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Keywords: Capital account openness, Financial integration, Covered interest parity, Capital controls, Foreign exchange market.

JEL Code: G15, F30, F31, F32

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1 Introduction

In the last three decades, the magnitude of cross-border capital flows has gone up by leaps and bounds as most emerging market economies (EMEs) actively took steps to systematically dismantle their capital controls and open up their economies to foreign investments. Yet from time to time these EMEs keep experimenting with capital control policies to satisfy myriad objectives such as, limiting exchange rate appreciation or preventing a sharp depreciation, increasing monetary policy independence, reducing inflation, dealing with volatility in financial markets and so on (Forbes et al., 2015).

This makes it harder to assess how open or closed a country's capital account truly is. In other words, what has been the *de-facto* outcome of the *de-jure* capital control actions taken by countries over time in response to global financial flows? Assessing a country's financial integration with the rest of the world using indices constructed out of *de-jure* capital controls often requires subjective judgements. This underscores the importance of relying on reduced form *de-facto* measures which reflect the net impact of capital control changes.

In this paper, we analyse the changes over time in the capital account openness of one of the largest emerging economies, India, and compare and contrast it to that of another large emerging economy, China, using a *de-facto* price based measure. These two countries are always pitted against each other in economic debates and discussions. As of 2021, together they account for one-third of the world population. India is the sixth largest economy in the world in terms of nominal GDP while China is the second largest, after the US. For the longest time both these countries were not financially integrated with the rest of the world and had highly regulated financial markets. Over the last few decades, both countries have embraced globalisation and greater financial liberalisation and deregulation, India in the 1990s and China from mid-1980s onwards.

At the same time, India and China are perhaps the only two countries in the world that till date have in place a complex and elaborate framework of capital controls. The respective authorities of these two countries keep changing their capital control policies on a fairly regular basis. As a result measuring the extent of their financial integration with the global economy is far from a straightforward exercise. Unlike many other EMEs, one cannot characterise India or China's capital account as either open or closed at any given point of time. Rather the extent of their financial integration has to be deciphered on a continuous basis from available data.

Existing evidence in the related literature measuring capital account openness shows that over the years, India's capital account has become relatively more open, while the same cannot be said for China. For example, Ma and McCauley (2013) compare the evolution of India and China's capital account openness based on eight *de-facto* measures for the period 2000-2012. They find India to be more financially open than China on six out of the eight measures. Similarly, Hutchison et al. (2012a) examine the effectiveness of capital controls in India by analysing the daily return differentials between the onshore Rupee market and the NDF market and do the same for China. They argue that the *de-jure* and *de-facto* capital openness in India have varied over the 1998-2011 period but a general trend of liberalisation is clearly evident.

We add to this literature by providing more recent evidence on the capital account openness of the two countries, especially for the post-Global Financial Crisis period when both the countries undertook significant relaxation of their capital controls. In India for example, many changes were implemented with regard to the capital control actions (CCAs). With respect to the foreign portfolio investment alone, India witnessed atleast five to six CCAs every year in the post-2008 period, which to a greater extent are in the direction of relaxations (Pandey et al., 2019b). On the other hand, in recent years, China's share in the world economy has been rising. China has been actively pursuing its goal of internationalisation of the Renminbi (RMB) which is critically

contingent upon capital account liberalisation. The inclusion of the RMB by the International Monetary Fund (IMF) in the basket of currencies that make up the special drawing rights (SDR) in October 2016, added further impetus to China's attempt to internationalise its currency.

These developments underscore the importance of analysing whether policy actions taken by the authorities of these two countries have translated into greater capital account openness in the more recent years.

Against this background, we assess the openness of the capital accounts of the two countries, by calculating the deviations from the Covered Interest Parity (CIP) which measure the degree of cross-border market segmentation caused by capital controls (Ma et al., 2004; Frankel, 1992). It is computed as the spread between the onshore interest rates and the offshore-market implied interest rate. A substantial onshore-offshore yield gap would indicate effective segmentation of the onshore and offshore markets via capital controls (Ma et al., 2004), whereas a negligible or a narrow gap between the two will indicate close to perfect capital mobility in the absence of capital controls.[1]

The advantage of a CIP based measure of capital account openness is that it captures all kinds of complexities in capital account related restrictions as reflected in the prices. It is also a dynamic measure which evolves in keeping with the degree of financial integration. For countries such as India or China, whose capital accounts are never fully open or entirely closed but instead the restrictions on foreign capital entry or exit undergo periodic and frequent changes, CIP deviations would reflect the changes over time in the extent of economies' financial integration.

To calculate CIP deviations, we use the offshore non-deliverable forward (NDF)[2] rates for the currencies of the two countries relative to the US dollar, and the respective onshore spot rates. Our main sample extends from August 1999 to February 2020 for India, while for China we analyse the period from June 2006 to February 2020. We also analyse the period from March 2020 to January 2021 for India during which India saw huge volatility in capital flows as a result of the Covid-19 pandemic. In response, the Indian authorities took measures to further ease inflows of foreign portfolio capital (Patnaik and Prasad, 2020).

In particular, we study the difference between the NDF implied yield and the onshore interest rate. The NDF market is free of capital controls which makes it a good candidate for capturing the market implied interest rates, especially when the NDF market in the home-currency is liquid.[3] The NDF implied yield captures the net covered rate of return that would be available to foreign participants on Indian (or Chinese) financial instruments had there been no restrictions on the capital account in the respective countries.

CIP is a pure arbitrage condition. In the ideal world of perfect capital mobility, and zero transactions costs, the CIP condition will hold, else riskless profitable arbitrage opportunities will arise. However, in the presence of capital market imperfections such as capital controls, there would be 'neutral bands' or 'no-arbitrage bands' around the theoretical parity condition, within which profitable arbitrage is not possible (Balke and Wohar, 1998). Outside the bands, the deviations will be arbitraged away as agents exploit the profit opportunities, whereas inside the bands, the CIP deviations will persist. These non-linear dynamics of CIP deviations outside and within the bands have been modeled in the literature using the threshold autoregression (TAR) model (Balke and Wohar, 1998; Balke and Fomby, 1997; Peel and Taylor, 2002).

In this paper, we use the Self-Exciting Threshold Autoregressive model (SETAR) to estimate

[1]The interpretation of the onshore / offshore interest spread assumes that both the onshore and offshore markets are highly liquid. It also assumes zero or negligible country and credit risk (Ma et al., 2004).

[2]There exists both onshore and offshore markets for trading in the Indian Rupee. The dominant segment of the offshore market is the non-deliverable forward (NDF) market.

[3]The USDINR, for instance, is one of the largest NDF market as detailed in Section 3.

the no-arbitrage bands on CIP deviations. The SETAR model allows the estimation of the upper and lower boundaries of the "no-arbitrage" bands (provided that the series follows a non-linear behaviour), and the speed of convergence outside the band. The size of the no-arbitrage band, and the speed of adjustment are interpreted as (inverse) measures of the level of financial integration of markets (Juhl et al., 2006; Levy Yeyati et al., 2009; Hutchison et al., 2012b; Hua et al., 2013).

Our analysis indicates large variability in the magnitude and the direction of the CIP deviations for India during our sample period. We find large and persistent deviations in the CIP, especially in the first half of our sample period. In general the negative CIP deviations, indicating capital outflow pressures, have been larger in magnitude compared to the positive deviations. This implies that the elaborate and complex system of CCAs that has been in place succeeded in preventing capital outflows more effectively than capital inflows. We find that CIP deviations start reducing considerably in the period after the Global Financial Crisis of 2008-09, indicating greater financial integration in the last decade. This could either be because of substantial relaxation of capital controls or lower effectiveness of existing controls or a combination of both.

The increasing trend of capital account openness is also reflected in the width of the no-arbitrage bands estimated using the SETAR model. Overtime, we observe that the size of the bands has narrowed down considerably, which implies greater *de-facto* capital account openness. The speed of convergence to the no-arbitrage bands has also come down, indicating arbitrage trades occur more rapidly in the presence of large CIP deviations.

When we apply our methodology to China, we find that our results reflect the general trajectory of China's capital account liberalisation process. Like India, China's capital account liberalisation has also been haphazard and gradual. And similar to India, China has also opened up more in recent periods. However our analysis shows that India's capital account has become substantially more open than that of China. Either China has liberalised more slowly compared to India or the capital controls in China are more binding than those in India. We find from our sub-period analysis that China experienced greater or more frequent capital inflow pressures compared to India. It appears that in the case of China, the controls on capital inflows were relatively more effective, as reflected in the large, positive CIP deviations across the sample period.

There is a growing literature that focuses on the CIP deviations of the advanced economies as well, especially the persistent deviations that have existed since the Global Financial Crisis of 2008-09. Du and Schreger (2021) argue that the deviations persist due to regulations imposed on the banks in the aftermath of the crisis, that restricted the flow of US dollars in the global market and created a wedge between the demand for and supply of US dollars. Cerutti et al. (2021) highlight the importance of other potential macro-financial variables in explaining CIP deviations in addition to regulatory changes.

When it comes to developing countries, Du and Schreger (2021) argue that these countries have strong capital controls that restrict foreign participation (i.e. foreign capital inflows) in the local currency government bond markets, and limit the international investments of local institutional investors. These capital controls create segmentation in clientele and market liquidity between the domestic government bond and the offshore, non-deliverable, cross-currency swap markets.

In particular, during times of global financial distress, the rise in the local currency bond yields in emerging markets is more muted due to local clientele effects, while the forward premium and CDS spreads spike in tandem with the heightened risk aversion of global investors, creating a significant negative local currency "credit" spread. The co-movement, or the lack thereof, between the onshore local currency bond yields and the offshore non-deliverable cross-currency

swap rates potentially offers researchers a de facto measure of market integration and capital controls. This *de-facto* approach is what we study in our paper to understand capital controls and market integration specifically for India and also for China.

The rest of the paper is structured as follows. In Section 2, we provide a brief background of India's capital account liberalisation process over the past several years. In Section 3 we discuss the growth of the NDF market for the Indian Rupee. In Section 4 we describe the problems with the *de-jure* measures of capital account openness. We present our empirical methodology and results in Section 5, including the calculation of the CIP deviation and estimation of the no-arbitrage bands. In Section 6 we analyse the evolution of the CIP deviation and the no-arbitrage bands across the various sub-periods. In Section 7 we summarize the recent policy actions taken by the Indian authorities to deepen and improve liquidity in the onshore market and analyse the behaviour of CIP deviations during the pandemic period. In Section 8 we apply our methodology to China and compare the results with those of India's. Finally we end with concluding remarks in Section 9.

2 India's capital account liberalisation

India adopted liberalisation reforms in the early 1990s prior to which it was primarily a closed economy especially with regard to its capital account transactions. This was part of a broader agenda of reforms initiated after the balance of payments crisis of 1991. On the external front, the reforms included dismantling of trade restrictions, move towards current account convertibility, a market oriented exchange rate regime and a gradual opening up of the capital account. While liberalising the capital account, the approach adopted was a calibrated one.

With the Latin American debt crisis of the early 1980s and the Asian financial crisis of 1997 fresh in mind, India prioritised certain kinds of flows and agents in the liberalisation process. In particular, India favoured non debt flows such as foreign direct investment (FDI) and portfolio investment flows over debt flows (Sengupta and Gupta, 2015; Mohan and Kapur, 2009). Currently, barring a few sectors, FDI is universally allowed. Portfolio equity flows have also witnessed significant liberalisation. In contrast, debt flows are subject to numerous restrictions including borrowers and lenders having to satisfy eligibility conditions, minimum maturity period, ceilings on interest rate spread and end-use restrictions.

While authorities have been gradually relaxing the legal restrictions that govern foreign investment flows, from time to time new restrictions have also been imposed on the foreign investors. As a result, despite the adoption of liberalisation reforms in 1990s, even today in India there exists a comprehensive and complex legal and regulatory framework of capital controls and an extensive array of restrictions on capital account transactions.[4] In an extensive study, Pandey et al. (2016) find that the capital controls system in India contains innumerable rules tailored to the asset class, investor type, recipient type, transaction magnitude etc. In other words, the capital account liberalisation that has been underway in India over the last couple of decades can be viewed as a continuous process.

Two recent studies, Pandey et al. (2016) and Pandey et al. (2019b), present detailed datasets on *de-jure* capital control actions (CCAs) taken by the Indian authorities since early 2000s which further underscore the point highlighted above and also demonstrate that in recent years majority of the CCAs undertaken in India have been aimed at opening up the capital account. [5] These datasets have been hand-constructed by studying the legal instruments issued by the

[4]See for example, Pandey et al. (2019a), Sengupta and Gupta (2015), Hutchison et al. (2012a), Shah and Patnaik (2008) among others, for a brief description of India's capital controls regime.

