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

Jiafei Hu† Haishan Yuan‡

University of Queensland

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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 one-year-forward outflows to settle bank-issued letters of credit. Interest differentials have greater impacts on the lower half of the outflow distribution, and induce entry into entrepôt trades. 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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†University of Queensland; e-mail: jiafei.hu@uq.net.au; address: Level 6, Colin Clark Building (39), School of Economics, University of Queensland, St Lucia QLD, Australia 4072.

‡Corresponding author; University of Queensland; e-mail: h.yuan@uq.edu.au; address: Level 6, Colin Clark Building (39), School of Economics, University of Queensland, St Lucia QLD, Australia 4072; phone: +61 7 3365 4027

# 1 Introduction

Following the Asian Financial Crisis in the late 1990s, scholars and policymakers revisited the wisdom of the speedy and unconditional liberalization of capital accounts, particularly for international capital flows to portfolio investments. Since then, the merit of capital controls has been intensively debated.[1] Over time, the question has shifted from whether to liberalize capital accounts to when and how a country should open its capital accounts. For outward-oriented developing economies, the large and frequent capital flows from trades in export-oriented economies may render effective capital controls difficult and costly. Therefore, deciding when and how to open capital accounts is particularly important (Prasad and Rajan, 2008).

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. "Entrepôt trades" 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*, or Chinese currency (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 interests 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 one-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. As long as the onshore rate is sufficiently higher than the offshore interest rate, the interest arbitrage

[1] See, e.g., Kaplan and Rodrik, 2002; Glick et al., 2006; and Forbes et al., 2015

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 are strongly correlated with RMB inflows from entrepôt trades. Moreover, RMB inflows from entrepôt trades closely predict one-year-forward RMB outflows to settle L/Cs.

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. Examining the distribution of outflowing L/C settlements, we find that onshore-offshore interest differentials increase the bottom half of the transaction values for one-year-forward L/C settlements more than the upper half of the distribution. We do not find that the interest differentials have a significant influence on the distributions of contemporary or one-year-forward outflowing wire transfers. These results are consistent with the presence of fixed costs associated with using L/Cs and entrepôt trades to arbitrage under capital capitals.

Furthermore, we find that a higher-interest differential induces both a larger number of L/C outflows and a greater average for an outflow. 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 three-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.[2] Rather than focusing on the effectiveness of imposing capital controls as emergency measures, our paper instead 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 engaging in international trades may circumvent capital controls and more broadly, regulation

[2]See e.g., De Gregorio et al. (2000); Jinjarak et al. (2013); and Mitchener and Wandschneider (2015).

and taxation.[3]

Furthermore, we contribute to the literature on capital account liberation and, in particular, the internationalization of the RMB. RMB's rise in the global monetary system in the first half of the 2010s has been widely noted.[4] How China manages to open up its capital accounts gradually will not only offer lessons to other developing countries but also have significant implications for the global monetary system. We show that opening up the use of the RMB in trade settlements will have a modest impact on China's de facto capital account openness. Since late 2015, however, the use of RMB in cross-border payments had declined by 30% to 40% from its peak in mid-2015 (SWIFT, 2016), which follows the disappearance of RMB's onshore-offshore interest gap. We find that cross-border interest arbitrages partially inflated the rise of RMB in trade settlement statistics.

Lastly, 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 arbitrages.

The rest of the paper is organized as follows. In the next section, we discuss the background 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 and Data

## 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 2014, ranks China's capital accounts among the least open. But tight de facto capital controls may be increasingly difficult and

[3] See e.g., Auguste et al. (2006); Fisman and Wei (2004); Fisman et al. (2008); and Davies et al. (2018).
[4] See, e.g., Fratzscher and Mehl (2014); IMF (2015); and Prasad (2016).

costly due to the large volume of trades China engages in nowadays (Prasad and Rajan, 2008). Possibly due to these considerations, policymakers have stated that a gradual and prudent liberalization of capital accounts is a long-term goal. To achieve this 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, which is the central bank of China and hereafter PBC, announced in July 2009 that commercial banks in Shanghai and four other cities may provide services for settling cross-border trades in RMB.[5] 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. In June 2010, the pilot program was extended to 20 provinces, including the province in our data set, and with all trading partners. In August 2011, China opened cross-border RMB settlements to all other provinces. A crucial aspect 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 transactions—were settled in RMB (IMF, 2015). Since China opened up cross-border settlements 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, due to 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. 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

[5]In addition to Shanghai, the other four pilot cities are all in Guangdong province: Guangzhou, Shenzhen, Zhuhai, and Donguan.

cross-border payments (SWIFT, 2016). See Cheung and Rime (2014) for more details on Hong Kong's role in RMB internationalization.

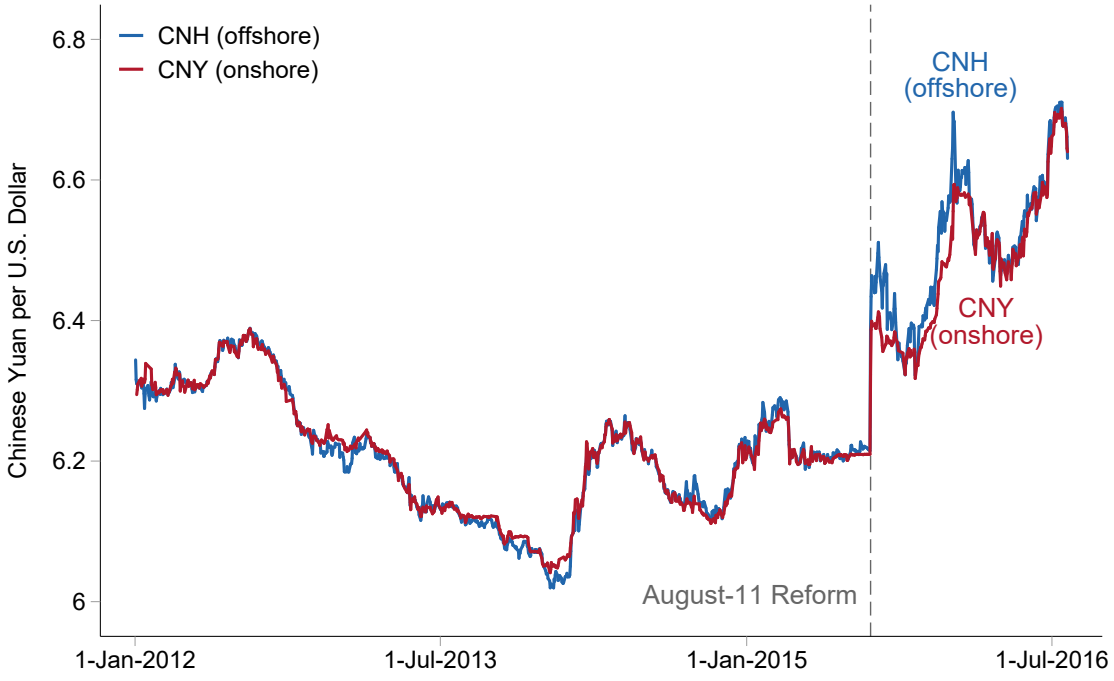

Notes: The figure above plots the daily interbank offered rates of Chinese yuan in Shanghai and Hong Kong, as well as their differences. The term for both interbank offered rates is three-month.

