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Bilateral swap agreement and Renminbi settlement in cross-border trade

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Abstract

This research empirically examines the impact of China's Renminbi (RMB) bilateral swap agreements (BSAs) on the usage of the currency in cross-border trade transactions. By using a unique dataset from SWIFT including cross-border settlement messages of 91 countries/regions between October 2010 and November 2015, we confirm that the signing of a RMB BSA helps to increase the number, the value and the proportion of RMB settlement in cross-border trade. Our results are robust with respect to the choice of different models, including multi-level mixed model, two-stage regression model, and difference-in-difference model. In addition to justifying the effectiveness of China's BSA-signing strategy to promote the RMB usage in trade settlement, our results clarify that the signing of those RMB BSAs is not purely for China's political ends as some scholars claim.

Keywords: RMB; Bilateral Swap Agreement; Cross-Border Trade; SWIFT

JEL classification codes: F33, F36, F42

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1   Introduction

The rise of China's currency, Renminbi (RMB), was a significant development of the international monetary system in the post-crisis era. Almost starting from scratch, the RMB has managed to substantially increase its market share in international trade and financial transactions over the past several years (BIS, 2016). Interestingly, the RMB internationalization is a government-driven process, in stark contrast with some historical precedents of internationalized currencies such as the USD and Japanese Yen whose internationalization journeys were primarily driven by market forces (Frankel, 2012).

As part of the authorities' efforts to push for the international use of the RMB, the People's Bank of China (PBoC), China's central bank, actively pursued signing RMB-denominated Bilateral Swap Agreements (BSAs) with other central banks. (Eichengreen and Kawai, 2015; Park, 2016) The first RMB BSA is signed between the PBoC and the Bank of Korea in December 2008. As of end-2017, the People's Bank of China (PBoC) has 36 outstanding RMB-denominated BSAs with other central banks, amounting to a total value of around 3.3 trillion yuan, equivalently USD 500 billion. The RMB BSAs generally have a 3-year maturity and are renewable although some of them were not renewed at their expirations. (Appendix 1)

A BSA is a swap line established between two central banks. It allows one party of the agreement to exchange a certain amount of its local currency for foreign currency funds from the counterparty at a pre-set or market exchange rate. Traditionally, BSAs function as a backstop liquidity facility so that a central bank is able to secure its access to foreign currency funding during times of market stress. A salient example in this respect is that the US Federal Reserve signed a number of temporary BSAs during the 2008-2009 Global Financial Crisis (GFC), with the objective of helping the counterparty central banks to tackle the liquidity squeeze of US dollar in their financial markets. In October of 2013, the US Federal Reserve made five of temporal BSAs into permanent standing arrangements, including: the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank.

A series of studies have been conducted to investigate the effectiveness of those temporary BSAs signed by the Federal Reserve at the height of global financial crisis while results are mixed. Taylor and Williams (2009) find no impact of these temporary BSAs on alleviating the drain of US dollar liquidity in the counterparties' financial markets. On the other hand, McAndrews et al. (2008) and Rose and Spiegel (2012) find certain evidence that these BSAs helped to stabilize market condition during the crisis period.

Differing from the ones signed by the US Federal Reserve, the PBoC's BSAs has a clear objective of facilitating the RMB internationalization through promoting the currency's usage in the

settlement of cross-border trade transactions. (PBoC, 2012). Toward this end, the RMB BSAs are designed to provide RMB funding to foreign importers so that they can pay in the RMB for their exports from China.

Compared to the existing literature about the US BSAs, research about the effectiveness of China's BSAs remains scant. This is mainly due to the lack of information, in particular the country-wide data of trade transactions settled by the RMB. The PBoC has such data but it has never been available to the public.

A few recent studies assess the effectiveness of the RMB BSAs via certain indirect evidence in the absence of information about the RMB trade settlement. The results are mixed. Zhang et al (2017) find a significantly positive effect of China's BSA signing on bilateral trade. However, McDowell (2019) questions the effectiveness of these RMB BSAs in terms of promoting cross-border trade settlement in the RMB. His arguments are based on the fact that not many RMB BSAs have been reported to be used after their signing.

The conclusion of McDowell (2019) deserves more scrutiny. Indeed, we believe that the effectiveness of the RMB BSAs should not solely be assessed on the basis of their amount being used. The BSAs with the PBoC is not the only channel through which foreign importers have access to the RMB funding for trade settlement. Since the inception of the RMB internationalization, China's authorities have been painstakingly developing offshore RMB markets to promote the international usage of the currency. It means that foreign importers can directly obtain the RMB funds from the offshore RMB market of its country.

It is noted that a RMB BSA can also play its role as a backstop liquidity facility to the offshore market of its signing counterparty. As such, the existence of a RMB BSA can help to encourage foreign importers and banks to more actively use the currency in settling trade transactions if they believe that a BSA is crucial to the stability of the RMB offshore market. We call it "confidence channel" through which a BSA is able to promote the use of the RMB in trade transaction settlement.

In essence, the effectiveness of the RMB BSAs needs to be assessed on the basis of relevant data. We have access to a unique dataset from SWIFT which provides the country-wide RMB settlement data. It enables us to fill the gap in the literature by empirically examining the impact of a RMB BSA signing on the RMB use in cross-border trade settlement.

In sharp contrast to McDowell (2019), our results confirm that the signing of a RMB BSA helps to increase the number, the value and the proportion of RMB settlement in cross-border trade. Our results are robust with respect to the choice of different regression models which are adopted to address a number of potential biases relating to the OLS model.

The rest of the paper is organized as follows. In the next section, we briefly introduce the backgrounds of RMB BSAs, especially against the backdrop of the RMB internationalization. Section 3 presents our main results. We conclude in section 4.

2   Background and data

The RMB internationalization and PBoC's BSA signing

The Chinese authorities set out to push for the internationalization of its currency in the aftermath of the 2008-2009 Global Financial Crisis (GFC) (See Chen and Cheung, 2011; Cheung, Ma and MaCauley, 2011). Toward this end, China's authorities launched its hallmark Pilot Program of RMB Settlement of Cross-Border Trade Transaction Settlement and expanded it in the following years to cover entire China to enable the currency to perform the functions of "Unit of Account" and "Medium of Exchange" in international trade. (Frankel, 2012)

At the beginning stage, one practical and fundamental obstacle to use the RMB in trade settlement is the lack of the RMB funding outside China, preventing foreign importers from settling trade transactions with Chinese exporters in the RMB. The problem fundamentally stems from the inconvertibility of the currency under the capital account, making it impossible for RMB funds to freely flow out of China.