[5]For the purposes of our study we take into account the capital control actions applicable to foreign portfolio investment (FPI) in equity, debt and derivatives markets and do not consider those with respect to foreign direct

authorities and they provide a comprehensive description of the changes that have taken place in CCAs in India over the last couple of decades. The fine-grained dataset constructed by Pandey et al. (2016) throws light on the CCAs pertaining to external commercial borrowing (ECB) by Indian firms. They classify each CCA into 'easing' vs. 'tightening'. Their database has 76 unambiguous CCAs about firms' foreign borrowing between January 2004 and September 2013. Of these, they find that 68 are easing actions whereas 8 are tightening.

As per the Pandey et al. (2016) database, the highest number of CCAs occurred in 2012 and 2013, towards the end of their sample period. Majority of these were aimed at easing restrictions on Indian firms. Most tightenings took place in the year 2007 in response to a surge in capital inflows. This shows that in recent years, the Indian authorities have been easing the capital controls and permitting more and more firms to borrow from abroad.

In another study, Pandey et al. (2019b) construct a database that quantifies the legal regulations applicable to foreign portfolio investors interested in investing in the Indian financial markets. The dataset constructed by them discerns information from legal instruments to identify whether the instrument tightens or eases capital controls on investment by foreign institutions in different asset classes such as debt, equity and derivatives. Foreign portfolio investment (FPI) constitutes a significant proportion of the capital inflows in India. The net investment by FPIs has increased manifold from USD 8.8 Billion in 1998-99 to USD 36.18 Billion in 2020-21.

Over a period of 18 years from January, 2000 to December, 2018, the Pandey et al. (2019b) dataset records a total of 151 CCAs. This implies that the rules governing foreign access to the Indian capital markets are, on average, revised *nine* times a year. The dataset covers various asset classes such as debt, equity, derivatives etc. The highest share of rule changes (42%) pertain to debt securities (both government and corporate debt), which saw a number of easing actions.

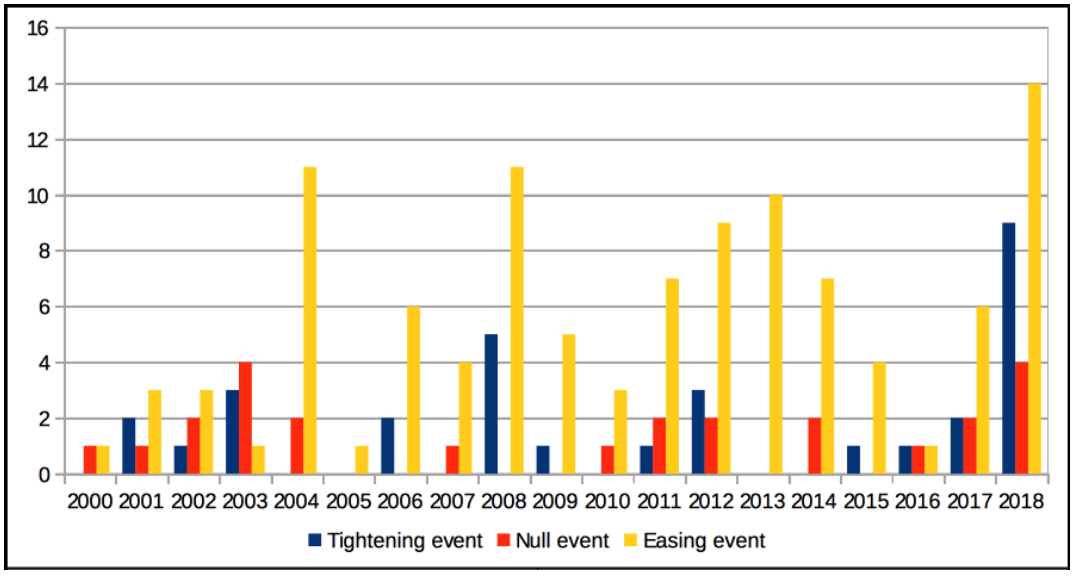
In their dataset, the year 2018 saw the maximum number of CCAs and the years 2000, and 2005 saw the least number of such events. They also classify the CCAs into easing and tightening events. FPI easing events denote events that have the effect of relaxation of existing controls or any action that makes it easier for foreign investors to invest in the host country. Conversely, FPI tightening events denote events that have the effect of increasing the capital controls or any actions that make it harder for foreign investors to invest in the host country.

Like the previous study on ECB, Pandey et al. (2019b) find that for the full period of the dataset, the easing events are substantially higher in number at 99, compared to the tightening events which were 27 in number. Figure 1 shows the number of easing and tightening events for FPI by the year. For all the years, except 2003 and 2006, the number of easing events is higher than the number of tightening events. The maximum number of FPI easing events took place in 2018 (14 in number) followed by 2008 (11), 2013 (10) and 2012 (9). The maximum number of FPI tightening events also took place in 2018 (9) followed by 2008 (4).

These two datasets combined together demonstrate the adhoc and continuous nature of capital account liberalisation in India. They also imply that in recent years, particularly since the Global Financial Crisis of 2008, there has been a steady relaxation of capital controls by Indian authorities on foreign investment flows. A number of changes in CCAs were also announced in 2019 and 2020. We discuss them in greater detail in Section 7. Some of the major CCAs during the sample period for FPI and ECB flows have been highlighted in Tables 1 and 2.

investment (FDI). This is because changes in FDI related restrictions are likely to impact *de-facto* openness with an even longer lag given the nature of these investments. This is also consistent with the strategy adopted in Hutchison et al. (2012b). We also use CCAs and capital controls interchangably.

Figure 1 Year-wise easing and tightening of capital controls on foreign portfolio investment



Source: Pandey et al. (2019b). A null event is one which can be characterised as neither a tightening nor an easing event; these were mostly associated with procedural changes governing foreign investments.

3 The Rupee NDF market

Due to the periodic and frequent imposition of capital account restrictions by the Indian authorities, international participants engaged in cross-border transactions are unable to obtain easy access to the onshore currency market to either hedge their exposures to the Indian Rupee (INR) or to speculate on the currency movements.[6] As a result, over the years an offshore non-deliverable forward (NDF) market has developed. The existence of NDF markets enables investors to carry out foreign exchange related transactions outside the regulatory framework of the onshore markets (Ma et al., 2004; McCauley et al., 2014).[7] By virtue of being located in financial centres outside India for example, participants in this market can escape the stringent capital account restrictions of India and yet take a speculative position on the expected changes in say the USDINR exchange rate. They are also able to hedge their exposures to the INR by accessing these non-deliverable forward contracts.

An NDF is similar to a regular forward foreign exchange contract, with the main difference that an NDF does not involve a physical settlement of the contract and exchange of currencies Guru (2009). The underlying premise is that the NDF contracts are traded on currencies that are not deliverable offshore.

The Rupee NDF market is a USD settled market on the USD-INR rate. The NDF contracts in Rupee are bilaterally settled and are traded in over the counter (OTC) market at various offshore locations such as Singapore, HongKong, London, Dubai and New York. Trading volumes are concentrated in the markets with highest trading time overlap. As a result, Singapore has emerged as the largest market trading USD-INR offshore. INR is also the most actively traded NDF in the London market along with South Korean Won.[8]

According to the Bank of International Settlements triennial survey, 2019, the global turnover of emerging economy currencies increased by almost 60% in the last three years and their global

[6] According to the BIS triennial survey (2019), over-the-counter trades in the Indian rupee accounts for 1.7% of the total global forex turnover, compared with 1.1% in the 2016 survey.

[7] Particpation restrictions on the onshore markets also impede the ability of international participants to take positions on these markets.

[8] see, Reserve Bank of India Bulletin, "Onshoring the Offshore", 2020.

share went up from 15% in 2013 to 23% in 2019. A major driver of this increase in share was the INR which experienced a near doubling of trading during this period.

Alongside the size of India's open economy, the INR NDF market has also grown substantially in size over the years. It has emerged as the second largest NDF market globally in terms of average daily turnover and is almost thrice as large as the onshore deliverable forward market. India accounts for about 18.2% of the global trade in NDFs (Thorat, 2019). The average daily turnover in the global NDF market in 2019 was about USD 259 billion and the INR along with South Korean Won, Brazilian Real and Taiwan New Dollar accounted for as much as 70% of the total NDF turnover.

The average daily volume for INR outright forwards stood at USD 62.72 billion in April 2019 compared with USD 29.91 billion in spot market trades. Within this category, NDFs accounted for a significant share of the increase in trading between 2016 and 2019. The INR NDF market now accounts for roughly 82% of the total outright forwards in USD-INR in 2019 as against 74.3% in 2016. The NDF volumes for the USD-INR currency pair reported a staggering three-fold increase, from around USD 16.4 billion in 2016 to USD 50 billion in 2019.

The offshore Rupee market is not only large it is also mostly unregulated. Volumes in the NDF market have recorded a dramatic rise over the years across multiple offshore centres due to multiple factors including favourable tax laws, ease of access owing to absence of any stringent regulations, market-making by large, global banks as well as participation by large hedge funds (Patel and Xia, 2019). NDF contracts with one-month or less maturity are typically the most liquid in the offshore INR market accounting for close to 70% of the total trades.[9]

4 *De-jure* vs. *de-facto* measures

There are two ways to measure capital account openness of a country: *de-jure* measures and *de-facto* measures. *De-jure* measures are constructed from the legal restrictions by collecting data on changes in regulations. Some of the relatively older cross-country *de-jure* measures are the Chinn-Ito index (Chinn and Ito, 2008) or the index constructed by Schindler (2009). These measures use the detailed capital controls published in the summary classifications table by the International Monetary Fund in the Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).

The more recent measures include the one in Forbes et al. (2015) who construct a dataset that tracks increases and decreases in controls on capital inflows, controls on capital outflows, and macro-prudential measures at a weekly frequency for 60 countries from 2009 through 2011. Likewise, Pasricha et al. (2018) construct a high frequency dataset on capital controls of 16 emerging market economies from 2001 to 2012. They count the policy changes separately, decomposing them into several categories. As discussed in Section 2, specifically for India, two studies, Pandey et al. (2016) and Pandey et al. (2019b) construct *de-jure* datasets of capital account restrictions.

There are three problems with using some of these *de-jure* measures to capture capital account openness. First, *de-jure* measures do not necessarily imply *de-facto* restrictions or openness. There always exist loopholes in any regulation. Hence, while many legal restrictions maybe in place, investors may find loopholes in them and be able to bring in more capital than what the *de-jure* measures would imply. Alternatively, it may well be the case that even when *de-jure* measures show that greater capital account openness, in reality foreign capital flows may not change much because the country in question has other impediments to foreign investment such as cumbersome tax laws etc. These will not get captured by *de-jure* measures of capital

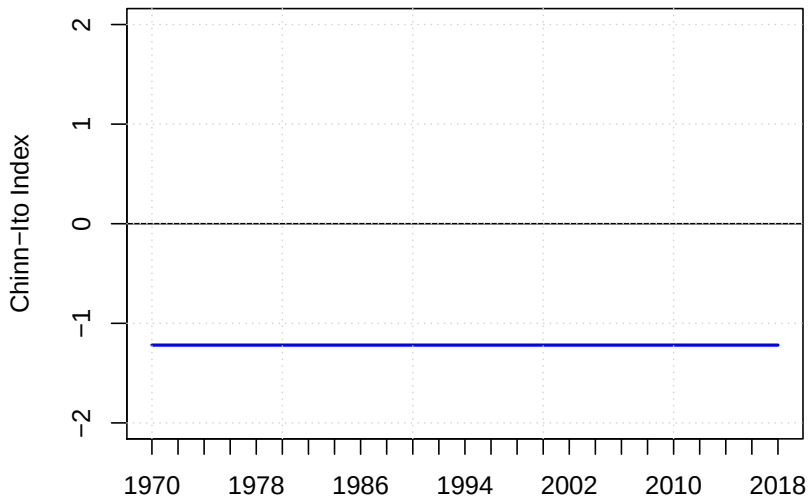
[9] see, Reserve Bank of India Bulletin, "Onshoring the Offshore", 2020.

openness. In these circumstances, *de-facto* measures of capital account openness help to get a better understanding of how open a country's capital account truly is.

Second, majority of the *de-jure* indices, especially those constructed on a yearly basis, fail to capture the intricacies of capital controls for specific countries owing to their low frequency. This problem becomes even more acute for a country like India, where it is possible that within a span of a year, many rules and regulations are changed by the authorities. In such a situation these *de-jure* measures would not convey an appropriate picture because the value of the indices typically do not change a lot over

time. For instance the well-known Chinn-Ito index which is often used in the literature as a benchmark index for measuring capital account openness fails to adequately capture the gradual relaxation of controls implemented in India since the mid 1990s; instead the index continues to assign the same score unless all restrictions are fully removed. This would erroneously imply for example that India has not experienced any capital account liberalisation at all since 1970 (see Figure 2).

