the original condition given in Equation (5), which must indicate imperfect capital mobility, as arbitrage opportunities would have occurred otherwise.

As we can see from the real interest rate decomposition (i.e. Equation (4)), in the case where the exchange risk premium is zero, covered and uncovered interest rate differentials are the same. If we require expected real depreciation to be zero as well, then covered interest rate differential becomes real interest rate differential. In the real world, neither of these two additional conditions is reasonable, leaving covered interest rate differential to be the most accurate indicator of true international capital mobility.

To summarize, I have provided reasons for the adoption of the covered interest rate differential, $(i - i^* - fd)$, as the indicator for international capital mobility among the four alternatives. This is done by first showing the caveats of the Feldstein-Horioka criterion, and then decomposing the real interest rate differential to take out factors that are not related to capital mobility, which then becomes the covered interest rate differential.

5 Data

As the theory in the previous section suggests, the measurement of capital mobility (i.e. covered interest rate differential) involves two countries, the home country and the foreign counterpart. I choose the United States as the relevant foreign country in this study for mainly two reasons. First of all, the United States is generally accepted as a large open economy. When we see a large covered interest rate differential between two countries that are both under heavy capital controls, it is difficult to quantify how much each country contributes to the observed capital immobility. Choosing the United States as China's counterpart in this study ensures that any affect on capital mobility can be attributed to China. Secondly, for the majority of the time period that this study concerns, China had been under a single currency peg regime, in which the RMB had been pegged to the US dollar alone[8] . In this case, the exchange rate between the RMB and, say, the euro, ultimately reflects the exchange rate between the dollar and the Euro and does not tell us much about the relationship between the two original currencies.

5.1 Sample Period

This study would not have been feasible in the past due to the long absence of a foreign exchange forward market for the RMB. Even though this market had been initiated in late 1998, in the few years immediately after its

[8]Even after the adoption of the basket peg in July 2005, some suspect that the US dollar is still weighed significantly heavier than other currencies in the basket.

establishment there had not been enough data points from which one is able to make meaningful inferences. Only until recently have the data become adequate enough to conduct this study. The sample period for the covered interest rate differential measurement is from Jan. 1999 to Apr. 2006, which covers, on a weekly basis, the whole period that the NDF rates are available up to the writing of this paper.

5.2 Weakness of Data

The major weakness of the data is that since the offshore NDF market prohibits the participation of Chinese residents, those who invest in the spot market and the NDF market may not overlap completely. In theory, the spot market and forward market should require an identical set of participants in order to reflect consistent expectation of the future[9]. (Recall that the forward rate encompasses the market's expectations of exchange rates in the future). Since this requirement is practically impossible in China, the data I am using is the closest to ideal given what is available. Under the assumption that people are identical and in absence of market manipulation, who participates in which market should not be a determining factor of market outcomes. As a result, I suspect that this discrepancy is going to have minor affects on the result of the study.

[9]Provided no one has any informational advantage over others, which is true in this case (as I assume that only public information is used).

5.3 Variables

Recall that the covered interest rate differential is the deviation from the covered interest rate parity (see Equation (7)). Mathematically, it is the following:

$$i - i^* - fd \tag{8}$$

where $fd = \ln F - \ln S$. The four variables required to estimate equation (8) are the domestic interest rate (i), the interest rate abroad (i^*), the spot exchange rate between the domestic currency and the foreign currency (S), and the forward exchange rate between these two currencies (F)[10]. I choose the risk-free interest rates because it is crucial that the investments in each country in this study carry exactly the same risk[11]. Since precisely quantifying risks is difficult and at times subjective, it is a tricky task to decide which investments have the exact same risk, unless they are both known to be risk-free.

Table 1 gives a summary of the data used in this study. They come from four different sources. The 3-month deposit rates in China are obtained from DataStream, which is a client-based software that provides major financial data such as security prices and interest rates. The 3-month US Treasury bill rates come from the Federal Reserve Statistical Release [12], a

[10]Note that the choice of foreign interest rate and foreign currency must correspond to the same country.

[11]The reasoning behind this is the simple principle that everything else being equal, higher risk implies higher return. Thus picking investments with different risks would incorporate irrelevant factors into the results.

