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 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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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 (see, e.g., Kaplan and Rodrik, 2002; Glick et al., 2006; and Forbes et al., 2015). Over time, the question has shifted from whether to liberalize capital accounts to when and how a country should open its capital accounts. For example, Korinek and Sandri (2016) suggest that optimal policy for financial stability in developing countries typically involves both domestic macroprudential regulation and capital controls.

Prasad and Rajan (2008) advocate a pragmatic approach to capital account liberalization, because countries must have sufficient institutional and economic development to benefit from financial openness. For outward-oriented developing economies, deciding when and how to open capital accounts is particularly important; for instance, the large and frequent capital flows from trades in export-oriented economies may render effective capital controls difficult and costly.

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 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. Despite the question's important policy implications, empirical studies have been inconclusive. Studies of specific countries typically find qualified success at best. For instance, see Jinjarak et al. (2013) for Brazil's capital control measures between 2008 and 2011; Mitchener and Wandschneider (2015) for capital controls in the U.S. during the financial crisis in the 1930s; and De Gregorio et al. (2000) for the effectiveness of Chilean unremunerated reserve requirement for taming surges in capital inflows in the 1990s. 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.

Evidence from cross-countries studies of capital controls' effectiveness is often mixed (see, e.g., Montiel and Reinhart, 1999). In a recent paper using a propensity-score matching approach, Forbes et al. (2015) find that a few capital-control measures have significant effects on specific macroeconomic variables, but most do not seem to have detectable effects on most macroeconomics variables. 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 and taxation. Auguste et al. (2006), for example, document that during the Argentine crisis, investors circumvented capital controls by purchasing cross-listed shares using local currency, then selling them abroad by converting them into dollar-denominated stocks. Using discrepancies in import-export statistics reported by Mainland China and Hong Kong, Fisman and Wei (2004) and Fisman et al. (2008) provide evidence that importing firms in China underreport their imports and import indirectly through Hong Kong to avoid tariffs. Davies et al. (forthcoming) show that multinational firms use transfer pricing to avoid corporate income tax.

Furthermore, we contribute to the literature on capital account liberation and, in particular, the internationalization of the RMB. The rise of the RMB in the global monetary system has been widely noted.[1] How China manages to gradually open up its capital accounts, as Beijing stated it would in 2015, 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.

Lastly, our paper is related to an emerging literature that studies the roles of intermediation and finance in international trade. In a recent paper, Schmidt-Eisenlohr (2013) provides a much-needed framework to analyze the important role of bank intermediation in international trades, particularly for trades with developing countries that lag behind in their development of contractual and legal institutions. Our findings show that bank instruments for trade finances may also be used for interest arbitrage. Moreover, whether domestic firms or foreign firms intermediate trades may play a role in the gains in trades (Antràs and Costinot, 2011) and the currency used for trades may affect the competitiveness of domestic firms vis-à-vis foreign firms in trade intermediation. Our findings shed light on the arbitrage opportunities available to trade intermediaries, which are well suited to exploit arbitrage profits during the RMB's internationalization.

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.

[1] See, e.g., Fratzscher and Mehl (2014); IMF (2015); and Prasad (2016).

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 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.

