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By Ke Song and Le Xia[1]

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, value and proportion of the 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.

Key words： RMB; bilateral swap agreement; cross-border trade; SWIFT

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Introduction

The rise of China's currency, the renminbi (RMB), is a significant development in the international monetary system in the aftermath of the 2008-2009 global financial crisis. 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 internationalisation is a government-driven process, in stark contrast to some historical precedents of internationalised currencies such as the USD and Japanese Yen whose internationalisation 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 was signed between the PBoC and the Bank of Korea in December 2008. As of end-2017, the PBoC had 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 three-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, with the objective of helping the counterparty central banks to tackle the liquidity squeeze of the USD in their financial markets. In October 2013, the US Federal Reserve made five of the temporal BSAs into permanent standing arrangements, e.g. BSAs with 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 USD liquidity in the counterparties'

financial markets. On the other hand, McAndrews, Sarkar, and Wang (2008) and Rose and Spiegel (2012) find certain evidence that these BSAs helped stabilise market condition during the crisis period.

Differing from the ones signed by the US Federal Reserve, the PBoC's BSAs have a clear objective of facilitating the RMB internationalisation 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 with 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 countrywide data of trade transactions settled in the RMB. The PBoC has such data but it has never made them 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 while McDowell (2019) questions the effectiveness of these RMB BSAs in terms of promoting crossborder trade settlement in the RMB.

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 countrywide 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.

Our results confirm that the signing of a RMB BSA helps to increase the number, value and proportion of the 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 organised as follows. In the next section, we briefly introduce the backgrounds of RMB BSAs, especially against the backdrop of the RMB internationalisation. We then present our main results in the following section. The final section concludes.

Background and data

The RMB internationalisation and PBoC's BSA signing

The Chinese authorities set out to push for the internationalisation of its currency in the aftermath of the 2008-2009 global financial crisis (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 the 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 the 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 the RMB funding to foreign importers which might have interest in participation of the 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 as shown in Figure 1(CBE 2017).

First, 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 the Egyptian pounds, EGP; PBoC in the RMB). i.e the CBE provides to China EGP. It opens an account on behalf of China in the EGP within the central bank, and the PBoC provides in exchange the RMB for the same amount. It opens an account in the PBoC on behalf of the CBE. Second, a domestic importer who imports goods from China applies for an RMB loan to a domestic bank. Third, 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. Fourth, the domestic bank directs the corresponding bank in China to transfer the RMB funds into a Chinese exporter's account, and the corresponding bank in China provides the RMB funds to the Chinese exporter. Fifth, the domestic importer repays the RMB loan at its maturity date. The domestic bank notifies the CBE of the repayment and transfers the RMB into the CBE's account within the PBoC through the corresponding bank in China.