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. As will be detailed in Section 2.3, we use three-month interbank offered rates in Shanghai and Hong Kong to measure onshore and offshore interest rates, respectively. We plot the two interbank rates in Figure 1, as well as their differences. Between mid-2012 and mid-2015, onshore interest rates are higher than the offshore rates for the 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 the bank intermediation facilitate such interest arbitrage.

However, as Figure 2 shows, the RMB's offshore exchange rates follow their onshore

rates much more closely during this period. The difference between credit markets and exchange markets in their scope of onshore-offshore deviation is that the large volume of international trades allows firms to explore 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: The figure above plots the onshore and offshore exchanges rate of the Chinese yuan. The dashed line indicates the August 11 reform by the PBC, which accompanied a 2% depreciation of the RMB on a single day.

Figure 2: 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 the same day.[6] In December 2015, the PBC again announced a reform to benchmark the RMB to a set of currencies instead of merely the U.S. dollar. For a while, the exchange markets seemed to be perplexed by PBC's moves. In the months after the August 11 announcement, exchange markets became more volatile. Moreover, as shown in Figure 2, 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.

## 2.2 Interest Arbitrage through Entrepôt Trades

Onshore-offshore interest differentials present opportunities for arbitrage. In this section, we demonstrate how bank-intermediated entrepôt trades enable such arbitrage.

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 (Feenstra and Hanson, 2004; Andriamananjara et al., 2004; and Fisman et al., 2008). Some duty-free ports, such as Hong Kong, Singapore, and 17$^{th}$ century Amsterdam, exploit their geographic, institutional, and economic advantages to specialize in entrepôt trades, and become known as entrepôt ports. Hong Kong, for example, intermediates a large portion of China's exports (Feenstra and Hanson, 2004).

Mainland China does not have an entrepôt port, and 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 in the

[6]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.

presence of prescribed documents. 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).

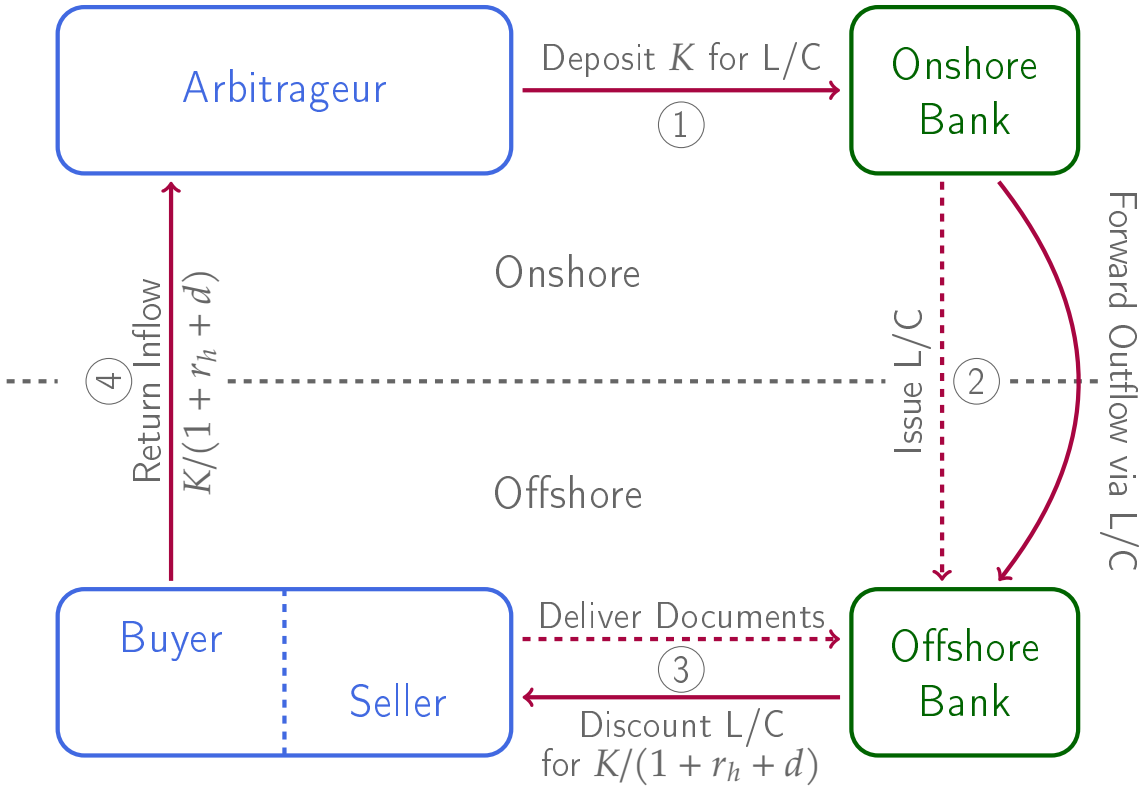
While cash in advance (import finance) and open accounts (export finance) are more popular for trades between developed countries, the bank-intermediated L/C is most popular in developing countries such as China and India. About one-third of firms state that the L/C was a top payment method for transactions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

In Figure 3, we illustrate how to arbitrage using fictitious entrepôt trades and L/Cs. An L/C-issuing bank in China typically requires that L/Cs to be fully collateralized. To initiate a round of arbitrage, the arbitrageur needs first to deposit an amount of RMB, denoted by $K$, in 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, namely 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, 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.[7]

Suppose the offshore interest rate is $r_h$, and the discounting charge is at a rate of $d$, then the discounted L/C yields $K/(1 + r_h + d)$.[8] A related party, namely the offshore "buyer," could then wire the proceeds from the discounted L/Cs back to the arbitrageur onshore, thus completing a round of arbitrage. The returned inflow $K/(1 + r_h + d)$ could again be deposited to the onshore bank to continue for another round of arbitrage. Suppose the onshore interest rate is $r_s$ and we abstract from the miscellaneous bank fees for the issuance

[7] A minimum fee would be charged if the proportional fees fell below a fixed amount. Some banks also charge a fixed fee on top of the variable fee.

[8] Typically, Hong Kong banks charge $d = 1/8\%$. See, for example, `http://www.dbs.com.hk/corporate/financing/trade-financing/export-services/letter-of-credit-negotiation-discounting`.




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

Figure 3: How to Arbitrage under Capital Controls through Entrepôt Trades

of the L/C, which are typically small and fixed; arbitrage would be profitable as long as $r_s > r_h + d$.

The offshore bank would not be paid until the maturity of the L/C, which means that the outflow of $K$ would not be recorded until one year after the issuance of the L/C. In our dataset, which we will describe in greater detail in the next section, we observe the payment date and whether a cross-border RMB flow settles an L/C, a wire transfer, or other transactions. However, we do not observe the issuing date of an L/C.