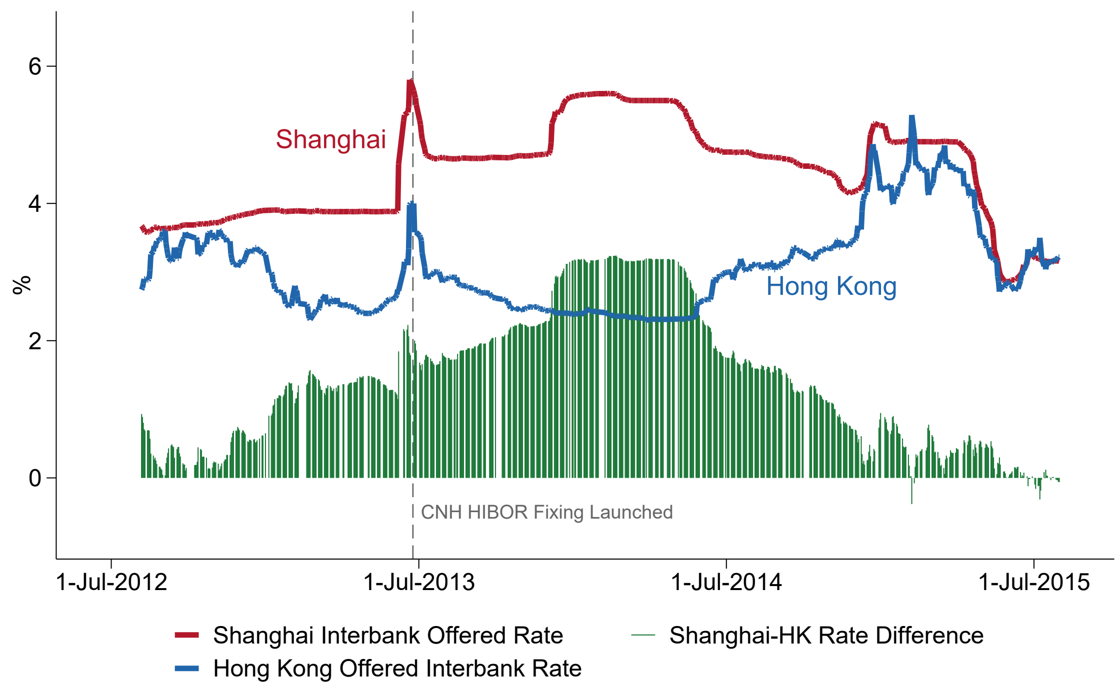
The People's Bank of China, which is the central bank of China and hereafter PBC, announced in July 2009 that commercial banks in Shanghai and four other cities may provide services for settling cross-border trades in RMB.[2] As a pilot program, these services were initially limited to a select set of 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

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

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

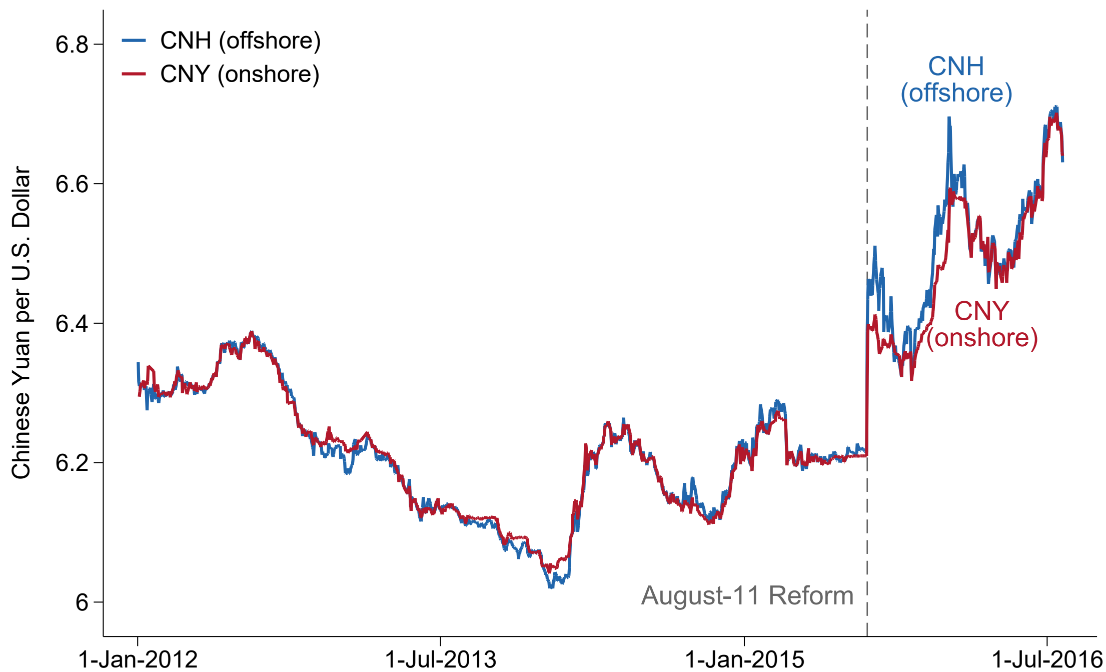


Notes: The figure above plots the daily interbank offered rates of Chinese yuan in Shanghai and Hong Kong, as well as their differences. The term for both interbank offered rates is three-month.