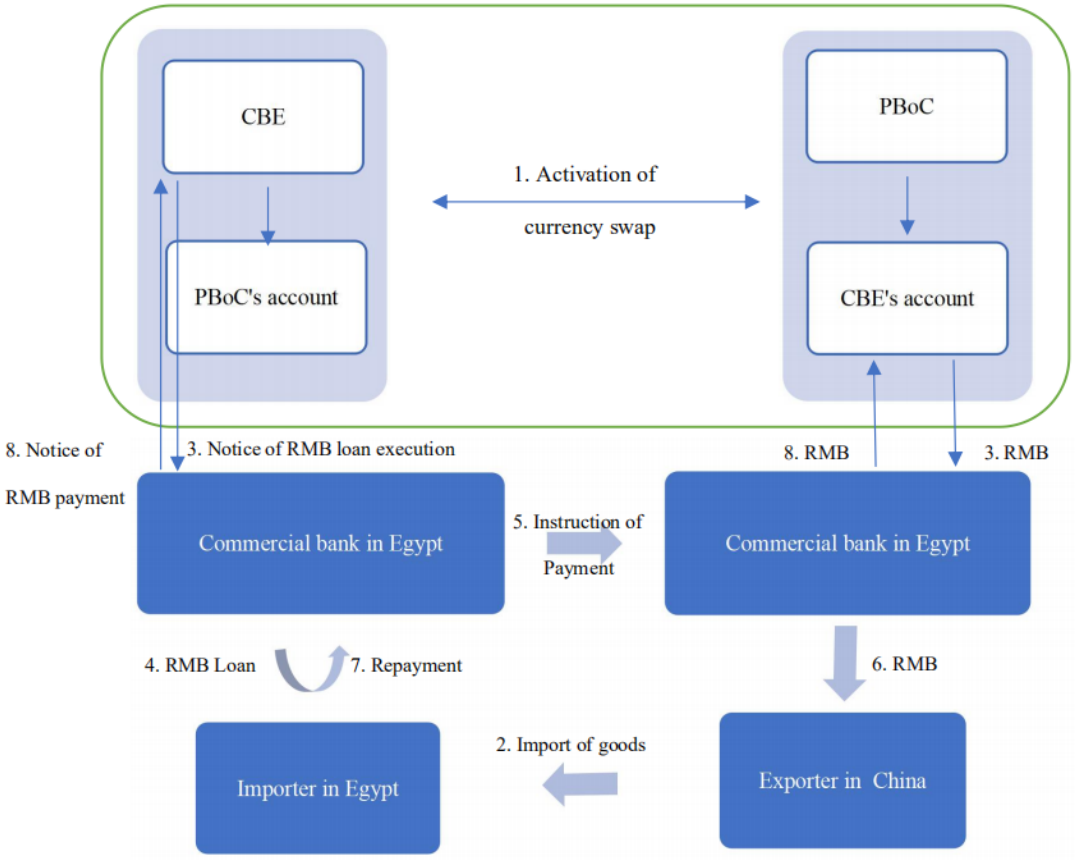

Figure 1. China FX currency swap agreement illustration from an importer perspective in Egypt.
Data source: CBE 2017.

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, Zhan, and Cheung (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 BSAs of about RMB 30 billion were used in the year compared to the then outstanding BSAs of RMB 803.5 billion (PBoC 2011). The PBoC (2015) 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 were small relative to the then total outstanding BSAs of around RMB 3 trillion.

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 the Chinese mainland 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 a certain number of the RMB funds through its BSA with China.

Some scholars express their doubt about the effectiveness of BSAs. Takatoshi (2011point out that the actual impact of the RMB BSAs might be limited due to 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 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 internationalisation, China's authorities have gradually loosened 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 stabilising the offshore market under the central bank's jurisdiction. Indeed, the HKMA used its BSA with the PBoC in 2011 for stabilising 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 stabilise 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. The research of 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) don't touch upon the BSA's direct impact on the RMB usage. To fill this gap in existing literature, our research directly focusses on the impact of the BSA signing on the use of the 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 internationalisation (Batten and Szilagyi 2016). As the world's largest electronic payment system, SWIFT has a standardised 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 classifies its 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 make it possible to measure to what extent the RMB has advanced on different dimensions towards a real international currency, including as 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), i.e. MT 700 (confirmations of the issuance of a trade documentary credit) which corresponds to trade invoicing. These aggregated data are bundled into monthly maturities for the period from October 2010 to November 2015. For each type of message, we have all transactions denominated in each SWIFT currency. Therefore, we are able to construct three variables for each type of message: (1) the number of transactions denominated in the RMB; (2) the value of transactions denominated in the RMB; and (3) the proportion of RMB denominated value to the total value for each country.

Empirical results

First of all, we divide our country/region samples 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 summarises some characteristics of the two country/region groups.

Table 1. Descriptive statistics.

	No swap agreement	With swap agreement	*T*-test for equality
# of countries	49	42	
GDP	52.99	59.55	-0.20
Population	62.96	40.28	0.78
Distance	7,815	7,433	0.45
Import (%)	10.33	10.59	-0.21
Export (%)	15.65	12.74	1.38

Note: This table shows the descriptive statistics of the sample countries/regions in our paper. *** represents significance level at 1%. GDP is in billion international dollar, population is in million, and distance is in kilometres.

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/region, we simply separate the window without BSA from window with

BSA for the whole sample period and directly compare (1) the number of transactions denominated in the RMB; (2) the value of transactions denominated in the RMB; and (3) the proportion of RMB denominated value to the total value for each country/region, with the MT 700 message. The sample we use is all the countries/regions that have a BSA with China. There are 42 countries/regions altogether, but Hong Kong of China, Malaysia, Singapore, and South Korea are dropped out of the sample since their BSAs cover the whole sample period which makes it impossible for us to compare. Therefore, the final sample consists of 38 countries/regions. The results are shown in Table 2.

