Sovereign Risk Premium, Bond Liquidity and Foreign Reserve Accumulation

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Motivation

Facts:

- Emerging countries borrow a substantial portion debt from foreign investors
- Large amount of sovereign debt emerging countries issued are denominated by foreign currency, referred as "original sin"

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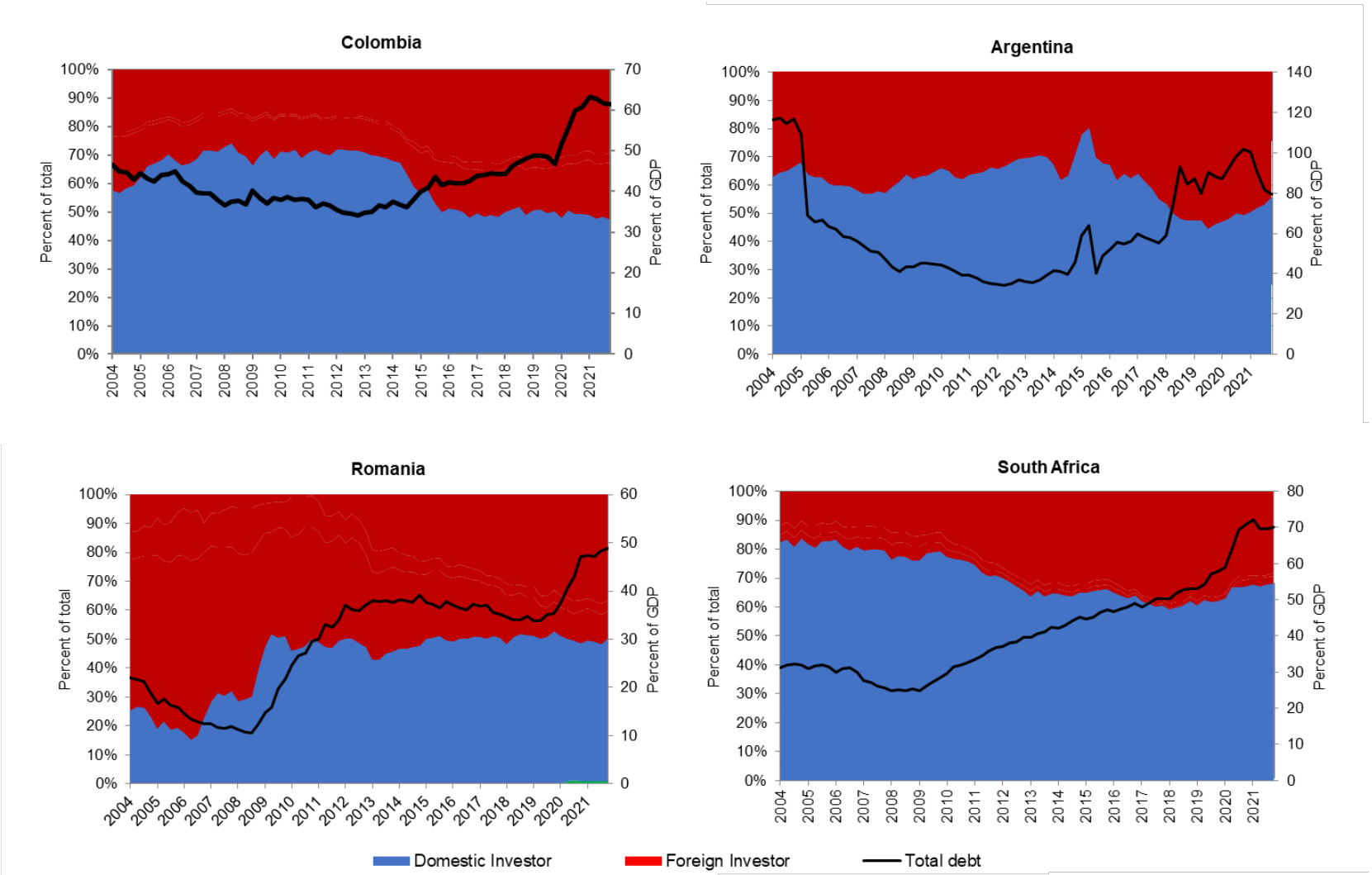


Date source: Arslandlp and Tsuda(2014) extended

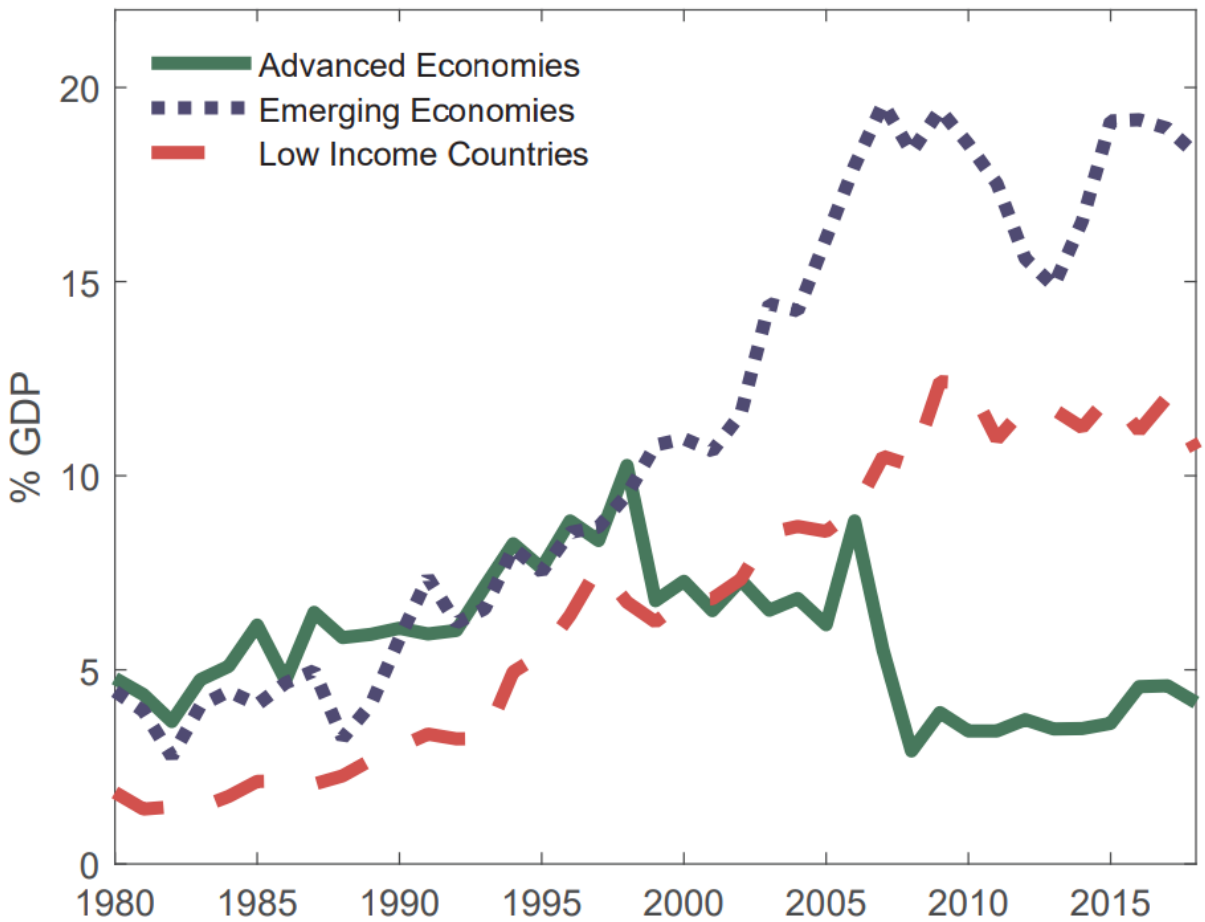
Motivation

Facts:

- Emerging countries borrow a substantial portion debt from foreign investors
- Large amount of sovereign debt emerging countries issued are denomited by foreign currency, referred as "original sin"
- Emerging countries' amount of foreign reserve accumulation increase dramatically from 1980s
- Number of sovereign defaults decreases from 1980s to now

Motivation

Figure: Reserve to GDP Ratio over years



Source: IMF

Outline

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  Sensitivity to global volatility.
  Bond liquidity condition.

Contribution

1. Use CDS spread instead of sovereign bond yield spread as measurement, and decompose CDS spread
2. Find foreign reserve accumulation has insignificant effect on default probability, and strong effect on risk premium
3. Use bond level data to explore factors affecting sovereign bond yield spread
4. Find foreign reserve accumulation improve bond liquidity condition and reduce spillover from global financial volatility

Literature Review

1. Sovereign Risk Premia
   Remolana et al(2008), Longstaff et al(2011 AEJ), Gilchristet et al(2021),

2. Foreign Reserve Policy
   Levy-Yeyati and Gomez (2020), **Sosa-Padilla & Sturzenegger (2021)**,
   Devereaux and Wu(2022), Bianchi,Hatchondo & Martinez(2018 AER)
   Bianchi & Sosa-Padilla (2020)

3. Bond Yield Spread & Liquidity
   Chen, Lesmond and Wei(2007 JF), Hund & Lesmond(2008)
   Dick-Nielsen et al (2012 JFE), Chaumont(2020), Passadore & Xu(2022)

1. **Effect of Reserve on Sovereign Credit Risk?**

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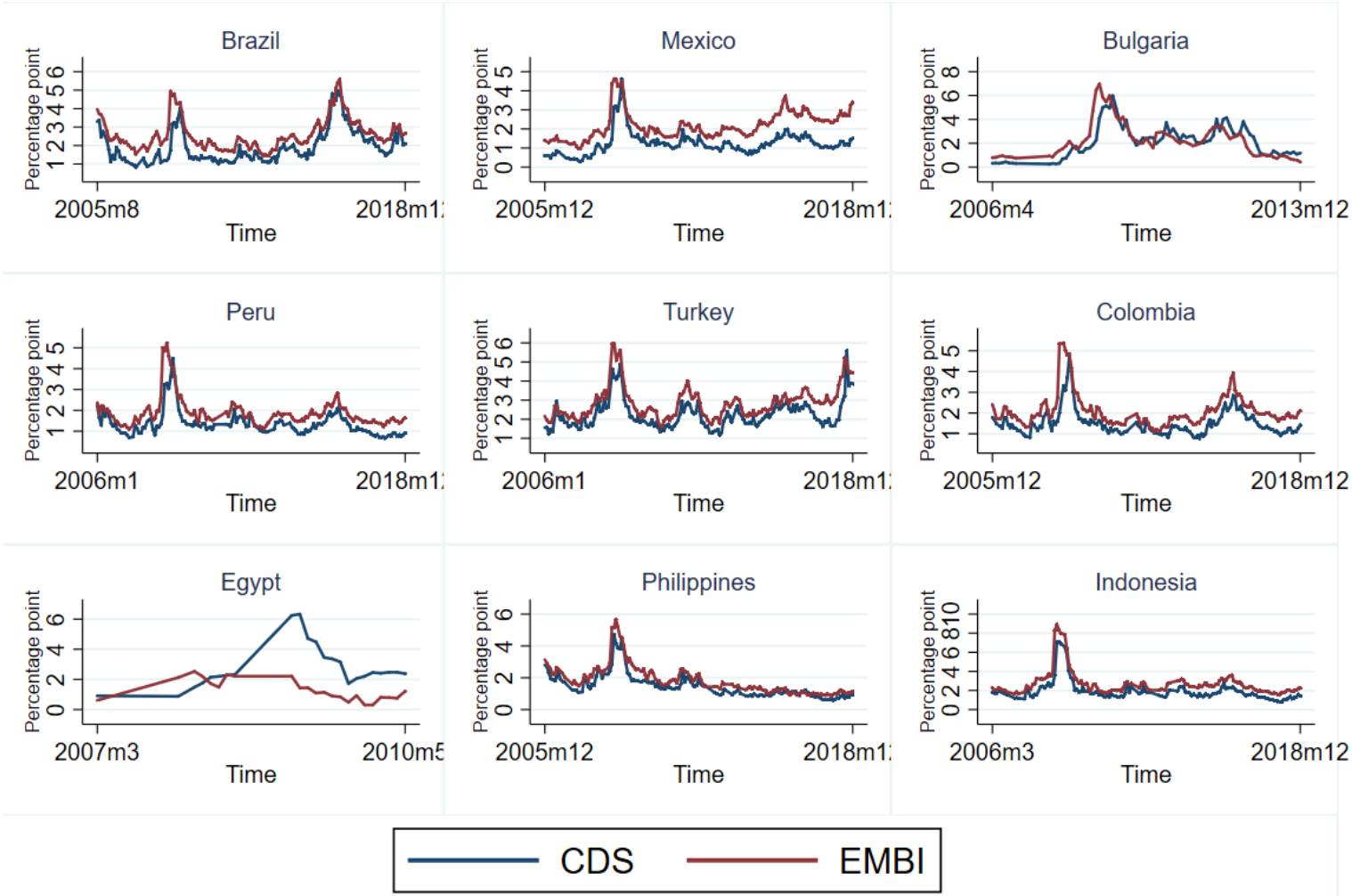
The other measurement commonly used in the literature: **5-year Sovereign Credit Default Swap(CDS) spread**

- CDS contract functions as an insurance contract against sovereign defaults
- Sovereign CDS spread is interpreted as Sovereign CDS premium

Data Comparison



Source: Bloomberg

Empirical Specification

Question:

- What is the effect of Reserve Ratio on Sovereign Credit Spread?
- Does CDS have identical results with credit spread?