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.



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

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.

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.[3] 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$^{\text{th}}$ century Amsterdam, exploit their geographic, institutional, and economic advantages to

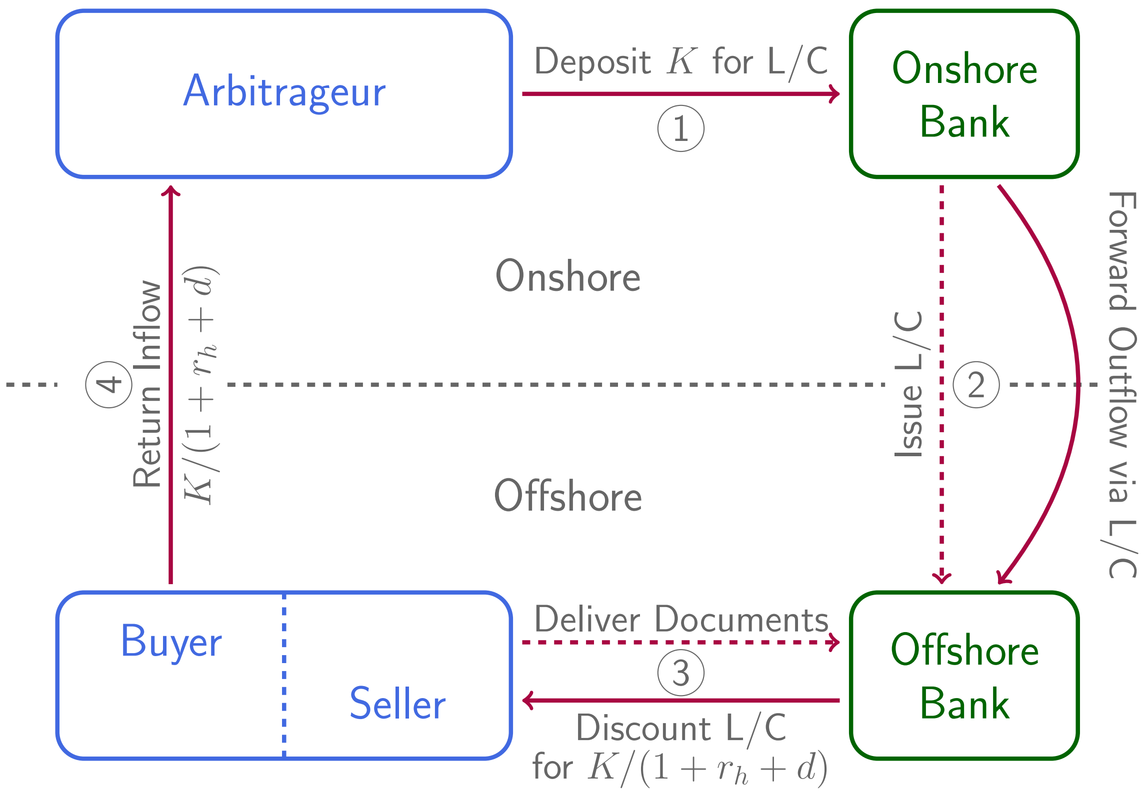
[3]This reform is, in theory, more market oriented. Before the reform, the RMB was allowed to float around a 2% band around a midpoint set by the PBC. The reform sets the midpoint of the floating band to the closing rate of the RMB on the previous day.

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 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.[4]



Notes: The flow chart above illustrates how an onshore firm may report entrepôt trades and use of an L/C 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

Suppose the offshore interest rate is r_h and the discounting charge is at a rate of d, then the discounted L/C yields $K/(1 + r_h + d)$.[5] 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 of the L/C, which

[4] 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.

[5] 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.

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.

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

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

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 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.