To address this problem, the PBoC seeks to sign more BSAs with other central banks and use them as a channel to provide RMB funding to the foreign importers which might have interest in participation of RMB trade settlement.

The central Bank of Egypt (CBE), which signed a BSA of RMB 18 billion with the PBoC in December 2016, illustrates how the BSA functions to help an Egyptian importer to obtain RMB funding for the trade settlement (Figure 1):

1   "The CBE and the PBOC activate the currency swap in advance, after which each party puts its local currency swap fund at the account within itself and under the name of the counterpart (CBE deposits in EGP, PBOC in RMB). i.e the (CBE) provides to China, Egyptian pounds (EGP). It opens an account on behalf of China in EGP within the central bank, and the (PBOC) provides in exchange Chinese Renminbi (RMB) for the same amount. It opens an account in the PBOC on behalf of the CBE.

2   A domestic importer who imports goods from China applies for an RMB loan to a domestic bank.

3   The domestic bank applies to the CBE for an RMB loan. After the review process, the CBE notifies the domestic bank of the approval for the RMB loan. Subsequently, the CBE requests the PBOC to transfer RMB fund from the CBE's account within the PBOC into the domestic bank's account with a corresponding bank in China.

4   The domestic bank directs the corresponding bank in China to transfer RMB funds into a Chinese exporter's account, and the corresponding bank in China provides RMB funds to the Chinese exporter.

5   The domestic importer repays RMB loan at its maturity date. The domestic bank notifies the CBE of the repayment and transfers RMB into the CBE's account within the PBOC through the corresponding bank in China."

Figure 1   China FX currency swap agreement illustration from an importer perspective in Egypt
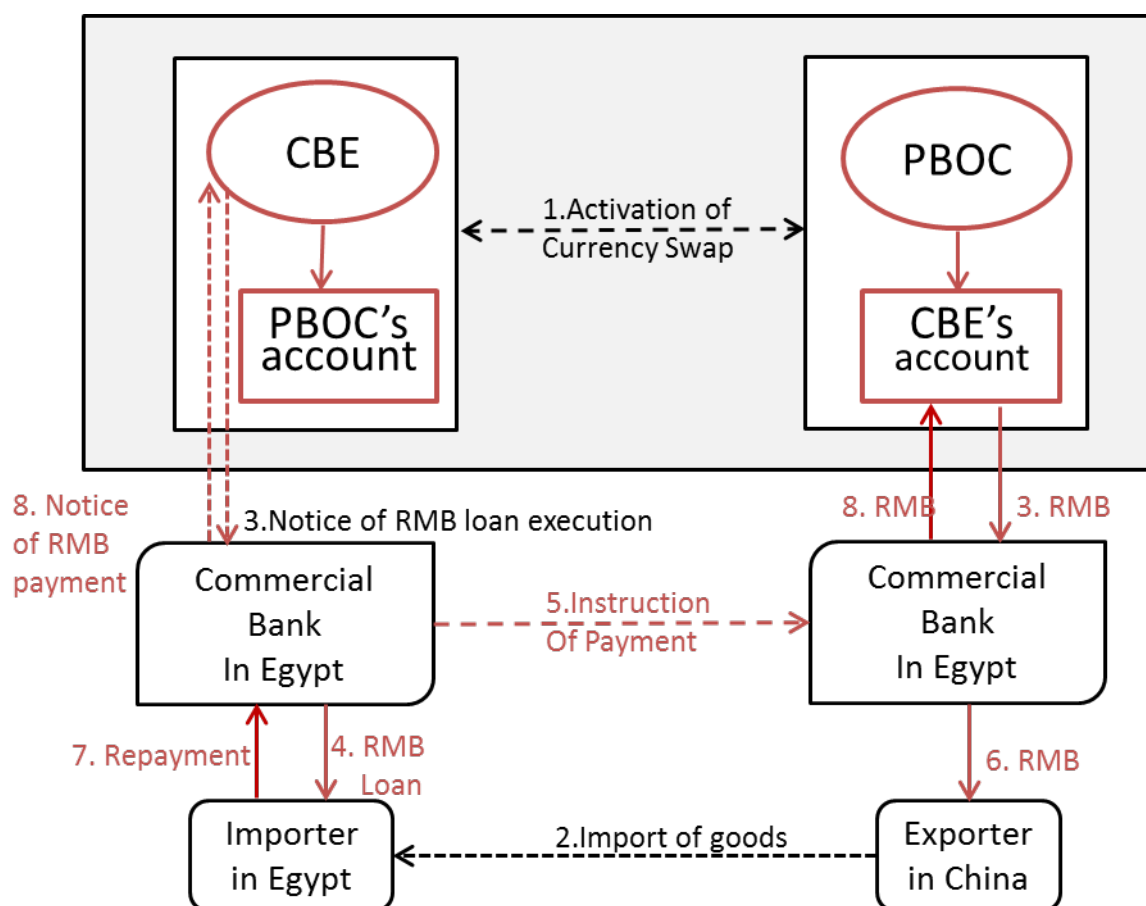
Source: The Treatment of Currency Swaps between Central Banks: Egypt Experience (the Central Bank of Egypt, 2017)

The trade-oriented nature of these RMB BSAs also reflects the PBoC's selection of its BSA partners. Previous research studies, including Garcia-Herrero and Xia (2015) and Liao and McDowell

(2015), find that the PBoC put emphasis on its trade relationship with the potential candidate although some other factors, including political relationships and societal institutional characteristics, also play a role in the singing of BSAs. Moreover, according to Lin et al (2016) the size of BSAs between the PBoC and other central banks positively correlates with the bilateral trade intensity as well as the presence of a bilateral free trade agreement.

Despite the fast-growing number of BSAs, the information about the real use of these RMB BSAs is scarce. The PBoC sporadically reports relevant information. In its 2010 annual report, the PBoC disclosed that about RMB 30 billion of BSAs were used in the year compared to the then outstanding BSAs of RMB 803.5 billion. (The PBoC, 2010) In a thematic report of "the RMB internationalization", the PBoC reports that, as of end-2014, the usage of RMB BSAs amounted to RMB 96.5 billion among which RMB 80.7 billion was initiated by the other central banks. The figures are small relative to the then total outstanding BSAs of around RMB 3 trillion (The PBoC, 2015)

News media also report the use of the RMB BSAs on a case-by-case basis from time to time. Generally, these reported cases are related to the traditional function of a BSA in providing liquidity to the counterparty rather than the specific use of the RMB trade settlements. For example, the Hong Kong Monetary Authority (HKMA), Hong Kong's de facto central bank, was reported to use the BSA with China in October 2011 to meet local banks' liquidity demand for the currency. At the beginning of 2016, the Argentinian government announced that it would obtain certain amount of RMB funds through its BSA with China.