Figure 2 Chinn Ito Index of capital account openness: India



The alternative is to use *de-facto* measures which solve some of the issues that arise from *de-jure* measures. There are two types of *de-facto* measures of capital account openness: quantity based and price-based. Quantity based measures use data on the gross or net cross-border capital flows. The magnitude of these flows indicates the efficacy of capital controls. However, large external flows can arise by avoidance or evasion of capital controls, just as small and stable flows do not necessarily imply effective controls, but lack of opportunities (Ma and McCauley, 2007). This reduces the reliability of quantity based measures to gauge capital account openness.

The other measure, which is based on prices, as captured by deviations from the covered interest parity (CIP) is a more direct and precise measure of capital account openness. Interest rate parity forms the bedrock assumption of international finance Frankel (1992). Sustained departures from the CIP condition indicate that the *de-jure* capital controls bind. An increase (decrease) in the deviations overtime indicate lower (higher) capital mobility and reduced (greater) integration with the global financial markets. In this paper, we focus on this price based measure to examine the degree of capital account openness for both India and China.[10]

[10]In a later section, we also present data on gross capital flows for India and analyse them alongside the changes in CIP deviations.

5 Empirical methodology

In this section we describe our main empirical strategy that relies on the calculation of CIP deviations, estimation of structural breaks and no-arbitrage bands. We first present our results for India and later discuss our findings for China using the same methodology.

5.1 Onshore-offshore yield

The covered interest parity condition says that the domestic interest rate must equal the sum of foreign interest rate and the expected depreciation of the currency, otherwise arbitrage opportunities will arise. Expected depreciation is typically measured using the difference between the currency forward and currency spot rates. If there is a difference between the domestic and foreign interest rates then investors can participate in the forward and spot market to arbitrage these differences. CIP works through this arbitrage concept. If however there exist capital controls then this arbitrage condition breaks down.

More specifically, under CIP, the forward exchange rate (F) of the home currency (for example, the INR), in the absence of capital controls, is linked by arbitrage to its spot rate (S) and the interest rate differential between the home currency (r) and the US dollar (i^{USD}) as given by:

$$F = S(1+r)/(1+i^{USD}) \tag{1}$$

When capital controls are binding, non-residents may not have full access to the domestic or onshore financial markets. The market is further constrained by central bank's intervention. In these circumstances, existence of a liquid non-deliverable forward (NDF) market offering relatively unrestricted access to the foreign participants helps. In that case the CIP equation becomes:

$$F_N = S(1+r)/(1+i^{USD}) \tag{2}$$

where F_N stands for non-deliverable forwards or NDFs. From Equation 2, we can obtain the NDF implied interest rate (Misra and Behera, 2006) as follows:

$$r = \frac{F_N}{S}(1+i_{USD}) - 1 \tag{3}$$

where S is the spot exchange rate of the US dollar in terms of the domestic currency, F_N is the NDF rate of a certain maturity, and i_{USD} is the interest rate on dollar deposits of the corresponding maturity. The deviation of the domestic interest rate from the NDF implied domestic yield is a measure of the CIP deviation and hence of financial integration. The greater the magnitude of the deviation, the lower the capital account openness of the home country. When the markets are well integrated, the CIP deviations will be close to zero. A zero-spread suggests the absence of effective capital controls, or the absence of depreciation or appreciation pressure on home currency or both (Misra and Behera, 2006).

We use the London Interbank Offer rate (LIBOR) and the Mumbai Interbank Offer Rate (MIBOR) as the foreing and domestic interest rates, respectively. We focus on 1-month maturity NDF rate given that most of the liquidity in the NDF market is in the 1-month maturity contracts as described in Section 3. Accordingly, we use the 1-month MIBOR and 1-month LIBOR.

We access daily data on NDF contracts and the spot rate from Thomson Reuters Eikon database, and obtain data on 1-month LIBOR rates on dollar deposits from the Federal Reserve Board. We obtain the MIBOR rate on Rupee deposits of same maturity from the Reserve Bank of

India's Database of Indian Economy. For the main analysis, our data spans a period of around 20 years, from August 1999 to February 2020.[11]

Figure 3 India: 1 month CIP deviations and India-US Interest rate differentials (MIBOR less LIBOR)

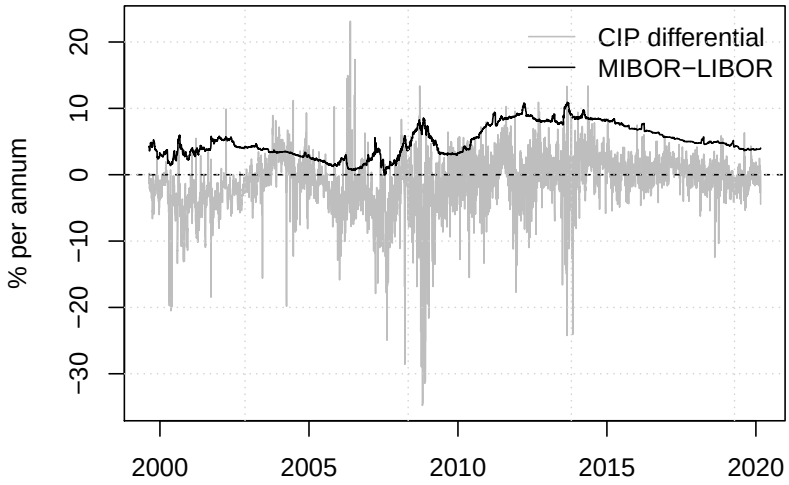


Figure 3 presents the annualized CIP deviations for our sample period along with the 1-month interest rate differential between MIBOR and LIBOR. The average interest rate differential between onshore Rupee denominated (MIBOR) and the USD denominated interest rate (LIBOR) during the sample period is around 5 percent, reaching its highest level of 11 percent in the post financial crisis period when the US Fed reduced the interest rates to stimulate growth but the Reserve Bank of India increased the rates to tame inflation. These patterns in interest rate differentials show up along with wide-ranging variations in CIP deviations across the sample period which we discuss below.

We observe significant variability in the magnitude, and the direction of the CIP deviations during our sample period, with several outliers around the time of the 2008 Global Financial Crisis (GFC). The sample is characterised with periods of large and persistent positive as well as negative CIP deviations. Negative deviations signify capital outflow pressures, whereas positive deviations imply capital inflow pressures, which are resisted by capital controls. During the GFC, as expected, we find sustained periods of large negative deviations implying significant capital outflow pressure. The fact that these negative deviations continued to exist for several days during the crisis indicate that the existing controls were effective in restricting capital outflow.

We also observe that in the period post 2009, the CIP deviation has become narrower, and more tightly distributed around zero, pointing towards greater financial integration of the Indian economy. In the pre-GFC period, the average CIP deviation was -2.58 percent, which reduced to -0.03 percent in the post-GFC period. These differences reflect the gradual policy shifts in capital control actions by the Indian policymakers. We further find that the positive CIP deviations have on average been smaller in magnitude compared to the negative deviations especially in the pre-GFC period indicating asymmetric controls over outflows and inflows.

Our findings thus far indicate that the elaborate and complex system of capital controls in India succeeded in preventing capital outflows more effectively than capital inflows at least in

[11] Since both MIBOR and LIBOR are annualized, we first de-annualize the two interest rates, compute the NDF implied interest rate, r, and then re-annualize it by multiplying by 12. We then compare the implied domestic yield with the MIBOR rate to capture the extent of CIP deviations (Hutchison et al., 2012b).

the first half of our sample period. Towards the latter half the existing controls proved to be less effective and there has been greater liberalisation of controls as reflected by tighter spread of CIP deviations around zero. We next analyse this gradual shift in the policy stance of Indian authorities from a completely closed capital account towards greater financial liberalisation by identifying sub-periods based on the structural break test.

5.2 Structural breaks

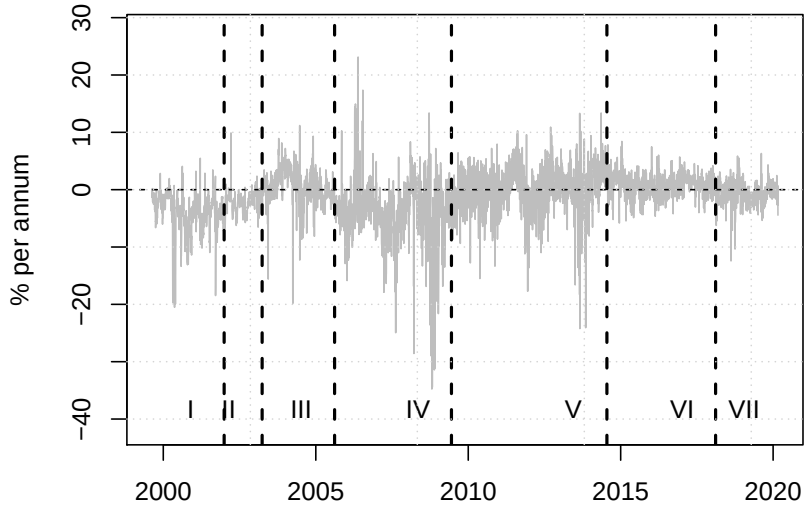
While one can exogenously identify the sub-periods of substantial variations based on capital control changes (as in Hutchison et al. (2012a)), this approach introduces subjectivity in the determination of break dates for these periods. We instead let the data identify the sub-periods based on the structural break test (Bai and Perron, 1998, 2003), and then trace the policy changes, capital control measures and macroeconomic developments for the identified sub-periods in Section 6.

The methodology for determining the dates of structural breaks endogenously is well-established in the literature.[12] Under the null hypothesis of no structural breaks, against the alternative that there are unknown number of breaks, the test checks for parameter instability across sub-periods in a standard linear regression model. The approach relies on estimating the breakpoints obtained by minimizing the residual sum of squares in each sub-period.

We use the Zeileis et al. (2010) approach which captures parameter instabilities not only in the regression coefficients but also in the error variance. This approach extends the ordinary-least squares regression approach of Bai and Perron (2003) to (quasi-)maximum likelihood models.

To determine the dates of structural break, we use weekly data,[13] instead of daily data to reduce the noise in the data. We conduct the test for 1, ..., 10 breaks and a minimal segment size of 50 observations in each sub-period. The optimal number of breaks are identified based on the LWZ information criterion.[14]

Figure 4 India: Daily CIP deviations from August 1999 to February 2020 along with corresponding structural breaks



[12] See for example, Andrews (1993), Bai (1994), Bai and Perron (1998), Bai and Perron (2003), Zeileis et al. (2003), Zeileis et al. (2010).

[13] We derive weekly values as median of daily values in a week.

[14] The LWZ information criterion imposes higher penalty than the BIC for $n > 20$. See Zeileis et al. (2010), Bai and Perron (2003), Liu et al. (1997).

Our test results identify a total of six structural breaks as the optimal number of segments where the LWZ information criterion assumes its minimum value. This yields a total of seven sub-regimes during our sample period. Figure 4 superimposes the dates of structural breaks on the CIP deviations graph. Table 3 provides the summary statistics for each of the sub-periods along with the corresponding dates. We discuss each sub-period in detail in Section 6.

Table 3 Summary statistics of CIP deviations and MIBOR-LIBOR differential for each sub-period for India

Sub-period	Start date	End date	No. of obs.	CIP Deviations (%)				MIBOR-LIBOR (%)
				Median	Mean	SD	Negative obs.	Mean
I	1999-08-18	2001-12-28	618	-3.44	-4.12	3.55	94.98	3.63
II	2001-12-31	2003-03-28	325	-2.04	-2.17	1.69	92.31	4.64
III	2003-03-31	2005-08-12	620	0.69	0.54	3.09	40.65	3.07
IV	2005-08-15	2009-06-12	995	-3.43	-3.86	5.63	83.72	3.12
V	2009-06-15	2014-07-18	1330	0.46	0.19	3.93	43.76	7.34
VI	2014-07-21	2018-02-09	929	1.05	0.90	1.84	26.80	6.61
VII	2018-02-12	2020-02-21	529	-0.47	-0.54	1.84	62.95	4.41

5.3 No-arbitrage bands

As per the CIP condition, a non-zero deviation suggests the possibility of arbitrage opportunities. However, not all non-zero deviations translate into arbitrage opportunities due to the presence of transactions costs and imperfect capital mobility controls. Hence arises the need to estimate the 'no-arbitrage bands'.

