Interest Arbitrage under Capital Controls: Evidence from Reported Entrepôt Trades*

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Abstract

Capital controls segment the offshore credit market of Chinese renminbi from the onshore market. Using a novel administrative data set, we provide evidence that firms arbitrage the onshore-offshore interest differentials using bank-intermediated "entrepôt trades," which supposedly re-export imports with little or no processing. Onshore-offshore interest differentials drive renminbi inflows from entrepôt trades, which strongly predict 1-year-forward outflows to settle bank-issued letters of credit. The patterns and timing of entrepôt trade flows are consistent with lending by onshore banks and borrowing from offshore banks through bank-intermediated trade finance. A larger interest differential allows transactions with a lower value to be profitable and induces entry into arbitrages. Our findings suggest that renminbi interest arbitrages are feasible but costly under capital controls.

Keywords: Capital Controls, RMB Interest Arbitrage, Entrepôt Trade, Trade Finance

JEL Classification Numbers: O24, F23, F33, G15, G18, G12

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1 Introduction

In this paper, we investigate how China's opening up the use of its currency in international trade settlements affects the effectiveness of its capital controls. We provide evidence that Chinese firms report fictitious "entrepôt trades" to circumvent capital controls. These are trades that re-export imports with little or no processing. Since entrepôt trades involve both capital inflows to and outflows from China, they are ideal for circumventing capital controls. Moreover, we show how the letter of credit (hereafter L/C), which is a bank-issued instrument commonly used in bank-intermediated trade finance, enables the interest arbitrage of the renminbi (hereafter RMB, or Chinese yuan) across onshore and offshore markets.

An arbitrageur in China may deposit an amount of RMB in an onshore bank, earning interest at the onshore rate. At the same time, the arbitrageur uses the deposit as collateral for the issuance of an L/C to an offshore bank with a 1-year maturity and a prescribed beneficiary—namely, the supposed "seller" in the entrepôt trade. The offshore "seller" may then discount the L/C into cash at the offshore rate plus a bank charge. Through a related party—i.e., the offshore "buyer" in the entrepôt trade—the discounted L/C flows back onshore as the cash payment to the arbitrageur acting as an entrepôt trader. If the onshore rate is sufficiently higher than the offshore interest rate, the interest arbitrage described above would be profitable.

Using administrative data on entrepôt-related capital flows from a populous province in China, we show that the onshore-offshore interest differentials for RMB strongly correlate with RMB inflows from entrepôt trades. Moreover, RMB inflows from entrepôt trades closely predict 1-year-forward RMB outflows to settle L/Cs. The timing and characteristics of the associated capital flows are consistent with RMB interest arbitrage through entrepôt trades.

Our findings suggest that onshore-offshore RMB interest arbitrage is feasible but costly. The amount of capital and the number of firms participating in interest arbitrage are driven by onshore-offshore interest differentials, which determine arbitrage profitability. In addition to examining the aggregate value of entrepôt trades, we also examine the size distribution of transactions that settle L/Cs. Fixed costs of entrepôt trades have a larger impact on the profitability of arbitrages with low L/C value than on the profitability of arbitrages with high L/C value. We find that onshore-offshore interest differentials have a larger impact on 1-year-forward L/C settlements with relatively low transaction value. Meanwhile, we do not find similar patterns for 1-year-forward outflows through wire transfer. Because forward L/C settlements are associated with interest arbitrage while forward wired outflows are not, these results support the presence of fixed costs from using L/Cs and entrepôt trades to arbitrage.

Furthermore, we find that a high-interest differential also encourages more firms to engage in entrepôt trades; some of the additional entrepôt traders are new entries from the beginning of our data set. Since a significant onshore-offshore interest differential exists during a 3-year interval, our findings suggest that the interest arbitrage identified in this paper is limited in its ability to equalize RMB interest rates across the Chinese mainland border.

Our paper contributes to several strands of literature. First, it adds to the literature that investigates the effectiveness of capital controls.[1] Rather than focusing on the effectiveness of imposing capital controls as emergency measures, our paper shows how relaxing some aspect of capital controls may have unintended consequences for capital flows. Our findings suggest that investors may often bypass capital controls, which limits their effectiveness. Therefore, our paper also contributes to the literature on how firms that engage in international trade may circumvent capital controls and, more broadly, regulation and taxation.[2] Moreover, our paper is related to an emerging literature that studies the important roles of financial intermediation in international trade (Schmidt-Eisenlohr, 2013). We show that bank instruments for trade finances may be exploited by trade intermediaries for interest arbitrage.

The rest of the paper is organized as follows. In the next section, we discuss the back-

[1] See, e.g., De Gregorio et al. (2000); Jinjarak et al. (2013); and Mitchener and Wandschneider (2015).
[2] See, e.g., Auguste et al. (2006); Fisman and Wei (2004); Fisman et al. (2008); and Davies et al. (2018).

ground related to China's capital controls and the RMB's offshore market, illustrate in greater detail how firms may use L/C-financed entrepôt trades to arbitrage under capital controls, and describe our data. We present our main findings in Section 3, and Section 4 concludes.

2 Background

2.1 Capital Controls and RMB Offshore Markets

China has long maintained strict controls on capital flows. The Chinn-Ito index, which measures de jure financial openness and is updated to 2018, ranks China's capital accounts among the least open. But tight de facto capital controls may be increasingly difficult and costly due to the large volume of trades China now engages in (Prasad and Rajan, 2008). Therefore, policymakers have stated that a gradual and prudent liberalization of capital accounts is a long-term goal. Several policies have been put in place. In particular, for several years the Chinese government has been promoting the use of the RMB for the settlement of international transactions.

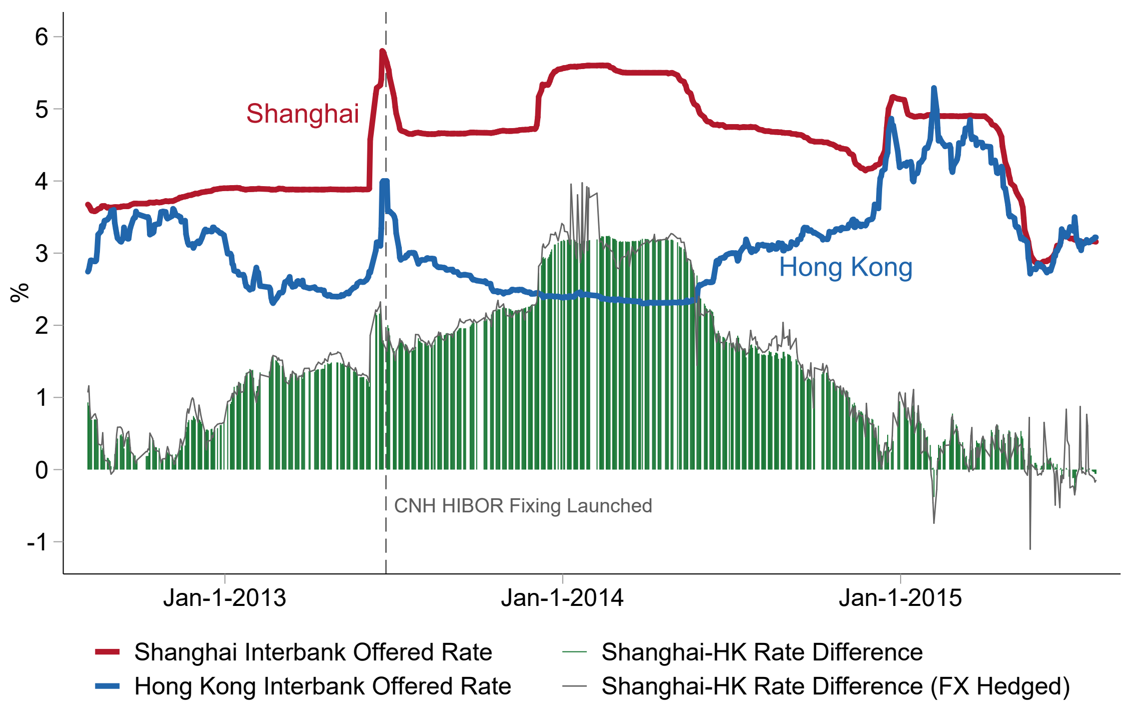
The People's Bank of China (hereafter PBC) announced in July 2009 that commercial banks in Shanghai and 4 other cities may provide services for settling cross-border trades in RMB.[3] In June 2010, this pilot program was extended to 20 provinces, including the province in our data set, and all trading partners. In August 2011, China opened cross-border RMB settlements to all other provinces. A crucial goal of RMB internationalization is to foster an active offshore RMB market. To this end, the PBC established a number of offshore RMB clearinghouses and swap lines with the central banks of several offshore RMB trading centers.

In 2009, virtually none of China's trades were settled in RMB. By 2014, however, almost 20% of goods trades—and about a quarter of service trades and other current-account

[3]In addition to Shanghai, the other 4 pilot cities are all in Guangdong province: Guangzhou, Shenzhen, Zhuhai, and Dongguan. As a pilot program, these services were initially limited to a select set of firms in each city and settlements with Hong Kong, Macau, and 10 Southeast Asian countries.

transactions—were settled in RMB (IMF, 2015). Since China opened up cross-border settlement of trades, offshore RMB deposits have grown rapidly. In 2014, offshore financial institutions had close to 2.5 trillion RMB on deposit, which equals about 1.5% of onshore deposits (IMF, 2015).

Hong Kong intermediates a significant portion of China's trades (Feenstra and Hanson, 2004) and has a head start on the RMB international-settlement business based on favorable policies from Beijing. Given these advantages, Hong Kong has become the primary offshore RMB center, accounting for about half of offshore deposits in 2014.[4]



Notes: The figure above plots the daily interbank offered rates of Chinese yuan in Shanghai and Hong Kong, as well as their differences. The term for both interbank offered rates is 3 months.

Figure 1: RMB Interbank Offered Rates and Shanghai–Hong Kong Rate Differentials

Capital controls segment onshore and offshore RMB markets, allowing onshore and offshore interest rates to diverge. In Figure 1, we plot the 3-month interbank offered rates in Shanghai and Hong Kong and their differences. Between mid-2012 and mid-2015,

[4]Two other major offshore RMB centers, Taiwan and Singapore, are far behind Hong Kong in RMB deposits. Since 2013, Hong Kong has consistently accounted for more than 70% of RMB offshore or cross-border payments (SWIFT, 2016). See Cheung and Rime (2014) for more details on Hong Kong's role in RMB internationalization.

onshore interest rates are higher than the offshore rates for most of the sample period. Onshore-offshore interest rate differentials could be large at times, peaking at 3% around late 2013 and early 2014. The persistent and significant onshore-offshore interest differentials provide opportunities for arbitrage if capital controls can be circumvented. In the following section, we will explain how entrepôt trades and bank intermediation facilitate such interest arbitrage.

2.2 Interest Arbitrage through Entrepôt Trades

Entrepôt trades re-export imported goods with little or no processing or repackaging; they match buyers and sellers across the globe, reduce transportation costs, and facilitate evasion of tariffs and other trade barriers.[5] As an entrepôt port, for example, Hong Kong intermediates a large portion of China's exports (Feenstra and Hanson, 2004).

