Jump-starting an international currency

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Motivation: Central Bank Swap Line Network

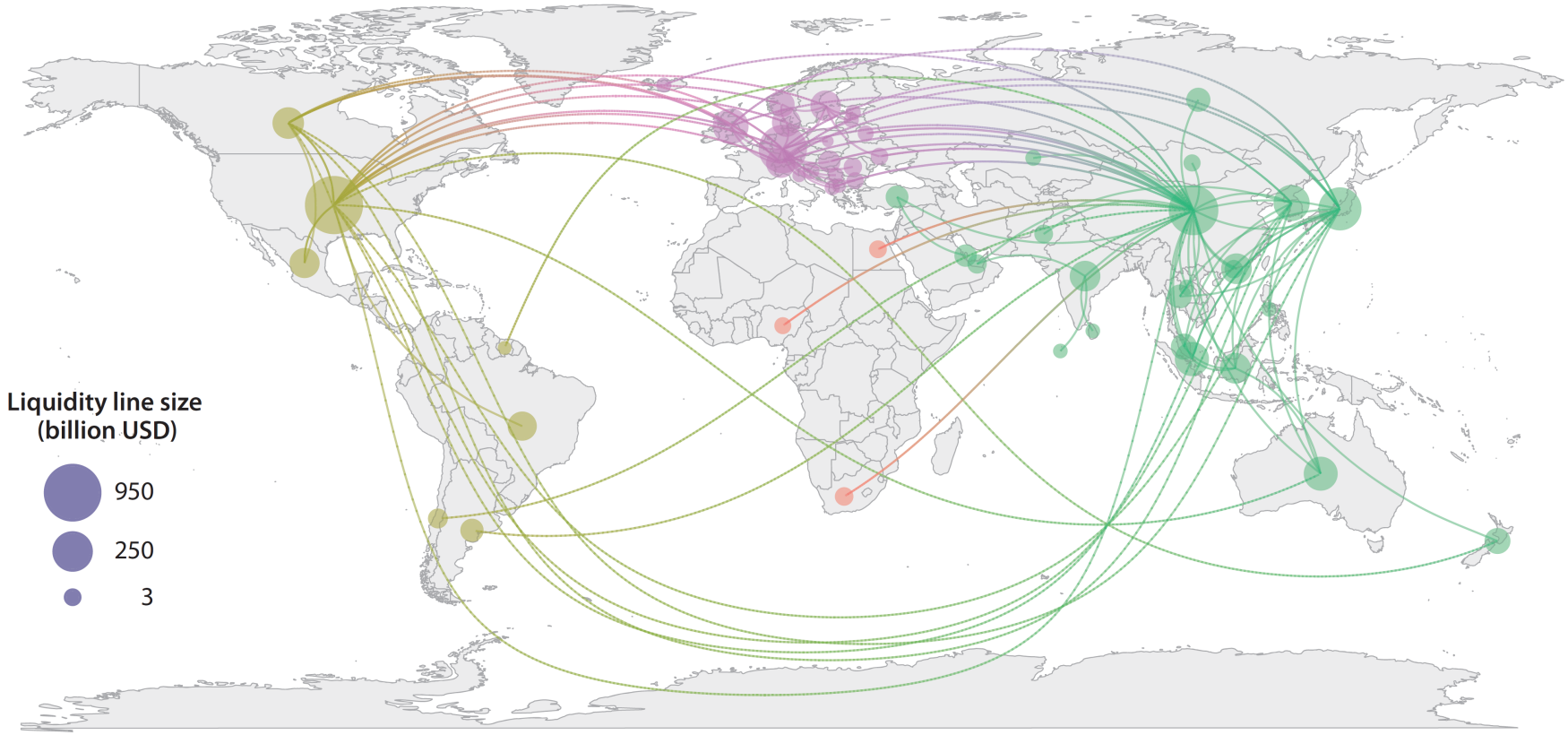

Figure 1

The bilateral network of liquidity lines between central banks at the end of 2020. The bubble size reflects the sum of either the notional limit of all liquidity lines available to a country or, if the line is unlimited, the historical drawings. Bubble color indicates region (continent). **Figure 1** was created with data from Perks et al. (2021) and augmented to include the European Central Bank's bilateral repo lines, which are sourced from Albrizio, Kataryniuk & Molina (2021).

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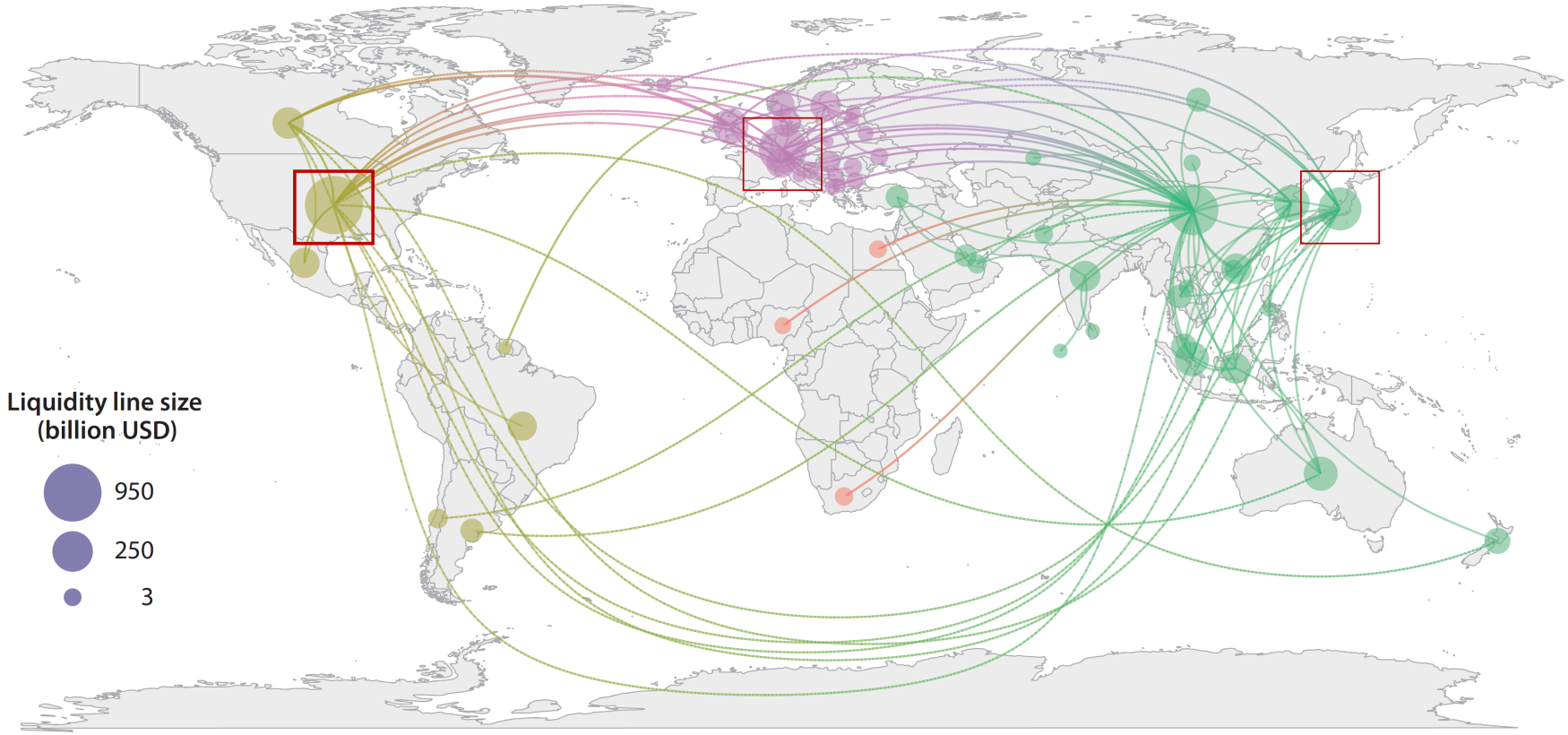

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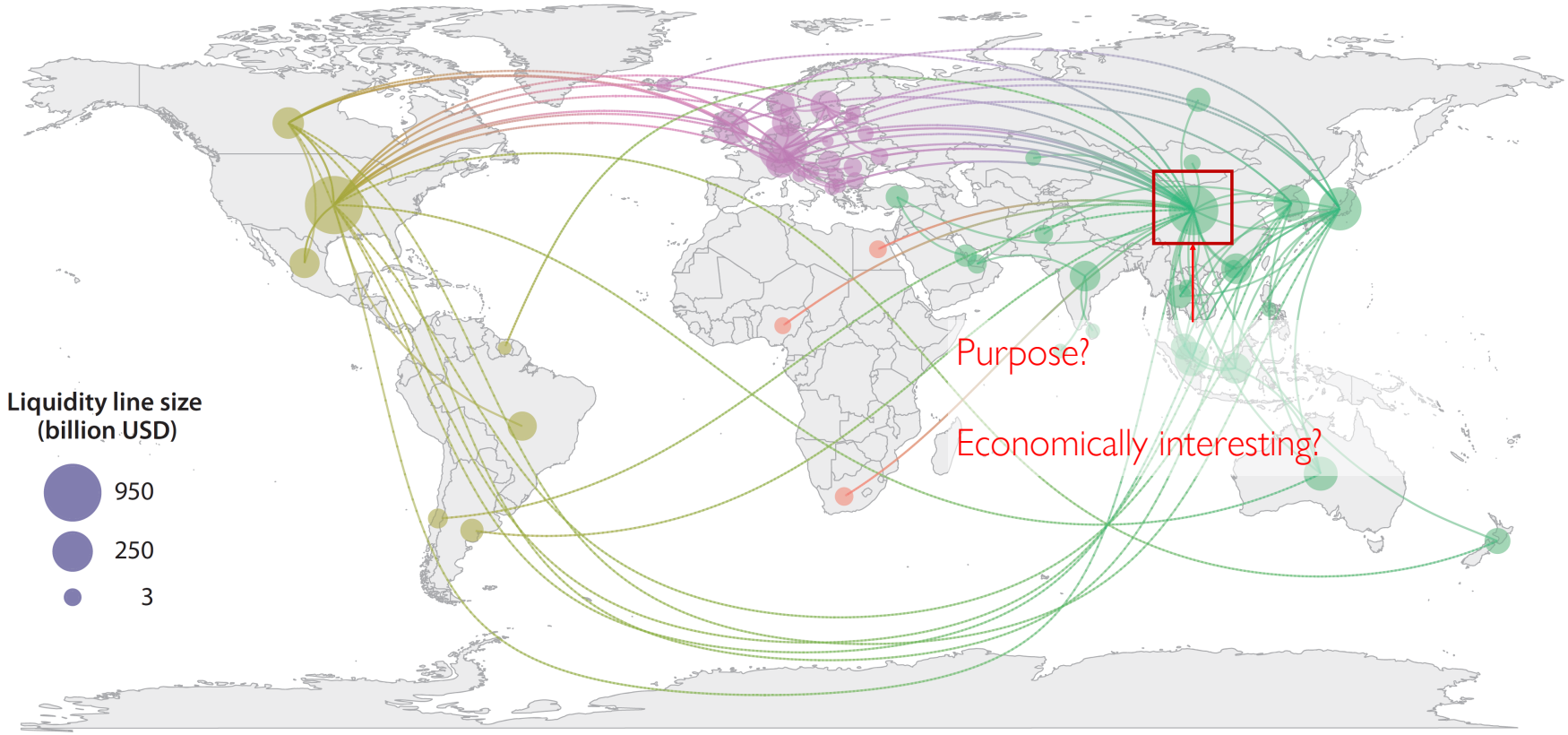

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This paper

As for the currency swap, it is an unexpected outcome of the global financial crisis […] due to the shortage of hard currencies and the difficulties in developing correspondent banking relationship on the part of commercial banks, some neighboring countries requested to enter into local currency swap agreements with China, in order to support and facilitate regional trade.