The presence of transactions costs and capital controls result in the formation of bands around the CIP deviations within which arbitrage will not be possible (Hutchison et al., 2012a; Hua et al., 2013). However, outside of these bands (or threshold values), arbitrage profit opportunities will emerge. In the presence of a liquid foreign exchange market, the force of arbitrage will bring back the deviations within the no-arbitrage boundaries. The threshold values (and thus the width of the bands computed as the difference between upper and lower thresholds), as well as the speed of reversion above and below the no-arbitrage bands depend upon capital controls restrictions, transactions costs and the institutional factors such as the size and liquidity of the spot and forward currency markets (Juhl et al., 2006; Levy Yeyati et al., 2009). We expect that with gradual relaxation in capital controls, the width of the no-arbitrage bands will reduce and the degree of arbitrage pressure as captured by speed of reversion within bands will increase.

To estimate the no arbitrage bands, we use the self exciting threshold autoregressive (SETAR) model.[15] The SETAR model is a piecewise linear model where different autoregressive processes are estimated depending on the state of the variable at time $t-1$. The autoregressive coefficients take different values depending on whether the previous value of the variable is above or below a certain threshold value, thus exhibiting regime switching dynamics. The SETAR model nests the linear AR model when all autoregressive coefficients are same across all regimes (Hutchison et al., 2012a).

We estimate a SETAR model that allows two thresholds in the CIP deviations. The upper and

[15]The SETAR model is a special, and the most simplest case of a non-linear threshold autoregressive (TAR) model (Tong, 1990) in which the regime-switching thresholds depend on the lagged values of the autoregressive model itself.

lower thresholds divide the series into three regimes. The model is given as:[16]

$$\begin{aligned}
\delta_t &= \alpha\delta_{t-1} + \epsilon_t && \text{if } \kappa_l < \delta_{t-1} < \kappa_u \\
\delta_t &= \kappa_l(1-\rho_l) + \rho_l\delta_{t-1} + \epsilon_t && \text{if } \delta_{t-1} \leq \kappa_l \\
\delta_t &= \kappa_u(1-\rho_u) + \rho_u\delta_{t-1} + \epsilon_t && \text{if } \delta_{t-1} \geq \kappa_u
\end{aligned}$$

where, δ_t is the time series of interest, in our case, CIP deviations, $\epsilon_t \sim N(0, \sigma^2)$, and κ_l and κ_u denotes the lower and upper thresholds respectively. The difference between the κ_l and κ_u form the no-arbitrage band. When δ_{t-1} lies within the band dictated by κ_l and κ_u, δ_t follows an autoregressive process with mean zero. However, when δ_{t-1} lies outside of the band, δ_t follows a different auoregressive process with a different mean (Peel and Taylor, 2002; Juhl et al., 2006; Martens et al., 1998). Aribtrage pressure will revert δ_t to being within the band. Inside the bands, the series may follow a random walk, indicating the absence of profitable arbitrage opportunities.

The thresholds (κ_l and κ_u) are not known and estimated by a sequential grid search method in the time series as suggested by Hansen (2000). In this method, a single threshold is first determined based on the value that minimizes the residual sum of squares using concentrated least squares. Once the first threshold is determined, conditional on that threshold, a grid search is again conducted to determine the second threshold.[17]

Note that the number of thresholds may not necessarily be two. It may be one, or the series may even not be non-linear in nature. To test for this possibility, for each sub-period obtained from the structural break tests (Section 5.2), we conduct the Hansen (1996) likelihood ratio test which tests for the null of linearity[18] to the alternative of non-linearity. Based on the results of the test, we estimate the thresholds (or not in case the series is linear) to obtain the no-arbitrage bands for each sub-period as specified by the SETAR model described above.

Table 4 reports the SETAR estimates for the seven subperiods identified in Section 5.2. The table shows the beginning and end dates of each sub period, the selected model (linear or two-regime or three-regime based on the Hansen test results), the estimated coefficients with the lagged δ_t term, and the number of observations.

In the three-regime model, the lower (negative) threshold serves as the lower boundary, while the higher (positive) threshold serves as the upper boundary of the no-arbitrage bands. In the two-regime model, the zero point is interpreted as the implicit second boundary (Hutchison et al., 2012a). When the series is in the outer regime, the speed of convergence (or reversion to the no-arbitrage bands) is measured by the estimated AR(1) coefficient. Lower the magnitude of the AR(1) coefficient, higher is the speed of reversion within no-arbitrage bands, indicating strong arbitrage pressure.

The test for the number of thresholds (versus the null of linearity) indicates a three-regime SETAR model in all sub-periods except sub-period VI. The Hansen test results indicate a linear model in sub-period VI.

Figure 5 plots the CIP deviations along with the estimated thresholds for each sub-period. In cases when both the thresholds turn out to be in the same direction (negative or positive), with

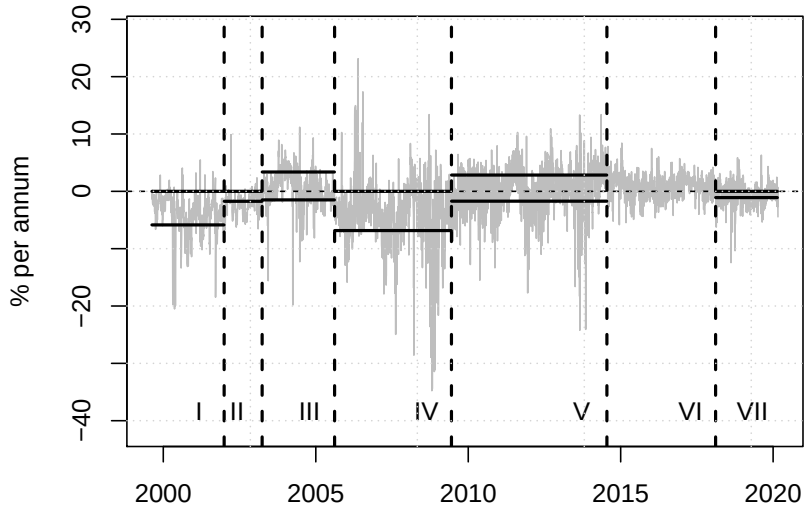
[16]This model is similar to the band-TAR model of Balke and Fomby (1997) and Peel and Taylor (2002). The main difference is that the band-TAR model assumes symmetric arbitrage bands on both sides, while this model allows for asymmertic arbitrage bands.

[17]In identifying the thresholds, we trim 10 percent of the observations on the tails. This implies that every value of the CIP deviation between the 10th and 90th percentile is used as a possible threshold in the grid search.

[18]We test for the null of linearity versus the alternative of one and two thresholds to determine the number of regimes in each sub-period.

one of the thresholds being close to zero, we set that threshold to zero for ease of interpretation of no-arbitrage bands.[19] We observe that the width[20] of the no-arbitrage bands varies across sub-periods, and has reduced overtime. In the next section, we analyse the CIP deviations and no-arbitrage bands across the various sub-periods in detail.

Figure 5 India: SETAR model results on 1-month CIP deviations with estimated boundaries



6 Structural breaks, capital controls and macroeconomic conditions in India

In this section we discuss the capital control actions, and analyse the macroeconomic conditions in India that the sub-periods were associated with, in order to deduce the trends in the magnitude and direction of the CIP deviations as well as on the width of the no-arbitrage bands.

Table 5 Macroeconomic developments in India in the sub-periods of 1-month CIP deviations

Sub-period	Start date	End date	Mean CIP deviation (%)	GDP growth (%)	Inflation (%)	Interest rate (%)	Currency volatility (%)
I	1999-08-18	2001-12-28	-4.12	5.79	3.85	8.44	2.14
II	2001-12-31	2003-03-28	-2.17	4.43	4.15	5.87	1.54
III	2003-03-31	2005-08-12	0.54	8.36	4.03	4.81	3.50
IV	2005-08-15	2009-06-12	-3.86	8.14	7.76	6.57	6.30
V	2009-06-15	2014-07-18	0.19	7.03	9.60	7.36	8.00
VI	2014-07-21	2018-02-09	0.90	7.62	4.71	6.95	4.73
VII	2018-02-12	2020-02-21	-0.54	5.28	4.09	6.09	5.21

Notes: GDP growth is the year on year growth rate in real GDP. We use the 2004-05 base year series till 2013-14 and the 2011-12 base year series after that. Inflation refers to year on year CPI inflation. Interest rate is the 91-day treasury bill rate which encompasses the monetary policy stance of the RBI. Currency volatility is the annualised volatility of the INR-USD nominal exchange rate. The data is sourced from the Economic Outlook databased maintained by the Centre for Monitoring Indian Economy (CMIE).

August 1999 - December 2001

The first sub-period was characterised by relatively stable macroeconomic conditions. The GDP

[19] Thus, we set the upper threshold for sub-periods I, II and IV, and lower threshold for sub-period VII to zero.

[20] It is computed as the difference between the positive and negative / upper or lower threshold.

growth rate was moderate at 5.8 percent, consumer price index inflation was reasonably low at 3.9 percent but the short-term interest rate proxied by the 91-day treasury bill rate was high at 8.4 percent (Table 5). The current account registered a small surplus on average during this period. This was also a period when the INR was relatively tightly pegged to the USD (Zeileis et al., 2010). This shows up in the low volatility (2.14 percent) of the nominal exchange rate in Table 5.

In terms of absolute magnitude, the average CIP deviation during this period (-4.12 percent) was the highest. Large and persistent negative deviations during this period indicate effective stemming of capital outflows (Table 3). The existing data on *de-jure* capital control actions shows that during this period the number of easing events exceeded the number of tightening events, though the magnitude of the easing was substantially lower than what was done in the second half of the sample period. This was also the period that saw relaxations in various rules governing ECB as well as FPI investment in equity and debt securities (Table 1). Yet the relatively high deviation from interest parity reflects that in early 2000s, India's capital account was still a reasonably closed one, and any steps taken to liberalise foreign investment were not big enough to create a major impact on openness.

The continued impact of the erstwhile closed capital account also manifests itself in the form of wider no-arbitrage bands. The SETAR model estimates the lower threshold at a CIP deviation of -5.86 percent. This implies that for any arbitrage activity to take place, the CIP deviation had to be lower than approximately 6 percent. The upper threshold is close to zero. As discussed earlier, for ease of interpretation, when both the thresholds are in the same direction (negative in this case), we set the threshold closer to zero-line (upper threshold) as zero. Thus, the width of the no-arbitrage bands computed by the difference between upper and lower thresholds, gives an estimated bandwidth of 5.9 percentage points (Table 4 and Figure 5). Within these bands no profitable arbitrage could be undertaken despite the large magnitude of CIP deviations. The speed of reversion to no-arbitrage bands as measured by the AR(1) coefficient in the upper and lower regimes is also low, indicating slower arbitrage and therefore, larger onshore-offshore market segmentation during this period.

The analysis suggests that the liberalisation process initiated in early to mid 1990s was not yet substantial or would have become effective with a long lag given that this entailed a big change in the status quo. In fact any meaningful change in capital account liberalisation took place only from early 2003 onwards as explained in Hutchison et al. (2012a), confirming that there was a deep legacy impact.

December 2001 - March 2003
During this shortest sub-period in our sample, the GDP growth on average was lower than the preceding period, at 4.4 percent. The 91-day treasury bill rate also was significantly lower at 5.9 percent whereas inflation inched up slightly to 4.15 percent. The average CIP deviation (-2.2 percent) continued to be negative and relatively wide, implying capital outflows pressure that was resisted by capital controls. The INR continued to be pegged to the USD as reflected in the lowest volatility of the entire sample (1.5 percent) of the exchange rate. The capital control relaxations that took place during this period were mostly incremental and as in the previous period, were relatively smaller in magnitude. Foreign institutional investment in debt securities were subject to limits once FII investment regulations shifted to the purview of the RBI in 2000.

Owing to largely negative CIP deviations, the estimated upper and lower thresholds once again turn out to be in the negative territory. We set the upper threshold to zero, and compute the width of the no-arbitrage band which declines to 1.74 percentage points from 5.86 percentage points in the first sub-period reflecting easing of capital constraints on outflows than before. Thus, the estimated bands indicate arbitrage pressure when CIP deviations went lower than

1.74 percent. However, the speed of reversion to the no-arbitrage bands based on the AR(1) coefficient continues to be low (with ρ_l= 0.7) in the lower regime, implying that the existing restrictions continued to have a strong effect on the arbitrage activity. The speed of mean reversion in the upper regime is high with the AR(1) coefficient, ρ_h =-0.1, indicating if and when the CIP deviations were positive[21], there was a strong arbitrage pressure to bring it close to zero.

March 2003 - August 2005
This was the period when the Indian economy experienced a boom with the average GDP growth rate at 8.4 percent. Inflation was controlled at 4 percent and interest rate had come down to 4.8 percent (from 8.4 percent in the first sub-period). The current account remained in surplus mode (0.3 percent of GDP). Volatility of the exchange rate increased as the authorities begin to towards a soft peg by the end of this period (Patnaik and Sengupta, 2021). Overall, this was a period of high growth rate, stable inflation and low interest rates.