Regression:

$$\text{SovereignCDS}_{n,t} = \alpha_n + \beta_1 \frac{Reserve}{GDP}_{n,t} + \beta_2 \frac{SovereignDebt}{GDP}_{n,t} + \beta_3 \frac{CorporateDebt}{GDP}_{n,t} + \eta LC_{n,t} + \mu GC_t + \varepsilon_{n,t}$$

- Monthly Data, 2001-2018, 14 Emerging Countries
- GC are global controls including Risk Averse and World Rate
- LC are local controls including Rating
- Robustness check:
  - Lagged independent variables
  - Change CDS as EMBI (Sosa-Padilla and Sturzenegger (2022))

Data Source

Name	Description	Source
CDS	CDS contract yield, converted from daily to monthly	Bloomberg
Risk Aversion	Merrill Lynch ICE BofAML Option-Adjusted Spreads	FRED
World Rate	US Treasury notes, 10 year World Rate constant maturity yield, bps	FRED
Credit rating	S&P rating, long term debt, end of period, foreign currency Credit rating. Consructed by Sosa-Padilla.	Standard& Poor's
Sovereign Debt	Public and publicly guaranteed The World Bank's, debt from private creditors	World Bank International Debt Statistics (IDS)
Private Debt	External debt stock's, private nonguaranteed	World Bank International Debt Statistics (IDS)

EMBI vs CDS as measurement

	CDS		Sosa-Padilla Results		Sosa-Padilla Small Sample	
	(1)	(2)	(3)	(4)	(5)	(6)
Reserve Ratio	-3.458	-8.106**	-2.584***	-2.760***	-1.987***	-1.488**
	(2.017)	(3.491)	(0.644)	(0.559)	(0.649)	(0.526)
Sovereign Debt	4.308**	9.864*	1.530***	1.560***	1.271**	3.267***
	(1.766)	(4.751)	(0.319)	(0.536)	(0.526)	(0.521)
Private Debt	3.371**	6.452**	0.742**	1.014***	1.172***	1.011**
	(1.176)	(2.904)	(0.333)	(0.313)	(0.333)	(0.400)
Rating	-8.573***	-7.387***	-0.360**	-0.348***	-1.951***	-1.446***
	(1.906)	(1.812)	(0.174)	(0.113)	(0.376)	(0.271)
Date Used	CDS	CDS	EMBI	EMBI	EMBI	EMBI
Fixed Effects	No	Yes	No	Yes	No	Yes
Global Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1859	1859	4497	4497	1859	1859
R sq. adj	0.393	0.437	0.520	0.569	0.573	0.696

Time clustered robust standard errors in parentheses.

Lagged Independent Variables

	Dependent variable: CDS spread					
	(1)	(2)	(3)	(4)	(5)	(6)
Reserve ratio	-8.106**			-7.605**		
	(3.491)			(3.158)		
Reserve ratio (L.1)		-7.239**			-7.298**	
		(3.215)			(3.197)	
Reserve ratio (L.2)			-6.972*			-6.486**
			(3.325)			(2.881)
Sovereign Debt	9.864*	7.948*	8.308*	8.950	8.217	7.206
	(4.751)	(3.724)	(3.906)	(10.64)	(10.34)	(10.46)
Private Debt	6.452**	6.582**	6.595**	-1.447	-1.693	-1.069
	(2.904)	(2.585)	(2.713)	(3.208)	(3.299)	(3.126)
Sovereign debt (L.1)				-0.987	-0.282	0.360
				(10.01)	(9.770)	(10.26)
Private debt (L.1)				8.170**	8.351**	7.269**
				(3.558)	(3.775)	(3.361)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Global Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1859	1729	1693	1729	1729	1612
Lagged Periods	0	1	2	0	1	2

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Step Map

1. **Effect of Reserve on Sovereign Credit Risk?**
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CDS component:

CDS decomposition: sovereign CDS spread can be decomposed into two components:

$$\textbf{Sovereign CDS Spread (Premium)}$$

$$= \underbrace{\textbf{Credit Default Premium}}_{\textbf{hypothetical risk neutral investor}} + \underbrace{\textbf{Credit Risk Premium}}_{\textbf{additional premium if investor is risk averse}}$$

- **Credit Default Premium**: Risk Component.
  Captures the expected sovereign default prob. Related to the probability to default.

- **Credit Risk Premium**: Risk Premium Component.
  Capture cov(sovereign default, investor good/bad states). Related to risk aversion, global financial volatility .....

CDS Decomposition

CDS spread is decomposed by method of Remolona et al(2008), credit rating method:

1. Moody rated sovereign bond safety for every sovereign country, by a letter grade.

Moody's Default Rate

Figure: Moody's Credit Rating for Brazil

CDS Decomposition

CDS spread is decomposed by method of Remolona et al(2008), credit rating method:

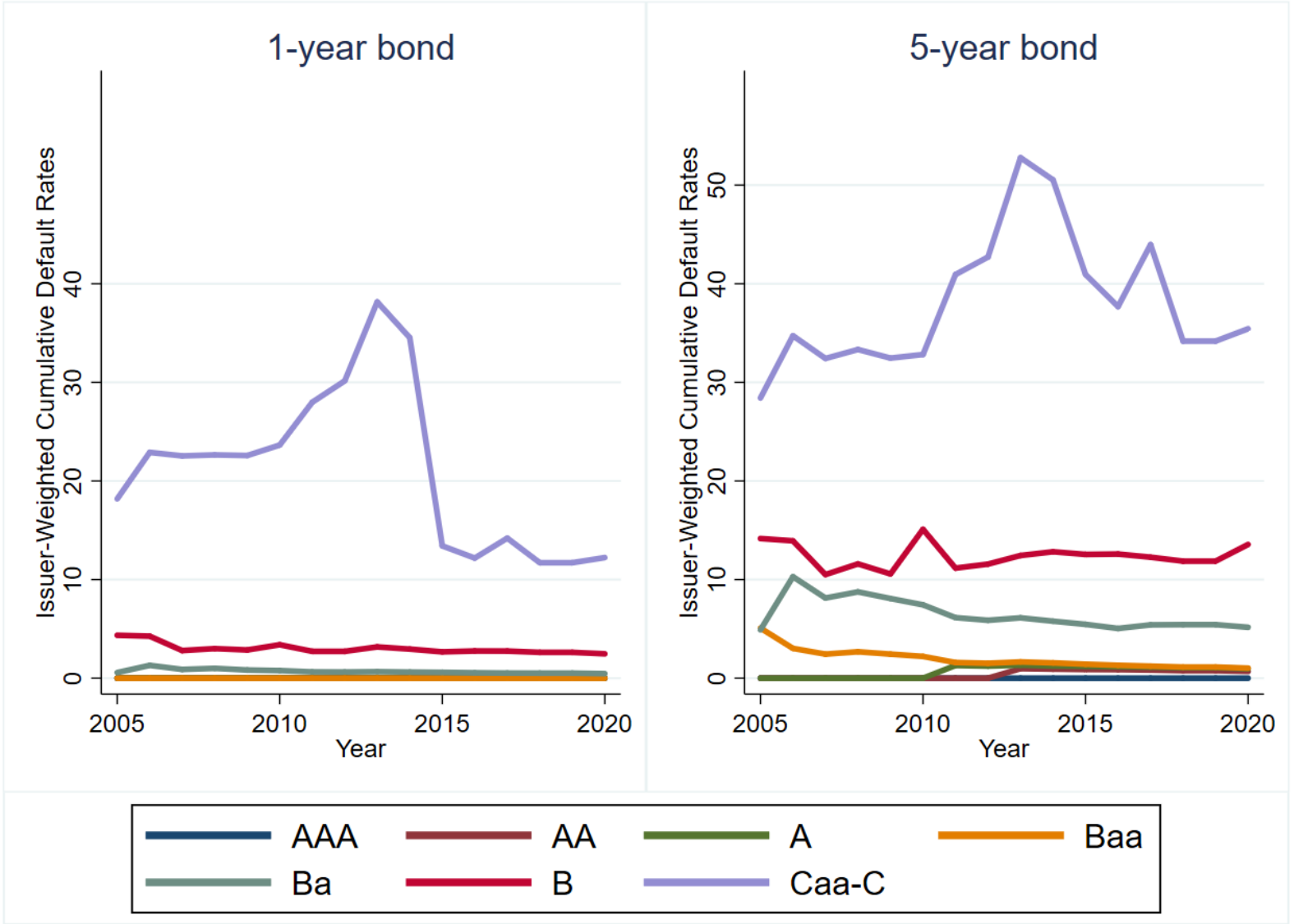
1. Moody rated sovereign bond safety for every sovereign country, by a letter grade.
2. Moody also publishes **Issuer-Weighted Cumulative Default Rates** in the annual **Sovereign Default and Recovery Rates Report**.

