Foreign Safe Asset Demand and the Dollar Exchange Rate
Jiang, Krishnamurthy, & Lustig (2021, JF)

International MacroFin Reading Group

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Overview

1. Background: What Explain Exchange Rate?
   - CIP Deviation & the Disconnection Puzzle
   - Stylized Facts of CIP Deviation and Treasury Basis
2. Jiang et al. (2021): CIP Deviations Predicts Exchange Rate
   - Overview: Mechanisms & Contributions
   - Theory & Testable Implications
   - Empirical Evidence
   - VAR Analysis
3. Discussion: What Can Be Done Based on Jiang et al. (2021)

Covered Interest Rate Parity (CIP) Deviation

- CIP deviation [Literature Review: Du & Schreger, (2022)]
  - **LIBOR (after GFC)** ⇔ **Bank's constraints:** Ivashina et al. (2015), Du et al. (2018a), Fang & Liu (2021), etc.
  - **Sovereign bond:** Du et al. (2018b), Engel & Wu (2018), Jiang et al. (2021), etc.

$$x_t \equiv y_t^{\$} + \left(f_t^1 - s_t\right) - y_t^* \tag{1}$$

  - When the dollar is strong, CIP deviations are wide (Advijev et al., 2019; Jiang et al., 2021)

- Exchange Rate Disconnection Puzzle (Meese & Rogoff, 1983):
  - The exchange rate **does not fluctuate** with fundamentals;
  - The exchange rate is **more volatile** than macroeconomic aggregates.

Stylized Facts of CIP Deviation and Treasury Basis

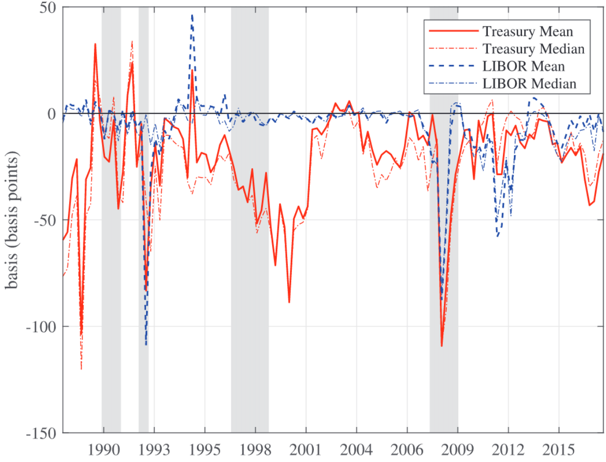


Figure: 1 Year U.S. LIBOR and Treasury Bases: $\text{Mean}(x_t^{\text{Treas}}) = -22\text{bp}$

Stylized Facts of CIP Deviation and Treasury Basis

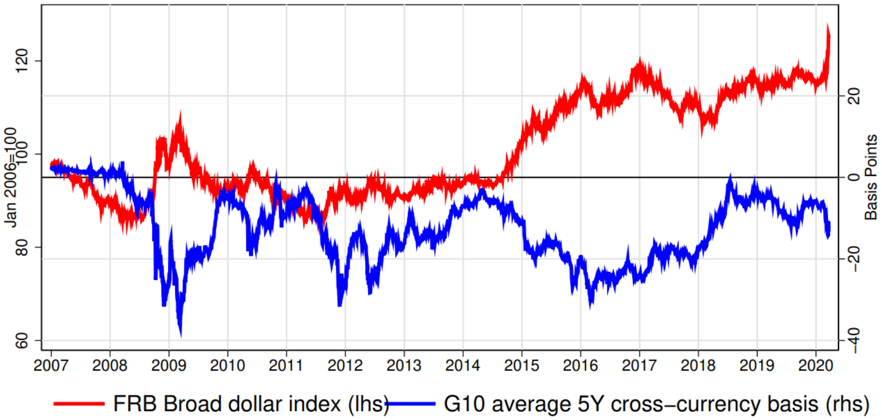


Figure: USD Strong when CIP Deviation High (Avdjiev et al. 2019)