In a reversal to the past policy on relaxing constraints on inflows, the process of capital account liberalisation during this period was relatively more skewed towards relaxing controls on capital outflows. Some additional restrictions on inflows were imposed. The overall attempt seemed to be to stem the surge of capital inflows which were triggered by India's improving growth prospects and favourable macroeconomic conditions. This shows up in the patterns in CIP deviation in this period, which, unlike the first two periods, saw a larger proportion of positive deviations (60%), reflecting net inflow pressures that were resisted by capital controls. However inflows continued despite the imposition of additional controls and CIP deviation narrowed to 0.5 percent. This potentially implies lower effectiveness of the inflow controls.

The thresholds for the no-arbitrage band were estimated between -1.49 and 3.89 percent. Thus, for arbitrage to take place, the estimated values indicate that the CIP deviations needed to be atleast more than 4 percent to induce capital inflows and below -1.5 percent to induce outflows. The asymmetry in these upper and lower limits indicate a shift towards liberalisation of net outflows, a departure from the previous two periods. The estimated AR(1) coefficient for the lower regime at 0.35 also indicates a faster reversion to no-arbitrage bands when the deviations exceeded the lower limit of -1.5 percent, but slow reversion when the CIP deviations were positive, once again confirming the presence of effective controls on inflows.

August 2005 - June 2009
This period, which also includes the GFC witnessed the second highest average CIP deviation in the last 20 years. India's capital account liberalisation process was impeded during this time in a relative sense. The volatility of the CIP deviations was also the highest during this period as shown in Table 3.

The CIP deviations were also affected by the worsening global economic conditions, higher counterparty risks and global liquidity shortages. During this time the current account recorded a deficit of 1.9 percent of GDP. The exchange rate moved away from the tight USD peg of the previous periods and exhibited greater flexibility as reflected in the increase in currency volatility (6.3 percent) in Table 5. This was also the time when CPI inflation began increasing sharply, and so did the short term interest rates, while GDP growth continued to be high at 8.1 percent.

Barring a short period in 2006, the CIP deviations in this period were primarily negative, indicating a effective controls on outflows. This is in line with the *de-jure restrictions* presented in Pandey et al. (2016) which shows that the highest number of capital account restrictions on Indian firms' foreign borrowing was in the year 2007. Likewise Pandey et al. (2019b) find that the second highest number of capital controls imposed on foreign portfolio investment by the Indian authorities was in the year 2008 (Figure 1).

[21]Positive deviations implying inflow pressure were low during this period.

The estimated thresholds for the no-arbitrage bands are -0.02 percent and -6.84 percent, implying the width of the no-arbitrage bands to be around 6.85 percentage points. The speed of reversion from the lower regime is also low compared to the speed in the upper regime, implying the presence of effective controls on capital outflows. In all, the widening of the no-arbitrage band, and the reduction in the speed of reversion are consistent with the further tightening of capital account restrictions and also the imposition of controls on capital outflows, in the aftermath of the 2008 crisis.

June 2009 - July 2014
The period after the 2008 crisis was marked by a dramatic increase in CPI inflation. At 9.6 percent, average inflation in this sub-period was highest during the sample period. Persistent monetary policy contraction pursued by India's central bank, RBI, raised the 91-day treasury bill rate to 7.4 percent. GDP growth started slowing down and current account deficit widened to 3.4 percent of GDP. The average interest rate differential was the highest in this period (Table 3) reflecting the fact that the India's central bank was tightening monetary policy in response to rising inflation whereas the US Fed was lowering the interest rate to zero in response to the GFC.

The other notable development of this period was the increase in currency volatility to 8 percent. The RBI substantially reduced its interventions in the foreign exchange market as a result of which the INR-USD became a free floating exchange rate. This was also the period when the Indian economy was hit by the Taper Tantrum shock with the US Fed's surprise announcement of stopping its Quantitative Easing program. In response to the sharp currency depreciation the RBI tightened monetary policy in order to stem capital outflows and also imposed several restrictions on capital outflows.

But by and large, after a temporary interruption, the Indian authorities once again commenced the process of gradual liberalisation of capital account. In terms of capital control actions, the number of easing events exceeded the number of tightening events during this period (Figure 1). More relaxations were announced on FPI investment in debt securities (Table 1). The average CIP deviations reflect this trend. The values ranged in both positive and negative zone, with the average at 0.2 percent. The positive value of average and median CIP deviations indicates, on average, capital inflow pressures. This is in line with the easing of global liquidity conditions which started when the US Fed initiated the quantitative easing program in the post-2008 period, as a result of which emerging economies like India witnessed a surge of inflows.

To understand the effectiveness of capital controls and the extent of arbitrage opportunities during this period, we turn to no-arbitrage bands and the speed of reversion to no-arbitrage bands based on AR(1) coefficient. The upper boundary for the bands is estimated at 2.4 percent, implying that the minimum CIP deviation needed to be more than 2.4 percent for profitable arbitrage to take place. On the lower side, the CIP deviation needed to be below -1.72 percent to induce capital outflows. The asymmetry in the boundaries reflect that the existing controls barred inflows more than the outflows. But once the deviation was above 2.4 percent, the speed of reversion to within no-arbitrage bands is high, based on the AR(1) coefficient of 0.09 indicating strong arbitrage pressure beyond the upper boundary. This was not true of the lower boundary, where the speed of reversion to no-arbitrage bands is lower with the AR(1) coefficient at 0.33, implying the existence of barriers in controls that constrained arbitrage. Hutchison et al. (2012a) observe that while the volume or quantity restrictions on capital inflows and outflows will likely have a larger impact on the speed of adjustment, taxes on flows would impact the width of the no-arbitrage bands. Thus, the difference in the speed of adjustment in the upper versus the lower boundary reflects the continued existence of quantity restrictions on outflows.

July 2014 - February 2018
By this time CPI inflation had been controlled and the average inflation was down to 4.7%.

This period also coincided with India's adoption of inflation targeting as a monetary policy framework. The interest rates continued to be high even though inflation had started coming down from the high levels of the post-2008 period. The interest rate differential came down from the previous high of 7.34% but remained high at 6.61%. Currency volatility went down as the RBI returned its focus to stabilising exchange rate fluctuations.

This period was characterised by a number of capital control easing events as well as a few tightening actions, as shown in Figure 1. New restrictions were placed on FII investment in shorter maturity government securities for example. There were also several other relaxations of FII as well as ECB flows (Table 1). For instance, the RBI allowed Indian firms eligible to raise ECB to issue rupee denominated bonds abroad. FIIs were also allowed to invest in exchange traded currency derivatives.

The CIP deviations were tighter and spread around zero, with the mean of 0.90 percent and a low standard deviation of 1.54 percent, indicating that the overall effect of the existing controls was limited, and the past measures undertaken by authorities towards liberalisation were working well.

Contrary to the previous sub-periods, the CIP deviations in this period do not exhibit a non-linear behavior. The Hansen test result indicates a linear model, implying that there was no arbitrage pressure in the observed range of CIP deviations. The overall range of the CIP deviations in this period is narrower than all the previous periods, indicating a relatively more open capital account than all the previous periods.

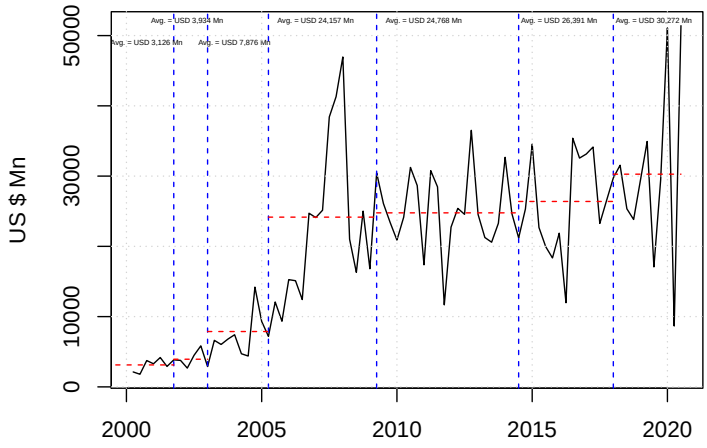
February 2018 - February 2020
In the final sub-period of our sample, we find that average CIP deviation was down to -0.5 percent, implying continued liberalisation of the capital account and reduction of barriers on foreign investments. The volatility of the CIP deviations was the same as the previous period. Average GDP growth rate came down to 5.3 percent. While currency volatility went up compared to the preceding period, inflation remained more or less the same.

This last sub-period also shows a further narrowing of the no-arbitrage bands (0.8 percentage points) indicating that the effectiveness of the net controls remained relatively weak during this period as well. This is in line with the *de-jure* measures which indicate that capital account restrictions were progressively relaxed in the last two sub-periods, and there were more easing episodes relative to the tightening episodes (Table 1).

To summarise, India's CIP deviations over time have become smaller in magnitude. The narrowing of the CIP deviation especially in the post-GFC period fits well with the *de-jure* data on capital control actions described in Pandey et al. (2019b). They find a large number of capital control relaxations announced by the Indian authorities in 2017 and 2018. In fact 2018 witnessed the maximum number of easing events since 2000. This hints at the possibility that capital control relaxations in recent years have resulted in greater financial integration of the Indian economy. While in the pre-GFC period, we find an asymmetric impact of capital controls with primarily the capital outflows being restricted, in the post-GFC period, we find that the existing controls have not been effecting in stemming either inflows or outflows.

The above pattern is also reflected in the *de-facto* quantity-based measure of capital account openness as shown in Figure 6 which plots the absolute values of gross capital flows in and out of Indian economy during our sample period. There was a sharp increase in the average value of gross capital flows from 2005 onwards followed by a steady increase over the next one decade. The last sub-period witnessed a jump in the average value of gross flows which is also consistent with our finding of narrowing CIP deviation during this time and a gradual liberalisation of capital account in India.

Figure 6 India: Gross capital flows (absolute values)



7 India's capital account liberalisation in the pandemic period

The Indian authorities implemented several changes with regard to capital control actions during the period of the Covid-19 pandemic. In this section we discuss these actions and their potential impact on capital account openness.

In 2019 a committee appointed by the central bank, RBI, suggested several measures to curb the rising influence of the offshore INR markets and to improve the ease of access to the onshore markets (Thorat, 2019). These included among other things, an extension of trading hours to make it easier for foreign investors to trade, permission to users to undertake over the counter currency derivative transactions upto USD 100 million without underlying exposure and the alignment of tax treatment with global standards.

Subsequently several of the committee's recommendations were accepted and implemented by the RBI in order to deepen and improve liquidity in the onshore forex markets. This was done with a view to reduce the risks associated with volatility spillovers from offshore markets, with segmentation between onshore and offshore markets impairing the efficiency of price discovery and undermining the regulatory framework (RBI, 2020).

From January 2020 onwards, domestic banks have been permitted to offer foreign exchange prices to users at all times. This was done to avoid hindrances to trading posed by time zone differences thus providing opportunities for domestic banks to access a larger international clientele. In addition, exchanges operating in India's International Financial Services Centre (IFSC) called Gujarat International Finance Tec (GIFT) City were permitted to offer INR derivative contracts with settlement in foreign currency. Further, in response to the heightened uncertainty induced by the pandemic, in a circular dated March 27, 2020,[22] the RBI permitted domestic banks which operate IFSC Banking Units to participate in the NDF market with effect from June 1, 2020.[23]

The first wave of the pandemic in India (March-September 2020) saw significant impact on foreign portfolio inflows, with the reduction in net capital flows in March 2020 alone comparable

[22]See "Statement on Developmental and Regulatory Policies", RBI Press Releases, March, 27, 2020.

[23]In May 2020, two IFSC exchanges launched INR derivative contracts according to Reserve Bank of India Bulletin, "Onshoring the Offshore", 2020. The share of INR derivatives at these exchanges however remains small accounting for only 2% of the total exchange traded INR derivatives turnover globally. The average daily turnover by domestic Indian banks in the non-deliverable derivatives contracts (forwards and options) was around USD 1.1 billion as of August 2020.

to the reduction that occurred over four months during the "taper tantrum" episode of 2013 (Patnaik and Prasad, 2020). However, recognizing that the shock was a global shock and not specific to India, the policy response was not the same as the event of 2013. The exchange rate was allowed to depreciate, with moderate intervention by the RBI in the forex market. The authorities relaxed controls on foreign portfolio investment, but took no action to limit capital outflows. The limit for foreign portfolio investment in corporate bond was increased, and the restriction on non-resident investment in specific securities issued by the central governement was removed (Patnaik and Prasad, 2020).