Moody's Default Rate

Issuer-weighted cumulative default rates
1983-2020

	Average Count	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Sovereign Issuers											
Aaa	14	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Aa	11	0.000%	0.000%	0.149%	0.413%	0.690%	0.834%	0.834%	0.834%	0.834%	0.834%
A	11	0.000%	0.061%	0.418%	0.684%	0.963%	1.403%	2.012%	2.642%	3.293%	3.976%
Baa	13	0.000%	0.345%	0.560%	0.785%	1.020%	1.376%	1.644%	1.935%	2.252%	2.593%
Ba	13	0.462%	1.337%	2.621%	3.747%	5.157%	6.218%	7.407%	8.854%	10.101%	11.282%
B	14	2.473%	5.455%	8.323%	11.079%	13.560%	15.955%	18.288%	20.576%	22.350%	23.938%
Caa-C	3	12.229%	20.502%	26.451%	31.924%	35.430%	38.207%	41.034%	44.357%	46.782%	48.680%
Investment-Grade	50	0.000%	0.105%	0.275%	0.452%	0.637%	0.857%	1.060%	1.272%	1.497%	1.733%
Speculative-Grade	30	2.692%	5.355%	7.873%	10.196%	12.293%	14.103%	15.930%	17.880%	19.431%	20.826%
All Rated	81	1.012%	2.069%	3.097%	4.043%	4.898%	5.667%	6.421%	7.215%	7.877%	8.491%

Moody's Default Rate



CDS Decomposition

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1. Moody rated sovereign bond safety for every sovereign country, by a letter grade.
2. Moody also publishes **Issuer-Weighted Cumulative Default Rates** in the annual **Sovereign Default and Recovery Rates Report**.
3. Given letter grade of a sovereign country, with the implied default rate, we can calculate the **Ratings-Implied Expected Loss** for every country.

CDS Decomposition

Following Remolona et al(2008), I calculate **Ratings-Implied Expected Loss (RIEL)** by the cumulative default rates for each country.

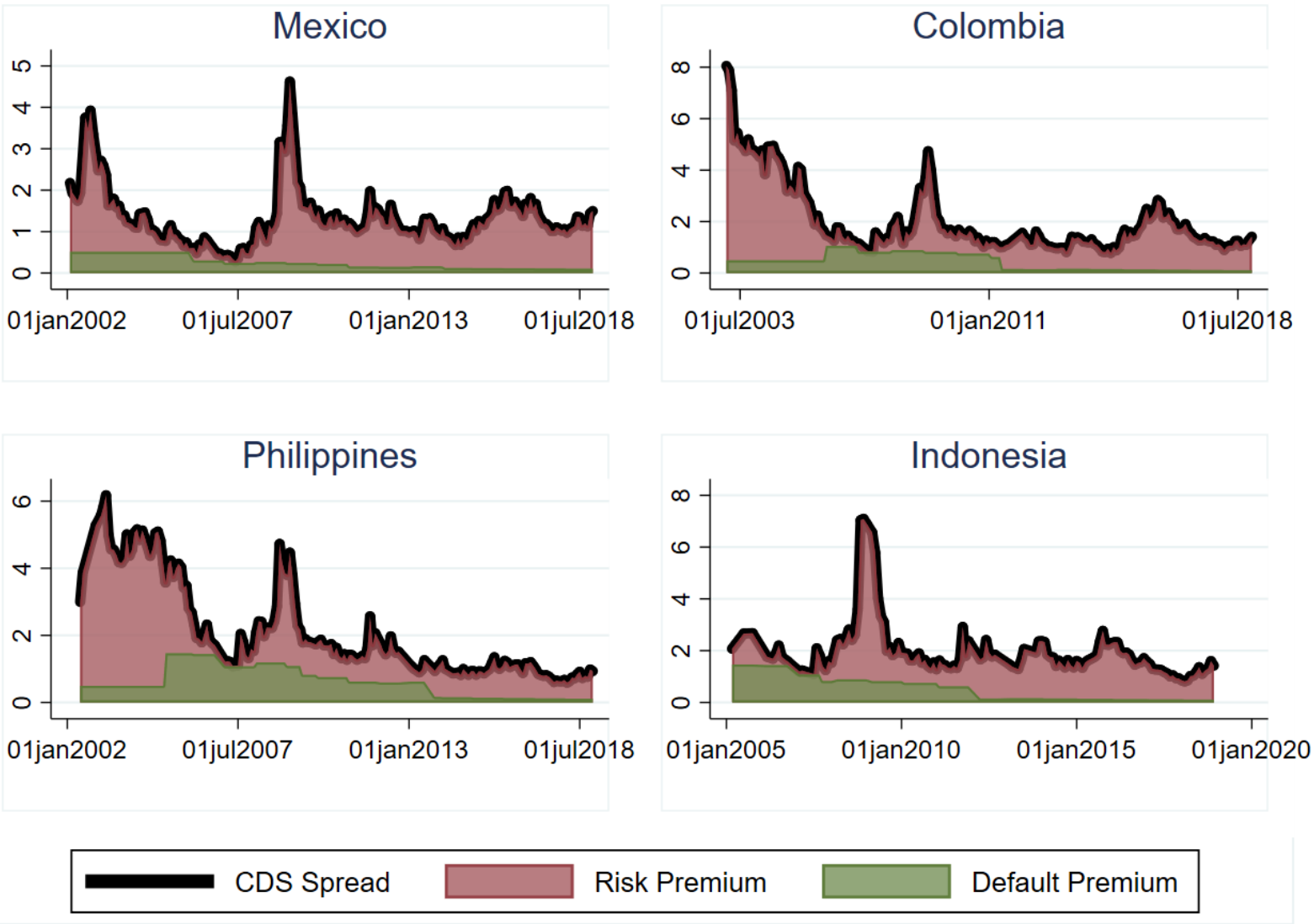
$$1 - PD_t(T) \times (1 - RR) = exp(-T \times RIEL_t(T))$$