For example, Takatoshi (2011) expresses his doubt about the actual impact of the RMB BSAs on the backdrop of China's still-closed capital account. McDowell (2019) tries to get more information about the real use of these RMB BSAs by sending inquiries to 35 central banks which have BSAs with China. Based on the limited responses from the central banks, McDowell (2019) concludes that these RMB BSAs are rarely being tapped.

The reported infrequent use of the BSAs with China has raised people's concerns about the effectiveness of the PBoC's BSA-signing strategy to promote the RMB usage in cross-border trade. McDowell (2019) infers that these RMB BSAs are ineffective in regard to its objective of increasing the RMB usage in trade settlement. Therefore, they should be understood as a form of financial statecraft which is deployed to achieve foreign policy ends.

The conclusion of McDowell (2019) deserves more scrutiny. Indeed, we believe that the effectiveness of the RMB BSAs should not solely be assessed on the basis of their amount. It is noted that the BSAs with the PBoC are not the only channel through which foreign importers have access to the RMB funding for trade settlement. Since the inception of the RMB internationalization, China's authorities gradually loosen their grip on the capital account to allow RMB funds to flow

out of China and thereby develop offshore RMB markets. Apart from the BSA channel, foreign importers can obtain the RMB funds from those offshore RMB markets as well.

It means that a RMB BSA can be tapped for the purpose of stabilizing the offshore market under the central bank's jurisdiction. Indeed, HKMA used its BSA with the PBoC in 2011 for stabilizing its offshore RMB market, which is also the largest one in the world. As such, the existence of a RMB BSA can help to reinforce the confidence of foreign banks and importers in using the RMB in their transaction settlement since the BSA will enable their central banks to have additional capacity to stabilize their offshore RMB markets.

All in all, the effectiveness of the RMB BSAs should be examined empirically. Unfortunately, there is scant literature in this respect. Zhang et al (2017) is an exception, which finds a significantly positive effect of swap agreements on trade. In their benchmark model, the signing of a RMB BSA would improve bilateral trade values between China and its partners by around 30%. However, Zhang et al (2017) doesn't touch upon the BSA's direct impact on the RMB usage. To fill this gap in existing literature, our research directly focuses on the impact of the BSA signing on the use of RMB in trade settlement.

SWIFT Data

Our empirical investigation of the RMB settlements largely hinges on the availability of relevant data. Fortunately, SWIFT, or the Society for Worldwide Interbank Financial Telecommunication, provides a unique dataset of cross-border settlements denominated in the RMB which has been used by some previous research to examine the progress of the RMB internationalization (Batten and Szilagyi, 2016). As the world's largest electronic payment system, SWIFT has a standardized bank-to-bank messaging system to facilitate fund transfer among its member banks. Every message in the SWIFT system represents a fund flow between two member banks.

In particular, Batten and Szilagyi (2016) report that SWIFT classify their data of message in a number of ways based on the type of financial product, relationship of counterparties (e.g. bank to bank versus bank to customer) as well as the currencies used in the transactions, which enable them to measure to what extent the RMB has advanced on different dimensions towards a real international currency including a unit of account; a medium of exchange for market transactions, and a store of value for saving.

We only use part of transaction data in Batten and Szilagyi (2016), MT 700 (confirmations of the issuance of a trade documentary credit) which corresponds to trade invoicing.

This aggregated data is bundled into monthly maturities for the period from October 2010 to November 2015. For each type of message, we have all transactions denominated for each SWIFT

currency. Therefore, we are able to construct three variables for each type of message: (i) the number of transactions denominated in the RMB; (ii) the value of transactions denominated in the RMB; and (iii) the proportion of RMB denominated value to the total value for each country.

3 Empirical results

First of all, we divide our country sample into two groups, one with a RMB BSA signed during the period from October 2010 to November 2015 and the other without BSA. In particular, the PBoC signed a RMB BSA with the ECB in October 2013. Therefore, we treat the Eurozone members which joined the currency union before October 2013 as in the first group. Table 1 summarizes some characteristics of the two country groups.

Table 1   Descriptive statistics

	No swap agreement	Have swap agreement	T-test for equality
# of countries	49	42	
GDP	52.99	59.55	–0.20
GDP/per capita	1.23	2.41	–2.88***
Population	62.96	40.28	0.78
Distance	7815	7433	0.45
Import (%)	10.33	10.59	–0.21
Export (%)	15.65	12.74	1.38

This table shows the descriptive statistics of the sample countries in our paper

Note: *, ** and *** represent significance level at 10%, 5%, and 1%, respectively.

Performance with and without a BSA

We then focus on the first group of countries/regions and make a direct comparison between the periods with and without BSAs. For each country, we simply separate the window without BSA and the window with BSA for the whole sample period and directly compare (i) the number of transactions denominated in the RMB; (ii) the value of transactions denominated in the RMB; and (iii) the proportion of RMB denominated value to the total value for each country, for the MT 700 message. The sample we use is all the countries that have a BSA with China. There are 42 countries altogether, but Hong Kong, Malaysia, Singapore, and South Korea are dropped out of the sample since all these four countries/regions have BSAs with China throughout the whole sample period which makes it impossible for us to compare. Therefore, the final sample consists of 38 countries. The results are shown in Table 2.

Table 2   Signing RMB BSA and its impact

		Without swap	With swap	Paired t-value for (log) diff	Signrank z value for (log) diff
# of obs.		38	38		
1. RMB number of	Mean	5.40	8.20	3.42***	
	Median	0.38	1.47		3.34***
2. RMB value of	Mean	1.44	2.647	3.98***	
	Median	0.595	1.173		3.20***
3. RMB proportion of	Mean	0.016	0.026	1.35	
	Median	0.001	0.003		2.32**

This table shows the different measures of cross-border trade in time periods with swap and without swap

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

In Table 2, we show that in the MT 700 message, the mean number of RMB denominated transactions is 5.40 for the "without-BSA" window, and it is 8.20 per month after a RMB BSA is signed with China. The log difference is significant at 1%. The median also exhibits significant increase. Similar patterns can also be found for the value of RMB denominated transactions. For the proportion of RMB denominated value, although the mean change is insignificant, the median change is significant at 5% level which might be due to the skewness of distribution among different countries. In short, the RMB-settled transactions indeed experienced a significant increase after the country/region signed a BSA with China.