Key Insight

- **Key insight:** Treasury bonds bring **convenience yields:**
  - Two potential sources:
    - **Convenience of treasury:** Liquidity & collateralizability, etc.
    - **Convenience of dollar:** **Absolute** certainty in dollar payment (**safety**)
  - Consequence: Pricing premium $\Leftrightarrow$ Low Required Return:

$$\underbrace{\mathbb{E}_t\left(M_{t+1}X_{t+1}\right)}_{Fundamental}\underbrace{e^{\lambda_t}}_{Premium} = P_t \quad \Leftrightarrow \quad \mathbb{E}_t\left(M_{t+1}R_{t+1}\right) = e^{-\lambda_t}$$

  - Caveat: Interpretation of **'safety'**:
    - "Not the same as the risk premium of a standard asset pricing model; it reflects a deviation due to **clientele demand**" (Krishnamurthy & Vissing-Jorgensen, 2011)

Research Question, Mechanism and Contributions

- **Research Question**: How does treasury CIP deviation link to exchange rate fluctuation?

- **Mechanism and Contributions**:
  - 1. CIP deviation x_t^{Treas} measures convenience yields fluctuations (a new way to interpret CIP deviation);
  - 2. Convenience yields increase cause dollar appreciate (partially solve disconnection puzzle by introducing new noise to exchange rate):

$$\underbrace{x_t^{\text{Treas}} \uparrow \Rightarrow^{imply}}_{measurement} \underbrace{\lambda_t \uparrow \Rightarrow^{cause} \$Demand \uparrow \Rightarrow^{cause} s_t \uparrow \& \ \mathbb{E}_t\left[s_{t+1}\right] \downarrow}_{causality}$$

Model Setup: How Foreign Invest in Default-free Bond?

- **Strategy 1**: Unhedged investment in US treasury
  - 1 to $\frac{1}{S_t}$ USD, invest to $\frac{1}{S_t}e^{y_t^\$}$ USD, back to $\frac{S_{t+1}}{S_t}e^{y_t^\$}$ local currency
  - **Best convenience:** Liquidity of treasury + Fixed USD payment
- **Strategy 2**: Unhedged investment in foreign default-free bond
  - 1 invest to $e^{y_t^*}$ local currency
  - **Worst convenience:** No liquidity of treasury + Unfixed USD payment
- **Strategy 3**: Forward-hedged investment in foreign default-free bond
  - 1 invest to $e^{y_t^*}$ local currency, using forward to get fixed dollar payment $\frac{1}{F_t^1}e^{y_t^*}$ USD, and convert back to $\frac{S_{t+1}}{F_t^1}e^{y_t^*}$ local currency
  - **Middle convenience:** No liquidity of treasury + Fixed USD payment

Asset Pricing Implication

- Law of one price $\Rightarrow \exists M^*_{t+1}$ (not unique unless market complete):

$$\mathbb{E}_t\left(M^*_{t+1}\frac{S_{t+1}}{S_t}e^{y^\$_t}\right) = e^{-\lambda^{\$,*}_t} \tag{2}$$

$$\mathbb{E}_t\left(M^*_{t+1}e^{y^*_t}\right) = e^{-\lambda^{*,*}_t} \tag{3}$$

$$\mathbb{E}_t\left(M^*_{t+1}\frac{S_{t+1}}{F^1_t}e^{y^*_t}\right) = e^{-\left[\lambda^{*,*}_t+\beta^*\left(\lambda^{\$,*}_t-\lambda^{*,*}_t\right)\right]} \tag{4}$$

  - $\lambda^{\$,*}_t$: Log convenience yield of foreign on unhedged treasury
  - $\lambda^{*,*}_t$: Log convenience yield of foreign on unhedged foreign bond

  - $\beta^* \in [0,1]$: Share of convenience comes from fixed USD payment

$$0 \leq \lambda^{*,*}_t \leq \lambda^{*,*}_t + \beta^*\left(\lambda^{\$,*}_t - \lambda^{*,*}_t\right) \leq \lambda^{\$,*}_t \tag{5}$$