- T: Sovereign Bond Maturity(set as 5 year)
- $PD_t(T)$: probability of default at time t for investment horizen T
- RR: recovery rate(set as 0.5)

Calculate default premium and risk premium:

- Default Premium$_t$ = $RIEL_t$
- Risk Premium$_t$ = CDS_t - $RIEL_t$

CDS Decomposition



Empirical Specification

$$\text{SovereignCDS}_{n,t}^{\text{Observed}} = \text{SovereignCDS}_{n,t}^{\text{Default Premium}} + \text{SovereignCDS}_{n,t}^{\text{Risk Premium}}$$

- **Regression:**

$$\text{SovereignCDS}_{n,t}^{\text{Observed}} = \alpha_n + \beta_1 \frac{Reserve}{GDP}_{n,t} + \beta_2 \frac{SovereignDebt}{GDP}_{n,t} + \beta_3 \frac{CorporateDebt}{GDP}_{n,t} + \beta_4 Rating_{n,t} + \mu GC_t + \varepsilon_{n,t}$$

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- GC are global controls including Risk Averse and World Rate

Default Premium v.s. Risk Premium

	CDS		Risk Premium		Default Premium	
	(1)	(2)	(3)	(4)	(5)	(6)
Reserve Ratio	-3.458	-8.106**	-3.428	-8.211**	-0.0297	0.106
	(2.017)	(3.491)	(2.022)	(3.303)	(0.245)	(0.542)
Sovereign Debt	4.308**	9.864*	4.288**	9.564**	0.0195	0.300
	(1.766)	(4.751)	(1.878)	(4.390)	(0.374)	(0.761)
Private Debt	3.371**	6.452**	3.458**	6.803**	-0.0865	-0.351
	(1.176)	(2.904)	(1.197)	(2.790)	(0.0955)	(0.459)
Rating	-8.573***	-7.387***	-6.292***	-5.501***	-2.281***	-1.886***
	(1.906)	(1.812)	(1.817)	(1.486)	(0.408)	(0.551)
Fixed Effects	No	Yes	No	Yes	No	Yes
Global Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1859	1859	1859	1859	1859	1859
R sq. adj	0.395	0.438	0.317	0.384	0.657	0.590

Cluster robust standard errors in parentheses.

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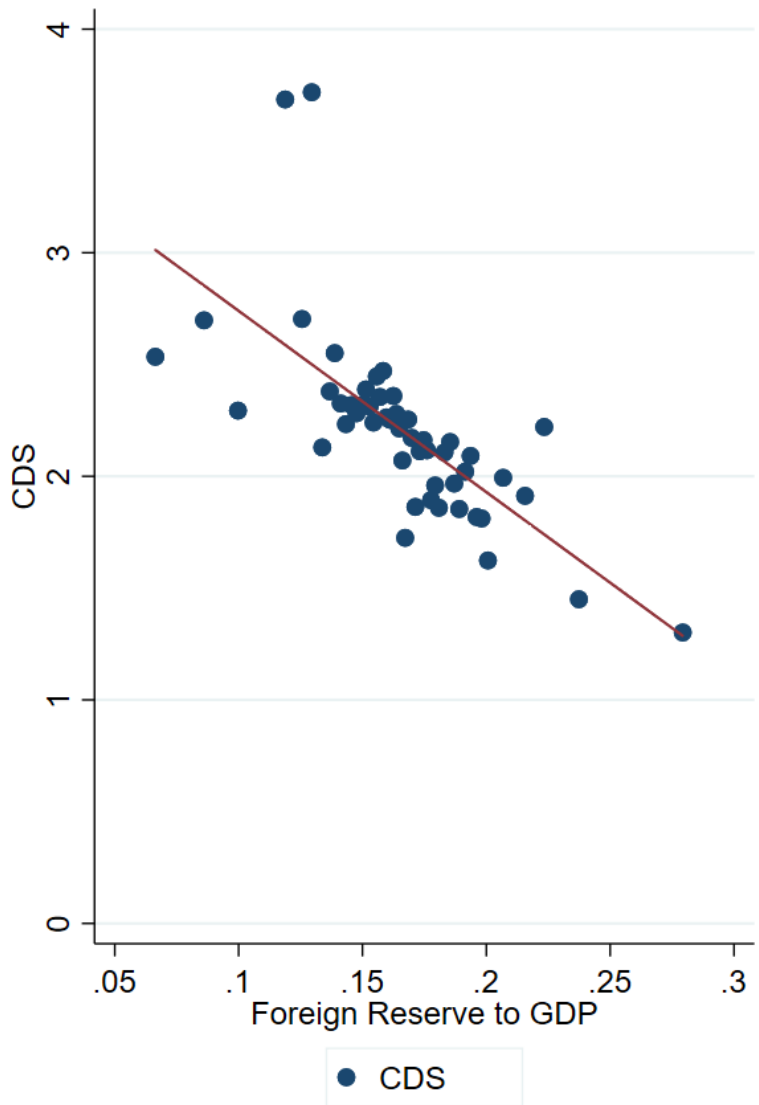
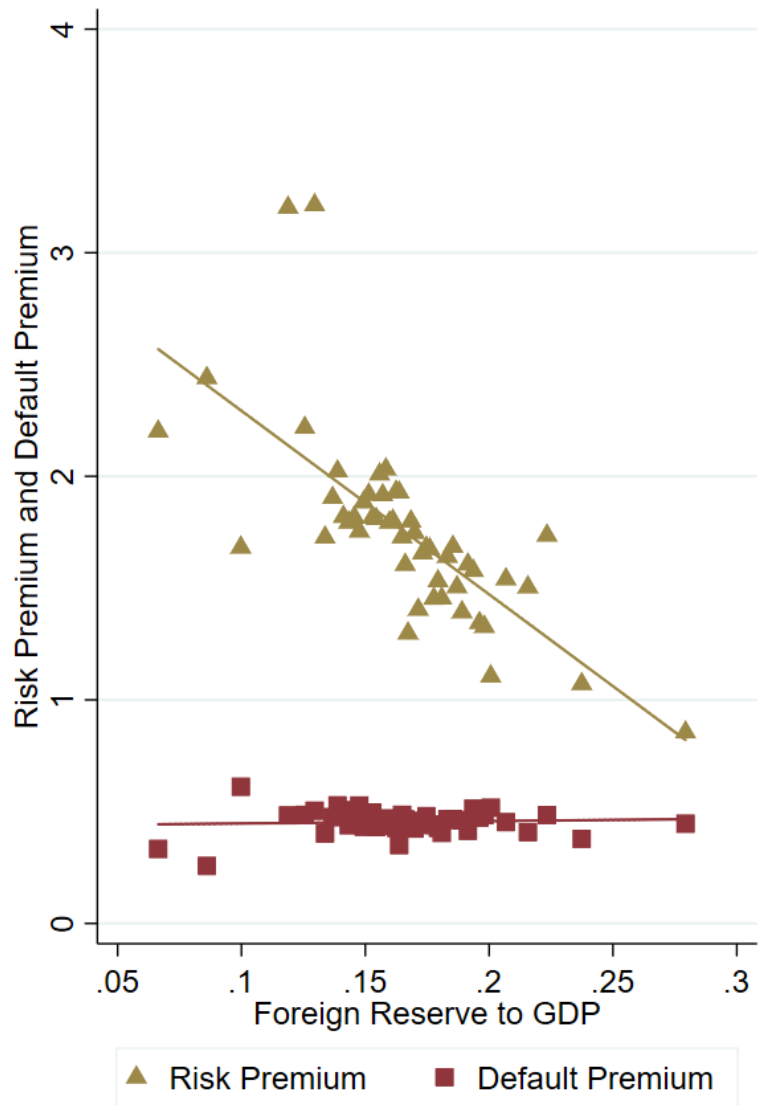
- Reserve Ratio lower Sovereign CDS Spread mainly through Risk Premium component rather than Default Premium component