[12]Treasury Bills are sold through weekly auctions.

website maintained by the Federal Reserve that contains a comprehensive selection of economic indicators and figures in the US [13]. It is accessible to the general public. The RMB/dollar spot exchange rates come from Pacific Exchange Rate Service, a web-based exchange rates database maintained by Prof. Werner Antweiler at the University of British Columbias Sauder School of Business. It is meant to be used for academic research and teaching purposes only. Finally, the RMB/dollar NDF rates are obtained from Bloomberg Professional[14], an extensive financial information system and databank with global coverage of companies, industries, and markets[15]. The frequency of the data is weekly, although in each year in the sample period there are a few weeks that are missing. I suspect that this is due to the absence of data during bank holidays. All rates are per annum[16].

Recall that there is a thin trading band associated with the dollar peg of the RMB (0.3%), that is, the PBC allows minor fluctuations of its currency around the daily reference rate. Figure 1 plots the NDF rates against the spot rates. Interestingly, almost all variations of the NDF rates fall within this thin trading band. This can be seen more clearly in Figure 2, which plots the forward discount fd.

Although not much information regarding capital mobility can be directly

[13]http://www.federalreserve.gov/Releases/

[14]I would like to thank the librarians at the Ford Library at Duke Universitys Fuqua Business School for their immense help with DataStream and Bloomberg Professional.

[15]Description courtesy of the website of Ford Library at Duke Universitys Fuqua Business School.

[16]The forward discount, fd, is annualized by multiplying $(\ln F - \ln S)$ by $360/90 \times 100$, i.e. $400 \times (\ln F - \ln S)$

Table 1: Data Description

Name	**Variable**	**Description**	**Source**	**Frequency**
3-month deposit rates in China	i	the risk-free nominal interest rate available to Chinese residents	Historical data are obtained from DataStream.	Weekly
3-month rates of the US Treasury Bill	i^*	the corresponding nominal interest rates in the US	Historical data are obtained from the Federal Reserve Statistical Release.	Weekly
3-month RMB/dollar spot exchange rates	S	the nominal unit price of the US dollar in terms of the RMB	Historical Data are obtained from the Pacific Exchange Rate Service.	Weekly
3-month RMB/dollar NDF rates	F	the nominal NDF rate of the RMB against the US dollar	Historical data are obtained from Bloomberg Professional.	Weekly

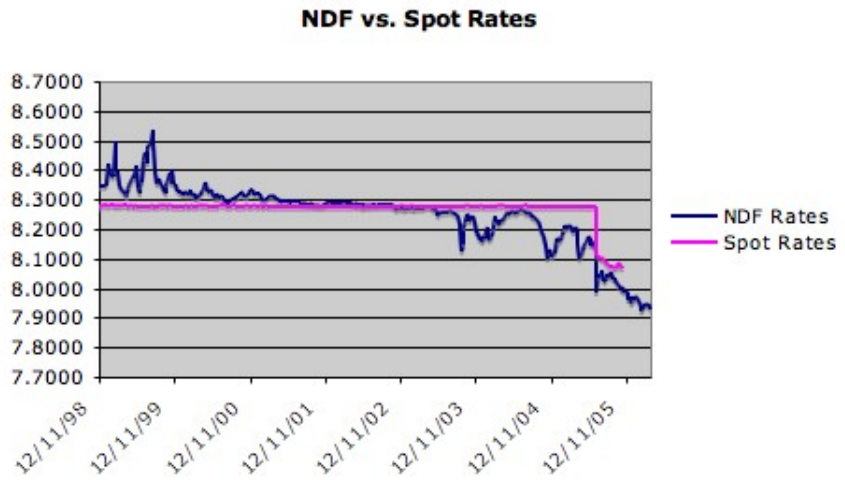

Figure 1: RMB 3-month NDF rates vs. 3-month spot rates, Jan. 1999 Apr. 2006

Figure 2: Forward Discount (fd), Jan. 1999 - Apr. 2006

obtained by looking at nominal interest rates alone, it is nonetheless interesting to see how these figures evolved over the sample period in both countries. We can see clearly in Figure 3 that the interest rates in the US varied much more heavily than those in China. In fact, there appear to be only two adjustments of the Chinese interest rates throughout the whole sample period (6/11/99 and 2/22/02) whereas the rest of it remains flat. It is reasonable to hypothesize from this observation that capital controls had been in place in China during this period of time. If the forward discount (fd) turns out to be small, with the Chinese interest rates remain more or less constant, I expect the resulting covered interest rate differential to largely reflect the fluctuation of the US interest rates [17].