Notice that for the interest arbitrages described above, there is no exchange rate risk since payments to sellers and from buyers are both denominated and settled in RMB. Unlike foreign exchange arbitrages that involve different currencies, the onshore-offshore

RMB interest arbitrages do not require exchange rate derivatives to hedge against the exchange rate risks.

If the buyer and seller are not subsidiaries of or wholly controlled by the arbitrageur, however, the RMB interest arbitrages involve risks from the fluctuation in the import and export prices, as well as counterparty risks in the interest arbitrages. Entrepôt traders need to find a seller and a buyer. Export prices may change between the import agreement with the seller and the export agreement with the buyer. Moreover, there are counterparty risks if the seller or the buyer does not honor their contract.

The risks associated with counterparties, however, could be eliminated or substantially reduced if the buyer and seller are subsidiaries or related parties of the arbitrageur. Moreover, even though an L/C matures in one year, the L/C beneficiary, i.e., the "seller", could fulfill the L/C-prescribed documentary delivery any time before the maturity or by the prescribed date on the L/C. Upon the delivery of L/C-proscribed documents, the beneficiary may choose to wait for the payment at the L/C maturity or discount the L/C at the beneficiary's local bank. In practice, an offshore seller could provide the L/C-prescribed documents immediately to the offshore bank upon the issuance of L/C by the buyer's onshore-bank, and discount the L/C for cash at the same time. By controlling the buyers and sellers, an arbitrageur not only reduces counterparty risks but also speeds up each round of arbitrage, which increases profit.

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. PBC, however, may refer arbitrageurs who violent PBC policy to court. Therefore, there are small but non-negligible legal risk in arbitrages through entrepôt trades.

## 2.3 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 values of the trades, identifiers of recipients and payers in China, and the settlement means for the 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 custom-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. dollar in the same year—to a peak of 294 billion yuan in 2014 before declining to 84.5 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 outflow is the L/C. During our sample period, L/C settlements account for 76.6% of entrepôt outflows of RMB. Other means, such as the old-fashioned mail transfers, account for only 1.3% of settled outflows. Therefore, the L/C's share of RMB payments to

| Inflow | | | | |
|---|---|---|---|---|
| Year | Amount (billion ¥) | Letter of Credit | Wire Transfer | Others |
| 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 | 1051.6 | 0.005 | 0.985 | 0.010 |

| Outflow | | | | |
|---|---|---|---|---|
| Year | Amount (billion ¥) | Letter of Credit | Wire Transfer | Others |
| 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 | 1072.5 | 0.766 | 0.221 | 0.013 |

Notes: The 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

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 one-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 exchanges 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 three-month maturity. For onshore interbank lending interest rates, we use the annualized three-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), partnered with Thomson Reuters, launched the 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 the 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 three and lowest three rates. The TMA interbank-offered rates by 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, suggesting that our calculation captures the offshore RMB interbank lending market similar to the post-fixing measure. The introduction of CNH HIBOR coincided with a spike in the interbank lending rates. However, as can be seen from 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 also obtain daily values of regular import, export, inflows, and outflows under capital account for our sample province from the provincial division of the PBC.

# 3 Interest Differentials and Reported Entrepôt Trades

As suggested in Section 2.3, 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.

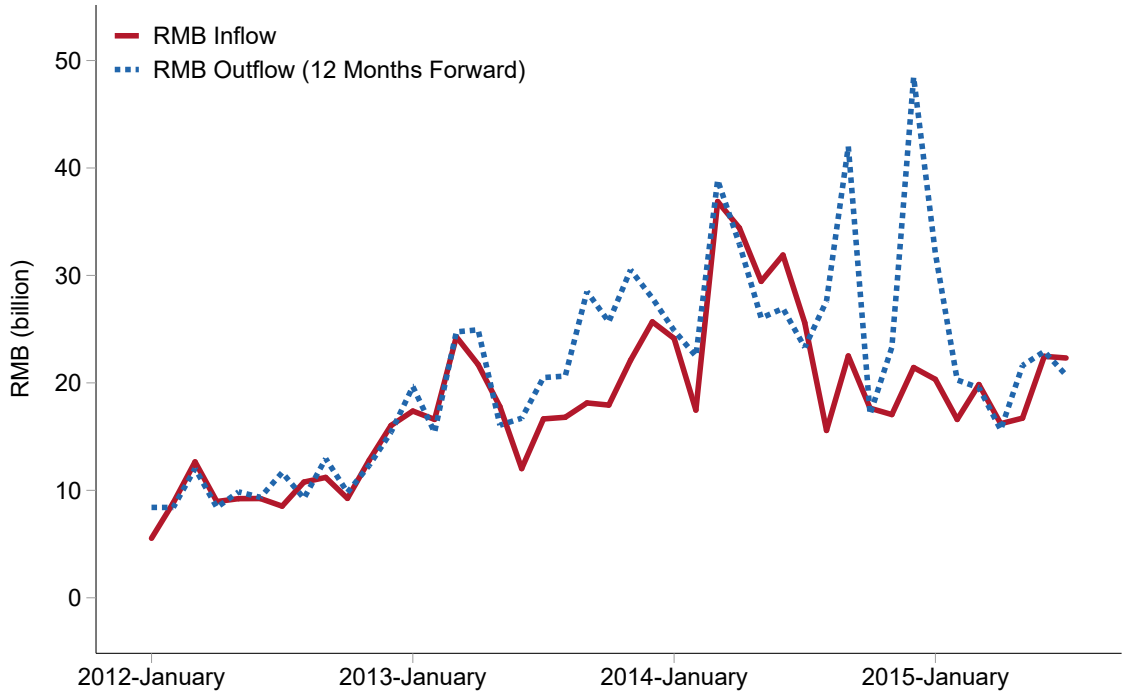
## 3.1 Aggregate RMB Flows

We argue that the rise of RMB inflows from reported entrepôt trades are driven by interest arbitrage. According to the flow chart in Figure 3, 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 one year to mature, inflows from entrepôt-enabling arbitrage should highly correlate to outflows from entrepôt trades 12 months forward.

In Figure 4, we plot RMB inflows from entrepôt trades and RMB outflows for entrepôt trades 12 months forward. The solid red line indicates the inflows and the blue dash line indicates outflows. Unless otherwise specified, figures in this paper use blue lines or bars for outflows and red lines or bars for inflows. Except in late 2014 and the first month in 2015, 12-month-forward inflows co-move closely with inflows.

The deviation in 12-month-forward outflows from inflows is associated with a policy shift in the Chinese exchange-rate regime in August 2015, which caused a sudden and sizable depreciation of the Chinese yuan against the U.S. dollar. From 2011 to July 2015, the exchange rate for RMB and the U.S. dollar ranges from 6.38 yuan per dollar to 6.05 yuan per dollar. On the eve of the policy shift, onshore and offshore exchange markets priced about 6.20 yuan per dollar. On the day the PBC announced the policy, Chinese yuan depreciated by 2% against the dollar (see Figure 2). The policy shift also led to a sharp divergence of onshore and offshore exchange rates of the RMB against the U.S. dollar.