In principle, the rationale behind these measures was to bring the offshore forex volumes to the onshore market, and to integrate the two markets. However, in the short term, such measures would have done little to improve the volumes in the onshore market. But it may have helped in better integrating the two markets. Beginning June 1, with banks arbitraging away the pricing differentials between onshore and offshore markets, the spreads between the two markets came down from more than Rupee one to zero/near zero.[24]

7.1 CIP deviations

In this section, we analyse the CIP deviations in the period between March 2020 to January 2021, in an attempt to understand the patterns of the CIP deviations and regulatory actions during the pandemic period.

Figure 7 India: CIP deviations and interest differential during the pandemic period, March 2020 to January 2021

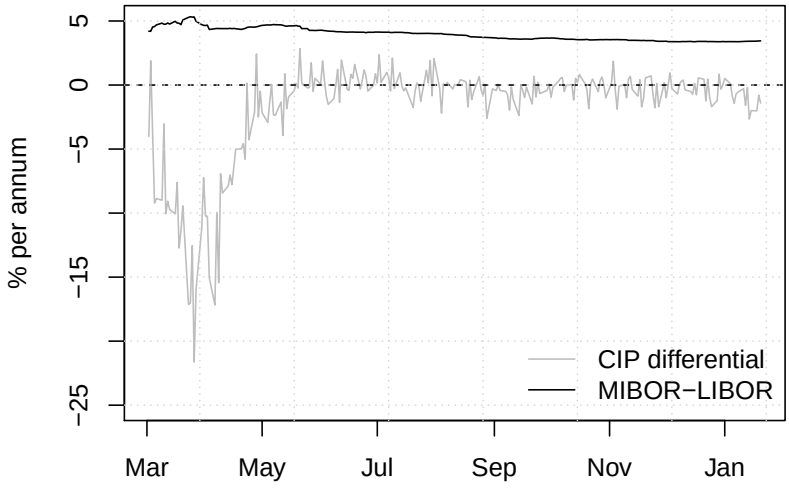


Figure 7 shows the CIP deviations from March 2020 to January 2021, along with the interest rate differential. In the period between Mar 11, 2020 to Apr 8, 2020, the daily CIP deviations ranged between -21.6 percent to -7.2 percent, with the average daily deviation being close to -12.4 percent. The interest differential during the same period ranged between 4.3 percent to 5.6 percent, up by atleast one percentage point from the previous three months. The large negative CIP deviations during that period meant higher implied interest rates than the domestic interest rates, and thus, higher capital outflows and depreciation pressures on the domestic currency. The graph also indicates that the CIP deviations reverted back to pre-pandemic levels by mid-April.

We next examine the non-linearity in the CIP deviations during the pandemic period and

[24]see, Reserve Bank of India Bulletin, "Onshoring the Offshore", 2020.

estimate the no-arbitrage bands. The Hansen test result rejects the null of linearity in favor of a 1-threshold model. We thus estimate a two regime SETAR model, assuming the other threshold at zero. The results indicate a lower threshold at -3 percent. We however exercise caution while interpreting these results as this was a short period of heightened uncertainty, which lasted until mid-April 2020. Financial markets worldwide were in a turmoil, and liquidity and credit risks were significantly elevated.

When we re-estimate the model, excluding the volatile period from March to April 2020, we find that the series turns out to be linear, with the average CIP deviation close to zero at -0.3 percent. The low value of the CIP deviation reflects the continued trend of financial integration that had started prior to the pandemic.

8 A comparison with China's *de-facto* openness

To help put India's results in context, in this section we apply our methodology to assess the extent of China's financial integration with the rest of the world and evaluate the effectiveness of its capital controls. Similar to India, China has in place a complex and elaborate system of capital controls. We first provide a brief overview of China's capital account liberalisation over the past two decades, followed by a discussion of the CIP deviations and no-arbitrage bands based on the CNY NDF and spot prices to understand the *de-facto* openness of China's capital account.

8.1 China's capital account liberalisation

Like India, China's process of capital account liberalisation has been slow and bumpy (Miao and Deng, 2019). Lam et al. (2017) provides a brief overview of the evolution of China's capital account openness. Until 1978, China was a closed economy. China started its journey towards liberalisation when Deng Xiaoping announced economic reforms in 1978. In 1996, China declared current account convertibility and accepted the obligations of Article VIII of the IMF Articles of Agreement. However, the capital account stayed inconvertible as most of the cross border financial transactions were heavily restricted or prohibited. In the aftermath of the Asian financial crisis of 1997, restrictions on capital flows were further tightened.

In 2001, in order to meet its commitments on financial sector liberalisation as part of its WTO (World Trade Organisation) obligations, China started easing capital flows, albeit cautiously. The first major step was announced in 2002 when China introduced the Qualified Foreign Institutional Investor (QFII) scheme in an attempt to encourage foreign portfolio inflows (Miao and Deng, 2019). This gave selected foreign investors limited access to the domestic financial market. In 2006, the policy shift from discouraging outflows to a balanced opening of the capital account led to the launch of the Qualified Domestic Institutional Investor (QDII) system. Relaxations were also extended to qualified retail investors under the QDII scheme to allow for outward portfolio investment.

Despite these measures, capital outflows remained low in comparison to inflows as FDI (Foreign Direct Investment) and portfolio flows continued to come in. This resulted in appreciation pressures on the Renminbi (RMB). As a result, the Chinese central bank, People's Bank of China de-pegged the RMB from the dollar in July 2005, marking the beginning of a managed floating exchange rate regime. By the end of 2007, RMB had appreciated by 13 percent. China also strengthened controls on capital inflows around the same time (Miao and Deng, 2019), presumably to resist further currency appreciation pressures.

To weather the effect of the GFC, around mid-2008, China re-pegged the RMB to dollar for two years, and also tightened controls on capital outflows to stabilize the domestic financial

system. Soon after, with the policy stance moving towards RMB internationalisation in 2009, the authorities reinitiated liberalisation efforts.

Capital inflow regulations were relaxed to meet financing gaps in the domestic economy. The registration procedures for FDI were streamlined in 2012. China also raised QFII quotas significantly to boost portfolio inflows.[25]

In essence, as discussed in McCowage (2018), over the decade or so leading upto 2014, policymakers gradually moved towards greater freedom in the movement of capital and flexibility in the exchange rate. Several measures were taken to ease restrictions on cross-border flows. Badar et al. (2021) find that the number of capital control measures increased from roughly 150 in 2011 to about 450 in 2016. Majority of these measures were directed at easing restrictions. All these steps were taken to meet specific external objectives that included promotion of the international use of RMB, inclusion of RMB into the SDR (Special Drawing Rights) basket of the International Monetary Fund, and inclusion of Chinese capital markets into global indices.

However, from late 2014, there was a notable change in market conditions in China. Even though China weathered the "taper-tantrum" of mid-2013 relatively well (Patnaik and Prasad, 2020), growth started declining. Private capital flows began to reverse, flowing out in net terms. China's growth outlook became weaker, prompting expectations for an easing of monetary policy and a depreciation of the RMB. Outflows accelerated in August 2015 following the unexpected decision by the People's Bank of China (PBC) to allow the currency to become more market determined (McCowage, 2018).

The authorities responded to capital outflows by halting the process of capital account liberalisation. New controls on capital outflows were implemented and existing controls were enforced more stringently, while efforts to encourage capital inflows continued. In 2015, the approvals for new QFIIs were suspended.

By the first half of 2016, the market conditions stabilised, helped by greater market confidence in the exchange rate regime. Progress towards the internationalisation of the RMB also led to its inclusion in the IMF's SDR in October 2016. During the 2016-2019 period, China continued to open up its fixed income markets to foreign investors, and took further measures to reduce restrictions on foreign investment inflows and outflows from equity markets (Patnaik and Prasad, 2020).

8.2 CIP deviations and no-arbitrage bands based on China offshore NDF market

In light of the previous discussion, we now analyse the CIP deviations computed from the Chinese offshore NDF and onshore spot markets, applying the same methodology described for India in Section 5.1. We obtain daily data on 1-month CNY-USD NDF contracts from Thomson Reuters Eikon.[26] However, the data are available only from June 2006 onwards. Hence we conduct the analysis from June 2006 to February 2020. We also obtain the 1-month

[25]The QFII scheme has been gradually made more liberal by allowing investment in domestic securities in RMB in 2011, by including Hong Kong subsidiaries of Chinese banks and insurers in 2012, and further extending it to allow Taiwan, UK, Singapore to invest in domestic securities using RMB proceeds raised overseas in 2013. The ceiling for QFIIs was raised to USD150 billion to boost inflows in the same year.

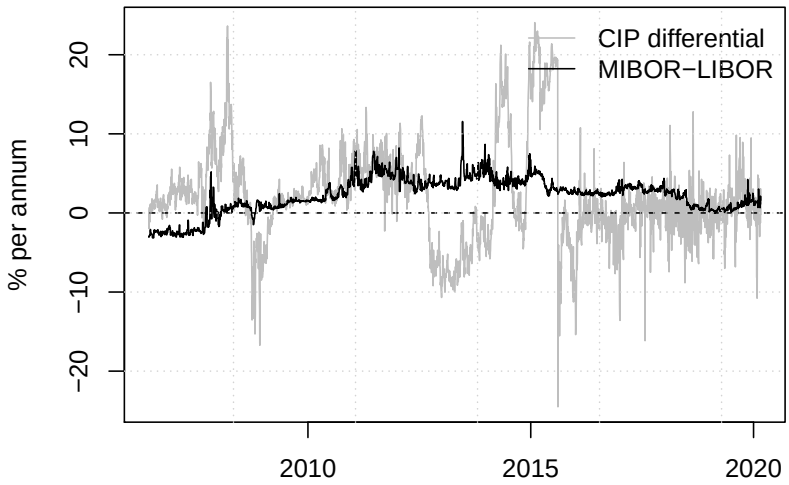
[26]The NDF market for CNY-USD has been in place since the 1990s. However, it has been gradually replaced by the offshore deliverable forwards (CNH) market, created in 2010 (McCauley et al., 2014; Schmittmann and Chua, 2020). The price differentials between the offshore CNH market and the CNY NDF market are however low, especially from 2016 onwards. Hence for the sake of consistency with the India analysis, we use the NDF CNY prices for our main estimations. We redo the analysis using the CNH prices, and find that the results remain largely the same. We report these in the Appendix.

Chinese Interbank Offer Rate (CHIBOR) from the Eikon database.[27]

Figure 8 shows the CIP deviations obtained from the NDF implied yield differential along with the difference between the LIBOR and CHIBOR rates. As can be seen from Figure 8, till about 2015, the CIP deviations were reasonably large and primarily positive implying that there were capital inflow pressures that were resisted by capital controls. This implies that despite the easing of controls that was done by the authorities during this period, the existing restrictions that continued to be in place were effective in preventing inflows to a large extent. This is in contrast to India where the controls were binding on outflows than inflows in the smaller positive CIP deviations.

The exceptions in the case of China were a very short period of time after the GFC of 2008 and the "taper-tantrum" episode of 2013 when China experienced capital outflow pressures like most emerging economies, and capital controls were used to prevent these outflows. From 2015 onwards the CIP deviations become relatively smaller in magnitude and more tightly bound around zero, indicating greater capital account liberalisation in the recent years, similar to what we find for India.

Figure 8 China: 1-month CIP deviations and Chinese-US Interest rate differentials (CHIBOR less LIBOR)



The structural break test indicates seven break points for China, yielding eight sub-periods. We present the summary statistics for each sub-period in Table 6. The corresponding no-arbitrage bands estimates from the SETAR model for each sub-period are shown in Figure 9. The Hansen test identifies a three-regime model in all except sub-periods V, VI and VIII. Sub-periods V and VI indicate a non-stationary process and we therefore do not estimate a linear AR model for these two sub-periods.[28] Table 7 presents the threshold and AR(1) coefficients estimates for the remaining sub-periods. As before, when both the thresholds turn out to be in the same direction (negative or positive), with one of the thresholds being close to zero, we set that threshold to zero for ease of interpretation of no-arbitrage bands.

[27]Unlike India, China did not implement any major change in capital controls during the pandemic period; hence we have not extended the China sample beyond February 2020. The 2006-2020 period give us a good window for carrying out a comparative analysis with India.

[28]The Augmented Dickey Fuller test for both the sub-periods (V and VI) fail to reject the null of unit root process at 5% level.