The lack of variation of the Chinese data becomes even clearer when presented in numerical form (Table 2). Notice that the average NDF rate and spot rate are very close, yet if we look at their standard deviations, the one of the NDF rates is about twice as big as that of the spot rates.

6 Empirical Specification

Recall that I hypothesized earlier that the Chinese economy had not been enjoying perfect capital mobility during the sample period of this study (Jan. 1999 to Apr. 2006). This hypothesis is going to be tested by an empirical estimation of China's covered interest rate differential, which was given in Equation (8): $i - i^* - fd$. If the hypothesis is correct, we should expect the

[17] See Equation (7). More details will be discussed in the findings section.

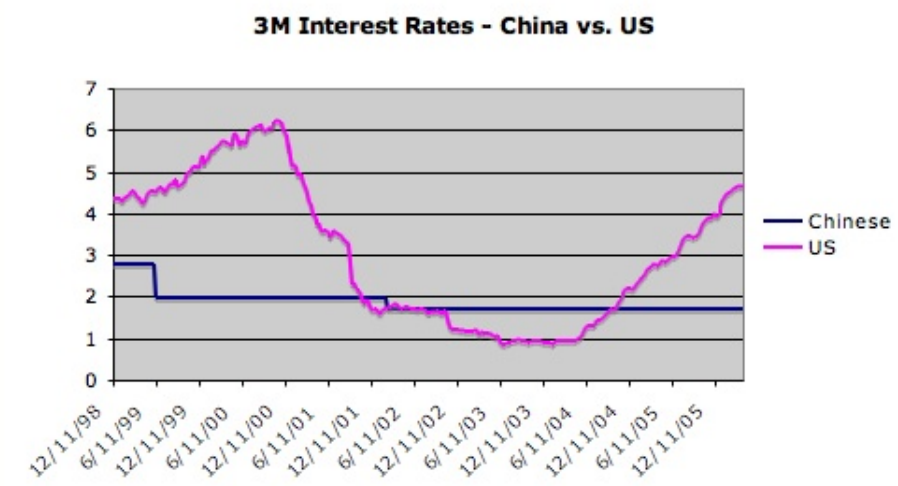

Figure 3: Chinese 3-month deposit rates vs. 3-month T-bill rates

Table 2: Average and standard deviation of variables

Name	**Variable**	**Average**	**Standard Deviation**
3-month deposit rates in China	i	1.8786	0.2677
3-month rates of the US Treasury Bill	i^*	3.072	1.7357
RMB/dollar spot exchange rates	S	8.2562	0.0634
RMB/dollar NDF rates	F	8.2503	0.1095

result of this estimation to be statistically significantly deviated from zero. Aside from its magnitude, the signs of the covered interest rate differential also play an important role in helping us understand China's capital mobility during the sample period. Specifically, a negative sign should indicate controls of capital outflow whereas a positive sign should indicate controls on capital inflow (Frankel, 1991). To see this, notice that a negative sign implies that $i < i^* - fd$, that is, the domestic return on capital is lower than that in the rest of the world, thus motivating investors to take capital out of the country. To prevent this from happening, restrictions must be placed on capital outflow. Applying similar reasoning yields that a positive sign of the covered interest rate differential indicates restrictions on capital inflow.

As mentioned earlier, the deviation from international covered interest rate parity largely attributes to a country's financial environment. In the case of China, several major macroeconomic events had occurred during the sample period. First of all, most countries in Asia were recovering from the Asian financial crisis in the late 1990s [18]. The most noticeable, however, happened around the year 2000 when China was expecting to enter the World Trade Organization (WTO). Generally speaking, a country's entrance to the WTO propels it to adopt more internationally accepted fiscal and monetary policies, which usually means a more liberal approach than what the country had previously been using. Thus, if such terms as liberalizing China's

[18]For a brief discussion of the Asian financial crisis, consult the website http://en.wikipedia.org/wiki/Asian financial crisis

financial system had been agreed in order to enter the WTO, a decrease in magnitude of its covered interest rate differential should be expected around this time. Moreover, the talk of China reforming its currency regime had become louder during the sample period of this study, while this is also the time during which the US dollar started to grow weaker and the balance of payment in China strengthened (IMF, 2000). All these factors should be kept in mind when evaluating the empirical results.