-- Zhou Xiaochuan, Governor of the PBoC, G30 Annual International Banking Seminar, October 2017.

Between the lines: internationalize the RMB in trade flows/finance.

Two contributions:

1. Empirics: PBoC swap lines 09-18 on RMB settlements, country level panel.
   - Signing a swap line associated with increased RMB use + lower synthetic borrowing costs.
2. Model: Understand the mechanism. SoE with trading firms deciding denomination of trade credit and invoicing. Compare rising and dominant currencies.
   - Can central bank policies jump-start currency use? When?
   - Model predictions on heterogeneity born out in the data.

Marginal contribution: jumpstart & non-dollar

- **Dominant currency;** we focus on jumpstart and on policies
  - Maggiori, 2017, Gourinchas, Rey and Sauzet, 2019, Gopinath et al., 2020, Gopinath and Stein 2022, Chahrour and Valchev, 2022
- **Currency invoicing literature;** complementarity across P and MC choices
  - Engel (2006) Gopinath, Itskhoki Rigobon (2010) Bacchetta van Wincoop (2005), Goldberg Tille (2008), Mukhin (2018)
- **Emphasis on working capital and finance;** RMB and rising, firms not banks
  - Amiti and Weinstein (2011) Gopinath and Stein (2018) Bruno and Shin (2019) Eren and Malamud (2019)
- **RMB policies and the USD swap lines;** model+test and different in aims+work
  - Eichengreen, Mehl and Chitu (2017), McDowell (2019), Clayton et al (2022), Bahaj and Reis (2022)
- **Empirics on currency choice;** payments rather than invoicing, all countries
  - Goldberg, Tille, 2016, Corsetti, Crowley, Han, 2018, Chen, Chung, Novy, 2018, Amiti, Itskhohi, Konings, 2019

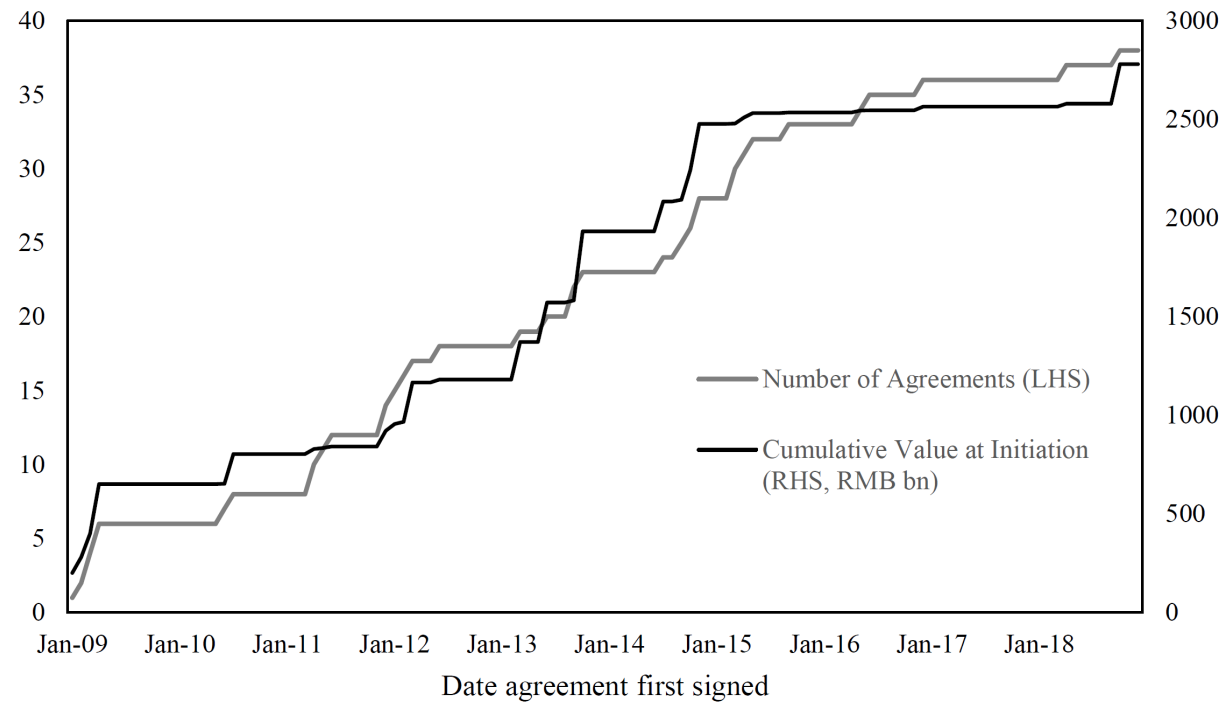
2. The PBOC swap lines and global payments data

The lines and their evolution

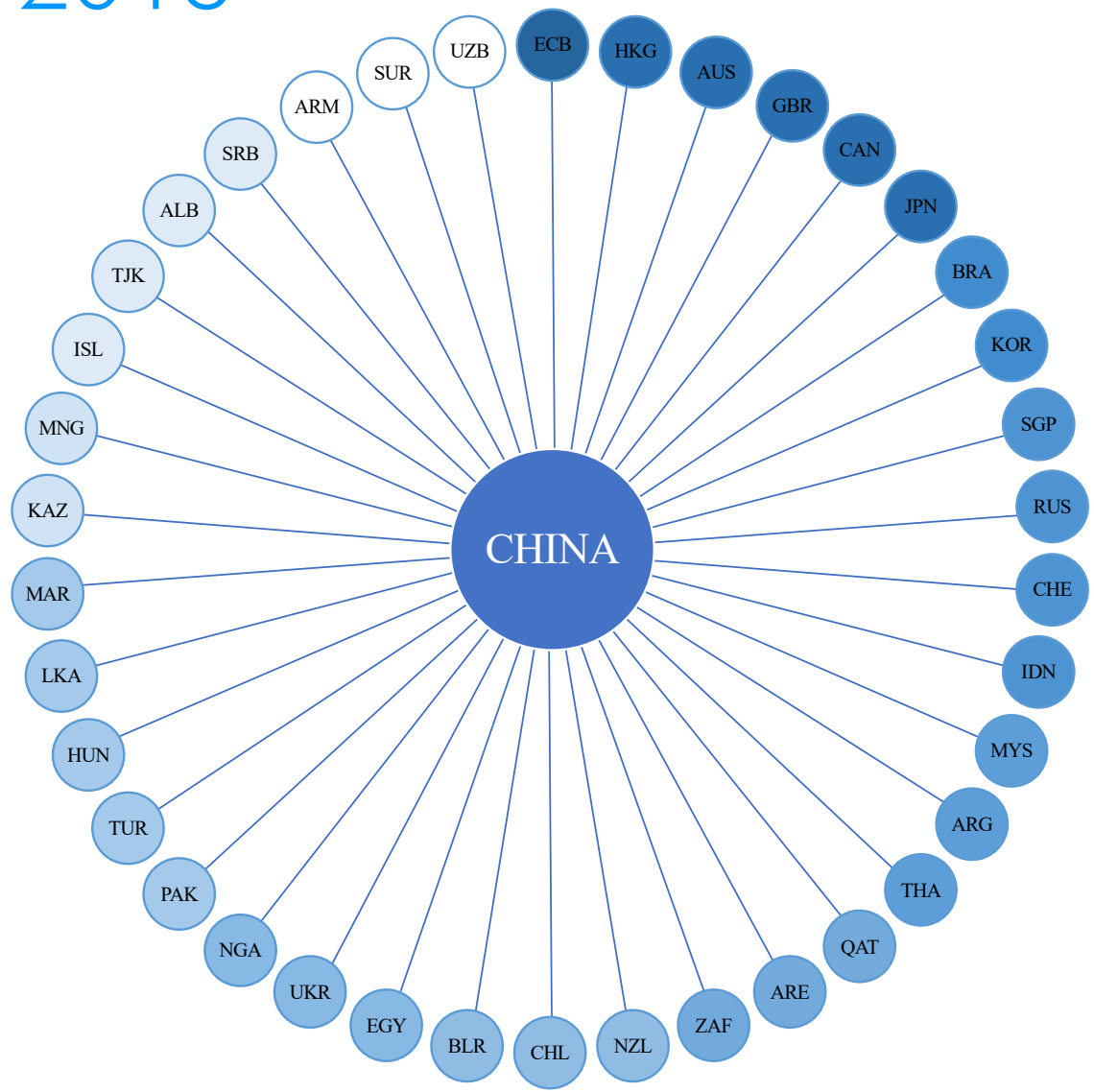
Straightforward way of thinking about the policy:

- Collateralised loan from PBoC => Counterparty CB.
- Used to provide RMB credit to local banking system at known price.
- Lent on to firms as trade credit. (Organised facility)
- In principle caps offshore borrowing costs.
- Insurance not direct subsidy.