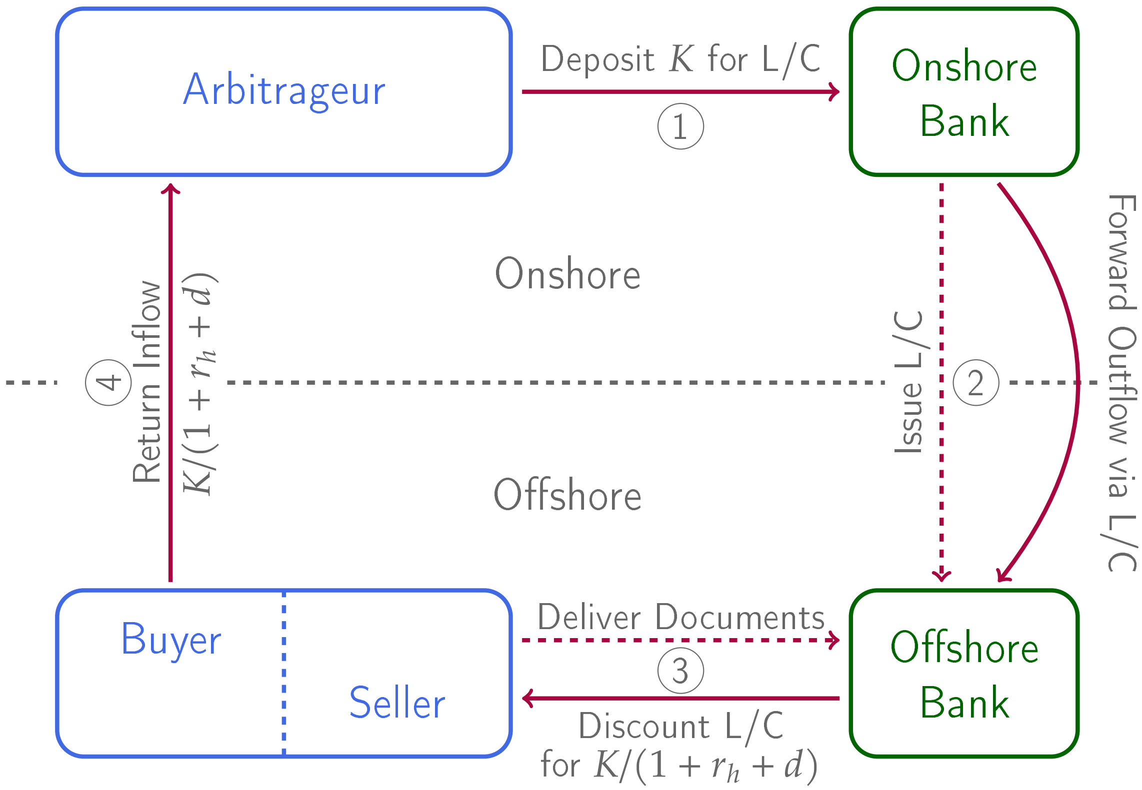
Mainland China does not have an entrepôt port, and thus Chinese firms usually do not enjoy the advantages of engaging in large-scale entrepôt trades. However, Chinese firms may report fictitious entrepôt trades to circumvent capital controls. Moreover, L/Cs, which are the dominant instrument for bank-intermediated finance for international goods trades, could enable cross-border interest arbitrage using fictitious entrepôt trades.

An L/C is a written document, issued by one bank to another, often overseas, at the request of a buyer of goods. The issuing bank of an L/C guarantees a particular payment to the seller when prescribed documents have been presented. While the payment is due at the maturity of the L/C, the seller may discount its L/C for cash at the overseas bank (Willsher, 1995; McLaughlin, 1949).

Whereas cash in advance (importer finance) and open accounts (exporter finance) are more popular for trades between developed countries, the bank-intermediated L/C is most popular in developing countries such as China and India. About one-third of firms state that the L/C was a top payment method for transactions with China in 2010 (Schmidt-Eisenlohr, 2013). The popularity of L/Cs highlights banks' important intermediary role

[5] See, e.g., Feenstra and Hanson (2004); Andriamananjara et al. (2004); and Fisman et al. (2008). Some duty-free ports, such as Hong Kong, Singapore, and 17th century Amsterdam, exploit their geographic, institutional, and economic advantages to specialize in entrepôt trade, and become known as entrepôt ports.

in international trade with countries that have weak contractual or legal institutions.



Notes: This chart illustrates how an onshore firm may report entrepôt trades and use L/Cs to conduct interest arbitrage. The solid red lines represent RMB capital flows. The dashed red lines represent the issuance of an L/C or delivery of documents, as prescribed in the L/C. The horizontal dashed line in the middle demarcates Mainland China (onshore) and the rest of the world, including Hong Kong, Macau, and Taiwan (offshore).

Figure 2: How to Arbitrage under Capital Controls through Entrepôt Trades

Figure 2 illustrates how to arbitrage using fictitious entrepôt trades and L/Cs. An L/C-issuing bank in China typically requires that L/Cs be fully collateralized. To initiate a round of arbitrage, the arbitrageur needs first to deposit some amount of RMB, denoted by K, at an onshore bank. The deposit could be interest-bearing at an onshore rate. The onshore bank then issues an L/C of K to an offshore bank. The L/C would specify the beneficiary—the offshore "seller"—and the documents to be delivered by the seller for K payable at the L/C's maturity. The typical maturity of RMB L/Cs is 360 days, which is twice the maturity of typical dollar L/Cs used in China. Upon notification of the L/C's issuance, the offshore "seller" delivers the required documents for acceptance and discounts the L/C at an offshore bank. Hong Kong banks typically charge the prevailing interest rate in the offshore market plus a fixed rate for discounting L/Cs.

Suppose the offshore interest rate is r_h and the discounting charge is at a rate of d; then the discounted L/C yields $K/(1 + r_h + d)$. A related party—the offshore "buyer"—could then wire the proceeds from the discounted L/Cs back to the arbitrageur onshore. The arbitrageur deposits the returned fund at the onshore rate, completing one round of arbitrage. The annual return of one round of arbitrage, r_a, is therefore:

$$r_a = \frac{Kr_s + \frac{K}{1+r_h+d}(1 + r_s)}{K} - 1 = r_s + \frac{r_s - r_h - d}{1 + r_h + d}. \tag{1}$$

If the onshore-offshore interest differential net of L/C discounting premium is positive—namely, $r_s > r_h + d$—an arbitrageur could earn a return higher than the onshore interest rate. Moreover, the returned inflow $K/(1 + r_h + d)$ at the onshore bank could fund another round of arbitrage.[6]

2.3 Risks and Transaction Costs

Export prices may change between the import agreement with the seller and the export agreement with the buyer, and buyers may not honor their contracts. These risks of price movements and counterparty defaults could be eliminated or substantially reduced if the buyer and seller are subsidiaries or related parties of the arbitrageur. Therefore, it is important that an arbitrageur controls offshore subsidiaries as the buyer and the seller.

Moreover, controlling offshore subsidiaries speeds up the entrepôt trades as interest

[6] In a frictionless world in which each round of arbitrage could be completed instantly and there are no transaction costs, the arbitrageur repeats infinite rounds but obtains a finite sum of capital K' in a year:

$$K' = \sum_{i=0}^{\infty} \frac{r_s K}{(1 + r_h + d)^i} = \frac{r_s(1 + r_h + d)K}{r_h + d}.$$

Thus, the maximum rate of return to arbitrage r_a^{∞} is

$$r_a^{\infty} = r_s + \frac{r_s - r_h - d}{r_h + d}.$$

arbitrages. Even though an L/C matures in 1 year, the L/C beneficiary—i.e., the "seller"—could fulfill the L/C-prescribed documentary delivery any time before the maturity and cash out by discounting the L/C. Because L/C discounting is the borrowing leg of the arbitrage, delays are costly.

Establishing offshore subsidiaries is therefore a fixed cost for engaging in interest arbitrages. Because large manufacturing companies and commodity trading companies often have offshore companies, particularly in Hong Kong, they are likely to have an advantage in engaging in interest arbitrages. In our data, these firms engaged in entrepôt trades with L/Cs earlier than other firms and accounted for a large share of these trade flows.[7]

By discounting the L/C, the offshore bank assumes a counterparty risk from the onshore bank that issues the L/C. The offshore bank charges a discounting premium d to compensate for assuming the counterparty risk, as well as any administrative costs. Typically, Hong Kong banks charge $d = 1/8\%$.[8] In addition to proportional charges, offshore banks charge fixed fees when offshore "sellers" discount the L/Cs for cash. Moreover, onshore banks may charge miscellaneous fees for the issuance of L/Cs.

Between mid-2012 and mid-2015, the onshore-offshore interest differential averaged 1.38% and peaked at 3% around late 2013 and early 2014. If discount premium $d = 1/8\%$ and there are no transaction costs, the return to one round of arbitrage, $r_a = r_s + \frac{r_s - r_h - d}{1 + r_h + d}$, averaged 5.66%, or 1.22% in excess of the average onshore interest rate. During most of this period, the onshore-offshore interest differential was higher than a discount premium of $d = 1/8\%$. Thus, one round of arbitrage would be profitable before any transaction costs.

With fixed costs, the initial arbitrage capital K must be sufficiently large to be profitable. For example, if there is a fixed cost of a quarter-million yuan, a 1.22% excess return would require at least 20 million yuan of arbitrage capital to be profitable. However, as in typical currency carry trades, arbitrageurs may lower the capital outlay by leveraging up. Moreover, as explained in the last section, after one round of arbitrage, the returned inflow $K/(1 + r_h + d)$ could again be deposited at the onshore bank to initiate another round

[7] See Online Appendix C for more details.

[8] See, for example, http://www.dbs.com.hk/corporate/financing/trade-financing/export-services/letter-of-credit-negotiation-discounting.

of arbitrage. In Online Appendix D, we show the extent to which the arbitrage return may be higher if an arbitrageur carries out multiple rounds of arbitrages.

The counterparty risks of the L/C issuing banks were low but fluctuated over our sample period. For example, a 1-year credit default swap (CDS) for the Bank of China was, on average, quoted at about 40 basis points during our sample period but briefly reached 70 basis points in mid-2013. Offshore L/C discounting banks may adjust their discounting premiums for counterparty risks. If so, the interest differential would need to be higher, perhaps by 40 basis points more than otherwise, for the arbitrage to be profitable. Anecdotally, the discounting premium may not be very high, because large state-owned banks issued the majority of L/Cs in China. A substantial share of these L/Cs were discounted by their offshore affiliates in Hong Kong. Unfortunately, we do not observe the actual discounting premium.

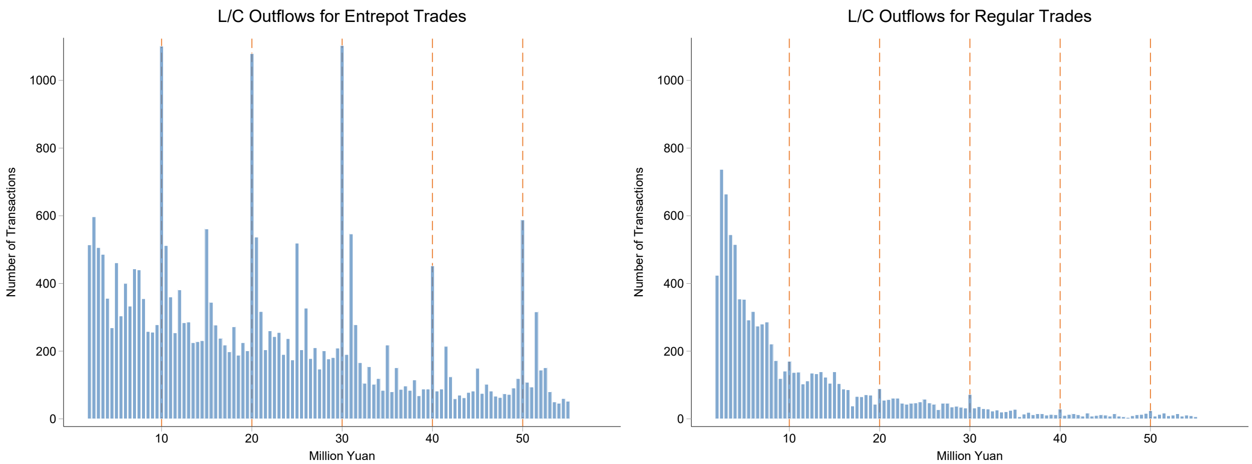
The presence of fixed costs suggests an economy of scale in interest arbitrage using L/Cs and entrepôt trades. Another source for the economy of scale is that a larger deposit enjoys higher interest rates. Although deposit rates in China were capped at a relatively low level during our sample period, banks offer higher interest rates for large deposits to circumvent interest rate regulations (He et al., 2015; Shen and Bian, 2017; Tan et al., 2016) through CDs for institutional investors, wealth management products, etc. Perry and Weltewitz (2015) show that the 3-month Shanghai Interbank Offered Rates closely track the weighted average rate of return from bank wealth management products. However, there might be a small variation in interest rates across banks for deposits of different sizes.[9]

As illustrated in Figure 2, an arbitrageur deposits a lump sum in a bank and uses it to underwrite L/Cs. The larger the deposit, the higher the rate the deposit earns. If an arbitrageur does not have sufficient funds for high-yield deposits, he may need to raise funds for the arbitrage. The higher the interest differential, the easier it is for the arbitrageur to raise sufficient funds to make the arbitrage profitable.