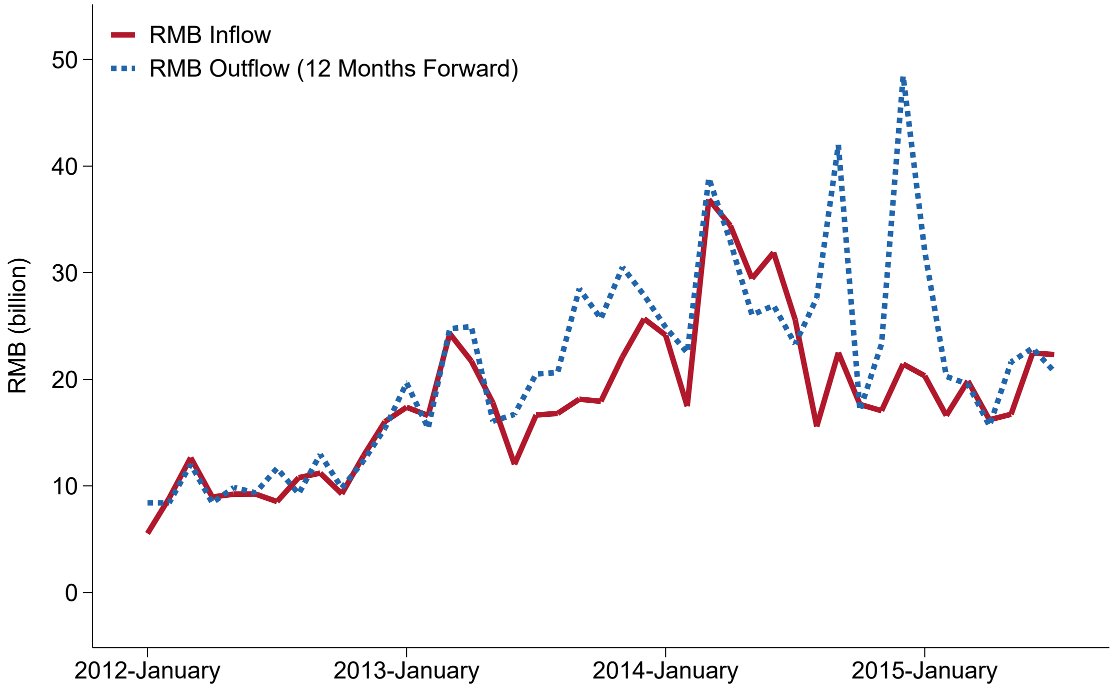
3 Interest Differentials and Reported Entrepôt Trades

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.