(a) Swap lines: number and amounts



Swap lines 2018

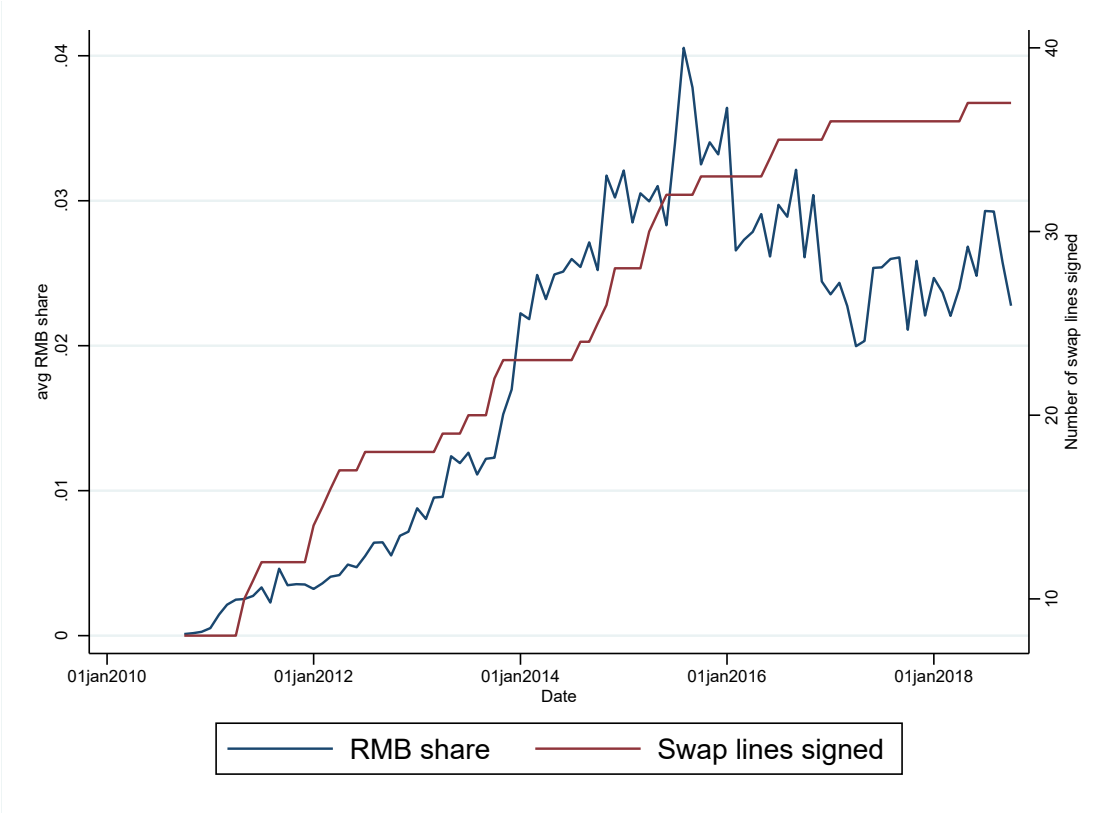


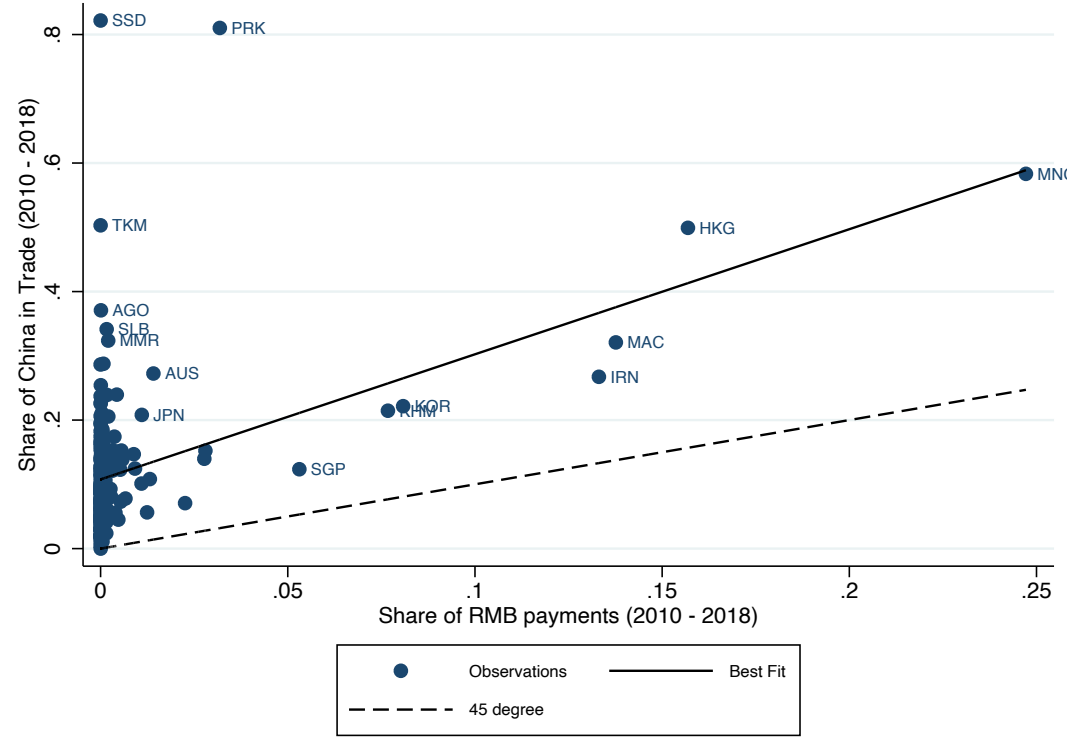
Country	Date of First Agreement (2009 onwards only)
Albania	12/09/2013
Argentina	02/04/2009
Armenia	25/03/2015
Australia	22/03/2012
Belarus	11/03/2009
Brazil	26/03/2013
Canada	08/11/2014
Chile	25/05/2015
ECB	08/10/2013
Egypt	06/12/2016
Hong Kong	20/01/2009
Hungary	09/09/2013
Iceland	09/06/2010
Japan	26/10/2018
Indonesia	23/03/2009
Kazakhstan	13/06/2011
Korea, Republic of	20/04/2009
Malaysia	08/02/2009
Mongolia	06/05/2011
Morocco	11/05/2016
New Zealand	18/04/2011
Nigeria	27/04/2018
Pakistan	23/12/2011
Qatar	03/11/2014
Russia	13/10/2014
Serbia	17/06/2016
Singapore	23/07/2010
South Africa	10/04/2015
Sri Lanka	16/09/2014
Surinam	18/03/2015
Switzerland	21/07/2014
Tajikistan	03/09/2015
Thailand	22/12/2011
Turkey	21/02/2012
United Kingdom	22/06/2013
Ukraine	26/06/2012
United Arab Emirates	17/01/2012
Uzbekistan	19/04/2011

Global payments dataset

- SWIFT Database of International Payments
  - Monthly bilateral payments data
  - Oct 2010-Oct 2018
  - Covers cross-border bank messages (focus on instructions to pay).
  - No information on who is making the payment (neither the bank or the client). Only currency is recorded.
  - NB: in trade, invoice and payment currency are typically the same (Friberg and Wilander, 2008). Trade finance as robustness (MT400+MT700).
- Measure of interest, <u>RMB share in cross border non-FX payments sent and received per month per country</u>.