Visualizing the Empirical Finding





Step Map

1. **Effect of Reserve on Sovereign Credit Risk?**
   - Significant negative effect
   - CDS replace EMBI as measurement
2. **Through Default Probability? Or risk premium?**
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Risk Premium component

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What is the key component of sovereign credit risk affected by Reserve policy?

To better address this question, construct a new dataset containing bond-level data.

Bond-Level Data

From Bloomberg, monthly frequency, secondary market:

- Bond Yield Spread (difference between bond yield and benchmark bond yield)
- Bid Price & Ask Price (Bid-Ask spread to measure bond liquidity)

	Bond Number	Observation	Start	End
Brazil	47	2866	8/2005	12/2021
Bulgaria	2	192	6/2006	1/2015
Colombia	34	2476	12/2005	12/2021
Egypt	24	773	2/2006	12/2020
Indonesia	76	5797	2/2006	12/2020
Kazakhstan	9	565	1/2006	12/2020
Mexico	43	3273	12/2005	12/2020
Peru	37	1978	1/2006	12/2020
Philippines	40	3123	12/2005	12/2020
Russia	39	2365	12/2005	12/2020
South Africa	22	1552	2/2006	12/2020
Thailand	6	256	1/2006	12/2020
Tunisia	3	325	12/2005	12/2020
Turkey	90	5985	1/2006	12/2021
Total	471	30984	8/2005	12/2021

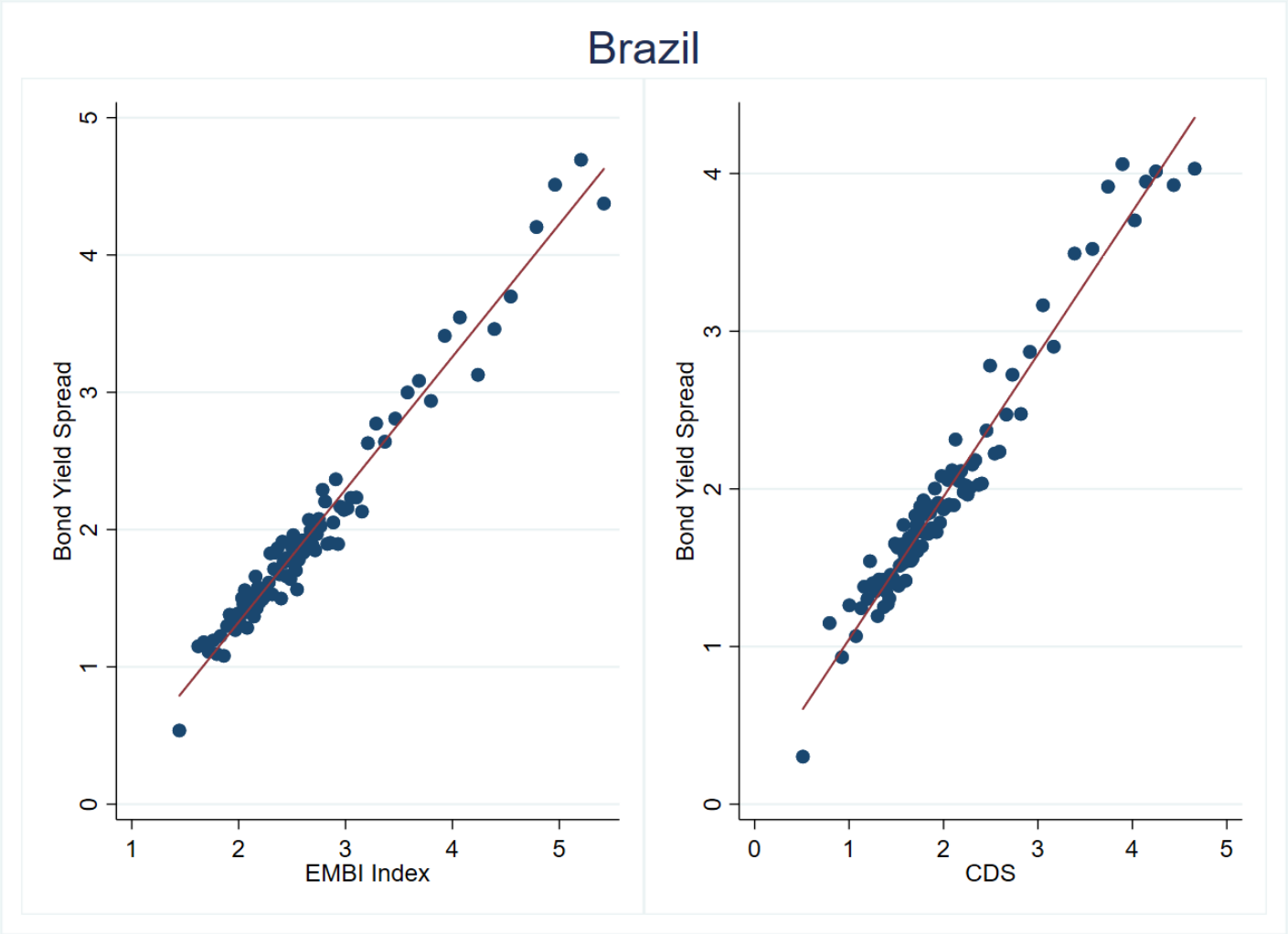
Why sovereign bond liquidity is important?