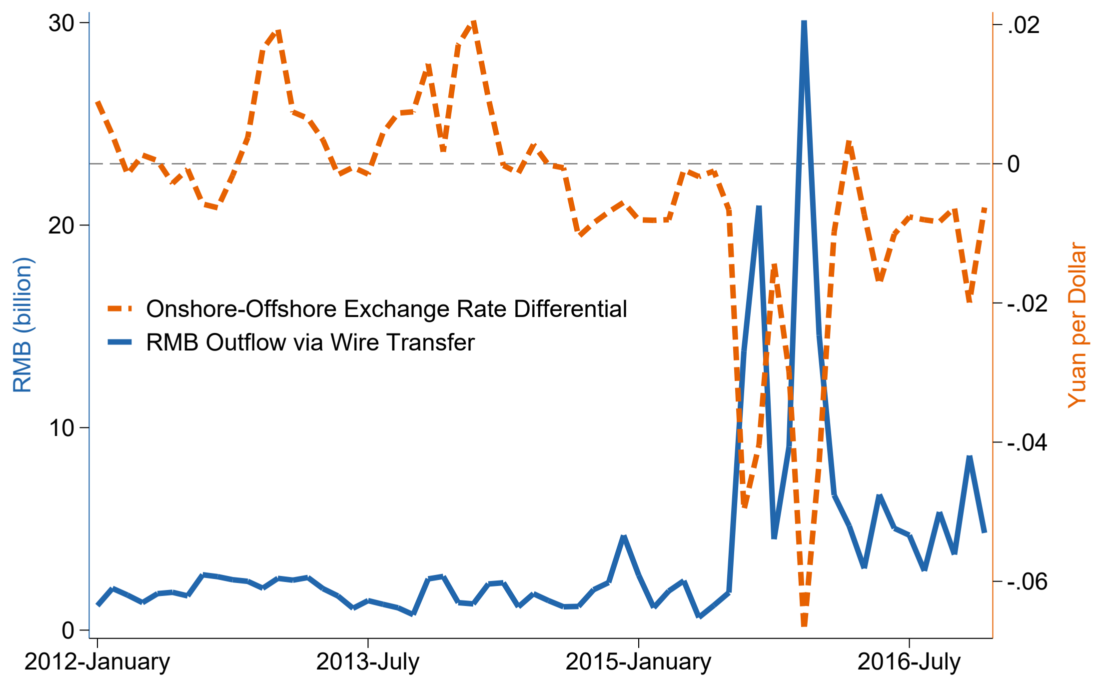


Notes: The figure above plots monthly RMB inflows (solid red line) and 12-month-forward RMB outflows (dashed blue line).

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

The 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 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.

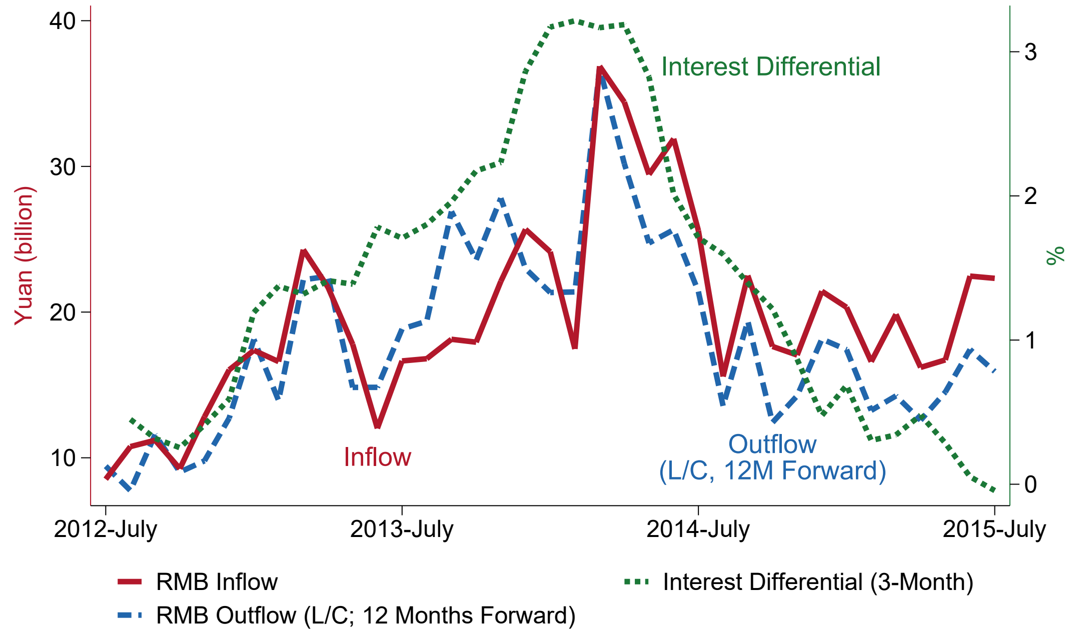


Notes: The figure above plots onshore-offshore exchange differentials (dashed orange line) and RMB outflows through wire transfers (solid blue line). Onshore-offshore exchange-rate differentials are measured in the difference in yuan per dollar between the onshore rate and the offshore rate, so that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

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

From Figure 5, it is clear that the sharp increase in entrepôt-related outflows through wire transfers coincides with the widening of onshore-offshore differentials of the RMB exchange rate against the U.S. dollar. Anticipating further depreciation of the RMB, firms may report entrepôt 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. 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 exactly for every entrepôt trade; an entrepôt trade could involve multiple inflows and outflows, and no regulation limits the time between inflows and outflows. The sharp co-movement between onshore-offshore exchange rate differentials and wired RMB outflows for entrepôt trades in the months after the August 11 announcement suggests that entrepôt trades may also be used for arbitrage in foreign exchange markets. However, since the window for exchange rate arbitrage is relatively short and we do not observe data sufficiently long after the window, we focus on interest arbitrage in this paper—specifically, on inflows before August 2015 to avoid confounding interest arbitrage with exchange arbitrage.