OLS results

We further use OLS to test the relationship between the BSA signing and the RMB-settled transactions. Specifically, we use the following regression:

$$Y_{im} = \alpha + \beta Swap_{im} + \gamma Control_{im} + \varepsilon_{im}$$

where Y_{im} contains the three target variables: the number of transactions denominated in the RMB, the value of transactions denominated in the RMB, as well as the proportion of RMB-denominated

transactions to total transaction value for country i, month m. $Swap_{im}$ is a dummy variable which equals 1 if country i has already signed a RMB swap agreement with China in month m, and 0 otherwise. $Control_{im}$ stands for a group of control variables and sources whose definitions are detailed in Appendix 2.

In this model, we use all the 91 sample countries/regions. The results are shown in Table 3.

Table 3   OLS regression results

	1 RMB number of transactions	2 RMB number of transactions	3 RMB value of transactions	4 RMB value of transactions	5 RMB proportion of transactions	6 RMB proportion of transactions
swap	83.45*** [10.77]	32.97*** [9.40]	2.323*** [21.45]	1.524*** [13.71]	0.0392*** [12.30]	0.0309*** [12.11]
imex		21.12*** [8.74]		0.934*** [5.47]		0.0495*** [5.64]
openness		4.158*** [8.23]		0.192*** [6.95]		0.00425*** [9.00]
population		–2.720*** [–3.14]		0.237*** [6.17]		–0.00135* [–1.85]
gdp		4.535*** [7.58]		0.530*** [17.40]		0.00617*** [9.03]
bank		–0.610*** [–7.09]		–0.00963*** [–3.77]		–0.000267*** [–3.07]
Time FE	No	Yes	No	Yes	No	Yes
_cons	3.628*** [15.31]	–1.398 [–0.77]	1.050*** [29.90]	–2.128*** [–19.98]	0.0162*** [14.61]	–0.0215*** [–6.94]
N	6552	5400	6552	5400	6552	5400

In this Table, we provide OLS regression results

Where dependent variable Y_{im} is one of the three target variables: number of RMB transactions, RMB value and proportion of RMB settlement for country i, month m. $Swap_{im}$ is a dummy variable which equals 1 if country i has signed the swap line contract with China in month m, and 0 otherwise.

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

In Table 3, the null hypothesis is that the signing of BSA has no impact on the counterparty country's transactions in the RMB. If the null hypothesis is true, then the coefficient of $Swap_{im}$ should not be significantly different from zero. In Table 3, we can see that all the coefficients of $Swap_{im}$ are significantly positive, indicating that the signing of BSA actually promotes the use of RMB in trade settlement.

However, the results in Table 3 are subject to at least the following biases. First, we are using the data where observations within one country or one year are clustered, and the use of a single level model may cause problems. We therefore need to use multilevel models. Second, the choice of signing the BSA with China might not be an exogenous decision. The level of RMB

settlement in the past may be an important factor driving the signing of a BSA with China. This endogeneity problem is not considered in the OLS results. Third, the number of transactions in the RMB, the value in the RMB, as well as the proportion of RMB transaction value for country i, month m may not be a stationary series, which could distort the previous OLS results.

Multi-level mixed model

To address the concern of clusters, we adopt the multi-level mixed model for random coefficients for both the countries and for the calendar years. Mixed models are characterized by containing both fixed and random effects. The fixed effects are analogous to standard regression coefficients and are estimated directly. The random effects are not directly estimated but are summarized in terms of their estimated variances and covariances. Random effects may take the form of random intercepts or random coefficients. In our analysis, we adopt the random intercepts models and the results are shown in Table 4. The definitions of the variables in table 4 are exactly the same as in those in table 3.

Table 4   Random coefficient models

	1 RMB number of transactions	2 RMB number of transactions	3 RMB value of transactions	4 RMB value of transactions	5 RMB proportion of transactions	6 RMB proportion of transactions
swap	0.159*** [3.30]	0.130*** [2.79]	0.474*** [3.94]	0.444*** [3.51]	0.012*** [2.85]	0.0125*** [4.35]
imex		0.295** [2.09]		0.808** [2.13]		0.0405*** [4.58]
openness		–0.00457 [–0.07]		0.099 [0.63]		0.00229 [0.76]
population		–0.0467 [–0.45]		0.0436 [0.20]		–0.00344 [–0.81]
gdp		0.339*** [4.09]		0.759*** [4.24]		0.00874** [2.55]
bank		–0.0066 [–1.08]		–0.0181 [–1.36]		–0.000141 [–0.55]
Random coeff. for country	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Constants	0.626** [5.25]	1.449*** [6.03]	1.449*** [6.03]	–0.62 [–1.17]	0.022*** [3.27]	–0.0094 [–0.93]
N	6552	5400	6552	5400	6552	5400

In this Table, we provide the estimation results for the mixed models, in which the coefficients are a mix of fixed parameters and random variables. We allow varying intercepts for countries and for different years. The variable names are defined in Appendix 2.

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

We can see that in Table 4, the coefficients of swap dummies in all the 6 specifications are sig-nifcantly positive, which is highly consistent with previous results. This result rejects the null hy-pothesis that the adoption of BSA has no impact on the RMB trade settlements, showing that even after controlling the possible impact of country-level and time-level clustering, the adoption of the BSA with China will promote the use of the RMB in trade settlement.

Endogeneity of BSA signing

In order to account for possible endogeneity of the event of BSA signing, we adopt the following Probit model:

$$prob(\mathbf{1}_{im}) = \gamma_i + \theta_i X_{im} + u_{im}$$

where the dependent variable is a dummy which equals one if country i has a signed BSA with China in month m, and zero otherwise. The X_{im} contains a number of explanatory variables, which are used in previous studies to predict the BSA signing (see Garcia-herrero and Xia, 2015; Liao and McDowell, 2015; Lin et al, 2016). These explanatory variables include: (1) *distance* between coun-try i and China, (2) *voice and accountability*, reflecting perceptions of the extent to which a coun-try's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media, (3) *political stability*, which measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism, (4) *gov-ernment effectiveness*, which reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such poli-cies, (5) *regulatory quality,* which reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development, (6) *rule of law*, which reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, and the likelihood of crime and violence, as well as (7) *control of cor-ruption*, which reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. In addition to these exogenous political factors, we also include the one-period lagged value of the number of transactions in RMB, the value in RMB, as well as the proportion of RMB settlement. The results of the Probit model are exhibited in Table 5.

