Deviations from Covered Interest Parity:
The Case of China*

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ABSTRACT

We study the empirical determinants of the Chinese renminbi (RMB) covered interest differential. The canonical macroeconomic variables including capital flight and the factors that affect country risk, and a few China-specific regulatory and institutional factors are considered. It is found that the effects of these canonical macroeconomic variables on the RMB covered interest differential are largely consistent with those reported in the literature. Further, the covered interest differential was affected by China's general capital control policy and its exchange rate reform program but not its political risk index. The effects of these explanatory variables on the covered interest differential appear to work mainly via the forward premium rather than the interest rate differential component. The results are largely the same across the on-shore and off-shore RMB forward rates that cover different sample periods.

JEL Classification: F3, F32, G15

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1. Introduction

China's official stance on exchange rate policy is to provide a stable exchange rate environment that is deemed to be a crucial factor for promoting trade and investment and, hence, economic growth. In recent years, China has been frequently criticized for pegging the value of its currency – renminbi (RMB) – at an artificially low level. The Mundell-Fleming trilemma framework suggests that a country may only choose two of the three macroeconomic policy goals: free capital flows, independent monetary policy, and stable foreign exchange rate. With a revealed preference for exchange rate stability, China imposes capital controls and retains monetary policy independence.[1] How effectively China could restrict free capital flows is critical for its exchange rate and macroeconomic stabilization policies.

China, in the recent years, has seen its economy getting more and more integrated with the world economy. While the pace of trade integration is phenomenal, it is hard to ignore the growing financial integration between China and the world economy. For instance, the gross cross-border capital flow per gross domestic product (GDP) increased from about 1% in 1982 to more than 12% in 2007. Despite the relatively fast integration process, China is arguably far away from being perfectly integrated with the world economy. Further, the trade and financial integration processes do not come along smoothly and without any costs.

Conceivably, the progressing integration process could make it increasingly difficult for China to maintain tight capital controls. Anecdotal evidence suggests that, since 2003, China has experienced large swings in both inward and outward capital flight. For instance, Cheung and Qian (2010) document that, for some periods, illicit capital outflows and inflows could be larger than the official foreign direct investment or the change in external debts. These large capital movements, in the absence of an efficient capital market, could inflict huge economic costs on China's economy.

Indeed, in the last few years, China has issued quite a few policy directives targeting capital flight and hot money. In general, China's policy is shifting from being more restrictive on capital outflows toward gradually balanced controls on both capital inflows and outflows.[2] Before establishing an efficient capital market, China's ability to maintain an effective capital

1 See, for example, Cheung *et al.* (2008) for China's monetary policy independence.
2 See, for example, Hung (2008) and Prasad and Wei (2007) for a detailed description of China's capital control policy.

control policy has significant implications for its ability to manage the economy and for the development of future policies of liberalizing capital management.

In the current exercise we study the RMB covered interest differential that is closely related to capital control effectiveness. In the absence of impediments to capital movement, covered interest parity suggests that assets of similar risk characteristics in different countries should commend the same rate of return. Capital controls that prohibit free capital flow between countries could drive a substantial wedge between returns across countries and lead to covered interest differentials. Perfectly effective capital control policies could sustain persistent covered interest differentials and partially effective policies could only maintain temporary deviations.

In the literature, the covered interest differential is shown to be determined by existing and future capital control policies and macroeconomic factors that could affect country risk, and, hence returns; see Aliber, (1973), Dooley and Isard (1980), Ito (1983), and Melvin and Schlagenhauf (1985). In the case of China, Cheung *et al.* (2003), for example, use *ex post* uncovered interest differentials to examine China's degree of integration with other economies. Ma and McCauley (2008) use the covered interest differential directly to study the effectiveness of China's capital control policy. They suggest that China's capital control is binding but not perfect; that is, there is capital flight but it is not large enough to equalize on-shore and off-shore yields on the Chinese RMB.

In the next section, we briefly discuss the empirical determinants of covered interest differentials considered in our empirical exercise. Some of these determinants are drawn from the literature and some are specific to China.