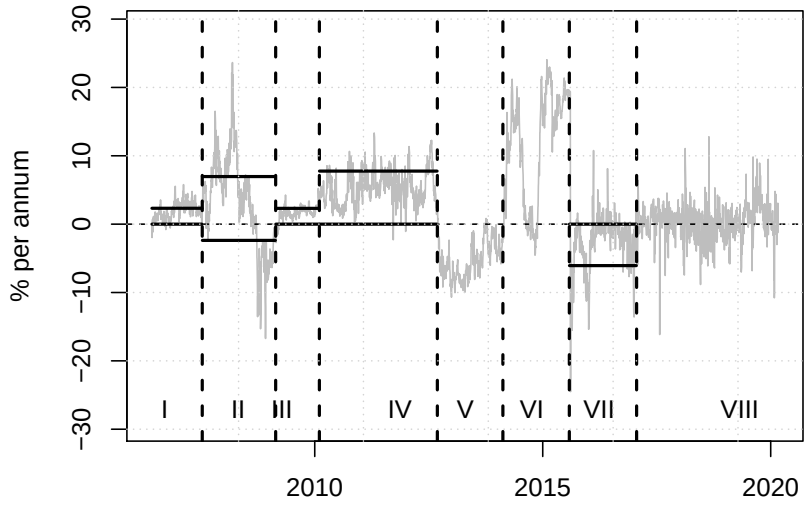
Table 6 Summary statistics of CIP deviations for each sub-period for China

Sub-period	Start date	End date	No. of obs.	CIP Deviations (%)				CHIBOR-LIBOR (%)
				Median	Mean	SD	Negative obs.	Mean
I	2006-06-07	2007-07-13	287	1.80	1.95	1.23	4.51	-2.48
II	2007-07-16	2009-02-20	420	4.06	3.17	7.01	29.76	0.27
III	2009-02-23	2010-02-05	250	1.64	1.60	1.10	8.00	1.21
IV	2010-02-08	2012-09-07	675	5.23	5.38	2.45	0.59	3.78
V	2012-09-10	2014-02-14	375	-5.83	-5.27	2.73	96.27	4.52
VI	2014-02-17	2015-07-31	379	14.71	11.80	7.98	13.28	4.13
VII	2015-08-03	2017-01-20	385	-1.60	-2.21	4.64	77.14	2.63
VIII	2017-01-23	2020-02-21	804	0.48	0.33	2.60	40.00	1.79

The average CIP deviations across the sub-periods corroborate the findings from Figure 8. Until 2012, the mean CIP deviation for China was positive with a very few observations being less than zero. While the deviations were relatively lower in the first (2 percent) and third (1.6 percent) sub-periods, they were substantially higher in the second (3.2 percent) and fourth (5.4 percent) sub-periods. This is also reflected in the asymmetric thresholds that we observe in the no-arbitrage bands estimation for these periods, where the positive threshold turns out to be significantly large for the second (7 percent) and fourth (7.8 percent) sub-periods.

This implies that the Chinese capital controls were effective in maintaining a wedge between the onshore and offshore yield differentials and preventing inflows. This seems particularly true for the period from 2010 to 2012 when most emerging economies were receiving a surge of foreign investment as a result of the quantitative easing program pursued by the US Fed in the post-GFC period. The AR(1) coefficient estimates in both these regimes are also high indicating low arbitrage pressure even when the deviations were high.

Figure 9 SETAR model estimation results on 1-month CIP deviations for China with estimated boundaries



The subsequent sub-period, from 2012 to 2014 saw the Chinese authorities relaxing the controls to boost portfolio inflows (Section 8.1). This is reflected in the narrowing of the average CIP deviations during this period. We also observe that the mean CIP deviation turned negative during this period, presumably reflecting the capital outflow pressures during the "taper-tantrum" episode of 2013, and controls imposed to prevent the outflows. The absence of the no-arbitrage bands in this period is due to the linear behavior of CIP deviations which implies that the entire sample of observations is within the no-arbitrage band.

The findings though consistent with the gradual liberalisation of Chinese capital account, are in contrast to India where the positive CIP deviations and the width of the no-arbitrage bands (for example mean CIP deviation of 0.2 percent in the 2009-2014 period in India compared to China's 5.4 percent deviation in the 2010-2012 period) were much smaller in magnitude. This implies that India during this period saw relatively less effectiveness of existing capital controls and greater financial integration with the global markets.

The sixth sub-period from February 2014 to July 2015 is characterised by large CIP deviations with the mean deviation at 11.8 percent, the highest in the sample. The Hansen test indicates a linear model for this sub-period, implying that the no-arbitrage bands lie outside the observed values of deviations. This is consistent with the policy stance during this period, which saw heightened market volatility and large capital outflows (Section 8.1). The authorities responded by halting of the process of capital account liberalisation, introducing new controls and tightening the enforcement of existing restrictions.

Post 2015 onwards, as macroeconomic conditions stabilised, we observe a narrowing down of the CIP deviations as well as of the width of the no-arbitrage bands, relative to the previous two sub-periods (V and VI). The Chinese authorities took tentative steps to once again ease restrictions on capital flows and allowed the RMB to become more market driven. Some of the policy actions that had been implemented to control outflows in 2015 and 2016 were withdrawn. For inward FDI, the authorities reduced investment restrictions and initiated new opening-up measures. This change of stance is reflected in the average CIP deviation of -2.2 percent in the 2015-2017 period, and the reduced width of no-arbitrage bands at -6.1 percentage points. The continued emphasis on easing gets reflected in the average CIP deviation of 0.3 percent in the last sub-period that ranges from 2017 to start of 2020, the lowest deviation in our sample. This is similar to what we find for India.

In summary, we find that while in both the countries the capital account has become more liberalised over the years, India now has greater *de-facto* openness compared to China. The Indian policy stance has continued to move towards increased financial integration especially in the post-GFC period. In contrast, the Chinese policy continued to maintain strict controls that were relatively more effective in curtailing capital movements during our sample period. This is evident both in the overall magnitude of the CIP deviations as well as in the width of the no-arbitrage bands particularly in the recent years.

9 Conclusion

Interest parity and arbitrage are age-old concepts in financial economics. In a day and age when a plethora of both *de-jure* and *de-facto* measures of a country's capital account openness have been used in the literature without there being any consensus as to which measure is better, a relatively under-utilised measure is a price-based one that uses deviations from the Covered Interest Parity.

In our paper, we study the changes in the capital account openness of the Indian economy using the CIP deviations and no-arbitrage band estimation and compare and contrast it to that of China. Both India and China offer great case studies to analyse CIP deviations, because both countries have in place an elaborate and complex system of capital controls and the respective authorities keep altering the rules on a regular basis thereby changing the underlying conditions for investors and arbitrageurs.

Our analysis reveals that over a 20-year period, India has achieved a substantial amount of financial liberalisation. On average CIP deviation has been quite small in size, but there have also been periods of wide deviations from the interest rate parity. Most notably, in recent years,

India seems to have become significantly more financially integrated with the global markets, as demonstrated by smaller CIP deviations and narrowing arbitrage bands.

When we implement our methodology for China we find that China too has become relatively open in the recent years. This is consistent with the capital account liberalisation strategy adopted by the authorities. However, a comparison of the magnitudes of CIP deviations in recent years reveals that India has a significantly more open capital account than China. Also China seems to have faced greater or more frequent capital inflow pressures compared to India and their controls on inflows appear to have been more effective.

References

Andrews, Donald W. K., "Tests for Parameter Instability and Structural Change With Unknown Change Point," *Econometrica*, 1993, *61* (4), 821–856.

Badar, Alam, Badar Iqbal, Nida Rahman, and Mohd Rahman, "Capital Account Liberalization and Capital Movement in China," *Journal of Comparative Asian Development*, 02 2021, *18*.

Bai, Jushan, "Least Squares Estimation of a Shift in Linear Processes," *Journal of Time Series Analysis*, 1994, *15*, 453–472.

_ **and Pierre Perron**, "Estimating and Testing Linear Models with Multiple Structural Changes," *Econometrica*, 1998, *66*, 47–79.

_ **and** _ , "Computation and analysis of multiple structural change models," *Journal of Applied Econometrics*, 2003, *18* (1), 1–22.

Balke, N. S. and M. E. Wohar, "Nonlinear dynamics and covered interest rate parity," *Empirical Economics*, 1998, (23).

Balke, Nathan S and Thomas B Fomby, "Threshold Cointegration," *International Economic Review*, 1997, *38* (3), 627–45.

Cerutti, Eugenio M., Maurice Obstfeld, and Haonan Zhou, "Covered interest parity deviations: Macrofinancial determinants," *Journal of International Economics*, 2021, *130* (C).

Chinn, Menzie D. and Hiro Ito, "A New Measure of Financial Openness," *Journal of Comparative Policy Analysis: Research and Practice*, 2008, *10* (3), 309–322.

Du, Wenxin and Jesse Schreger, "CIP Deviations, the Dollar, and Frictions in International Capital Markets," NBER Working Papers 28777, National Bureau of Economic Research, Inc May 2021.

Forbes, Kristin, Marcel Fratzscher, and Roland Straub, "Capital-flow Management Measures: What Are They Good For?," *Journal of International Economics*, 2015, *96* (1), S76–S97.

Frankel, Jeffrey A., "Measuring International Capital Mobility: A Review," *American Economic Review*, 1992, *82*, 197–202.

Guru, Anuradha, "Non-deliverable forwards market for Indian rupee: An empirical study," *Indian Journal of Economics and Business*, 2009, *8*, 245–260.

Hansen, Bruce E., "Sample Splitting and Threshold Estimation," *Econometrica*, 2000, *68* (3), 575–603.

Hua, Changchun, Philip Ng, Raymond Yuen, and R. S Craig, "Development of the Renminbi Market in Hong Kong SAR: Assessing Onshore-Offshore Market Integration," IMF Working Papers 2013/268, International Monetary Fund December 2013.

Hutchison, Michael M, Gurnain Kaur Pasricha, and Nirvikar Singh, "Effectiveness of Capital Controls in India: Evidence from the Offshore NDF Market," *IMF Economic Review*, 2012, *60* (3), 395–438.

Hutchison, Michael, Rajeswari Sengupta, and Nirvikar Singh, "India's Trilemma: Financial Liberalisation, Exchange Rates and Monetary Policy," *The World Economy*, 2012, *35* (1), 3–18.

Juhl, Ted, William Miles, and Marc D. Weidenmier, "Covered Interest Arbitrage: Then versus Now," *Economica*, 2006, *73* (290), 341–352.

Lam, W., Markus Rodlauer, and A. Schipke, "Modernizing China : Investing in Soft Infrastructure," in "in" 2017.

Levy Yeyati, Eduardo, Sergio L. Schmukler, and Neeltje Van Horen, "International financial integration through the law of one price: The role of liquidity and capital controls," *Journal of Financial Intermediation*, 2009, *18* (3), 432–463.

Liu, Jian, Shiying Wu, and James V. Zidek, "On Segmented Multivariate Regression," *Statistica Sinica*, 1997, *7* (2), 497–525.

Ma, Guonan and Robert McCauley, "Do China's capital controls still bind? Implications for monetary autonomy and capital liberalisation," BIS Working Papers 233, Bank for International Settlements 2007.

_ and Robert N. McCauley, "Is China or India more financially open?," *Journal of International Money and Finance*, 2013, *39* (C), 6–27.

_ , Corrinne Ho, and Robert N McCauley, "The markets for non-deliverable forwards in Asian currencies," *BIS Quarterly Review*, June 2004.

Martens, M., P. Kofman, and T. Vorst, "A threshold error correction model for intraday futures and index returns," *Journal of Applied Econometrics*, 1998, *13*, 245–263.

McCauley, Robert N, Chang Shu, and Guonan Ma, "Non-deliverable forwards: 2013 and beyond," *BIS Quarterly Review*, March 2014.

McCowage, Madeleine, "Trends in China's Capital Account," *Reserve Bank of Australia - Bulletin*, 06 2018, *18*.

Miao, Yanliang and Tuo Deng, "China's capital account liberalization: a ruby jubilee and beyond," *China Economic Journal*, 2019, *12* (3), 245–271.

Misra, Sangita and Harendra Behera, "Non Deliverable Foreign Exchange Forward Market: An Overview," *Reserve Bank of India Occasional Papers*, Winter 2006, *27* (3).

Mohan, Rakesh and Muneesh Kapur, "Managing The Impossible Trinity: Volatile Capital Flows And Indian Monetary Policy," Stanford Center for International Development, CA Working Papers 401, Stanford Center for International Development 2009.

Pandey, Radhika, Gurnain Pasricha, Ila Patnaik, and Ajay Shah, "Motivations for capital controls and their effectiveness," Working Papers, National Institute of Public Finance and Policy 2016.

_ , Rajeswari Sengupta, Aatmin Shah, and Bhargavi Zaveri, "Evolution of capital controls on foreign institutional investment in India," Indira Gandhi Institute of Development Research, Mumbai Working Papers 2019-034, Indira Gandhi Institute of Development Studies 2019.