Table 5   The factors determining the signing of BSAs

Panel A   Probit results

	(1)	(2)	(3)
RMB number of transactions$_{t-1}$	0.00247*** [9.66]		
RMB value of transactions$_{t-1}$		0.0924*** [16.20]	
RMB proportion of transactions$_{t-1}$			1.783*** [10.83]
distance	-0.420*** [-11.56]	-0.366*** [-10.04]	-0.396*** [-10.59]
voice and accountability	0.134*** [3.73]	0.0557 [1.56]	0.0252 [0.72]
political stability	-0.00563 [-0.18]	0.0219 [0.68]	-0.0795** [-2.53]
government effectiveness	0.955*** [10.25]	0.687*** [7.20]	0.936*** [10.00]
regulatory quality	-0.400*** [-5.35]	-0.159** [-2.12]	-0.180** [-2.43]
rule of law	0.0413 [0.38]	0.0359 [0.32]	0.0713 [0.66]
control of corruption	-0.364*** [-5.00]	-0.334*** [-4.51]	-0.353*** [-4.82]
constant	2.647*** [8.25]	1.973*** [6.06]	2.359*** [7.08]
# of observations	6458	6458	6458

This table provides results for a probit regression:

$$prob(\mathbf{1}_{im}) = \gamma_i + \theta_i X_{im} + u_{im}$$

where dependent variable $\mathbf{1}_{im}$ equals 1 if country i has the swapline with China in month m, and 0 otherwise. X_{im} is the set of explanatory variables described in Appendix 2

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

Panel B   Marginal effects

	(1)	(2)	(3)
RMB number of transactions$_{t-1}$	0.0006*** [9.88]		
RMB value of transactions$_{t-1}$		0.0225*** [17.18]	
RMB proportion of transactions$_{t-1}$			0.447*** [11.10]

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

Panel C   Probit models considering one control variable at a time

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RMB number of transaction $_{t-1}$	0.00343*** [12.35]	0.00358*** [12.72]	0.00346*** [12.13]	0.00288*** [10.34]	0.00313*** [10.90]	0.00312*** [11.03]	0.00319*** [11.20]
distance	-0.368*** [-11.67]						
voice and accountability		0.196*** [10.80]					
political stability			0.188*** [10.17]				
government effectiveness				0.301*** [15.68]			
regulatory quality					0.258*** [13.06]		
rule of law						0.247*** [13.78]	
control of corruption							0.201*** [12.04]
Constant	2.363*** [8.52]	-0.897*** [-44.77]	-0.869*** [-43.96]	-0.985*** [-45.26]	-0.970*** [-44.76]	-0.939*** [-45.21]	-0.914*** [-45.05]
N	6458	6458	6458	6458	6458	6458	6458

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

The results from Panel A, Table 5 confirm our concerns that the selection of RMB BSA partners is indeed endogenous, since the estimated coefficients for all three lagged variables (the number of transactions in the RMB, the value in the RMB, as well as the proportion of RMB settlement) are significantly positive. Panel B of Table 5 shows the marginal effect. For example, one percent increase in the total number of RMB denominated transactions leads to 0.11% higher in the probability that country i will sign the BSA contract with China. The results from other specifications are highly consistent, confirming the endogeneity of the events.

In Panel C of Table 5, we show the same Probit model running on the control variables separately. We can see that some of the inconsistent signs of the coefficients in Panel A, Table 5 come from the multicollinearity between the political factors. If we run the Probit models on individual control variables separately, all the political factors have a significantly positive coefficient. The results show that the political reasons are among the major driving forces that increase the probability of signing a BSA with China.

Non-stationarity of variables

Another concern that we have is the possible non-stationarity of the series. In order to test the stationarity, we limit our sample to countries with BSA contract in our sample. Moreover, Argentina, Belarus, and Indonesia are dropped out of the sample since they move from the status from no swap to swap, causing complexity. Also, Hong Kong, Singapore, and Malaysia have all "with-swap" status in the sample. To be consistent with the later results, these three countries are dropped out. There are 28 countries in this sample. We first calculate the monthly mean values of the number of transactions in the RMB, the value in the RMB, as well as the proportion of RMB settlement, across different countries, and form a time-series. Subsequently, Dicky-Fuller test is used in the three variables' series to test the stationarity). We can see from Panel A of Table 6 that, the null hypothesis of non-stationarity cannot be rejected, indicating that the existence of non-stationarity is indeed a valid concern.

Table 6   Stationarity of variables

Panel A   Raw values

MT 700	RMB number of transactions	RMB value of transactions	RMB proportion of trasactions
Z(t)	–1.96	–2.11	–2.52
p-value	0.302	0.238	0.110

Panel B   Abnormal values

MT 700	RMB number of transactions	RMB value of transactions	RMB proportion of transactions
Z(t)	–4.68	–4.13	–4.42
p-value	0.000	0.001	0.000

In this Table, we check the potential trend by using the Dicky-Fuller test in Panel A. In panel B, we check the abnormal values for the RMB number,value and proportion of transactions. The abnormal values in the RMB number,value and proportion of the transactions are defined as:

$$ab\_value_{im} = value_{im} - value_{bm}$$

where $value_{bt}$ is the benchmark RMB number, value and proportion of transactions in month t. $value_{im}$ is their value for country i in our sample in month m.

We adopt the following methodology to tackle the non-stationarity: First, we choose all the countries with no BSA with China in the sample period and calculate the cross-sectional mean of the number of transactions in the RMB, the value in the RMB, as well as the porportion of RMB settlement as a benchmark, which captures the trend of RMB settlement, but is free of the impact of signing the contract of BSA with China. Then, we define the abnormal value as:

$$ab\_value_{im} = value_{im} - value_{bm}$$

where $value_{bm}$ is the benchmark number , **value** and **proportion of RMB transactions** in month m. $value_{im}$ is the benchmark number , **value** and **proportion of RMB transactions** for country i in our sample in month m. ab_value_{im} is the abnormal value, which is the difference between $value_{im}$ and $value_{bm}$. We then calculate the time-series of ab_value_{im} by taking the mean across different countries in month m. Panel B of Table 6 shows the Dick-Fuller test results of the time-series of the abnormal values of the three target variables. The results show that, in all cases, the null hypotheses of non-stationarity are rejected, and we prove that the abnormal values do not suffer from a non-stationarity problem.