One data issue for our empirical exercise is the choice of forward rates for constructing the RMB covered interest differential. In our exercise, we use both the non-deliverable and on-shore forward rates. One advantage of non-deliverable forward rates is that these rates are determined outside China and are not subject to the Chinese jurisdiction. Thus, they could be interpreted as a proxy for the market expected future RMB exchange rate. The on-shore forward rates are prices local Chinese firms could use to hedge their exchange rate risk and are only available recently.

Another data issue is the choice of capital flight measure, which is an important factor for assessing the effectiveness of capital controls. In this exercise, we adopt the Chow and Lin method to construct the monthly version of the World Bank measure of capital flight. These data issues are discussed in Section 3.

The estimation results are discussed in Section 4 and some concluding remarks are offered in Section 5.

2. Determinants of Cover Interest Differential

Covered interest differential exists in the presence of capital controls and country risk (Aliber, 1973, Dooley and Isard, 1980, and Frankel and Engel, 1984). By restricting capital movement in and/or out of a country, capital control policies could create a gap between returns of domestic and foreign investments. A perfect control policy offers authorities a tight grip on, say, domestic interest rates. The folklore, however, is that capital controls are never perfect – people always find some ways to circumvent regulations. Thus, capital controls impede but do not eliminate capital flows between countries.

To what extent does a given capital control policy affect capital movement? The policy's potency depends on, among other things, how it is being implemented and the country's economic structure. The same capital control policy could yield different outcomes in different countries. Thus, the use of *de jure* capital control classifications may not accurately represent the effect of capital controls on observed covered interest differentials.[3]

In the subsequent sections, we use capital flight as a proxy for *de facto* capital control effort. Capital flight, the illicit capital movement that circumvents control measures, indicates the effectiveness of capital controls. We take a low level of capital flight as a result of serious capital controls. A high level of capital flight suggests a porous control environment. It is postulated that capital flight has a negative effect on the country's currency covered interest differential.

Besides capital controls, covered interest differentials are affected by macroeconomic factors that contribute to country risk. Because country risk is not directly observable, we follow the literature and consider three components of country risk.[4] Specifically, the three components are: a) solvency, b) liquidity, and c) economic stability. Intuitively, the country risk increases if a country has a deteriorating solvency position, worsening liquidity condition, or destabilizing

[3] See, for example, Magud and Reinhart (2007) for issues related to *de jure* capital control measures.

[4] See for example, Edwards (1984, 1986), Favero, Giavazzi, and Spaventa (1997), Eichengreen and Mody (1998), Kamin and von Kleist (1999), Kaminsky and Schmukler (2001), Merrick (2001), Mauro, Sussaman, and Yafeh (2002), Rigobon (2002), and Baek, Bandopadhyaya, and Du (2005).

economic climate. The effect of these three components on a country's covered interest differential follows from the axiom that investors demand a higher yield margin to assume a higher level of risk. Thus, factors that increase country risk have a positive impact on covered interest differentials.

The macroeconomic factors used to capture a country's solvency position (and their effect on covered interest differentials given in parentheses) are the real GDP growth rate (-), total external debt (+), and government budget deficits (+). The liquidity condition is assessed by the international reserves to GDP ratio (-). The economic stability factors are the inflation rate (+), inflation volatility (+), the exchange rate change (+/-), and exchange rate volatility (+).[5]

In studying the RMB covered interest differential, we include three China-specific regulatory and institutional factors. The first factor is a dummy variable that represents China's capital control policy. It captures the shift of China's policy bias from tightening to loosening and from primarily controlling outflow to controlling both inflow and outflow. We expect a narrow covered interest differential in the presence of a loose capital control policy.

The second factor is a dummy variable for the foreign exchange reform that took place in July, 2005. The long waited foreign exchange reform is conducted in the typical Chinese style of gradualism – a 2.1% one-off RMB revaluation in July, 2005 followed by gradual appreciation.[6] The policy change reduces the probability of a one-off sharp appreciation risk. Thus, the policy is likely to reduce covered interest differential.

The third factor is related to China's political risk. It is expected that a higher RMB covered interest differential follows a higher level of political risk. We use the political risk index variable from ICRG, which is constructed from 12 elements including bureaucracy quality, corruption, law and order.