If a substantial share of deposits that underwrite L/Cs are put into money market in-

[9]The Hong Kong Interbank Offered Rate, however, should proxy for the discounting interest rate for L/C well. This is because L/C-issuing onshore banks are the counterparties and have low default risk; L/C discounting rates in Hong Kong typically use the Hong Kong interbank lending rate plus fixed basis points.

struments that have a round-number face value, we would see significant bunching of L/C outflows around round numbers. For example, certificates of deposit for institutional investors in China require a minimum deposit of 10 million yuan and are typically denominated in multiples of 10 million.



Notes: The histograms above plot the truncated distribution of L/C transaction amounts. Histograms on the left and right plot outward L/C settlements for entrepôt trades and regular one-way trades, respectively.

Figure 3: Round-number Bunching of L/C Outflows

Figure 3 shows that this is precisely what we find for entrepôt outflows settled through L/Cs (left subplot). Note that L/Cs are not expected to be issued at round-number values. Moreover, if these L/Cs settle real entrepôt trades, it is unlikely that there is substantial bunching at round numbers. Indeed, if we focus on L/C settlements for regular one-way trades, we find only a very modest amount of bunching around round numbers (right subplot). The round-number bunching of L/C payment amounts also provides corroborating evidence that a substantial portion of the entrepôt trades are fictitious.

The PBC is responsible for regulating across-border settlements and capital controls, but mainly through commercial banks. The PBC could direct commercial banks to follow administrative procedures, but lacks authority to punish any firms or individuals who engage in fictitious entrepôt trades. The PBC may, however, refer arbitrageurs who violate PBC policy to court. Therefore, there is a small legal risk in arbitrage through entrepôt trades.

In a typical carry trade, traders profit from interest rate differences by borrowing a low-interest currency and lending a high-interest currency. Carry trades are risky because of exchange rate fluctuation between the opening and closing of currency positions. To hedge against the exchange rate risk, traders may long a forward contract for the low-interest currency simultaneously as they convert the low-interest currency to the high-interest currency at spot price. The hedging cost is the forward premium of the low-interest currency over its spot price. No arbitrage implies the covered interest parity (CIP)—that is, the currency forward premium equals the interest rate differential.

Onshore and offshore RMB are nominally the same currency. In practice, onshore RMB (CNY) and offshore RMB (CNH) are akin to two currencies, given that each has its own interest rates and exchange rates. The possible divergence of CNY and CNH in their exchange rates presents a risk. The onshore-offshore interest differential may reflect such foreign exchange (FX) risk.

In the onshore-offshore RMB interest arbitrage enabled by entrepôt trades, the L/C transfers onshore funds offshore *at parity* in 1 year when the L/C matures. Through a related party—i.e., the seller in the entrepôt trade—the L/C is discounted at the offshore rate for cash, which then flows back onshore. The RMB returning from offshore to onshore is, again, converted *at parity*. Therefore, entrepôt trades with L/Cs facilitate RMB interest arbitrage by (i) bypassing capital controls and (ii) converting spot and forward onshore/offshore RMB *at parity*.

To complete one round of arbitrage, the offshore RMB may flow back onshore within a few weeks, if not days. However, there may be an FX risk in the onshore-offshore RMB interest arbitrage to the extent that there may be delays for offshore RMB flowing back onshore. The offshore bank that discounts the L/C may have exposure and funding requirements for both onshore and offshore RMB, and they may pass on the FX risk cost on to the arbitrageurs.

To account for the potential FX risk, we define a CNH basis related to CNY similar to the cross-currency basis in Du et al. (2018):

$$x = log(1 + r_s) - [log(1 + r_h) - \rho] \approx r_s - (r_h - \rho),$$

where ρ is the forward premium of CNY against CNH.[10]

If the CIP holds for onshore and offshore RMB, then

$$1 + r_s = (1 + r_h)\frac{S}{F}, \tag{2}$$

where S is the spot exchange rate of CNH/CNY and F the 1-year-forward exchange rate of CNH/CNY. These rates are expressed in units of offshore RMB per unit of onshore RMB.

Under CIP, the forward premium $\rho = log(F) - log(S)$ should offset the interest differentials between CNY and CNH. Accordingly, the CNH basis x, being the log difference between the two sides of the CIP equation, is zero. In other words, CIP implies a net cost of swapping low-interest CNH for high-interest CNY. A positive CNH basis suggests that the onshore RMB rate is higher than the synthetic RMB interest rate by swapping the offshore RMB interest rate into onshore RMB.

For a liquidly traded currency pair, one could hedge the FX risk with a forward currency contract. CNH/CNY forward and spot contracts are not traded. But using traded spot and forward contracts for CNH/USD and CNY/USD, we could impute the implied hedging costs.[11]

The gray line in Figure 1 represents the onshore-offshore interest differential after adjusting for the CNH/CNY forward premium—namely, the CNH basis x. Interestingly, the gray line follows the green line closely, which suggests that the CNH/CNY forward premium/discount is small relative to the CNY-CNH interest differential. With $\rho \approx 0$, the FX-hedged interest differential x is close to the unhedged interest differential:

$$x \approx (1 + r_s) - (1 + r_h)\frac{S}{F} \approx r_s - r_h.$$

[10]For modest interest rates, as in our data, the log-linear approximation above has small approximation errors.

[11]See Online Appendix B for more details. We thank an anonymous referee for suggesting this.

Moreover, despite the higher interest rates of onshore RMB, the forward premium of onshore RMB, ρ, is often positive. In other words, the low-interest offshore RMB often had a negative implied forward premium, which is opposite under CIP. While it is not directly comparable due to distinct regulatory and FX regimes, our finding echoes the large and persistent CIP deviations for G-10 currencies in the post-crisis period (Du et al., 2018).

2.4 Data Description

Our primary data set consists of all RMB inflows and outflows reported from entrepôt trades from 2011 to 2016 in a coastal province of China. This province has one of the largest economies and highest income levels in China. As of 2016, the provincial per capita GDP in either nominal terms or at purchasing power parity is similar to that of Poland and Argentina, and the province's population is larger than both countries. We obtained our data from a provincial division of the PBC.

Our data include payment and receipt dates, transaction value of the trades, identifiers of recipients and payers in China, and settlement means for receipts (inflows) and payments (outflows). Cross-border RMB transactions for entrepôt trades are reported and categorized separately from those for the usual one-way trades, i.e., import or export. The PBC requires that RMB inflows match RMB outflows for entrepôt trades, but expects weaker documentary evidence of actual trades for entrepôt trades than one-way trades. For example, entrepôt trades do not need customs-clearing documents for cross-border RMB settlements.

Most RMB receipts from reported entrepôt trades are settled through wire transfers. In Table 1, we tabulate the shares of wire transfers in RMB inflows from entrepôt trades by year. As shown in the upper panel, 98.5% of inflows from entrepôt trades are settled by wire transfers. The share of wire transfers varies little, ranging from 96.1% in 2011 to 99.1% in 2014 and 2015. However, RMB inflows from entrepôt trades vary widely. The second column of the upper panel of Table 1 shows total entrepôt inflows. Total inflows start from the lowest value in 2011 at 67.2 billion yuan—which is equivalent to 10.4 billion U.S. dollars in the same year—to a peak of 294 billion yuan in 2014 before declining to 84.5

Inflow				
Year	Amount (billion ¥)	Letter of Credit	Wire Transfer	Other
2011	67.2	0.003	0.961	0.035
2012	123.1	0.006	0.978	0.016
2013	227.1	0.004	0.981	0.015
2014	294.1	0.003	0.991	0.006
2015	255.7	0.005	0.991	0.003
2016	84.5	0.014	0.985	0.002
Total	1,051.6	0.005	0.985	0.010
Outflow				
Year	Amount (billion ¥)	Letter of Credit	Wire Transfer	Other
2011	14.0	0.567	0.400	0.032
2012	96.5	0.737	0.249	0.013
2013	127.9	0.801	0.174	0.025
2014	271.3	0.907	0.085	0.009
2015	353.9	0.733	0.255	0.012
2016	208.9	0.647	0.343	0.009
Total	1,072.5	0.766	0.221	0.013

Notes: Exchange rates for Chinese yuan per U.S. dollar ranged from 6.041 to 6.956 and averaged 6.336 between 2011 and 2016.

Table 1: Shares of RMB Flows Settled by Letter of Credit and Wire Transfer

billion yuan in 2016. In the next section, we will show that the entrepôt inflows move with the onshore-offshore interest differentials of RMB.

Wire transfers, however, settle a minority of RMB outflows from reported entrepôt trades. In the lower panel of Table 1, we show the shares of entrepôt outflows paid through wire transfers and other means. From 2011 to 2016, only 22% of entrepôt payments denominated in RMB are paid through wire transfers; the primary settlement method for entrepôt outflows is the L/C. During our sample period, L/C settlements account for 76.6% of entrepôt outflows of RMB. Other means, such as old-fashioned mail transfers, account for only 1.3% of settled outflows. Therefore, the L/Cs' share of RMB payments to foreign sellers negatively correlates with the share of wire transfers, which varies widely from 40% in 2011 to 8.5% in 2014. As we will report in the next section, RMB inflows and 1-

year-forward outflows each year have similar magnitudes, except in 2015 and 2016.

We also downloaded the on-shore and off-share interbank lending interest rates and the exchange rates for the Chinese yuan against the U.S. dollar from Bloomberg. Following Dooley and Isard (1980) and Herrera and Valdés (2001), we focus on interbank rates with 3-month maturity. For onshore interbank lending interest rates, we use the annualized 3-month Shanghai Interbank Offered Rates for RMB, as in Chang et al. (2015), who study optimal Chinese monetary policy with capital controls. For offshore interbank lending interest rates, we use the annualized Hong Kong Interbank Offered Rates for Chinese Yuan (hereafter CNH HIBOR), as well as our calculation of the CNH HIBOR from individual interbank-offered rates before the introduction of CNH HIBOR fixing.

The Hong Kong Treasury Markets Association (TMA), in partnership with Thomson Reuters, launched CNH HIBOR fixing in June 2013. The fixing calculates the CNH HIBOR based on the interbank-offered rates provided by the 16 regional and global banks most active in offshore RMB lending markets. The CNH HIBOR is published at 11:15 AM Hong Kong time on each trading day. Since the introduction of CNH HIBOR fixing, it has become a widely used benchmark for interest pricing in offshore markets for RMB lending and interest-rate derivatives. Before introduction of the fixing, the TMA published the interbank-offered rates of the 13 banks most active in offshore RMB lending markets. We collected these interbank-offered rates of individual banks from the TMA and calculated the pre-fixing counterpart of the CNH HIBOR similarly to the post-fixing formula, i.e., by taking the average of all rates after dropping the highest and lowest three rates. The TMA interbank-offered rates for 13 individual banks are available from August 6, 2012, to the introduction of CNH HIBOR fixing.

In Figure 1, we plot the CNH HIBOR before and after the fixing using a blue line. The pre-fixing calculation of CNH HIBOR connects smoothly with the post-fixing CNH HIBOR at the introduction of the fixing, which suggests that our calculation captures the offshore RMB interbank lending market similarly to the post-fixing measure. Introduction of the CNH HIBOR coincided with a spike in interbank lending rates. However, as can be seen in Figure 1, the spike also coincides with a spike in onshore interbank lending rates, as measured by the Shanghai Interbank Offered Rates (red line), which suggests that the spike is not an artifact of CNH HIBOR fixing or our calculations. As shown in Figure 1, onshore and offshore RMB interest rates have converged since mid-2015. Therefore, we focus on entrepôt trade samples from July 2012 to July 2015 for inflows and July 2013 to July 2016 for outflows.