6.1 A First Look At the Chinese Covered Interest Rate Differential

The following table shows the estimation of equation (8) using the data described in the previous section.

Table 3: Descriptive statistics of covered interest rate differential in China: Jan. 1999 to Apr. 2006

Sample Size	**Mean**	**Median**	**Standard Deviation**	**Max.**	**Min.**
370	−0.8833	−0.0962	4.2758	8.1245	−15.0852

Frankel (1991) provides the covered interest rate differentials of 25 countries from 1982 to 1988. Judging from the mean alone, the Chinese data in this study mostly resemble the closed European economies in the 1980s (in absolute value), which collectively had a mean of -1.1. All of these countries had implemented various degrees of capital controls at some point in the sample period. The negative sign signals that the controls had been put to

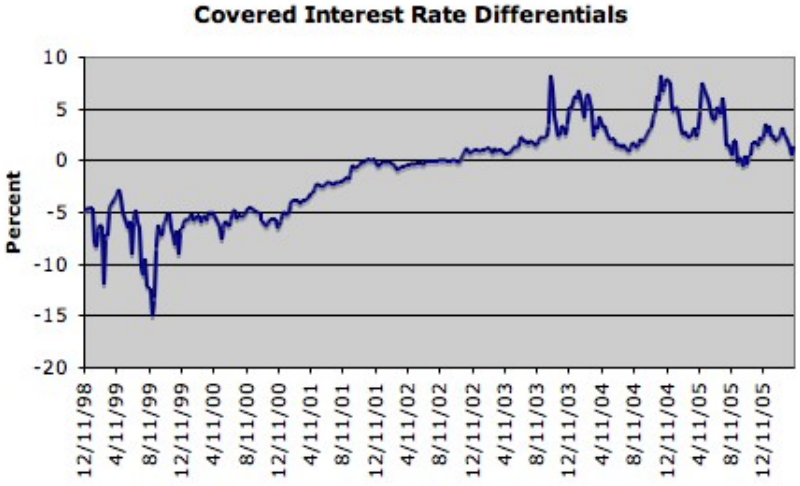

Figure 4: Covered interest rate differentials in China: Jan. 1999 to Apr. 2006

discourage capital outflow. A closer inspection of the descriptive statistics of the Chinese covered interest rate differentials shows that there had been a large degree of fluctuation with the maximum being as high as 15.0852 (in absolute value). Furthermore, the maximum and the minimum have opposite signs, indicating that there exists at least one point during the sample period at which controls on capital had been switched from outflow to inflow. We can learn from these additional characteristics that policy changes were very likely to have happened during the sample period. A plot of the variable for the whole period will paint a more complete picture of the variation of the covered interest rate differential (see Figure 4).