3. The Basic Empirical Specification and Data

Following the discussion in the previous section, the basic covered interest differential regression specification is given by

$$Y_t = \alpha + \Sigma_i^p \beta_i Y_{t-i} + \theta' X_t + \psi' Z_t + \varepsilon_t, \qquad (1)$$

[5] Some studies used the probability of debt default or eurocurrency spreads as proxies for country risk. However, both proxies could be problematic (Melvin and Schlagenhauf, 1985).

[6] The gradual appreciation came to a halt in the second half of 2008 in the midst of the global financial crisis.

where Y_t is the RMB covered interest differential at time t, X_t is a vector that includes the canonical explanatory variables including capital flight and other macroeconomic factors mentioned in the previous section, Z_t contains the three China-specific explanatory variables, and ε_t is the error term.

Monthly data from January 1999 to June 2008 are considered. The starting point of the sample period is determined by data availability.

Data on one-month RMB interbank offer rates (Chibor), one-month US dollar London interbank offer rates (Libor), spot RMB exchange rates per US dollar, and one-month non-deliverable forward rates of RMB per US dollar are used to construct the RMB covered interest differential variable.[7] A large value of Y_t implies a high covered return on RMB. In addition to non-deliverable forward rates, we consider on-shore forward rates – see subsection 4.3. The lags of Y_t are included to describe dynamics not captured by macroeconomic variables and China-specific factors.

The capital flight variable – a measure of *de facto* capital control intensity – is derived from the World Bank residual method, which is a common approach to assess the amount of capital flight. In essence, the method assesses the magnitude of capital flight by comparing capital inflows and outflows reported in the balance of payments statistics.[8] The use of balance of payments statistics yields only quarterly capital flight data. The monthly quarterly data are interpolated from quarter data using the Chow and Lin (1971). The data construction procedure is described in the Appendix.[9] The monthly Chinese GDP data used are also obtained using the same procedure from quarterly data.

These variables and others used in the empirical analysis are defined in the Appendix.

4. Empirical Results

We examine the stationary property of each variable considered in our regression analysis using the Elliott, Rothenberg and Stock (1996) ADF-GLS unit root test, which assumes the highest test power among unit root tests. The finite sample critical values from Cheung and

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[7] See, for example, Ma *et al.* (2004) for a discussion of the RMB non-deliverable forward market.

[8] See, for example, Claessens and Naudé (1993) and Kar and Cartwright-Smith (2008) for a detailed description of various capital flight measures and their limitations.

[9] Essentially, information from monthly data on comparable and related variables is used to obtain the monthly capital flight and GDP data from the corresponding quarterly data. Wilcox (1983), for example, reports that the Chow and Lin method can successfully recover the essential dynamic characteristics of a data series, including autocorrelation structure and turning points.

Lai (1995) are used to assess statistical significance. For brevity, the unit root test results are not reported but are available upon request. It is found that the covered interest differential variable, capital flight, and most other macroeconomic variables considered are stationary variables. For variables that are determined to be I(1) non-stationary, they enter the regression in their first differences.

Since capital flight may be endogenous with respect to covered interest differentials, we estimate equation (1) using the instrumental variable method. Specifically, the instrument for capital flight is trade openness. The choice of trade openness is motivated by the link between capital flight and mis-invoicing of exports and imports. Indeed, it is widely perceived that trade mis-invoicing via under- and over-invoicing imports and exports is a common strategy to evade capital controls and to move money in and out of China, and, thus, is an important conduit for capital flight. A higher level of openness offers a better chance to manipulate the reported trade prices and the related capital flight.[10]

4.1 Basics Estimation Results

The results of estimating Equation (1) are reported in the first column of Table 1. With a few exceptions, we only present variables with a significant coefficient estimate in the Table for brevity.[11] The lag structure of the lagged dependent variable covered interest differential (CID) is determined by the Bayesian information criterion and the properties of the estimated residuals. The marginally significant Y_{t-3} is included to ensure that there is no serial correlation among the estimated residuals. The covered interest differential variable displays a rather complex dynamics that is not explained by the selected macroeconomic variables and China-specific factors. The coefficient estimates suggested that there is considerable amount of one-period persistence that is mostly reversed in the subsequent period. In passing it is noted that the use of quarterly data would not reveal this kind of dynamics and, thus, could lead to distorted results.