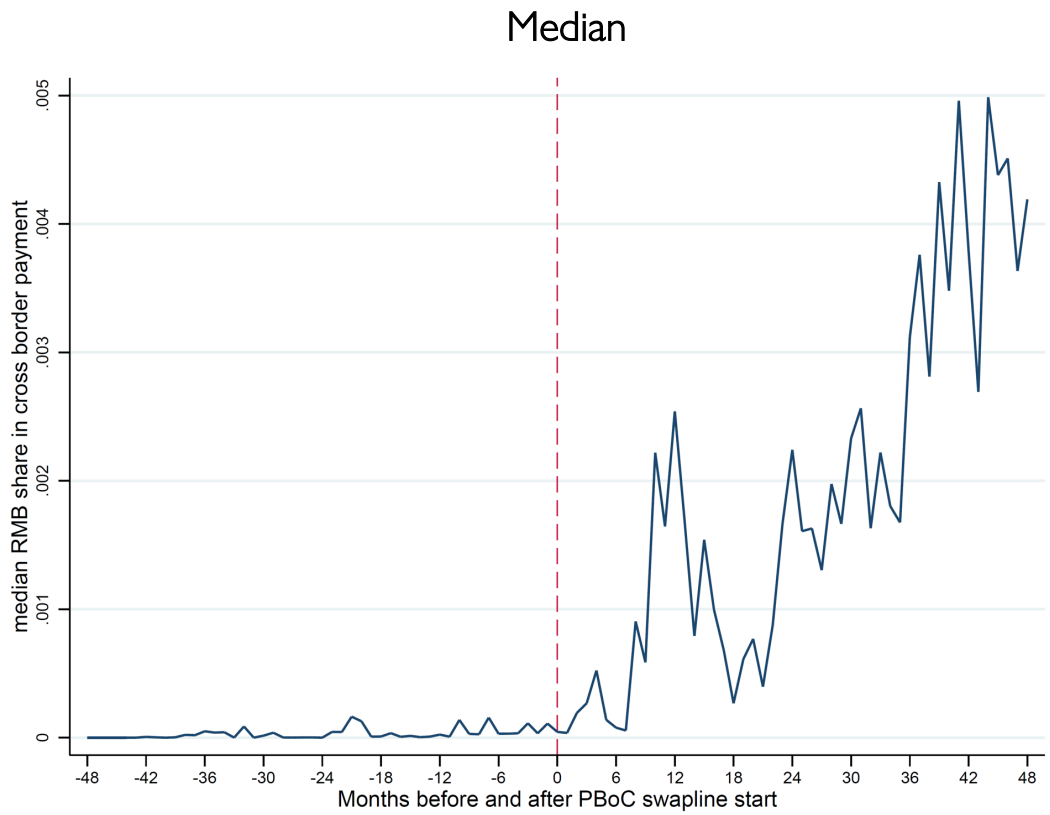
A first look at the data

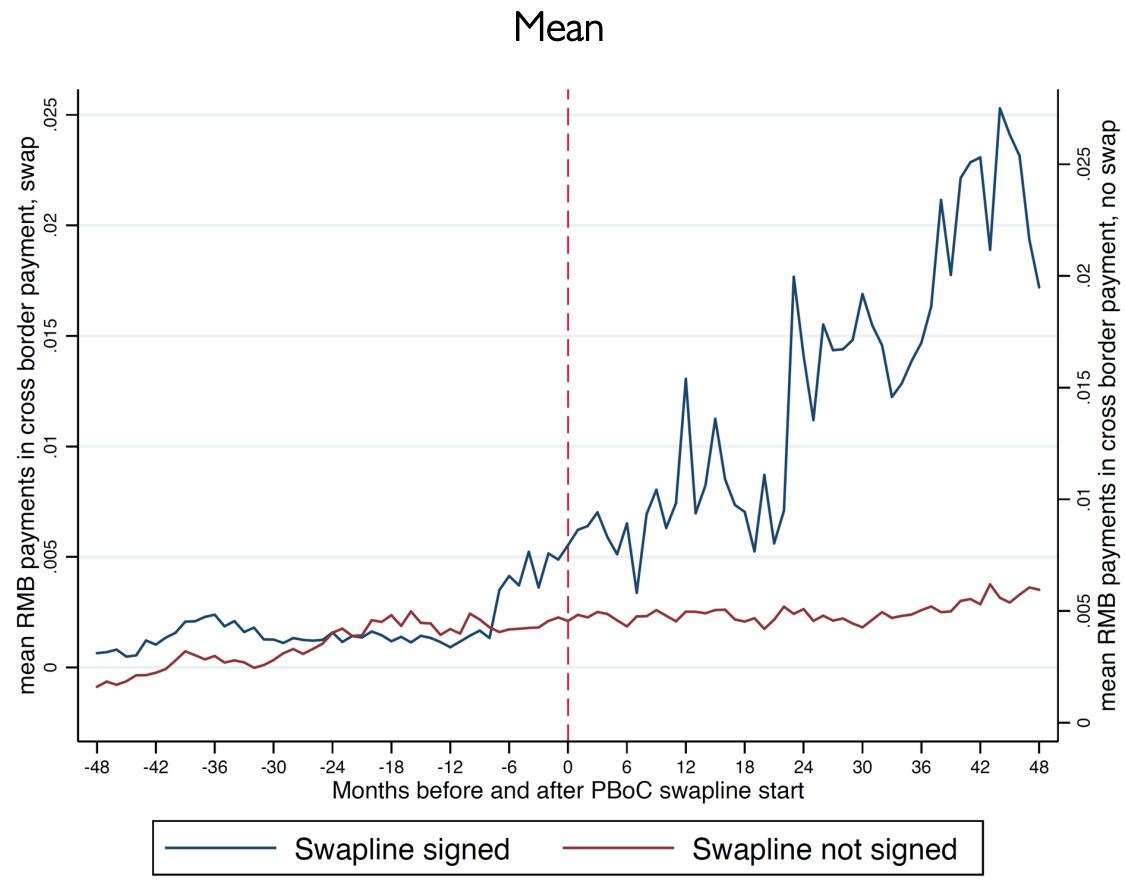




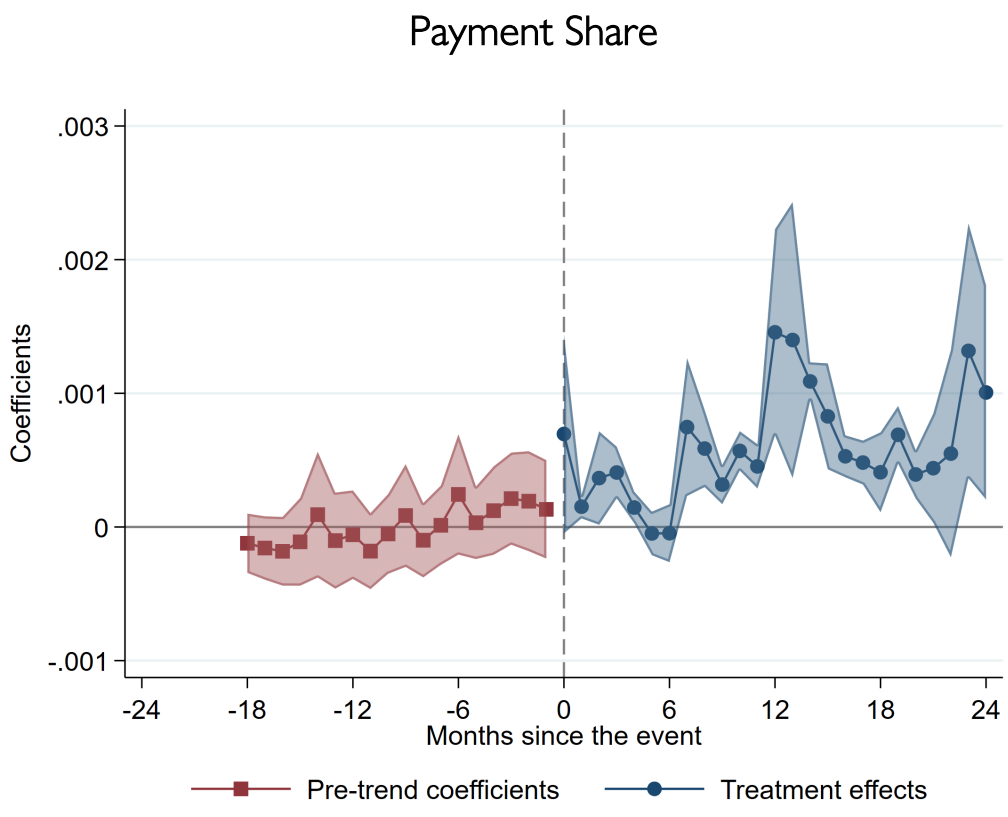
- Extensive margin important.
- Consolidate Macau+HK into China.
- Focus on developing countries (robust to relaxing this).

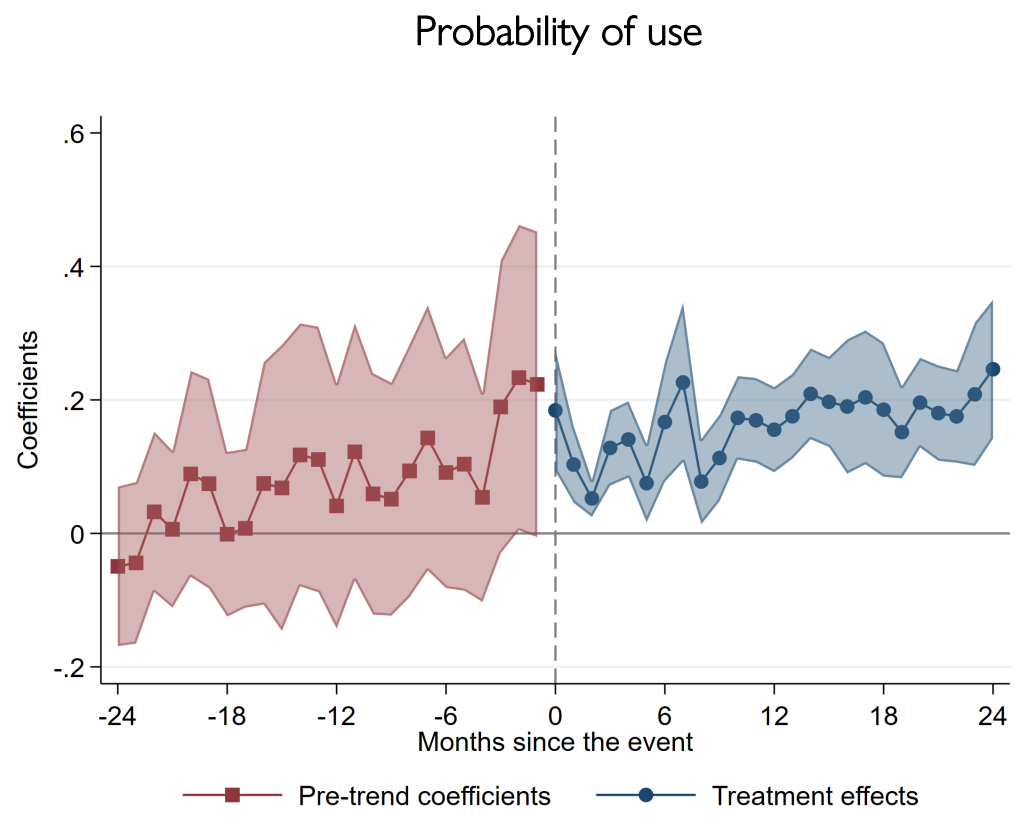
RMB payment share after swap line signed





Event Study Plots





Conditional on trade and financial linkages with China and other Chinese intergration policies.

Baseline Specification

$$1(\text{Rpayment}_{i,t} > 0) = \alpha_i + \alpha_t + \beta \times \text{SwapLine}_{i,t} + \gamma \times \text{Controls}_{i,t} + \text{error}_{i,t}.$$

Staggered diff-in-diff interpretation: use Borusyak and Jaravel, 2022: robust to using TWFE, large pure treatment group.

21 countries treated in sample.

Controls (factors that drive RMB usage and signing the swap line):

- China trade (trade agreement with China, exports and imports from the country to China (log $/share of GDP)): country-specific change in economic relationship with China.
- Chinese policy (RMB clearing bank, membership of AIB, direct investment flows): non-trade flow related, policies distinct from but correlated with the swap lines being signed.
- RMB share used by country neighbors: region-specific factors due to trade, or political developments in relation with China. Not going to talk much about spillovers today.

Linear probability model (extensive margin)

	No controls (1)	Time & Seasonal f.e. (2)	Incl. Neigh. Share (3)	Incl. China Trade (4)	Incl. China Policy (5)
$SwapLine_{i,t}$	0.2861***	0.1362***	0.1308***	0.1294***	0.1344***
	(0.039)	(0.044)	(0.046)	(0.045)	(0.044)
Country f.e.	Yes	Yes	Yes	Yes	Yes
Time f.e.	No	Yes	Yes	Yes	Yes
Neighbor Use Control	No	No	Yes	Yes	Yes
China Trade Controls	No	No	No	Yes	Yes
China Policy Controls	No	No	No	No	Yes
Observations	12513	12513	12513	12513	12513

S.E. clustered by country in parentheses, * $p < 0.1$, **,$p < 0.05$, *** $p < 0.01$

Intensive margin

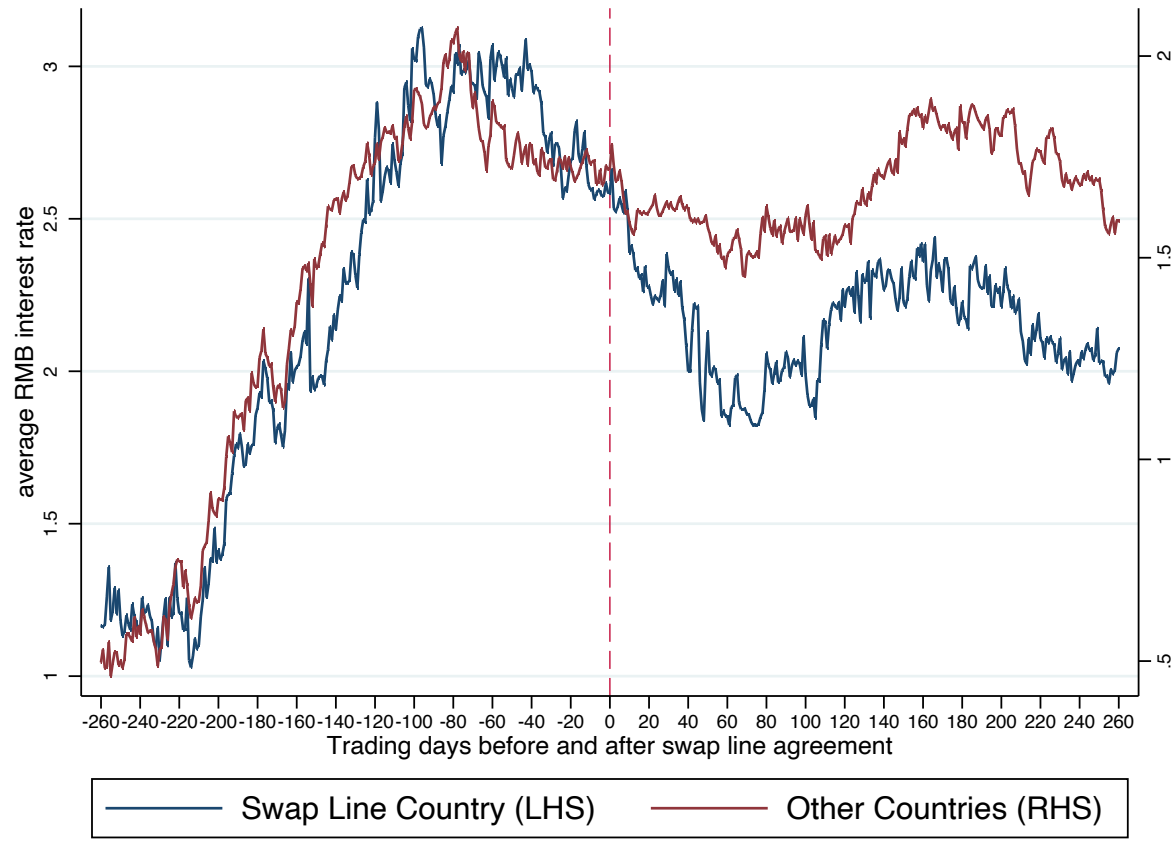
	$Rshare_{i,t}$		PPML	
	Time & Seasonal f.e.	All Controls	Time & Seasonal f.e.	All Controls
	(1)	(2)	(3)	(4)
$SwapLineAgreement_{i,t}$	0.0092***	0.0087***	1.4971***	0.9341***
	(0.0002)	(0.0001)	(0.271)	(0.291)
Country f.e.	Yes	Yes	No	No
Country×Seasonal f.e.	No	No	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
Neighbor Use Control	No	Yes	No	Yes
China Trade Controls	No	Yes	No	Yes
China Policy Controls	No	Yes	No	Yes
Observations	12513	12513	6432	4751

S.E. clustered by country in parentheses, * $p < 0.1$, **,$p < 0.05$, *** $p < 0.01$

Offshore RMB borrowing costs

- No measures of RMB denominated borrowing costs by country.
- Can look at synthetic borrowing costs swapping local currency to RMB (wholesale measure).
- Multiple routes: CNY and CNH. Taken minimum.
- Daily data for 23 currencies.
- Consistent with other literature on swap lines.