In addition, we obtain daily values of regular imports, exports, inflows, and outflows under capital accounts for our sample province from the provincial division of the PBC.

3 Interest Differentials and Reported Entrepôt Trades

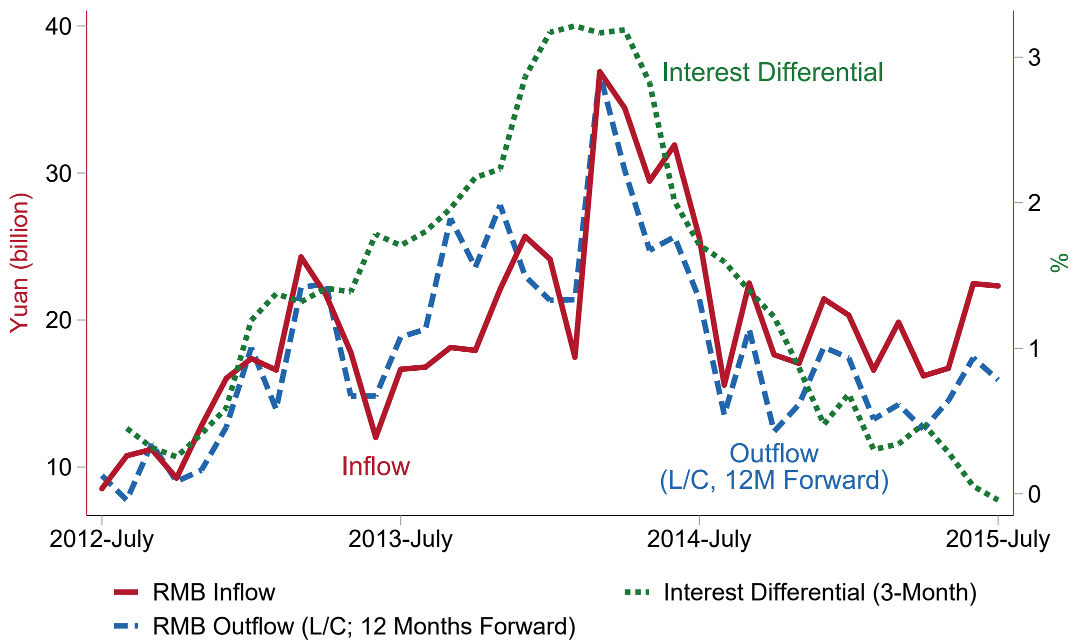
3.1 Aggregate RMB Flows

As suggested in Section 2.4, RMB cross-border flows from entrepôt trades vary greatly between 2011 and 2016. In this section, we show that entrepôt inflows and outflows are strongly associated with onshore-offshore interest differentials.

We argue that the rise of RMB inflows from reported entrepôt trades is driven by interest arbitrage. According to the flow chart in Figure 2, a round of arbitrage ends with discounted cash flowing back onshore. To initiate another round of arbitrage, the arbitrageur deposits the returned cash into a bank, earning an onshore interest rate, and uses the deposit as collateral for a new L/C issued to an offshore entity and its associated settlement bank. As an RMB L/C typically has 1 year to mature, inflows from entrepôt-enabling arbitrage should highly correlate with outflows from entrepôt trades 12 months forward.

We restrict our sample to the period before mid-2015. The onshore-offshore interest gap had mostly converged by mid-2015. Moreover, there was a policy shift in the Chinese FX regime in August 2015, which caused a sudden and sizable depreciation of the Chinese yuan against the U.S. dollar. The policy shift also led to a sharp divergence of onshore and offshore exchange rates of the RMB against the U.S. dollar. As discussed in Online Appendix A, the exchange rate of offshore RMB followed closely that of onshore RMB before the August 2015 policy shift, but deviated substantially in the months following the shift. Possible FX arbitrage and capital flight after August 11, 2015 may confound RMB flows from interest arbitrage.

Moreover, we focus on 12-month-forward L/C settlements for outflows. As discussed above, L/Cs settlements are unrelated to exchange rate arbitrages but crucial for interest arbitrages, which during our sample period require lending onshore and borrowing offshore. An L/C, which is underwritten by an onshore deposit and could be discounted offshore for cash at the offshore rate, does just that.



Notes: The figure above plots the onshore-offshore RMB interest differential (dashed green line), RMB inflows from entrepôt trades, and 12-month-forward RMB outflows to settle L/Cs. Inflows and outflows are monthly aggregates in billion yuan (left scale). Interest differentials are in percentages (right scale).

Figure 4: Onshore-offshore Interest Differentials, RMB Inflows, and 12-Month-Forward L/C Outflows

In Figure 4, we plot the monthly entrepôt-related RMB inflows and 12-month-forward outflows settled by L/Cs, along with average onshore-offshore interest differentials. Starting from mid-2012, differences between the Shanghai Interbank Offered Rate and the Hong Kong Interbank Offered Rate for RMB widen and peak around late 2013 and early 2014. Gradually, interest-rate differentials drop, reaching close to zero in July 2015. RMB inflows from entrepôt trades follow a similar pattern. At the peak of the onshore-offshore interest differential in early 2014, about 40 billion yuan each month flow into the province in our data under entrepôt trades, which is three times larger than the monthly inflow in mid-2012 when the interest differential is close to zero. The dashed blue line in Figure 4 represents 12-month-forward L/C outflows, which clearly comove with the inflows represented by the solid red line.

To estimate the magnitude of the interest differentials' effects on entrepôt flows, we next regress the log inflows and log 52-week-forward L/C outflows on the interest differentials using daily flows. In the left panel of Table 2, we report estimates for entrepôt inflows. In the right panel of Table 2, we report estimates for 52-week-forward L/C outflows.[12] In all regressions in this paper, we use the heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1986). To be conservative, we allow the maximum lag allowed for autocorrelation to be 365 days. Leaving the maximum lag to be 31 days, as in the default setting, or doubling the length of the maximum lag gives quantitatively similar results that remain highly statistically significant.

The univariate estimate in Column (1) of Table 2 suggests that a 1-percentage-point increase in the onshore-offshore differential of interbank-offered rates between Shanghai and Hong Kong induces an increase of 19 log points, or 21% in RMB inflows, from reported entrepôt trades. The estimate is statistically significant at the 1% level. As there could be day-of-the-week effects, we add a set of indicator variables to indicate the day of the week and report the estimates in Column (2). The point estimate is unchanged in both magnitude and statistical significance. In Column (3), we additionally control for the onshore-offshore differentials of the Chinese yuan exchange rate against the U.S. dollar. The estimated effect of interest-rate differentials increases slightly, to 23% (21 log points), and remains statistically significant at the 1% level. We do not find that onshore-offshore exchange rate differentials significantly affect entrepôt inflows in the sample period, which is from August 6, 2012, to July 31, 2015. To further control for potentially confounding

[12]If the day 52 weeks forward of the interest rate differential is a non-trading day, we use the L/C outflow of the next trading day.

	Inflow				Outflow (L/C, 1-Year Forward)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interest Rate Differential	0.190***	0.190***	0.207***	0.213***	0.294***	0.292***	0.279***	0.286***
	(0.070)	(0.069)	(0.068)	(0.057)	(0.058)	(0.061)	(0.062)	(0.056)
Exchange Rate Differential			-4.127	-2.933			3.417	4.362*
			(2.519)	(2.396)			(2.516)	(2.360)
Export				0.246***				0.127
				(0.046)				(0.158)
Import				-0.191*				-0.159*
				(0.105)				(0.092)
Capital Account Inflows				0.036*				-0.016
				(0.019)				(0.022)
Capital Account Outflows				0.050***				0.040**
				(0.012)				(0.019)
Day of Week Fixed Effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
R^2	0.172	0.228	0.236	0.286	0.133	0.281	0.282	0.289
Observations (days)	698	698	698	697	698	698	698	697

Notes: Newey-West heteroskedasticity-autocorrelation robust standard errors with a lag of 365 days are in parentheses. Constants are included in all specifications, but not shown. Export, Import, Capital Account Inflows, and Capital Account Outflows are daily values in logarithms for our sample province.

$* \, p < 0.10$; $** \, p < 0.05$; $*** \, p < 0.01$.

Table 2: Onshore-offshore Interest Differentials and RMB Inflows and Outflows

macroeconomic variables, we include the logarithm values of daily import and export settlements for regular one-way trades, as well as capital inflows and outflows under the capital account.[13] As reported in Column (4), our main estimate after controlling for these macroeconomic variables is quantitatively similar and remains significant at the 1% level.

Onshore-offshore interest differentials are estimated to have a larger effect on 52-week-forward L/C outflows for entrepôt trades, ranging from 32.2% to 34.2% (27.9 to 29.4 log points). In Columns (5), (6), (7), and (8), we report the estimated effects with the same controls as those included in Columns (1) to (4), respectively. Standard errors for key coefficient estimates in forward L/C outflow regressions are typically smaller than those in inflow regressions. Therefore, the estimated effects of interest differentials are all significant at the 1% level across specifications. The estimates' larger magnitude and greater precision likely reflect the fact that forward L/C outflows more closely capture the activities of interest arbitrage.

RMB inflows from interest arbitrage may not react to interest differentials on the same day. Similarly, there might be a few days' gap between when an arbitrageur deposits cash as collateral for an L/C and issuance of the L/C. Therefore, potential delays and uncertainty in the timing of arbitrage activities may introduce biases by mismatching interest differentials and inflows and forward outflows. To address these concerns, we estimate the effects of 1-day-lagged and the 1-week moving average of interest-rate differentials on inflows and forward outflows. Estimates for inflows and outflows change little and remain significant at the 1% level. These robustness tests suggest that the uncertain timing and potential delays associated with interest arbitrage are unlikely to qualitatively bias our estimates, possibly due to series correlation in the interest differentials.

Moreover, we obtain quantitatively similar and statistically significant estimates as those reported in Table 2 if we replace the interest differential either (i) with CNH basis as detailed in Section 2.3 and Online Appendix A; or (ii) with the interest differential minus the Bank of China 1-year CDS spread.

[13]These capital inflows and outflows are mainly driven by foreign direct investments and overseas direct investments.

3.2 Interbank Certificates of Deposit Regulation

Although a number of macroeconomic variables have been controlled for in Table 2, one may still be concerned that the correlation between RMB inflows and outflows from unobserved factors from entrepôt and onshore-offshore interest differentials remains spurious due to omitted variables. In this section, we exploit a policy shock to identify the potential causal impacts of onshore-offshore interest differentials on RMB cross-border flows from entrepôt trades.

Over the last decade, China slowly liberalized its tightly controlled credit market. On December 7, 2013, the PBC announced its interim provisions on for interbank certificates of deposit management. The reform allowed deposit-taking institutions to issue negotiable interbank certificates of deposit (CDs), which amounted to the first money market instruments whose interest rates were freely determined by the credit market. The provisions also standardized the maturities of these interbank CDs. In the medium and long run, the reform allowed the interbank lending market to be more responsive to market conditions and better management of liquidity risk.

In the short run, however, the reform raised interest rates in the interbank lending market for two reasons. First, before the reform, banks relied on short-term borrowing in interbank markets to meet their liquidity needs. Smaller banks also relied on the interbank market to borrow short and lend long, which created maturity mismatches and liquidity risk. Standardizing CD maturities and the introduction of negotiable interbank CDs means that smaller banks must now borrow money of longer maturity to finance their operations. After these changes, they would also need to offer higher interest rates in the retail market to attract deposits.

Second, the reform also designated the largest state-own banks as market makers in CD markets. Through their vast network of branches and brand names, large state-owned banks attract retail deposits at lower rates and typically lend in the interbank market. When the interbank CD market matured, smaller banks would, and did eventually, become the predominant issuers. As the interbank CD market started, however, the issuance of CDs by the largest state-owned banks withdrew liquidity and raised the cost of borrowing for smaller banks.[14]

In Figure 5, the horizontal axis represents the number of weeks related to the announcement of the interbank CD reform; the vertical axis on the left indicates onshore-offshore RMB interest rate differentials, and the vertical axis on the right indicates the RMB inflows from entrepôt. As shown by the blue circles, the interbank CD reform induced a sharp increase in the Shanghai Interbank Offered Rate, which benchmarked for the interbank CDs per the interim provisions. As shown by the red diamonds, RMB inflows from entrepôt trades also increased following the increase in interest differentials, though with increased volatility and some delays. The increased volatility and delays may partially be due to the timing. For example, outliers 4 to 8 weeks after the reform coincide with the Gregorian New Year and Chinese New Year holidays.