The RMB covered interest differential is negatively affected by capital flight (KF). A higher level of capital flight that is indicative of less restrictive capital control efforts reduces the RMB covered interest return. The result is in line with the findings of Dooley and Isard (1980), Ito (1983), and Melvin and Schlagenhauf (1985). Nevertheless, it is not statistically significant.

10 Qualitatively similar results were obtained when the lagged KF was used as the instrument.
11 The complete result is available upon request.

Not all the macroeconomic factors used as proxies for country risk are statistically significant. For instance, the liquidity factor represented by the international reserves to GDP ratio is not significant and, thus, not reported in the Table. The significant macroeconomic factors, however, mostly have a sign that is consistent with theoretical predictions. For instance, the real GDP growth (RGDPG) has a negative coefficient estimate - high economic growth lowers RMB covered interest differentials. The finding is in accordance with the notion that high economic growth alleviates the level of country risk, and hence, reduces the level of covered interest differential.

Three of the four economic stability proxy variables are significant. High exchange rate volatility (EV) and high inflation volatility (InflV) – the symptoms of economic instability – have the expected positive impact on RMB covered interest differentials. Again, a high covered return is required to assume a high level of country risk. The nominal effective exchange rate (NEER) is an index measuring the general strength of RMB. A positive value of the change in NEER (*d*NEER) means RMB appreciates against a basket of foreign currencies. Given the conservative Chinese exchange rate policy, we expect a high NEER reduces the possibility of a jump in its value in the near future and, thus, does not add to the required covered return. Thus, the negative estimate of *d*NEER suggests that an appreciation of RMB softens the pressure (or the expectations) of further RMB appreciation and, hence, a negative coefficient estimate.

While China's political risk does not affect RMB covered interest differentials, the other two China-specific factors show up significantly in the regression. Specifically, the policy control dummy variable (CONTROL) and the foreign exchange reform variable (REFORM) have a negative coefficient. During the sample period, China is loosening its grip on capital control and the CONTROL variable is decreasing. In the content of China, a weaker capital control environment makes it more difficult to deter hot money inflow and to resist the pressure to appreciate RMB. If it is the case, then a looser control leads to an expected RMB appreciated, a lower RMB forward discount, and a higher covered return, *ceteris paribus.*

The estimated negative effect of the reform variable REFORM is in line with the conventional wisdom. With a one-time appreciation in July 2005 and the subsequent managed appreciation process, the possibility of another large jump in the future value of RMB is subsided. Thus, covered interest differentials in the post-reform period are lower than those in the pre-reform period, *ceteris paribus*.

Overall, specification (1) explains the RMB covered interest differential variable quite well with the sample adjusted R-squares statistic of 86% and estimated residuals pass the Box-Ljung test.

4.2 Components of Covered Interest Differential

The covered interest differential variable considered in the previous subsection is the sum of two components - interest rate differential and forward premium. Although China's on-shore money market is undergoing a liberalization process and transiting from a mostly government directed to a more market force driven market, the RMB interest rate is *de facto* a government dictated rate. Further, the domestic money market is not open to all investors – especially foreign investors.[12]

The non-deliverable forward rates used to construct the forward premium, however, are determined outside China and, in principle, are not subject to the Chinese jurisdiction. These rates are the result of the interplay between market forces and could be interpreted as a market proxy for the expected future Chinese RMB exchange rate. For instance, during 2003-2005, the speculation of RMB revaluation drove up its non-deliverable forward rate and induced an average of about US$55 billion hot money inflow per year.[13]

Given their different determination mechanisms, the interest rate differential and the forward premium components could react differently to the determinants of covered interest differential. Some explanatory variables may affect the RMB covered interest differential via the forward premium channel and some via the interest rate differential. To capture this idea, we decomposed the covered interest differential into its interest rate differential (RDIFF) and forward premium (PREM) component; that is CID = RDIFF + PREM. Then, we regressed each one of these two components on the explanatory variables included in equation (1). The results are reported in the second and third columns of Table 1.