Table 2. RMB BSA singing and its impact.

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

Notes: This Table shows the different measures of cross-border trade in time periods with swap and without swap. ** and *** represent the significance level at 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 swap' window, and it is 8.20 per month after a RMB swap 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 the 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 swap 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 net number of transactions denominated in the RMB, as well as the ratio of RMB-denominated transactions to total transaction value for country/region i, month m. $Swap_{im}$ is a dummy variable which equals 1 if country/region 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 Number of RMB transactions	2 Number of RMB transactions	3 RMB value of transactions	4 RMB value of transactions	5 RMB proportion of transactions	6 RMB proportion of transactions
Swap	83.45***	32.97***	2.323***	1.524***	0.0392***	0.0309***
	[10.77]	[9.40]	[21.45]	[13.71]	[12.30]	[12.11]
ImEx		21.12***		0.934***		0.0495***
		[8.74]		[5.47]		[5.64]
Openness		4.158***		0.192***		0.00425***
		[8.23]		[6.95]		[9.00]
Population		-2.720***		0.237***		-0.00135*
		[-3.14]		[6.17]		[-1.85]
GDP		4.535***		0.530***		0.00617***
		[7.58]		[17.40]		[9.03]
Bank		-0.610***		-0.00963***		-0.000267***
		[-7.09]		[-3.77]		[-3.07]
Time FE	No	Yes	No	Yes	No	Yes
_cons	3.628***	-1.398	1.050***	-2.128***	0.0162***	-0.0215***
	[15.31]	[-0.77]	[29.90]	[-19.98]	[14.61]	[-6.94]
N	6,552	5,400	6,552	5,400	6,552	5,400

Notes: 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 of transctions, and RMB proportion of transctions for country/region i, month *m*. $Swap_{im}$is a dummy variable which equals 1 if country/region *i* has signed the swap line contract with China in month *m*, and 0 otherwise. * and *** represent the significance level at 10% and 1%, respectively.

In Table 3, the null hypothesis is that the signing of BSA has no impact on the counterparty country/region'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 RMB's use 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/region 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 net amount in the RMB, as well as the ratio of RMB transaction value for country/region *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 characterised 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 summarised 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 intercept 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 Number of RMB transactions	2 Number of RMB transactions	3 RMB value of transactions	4 RMB value of transactions	5 RMB proportion of transactions	6 RMB proportion of transactions
Swap	0.159***	0.130***	0.474***	0.444***	0.012***	0.0125***
	[3.30]	[2.79]	[3.94]	[3.51]	[2.85]	[4.35]
ImEx		0.295**		0.808**		0.0405***
		[2.09]		[2.13]		[4.58]
Openness		-0.00457		0.099		0.00229
		[-0.07]		[0.63]		[0.76]
Population		-0.0467		0.0436		-0.00344
		[-0.45]		[0.20]		[-0.81]
GDP		0.339***		0.759***		0.00874**
		[4.09]		[4.24]		[2.55]
Bank		-0.0066		-0.0181		-0.000141
		[-1.08]		[-1.36]		[-0.55]
Random coeff. for						
Country	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Constants	0.626**	1.449***	1.449***	-0.62	0.022***	-0.0094
	[5.25]	[6.03]	[6.03]	[-1.17]	[3.27]	[-0.93]
N	6552	5400	6552	5400	6552	5400

Notes: 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/regions and for different years. The variable names are defined in Appendix 2. ** and *** represent the significance level at 5% and 1%, respectively.

We can see that in Table 4, the coefficients of swap dummies in all the six specifications are signifcantly positive, which is highly consistent with previous results. This result rejects the null hypothesis that the BSA

adoption has no impact on the RMB trade settlements, showing that even after controlling for 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:

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

where the dependent variable is a dummy which equals 1 if country/region *i* has a signed BSA with China in month *m*, and 0 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, Zhan, and Cheung 2016). These explanatory variables include: (1) *Distance* between country/region *i* and China, (2) *Voice and Accountability*, reflecting perceptions of the extent to which a country/regions'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) *Government 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 policies, (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 Corruption*, 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 the