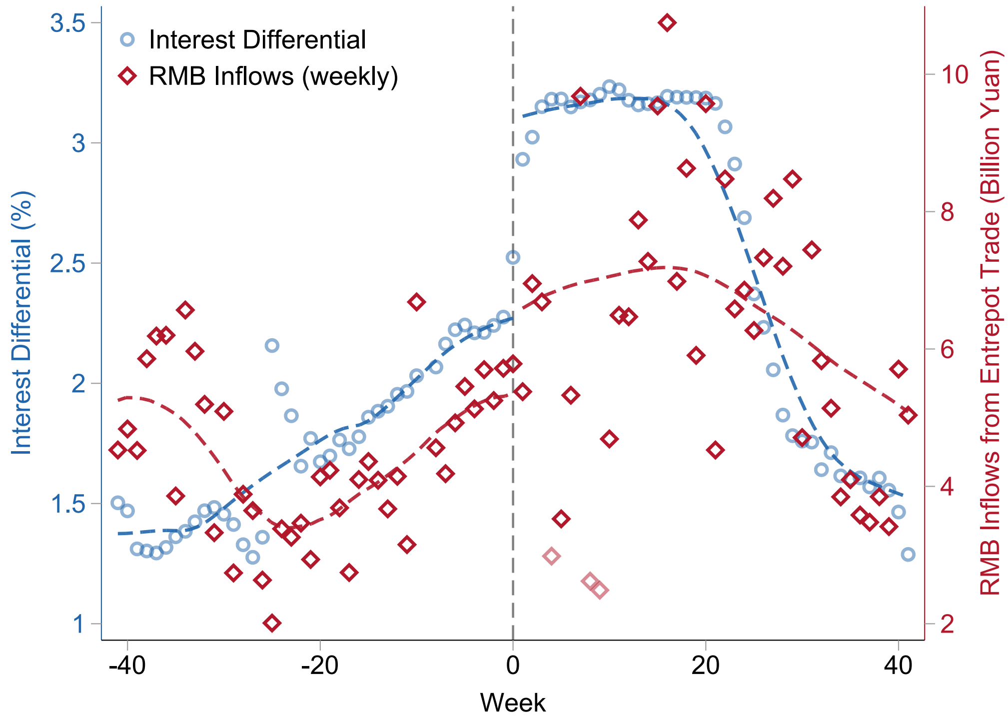
Figure 5 naturally suggests a fuzzy regression discontinuity (RD) design, in which time is the running variable. The policy shock provides an instrumental variable for the potentially endogenous interest differentials. To implement the fuzzy RD design, we control for a quadratic polynomial of the running variable and use the 81-week event window, as in Figure 5. We find that a 1-percentage-point increase in the onshore-offshore interest differential induces a rise of 27% (24 log points) in RMB inflows for reported entrepôt trades. The 2SLS estimate is statistically significant at the 10% level. Controlling for the New Year holidays with an indicator variable leads to a larger estimate of 49% (40 log points), which is significant at the 1% level.[15]

3.3 Distribution of RMB Flows and Entry to Arbitrage

The persistent onshore-offshore interest differentials during our sample period suggest that the interest arbitrage identified in this paper is insufficient to close the interest differ-

[14]For example, on December 12, 2013, China's 4 largest state-owned banks, along with China Development Banks, issued 19 billion in interbank CDs.

[15]We use HAC standard errors with a lag of 4 weeks. We have a strong first stage, and a weak instrument is easily rejected. One may be concerned that the imprecise timing of the policy shock's effects on interest rates and RMB inflows may bias our estimates. We could assess the robustness by dropping one or two weeks of observations right after the policy announcement. If we use such a "donut-hole RD" (Barreca et al., 2011), we obtain similar estimates.



Notes: The figure above plots onshore-offshore interest rate differentials and RMB inflows from entrepôt trades around the introduction of interbank certificates of deposit. The blue circles represent weekly average of interest rate differentials. The red diamonds represent the weekly RMB inflows from entrepôt trades. The horizontal axis represents the number of weeks since or before the introduction of the interbank certificate of deposit. The blue and red dashed lines are local linear fits of the blue circles and red diamonds, respectively, on either side of week 0, when the interbank CDs was introduced.

Figure 5: Introduction of Interbank Certificates of Deposit

entials quickly. The onshore-offshore interest gap may primarily be influenced by onshore and offshore RMB lending markets, general international trade, and foreign direct investments. RMB flows from entrepôt trades by Chinese firms are likely to be small relative to other factors that determine onshore and offshore interest rates and, hence, their gaps.

Several factors limit interest arbitrage through entrepôt trades. First, there might be delays at each step of the arbitrage identified in Figure 2. These delays lower the return on arbitrage compared with that in a frictionless world. Second, it may be costly to obtain entrepôt-related documents to circumvent capital controls. Third, it may be costly to obtain start-up capital to initiate the first round of arbitrage. These frictions in RMB interest arbitrage not only limit the extent to which arbitrage activities reduce arbitrage opportunities, but also have implications for the distribution of transaction values in entrepôt-enabled arbitrage.

In the presence of fixed costs, the low end of the distribution of arbitrage flows would be more affected by arbitrage returns. On the one hand, a lower interest difference means that a larger denominated L/C is required to cover the fixed costs and break even. Thus the repeated arbitrage rounds, in which arbitrage flow declines in each round, may stop earlier. Therefore, for existing arbitrage capital, there may be a negative correlation between the break-even threshold and the interest difference. On the other hand, a high arbitrage return likely draws capital into arbitrage.[16]

To assess how the arbitrage return affects the distribution of arbitrage flows, we estimate the following quantile regression:

$$Q_\tau(Y_{it}) = \delta_\tau D_t + X_t'\beta_\tau, \tag{3}$$

where $\tau \in (0,1)$ indicates a specific quantile; $Q_\tau(Y_{it})$ measures the τ quantile of RMB flows of transaction i in period t; D_t is the difference between interbank rates in Shanghai and Hong Kong measured in percentages; and X_t is a vector of control variables, including the onshore-offshore RMB exchange-rate differential and day-of-the-week indicator variables, as in Table 2.

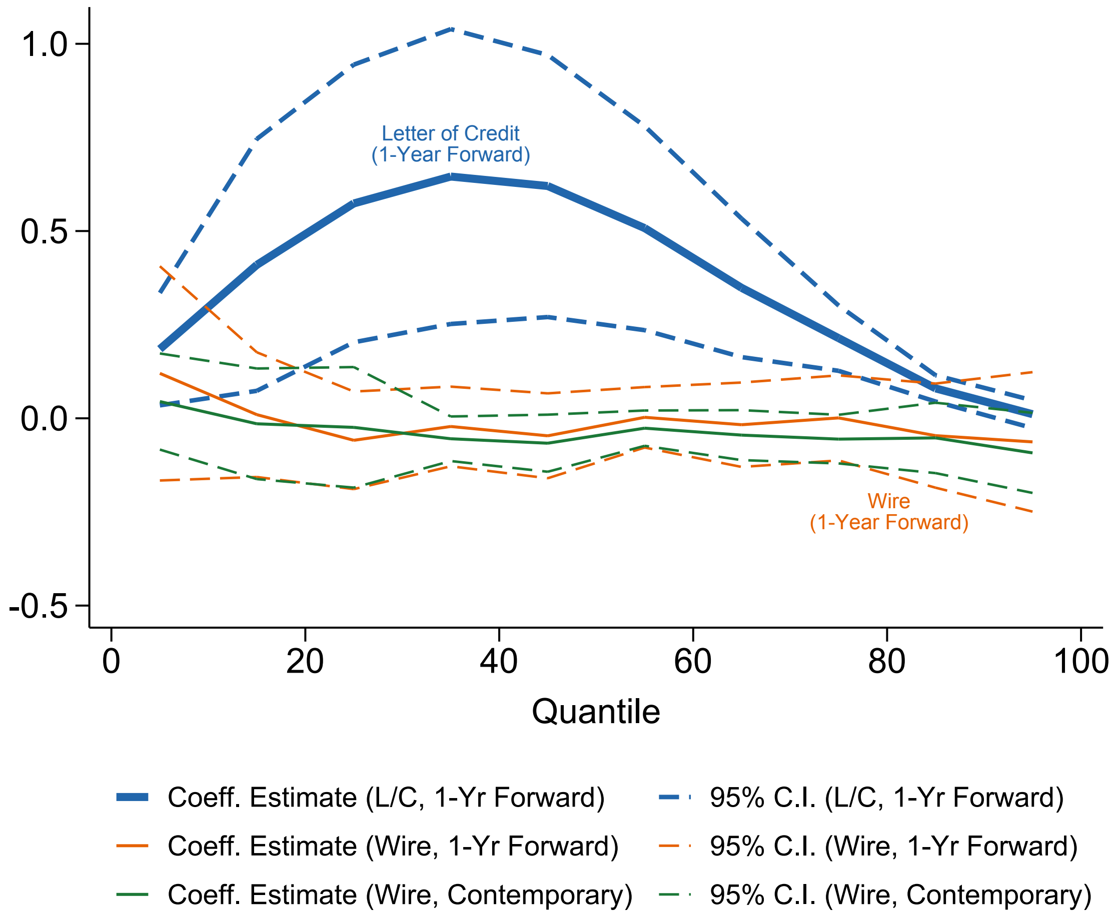
In a setting in which group-level random or fixed effects are present, the traditional Koenker and Bassett (1978) estimator would be biased (Hausman et al., 2016). In a panel or group setting in which the key explanatory variable of interest varies at a group level, Chetverikov et al. (2016) propose a 2-step quantile estimator that is consistent in the presence of such group effects. Therefore, we estimate the impacts of the interest differential on the distribution of log value of entrepôt trade transactions using Chetverikov et al. (2016). In particular, we calculate the τ quantile of RMB flows of transaction i on day t, i.e., $Q_\tau(Y_{it})$, in the first step. In the second step, we regress quantile values $Q_\tau(Y_{it})$ on the interest differentials and control variables, as for those in Table 2. The consistency of this estimator

[16]See Online Appendix D & E for more detailed discussion.

requires that the number of transactions in a day be sufficiently large. But the asymptotics allows the number of observations/transactions per day to grow at a slower rate than the rate at which the number of days in the sample period grows. This estimator also allows us to account for serial correlation in the errors term using Newey and West (1986) HAC standard errors. Chetverikov et al. (2016) show that standard heteroskedasticity robust errors are valid for their 2-step estimator.

We measure arbitrage transaction values using the log value of 1-year-forward outflows for reported entrepôt trades settled with bank-issued L/Cs. Issuing, claiming, and discounting L/Cs is likely to accrue some fixed costs. For example, a typical L/C discounting service at a Hong Kong bank charges a fixed service rate on top of the discount rate linked to the prevailing market interest rate. A minimum fee is charged, however, if the transaction value is insufficiently large. Moreover, inflows are typically transferred via wire transfer, which is relatively less costly to carry out. Firms often split and combine chunks of RMB when they wire their proceeds back onshore. As shown in Online Appendix Figure A.2, distributions of transaction values differ for inflows and L/C outflows, particularly at the low end of their distributions. Due to space constraints, we do not plot the distribution of outflows that include both L/C outflows and wire-outward transfers, which is quite similar to the distribution of L/C outflows.