The interest differential variable (RDIFF) displays a high level of persistent with an AR(1) coefficient estimate of 0.955. The capital flight (KF) variable is negative but not significant. The first-differenced fiscal deficit variable (*d*FISC) that is related to solvency is the only significant

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[12] See, for example, Nagai and Wang (2007) and Xie (2002).

[13] Authors' calculation based on the notion of hot money = errors and omissions + portfolio investment inflows (Prasad and Wei, 2007).

macroeconomic factor. It is significant at the 10% level with a negative sign; indicating a high government deficit widens the interest rate differential.

The forward premium (PERM) yields estimation results that are comparable to those for the covered interest differential regression presented under the first column. The capital flight variable again has a negative coefficient and is insignificant. It is of interest to compare the capital flight estimates across these three regressions despite their insignificance. While all these estimates are negative, the one for PERM is much larger than the RDIFF one. If these estimates are significant, then we would say that the capital flight effect on covered interest differentials works mainly through the forward premium, instead of the interest rate differential, channel.

The macroeconomic factors, real GDP growth (RGDPG), nominal effective exchange rate (*d*NEER), exchange rate volatility (EV), and inflation volatility (InflV) have the same signs as those under the first column. All four variables with the exception of InflV are statistically significant. The inflation volatility variable is reported because its inclusion raises the adjusted R-squares estimate from 73% to 81%.[14]

Comparing the results in these three columns, we observed that the two components of covered interest differential respond differently to the determinants. The dissimilar response patterns could be attributed to their different determination mechanisms noted in the beginning of this subsection. The interest rate differential component is quite persistent and responds only to a few economic factors. The forward premium component, on the other hand, behaves quite similar to the covered interest differential. Interestingly, none of China-specific factors shows up significant in both the interest rate differential and forward premium equations.

4.3 On-shore Forward data

In the previous two subsections, the forward premium and the resulting covered interest differential variable is based on non-deliverable forward rates that are determined outside China. Since the exchange rate reform in July 2005, the Chinese central bank, People's Bank of China, has encouraged the trading of RMB forwards in China. State banks, non-bank financial institutions, foreign banks and financial institutions, and even non-financial enterprises are allowed to register and participate in the on-shore RMB forward market. Forward contracts of RMB vis-à-vis five major foreign currencies – the US dollar, Euro, Japanese yen, Hong Kong

[14] In fact, if the openness instrumental variable is not used, the InflV variable is positively significant.

dollar, and British pound – are currently offered in the on-shore forward market. Comparing with the off-shore non-deliverable RMB forward market, the on-shore market is a relatively shallow market in which transactions are mostly hedge demands from corporations. It is under close government supervision and regulations. Apparently, the pricing in this market is influenced by interest rate parity (Peng *et al.* 2007).

Despite the on-shore RMB forward data are available only for a relatively short time period, we would like to investigate if the results reported in Table 1 are robust to the choice of forward data. Further, it is of interest to know if the on-shore and off-shore variables have different responses to the selected macroeconomic factors. To this end, we re-estimated equation (1) using the RMB covered interest differential constructed from the on-shore RMB forward rate as the dependent variable. For comparison purposes, we also repeated the regressions for the two components of the alternative covered interest differential variable. The sample size of these regressions is from October 2005 to June 2008. The results are presented in Table 2. It is noted that the two China-specific factors; namely CONTROL and REFORM, are not included because these two dummy variables show no variation in the shortened sample. The political risk factor, again, is not significant. Thus, these three China-specific variables are not listed in Table 2.

Besides the absence of the China-specific factors and the real GDP growth variable, the estimates from the regression based on the RMB covered interest differential constructed from the on-shore forward rate (OSCID) are quite comparable to the corresponding ones in Table 1. The dynamic structure of the OSCID resembles the one of CID in Table 1. In both case, three lagged dependent variables are required to remove serial correlation in estimated residuals. The coefficient estimates of the included variables are qualitatively the same as those in Table 1 – they have the same signs. However, the coefficient estimates of the OSCID regression are larger in magnitude than the corresponding ones for CID.