Difference-in-Difference Model

One way to deal with the parallel-trend possibility is to apply a difference-in-difference regression, which requires weaker assumptions. For each country i that signs BSA with China, we adopt a 24-month window before and after the BSA is signed. Our control group contains all the countries in our sample that have not signed BSA at all. For each country in the test group, we select the country which is most similar to the test group country in terms of the average GDP in the 48-month window. We run the following difference in difference regression:

$$Y_{im} = \alpha + \beta Test_{im} + \gamma Post_{im} + \theta Test_{im} * Post_{im} + \varepsilon_{im}$$

where Y_{im} contains the three target variables: RMB number of transactions, lRMB value of transactions, andRMB proportion of transactions for country i, month m. $Test_{im}$ is a dummy variable which equals 1 if country i has signed the swap line with China, and 0 for the control group. $Post_{im}$ is a dummy variable which equals 1 if country i has signed the swap line contract with China in month m or its corresponding test country has signed the swap line with China in month m if it is a control country, and 0 otherwise. We can see that the interaction term of $Test_{im}$ and $Post_{im}$ are significantly positive in all the three settings, implying that after controlling for the possible common trend, the countries that have signed BSA with China show significant increase in the number of RMB transactions, value of RMB transactions, as well as proportion of RMB transactions. The results from the difference-in-difference regression are highly consistent with the previous ones.

Table 7   Difference-in-difference regression

	RMB number of transactions	RMB value of transactions	RMB proportion of transactions
Test	0.316***	1.082***	0.00651**
	[6.48]	[8.02]	[2.44]
Post	0.0662	0.322***	0.00599*
	[1.42]	[2.72]	[1.73]
Test*Post	0.308***	0.350*	0.00891*
	[3.80]	[1.75]	[1.95]
Constant	0.419***	1.068***	0.0101***
	[13.66]	[13.30]	[4.96]
# of observation	3536	3536	3536

In this Table, we run the following difference in difference regression:

$$Y_{im} = \alpha + \beta Test_{im} + \gamma Post_{im} + \theta Test_{im} * Post_{im} + \varepsilon_{im}$$

where Y_{im} contains the three target variables: RMB number of transactions, lRMB value of transactions, andRMB proportion of transactions for country i, month m. $Test_{im}$ is a dummy variable which equals 1 if country i has signed the swap line with China, and 0 for the control group. $Post_{im}$ is a dummy variable which equals 1 if country i has signed the swap line contract with China in month m or its corresponding test country has signed the swap line with China in month m if it is a control country, and 0 otherwise.

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

IV regression results

We now apply the instrumental variable regression to control for both endogeneity and non-stationary concerns. Given the endogenous nature of the variables, we follow Lin, Zhan and Cheung (2016), and consider the political and institutional variables discussed in Table 4 as the exogeneous factors, and use the following regression.

In the first stage, we run the following probit model

$$Swap_{im} = \alpha_1 + \beta_1 Y_{im-1} + \gamma_1 EF_i + \epsilon_{im}$$

Where $Swap_{im}$ is a dummy variable which equals 1 if country i has signed the swap line contract with China in month m, and 0 otherwise. Y_{im-1} is the one-period lagged abnormal values of the target variables (number of transactions, value, as well as RMB proportion settlement for country i, month m) EF_i is the political and institutional variables discussed in Table 4, and ϵ_{im} is the error term.

The second stage includes the following regression:

$$Y_{im} = \alpha + \beta \widehat{Swap}_{im} + \gamma Control_{im} + \varepsilon_{im}$$

where Y_{im} contains the abnormal values of the three target variables: number of transactions, value, as well as RMB proportion settlement for country i, month m. $\widehat{Swap}_{im}$ is the fitted value from Stage

1 regression. The control variables include the imports and exports as a percentage of GDP in country i, month m, the degree of openness of country i, as well as the GDP and population of country i, month m. The results are shown in Table 8.

Table 8   Detrended results

	1 RMB number of transactions	2 RMB number of transactions	3 RMB value of transactions	4 RMB value of transactions	5 RMB proportion of transactions	6 RMB proportion of ransactions
swap	12.22*** [7.59]	10.67*** [7.10]	37.88*** [7.34]	31.52*** [7.03]	3.824*** [22.44]	1.020*** [4.66]
ImEx		0.295*** [3.32]		0.725*** [2.75]		0.0261*** [3.43]
Openness		−0.00301 [−0.15]		0.114* [1.83]		0.00127 [0.71]
Population		−0.0398 [−1.00]		−0.144 [−1.21]		−0.00611* [−1.75]
GDP		0.117*** [3.51]		0.371*** [3.71]		0.00860*** [2.96]
bank		−0.00147 [−1.54]		−0.00949*** [−3.27]		−0.000139* [−1.69]
Time FE	No	Yes	No	Yes	No	Yes
_cons	−5.484*** [−7.29]	−5.112*** [−7.14]	−16.69*** [−6.92]	−14.71*** [−6.90]	−1.764*** [−19.75]	−0.500*** [−4.85]
Swap						
RMB number of transactionst-1	0.0693*** [7.61]	0.073*** [7.20]				
RMB value of transactionst-1			0.0221*** [7.36]	0.0242*** [7.20]		
RMB proportion of transactionst-1					0.185*** [20.31]	0.690*** [4.71]
Instruments	Yes	Yes	Yes	Yes	Yes	Yes
_cons	0.529*** [19.80]	0.630*** [14.77]	0.525*** [20.23]	0.658*** [14.18]	0.493*** [36.39]	0.595*** [13.84]

In this Table, we run the following regression:

$$Y_{im} = \alpha + \beta \widehat{Swap}_{im} + \gamma Control_{im} + \varepsilon_{im}$$

where Y_{im} contains the abnormal values of the three target variables: RMB number, value and proportion of transactions for country i, month m. We use IV regression with a set of explanatory variables described in Appendix 2.

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

Table 8 shows highly consistent results with those from Table 3. Even after controlling the endogeneity and non-stationarity problems, in all the 6 settings, the coefficients of $\widehat{Swap}_{im}$ are significantly positive, implying that the signing of a BSA will significantly promote the RMB denominated transactions in international trade.