Figure 6 reports the point estimates and confidence intervals of δ at various quantiles. As shown by the blue lines, the quantile effects of the interest differential exhibit a hump shape as one moves across quantiles. Interest differentials have the highest impact around the 35$^{\text{th}}$ percentile of the outflow distribution. A 1-percentage-point increase in interest differentials increases the 35$^{\text{th}}$ percentile of forward L/C outflows as much as 75 log points (212%), which is equivalent to doubling the 35$^{\text{th}}$ percentile. Throughout the quantiles from 0.05 to 0.95, quantile effects, as measured by δ_τ, are significant at the 5% level. While quantile effects are more precisely estimated in the upper quantiles, they appear to be larger in the bottom half of the distribution. But at the lowest estimated quantile, i.e., $\tau = 0.05$, the effects of the interest differentials are modest, which is likely driven by the entry of arbitrageurs with small start-up capital and, hence, transaction values. Therefore,



Notes: The figure plots the estimates of δ_τ in Equation (3), which are the quantile effects of onshore-offshore interest differentials on the distribution of RMB outflows at various quantiles indicated by τ. The thick blue line, the thin orange line, and the thin green line represent, respectively, the quantile effects on 1-year-forward outflow settling L/Cs, on 1-year-forward RMB outflows through wire transfers, and on contemporary outward wire transfers. The dashed lines in corresponding colors indicate 95% confidence intervals using Newey-West HAC standard errors with a lag of 365 days.

Figure 6: Onshore-offshore Interest Differentials on the Distribution of RMB Outflows

the quantile effects' pattern is consistent with the considerable fixed costs associated with carrying out interest arbitrage.

As a placebo test, we also estimate two specifications in which the outcome variables are the log value of outflows for entrepôt trades paid by means other than L/C, which is mostly wire transfers. If the main driver of these entrepôt trade flows is arbitrage activities, the interbank interest differences between Shanghai and Hong Kong should not affect contemporary or 1-year-forward outflows through wire transfers. We report the point estimates and confidence intervals of δ in these two placebo specifications at various quantiles in Figure 6, along with our main quantile effects estimates. As expected, interest differentials do not have statistically significant effects on different quantiles of 1-year-forward or contemporary outflows via wire transfers; in addition, the point estimates are usually small compared with those from the main quantile specification.

To examine which margins drive increases in entrepôt trades when interest differentials are high, we carry out some decomposition analyses. In particular, we first decompose the increase in daily entrepôt trade flows into the number of transactions and the average value of a transaction. We then further decompose the extensive margin of transactions into the number of trading firms and the number of transactions per firm—i.e., the extensive and intensive margins regarding trading firms.

As detailed in Online Appendix E, our findings suggest that the entry of new firms may account for a substantial part of the increase in entrepôt trades when interest differentials are high. Therefore, we further examine arbitrageurs' entry. We identify new firms as those that appear in our sample for the first time since the beginning of the sample on January 1, 2011. For more details, see Online Appendix E.

Overall, the results in Appendix Table A.2 suggest that a higher interest differential induces the entry of more new firms in absolute and relative terms and increases the transaction volume attributed to entering firms. For example, assuming quadratic trends, a 1-percentage-point increase in interest differentials increases the number of new firms by 0.8 and the share of new firms by 0.01. For comparison, the average number of entering firms is two per day, and the average share of new firms is 5%.

In sum, the findings in this section suggest that there are considerable fixed costs involved in using entrepôt trades to conduct interest arbitrage across onshore and offshore RMB markets.

4 Concluding Remarks

Historically, dollar-denominated instruments for trade finance contributed to the rise of the U.S. dollar in international trade (Eichengreen and Flandreau, 2012). China's central bank appears to follow this historical lesson by promoting RMB-denominated L/Cs for trade finance. However, we find that RMB-denominated L/Cs facilitated interest arbitrage across onshore and offshore credit markets of RMB. As a result, China's capital controls became less effective and statistics on the rise of RMB-denominated trades were inflated.

Since L/C-assisted interest arbitrage relies on entrepôt trades to circumvent capital controls, trade intermediaries were well positioned to exploit these arbitrage opportunities. Future studies may shed light on whether such arbitrage opportunities promote or crowd out the adoption of RMB as the invoicing currency in international trades.

References

Andriamananjara, Soamiely, Hugh Arce, and Michael J. Ferrantino (2004) "Transshipment in the United States," *U.S. International Trade Commission Office of Economics Working Paper*.

Auguste, Sebastian, Kathryn M.E. Dominguez, Herman Kamil, and Linda L. Tesar (2006) "Cross-Border Trading as a Mechanism for Implicit Capital Flight: ADRs and the Argentine Crisis," *Journal of Monetary Economics*, Vol. 53, pp. 1259–1295.

Barreca, Alan I, Melanie Guldi, Jason M Lindo, and Glen R Waddell (2011) "Saving Babies? Revisiting the Effect of Very Low Birth Weight Classification," *Quarterly Journal of Economics*, Vol. 126, pp. 2117–2123.

Chang, Chun, Zheng Liu, and Mark M. Spiegel (2015) "Capital Controls and Optimal Chinese Monetary Policy," *Journal of Monetary Economics*, Vol. 74, pp. 1–15.

Chetverikov, Denis, Bradley Larsen, and Christopher Palmer (2016) "IV Quantile Regression for Group-Level Treatments, with an Application to the Distributional Effects of Trade," *Econometrica*, Vol. 84, pp. 809–833.

Cheung, Yin-Wong and Dagfinn Rime (2014) "The Offshore Renminbi Exchange Rate: Microstructure and Links to the Onshore Market," *Journal of International Money and Finance*, Vol. 49, pp. 170–189.

Davies, Ronald B., Julien Martin, Mathieu Parenti, and Farid Toubal (2018) "Knocking on Tax Haven's Door: Multinational Firms and Transfer Pricing," *Review of Economics and Statistics*, Vol. 100, pp. 120–134.

De Gregorio, José, Sebastian Edwards, and Rodrigo O. Valdes (2000) "Controls on Capital Inflows: Do They Work?" *Journal of Development Economics*, Vol. 63, pp. 59–83.

Dooley, Michael P. and Peter Isard (1980) "Capital Controls, Political Risk, and Deviations from Interest-Rate Parity," *Journal of Political Economy*, Vol. 88, pp. 370–384.

Du, Wenxin, Alexander Tepper, and Adrien Verdelhan (2018) "Deviations from covered interest rate parity," *Journal of Finance*, Vol. 73, pp. 915–957.

Eichengreen, Barry and Marc Flandreau (2012) "The Federal Reserve, the Bank of England, and the Rise of the Dollar as an International Currency, 1914–1939," *Open Economies Review*, Vol. 23, pp. 57–87.

Feenstra, Robert C and Gordon H Hanson (2004) "Intermediaries in Entrepôt Trade: Hong Kong Re-Exports of Chinese Goods," *Journal of Economics & Management Strategy*, Vol. 13, pp. 3–35.

Fisman, Raymond, Peter Moustakerski, and Shang-Jin Wei (2008) “Outsourcing Tariff Evasion: a New Explanation for Entrepôt Trade,” *Review of Economics and Statistics*, Vol. 90, p. 587–592.

Fisman, Raymond and Shang-Jin Wei (2004) “Tax Rates and Tax Evasion: Evidence from “Missing Imports” in China,” *Journal of Political Economy*, Vol. 112, pp. 471–496.

Funke, Michael, Chang Shu, Xiaoqiang Cheng, and Sercan Eraslan (2015) “Assessing the CNH-CNY Pricing Differential: Role of Fundamentals, Contagion and Policy,” *Journal of International Money and Finance*, Vol. 59, pp. 245–262.

Hausman, Jerry, Ye Luo, and Palmer Christopher (2016) “Errors in the Dependent Variable of Quantile Regression Models,” *Working Paper*.

He, Dong, Honglin Wang, Xiangrong Yu et al. (2015) “Interest Rate Determination in China: Past, Present, and Future,” *International Journal of Central Banking*, Vol. 11, pp. 255–277.

Herrera, Luis Oscar and Rodrigo O. Valdés (2001) “The Effect of Capital Controls on Interest Rate Differentials,” *Journal of International Economics*, Vol. 53, pp. 385–398.

IMF (2015) “Review of the Method of the Valuation of the SDR—Initial Considerations,” *International Monetary Fund*, Vol. November.

Jinjarak, Yothin, Ilan Noy, and Huanhuan Zheng (2013) “Capital Controls in Brazil–Stemming a Tide with a Signal?” *Journal of Banking & Finance*, Vol. 37, pp. 2938–2952.

Koenker, Roger and Gilbert Bassett (1978) “Regression Quantiles,” *Econometrica*, pp. 33–50.

McLaughlin, Chester B (1949) “The Letter of Credit Provisions of the Proposed Uniform Commercial Code,” *Harvard Law Review*, Vol. 63, p. 1373.

Mitchener, Kris James and Kirsten Wandschneider (2015) “Capital Controls and Recovery from the Financial Crisis of the 1930s,” *Journal of International Economics*, Vol. 95, pp. 188–201.

Newey, Whitney K. and Kenneth D. West (1986) “A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix,” *Econometrica*, Vol. 55, pp. 703–08.

Perry, Emily and Florian Weltewitz (2015) “Wealth Management Products in China,” *Reserve Bank of Australia Bulletin*, Vol. 2015 June Quarter.

Prasad, Eswar S. and Raghuram G. Rajan (2008) “A Pragmatic Approach to Capital Account Liberalization,” *Journal of Economic Perspectives*, Vol. 22, pp. 149–172.

Schmidt-Eisenlohr, Tim (2013) "Towards a Theory of Trade Finance," *Journal of International Economics*, Vol. 91, pp. 96–112.

Shen, Yan and Wenlong Bian (2017) "Interest Liberalization and the Estimation of Implicit Interest Rates in China's Banking Sector," *Asian Economic Papers*, Vol. 16, pp. 287–307.

SWIFT (2016) "RMB Tracker," *SWIFT RMB Tracker*, URL: `https://www.swift.com/sites/default/files/resources/swift_bi_rmbtracker_slides_january16.pdf`.

Tan, Yuyan, Yang Ji, and Yiping Huang (2016) "Completing China's Interest Rate Liberalization," *China & World Economy*, Vol. 24, pp. 1–22.

Willsher, Richard (1995) "Letter of Credit," in *Export Finance*: Springer, pp. 176–177.

Online Appendix

A RMB Exchange Rates

As Figure A.1 shows, the RMB's offshore exchange rates follow their onshore rates much more closely from 2012 to mid-2015. The difference between credit markets and exchange markets in their scope of onshore-offshore deviation is that the large volume of international trade allows firms to exploit any onshore-offshore exchange-rate differentials more easily. If the RMB is cheaper against the U.S. dollar offshore, Chinese exporters may choose to convert their receipts into dollars offshore, then wire RMBs back; similarly, if the RMB is more expensive against the U.S. dollar offshore, Chinese importers may choose to wire their payments in RMBs and ask foreign sellers to convert RMBs to dollars offshore (Funke et al., 2015). The close link between offshore and onshore RMB exchange markets is supported by Cheung and Rime's (2014) finding that order flows in the offshore RMB exchange market have significant impacts on the onshore RMB exchange market, and that the offshore exchange market's link to its onshore counterpart is increasing over time.

Notes: Onshore and offshore exchange rates of the Chinese yuan. The dashed line indicates the August 11, 2015 reform by the PBC, which accompanied a 2% depreciation of the RMB on a single day.

Figure A.1: Onshore-offshore Exchange Rates of Chinese Yuan

On August 11, 2015, the PBC announced a reform in the setting of trading bands around which the RMB is allowed to float, and shocked the market by depreciating the RMB against the U.S. dollar by 2% on itsthe same day.[17] In December 2015, the PBC again announced a reform to benchmark the RMB to a set of currencies instead of only the U.S. dollar. For a while, the FX markets seemed to be perplexed by the PBC's moves. In the months after the August 11 announcement, exchange markets became more volatile. Moreover, as shown in Figure A.1, offshore RMB exchange rates deviated from onshore rates much more than they had in the previous period. Because of this turbulence in onshore and offshore RMB exchange markets and the fact that RMB interest-rate differentials have been close to zero since August 2015, we focus on the period before August 2015.