Credit spread puzzle: simultaneous high credit spreads and low default frequency

- sovereign bonds are traded in OTC market where trading is infrequent
- takes time for a sovereign bond holder to find a counterparty to trade bonds
- investors turns to hold bonds which is easier to trade
- investors should be compensated for bond illiquidity

Related literature: Passadore & Xu(2022), Chaumont (2022)

Bond Yield Spread vs EMBI & CDS



Source: Bloomberg

Empirical Specification

- **Question:** How sovereign bond yield spread is determined?
- **Regression:**

$$\text{YieldSpread}_{i,t} = \alpha_i + \beta_1 \text{Bid-AskSpread}_{i,t} + \beta_2 \text{Coupon}_{i,t} + \beta_3 \text{Rating}_{i,t} + \beta_4 \text{TimetoMaturity}_{i,t} + \beta_5 \text{Age}_{i,t} + \eta GC_t + \varepsilon_{i,t}$$

- GC are global controls including VIX and World Rate
- Empirical methodology is similar to Chen, Lesmond and Wei(2007) (on corporate bond)

Bond Yield Spread Determination

	Sovereign Yield Spread		
	(1)	(2)	(3)
Bid-Ask Spread	0.334***	0.262***	0.229**
	(0.044)	(0.079)	(0.098)
Coupon	-0.430		
	(0.402)		
Rating	-1.427***	-1.432***	-1.395***
	(0.045)	(0.073)	(0.066)
Time to Maturity	0.032***	0.002	0.063**
	(0.001)	(0.014)	(0.027)
Age	-0.034***		
	(0.002)		
WRate	-0.893***	-0.383***	0.475**
	(0.025)	(0.141)	(0.188)
VIX	0.056***	0.069***	0.074***
	(0.001)	(0.006)	(0.006)
Cons	5.583***	5.022***	3.336***
	(0.144)	(0.238)	(0.383)
Bond FE	No	Yes	Yes
Year Dummy	No	No	Yes
Observations	20534	20528	20528
R sq. adj	0.211	0.321	0.337

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Results:

- When the bond is more illiquid, it has higher yield spread, empirically support Passadore and Xu(2022)
- Improvement in liquidity causes a reduction in yield spread
- Justify the concern that yield spread can be fully explained by default risk determinants

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   - Construct bond level Dataset
   - Bond yield determination: liquidity, global factor ...

Step Map

1. **Effect of Reserve on Sovereign Credit Risk?**
   - Significant negative effect
   - CDS replace EMBI as measurement
2. **Through Default Probability? Or risk premium?**
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3. **Through which specific component in risk premium?**
   - Construct bond level Dataset
   - Bond yield determination: liquidity, global factor ...
4. **How Reserve affect Liquidity & Global Factor?**

Empirical Specification

- **Question:**
  - Does Reserve still significant lower Sovereign Yield Spread for bond-level data?
  - How does interaction with VIX will affect on the results?

- **Regression:**

$$\text{YieldSpread}_{i,t} = \alpha_i + \beta_1 \text{ReserveRatio}_{i,t} + \beta_2 VIX + \beta_3 VIX \times ReserveRatio + \eta GC_t + \mu LC_{i,t}$$

- GC are global controls including World Rate
- LC_i are local controls including Coupon, Rating, Time to Maturity and Age of every bonds i.

Reserve Ratio on Sovereign Yield Spread

	Sovereign Yield Spread		
	(1)	(2)	(3)
Reserve Ratio	-1.668***	-1.145**	-0.969*
	(0.073)	(0.467)	(0.501)
World Rate	-1.017***	-0.402***	0.503**
	(0.022)	(0.146)	(0.196)
VIX	0.059***	0.071***	0.078***
	(0.001)	(0.006)	(0.006)
Reserve ratio x VIX			
Bond FE	No	Yes	Yes
Year Dummy	No	No	Yes
Bond Control	Yes	Yes	Yes
Observations	23687	23687	23687
R sq. adj	0.392	0.608	0.648

Time clustered robust standard errors in parentheses.

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Observations	23687	23687	23687
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Time clustered robust standard errors in parentheses.

Results::

- Negative effect of Reserve Ratio on Sovereign Yield Spread is still significant on bond level data
- Market Panic can significantly push up the Sovereign Yield Spread

Reserve Ratio on Sovereign Yield Spread

	Sovereign Yield Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
Reserve ratio	-1.668***	-1.145**	-0.969*	-0.026	0.631	0.213
	(0.147)	(0.738)	(0.759)	(0.354)	(0.797)	(0.891)
World Rate	-1.017***	-0.472***	0.503**	-1.010***	-0.477***	0.496**
	(0.022)	(0.146)	(0.196)	(0.022)	(0.144)	(0.195)
VIX	0.059***	0.071***	0.078***	0.073***	0.087***	0.088***
	(0.001)	(0.006)	(0.006)	(0.003)	(0.008)	(0.007)
Reserve ratio x VIX				-0.091***	-0.104***	-0.069***
				(0.015)	(0.024)	(0.024)
Bond FE	No	Yes	Yes	No	Yes	Yes
Year Dummy	No	No	Yes	No	No	Yes
Bond Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23687	23676	23676	23687	23676	23676
R sq. adj	0.392	0.608	0.648	0.394	0.610	0.649

Time clustered robust standard errors in parentheses.

Reserve Ratio on Sovereign Yield Spread

	Sovereign Yield Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
Reserve ratio	-1.668***	-1.145**	-0.969*	-0.026	0.631	0.213
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World Rate	-1.017***	-0.472***	0.503**	-1.010***	-0.477***	0.496**
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VIX	0.059***	0.071***	0.078***	0.073***	0.087***	0.088***
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Reserve ratio x VIX				-0.091***	-0.104***	-0.069***
				(0.015)	(0.024)	(0.024)
Bond FE	No	Yes	Yes	No	Yes	Yes
Year Dummy	No	No	Yes	No	No	Yes
Bond Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23687	23676	23676	23687	23676	23676
R sq. adj	0.392	0.608	0.648	0.394	0.610	0.649

Time clustered robust standard errors in parentheses.