In Figure 5, we plot the onshore-offshore differentials of the RMB exchange rate against

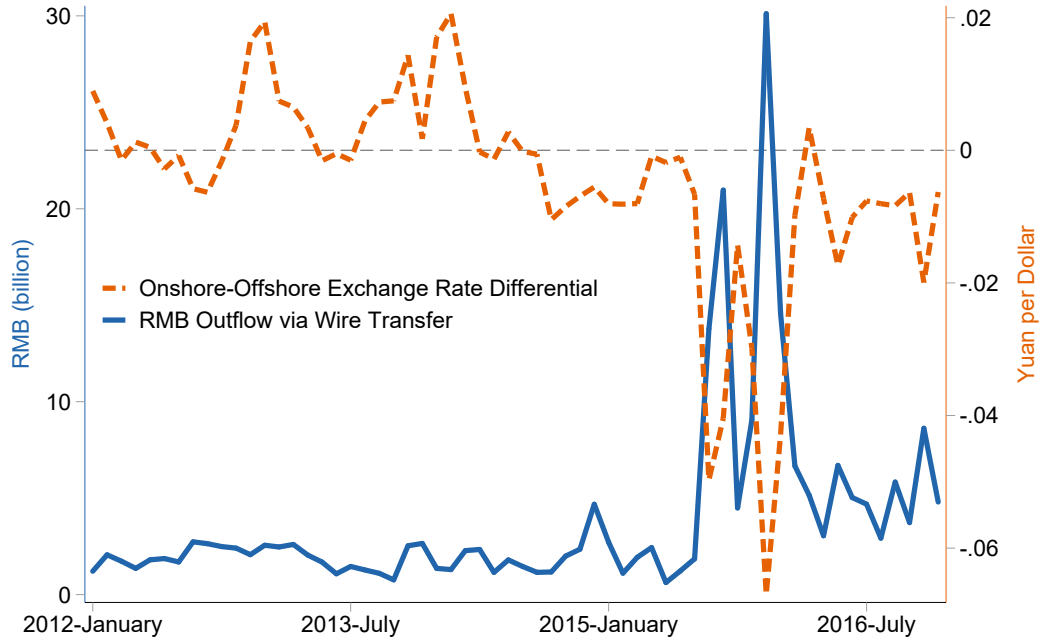



Notes: The figure above plots monthly RMB inflows (solid red line) and 12-month-forward RMB outflows (dashed blue line).

Figure 4: RMB Inflows and 12-Month-Forward RMB Outflows

the U.S. dollar. Before the foreign-exchange policy shift, the onshore-offshore differentials of RMB exchange rates were small, typically within 0.02 yuan per dollar. However, in the first six months following the exchange-rate policy change, the onshore-offshore RMB exchange rates diverge considerably. At its peak, the RMB in offshore markets was much cheaper than in onshore markets; one U.S. dollar could be exchanged for 0.06 yuan more in offshore markets than in onshore markets. Exchange-rate differentials are associated with a sharp increase in entrepôt-related outflows through wire transfers. The blue line in Figure 5 denotes these wire transfers from reported entrepôt trades and their strong relationship with onshore-offshore exchange-rate differentials during those turbulent months.

From Figure 5, it is clear that the sharp increase in entrepôt-related outflows through wire transfers coincides with the depreciation of RMB and the widening of onshore-offshore differentials of the RMB exchange rate against the U.S. dollar after the August 11 announcement. Anticipating further depreciation of the RMB, firms may report entrepôt




Notes: The figure above plots onshore-offshore exchange differentials (dashed orange line) and RMB outflows through wire transfers (solid blue line). Onshore-offshore exchange-rate differentials are measured in the difference in yuan per dollar between the onshore rate and the offshore rate, so that a positive differential indicates that the yuan is cheaper onshore.

Figure 5: Onshore-Offshore RMB Exchange-rate Differentials and RMB Outflows via Wire Transfers

trades to transfer RMB offshore and convert RMB into dollars in the unregulated offshore foreign exchange market.

Entrepôt traders may also conduct exchange-rate arbitrage using entrepôt trades. When offshore RMB is more expensive than the onshore RMB, an arbitrageur may convert U.S. dollars to RMB onshore (mainland China), report imports to wire the RMB offshore, convert the RMB to U.S. dollars offshore, and wire the U.S. dollars back onshore. In short, an exchange rate arbitrage requires an RMB outflow and a dollar inflow. When offshore RMB is cheaper than the onshore RMB, as it was the case in the months after the August-11 announcement, an exchange arbitrage requires the opposite, i.e., an RMB inflow and a dollar outflow.

Under PBC regulations, commercial banks providing services to entrepôt traders settling with RMB must match inflows and outflows for each firm. For example, entrepôt

traders are not allowed to wire RMB out for purchases and receive dollar payments from re-exportation of the goods. In practice, however, banks likely lack the capacity to match the inflow and outflow precisely for every entrepôt trade; an entrepôt trade could involve multiple inflows and outflows, and no regulation limits the time between inflows and outflows. Through offshore related parties, entrepôt traders may also inflate the import or export prices to transfer RMB into and out of China mainland.

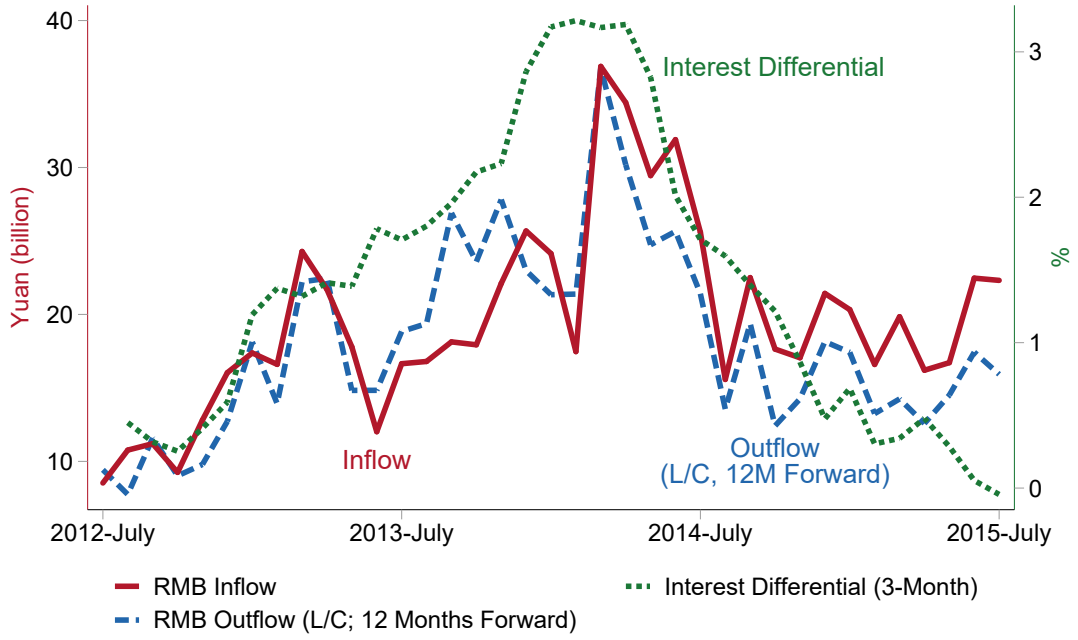
For either capital outflows due to depreciation expectation or exchange rate arbitrages, wire transfers would offer the immediacy. RMB outflows via L/Cs not only delay the outflows and conversion of RMB into dollars but also incur unnecessary costs that are associated with the issuance and discounting of L/Cs.