Because arbitrage with entrepôt trades links inflows to 12-month-forward L/C outflows, but not outgoing wire transfers, in the rest of this paper we focus on how entrepôt inflows and 12-month-forward L/C outflows relate to onshore-offshore interest differentials. 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. Starting 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,



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

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 inflows. In the right panel of Table 2, we report estimates for 52-week-forward L/C outflows.[6] 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

[6] 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)
Interest Rate Differential	0.190***	0.190***	0.207***	0.294***	0.292***	0.279***
	(0.070)	(0.069)	(0.068)	(0.058)	(0.061)	(0.062)
Tuesday		0.154***	0.152***		-0.678***	-0.677***
		(0.014)	(0.015)		(0.052)	(0.053)
Wednesday		0.274***	0.272***		-0.779***	-0.778***
		(0.017)	(0.018)		(0.081)	(0.082)
Thursday		0.269***	0.266***		-0.861***	-0.859***
		(0.029)	(0.030)		(0.049)	(0.050)
Friday		0.277***	0.273***		-0.702***	-0.698***
		(0.022)	(0.022)		(0.062)	(0.063)
Exchange Rate Differential			-4.127			3.417
			(2.519)			(2.516)
R^2	0.172	0.228	0.236	0.133	0.281	0.282
Observations (days)	698	698	698	698	698	698

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.

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

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

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.

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 (4), (5), and (6), we report the estimated effects with the same controls as those included in Columns (1) to (3), 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% 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 interest-rate differentials on inflows and forward outflows.

In Table 3, we report these estimates in Column (2) and Column (5), respectively, for inflows and outflows. For comparison, we also report baseline estimates from Table 2 in Column (1) and Column (4). Estimates become slightly larger and remain significant at the

	Inflow			Outflow (L/C, 1-Year Forward)		
	(1)	(2)	(3)	(4)	(5)	(6)
Interest-Rate Differential	0.207***			0.279***		
	(0.068)			(0.062)		
Interest-Rate Differential (lag)		0.208***			0.279***	
		(0.067)			(0.061)	
Interest-Rate Differential (1-week moving average)			0.218***			0.265***
			(0.066)			(0.058)
R^2	0.236	0.236	0.242	0.282	0.283	0.314
Observations (days)	698	697	698	698	697	698

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-offsore exchange-rate differentials are included in all specifications, but not shown.

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

Table 3: Onshore-Offshore Interest Differentials and RMB Inflows and Outflows: Robustness to Timing

1% level. We also estimate the effects of the one-week moving average of interest differentials on total inflows and forward outflows in the past week. Estimate for inflows changes little; estimates for forward outflows changes from 0.279 to 0.263, but 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 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 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.