Upon inspecting FIgure 4, one might notice the cluster of fluctuation

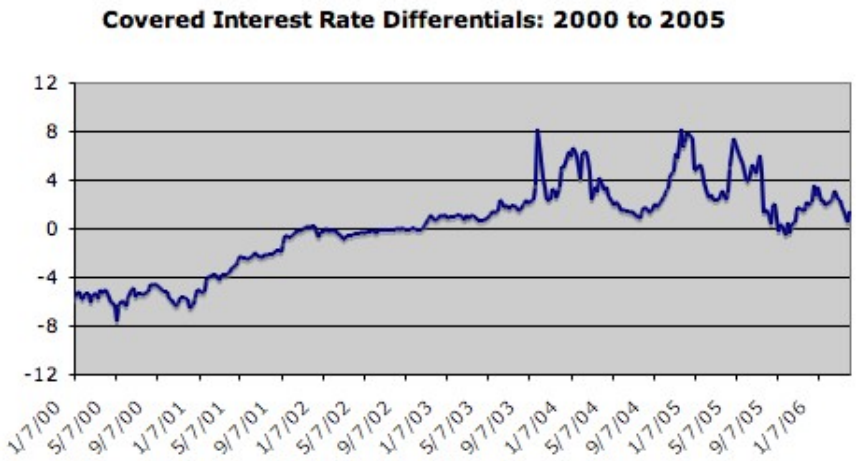

Figure 5: Covered interest rate differentials in China: Jan. 2000 to Apr. 2006

before the year 2000. Considering that this is within one year the RMB NDF market was established and the trading volume was thin, it is a good idea to ignore the first year's data. A refined plot is given in Figure 5. The same results are shown numerically in Table 4.

Table 4: Descriptive statistics of covered interest rate differential in China: Jan. 2000 to Apr. 2006

Sample Size	**Mean**	**Median**	**Standard Deviation**	**Max.**	**Min.**
317	0.1579	0.6138	3.5399	8.1245	−7.7251

Without the noises right after the establishment of the NDF market, the mean of the Chinese covered interest rate differentials has decreased dramatically (from to -0.8833 0.1579). The new mean puts China on par

with some of the Open Atlantic DC's such as the United Kingdom and the Netherlands in the 1980s (see Appendix A). Yet, a quick look at the maximum and minimum tells us that the relatively small mean may simply be a result of the positive the negative numbers offsetting each other. Indeed, the relatively large standard deviation suggests that the fluctuation is much bigger in the Chinese case.

6.2 The 2001 Scenario

The first noteworthy change of the Chinese covered interest rate differential happened around the beginning of the year 2001, where the values began to move closer to 0. Interestingly (and perhaps not too surprisingly), this is exactly around the time when China was preparing to enter the WTO. Clearly, a decrease in magnitude shows that the deviation from international covered interest rate parity was shortening. As mentioned earlier, the expectation to enter the WTO catalyzes a country's process to financial liberalization. Specifically, it facilitates the increase in foreign direct investment and elimination of market inefficiency (IMF, 2000). In China's case, it had entered into bilateral agreements with the US in which China would reduce tariff and quotas in certain industries. In addition, it had agreed to offer better terms to foreign firms doing business in the country. For example, it had given full trading and distribution rights to foreign firms in agriculture and full national treatment to foreign banks (IMF 2000). The pressure from the entering the WTO seemed to have motivated the PBC to loosen some of its

previously tightly controlling monetary policies.

6.3 2002 - 2004

Sometime around the end of 2001/beginning of 2002, the Chinese covered interest rate differentials became really small. In addition, the sign of the value changed from negative to position, indicating that restrictions had been switched from capital outflow to inflow.

Over the past two decades, the Chinese economy had been proven to show certain cyclical patterns. The cycles usually start with the government easing monetary and fiscal policies in favor of large state-own enterprises. Because of the relaxed policies, inflation surges. Before it goes out of control, the government takes action to tighten its policies in an attempt to cool down the overheating economy. Over the 2002 to 2004 period China seemed to be repeating such a cycle, which can be seen from the rapid growth in GDP and investment rate. Despite the sudden outbreak of the Severe Acute Respiratory Syndrome (SARS), which postpone the PBC's action, tightened monetary policies were put into effect starting mid-2003. (IMF, 2004)

In terms of covered interest rate differentials, the tighten policies were reflected by the sharp increase in December, 2003. The increase in covered interest rate differential (which had been positive over this time period) indicates tighter controls on capital inflow. Judging from Figure 5, the cycle seemed to have ended by mid 2004. Two more cycles appeared immediately afterward (mid 2004 to early 2005, early 2005 to end of 2005). Notice that a

sharp drop of the covered interest rate differential occurred during the week between July 15 and July 22, 2005, which corresponds exactly to the PBC's announcement of its currency revaluation on July 21. Since then the covered interest rate differential remained below 4.

One thing to bear in mind is that while a high covered interest rate differential definitely indicates barriers to free capital mobility, the reverse of the statement needs not to be true. Thus, during the time when the Chinese covered interest rate differentials were low (mostly during 2002), no conclusion can be drawn regarding the country's level of capital mobility.