For instance, the capital flight variable (KF) has a more negative and, more importantly, statistically coefficient estimate. That is, the capital flight is significant for the covered interest differential based on on-shore forward rates though it is not significant for the differential derived from off-shore forward rates. Further, the nominal effective exchange rate (*d*NEER), exchange volatility (EV), and inflation volatility (InflV) variables that capture economic stability have a larger impact on OSCID than on CID. Compared with CID, OSCID is more responsive to the significant macroeconomic determinants.

The second column in Table 2 is labeled OSRDIFF for "consistency". It presents the results on the interest rate differential regression based on the sample in which the off-shore RMB forward rate data are available. The only significant variable is the lagged interest rate differential. The capital flight variable is not significant as it is in Table 1 – we reported it for comparison purposes. The *d*FISC variable is not significant with the reduced sample size.

The "OSPREM" regression that has forward premiums based on the on-shore RMB forward rates as the dependent variable shares some similarities with the OSCID regression. The macroeconomic variables – capital flight, nominal effective exchange rate, exchange volatility, and inflation volatility – that affect OSCID are also statistically significant. In fact, the coefficient estimates in the OSPREM equation are usually larger (in magnitude) than the corresponding ones in the OSCID equation. That is, the forward premium is likely to be the conduit through which these macroeconomic factors affecting the covered interest differential.

In sum, when we take the substantial reduction in sample size into consideration, the estimates in Tables 1 and 2 are qualitatively similar. The identified empirical determinants appear robust to the alternative choices of forward data.

5. Concluding Remarks

With the growing importance of China in the global market, a plethora of studies on China emerge. These studies cover, for example, its phenomenal economic growth trajectory, its ability to attract foreign direct investment and its deployment of outward direct investment, its exchange rate policy, the international reserves it amassed in the new millennium, and its real and financial integration with the world economy.[15] There are, however, only a few studies on China's capital control policy. In this exercise, we study the determinants of the RMB covered interest differential, which is a proxy for the effectiveness of capital controls.

Our empirical exercise considers the canonical macroeconomic variables including capital flight and the factors that affect country risk, and a few China-specific regulatory and institutional factors. It is found that the effects of these canonical macroeconomic variables on the RMB covered interest differential are largely consistent with those reported in the literature. The results, again, are largely the same across the two different choices of RMB forward rates

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15 See, for example, Blanchard and Giavazz (2006), Cheung *et al.* (2007), Cheung and Qian (2009), Eichengreen and Tong (2007), Feenstra and Wei (2009), Hale and Long (forthcoming), Jeanne (2007), and Lane and Schmukler (2007).

(on-shore and off-shore rates) that cover different sample periods. In that sense, the China case is not much different from the other cases. Further, there is evidence that the RMB covered interest differential was affected by China's general capital control policy and its exchange rate reform program but not China's political risk index.

Since its economic reform policy started in the late 1970s, China has embarked on the process of integrating with the global economy. At the same time, the Chinese economy is undergoing a swift transition from a planned economy to a market economy. In the process, China has gradually loosened its grip on both the trade and finance areas. Policies are instituted to direct the path of economic development and, from time to time, are formulated to accommodate economic reality. Capital control policies are of no exception. They offer the authorities an extra degree of freedom in contemplating macroeconomic policies for the so-called "unorthodox" China-style economic experiment.

The Chinese authorities have repeatedly proclaimed their ultimate policy goal is to lift capital controls and let market forces to play the role in, say, determining the RMB exchange rate.[16] Understandably, China would like to be in charge of the transition process to a less controlled policy environment and be sure the process is controllable and does not jeopardize the stability of the Chinese economy. One issue China has to face is the ability of its relatively underdeveloped financial sector to handle and absorb shocks – both real and financial – to the economy.