B CNH Basis

In practice, onshore RMB (CNY) and offshore RMB (CNH) are akin to two currencies, given that each has its own interest rate and exchange rate. The possible divergence of CNY and CNH in their exchange rates presents a risk, and the onshore-offshore interest differential may reflect such an foreign exchange (FX) risk. To account for the potential FX risk, we define a CNH basis for RMB similar to the cross-currency basis for dollar in Du et al. (2018):

$$x = log(1 + r_s) - [log(1 + r_h) - \rho],$$

where r_s is the onshore interest rate of RMB, r_h is the offshore rate, and ρ is the forward premium of CNY against CNH. For modest interest rates, as in our data, the log-linear approximation, $x \approx r_s - (r_h - \rho)$, has small approximation errors.

The CNH basis captures the onshore-offshore interest differential of RMB after adjusting the cost of hedging the FX risk. If the CIP holds, forward premium ρ should offset the interest differentials between CNY and CNH so that the CNH basis x is zero. In other words, the CIP implies a net cost of swapping low-interest CNH into high-interest CNY. A

[17] This reform is, in theory, more market oriented. Before the reform, the RMB was allowed to float around a 2% band around a midpoint set by the PBC. The reform sets the midpoint of the floating band to the closing rate of the RMB on the previous day.

positive CNH basis suggests that the onshore RMB rate is higher than the synthetic RMB interest rate by swapping the offshore RMB into onshore RMB.

Similar to the cross-currency basis in Du et al. (2018), which focuses on the U.S. dollar vis-à-vis G-10 currencies, the CNH basis measures the deviation from the CIP condition:

$$1 + r_s = (1 + r_h)\frac{S}{F},$$

where S is the spot exchange rate of CNH/CNY and F the 1-year-forward exchange rate of CNH/CNY. These rates are expressed in units of offshore RMB per unit of onshore RMB. In logs, we have:

$$log(1 + r_s) = log(1 + r_h) + [log(S) - log(F)] = log(1 + r_h) - [log(F) - log(S)].$$

Let $\rho = log(F) - log(S)$, the CNH basis x would be the CIP deviation $log(1 + r_s) - [log(1 + r_h) - \rho]$.

For a liquidly traded currency pair, one could hedge the FX risk with a forward currency contract. CNH/CNY forward and spot contracts are not traded. But by using traded spot and forward contracts for CNH/USD and CNY/USD, we could impute the implied hedging costs. Let $S^{CNH/USD}$ be the spot rate of CNH per unit of USD and $F^{CNH/USD}$ be the forward rate. Similarly, define $S^{CNY/USD}$ and $F^{CNY/USD}$ for CNY instead of CNH. Again, these rates are expressed in units of offshore RMB per unit of U.S. dollar. Then:

$$\begin{aligned} log(F) &= log(\frac{F^{CNH/USD}}{F^{CNY/USD}}) \\ log(S) &= log(\frac{S^{CNH/USD}}{S^{CNY/USD}}). \end{aligned}$$

Note that the 1-year-forward L/C in an entrepôt trade enables interest arbitrage by bypassing capital controls and functioning as a 1-year-forward CNH/CNY contract at parity. In a frictionless world, the supposed "buyer" in an entrepôt trade discounts the L/C momentarily after its issuance and wires the capital back onshore immediately. Then, the entrepôt trade also provides a spot CNH/CNY contract at parity. In practice, since there may be delays, the entrepôt trade provides a futures option contract for CNH/CNY at parity. Thus, an entrepôt trade with an L/C not only circumvents capital controls, uses bank-intermediation for international trade to finance, but also limits the CNH/CNY FX exposure. However, as noted before, the implicit spot and forward CNH/CNY contracts come with regulatory and legal risks.

C Which Firms Arbitrage Through Entrepôt Trades

The fixed costs in each round of arbitrage prevent arbitrageurs with insufficient capital from engaging in arbitrage through entrepôt trades. The most important barriers, however, are likely the fixed costs related to establishing related trading entities offshore to facilitate interest arbitrages using entrepôt trades. As discussed in Section 2.2, interest arbitrage is risky if the "seller" and "buyer" of an entrepôt trade are not controlled by the arbitrageur. We find that, conditioning on the dates of the transaction, firms that enter into entrepôt trades for the first time in our dataset were twice as likely to trade with entities that had not been paid by any firms before. These new recipients and payees are likely to be newly established related entities offshore.

In our dataset, trading companies account for 73% of L/C payments and 58% of L/C outflows in value. Large manufacturing firms and trading companies are likely to have subsidiaries offshore, particularly in Hong Kong, to facilitate international trade. Existing subsidies in Hong Kong are likely to provide advantages for firms that engage in interest arbitrage through entrepôt trades. Entities registered in Hong Kong received 58% of RMB payments for regular imports and 57% for entrepôt trades. Firms that conduct regular trades in RMB are likely to have established related parties in Hong Kong, which reduces the fixed costs of interest arbitrage through entrepôt trades. Indeed, firms that have ever conducted a regular trade in our sample, on average, entered into an entrepôt trade about 5 months earlier than those that had never conducted a regular trade in RMB.

Moreover, 15% of trading companies specialize in commodities such as steel, copper, and fuel. These companies account for 10% of L/C outflow transactions, but 16% of outflows in value. Large working capital, as reflected by these companies' trading volume, along with their offshore subsidiaries likely provides them with advantages in interest arbitrage with fixed costs. Indeed, the first entrepôt trade by these firms were, on average, 4 months earlier than other firms. Admittedly, these commodity trading firms may be conducting real entrepôt trades. However, we do not find that the RMB inflow-outflow patterns for these firms are significantly different from other firms. In particular, we look at how inflows correlate with L/C outflows 1 year forward, similar to what is plotted in Figure 1 but at the firm level instead of the aggregate level. Unlikes fictitious entrepôt trade arbitrage, real entrepôt trades need not use L/Cs with maturity as long as one year. Moreover, imports need not be resold in bulk at the same time. However, the share of quarterly 1-year-forward L/C outflows that were within 10% of inflows among these commodity trading companies is similar to that among other firms.

D Distribution of RMB Flows

The persistent onshore-offshore interest differentials during our sample period suggest that the interest arbitrage identified in this paper is insufficient to close the interest rate gap quickly. Except for entrepôt ports such as Hong Kong and Singapore, entrepôt trades typically account for a small fraction of total trades. Mainland China, for instance, does not have a significant entrepôt port. Moreover, despite recent efforts and progress in RMB internationalization, the RMB is still far from being a major transaction currency in international trade. The onshore-offshore interest gap may primarily be influenced by onshore and offshore RMB lending markets, general international trade, and foreign direct investments. RMB flows from entrepôt trades by Chinese firms are likely to be small relative to other factors that determine onshore and offshore interest rates and, hence, their gaps.

Moreover, several factors limit interest arbitrage through entrepôt trades. First, there might be delays at each step of the arbitrage identified in Figure 2. These delays lower the return on arbitrage compared with that in a frictionless world. Second, it may be costly to obtain entrepôt-related documents to circumvent capital controls. Third, it may be costly to obtain start-up capital to initiate the first round of arbitrage. These frictions in RMB interest arbitrage not only limit the extent to which arbitrage activities reduce arbitrage opportunities, but also have implications for the distribution of transaction values in entrepôt-enabled arbitrage.

After start-up capital is obtained, the interest arbitrage illustrated in Figure 2 could, in theory, be repeated infinite times. In practice, however, arbitrage capital depreciates after each round of arbitrage. To see this, let the onshore deposit rate be r_s; the offshore risk-free lending rate is equal to the offshore borrowing rate at r_h; the bank charges a premium at rate d for discounting an L/C for cash; and the arbitrageur's start-up capital is K. If onshore banks do not charge fees for the issuance of L/Cs, the return inflow would be $K/(1+r_h+d)$ after the first round of arbitrage. The start-up capital is deposited onshore, earning an annual rate r_s. Therefore, in a frictionless world in which each round of arbitrage could be completed instantly, the arbitrageur repeats infinite rounds but obtains a finite sum of capital K' in a year:

$$K' = \sum_{i=0}^{\infty} \frac{r_s K}{(1 + r_h + d)^i} = \frac{r_s(1 + r_h + d)K}{r_h + d}. \tag{4}$$

Thus, the maximum rate of return to arbitrage r_a^∞ is

$$r_a^\infty = r_s + \frac{r_s - r_h - d}{r_h + d}. \tag{5}$$

As long as a positive onshore-offshore interest differential net of L/C discounting premium exists—namely, $r_s > r_h + d$—the arbitrageur could earn a return higher than the onshore interest rate. If the arbitrageur could borrow the initial arbitrage capital K at the onshore rate r_s, the arbitrageur could earn a risk-free profit of $K(r_s - r_h - d)/(r_h + d)$.

If there is a fixed cost F for engaging in arbitrage, a firm endowed with start-up capital K engages in arbitrage if and only if $(r_a^\infty - r_s)K > F$. A high arbitrage rate of return allows a smaller amount of arbitrage capital to be profitable. If the arrival of start-up arbitrage capital is independent of the arbitrage return and fixed costs, then a higher arbitrage return decreases the lowest quantiles of start-up capital. Since the initial capital determines the size of subsequent entrepôt-enabled flows, a higher arbitrage return would, in turn, lower the lowest quantiles of entrepôt inflows and 1-year-forward outflows.

Moreover, so far we have abstracted from bank fees for the issuance of an L/C, which are typically fixed regardless of the face value of the L/C. Suppose the bank fees associated with the L/C issuance, as well other fixed costs for each round of arbitrage, sum to L. Then, instead of infinite rounds of arbitrage the initial capital K could have carried out, the arbitrage would stop once the return inflow $\tilde{K}$ is no longer large enough. The arbitrage stops when the 1-year return from depositing the return inflow onshore is no larger than the return from another round of arbitrage:

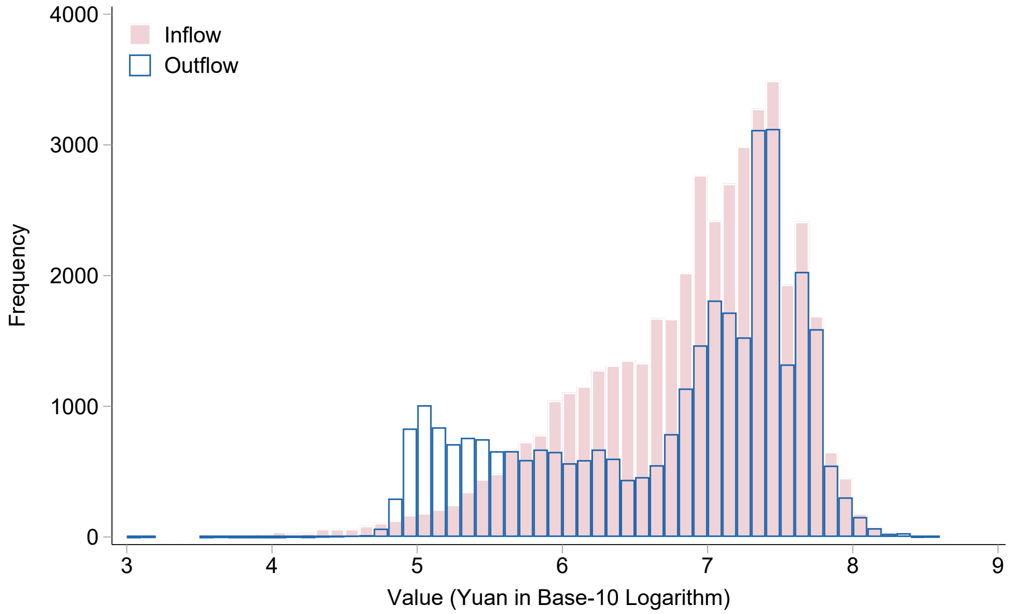
$$\tilde{K}(1+r_s) \geq r_s\tilde{K} + (1+r_s)\left(\frac{\tilde{K}}{1+r_h+d} - L\right),$$

i.e.,

$$\tilde{K} \leq L\left(\frac{r_s}{1+r_s} - \frac{r_h+d}{1+r_h+d}\right)^{-1} := K_{min}. \tag{6}$$

Again, the minimum arbitrage flow K_{min} would be negatively related to the onshore-offshore interest differential.