In this paper, we focus on interest arbitrage—specifically, on inflows before August 2015 and outflows via L/Cs before August 2016. Exchange rate arbitrage is beyond the scope of this paper. Moreover, we do not have trade settlement payments in currency other than RMB. If exchange rate arbitrage did take place under the disguise of entrepôt trades, there would be (i) a net inflow of RMB and a net outflow of U.S. dollars, or (ii) a net outflow of RMB and a net inflow of U.S. dollars, depending on whether onshore rate is higher than the offshore rate. However, we could only observe whether there is a net inflow or outflow of RMB through entrepôt trades.

We restrict our sample to interest arbitrage before mid-2015 for two reasons. First, the onshore-offshore interest gap had converged to close to zero by mid-2015. Second, potential exchange rate arbitrage and capital flight after August-11 may confound RMB flows from interest arbitrage.

Moreover, we focus on 12-month forward L/C settlements for outflows. As discussed before, 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/Cs, which is underwritten by an onshore deposit and could be discounted offshore for cash at the offshore rate, does just that.

In Figure 6, we plot the monthly entrepôt-related RMB inflows and 12-month-forward outflows settled by L/Cs, along with average onshore-offshore interest differentials. Start-




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 6: Onshore-Offshore Interest Differentials, RMB Inflows, and 12-Month-Forward L/C Outflows

ing from mid-2012, differences between the Shanghai Interbank Offered Rates and the Hong Kong Interbank Offered Rates 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 6 indicates 12-month-forward L/C outflows, which clearly co-move with the inflows indicated 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

| | 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 value 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

inflows. In the right panel of Table 2, we report estimates for 52-week-forward L/C outflows.[9] In all regressions in this paper, we use the heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1986), in which the maximum lag allowed for autocorrelation is 365 days.

The univariate estimate in Column (1) of Table 2 suggests that a one 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 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 macroeconomic variables, we include logarithms value of daily import and export settlements for regular one-way trades, as well as capital inflows and outflow under the capital account.[10] As reported in Column (4), our main estimate after controlling these macroeconomic variables is quantitative similarly and remains significant at the 1%.

Onshore-offshore interest differentials are estimated to have a larger effect on 52-week-forward L/C outflows for entrepôt trades, ranging from 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 the forward L/C outflow regressions are typically smaller than those in the inflow regressions. Therefore, the estimated effects of interest differentials are all significant at the 1%

[9] 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.

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

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 one-day-lagged and the one-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.

## 3.2 Interbank Certificates of Deposit Regulation

Although a number of macroeconomic variables have been controlled 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 remain spurious due to omitted variables. In this section, we exploit a policy shock to identify the potential causal impacts of the onshore-offshore interest differentials on RMB cross-border flows from entrepôt trades.

In the last decade, China slowly liberalized its tightly controlled credit market. On December 7, 2013, the PBC announced their interim provisions on interbank certificates of deposit management. The reform allowed deposit-taking institutions to issue negotiable interbank certificates of deposits (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 the market conditions and better management of liquidity risks.

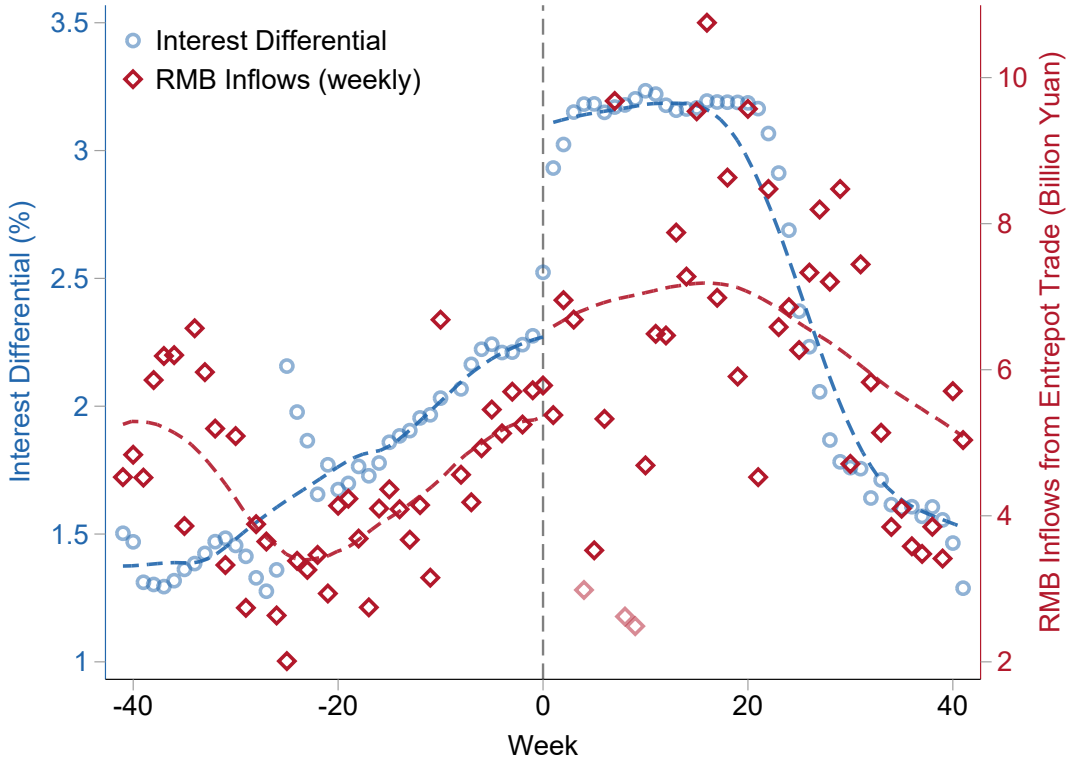
In the short run, however, the reform pushed up the interest rates in the interbank lending market for two reasons. First, before the reform, banks relied on short-term borrowing in the interbank markets to meet their liquidity needs. Smaller banks also relied on the interbank market to borrow short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

Second, the reform also designated the largest state-own banks as market makers in the CD markets. Through their vast network of branches and brand names, large state-owned banks attract retail deposits at lower rates and are typically lending in the interbank market. When the interbank CD market matured, the smaller banks would and did eventually became the predominant issuers. As the interbank CD market started, however, the issuances of CDs by the largest state-owned banks withdrew liquidity and pushed up the cost of borrowing for smaller banks.[11]

In Figure 7, 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 hollow blue circles, the interbank CD reform induced a sharp increase in the Shanghai Interbank Offered Rates, which benchmarked for the interbank CDs per the interim provisions. As shown by the red hollow diamonds, the RMB inflows from entrepôt trades also increased following the increase in the interest differentials, though with increased volatility and some delays. The increased volatility and delays may be partially due to the timing. For example, the outliers four to eight weeks after the reform coincide with the Gregorian New Year and Chinese New Year public holidays.