RMB, the net amount in the RMB, as well as the ratio of the 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)
Number of RMB 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***	-0.366***	-0.396***
	[-11.56]	[-10.04]	[-10.59]
Voice and Accountability	0.134***	0.0557	0.0252
	[3.73]	[1.56]	[0.72]
Political Stability	-0.00563	0.0219	-0.0795**
	[-0.18]	[0.68]	[-2.53]
Government Eeffectiveness	0.955***	0.687***	0.936***
	[10.25]	[7.20]	[10.00]
Regulatory Quality	-0.400***	-0.159**	-0.180**
	[-5.35]	[-2.12]	[-2.43]
Rule of Law	0.0413	0.0359	0.0713
	[0.38]	[0.32]	[0.66]
Control of Corruption	-0.364***	-0.334***	-0.353***
	[-5.00]	[-4.51]	[-4.82]
constant	2.647***	1.973***	2.359***
	[8.25]	[6.06]	[7.08]
# of observations	6,458	6,458	6,458

Panel B: Marginal effects

	(1)	(2)	(3)
Number of RMB 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]

Panel C: Probit models considering one control variable at a time

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of RMB transactions $_{t-1}$	0.00343***	0.00358***	0.00346***	0.00288***	0.00313***	0.00312***	0.00319***
	[12.35]	[12.72]	[12.13]	[10.34]	[10.90]	[11.03]	[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***	-0.897***	-0.869***	-0.985***	-0.970***	-0.939***	-0.914***
	[8.52]	[-44.77]	[-43.96]	[-45.26]	[-44.76]	[-45.21]	[-45.05]
N	6,458	6,458	6,458	6,458	6,458	6,458	6,458

Notes: This table provides results for a probit regression: $\boldsymbol{prob}(\mathbf{1}_{im}) = \gamma_i + \theta_i X_{im} + u_{im}$, where dependent variable $\mathbf{1}_{im}$equals 1 if country/region *i* has the swap line with China in month *m*, and 0 otherwise. $X_{im}$is the set of explanatory variables described in Appendix 2. ** and *** represent significance level at 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 (*number of RMB transations*, *RMB vaule of transcations*, *RMB proportion of transctions*) 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/region *i* will sign a BSA 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 model 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/regions with a BSA in our sample. Moreover, Argentina, Belarus, and Indonesia are dropped out of the sample since they move from no swap to with swap, causing complexity. Also, Hong Kong of China, Singapore, and Malaysia have a 'with swap' status throughout the sample time. To be consistent with the later results, these three countries/regions are dropped out. So there are 28 countries/regions 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 the RMB settlement across different countries/regions, 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	*Number of RMB 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	*Number of RMB 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

Notes: 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 transactions, net amount and percent 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/region *i* in our sample in month *m*.

We adopt the following methodology to tackle the non-stationarity: First, we choose all the countries/regions 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 the RMB settlement as a benchmark, which captures the trend of the RMB settlement, but is free of the impact of signing a BSA with China. Then, we define the abnormal value as:

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

where $value_{bm}$ is the benchmark transactions, net amount and percent in month m. $value_{im}$ is the benchmark transactions, net amount and percent for country/region 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/regions 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/region *i* that signs a BSA with China, we adopt a 24-month

window before and after the BSA is signed. Our control group contains all the countries/regions in our sample that have no BSA at all. For each country/region in the test group, we select the country/region which is most similar to the test group country/region in terms of the average GDP in the 48-month window. We run the following difference in difference regression:

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

where Y_{im} contains the three target variables: log(*number of RMB transactions*+1), log(RMB value of transactions+1), as well as RMB proportion of transactions for country/region i, month m. $\text{test}_{\text{im}}$is a dummy variable which equals 1 if country/region i has signed the swap line with China, and 0 for the control group. $Swap_{im}$is a dummy variable which equals 1 if country/region *i* has signed the swap line contract with China in month m, and 0 otherwise. We can see that the interaction term of $test_{im}$ and $Swap_{im}$ are significantly positive in all the three settings, implying that after controlling for the possible common trend, the countries/regions that have signed a BSA with China show significant increase in the number of RMB transactions, net amount of RMB transactions, as well as percentage of RMB transactions. The results from the difference-in-difference regression are highly consistent with the previous ones.

Table 7. Difference-in-difference regression.