Figure 9: Cost of RMB borrowing before and after a swap line is signed



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- Daily data for 23 currencies.
- Consistent with other literature on swap lines

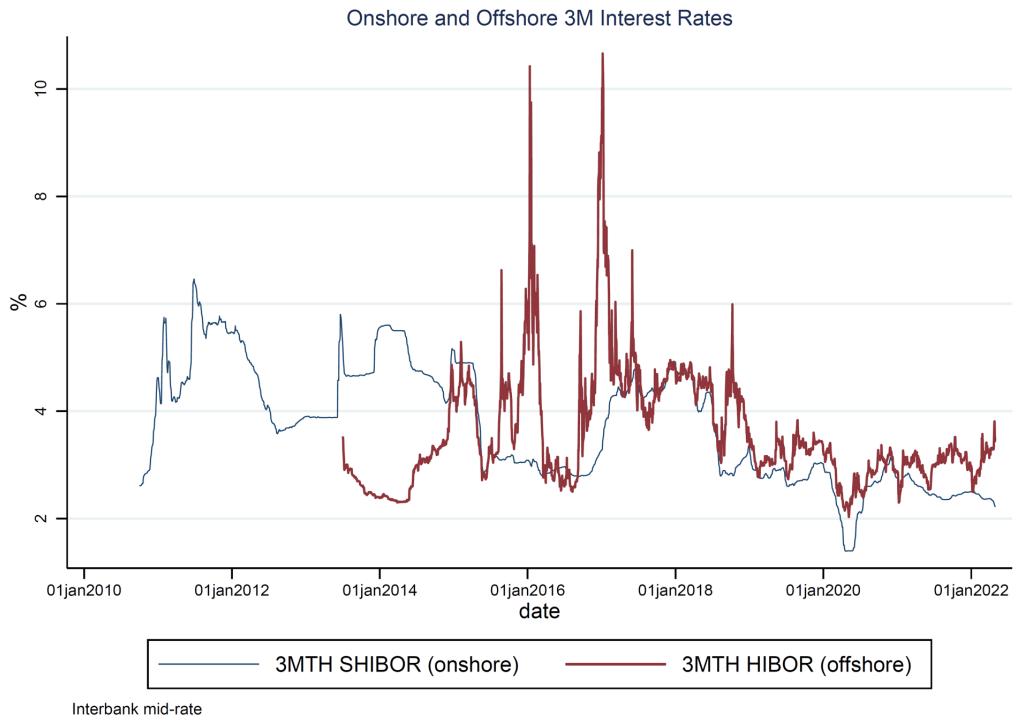
	Baseline	Spread v Chinese Rate	3 month tenor	Emerging Markets Only
	(1)	(2)	(3)	(4)
$\text{SwapLine}_{i,t}$	-0.7937**	-0.8254**	-0.7466**	-1.296**
	(0.322)	(0.318)	(0.336)	(0.594)
Country Fixed Effects	Yes	Yes	Yes	Yes
Trading Day Fixed Effects	Yes	Yes	Yes	Yes
Observations	66727	66727	68137	37296
Number of Countries	24	24	24	14

S.E. clustered by country and time in parentheses, * $p < 0.1$, **,$p < 0.05$, *** $p < 0.01$

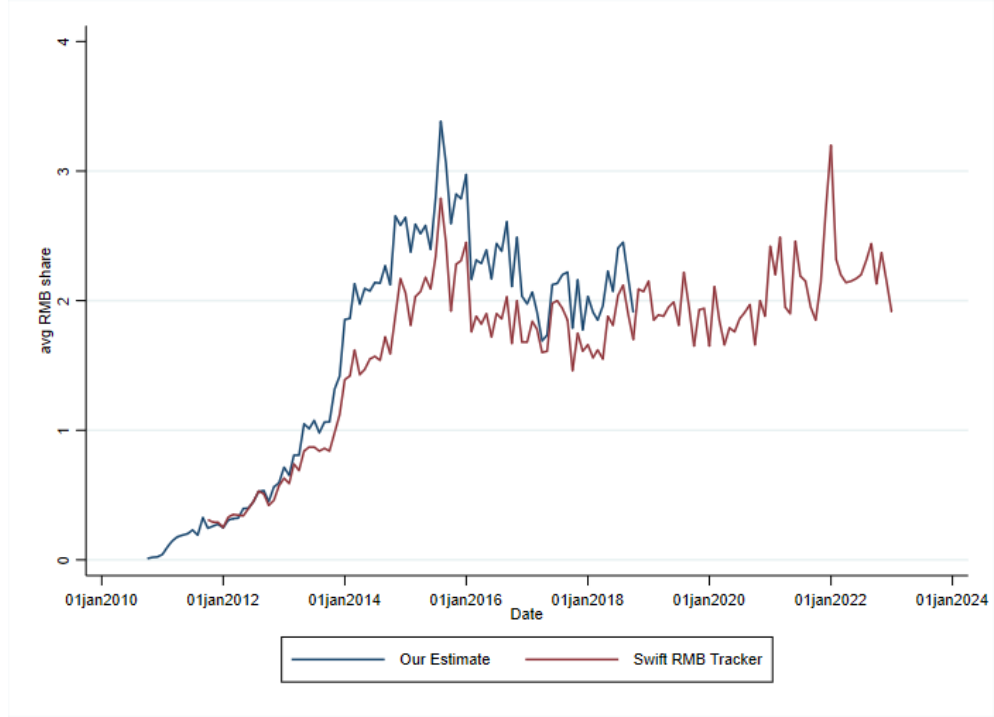
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

2015 CNY Reform

Shock to offshore borrowing costs…



…reversed rise of the RMB…



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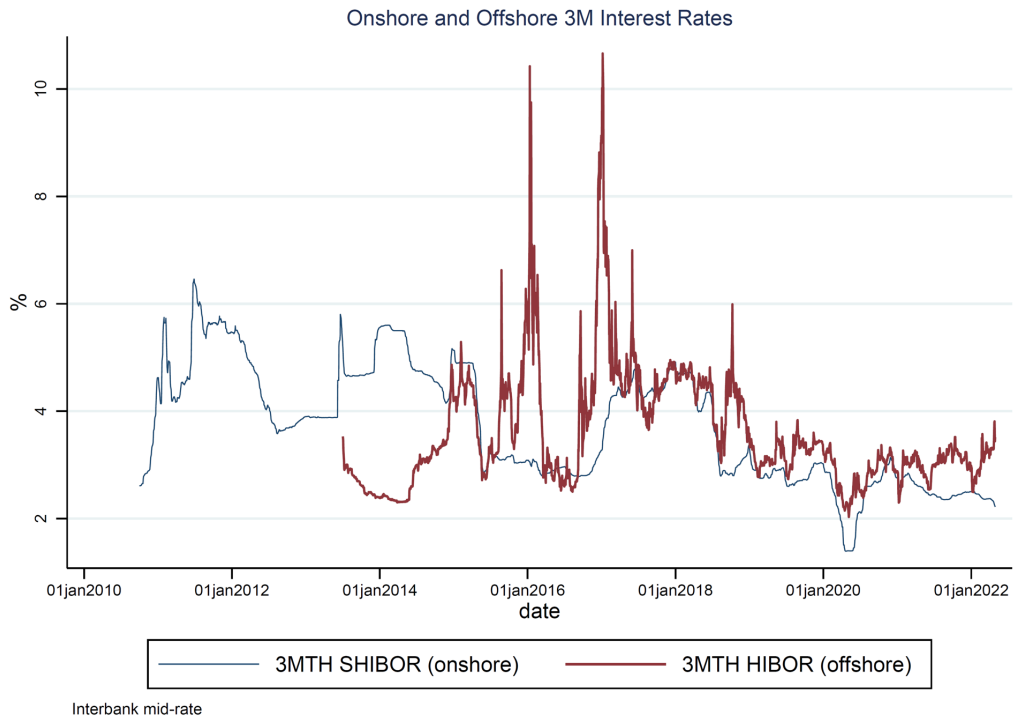
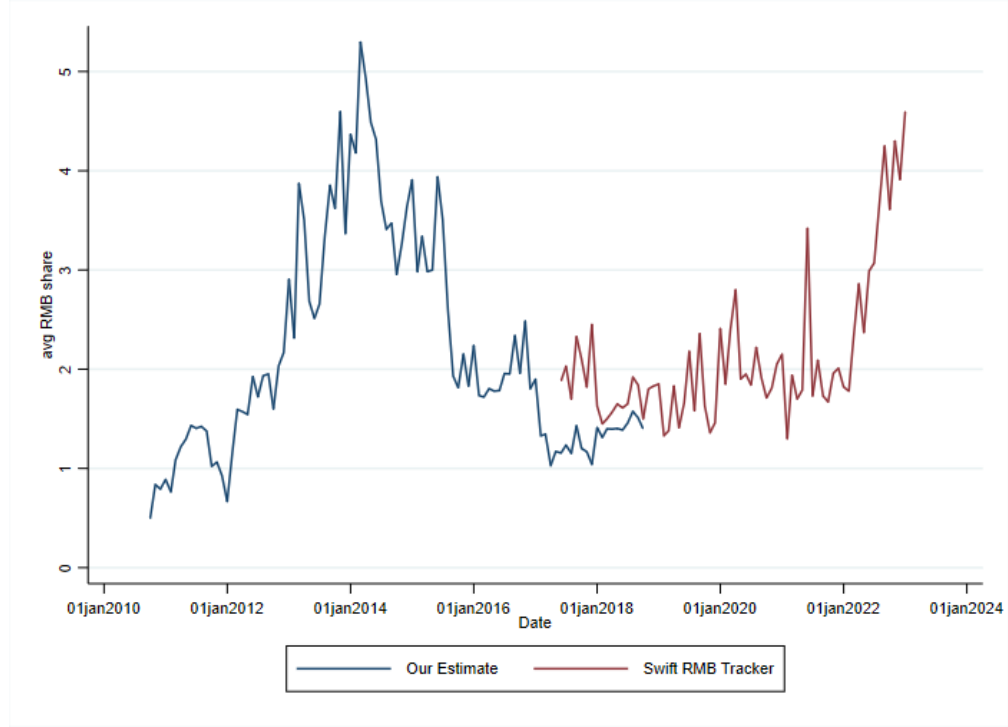
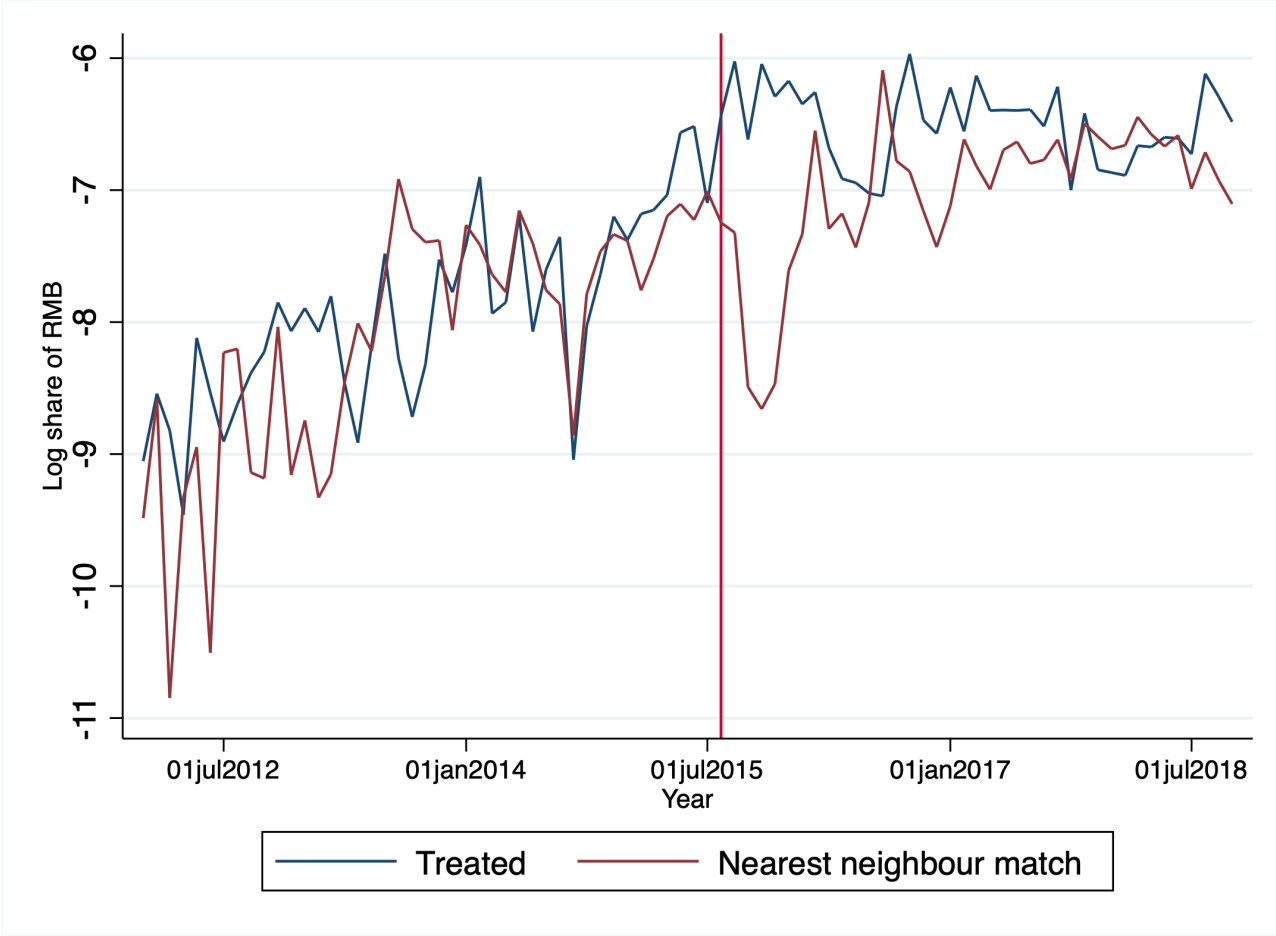