Figure 7 naturally suggests a fuzzy regression discontinuity (RD) design, where time is the running variable. The policy shock provides an instrumental variable for the po-

[11] For example, on December 12, 2013, China's four largest state-owned banks, along with China Development Banks, issued 19 billions of interbank CDs.




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 hollow blue circles indicate the weekly average of interest rate differentials. The hollow red diamonds indicate the weekly RMB inflows from entrepôt trades. The horizontal axis indicates 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 7: Introduction of Interbank Certificates of Deposit

tentially 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 7. We find that a one percentage point increase in the onshore-offshore interest differential induces a rise of 24 log points in RMB inflows for reported entrepôt trades. The 2SLS estimate is statistically significant at the 10%. Controlling the new year holidays with an indicator variable leads to a larger estimate of 40 log points, which is significant at the 1% level.[12]

[12]We use HAC standard errors with a lag of 4 weeks. We have a strong first stage, and weak instrument is easily rejected. One may be concerned that the imprecise timing of the policy shock's effects on interest rate 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),

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

Moreover, several factors limit the interest arbitrage through entrepôt trades. First, there might be delays in each step of the arbitrage identified in Figure 3. These delays lower the return on arbitrage compared to 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 3 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

we obtain similar estimates.

be completed instantly, the arbitrageur repeats infinite rounds but obtains a finite sum of capital $K'$ in a year:

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

Thus, the rate of return to arbitrage $r_a$ is:

$$r_a = r_s + \frac{r_s - r_h - d}{r_h + d}. \tag{2}$$

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 $(r_a - r_s)K > F$. 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 one-year-forward outflows.

Moreover, so far we have abstracted from bank fees for the issuance of an L/C, which are typically fixed fees 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 that 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 one-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.,

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

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

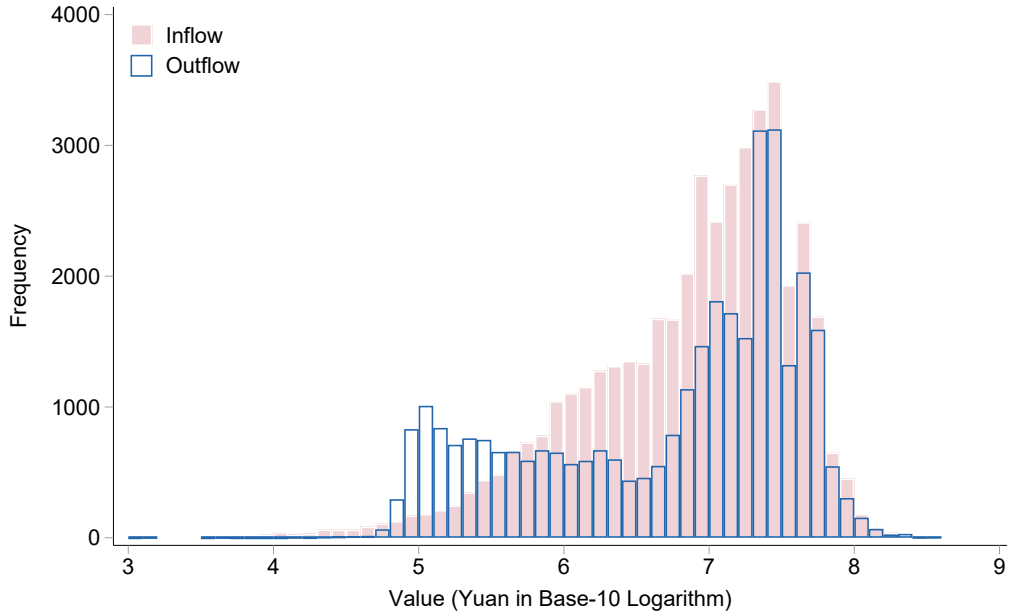
However, a high arbitrage return likely draws capital into arbitrage. Still, in the presence of fixed costs, the low end of the distribution of the arbitrage flows would be more affected by arbitrage returns. This is because fixed costs affect the profitability of arbitrage more when the arbitraging capital is small and the size of subsequent arbitrage flows is determined by the initial arbitrage capital $K$. 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 $\tau$ quantile of RMB flows of transaction $i$ in period $t$; $D_t$ is the difference between interbank rates in Shanghai and in 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 two-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 $\tau$ 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 those in Table 2. The consistency of this estimator requires that the number of transactions in a day be sufficiently large. But the asymptotic 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 the Newey and West (1986) HAC standard errors. Chetverikov et al. (2016) show that standard heteroskedasticity robust errors are valid for their two-step estimator.