Size of the Swapline

Up to now we have been considering the swap line as a binary variable. But the size of the swap line may also have an effect as well. In order to check the possible impact of size of the swap line, we used the size of the swap line signed between country i and China, scaled by the GDP of country i in the year the swap line is signed, to capture the size. And then we run the following regression:

$$Y_{im} = \alpha + \beta Size_{im} + \gamma Control_{im} + \varepsilon_{im}$$

where Y_{im} contains the three target variables: number of RMB transactions, RMB value, as well as RMB proportion of transactions for country i, month m. $Size_{im}$ is the size of swap line for country i, month m, as defined above. The results are shown in Table 9.

Table 9   Size of the swap line

	1 RMB number of transactions	2 RMB number of transactions	3 RMB the value of transactions	4 RMB the value of transactions	5 RMB proportion of transactions	6 RMB proportion of transactions
size	2278.7*** [13.53]	1008.4*** [9.85]	19.67*** [15.68]	21.59*** [13.84]	0.799*** [16.46]	0.638*** [11.35]
imex		−22.46** [−2.38]		1.478*** [4.06]		0.0468*** [4.94]
openness		19.24*** [10.38]		0.531*** [8.84]		0.0126*** [10.85]
population		6.358*** [3.56]		0.645*** [7.20]		0.00538*** [2.67]
gdp		4.306*** [3.76]		0.541*** [7.92]		0.00681*** [3.89]
bank		−2.494*** [−9.60]		−0.0520*** [−8.74]		−0.00116*** [−5.54]
Time FE	No	Yes	No	Yes	No	Yes
_cons	−23.16*** [−8.72]	−0.0849 [−0.02]	1.667*** [22.96]	−1.050*** [−3.96]	0.00774*** [6.07]	−0.0187*** [−3.12]
N	2160	1896	2160	1896	2160	1896

In this we provide results of the regressions where it is accounted for the size of the swap line.

Y_{im} contains the three target variables: number of RMB transactions, RMB net amount, and RMB percentage settlement for country i, month m. $Size_{im}$ is the size of swap line for country i, month m.

Note: *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

The results in Table 9 are highly consistent with those in Table 3, meaning that the size of the swap line may also promote the international settlement between China and the target country.

4 Conclusions

To push forward the internationalization of its currency, China's authorities have deployed a large number of initiatives to increase the international use of the RMB, among which is that China's central bank, the People's Bank of China (PBoC) actively signed the RMB-denominated Bilateral Swap Agreements (BSAs) with other central banks.

Our research is among the first which empirically examine the effectiveness of RMB BSAs. Thanks to the unique data provided by SWIFT, we are able to directly investigate the impact of the BSA signing on RMB-denominated transactions rather than the general bilateral trade.

Our results confirm that the signing of a RMB BSA helps to increase the number, the value and the proportion of RMB settlement in cross-border trade. Our results are also robust with respect to the choice of different regression models which are adopted to address a number of potential biases related to the OLS model.

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Appendix 1   China's bilateral local currency swap agreements, as of end-2017

Partner economies	Swap line size	Effective date	Expiration date	Duration (year)
South Korea	RMB 180 bn/KRW 38,000 bn	12 Dec. 2008	Dec. 2011	3
renewed	RMB 360 bn/KRW 64,000 bn	11 Oct. 2011	Oct. 2014	3
renewed	RMB 360 bn/KRW 64,000 bn	11 Oct. 2014	Oct. 2017	3
renewed	RMB 360 bn/KRW 64,000 bn	11 Oct. 2017	Oct. 2020	3
Hong Kong	RMB 200 bn/HKD 227 bn	20 Jan. 2009	Jan. 2013	3
renewed	RMB 400 bn/HKD 490 bn	22 Nov. 2011	Nov. 2014	3
renewed	RMB 400 bn/HKD 505 bn	27 Nov. 2014	Nov. 2017	3
renewed	RMB 400 bn/HKD 470 bn	22 Nov. 2017	Nov. 2017	3
Malaysia	RMB 80 bn/MYR 40 bn	8 Feb. 2009	Feb. 2012	3
renewed	RMB 180 bn/MYR 90 bn	8 Feb. 2012	Feb. 2015	3
renewed	RMB 180 bn/MYR 90 bn	17 Apr. 2015	Apr. 2018	3
Belarus	RMB 20 bn/BYR 8,000 bn	11 Mar. 2009	Mar. 2012	3
renewed	RMB 7 bn/BYR 16,000 bn	10 May 2015	May 2018	3
Indonesia	RMB 100 bn/IDR 175,000 bn	23 Mar. 2009	Mar. 2012	3
renewed	RMB 100 bn/IDR 175,000 bn	1 Oct. 2013	Oct. 2016	3
Argentina	RMB 70 bn/ARS 38 bn	2 Apr. 2009	Apr. 2012	3
renewed	RMB 70 bn/ARS 90 bn	18 Jul. 2014	Jul. 2017	3
renewed	RMB 70 bn/ARS 175 bn	18 Jul. 2017	Jul. 2020	3
Iceland	RMB 3.5 bn	10 Jun. 2010	Jun. 2013	3
renewed	RMB 3.5 bn/ISK 66 bn	11 Sep. 2013	Sep. 2016	3
renewed	RMB 3.5 bn/ISK 66 bn	21 Dec. 2016	Dec. 2019	3
Singapore	RMB 150 bn/SGD 30 bn	23 Jul. 2010	Jul. 2013	3
renewed	RMB 300 bn/SGD 60 bn	7 Mar. 2013	Mar. 2016	3
renewed	RMB 300 bn/SGD 60 bn	7 Mar. 2016	Mar. 2019	3
New Zealand	RMB 25 bn/NZD 5bn	18 Apr. 2011	Apr. 2014	3
renewed	RMB 25 bn/NZD 5bn	25 Apr. 2014	Apr. 2017	3
renewed	RMB 25 bn/NZD 5bn	19 May 2017	May 2020	3
Uzbekistan	RMB 0.7 bn/UZS 167 bn	19 Apr. 2011	Apr. 2014	3
Mongolia	RMB 5 bn/MNT 1000 bn	6 May 2011	May 2014	3
renewed	RMB 10 bn/MNT 2000bn	20 Mar. 2012	Mar. 2015	3
renewed	RMB 15 bn/MNT 4.5 tn	21 Aug. 2014	Aug. 2017	3
renewed	RMB 15 bn/MNT 5.4 tn	6 Jul. 2017	Jul. 2020	3
Kazakhstan	RMB 7 bn/KZT 150 bn	13 Jun. 2011	Jun. 2014	3
renewed	RMB 7 bn/KZT 200 bn	14 Dec. 2014	Dec. 2017	3
Thailand	RMB 70 bn/THB 320 bn	22 Dec. 2011	Dec. 2014	3
renewed	RMB 70 bn/THB 370 bn	22 Dec. 2014	Dec. 2017	3
renewed	RMB 70 bn/THB 370 bn	22 Dec. 2017	Dec. 2020	3