Compared with, say, the US financial system, the Chinese financial sector is quite under-developed and is commonly perceived to have only limited capacity to handle volatility and shocks that are commonly observed in the modern financial world. Thus, before China has developed a well-functioning and efficient financial sector, the authorities are likely to leverage on capital control measures to manage capital movements and foreign exchange transactions. At the same time, the effectiveness of these control measures could have implications for China's progress in liberalizing its financial market and conducting monetary policy, when it is in the process of building a robust financial system that could sustain real and financial shocks.

Our exercise suggests that the RMB covered return differential is affected by both the canonical macroeconomic determinants and some China-specific factors. Thus, we have the

[16] The Chinese President Hu Jintao repeated the similar message in, say, the recent held second summit of Brazil, Russia, India and China; see http://www.fmprc.gov.cn/chn/gxh/tyb/zyxw/t682096.htm.

usual prescription of a stable economic environment that is essential for China to manage capital flows and, hence, its macro-economy; especially before its financial sector has both the depth and breadth to handle the considerable shocks to the economy.

Appendix

A: Data – Definition and Sources

The appendix lists the definitions of the variables used in the study and their sources.

KF	The stock of China's capital flight in trillion US$. The US dollar LIBORs are used to compound capital flight data and the compounded series is adjusted by the US inflation rates. The World Bank residual method is used to construct the capital flight data. The required balance of payments data are obtained from the State Administration of Foreign Exchange (SAFE) of China.
CID	The covered interest differential. It is given by (r-r*)/(1+r*) –(F-S)/S, where r is the Chinese interbank offer rate (CHIBOR), r* is the US$ LIBOR, F is the RMB non-deliverable forward rate; and S is the spot exchange rate (yuan/$).
OSCID	The covered interest differential when China's on-shore forward rate is used.
RGDPG	China's real GDP growth rate calculated from seasonal adjusted data from CEIC.
FISC	China's government deficit scaled by GDP. (Data source: CEIC)
NEER	The RMB nominal effective exchange rate. (Data source: IFS)
InflV	China's inflation volatility, calculated from the conditional variance in a GARCH(1,1) model.
EV	The RMB exchange rate volatility, calculated as the standard deviation daily RMB exchange rate. (Data source: CEIC)
REFORM	A dummy variable for China's July, 2005 exchange rate policy reform, I(t>=July, 2005).
CONTROL	A dummy variable to capture the timing of China's capital control policy changes. It is assigned a value of +1 for the observations before Sept. 2001, when China tightened capital outflow; a value 0 for the observations between Sept. 2001 and Oct. 2002, when it is deemed as a transition period; and a value -1 for the observations after Oct. 2002, when Chinese authorities starts to encourage or promote capital outflow.
RDIFF	Interest rate differential, expressed as (r-r*)/(1+r*). The data is calculated by subtracting the US$ LIBOR from CHIBOR.
PREM	The RMB non-deliverable forward premium given by, $(NDF_{t+k} - e_t)/e_t$, where NDF_t and e_t are, respectively, non-deliverable forward and spot rates expressed as the price of RMB. The 90-day and 30-day forwards are used in, respectively, quarterly and monthly data regressions.
OSPREM	The RMB on-share forward premium.
OPEN	China's trade openness, calculated from (X+M)/GDP.
Trend	A time trend variable.

B: **Constructing the monthly capital flight and GDP data**

Following Cheung and Qian (2010), we use the Chow and Lin (1971) method that is built upon Chang and Liu (1951) to extract the information to construct monthly capital flight and GDP data. For example, to construct the monthly GDP series, the Chow and Lin method uses information on variables that are closely related to GDP and, at the same time, available on the monthly frequency. Usually, these monthly variables are components of GDP. Wilcox (1983), for example, reports that the Chow and Lin method can successfully recover the essential dynamic characteristics of a data series, including autocorrelation structure and turning points.