Empirical Specification

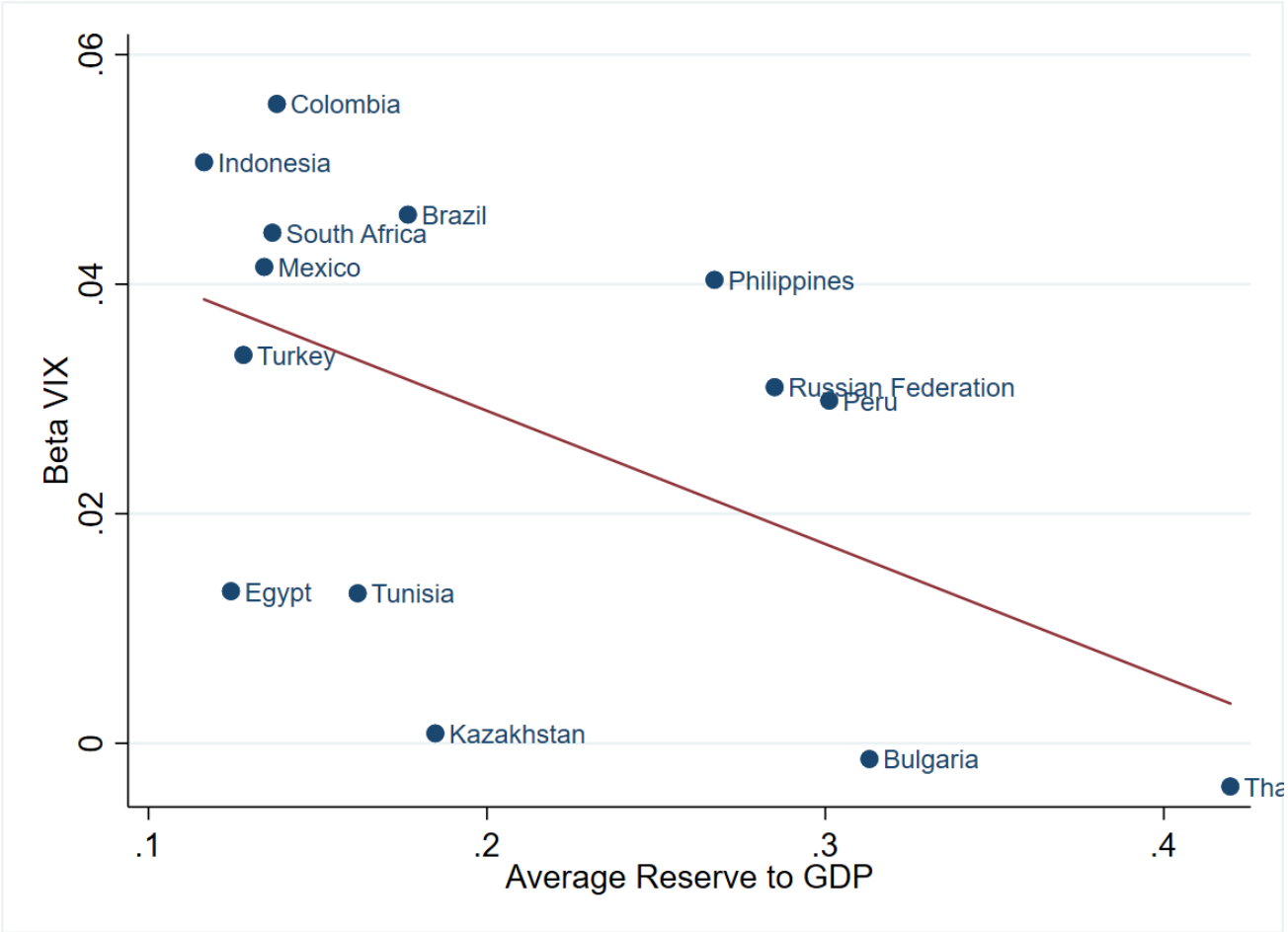
- **Question:**
  - Holding more reserve really lower the sensitivity of sovereign yield spread to global factor?

- **Regression:**

$$\Delta \text{YieldSpread}_{n,t} = \alpha_n + \beta^n_{VIX} \Delta \text{VIX}_t + GC_t + \varepsilon_{n,t}$$

- GC are global controls including World Rate and VIX
- β^n_{VIX} can be interpreted as sensitivity of country n's Yield Spread to the global financial cycle

Visualizing the Empirical Finding



Empirical Specification

- **Question:**
  - Does Reserve still significant lower Bid-Ask Spread?
  - How does interaction with VIX will affect on the results?

- **Regression:**

$$\text{Bid-AskSpread}_{i,t} = \alpha_i + \beta_1 \text{ReserveRatio}_{i,t} + \beta_2 VIX + \beta_3 VIX \times ReserveRatio + \eta GC_t + \mu LC_{i,t}$$

- GC are global controls including World Rate
- LC_i are local controls including Coupon, Rating, Time to Maturity and Age of every bonds i.

Reserve Ratio on Bid-Ask Spread

	Bid-Ask Spread		
	(1)	(2)	(3)
Reserve Ratio	0.022***	0.324*	-0.549***
	(0.045)	(0.189)	(0.198)
World Rate	-0.211***	-0.171***	0.172**
	(0.012)	(0.033)	(0.063)
VIX	0.011***	0.011***	0.015***
	(0.001)	(0.002)	(0.002)
Reserve ratio x VIX			
Bond FE	No	Yes	Yes
Year Dummy	No	No	Yes
Bond Control	Yes	Yes	Yes
Observations	23687	23680	23680
R sq. adj	0.098	0.341	0.373

Time clustered robust standard errors in parentheses.

Reserve Ratio on Bid-Ask Spread

	Bid-Ask Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
Reserve ratio	0.022	0.324*	-0.549***	-0.931***	-0.613	-1.691***
	(0.045)	(0.189)	(0.198)	(0.229)	(0.419)	(0.415)
World Rate	-0.211***	-0.171***	0.172***	-0.215***	-0.169***	0.179***
	(0.012)	(0.033)	(0.063)	(0.012)	(0.034)	(0.065)
VIX	0.011***	0.011***	0.015***	0.003*	0.003	0.005**
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Reserve ratio x VIX				0.053***	0.055***	0.066***
				(0.014)	(0.019)	(0.018)
Bond FE	No	Yes	Yes	No	Yes	Yes
Year Dummy	No	No	Yes	No	No	Yes
Bond Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23687	23680	23680	23687	23680	23680
R sq. adj	0.098	0.341	0.373	0.101	0.344	0.378

Time clustered robust standard errors in parentheses.

- Reserve ratio significantly decrease bid-ask spread of sovereign bond even interaction of Reserve ratio and VIX added.

Step Map

1. **Effect of Reserve on Sovereign Credit Risk?**
   - Significant negative effect
   - CDS replace EMBI as measurement
2. **Through Default Probability? Or risk premium?**
   - CDS decomposition
   - Through Risk Premium rather than Default Premium
3. **Through which specific component in risk premium?**
   - Construct bond level Dataset
   - Bond yield determination: liquidity, global factor ...
4. **How Reserve affect Liquidity & Global Factor?**
   - Lower sensitivity of sovereign risk to global shock
   - More Reserve lower Bid-Ask Spread

Conclusion

1. Holding more foreign reserves significantly lower sovereign credit risk, mainly through risk premium component rather than default premium component.
2. Reserve accumulation does not significantly lower possibility to default.
3. Reserve accumulation can effectively lower sensitivity of sovereign risk to the global financial factor.
4. Holding more reserve improve liquidity condition of the sovereign bond the country issued.

The End

Thank you!

Welcome for questions and comments!