Partner economies	Swap line size	Effective date	Expiration date	Duration (year)
Pakistan	RMB 10 bn/PKR 140 bn	23 Dec. 2011	Dec. 2014	3
renewed	RMB 10 bn/PKR 165 bn	23 Dec. 2014	Dec. 2017	3
UAE	RMB 35 bn/AED 20 bn	17 Jan. 2012	Jan. 2015	3
renewed	RMB 35 bn/AED 20 bn	14 Dec. 2015	Dec. 2018	3
Turkey	RMB 10 bn/TRY 3 bn	21 Feb. 2012	Feb. 2015	3
renewed	RMB 12 bn/TRY 5 bn	26 Sep. 2015	Sep. 2018	3
Austrilia	RMB 200 bn/AUD 30 bn	22 Mar. 2012	Mar. 2015	3
renewed	RMB 200 bn/AUD 40 bn	30 Mar. 2015	Mar. 2018	3
Ukraine	RMB 15 bn/UAH 19 bn	26 Jun. 2012	Jun. 2015	3
renewed	RMB 15 bn/UAH 54 bn	15 May 2015	May 2018	3
Brazil	RMB 190 bn/BRL 60 bn	26 Mar. 2013	Mar. 2016	3
England	RMB 200 bn/GBP 20 bn	22 Jun. 2013	Jun. 2016	3
renewed	RMB 350 bn/GBP 35 bn	20 Oct. 2015	Oct. 2018	3
Hungary	RMB 10 bn/HUF 375 bn	9 Sep. 2013	Sep. 2016	3
renewed	RMB 10 bn/HUF 416 bn	12 Sep. 2016	Sep. 2019	3
Albania	RMB 2 bn/ALL 35.8 bn	12 Sep. 2013	Sep. 2016	3
EU	RMB 350 bn/EUR 45 bn	8 Oct. 2013	Oct. 2016	3
renewed	RMB 350 bn/EUR 45 bn	27 Sep. 2016	8 Oct. 2019	3
Switzerland	RMB 150 bn/CHF 21 bn	21 Jul. 2014	Jul. 2017	3
renewed	RMB 150 bn/CHF 21 bn	21 Jul. 2017	Jul. 2020	3
Sri Lanka	RMB 10 bn/LKR 225 bn	16 Sep. 2014	Sep. 2017	3
Russia	RMB 150 bn/RUB 815 bn	13 Oct. 2014	Oct. 2017	3
renewed	RMB 150 bn/RUB 1325 bn	22 Nov. 2017	Nov. 2020	3
Qatar	RMB 35 bn/QAR 20.8 bn	3 Nov. 2014	Nov. 2017	3
renewed	RMB 35 bn/QAR 20.8 bn	2 Nov. 2017	Nov. 2020	3
Canada	RMB 200 bn/CAD 30 bn	8 Nov. 2014	Nov. 2017	3
renewed	RMB 200 bn/CAD 30 bn	8 Nov. 2017	Nov. 2020	3
Suriname	RMB 1 bn/SRD 0.52 bn	18 Mar. 2015	Mar. 2018	3
Armenia	RMB 1 bn/AMD 77 bn	25 Mar. 2015	Mar. 2018	3
South Africa	RMB 30 bn/ZAF 54 bn	10 Apr. 2015	Apr. 2018	3
Chile	RMB 22 bn/CLF 2200 bn	25 May 2015	May 2018	3
Tajikistan	RMB 3 bn/TJS 3 bn	3 Sep. 2015	Sep. 2018	3
Morocco	RMB 10 bn/MAD 15 bn	11 May 2016	May 2019	3
Serbia	RMB 1.5 bn/RSD 27 bn	17 Jun. 2016	Jun. 2019	3
Egypt	RMB 18 bn/EGP 47 bn	6 Dec. 2016	Dec. 2019	3

Appendix 2   Variable definitions and sources

Variable	Definition	Source
Swap	A dummy variable equals to 1 if the country has signed a RMB swap line agreement with China and equals to 0 otherwise.	People's Bank of China
Distance	The log value of the distance between China and the host economy (capital-to-capital)	http://privatewww.essex.ac.uk/~ksg/data-5.html
Bank	The number of commercial bank branches per 100,000	The World Bank. https://www.worldbank.org/en/publica-tion/gfdr/data/global-financial-development-database
GDP	The log value of an economy's nominal gross domes-tic production in current US dollars	World Economic Outlook Databases, IMF
Population	The log value of an economy's population	World Economic Outlook Databases, IMF
ImEx	The ratio of an economy's imports and exports with China to its total imports and exports (%).	Direction of Trade Statistics, IMF
FTA	A dummy variable equals to 1 if China and the coun-terpart have a Free Trade Agreement and equals to 0 otherwise.	China's Ministry of Commerce
Openness	The Chinn-Ito Financial Openness Index measures a country's degree of capital account openness. A higher index number means more capital account openness.	http://web.pdx.edu/~ito/Chinn-Ito_web-site.htm
Voice and Accountability	Reflects perceptions of the extent to which a coun-try's citizens are able to participate in selecting their government, as well as freedom of expression, free-dom of association, and a free media.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/govern-ance/wgi/index.aspx#home
Political Stability	Political Stability and Absence of Violence/Terror-ism measures perceptions of the likelihood of politi-cal instability and/or politically-motivated violence, including terrorism.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/govern-ance/wgi/index.aspx#home
Government Ef-fectiveness	Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the cred-ibility of the government's commitment to such poli-cies.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/govern-ance/wgi/index.aspx#home
Regulatory Quality	Reflects perceptions of the ability of the government to formulate and implement sound policies and regu-lations that permit and promote private sector devel-opment.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/govern-ance/wgi/index.aspx#home
Rule of Law	Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/govern-ance/wgi/index.aspx#home
Control of Corruption	Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "cap-ture" of the state by elites and private interests.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/govern-ance/wgi/index.aspx#home

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