_ , _ , _ , and _ , "Legal restrictions on foreign institutional investors in a large, emerging economy: a comprehensive dataset," *Data in Brief*, 2019, *28*.

Pasricha, Gurnain Kaur, Matteo Falagiarda, Martin Bijsterbosch, and Joshua Aizenman, "Domestic and multilateral effects of capital controls in emerging markets," *Journal of International Economics*, 2018, *115* (C), 48–58.

Patel, Nikhil and Dora Xia, "Offshore markets drive trading of emerging market currencies," *BIS Quarterly Review*, December 2019.

Patnaik, Ila and Eswar Prasad, "IMF Advice on Capital Flows to People's Republic of China and India," IEO Background Paper 20-02/08, International Monetary Fund 2020.

_ **and Rajeswari Sengupta**, "Analysing India's Exchange Rate Regime," NIPFP Working Papers 353, National Institute of Public Finance and Policy August 2021.

Peel, David A and Mark P Taylor, "Covered Interest Rate Arbitrage in the Interwar Period and the Keynes-Einzig Conjecture," *Journal of Money, Credit and Banking*, February 2002, *34* (1), 51–75.

RBI, "Onshoring the Offshore," RBI Bulletin, Reserve Bank of India 2020.

Schindler, Martin, "Measuring Financial Integration: A New Data Set," *IMF Staff Papers*, 2009, *56* (1), 222–238.

Schmittmann, Jochen M. and Han Teng Chua, "Offshore Currency Markets: Non-Deliverable Forwards (NDFs) in Asia," IMF Working Papers 2020/179, International Monetary Fund September 2020.

Sengupta, Rajeswari and Abhijit Sen Gupta, "Policy tradeoffs in an open economy and the role of G-20 in global macroeconomic policy coordination," Indira Gandhi Institute of Development Research, Mumbai Working Papers 2015-024, Indira Gandhi Institute of Development Research, Mumbai, India 2015.

Shah, Ajay and Ila Patnaik, "Managing Capital Flows: The Case of India," ADB Institute Working Papers 98, ADB Institute 2008.

Thorat, Usha, "Report of the Task Force on Offshore Rupee Markets," Technical Report, Reserve Bank of India 2019.

Tong, Howell, *Non-linear Time Series. A Dynamical System Approach*, Oxford Science Publications, 1990.

Zeileis, A., A. Shah, and I. Patnaik, "Testing, Monitoring and Dating Structural Changes in Exchange Rate Regimes," *Computational Statistics and Data Analysis*, 2010, *54* (6), 1696–1706.

_ **, C. Kleiber, W. Kramer, and K. Hornik**, "Testing and Dating Structural Changes in Practice," *Computational Statistics and Data Analysis*, 2003, *44*, 109–123.

Appendix A CIP deviations based on Offshore CNH markets

Figure A.1 SETAR model estimation results on 1-month CIP deviations for China based on offshore CNH market with estimated boundaries

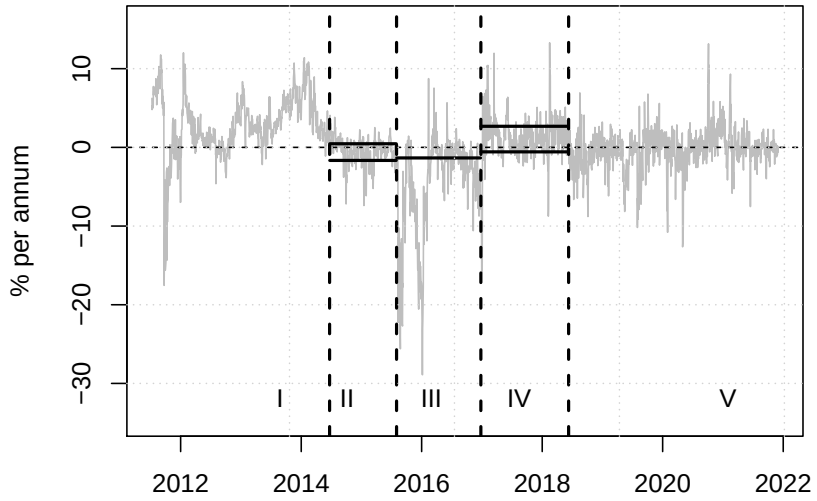


Table 1 Brief overview of capital controls on foreign portfolio investment in India, 2000-2020

2000	Enactment of Foreign Exchange Management Act (FEMA), bringing Foreign Institutional Investment (FII) under the regulatory purview of RBI.
1995-2004	FII investment in debt securities was subject to a limit of USD 1 billion. Separate limits of investment were prescribed via the 70:30 route and the 100% debt route. USD 100 million was permitted under the 70:30 route and USD 900 billion was permitted under the 100% debt route.
2003	The rules governing External Commercial Borrowing (ECB) by Indian firms were relaxed. Restrictions on Overseas Corporate Bodies (NRI controlled companies) investing in India were tightened. Some more restrictions imposed on FIIs.
2004	The overall FII limit in debt securities was increased from USD 1 billion to USD 1.75 billion. In December, 2004 a separate ceiling of USD 500 million was imposed on FII investment in corporate bonds. Since then, separate limits are announced for Government bonds and corporate bonds. In the subsequent years there has been a gradual relaxation in the quantitative limits for FPI investment in government and corporate bonds.
2006	FII debt limit increased from USD 1.75 billion to 2 billion for Government bonds and from USD 0.5 billion to 1.5 billion for corporate bonds. Investment eligibility of FIIs broadened. FII investment upto 23 percent permitted in market infrastructure institutions in the securities markets, such as stock exchanges, depositories, and clearing corporations.
2007	Interest rate caps were imposed to reduce inflows. Inflows to capital goods were restricted.
2008	Cumulative debt investment limits raised from USD 3.2 billion to USD 5 billion and from USD 1.5 billion to USD 3 billion for FII investments in government securities and corporate debt, respectively. No more demarcation of FII investments in debt securities under the 70:30 and 100% route.
2010	Foreign investment limit in government debt increased from USD 5 billion to USD 10 billion and in corporate debt from USD 15 to USD 20 billion. FIIs allowed to invest in goverment bonds (Long) and corporate bonds with a residual maturity of 5 years up to USD 5 billion each.
2011	FII debt limit increased from USD 20 billion to 25 billion for corporate bonds and from USD 10 billion to USD 15 billion for government bonds. Increase in total limit available to FIIs for investment in listed NCDs or bonds to USD 40 billion by raising the sub limit of USD 25 billion for investment in the infrastructure sector. Lock-in period reduced to 1 year for investments in infrastructure sector.
2012	Limits for FII investment increased from USD 15 billion to USD 20 billion in government bonds.
2013	The separate sub-limits of FII investment in Government debt-Old and Government debt-Long were merged into a single limit of USD 25 billion, eventually raised to USD 30 billion. The separate sub-limits of FII investment in corporate debt were merged into a single limit of USD 51 billion. In the Government Debt Long Term category, the provision regarding 3 years residual maturity at the time of first purchase was removed. However, within this category, FIIs were not allowed to invest in short term paper like treasury bills. Investment in corporate debt enhanced by USD 5 bn from USD 20 bn to USD 25 bn and subsequently from USD 25 billion to 30 billion. Steps were taken to liberalise ECB by Indian firms. Curbs were imposed on currency trading as well as on FII outflows.

Table 2 Brief overview of capital controls on foreign portfolio investment in India, 2000-2020, continued

2014	FIIs allowed to invest in exchange traded currency derivatives.
2015	RBI prohibited FIIs from investing in: (a) G-secs with a maturity period of less than three years, and (b) liquid and money market market mutual funds. FII investment in rupee denominated debt securities moved from quantitative restrictions to percentage based limits. Aggregate FII investment in any G-sec issuance was capped at 20% of the outstanding stock of that issuance. RBI allowed Indian firms eligible to raise ECB to issue rupee denominated bonds within the overarching ECB policy.
2017	FII investment limits in Government bonds enhanced.
2018	RBI withdrew the restriction on investment in G-secs with a minimum residual maturity of 3 years. RBI re-allocated the sub-limits for investment among general FIIs and "long-term FPIs". The existing condition with respect to FII investment in G-secs with less than 1 year maturity was relaxed, and the investment cap was increased to 30% of the total investment of the FII in that category. For corporate bonds, the framework moved from quantitative limits to percentage based limits.
2019	A new route for FII investment, referred to as the "Voluntary Retention Route" (VRR), was announced. Under this route, FIIs were allowed to invest in G-secs of all maturities subject to conditions such as minimum investment size, lock-in period, etc. RBI announced a "Fully Accessible Route" (FAR) that gives unlimited access to FIIs but only to a select set of G-Secs, specified by the RBI from time to time. The existing condition that no FPI shall have an exposure of more than 20% of its corporate bond portfolio to a single corporate (including exposure to entities related to the corporate) was withdrawn.
2020	Short-term investment limit applicable to FIIs investing in G-Secs and corporate bonds was increased from 20% to 30% of the total investment. FPI investments in debt instruments issued by Asset Reconstruction Companies and by an entity under the Corporate Insolvency Resolution Process as per the resolution plan approved by the National Company Law Tribunal under the Insolvency and Bankruptcy Code, 2016 would be exempted from the short term investment limits.

Sub-period	Start date	End date	Lower threshold	Upper threshold	% of obs.			AR(1) coefficient (SE)			AIC	Obs.
					Low	Medium	Upper	Low	Medium	High		
I	1999-08-18	2001-12-28	-5.86	-0.78	23	66	11	0.65 (0.06)	0.82 (0.08)	-0.81 (0.21)	1010.41	618
II	2001-12-31	2003-03-28	-1.74	-0.90	61	22	17	0.70 (0.08)	-2.09 (0.67)	-0.11 (0.12)	167.31	325
III	2003-03-31	2005-08-12	-1.49	3.89	21	68	11	0.35 (0.07)	0.76 (0.08)	-0.67 (0.21)	1072.92	620
IV	2005-08-15	2009-06-12	-6.84	-0.02	19	64	17	0.48 (0.06)	0.40 (0.11)	0.12 (0.09)	3137.38	995
V	2009-06-15	2014-07-18	-1.72	2.84	24	53	23	0.33 (0.06)	0.24 (0.10)	0.09 (0.12)	3341.19	1330
VI	2014-07-21	2018-02-09							0.30 (0.03)			929
VII	2018-02-12	2020-02-21	-0.80	-0.26	41	14	45	0.13 (0.08)	-3.48 (1.23)	-0.06 (0.11)	589.22	529

Table 4: India: Results from SETAR model on 1-month CIP deviations

Sub-period	Start date	End date	Lower threshold	Upper threshold	% of obs.			AR(1) coefficient (SE)			AIC	Obs.
					Low	Medium	Upper	Low	Medium	High		
I	2006-06-07	2007-07-13	1.33	2.32	34	31	35	0.52 (0.12)	0.29 (0.27)	0.40 (0.10)	-186.17	287
II	2007-07-16	2009-02-20	-2.38	6.96	23	50	27	0.74 (0.06)	0.91 (0.05)	0.91 (0.05)	479.54	420
III	2009-02-23	2010-02-05	1.13	2.31	23	57	20	0.98 (0.07)	0.49 (0.13)	0.58 (0.11)	-333.03	250
IV	2010-02-08	2012-09-07	3.07	7.76	18	64	17	0.36 (0.14)	0.89 (0.05)	0.98 (0.10)	427.84	675
V	2012-09-10	2014-02-14							0.94 (0.02)		1093.31	375
VI	2014-02-17	2015-07-31							0.98 (0.01)		1329.71	379
VII	2015-08-03	2017-01-20	-6.07	-2.32	16	26	58	0.42 (0.10)	0.66 (0.27)	0.723 (0.05)	715.62	385
VIII	2017-01-23	2020-02-21							0.45 (0.03)		3641.03	804

Table 7: China: Results from SETAR model estimation on 1-month CIP deviations

Sub-period	Start date	End date	Lower threshold	Upper threshold	% of obs.			AR(1) coefficient (SE)			AIC	Obs.
					Low	Medium	Upper	Low	Medium	High		
I	2011-07-11	2014-06-20							0.90 (0.02)		2892.34	770
II	2014-06-23	2015-07-31	-1.66	0.46	18	52	30	0.16 (0.13)	0.62 (0.18)	0.97 (0.19)	151.97	289
III	2015-08-03	2016-12-23	-1.34		66		34	0.89 (0.03)		0.38 (0.15)	743.39	365
IV	2016-12-26	2018-06-08	-0.57	2.68	15	60	25	0.96 (0.08)	0.81 (0.16)	0.75 (0.10)	574.96	380
V	2018-06-11	2021-11-26							0.61 (0.03)		3823.36	904

Table A.1: China: Results from SETAR model estimation on 1-month offshore CNH market based CIP deviations