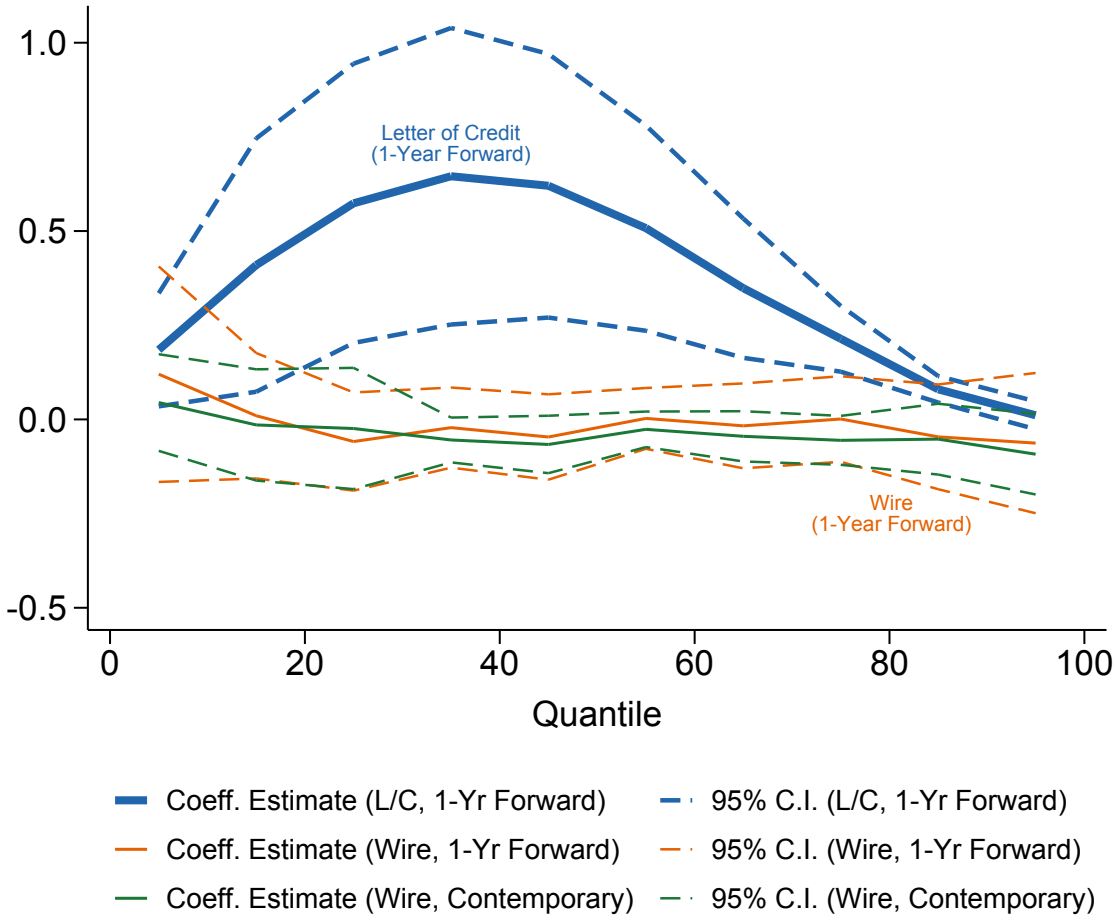



Notes: The histogram above plots the distributions of log transaction values of RMB inflows and outflows from January 2012 to July 2015. Solid pink bars represent inflows, and hollow blue bars represent outflows. Logarithms are base-10 for ease of interpretation.

Figure 8: Distribution of Transactional Values of RMB Inflows and Outflows

We measure the arbitrage transaction values using the log value of one-year-forward outflows for reported entrepôt trades settling bank-issued L/Cs. Issuing, claiming, and discounting L/Cs are 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 transferred via wire transfer, which is relatively less costly to carry out. Firms often split and combine chunks of RMB when they wire transfer their proceeds back onshore. As shown in Figure 8, 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 out-

flows that include both L/C outflows and wire-outward transfers, which is quite similar to the distribution of L/C outflows.




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

Figure 9: Onshore-Offshore Interest Differentials on the Distribution of RMB Outflows

Figure 9 reports the point estimates and confidence intervals of $\delta$ 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 impacts around

the 35$^{th}$ percentile of the outflow distribution. A one percentage point increase in interest differentials increases the 35$^{th}$ percentile of forward L/C outflow as much as 75 log points (212%), which is equivalent to doubling the 35$^{th}$ percentile. Throughout the quantiles from 0.05 to 0.95, quantile effects, as measured by $\delta_\tau$, 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, 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 one-year-forward outflows through wire transfers. We report the point estimates and confidence intervals of $\delta$ in these two placebo specifications at various quantiles in Figure 9, along with our main quantile effects estimates. As expected, interest differentials do not have statistically significant effects on different quantiles of one-year-forward or contemporary outflows via wire transfers; in addition, the point estimates are usually small compared to those from the main quantile specification.

## 3.4 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

$$\ln(n_t) = \gamma_E D_t + X_t'\beta_E + \epsilon_t^E \tag{4}$$

$$\ln(\bar{y}_t) = \gamma_I D_t + X_t'\beta_I + \epsilon_t^I \tag{5}$$

where, as before, $D_t$ is the interest differentials, $X_t$ is a vector of control variables, $\epsilon_t^E$ and $\epsilon_t^I$ are error terms, and the others are coefficients to be estimated.

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

$$\ln(y_t) = (\gamma_E + \gamma_I)D_t + X_t'(\beta_E + \beta_I) + (\epsilon_t^E + \epsilon_t^I) \tag{6}$$

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

$$\ln(n_t^F) = \gamma_F D_t + X_t'\beta_F + \epsilon_t^F \tag{7}$$

$$\ln(n_t^P) = \gamma_P D_t + X_t'\beta_P + \epsilon_t^P \tag{8}$$

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 $\gamma$ for various margins in Table 3. In the upper panel of Table 3, the dependent variables concern entrepôt inflows; in the lower panel of Table 3, the dependent variables concern the one-year-forward L/C outflows for entrepôt trades. For comparison, we report again in Column (A) the baseline estimations of Equation (6), where the dependent variables are the daily total inflows or forward outflows. In Column (I), we report the estimates of $\gamma_I$ in Equation (5), which concerns the intensive margins of average value per inflow/outflow. In Column (E), we report the estimates of $\gamma_E$ in Equation (4), 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 logarithms 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 3: Decomposing the Effects of Onshore-Offshore Interest Differentials on RMB flows

flows/transactions. In Column ($E_p$), we report the estimates of $\gamma_P$ in Equation (8), which concerns the margin of the number of transactions per trading firm. In Column ($E_f$), we report the estimates of $\gamma_F$ in Equation (7), 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 one percentage point increase in interest differential increases the number of inflows by about 19 log points, which is significant at the 1% level. A one percentage point increase in interest differential only increases the average value of a 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 combined funds from different transactions. On the other hand, outflows from entrepôt trades, and interest arbitrages, in particular, were typically paid via L/Cs, whose issuance and discounting were costly. Banks charge fees for the issuance and discounting L/Cs and shipment documents were required to discount an L/C for cash. Accordingly, forward L/C outflows should more precisely capture the scale and transaction frequency for interest arbitrages than inflows. Therefore, our preferred measure for the decomposition is the 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. A one percentage point increase in interest differentials increases the number of transactions by 15 log points and increases the average transaction value by 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 one percentage point increase in interest differentials increases the number of transacting firms by 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 about the date of their first L/C issuance—which needs to be deduced from the forward L/C outflows—we focus on inflow transactions to identify entering firms. Because the firms that we identify as new entries may have had transactions prior to our sample period, new firms may be overestimated. However, left-censoring likely affect 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 on firm entries. In the top panel of Table 4, 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 among 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.

Overall, results in Table 4 suggest that a higher interest differential induces the entry

| 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 among all trading firms in the middle panel; and new trading firms' share of transaction volume among 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 4: Onshore-Offshore Interest Differentials and Entry of Entrepôt Traders

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 one-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 one 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 the 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 a 5% level with linear, quadratic, and cubic trend specifications. A one percentage point increase in interest differentials increases new firms' share of transaction volume by 1.6 percentage points, which is statistically significant at a 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.

## 3.5 Economy of Scale in Interest Arbitrage

The last two subsections suggest an economy of scale in interest arbitrage. One source for the economy of scale is the presence of fixed costs for each round of arbitrage. Onshore banks charge miscellaneous fees for the issuance of L/Cs. In additional to proportional charges, offshore banks also charge fixed fees when offshore "sellers" discount the L/Cs for cash. Different banks charge different fees at various rates. By our estimate, these fees amount to about 20,000 yuan or 0.2% for an L/C of 10 million yuan, which is the median transaction value in our sample. Moreover, there are likely costs associated with shipment documents that are required for the L/C discounting as well. There have been reports that circular shipments of high-value commodities such as gold and computer chips have been used to produce shipment records.