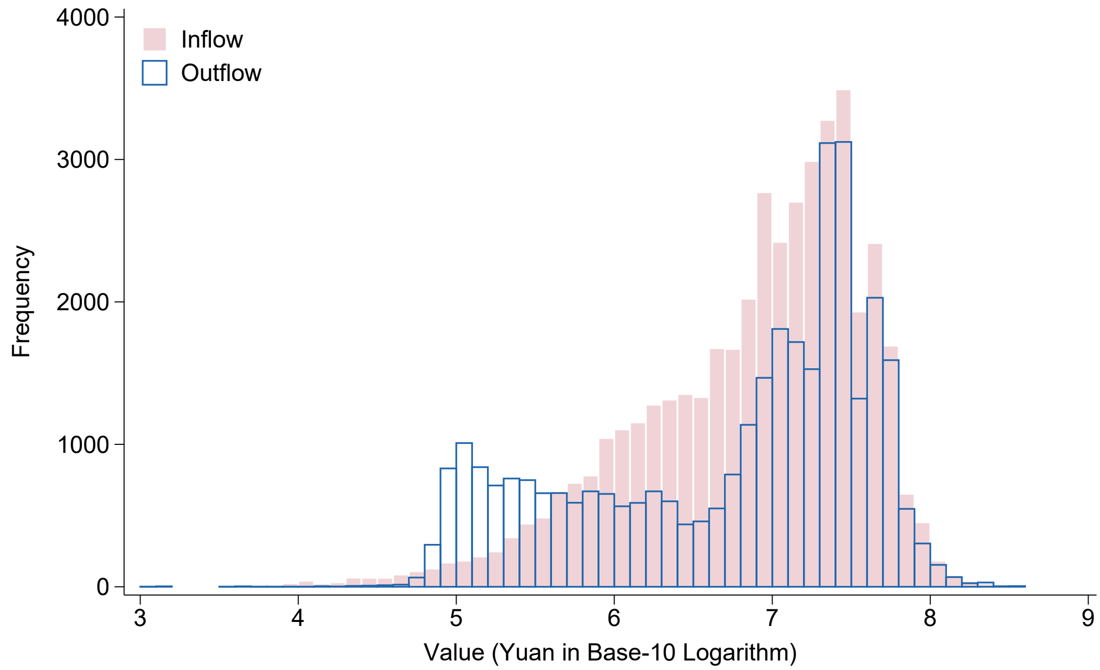
However, a high arbitrage return likely draws capital into arbitrage. Still, in the presence of fixed costs, the low end of the distribution of the arbitrage flows would be more affected by arbitrage returns. This is because fixed costs affect the profitability of arbitrage more when the arbitraging 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 τ 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 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 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.

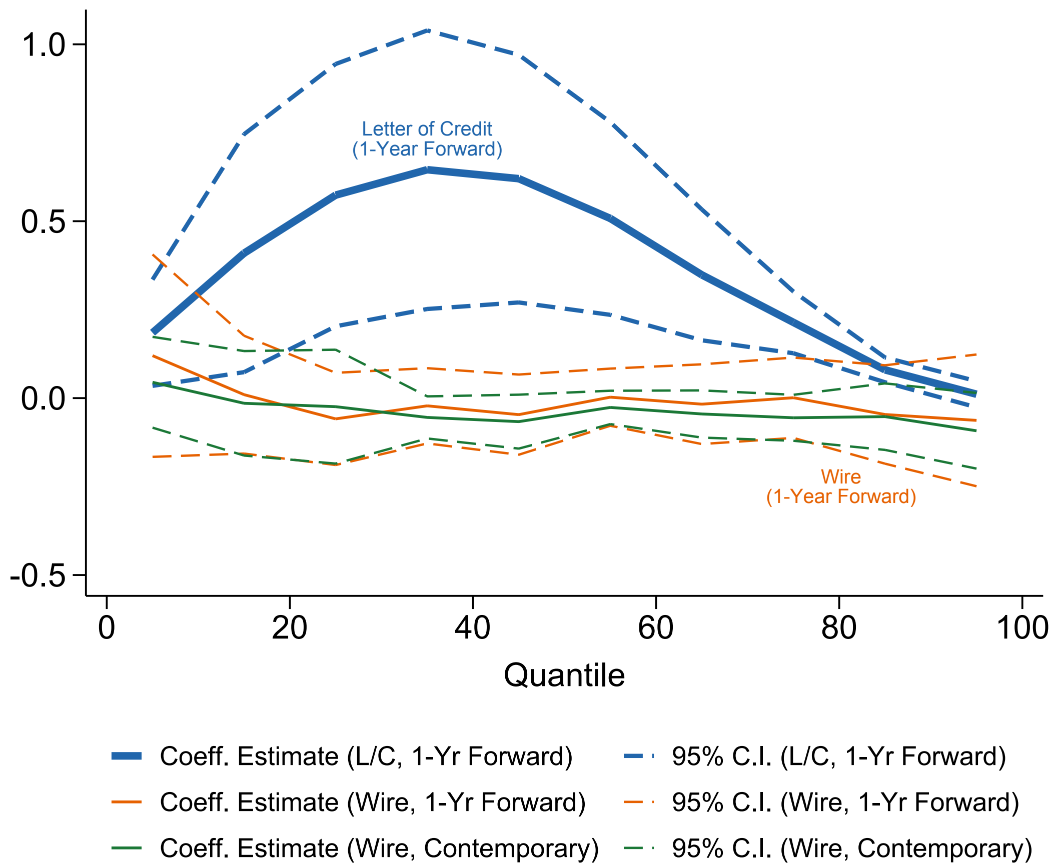
We measure the arbitrage transaction values using the log value of one-year-forward outflows for reported entrepôt trades settling bank-issued L/Cs. Issuing, claiming, and discounting L/Cs are likely to accrue some fixed costs. For example, a typical L/C discounting service at a Hong Kong bank charges 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 7, 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.