6.4 Sensitivity Analysis

Under normal circumstances, it is standard practice to use the logarithm approximation when dealing with rates such as those in this paper [19]. Since it is feasible to compute the Chinese covered interest rate differentials without the approximation, I am going to do so to see how precise the approximation is.

Deriving directly from Equation (5) (without taking the natural log) yields the following equation:

$$1 + i - \frac{(1 + i^*) \cdot F}{S} \tag{9}$$

Using the data described in Section 5, I am able to compute Equation (9). Figure 6 shows the approximation (Equation (8)) and Equation (9) in one

[19] For example, Equation (8) is the log approximation of what would have been derived from Equation (5).

plot.

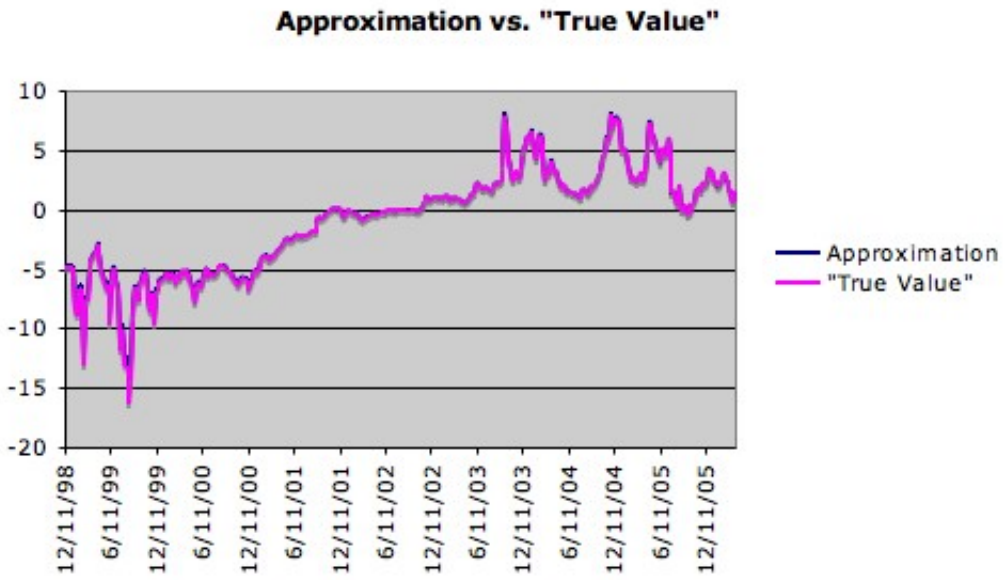

Figure 6: Approximation vs. "True Value"

As we can see from Figure 6, it is almost impossible to tell the two curves apart. Mathematically, the difference of these two curves is reported in Table 5.

Table 5: Descriptive statistics of the difference between the approximation and "true values" of the Chinese covered interest rate differentials

Sample Size	**Mean**	**Standard Deviation**	**Max.**	**Min.**
370	-0.0766	0.1779	0.1060	-1.4097

From both Figure 6 and Table 5 we can see that taking the natural log indeed works very well as a way to approximate Equation (9).

7 Conclusion

From the previous section we see that the estimation of the Chinese covered interest rate differential yields large numbers (with a mean of -0.88 and high of 8.12 in absolute value). Comparing this result to what has previously been done, the state of capital mobility in China during the sample period of this study mostly resembles the closed European DCs in the 1980s (Frankel, 1991). This is strong evidence that China had not been enjoying free capital mobility during the sample period, which supports my original hypothesis. Furthermore, the negative sign of the covered interest rate differential before 2003 suggests that capital controls had been mainly placed on capital outflow, while the positive sign since then suggests the focus of capital controls had been switched to capital inflow.