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 the interest arbitrages using entrepôt trades. As discussed in Section 2.2, the interest arbitrages are risky unless the "seller" and "buyer" of an entrepôt trade are controlled by the arbitrageur. We find that, conditioning on the dates of the transactions, firms that enter into entrepôt trades for the first time in our dataset were two times more likely to trade with entities that had not been paid or a recipient 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% L/C outflows in value. Large manufacturing firms and trading companies are likely to have sub-

sidiaries offshore, particularly in Hong Kong, to facilitate international trades. Existing subsidies in Hong Kong are likely to provide advantages for these firms to engage in interest arbitrage through entrepôt trades. Entities that registered in Hong Kong received respectively 58% of the RMB payments for regular import and 57% for entrepôt trades. Firms that conduct regular trades in RMB are likely to have established related parties in Hong Kong, which reduce the fixed costs of interest arbitrages through entrepôt trades. Indeed, firms that have ever conducted a regular trade in our sample on average entered into an entrepôt trade about five months earlier than those who had never conducted a regular trade in RMB.

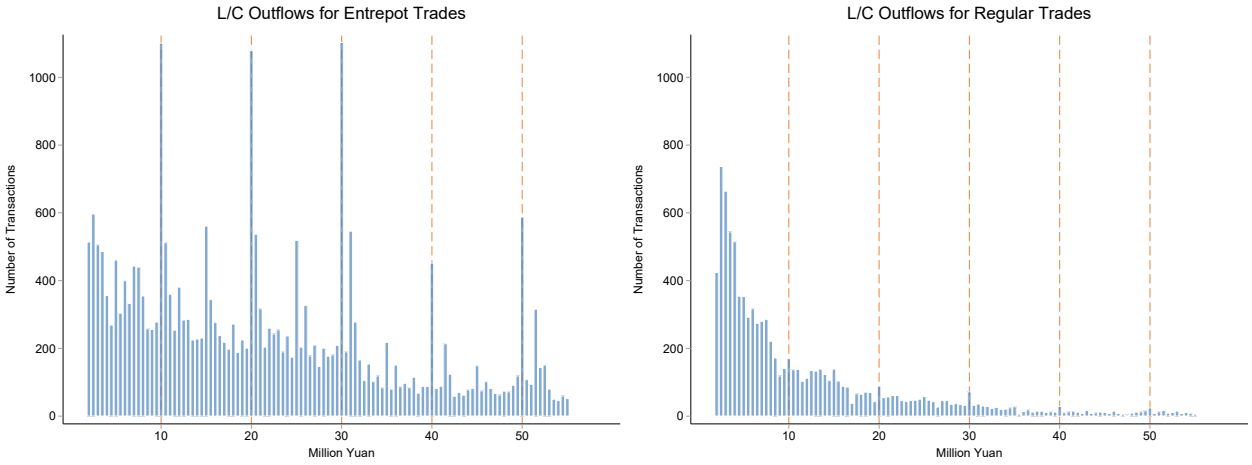
Moreover, 15% of trading companies specialize in commodities such as steel, copper, and fuel. These companies account for 10% of the L/C outflow transactions but 16% of the outflows in value. The large working capital, as indicated by these companies' trading volume, along with their offshore subsidiaries,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

Another source for the economy of scale is that a larger amount of 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 rate for large deposits to circumvent interest rate regulation (He et al., 2015; Shen and Bian, 2017; Tan et al., 2016) through CD for institutional investors, wealth management products, etc. Perry and Weltewitz (2015) show that the 3-month Shanghai Interbank Offered Rates closely track the weighted av-

erage rate of return from bank wealth management products. However, there might be a small variation of interest rates across banks for deposits of different size.[13]

As we mentioned before, an arbitrageur deposits a lump sum into a bank and uses it to underwrite L/Cs. The larger is the deposit; the higher rate would the deposit earns. If an arbitrageur does not have sufficient fund to high-yield deposits, he may need to raise funds for the arbitrage. The higher is the interest differentials; the easier is for the arbitrageur to raise sufficient fund that makes the arbitrages profitable.

If a substantial share of deposits that underwrite L/Cs are put into money market instruments that have a round-number face value, we would see significant bunching of L/C outflows bunch around round numbers. For example, the certificates of deposit for institutional investors in China requires a minimum deposit of 10 million yuan and are typically denominated in the multiples of 10 million.




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

Figure 10: Round-number Bunching of L/C Outflows

Figure 10 show that this is precisely what we find for entrepôt outflows settled through L/C (left subplot). Notes that L/Cs are not expected to be issued at round-number values.

[13]The Hong Kong Interbank Offered Rates, however, should proxy the discounting interest rate for L/C well. This is because L/C-issuing onshore banks are the counter-parties and they have low default risks. Indeed, the L/C discounting rates in Hong Kong typically use the Hong Kong interbank lending rate plus fixed basic points.

Moreover, if these L/Cs settle real entrepôt trades, it is unlikely that there is substantial bunching at around numbers. Indeed, if we focus on the L/C settlements for regular one-way trades, we only find a very modest amount of bunching around round numbers (right subplot). The round-number bunching of the L/C payment amounts also provide corroborating evidence that a substantial part of the entrepôt trades is fictitious.

In the presence of fixed costs, interest arbitrages would be more profitable when the onshore-offshore interest gaps are larger. Therefore, higher interest gaps attract entries. Arbitrageurs may also scale up their operation as well. If we look at the decomposition of L/C outflows in Table 3, about half of the increase in the aggregate volume of entrepôt trades could be attributed to the larger transaction value per L/C. However, given the economy of scale in interest arbitrages, one may ask what prevents exiting arbitrageurs to scale up their entrepôt trades further. One plausible barrier to further scale up arbitrage regulation may be to raise more fund for the operation. More fund from large-capital holders would be required, but these capital holders are likely to enjoy higher deposit rates. Another plausible limit is the risk of detection by the central bank. The transaction value was of entrepôt trades already fairly large. The median value of entrepôt outflows is equivalent to the transaction value for regular one-way imports at the 85 percentile. The 90 percentile of entrepôt outflows is larger than the 97 percentile of outflows from regular trades. Moreover, shipment records of goods of huge value would be needed to document the trades and discount the L/C. Because of these limits, Figure 9 shows that the highest quantile of L/C outflows are not significantly affected by the interest differentials although the rest of the outflow distribution was.

# 4 Concluding Remarks

Historically, dollar-denominated instruments for trade finance contributed to the rise of U.S. dollar in international trades (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 had facilitated interest

arbitrages across the onshore and offshore credit markets of RMB. As a result, China's capital control became less effective and the statistics on the rise of RMB-denominated trades were inflated.

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

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