…especially in trade finance



Swap line insured against interest rate shock



- 16 countries signed swap line agreement as of August 2015.
- 12 countries consistent RMB users (non-zero) without swap line. Control group.
- Allows for log specification.
- Nearest neighbor match on 2014-Aug 2015 RMB usage, distance from China, PPP GDP.

Only payments related to trade finance

	No controls (1)	Time & Seasonal f.e. (2)	Incl. Neigh. Share (3)	Incl. China Trade (4)	Incl. China Policy (5)
$\text{SwapLine}_{i,t}$	0.1709***	0.1524***	0.1482***	0.1476***	0.1344***
	(0.003)	(0.008)	(0.010)	(0.010)	(0.019)
Country f.e.	Yes	Yes	Yes	Yes	Yes
Time f.e.	No	Yes	Yes	Yes	Yes
Neighbor Use Control	No	No	Yes	Yes	Yes
China Trade Controls	No	No	No	Yes	Yes
China Policy Controls	No	No	No	No	Yes
Observations	12513	12513	12513	12513	12513

S.E. clustered by country in parentheses, * $p < 0.1$, **,$p < 0.05$, *** $p < 0.01$

Preview of extra results

- Ex-payments to China.
- Synthetic control.
- Spillover onto neighbors.
- No effect on trade (just denomination).

Excluding China

	No controls (1)	Time & Seasonal f.e. (2)	Incl. Neigh. Share (3)	Incl. China Trade (4)	Incl. China Policy (5)
$SwapLine_{i,t}$	0.2847***	0.1816***	0.1728***	0.1707***	0.1739***
	(0.043)	(0.046)	(0.046)	(0.046)	(0.0502)
Country f.e.	Yes	Yes	Yes	Yes	Yes
Time f.e.	No	Yes	Yes	Yes	Yes
Neighbor Use Control	No	No	Yes	Yes	Yes
China Trade Controls	No	No	No	Yes	Yes
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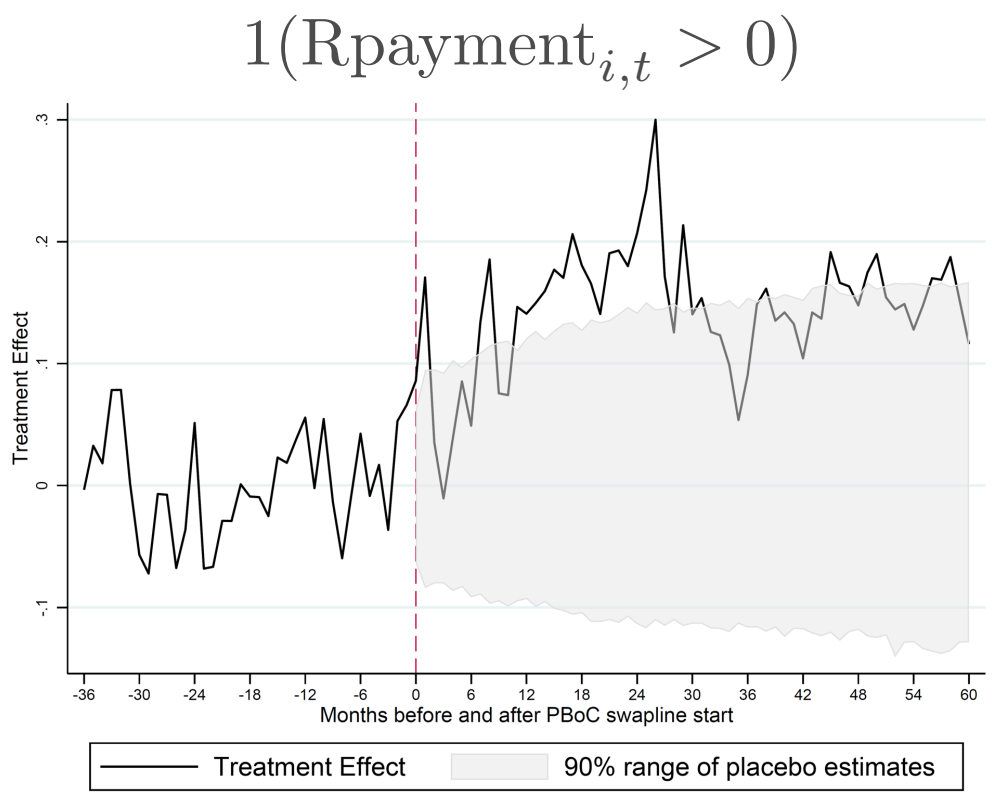
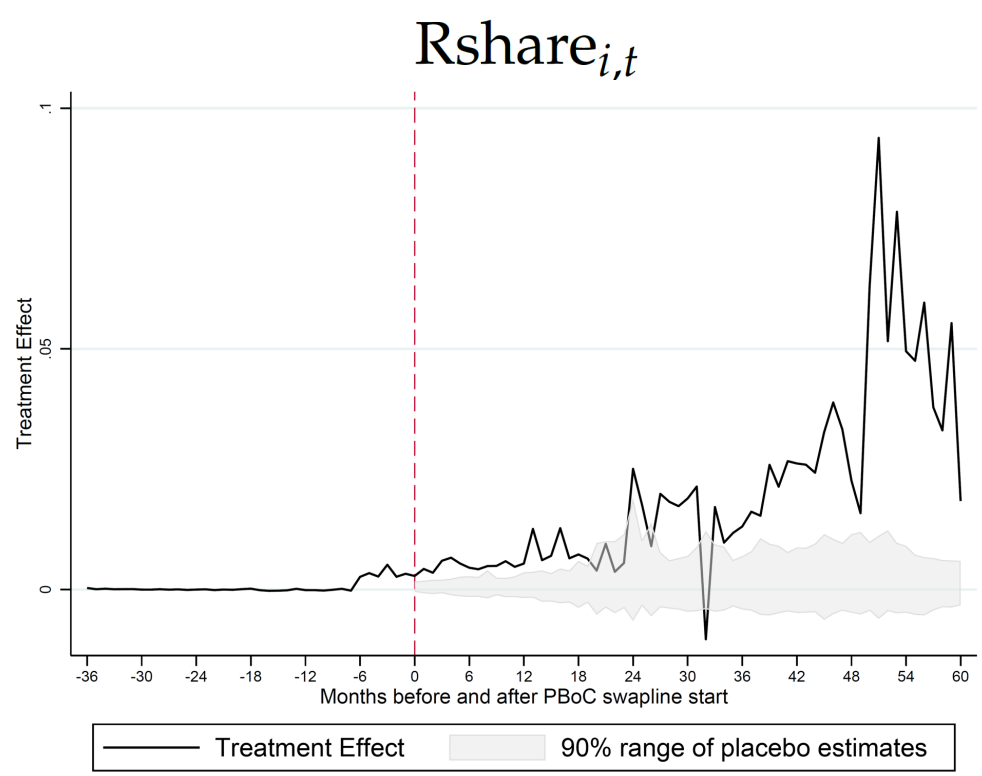
Synthetic control estimates





Cavello et al (2013) approach. Match on control variables.

Effect on trade with China

	Trade Shares with China			
	Imports		Exports	
	Time & Seasonal f.e.	Incl. Controls	Time & Seasonal f.e.	Incl. Controls
	(1)	(2)	(3)	(4)
$SwapLine_{i,t}$	0.0003	-0.0009	-0.0106*	-0.0125**
	(0.003)	(0.0033)	(0.006)	(0.005)
Country f.e.	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	No	Yes
Neighbor Trade Control	No	Yes	No	Yes
China Policy Controls	No	Yes	No	Yes
Observations	12513	12513	12513	12513

S.E. clustered by country parentheses, * $p < 0.1$, **,$p < 0.05$, *** $p < 0.01$

Spillover effects

Outcome Variable:	$NeighborUse_{i,t}$		$1(Rpayment_{i,t} > 0)$		$Rshare_{i,t}$	
	All Neighbors	Ex. Neighbors with Swapline	Time & Seasonal f.e.	Incl. Controls	Time & Seasonal f.e.	Incl. Controls
	(1)	(2)	(3)	(4)	(3)	(4)
$SwapLine_{i,t}$	0.1378***	0.0989***	0.0765	0.1133	-0.0002	0.000
	(0.014)	(0.017)	(0.089)	(0.093)	(0.001)	(0.001)
$SwapLine_{i,t} \times$			0.3920**	0.3835**	-0.0028	-0.0024
$NeighborSwap_{i,t}$			(0.179)	(0.175)	(0.002)	(0.002)
$(1 - SwapLine_{i,t}) \times$			0.5978*	0.5870*	0.0110	0.0106
$NeighborSwap_{i,t}$			(0.323)	(0.327)	(0.008)	(0.008)
Country f.e.	Yes	Yes	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes	Yes	Yes
China Trade Controls	No	No	No	Yes	No	Yes
China Policy Controls	No	No	No	Yes	No	Yes
Observations	12513	12513	12513	12513	12513	12513

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2. The model of choice of currency of credit

Small open economy, 3 periods

Each firm chooses:

1. Technology: composition of inputs, x_r versus x_d
2. Sticky price: it will charge in which currency (in different markets).