Although this study closely investigates the capital mobility in China since 1999, the sample period may not be large enough from which we could draw more general conclusions such as the effectiveness of certain monetary policies. Ideally, I would like to examine the international capital mobility in China since its adoption of the open-up policy in 1979 [20]. Since data on the NDF rates, which are required for this study, are not available before 1999 due to the absence of a foreign exchange forward market, other methods must be sought out. Alternative and indirect ways of measuring capital mobility in developing countries, specifically those lacking accurate historical data

[20]The open-up policy is arguably China's first step taken to transform itself from a strictly planned economy to a market-oriented one.

and a foreign exchange forward market, have been proposed in recent years. Some of these methods do not require the forward rates, the lack of which is precisely what prevents this study to go further back in time. Being fairly new ideas, these methods do not seem to have been contested enough to serve as benchmarks like the covered interest rate differential. However, for future research it would be interesting to apply these methods to the sample period in this study and compare them with the results produced by the covered interest rate differential criterion. Doing so may provide some insights to the accuracy and plausibility of these new methods. Should discrepancies occur and remedies be possible, estimations of capital mobility that cover the whole desired time period may be achievable.

Notes

Shortly after I started this project, China established an onshore RMB forward market. It is my understanding that there exist restrictions on who can and cannot participate in this market. Regrettably, I did not have a chance to look further into the onshore market. Nonetheless, I gathered some data. Below is a plot of the onshore forward rates vs. the NDF rates starting Oct. 19th, 2005.

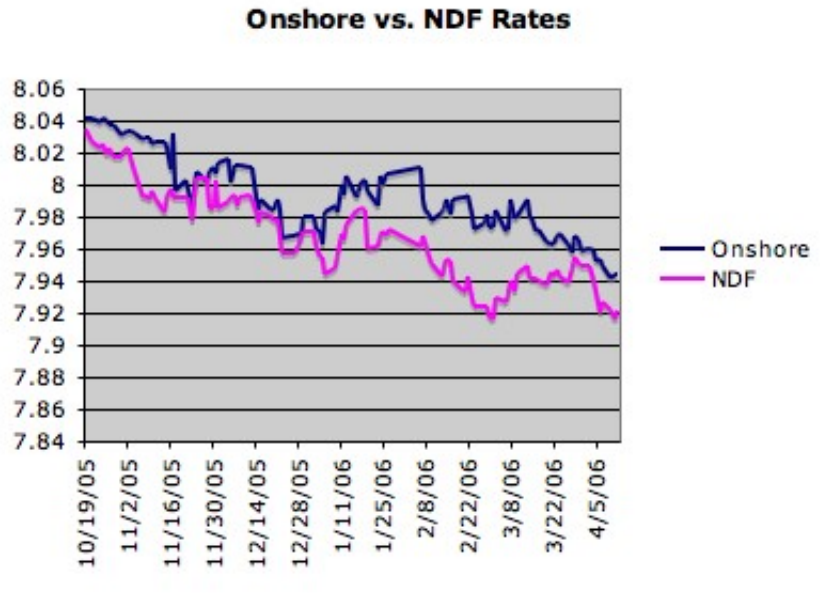

Figure 7: Onshore forward vs. NDF rates, Oct. 19th, 2005 - Apr. 12th, 2006

Appendix A (Source: Frankel, 1991)

	# of Observations	Means	Standard Deviation
Open Atlantics DCs			
Canada	68	-.10	.21
Germany	68	.35	.24
Netherlands	68	.21	.13
Switzerland	68	.42	.23
United Kingdom	68	-.14	.20
Group	340	.14	.21
Liberalizing Pacific LDCs			
Hong Kong	68	.13	.28
Malaysia	63	-1.46	1.28
Singapore	64	-.30	.31
Group	195	-.52	.76
Closed LDCs			
Bahrain	64	-2.15	1.06
Greece	58	-9.39	6.08
Mexico	53	-16.47	12.01
Portugal	61	-7.93	9.59
South Africa	67	-1.07	9.55
Group	293	-6.64	8.23
Closed European DCs			
Austria	65	.13	.39
Belgium	68	.12	.26
Denmark	68	-3.53	1.57
France	68	-1.74	2.68
Ireland	66	-.79	4.17
Italy	68	-.40	1.92
Norway	50	-1.03	.76
Spain	67	-2.40	3.66
Sweden	68	-.23	.45
Group	588	-1.10	2.25
Liberalizing Pacific DCs			
Australia	68	-.075	1.94
Japan	68	.09	.21
New Zealand	68	-1.63	.242
Group	204	-.76	1.78
All Countries	1620	-1.73	3.81

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