To get a sense of how transaction costs affect the arbitrage return, we simulate the net return after accounting for these fixed costs. In particular, we apply the stopping rule in Eq. (6) and adjust for the fixed cost F to start arbitrage. Assume that the start-up arbitrage capital K is 20 million yuan; the onshore interest rate r_s is 4%; the offshore interest rate r_h is 3%; the discounting premium d is 0.125%; the each-round fixed cost L is 20,000 yuan; and the start-up fixed cost F is $250,000$ yuan. Then the arbitrage return would be 15.6% per year. If the arbitrage capital is only 10 million yuan, however, the arbitrage return would only be 5.3% per year. If the discount premium d is 0.5% instead, then even 20 million of arbitrage capital would only return 4.8% per year when there is a 1-percentage-point interest differential. With interest differential $r_s - r_h = 1\%$ and $d = 0.5\%$, an arbitrageur would need 50 million yuan of arbitrage capital K to get a 10.6% annual return. However, suppose $r_s = 4.5\%$, $r_h = 3\%$, $d = 1/8\%$ so that the interest differential is 1.5 percentage point, then 10 million of arbitrage capital would be enough to generate a return of 18.8%.



Notes: Distributions of log transaction values of RMB inflows and outflows from January 2012 to July 2015. Solid pink bars represent inflows, and hollow blue bars represent outflows. Logarithms are base-10 for ease of interpretation.

Figure A.2: Distribution of Transactional Values of RMB Inflows and Outflows

E Entry to Arbitrage

To examine which margins drive increases in entrepôt trades when interest differentials are high, we carry out some decomposition analyses. In particular, we first decompose the increase in daily entrepôt trade flows into the number of transactions and the average value of a transaction. Let y_t be the daily inflows or outflows of RMB from entrepôt trades on day t; n_t the number of transactions; and $\bar{y}_t$ the average transaction value. Then,

$$\ln(y_t) = \ln(n_t) + \ln(\bar{y}_t).$$

To separately estimate the impacts on the extensive margins and intensive margins of entrepôt flows, we estimate

$$\ln(n_t) = \gamma_E D_t + X_t'\beta_E + \epsilon_t^E \tag{7}$$

$$\ln(\bar{y}_t) = \gamma_I D_t + X_t'\beta_I + \epsilon_t^I, \tag{8}$$

where, as before, D_t is the interest differential, X_t is a vector of control variables, ϵ_t^E and ϵ_t^I are error terms, and the rest are coefficients to be estimated.

Due to the specifications' log-linearity, our baseline specification for daily entrepôt flows is simply the sum of the above two regression equations:

$$\ln(y_t) = (\gamma_E + \gamma_I)D_t + X_t'(\beta_E + \beta_I) + (\epsilon_t^E + \epsilon_t^I). \tag{9}$$

We could further decompose the extensive margin of transactions into the number of trading firms and the number of transactions per firm, i.e., the extensive margins and intensive margins regarding trading firms. In particular, we separately estimate

$$\ln(n_t^F) = \gamma_F D_t + X_t'\beta_F + \epsilon_t^F \tag{10}$$

$$\ln(n_t^P) = \gamma_P D_t + X_t'\beta_P + \epsilon_t^P, \tag{11}$$

where n_t^F is the number of trading firms on day t and n_t^P is the average number of transactions per firm.

We report the estimates of γ for various margins in Table A.1. In the upper panel of Table A.1, the dependent variables concern entrepôt inflows; in the lower panel of Table A.1, the dependent variables concern 1-year-forward L/C outflows for entrepôt trades. For comparison, we report again in Column (A) the baseline estimations of Equation (9), where the dependent variables are daily total inflows or forward outflows. In Column (I), we report the estimates of γ_I in Equation (8), which concerns the intensive margins of average value per inflow/outflow. In Column (E), we report the estimates of γ_E in Equation (7), which concerns the extensive margin measured by the daily number of

Outcome Variable (log):	Total Value (A)	Mean Value (I)	Transactions (E)	Transactions per Firm (E_p)	Transacting Firms (E_f)
			Inflow		
Interest Rate Differential	0.207***	0.016	0.191***	-0.005	0.196***
	(0.068)	(0.057)	(0.022)	(0.010)	(0.021)
R^2	0.236	0.010	0.316	0.043	0.351
Observations (days)	698	698	698	698	698
Outcome Variable (no log):					
Mean	0.990	0.018	53.82	1.39	38.8
Standard Deviation	0.428	0.005	19.04	0.20	13.3
			Outflow (L/C, 1-Year Forward)		
Interest Rate Differential	0.279***	0.130***	0.149**	-0.094*	0.242***
	(0.062)	(0.020)	(0.064)	(0.052)	(0.019)
R^2	0.282	0.133	0.285	0.179	0.377
Observations (days)	698	698	698	698	698
Outcome Variable (no log):					
Mean	0.774	0.019	40.71	1.50	26.6
Standard Deviation	0.610	0.007	29.13	0.39	15.7

Notes: Newey-West heteroskedasticity-autocorrelation robust standard errors with a lag of 365 days are in parentheses. Constants, day-of-the-week indicator variables, and onshore-offshore exchange-rate differentials are included in all specifications, but not shown. The outcome variables conern inflows in the top panel and one-year-forward L/C outflows in the bottom panel. In Column (A), the dependent variable is the logarithm of daily total value of inflows (top panel) or outflows (bottom panel) in billion yuan. In Column (I), the dependent variable is the log average value of inflow/outflow transactions in one day. In Column (E), the dependent variable is the log number of inflow/outflow transactions in one day. In Column (E_n), the dependent variable is the log number of transactions per firm. In Column (E_f), the dependent variable is the log number of transacting firms. The last two rows of each panel provide summary statistics for outcome variables before taking logarithms.

$* p < 0.10$; $** p < 0.05$; $*** p < 0.01$.

Table A.1: Decomposing the Effects of Onshore-offshore Interest Differentials on RMB flows

flows/transactions. In Column (E_p), we report the estimates of γ_P in Equation (11), which concerns the margin of the number of transactions per trading firm. In Column (E_f), we report the estimates of γ_F in Equation (10), which concerns the extensive margin of the number of trading firms. For interpretation of the estimates, we also report the means and standard deviations of the outcome variables before taking the natural logarithm at the bottom of each panel.

The effects of higher interest differentials on total inflows are mainly driven by more inflows rather than by larger average value per inflow. A 1-percentage-point increase in the interest differential increases the number of inflows by about 21% (19 log points), which is significant at the 1% level. A 1-percentage-point increase in the interest differential only increases the average value of an inflow by about 1.6%, which is statistically insignificant at any conventional level. Moreover, the higher number of transactions due to a higher interest differential is entirely driven by a larger number of trading firms. The effects of interest differentials on the number of transactions per firm are insignificant, both economically and statistically.

RMB inflows for entrepôt trades were typically sent through wire transfers, which had low transaction costs. Entrepôt traders often split and combine funds from different transactions. On the other hand, outflows from entrepôt trades, and interest arbitrage in particular, were typically paid via L/Cs, whose issuance and discounting are costly. Banks charge fees for issuing and discounting L/Cs, and shipment documents are required to discount an L/C for cash. Accordingly, forward L/C outflows should more precisely capture the scale and transaction frequency for interest arbitrage than inflows. Therefore, our preferred measure for the decomposition is forward L/C outflows.

For forward L/C outflows, interest differentials affect both the average transaction value and the number of transactions per day. Moreover, both margins contribute to a roughly equal degree to the effects on daily transactions. A 1-percentage-point increase in interest differentials increases the number of transactions by 16% (15 log points) and increases the average transaction value by 14% (13 log points). Both estimates are statistically significant at the 1% level. Similar to the case for inflows, the effects of interest differentials on the number of forward L/C transactions is predominantly driven by the number of trading firms. A 1-percentage-point increase in interest differentials increases the number of transacting firms by 27% (24 log points), which is significant at the 1% level. The impact of interest differentials on the number of forward L/C outflows per firm is negative but imprecisely estimated.

The results discussed above suggest that the entry of new firms may account for a substantial part of the increase in entrepôt trades when interest differentials are high. We further examine arbitrageurs' entry. We identify new firms as those that appear in our sample for the first time since the beginning of the sample on January 1, 2011. For firms starting to arbitrage, the first recorded transaction would be the return inflow from their first round of arbitrage. Moreover, since we have more accurate data on firms' first inflow in our sample than on the date of their first L/C issuance—which must be deduced from the forward L/C outflows—we focus on inflow transactions to identify entering firms. Because the firms we identify as new entries may have had transactions prior to our sample period, new firms may be overestimated. However, left-censoring likely affects only a tiny fraction of firms. Entrepôt trading volume and the number of trading firms are both small at the beginning of our sample period, and therefore onshore-offshore interest differentials are likely also small before 2011. Moreover, the PBC only approved the province in our data set for settling trades in RMB in June 2010. To mitigate the potential left-censoring problem in identifying new entries, we include linear, quadratic, and cubic time trends in our specifications when estimating the effects of interest differentials on the entry of entrepôt trading firms.

We focus on three measures of firm entry. In the top panel of Table A.2, we report coefficient estimates of interest differentials on the number of new firms. In the middle panel, we report coefficient estimates of interest differentials on the share of new firms of all trading firms. In the bottom panel, we report coefficient estimates of interest differentials on new firms' share of total inflow value. Columns from left to right indicate specifications for none, linear, quadratic, and cubic time trends, respectively. We normalize the time variable to begin with zero and end with one over our sample period.

Time Trend:	None	Linear	Quadratic	Cubic
Dependent Variable:	Number of New Firms			
Interest Rate Differential	0.603***	0.596***	0.820***	0.811***
	(0.122)	(0.112)	(0.261)	(0.237)
Dependent Variable:	Share of New Firms			
Interest Rate Differential	0.004	0.004**	0.010**	0.009***
	(0.003)	(0.002)	(0.004)	(0.003)
Dependent Variable:	New Firms' Share of Transaction Volume			
Interest Rate Differential	0.002	0.002	0.016***	0.016***
	(0.004)	(0.003)	(0.006)	(0.003)
Observations (days)	698	698	698	698

Notes: Outcome variables are the number of new entrepôt trading firms in one day in the top panel; the share of new entrepôt trading firms of all trading firms in the middle panel; and new trading firms' share of transaction volume of all trading firms in the bottom panel. New entrepôt trading firms are identified as never before having had an entrepôt-related inflow from the beginning of our sample. In Column None, no time trend is included. Columns Linear, Quadratic, and Cubic, respectively, include linear, quadratic, and cubic time trends. Newey-West heteroskedasticity-autocorrelation robust standard errors with a lag of 365 days are in parentheses. Constants, day-of-the-week indicator variables, and onshore-offshore exchange-rate differentials are included in all specifications, but not shown.
$* p < 0.10$; $** p < 0.05$; $* * * p < 0.01$.

Table A.2: Onshore-offshore Interest Differentials and Entry of Entrepôt Traders

Overall, the results in Table A.2 suggest that a higher interest differential induces the entry of more new firms in absolute and relative terms and increases the transaction volume attributed to entering firms. Controlling for polynomial time trends tends to increase the magnitudes and statistical significance of the estimates. For example, assuming linear trends, a 1-percentage-point increase in interest differentials increases the number of new firms by 0.6 and the share of new firms by 0.004. For comparison, the average number of entering firms is two per day, and the average share of new firms is 5%. With quadratic trends, however, a 1-percentage-point increase in interest differentials increases the number of new firms by 0.8 and the share of new firms by 0.01. Estimates from cubic-trend specifications are similar to those from quadratic-trend specifications. Estimated coefficients of interest differentials' effects on the number of new firms and the share of new firms are all significant at the 5% level with linear, quadratic, and cubic trend specifications. A 1-percentage-point increase in interest differentials increases new firms' share of transaction volume by 1.6 percentage points, which is statistically significant at the 1% level, in the quadratic and cubic specifications. For comparison, the average share of inflows to entering firms is 5%. Estimates from linear or no time-trend specifications, however, are not statistically significant.