Know:

- Average interest rate
- Relative cost of inputs

Small open economy, 3 periods

Period 0: Pricing Choices → Period 1: Production → Period 2: Delivery

Each firm chooses:

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Firm:

1. Buys inputs using the committed composition
2. Borrows to pay for them in matching currency

Risk realises:

- Firm-specific interest rate
- Exchange rates
- Demand shocks

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Risk realises:

- Firm-specific interest rate
- Exchange rates
- Demand shocks

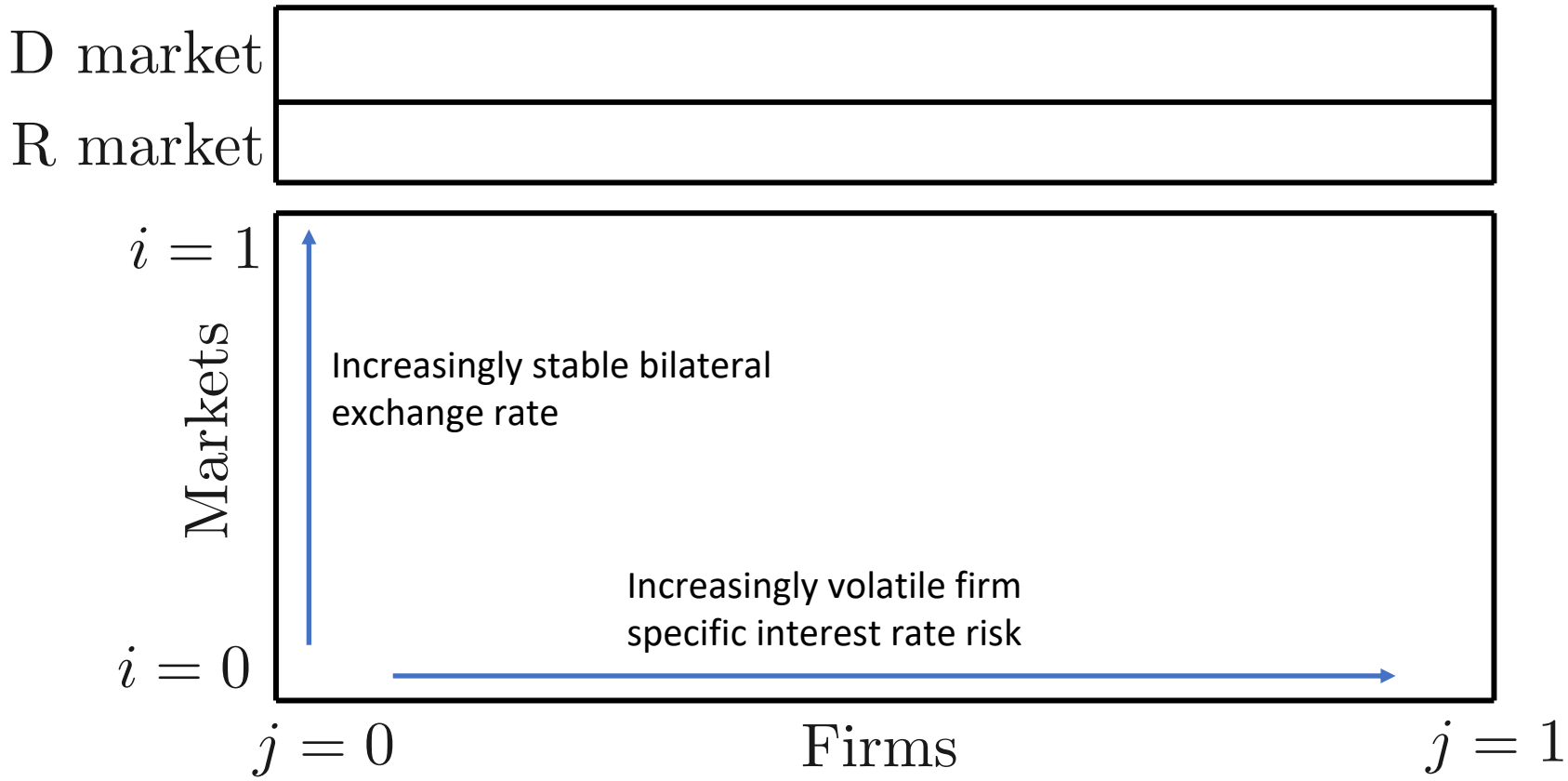
Firm:

1. Sells goods to each market, collect revenue.
2. Repays debt (credibly), distributes profits.

Mechanical period

Firms and geography

- Firms: $j \in [0,1]$
- Markets: dominant D; rising R; $i \in (0,1)$ other SOEs; bilateral FX s_i, s_d, $s_r \in \mathrm{S}$.



Technologies and cost function

Each firm chooses production technology $\boldsymbol{\eta}^j$

$$x^j = \min\left\{\frac{x_r^j}{\eta^j}, \frac{x_d^j}{1-\eta^j}\right\} \qquad y^j = (x^j)^\alpha (l^j)^{1-\alpha}$$

Must borrow to pay for x inputs, $\rho_d, \ \rho_r$ also cost of credit

- Terms of borrowing in D: $1/b_d$
- Terms of borrowing in R: $\varepsilon_j/b_r, \ \varepsilon_j \sim G(\varepsilon_j)$
- Non-credit input, stochastic: w

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$$x^j = \min\left\{\frac{x_r^j}{\eta^j}, \frac{x_d^j}{1-\eta^j}\right\} \qquad y^j = (x^j)^\alpha (l^j)^{1-\alpha}$$

Must borrow to pay for x inputs, ρ_d, ρ_r also cost of credit

- Terms of borrowing in D: $1/b_d$
- Terms of borrowing in R: ε_j/b_r, $\varepsilon_j \sim G(\varepsilon_j)$
- Non-credit input, stochastic: w

$$C(\eta^j, \varepsilon^j, s_r, s_d, w) = \left[\frac{\eta^j s_r \rho_r \left(\frac{\varepsilon^j}{b_r}\right) + (1-\eta^j) s_d \rho_d \left(\frac{1}{b_d}\right)}{\alpha}\right]^\alpha \left(\frac{w}{1-\alpha}\right)^{1-\alpha}.$$

Period 0 choice of pricing

For each market, choose sticky price and pricing technology:

$$\mathcal{P}_i^j \in \{PCP, LCP, DCP, RCP\}$$

Market demand has constant elasticity of demand θ and demand shifter q_i.

E.g. demand under RCP: $y_i^j = (p_i^j s_r / (q_i s_i))^{-\theta}$

Log-normal joint pdf $H(S, Q, w)$, mean μ , variance Σ (elements σ)

Assume: $\mu_d = \mu_r$ & $\sigma_d = \sigma_r$.

Ex post deviations from a constant markup over marginal cost lead to lower profits. Shocks to exchange rates, cost of inputs, borrowing costs, affect profits differently depending on the firm's choice of currency for credit and pricing.

Forces in the model

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$$\theta\left(\sigma_r^2 - \sigma_{rd}\right) > (1-\alpha)(\sigma_{rw} - \sigma_{dw}) + \theta\left(\sigma_{ri} - \sigma_{di}\right) + \theta\left(\sigma_{rq_i} - \sigma_{dq_i}\right). \tag{10}$$

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$$\underbrace{\theta\left(\sigma_r^2 - \sigma_{rd}\right)}_{\text{Benefit from aligning denomination of marginal cost to price.}} > \underbrace{(1-\alpha)(\sigma_{rw} - \sigma_{dw}) + \theta\left(\sigma_{ri} - \sigma_{di}\right) + \theta\left(\sigma_{rq_i} - \sigma_{dq_i}\right)}_{\text{Potential cost if d currency is a better operational hedge.}}. \tag{10}$$

Assum. 1: Neither r nor d currency has a hedging advantage.

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(c) *If the firm chooses r-credit, and the d and r currencies are otherwise identical in terms of mean and variance, then RCP is preferred to LCP in market i if the variance of the local exchange rate is sufficiently high:*

$$\sigma_i^2 - 2\alpha\sigma_{ir} - 2(1-\alpha)\sigma_{iw} \geq \Phi \equiv \sigma_r^2 - 2\alpha\sigma_r^2 - 2(1-\alpha)\sigma_{rw}. \tag{11}$$

Period 0 choice of credit

Proposition 2. *The firm will choose r-credit ($\eta^j = 1$) if*

$$\left(\int \left(\varepsilon^j\right)^{\alpha} dG^j(\varepsilon^j) \right)^{1/\alpha} \leq \left(\frac{b_r}{b_d}\right) \left(\frac{\rho_d}{\rho_r}\right) \Psi(\mu, \Sigma, \mathcal{P}^j).$$

Otherwise, it will choose d-credit. Under assumption 1, $\Psi(\mu, \Sigma, \mathcal{P}^j)$ is equal to one if the r and d markets are equal in size. Starting from this point, $\Psi(\mu, \Sigma, \mathcal{P}^j)$ is increasing in the size of the r-market.

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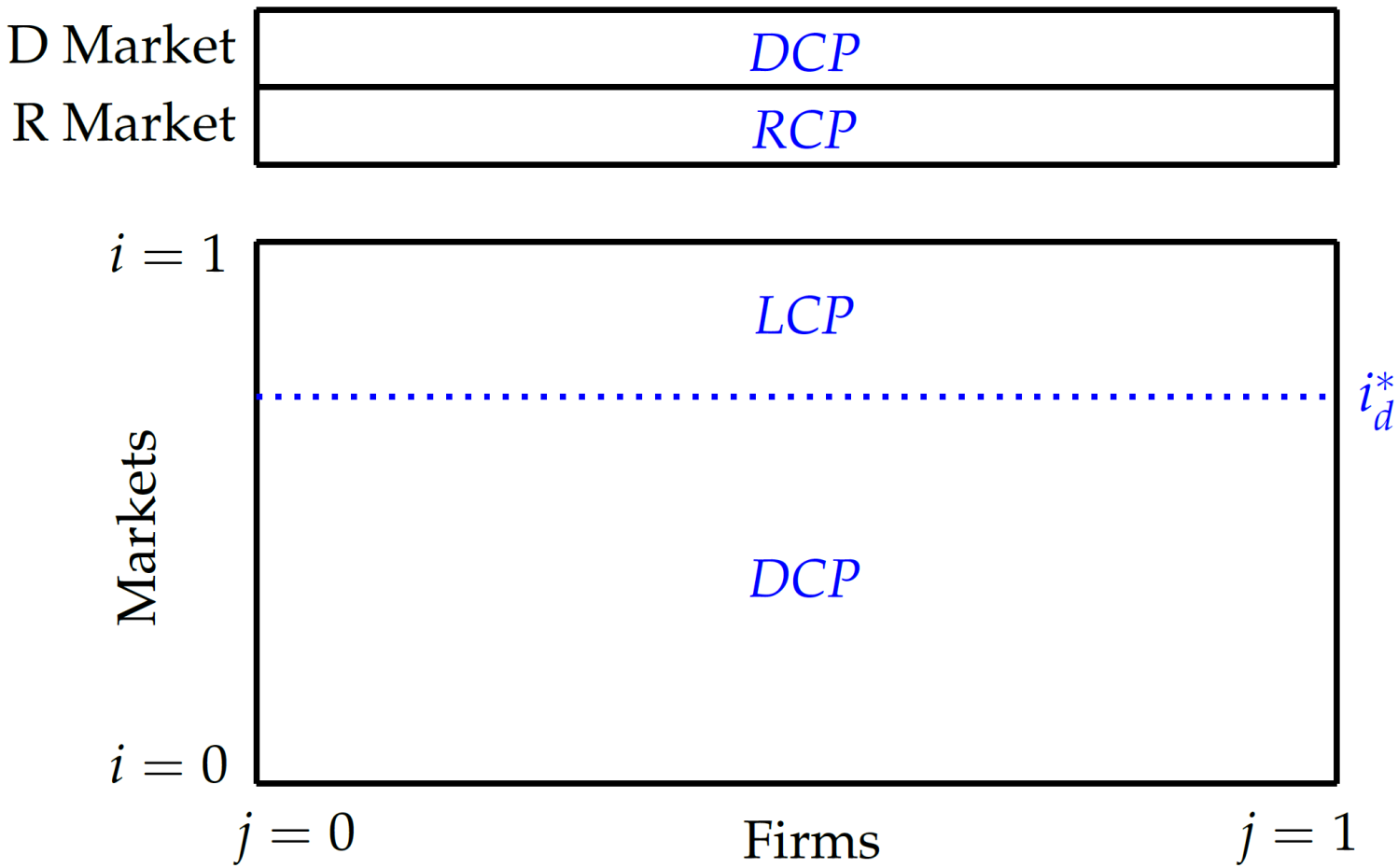
Swap line shifts the effective distribution of borrowing costs to