The residual method based capital flight is given by

$$Capital\ flight = \Delta ExD + NFDI - CAD - \Delta IR.$$

where ΔExD is the change in external debts, *NFDI* is the net foreign direct investment; *CAD* is the current account deficit, and ΔIR is the change in international reserves. Monthly data on international reserves are available. Thus, we have to construct the monthly data on *CAD*, *NFDI*, and ΔExD. In our exercise, data on China's trade balance are used to derive the monthly current account balance. The net foreign direct investment series is derived using data on inward foreign direct investment. The monthly external debt series is derived from the regression framework given in Eaton and Gersovitz (1981) with a dummy variable capturing China's Qualified Foreign Institutional Investor program that was instituted in 2002 and allows designated foreign entities to participate in the local Chinese stock markets.

For the GDP data, only data on the aggregate consumption component are not available at the monthly frequency. Thus, we derived monthly consumption data using information on monthly retail sales on consumer goods, and the consumption of transportation and telecommunication services (Chang and Liu, 1951).

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Table 1: Determinants of China's Covered Interest Differentials (Off-Shore Forward Rates)

CID		RDIFF		PREM	
CID(-1)	0.774***	RDIFF(-1)	0.955***	PREM(-1)	0.528**
	(0.13)		(0.09)		(0.24)
CID(-2)	-0.467***	KF	-0.113	PREM(-2)	-0.484*
	(0.15)		(0.45)		(0.25)
CID(-3)	0.156	*d*FISC	2.461*	KF	-1.757
	(0.10)		(1.38)		(2.21)
KF	-0.757			RGDPG	-0.080**
	(0.86)				(0.04)
RGDPG	-0.083**			*d*NEER	-0.034***
	(0.04)				(0.01)
*d*NEER	-0.046***			EV	8.197***
	(0.01)				(2.78)
EV	9.090***			InflV	0.068
	(3.00)				(0.05)
InflV	0.063***				
	(0.02)				
CONTROL	-0.063*				
	(0.03)				
REFORM	-0.202***				
	(0.08)				
Trend	0.122**		0.004		0.200*
	(0.06)		(0.02)		(0.10)
Constant	-0.439**		-0.009		-0.644**
	(0.18)		(0.05)		(0.28)
Adj.R-squares	0.86		0.86		0.81
Obs.	111		113		112
Q-stat(12)	1.81		10.01		17.76
Q-stat(24)	7.11		15.60		28.03

Note: The table reports the results of the IV regression with *d*OPEN (trade openness) as the instrument for KF. Robust standard errors are given in the parentheses. "***", "**" and "*" denote significance at the 1%, 5%, and 10% levels, respectively. "Q-stat(12)" and "Q-stat(24)" are the Box-Ljung Q-statistics calculated from the first 12 and 24 estimated residual autocorrelations. None of the Q-statistics is significant.

Table 2: Determinants of China's Covered Interest Differentials (On-Shore Forward Rates)

OSCID		OSRDIFF		OSPREM	
OSCID(-1)	0.750***	RDIFF(-1)	0.542***	OSPREM(-1)	0.464***
	(0.07)		(0.18)		(0.07)
OSCID(-2)	-0.630***	KF	-0.277	OSPREM(-2)	-0.605***
	(0.09)		(0.40)		(0.14)
OSCID(-3)	0.482***			KF	-1.755**
	(0.08)				(0.72)
KF	-0.924*			*d*NEER	-0.031**
	(0.52)				(0.01)
*d*NEER	-0.050***			EV	18.148***
	(0.01)				(4.41)
EV	15.734***			InflV	0.137***
	(2.79)				(0.04)
InflV	0.127***				
	(0.03)				
Trend	-1.028***		0.579**		-1.105***
	(0.30)		(0.25)		(0.38)
Constant	4.439***		-2.708**		4.989***
	(1.36)		(1.15)		(1.68)
Adj.R-squares	0.88		0.81		0.64
Obs.	30		32		31
Q-stat(12)	7.65		11.64		11.34
Q-stat(24)	16.29		28.62		24.15

Note: The table reports the results of the IV regression with *d*OPEN (trade openness) as the instrument for KF. Robust standard errors are given in the parentheses. "***", "**" and "*" denote significance at the 1%, 5%, and 10% levels, respectively. "Q-stat(12)" and "Q-stat(24)" are the Box-Ljung Q-statistics calculated from the first 12 and 24 estimated residual autocorrelations. None of the Q-statistics is significant.