	Number of RMB transactions	*RMB value of transactions*	*RMB proportion of transactions*
Test	0.316***	1.082***	0.00651**
	[6.48]	[8.02]	[2.44]
Swap	0.0662	0.322***	0.00599*
	[1.42]	[2.72]	[1.73]
*Test*Swap*	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	3,536	3,536	3,536

Notes: In this Table, we run the following difference in difference regression: $Y_{im} = \alpha + \beta Test_{im} + \gamma Swap_{im} + \theta Test_{im} * Swap_{im} + \varepsilon_{im}$, where Y_{im}contains the RMB number, value and proportion of transactions for country/region *i*, month *m*. $test_{im}$is a dummy variable which equals 1 if country/region *i* has signed the swap line contract with China, and 0 for the control group. $Swap_{im}$is a dummy variable which equals 1 if country/region *i* has signed the swap line contract with China in month *m*, and 0 otherwise. *, **, and *** represent the 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/region *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 RMB transactions*, *RMB value of transctions*, and *RMB proportion of transctions* for country/region *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 RMB transactions*, *RMB value of transctions*, and *RMB proportion of transctions* for country/region *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/region *i*, month *m*, the degree of openness of country/region *i*, as well as the GDP and population of country/region *i*, month *m*. The results are shown in Table 8.

Table 8. Detrended results.

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

Notes: 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*. $Swap_{im}$ is a dummy variable which equals 1 if country/region *i* has signed the swap line contract with China in month m, and 0 otherwise. we use IV regression with a set of explanatory variables described in Appendix 2. *, **, and *** represent significance level at 10%, 5% and 1%, respectively.

Table 8 shows highly consistent results with those from Table 3. Even after controlling for the endogeneity and non-stationarity problems, in all the six 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 swap line

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/region *i* and China, scaled by the GDP of country/region *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 of transctions*, and *RMB proportion of transctions* for country/region *i*, month *m*. $Size_{im}$ is the size of swap line for country/region *i*, month *m*, as defined above. The results are shown in Table 9.

Table 9. Size of the swap line.

	1	2	3	4	5	6
	Number of RMB transactions	*Number of RMB transactions*	*RMB value of transactions*	*RMB value of transactions*	*RMB proportion of transactions*	*RMB proportion of transactions*
Size	2278.7***	1008.4***	19.67***	21.59***	0.799***	0.638***
	[13.53]	[9.85]	[15.68]	[13.84]	[16.46]	[11.35]
ImEx		-22.46**		1.478***		0.0468***
		[-2.38]		[4.06]		[4.94]
Openness		19.24***		0.531***		0.0126***
		[10.38]		[8.84]		[10.85]
Population		6.358***		0.645***		0.00538***
		[3.56]		[7.20]		[2.67]
GDP		4.306***		0.541***		0.00681***
		[3.76]		[7.92]		[3.89]
Bank		-2.494***		-0.0520***		-0.00116***
		[-9.60]		[-8.74]		[-5.54]
Time FE	No	Yes	No	Yes	No	Yes
_cons	-23.16***	-0.0849	1.667***	-1.050***	0.00774***	-0.0187***
	[-8.72]	[-0.02]	[22.96]	[-3.96]	[6.07]	[-3.12]
N	2,160	1,896	2,160	1,896	2,160	1,896

Notes: In this table we provide results of the regressions where it is accounted for the size of the swap line. ** and *** represent the significance level at 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/region.

Conclusions

To push forward the internationalisation of its currency, the Chinese 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 PBoC, has actively signed the RMB-denominated BSAs with other central banks.

Our research is among the first which empirically examines 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, value and proportion of the 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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Appendices

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
China's 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
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
United Kindoms	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 which equals to 1 if the country/region 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://ksgleditsch.com/data-5.html
Bank	the number of commercial bank branches per 100,000	The World Bank. https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database
GDP	The log value of an economy's nominal gross domestic 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 which equals to 1 if China and the counterparty 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/region's degree of capital account openness. A higher index number means more capital account openness.	http://web.pdx.edu/~ito/Chinn-Ito_website.htm
Voice and Accountability	Reflects perceptions of the extent to which a country/region's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/governance/wgi/index.aspx#home

Political Stability	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/governance/wgi/index.aspx#home
Government Effectiveness	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 policies.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/governance/wgi/index.aspx#home
Regulatory Quality	Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/governance/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/governance/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 'capture' of the state by elites and private interests.	Worldwide Governance Indicators, World Bank http://info.worldbank.org/governance/wgi/index.aspx#home

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Disclosure statement

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