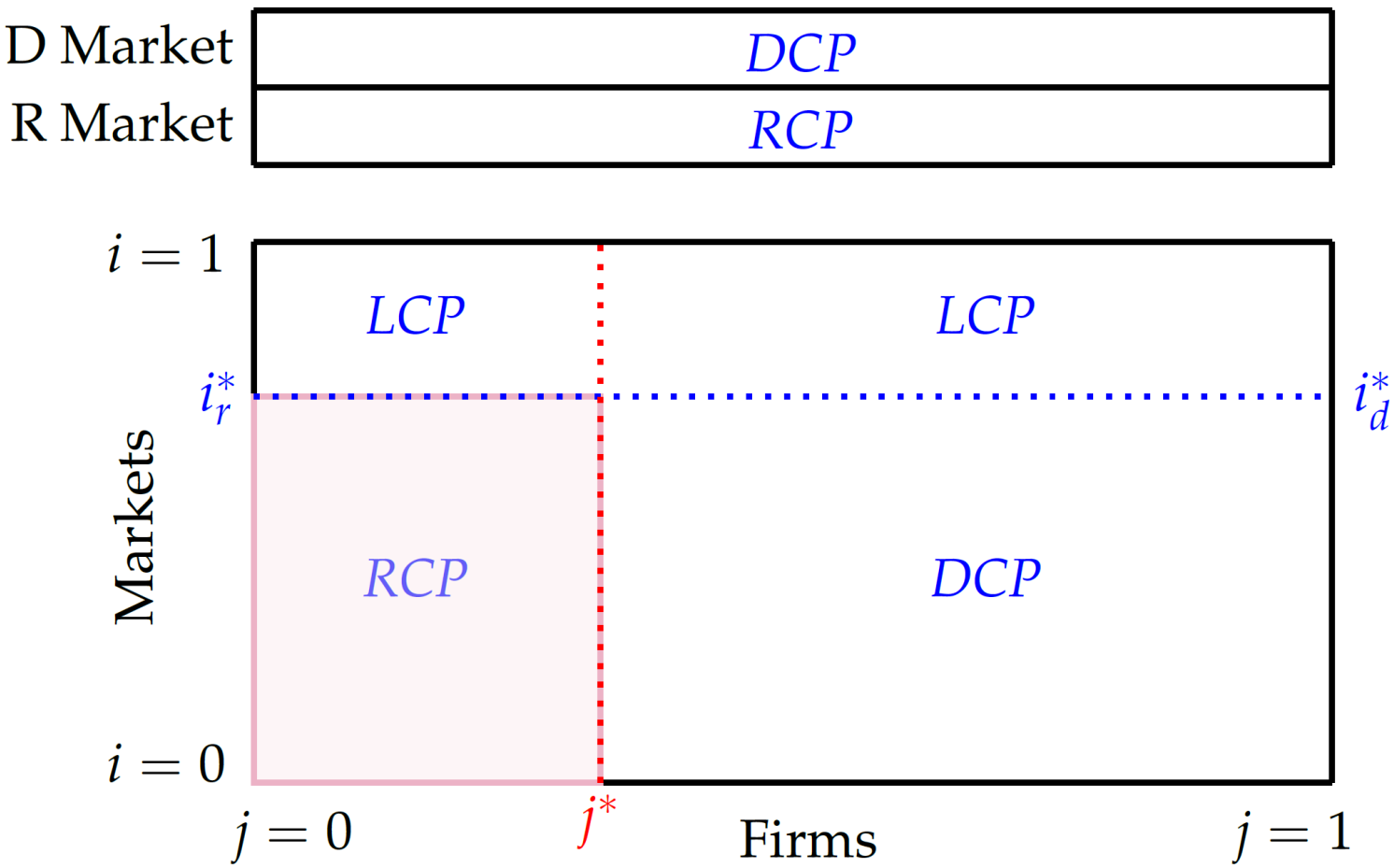
$$\tilde{G}^j(\varepsilon^j) = \begin{cases} 1 & \text{if } \varepsilon^j \geq \varepsilon^{swap} \\ G^j(\varepsilon^j)/G^j(\varepsilon^{swap}) & \text{if } \varepsilon^j < \varepsilon^{swap} \end{cases}$$

so that $\tilde{G}^j(\varepsilon^j)$ is first-order stochastically dominated by $G^j(\varepsilon^j)$ under the new distribution.

Starting point, dominant currency



Add a swap line



- Holding $\mathcal{P}^j$ fixed some firms cross threshold Ψ
- Choose RCP over LCP if local currency sufficiently volatile (threshold Φ)
- Choose RCP over PCP if strong enough correlation with local inputs:

$$\sigma_{rw} \geq \Omega \equiv \sigma_r^2 \left(\frac{0.5 - \alpha}{1 - \alpha} \right)$$

- Complementarity: Ψ is lower the more RCP is used (primitive: size of r-market).

Why so few international currencies?

- Credit denominated in the currency too expensive (or rationed)
- Country small as a share of a market for goods. Weakens complementarity.
- Exchange rate too volatile, prefer LCP over RCP. .
- Currency uncorrelated with other inputs. PCP preferred.

Sorting and the effects of the swap line

Proposition 4. *Consider a firm that initially uses d-credit, for whom the distribution of ε^j shifts to $\tilde{G}^j(\varepsilon^j)$ from $G^j(\varepsilon^j)$, as defined in proposition 3(a), as a result of a new swap line. The swap line will have a greater impact on the firm's use of the r-currency, either in terms of picking r-credit or increasing the share of markets where the firm chooses RCP conditional on choosing r-credit, if:*

(a) the size of the r market becomes larger, starting from the point where the d and r markets are approximately the same size;

(b) domestic costs are closely aligned with the international currencies such that σ_{rw} is greater;

(c) α is higher, so there are more imported inputs using credit.

Sorting and the effects of the swap line

Table 10: The effect of the swaplines: heterogenous responses

	Chinese Trade Share			Price Covariance			Intermediate Imports Share			Export Working Capital Needs		
	low	medium	high	low	medium	high	low	medium	high	low	medium	high
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\text{SwapLine}_{i,t}$	0.1458	0.1056	0.2524***	-0.0593	0.0341	0.1821	-0.0620	0.1761	0.2309***	-0.0403	0.2130**	0.1672
	(0.132)	(0.121)	(0.095)	(0.074)	(0.233)	(0.142)	(0.048)	(0.134)	(0.086)	(0.083)	(0.082)	(0.109)
Country f.e.		No			No			No			No	
Country×Seasonal f.e.		Yes			Yes			Yes			Yes	
Time f.e.		Yes			Yes			Yes			Yes	
Neighbor Use Control		Yes			Yes			Yes			Yes	
China Trade Controls		Yes			Yes			Yes			Yes	
China Policy Controls		Yes			Yes			Yes			Yes	
Observations		12804			4268			12707			12707	
Number of Countries		132			46			131			131	
F-stat high vs low		0.05			2.99*			10.17*			2.77*	

S.E. clustered by country and time in parentheses, * $p < 0.1$, **,$p < 0.05$, *** $p < 0.01$

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5. Conclusion

USD in 1912

- **Start:** World's largest exporter, but USD 0% of trade finance. All in sterling, in London
- Federal Reserve Act (and Strong at FRBNY)
  - De-regulate: US banks branches abroad
  - Stable exchange rate and inflation
  - Liquid secondary market and Fed has buyer of last resort of trade acceptances
- By 1925 USD very large, by 1945 dominant
  - Policy?
  - Luck (war) over London?
  - Inevitable as US became world creditor?

RMB in 2009

- **Start:** largest goods exporter, world creditor, RMB not used at all given capital controls
- Policies starting in July 09:
  - De-regulate: trade settlement pilot scheme
  - Market: CNH in HK offshore market
  - Stable exchange rate: dollar peg
  - Buyer of last resort: PBoC swap lines
- Outcomes:
  - 2016, IMF includes it in SDR basket
  - 2019, 2% of official foreign exchange rate reserves.
  - Coincidence, luck, policies?

Parting thoughts

- International currency status depends on: (i) financial markets, working capital credit, (ii) policy central bank actions

- Empirics: RMB swap line by removing right-tail risk of RMB financing increased probability a country making or receiving RMB payments.

- Model: complementarity between credit and invoicing. Three thresholds that most countries do not meet. Some do, and policy can cause jumpstart.

- Further rise of RMB? Still far from Federal Reserve Act

Appendix Material

Table 1: Summary statistics: main regression sample

	mean	p50	min	max	sd
RMB payments					
RMB payment sent/received ($1(\text{Rpayment}_{i,t} > 0)$)	.258	0	0	1	.438
RMB payment sent/received excluding to/from China	.133	0	0	1	.340
RMB payment sent	.257	0	0	1	.438
RMB payment received	.258	0	0	1	.438
RMB trade credit sent/received (MT400 or MT700)	.050	0	0	1	.217
RMB share in all payments ($\text{Rshare}_{i,t}$)	.004	0	0	.925	.033
Economic Linkages with China					
Goods exports to China (% GDP)	.095	.026	0	.964	.158
Goods imports from China (% GDP)	.128	.112	0	.787	.082
Chinese direct investment (% GDP)	.017	0	0	24.64	.262
Neighbor Variables					
Share of neighbors using RMB (Neighbor $\text{Use}_{i,t}$)	.271	.2	0	1	.267
Share of neighbors with swap line (Neighbor $\text{Swap}_{i,t}$)	.099	0	0	.8	.156
China policies					
Has a PBoC Swap Line($\text{SwapLine}_{i,t}$)	.091	0	0	1	.287
Membership of AIIB	.067	0	0	1	.251
Has RMB Clearing Bank	.018	0	0	1	.134
Has Free Trade Agreement	.009	0	0	1	.093
Cumulative number of state visits	.136	0	0	6	.456
Country Characteristics					
Intermediate input share	.466	.473	.076	.802	.112
Export working capital needs	.150	.151	.080	.206	.021
Observations	12804				