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 7: Distribution of Transactional Values of RMB Inflows and Outflows

Figure 8 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 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 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, the the quantile effects' pattern is consistent with the considerable fixed costs associated with carrying out interest



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

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 δ in these two placebo specifications at various quantiles in Figure 8, 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.

3.3 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, ϵ_t^E and ϵ_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 γ for various margins in Table 4. In the upper panel of Table 4, the dependent variables concern entrepôt inflows; in the lower panel of Table 4, 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 γ_I in Equation (5), which concerns the intensive margins of average value per inflow/outflow. In Column (E), we report the estimates of γ_E in Equation (4), which concerns the extensive margin measured by the daily number of flows/transactions. In Column (E_p), we report the estimates of γ_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 γ_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

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 4: Decomposing the Effects of Onshore-Offshore Interest Differentials on RMB flows

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.

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 5, 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.

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 5: Onshore-Offshore Interest Differentials and Entry of Entrepôt Traders

Overall, results in Table 5 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 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.

4 Concluding Remarks

Perhaps surprisingly, the RMB's initial path to internationalization has some striking similarities with the U.S. dollar's historical rise as an international currency. At the beginning of the 20$^{\text{th}}$ century, when the U.S. had already become a leading trading country but British sterling still dominated international trade, the U.S. dismantled regulatory barriers so that its banks could provide dollar-denominated trade finance, and its newly created central bank vigorously promoted the use of the dollar in trades. Dollar-denominated trade finance rose rapidly from virtually zero to a sizable share within a decade (Eichengreen and Flandreau, 2012).

While current international political and economic institutions differ from those of a century ago, and we by no means argue that the RMB would replace the dollar in the same way the dollar replaced sterling as the dominant international reserve currency, recent studies suggest that multiple currencies could co-exist as leading international trading and reserve currencies for an extended period (Eichengreen and Flandreau, 2012; and Chiţu et al., 2014). Domestic financial development, such as the spread of RMB-dominated L/Cs, is likely to contribute to the RMB's internationalization as the spread of dollar-denominated bankers acceptances in international trade did for the dollar a century ago. We leave to future studies whether the arbitrage activities identified in our paper facilitate the use of RMB L/Cs by providing liquidity or economy of scale in RMB L/Cs, or crowd out traditional use of L/Cs for trade finance.

In the short run, however, the circular capital flows due to arbitrage are likely to distort statistics on RMB capital flows by inflating the use of RMB in international trades. For example, RMB flows for entrepôt trades account for about 60% of cross-border RMB flows for our sample province in 2015 (PBC, 2016). Moreover, since arbitrage activities amount to increased lending between onshore and offshore banks—and larger balance sheets for the banks intermediating arbitrage—it is unclear whether such capital flows pose a systematic risk for the financial sector.

Opportunities to arbitrage onshore-offshore RMB interest differentials existed for most of our three-year sample period. It is beyond the scope of this paper to determine whether such arbitrage opportunities are unique to the transition period during which the RMB was being promoted for international trades, or this would resurface regularly if China halts its capital account liberalization. However, this question is crucial for understanding the trade-offs for a large economy in the process of opening up its capital accounts. As a starting point for future studies, our paper provides a useful lesson on how arbitrage activities circumvent capital controls in the initial stages of RMB internationalization.

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