Asset Pricing Implication

- Assumption: $M_{t+1}^{\$}$ and S_{t+1} are jointly log-normal
  - Combine (2) (3): Convenience yield **cause** exchange rate changes

$$\mathbb{E}_t\left[\Delta s_{t+1}\right] + \left(y_t^{\$} - y_t^*\right) = rp_t^* - \left(\lambda_t^{\$,*} - \lambda_t^{*,*}\right) \tag{6}$$

$$rp_t^{\$} \equiv: -\operatorname{cov}_t\left(m_{t+1}^*, \Delta s_{t+1}\right) - \frac{1}{2}\operatorname{var}_t\left[\Delta s_{t+1}\right]$$

  - Combine (2) (4): CIP deviation **measures** convenience yield

$$x_t^{\text{Treas}} \equiv: y_t^{\$} + \left(f_t^1 - s_t\right) - y_t^* = -\left(1-\beta^*\right)\left(\lambda_t^{\$,*} - \lambda_t^{*,*}\right) \tag{7}$$

  - Cancel out the blue part and iterate forward, we get proposition 1

Testable Implication of the Model

Proposition 1

(a). The level of the nominal exchange can be written as

$$s_t = \underbrace{-\mathbb{E}_t \sum_{\tau=0}^{\infty} \frac{x_{t+\tau}^{\text{Treas}}}{1-\beta^*}}_{\text{Treasury Basis}} + \mathbb{E}_t \sum_{\tau=0}^{\infty} \left(y_{t+\tau}^{\$} - y_{t+\tau}^{*} \right) \underbrace{- \mathbb{E}_t \sum_{\tau=0}^{\infty} rp_{t+\tau}^{*}}_{\text{Risk Premium}} + \mathbb{E}_t \left[\lim_{T\to\infty} s_{t+T} \right] \quad (8)$$

(b). The expected log excess return of a long position in Treasury is increasing in the risk premium and the Treasury basis

$$\mathbb{E}_t \left[\Delta s_{t+1} \right] + \left(y_t^{\$} - y_t^{*} \right) = \frac{1}{1-\beta^*} x_t^{\text{Treas}} + rp_t^{*} \quad (9)$$

Testable Implication of the Model

Proposition 1 (Continued)

(c). The change in the nominal exchange rate can be decomposed as

$$\Delta s_{t+1} = \left(\mathbb{E}_{t+1} - \mathbb{E}_t\right) s_{t+1} + \mathbb{E}_t \left[\Delta s_{t+1}\right] \tag{10}$$

where the innovation is given by

$$\begin{aligned}\left(\mathbb{E}_{t+1} - \mathbb{E}_t\right) s_{t+1} = & \underbrace{-\left(\mathbb{E}_{t+1} - \mathbb{E}_t\right) \sum_{\tau=1}^{\infty} \frac{x_{t+\tau}^{\text{Treas}}}{1-\beta^*}}_{\text{Treasury Basis Innovation}} + \underbrace{\left(\mathbb{E}_{t+1} - \mathbb{E}_t\right) \sum_{\tau=1}^{\infty} \left(y_{t+\tau}^{\$} - y_{t+\tau}^{*}\right)}_{\text{Return Innovation}} \\ & \underbrace{-\left(\mathbb{E}_{t+1} - \mathbb{E}_t\right) \sum_{\tau=1}^{\infty} rp_{t+\tau}^{*}}_{\text{Risk Premium Innovation}} + \left(\mathbb{E}_{t+1} - \mathbb{E}_t\right) \lim_{T\to\infty} s_{t+T}.\end{aligned} \tag{11}$$

Test Proposition 1(c): Treasury Basis and Exchange Rate

- **Assumption:** Process of treasury basis x^{Treas} is AR(1) :

$$x_t^{\text{Treas}} - \mu_x = \phi_a \left(x_{t-1}^{\text{Treas}} - \mu_x \right) + \varepsilon_t \tag{12}$$

- The innovation is therefore:

$$\begin{aligned}(\mathbb{E}_t - \mathbb{E}_{t-1})\, s_t = &- \frac{(\mathbb{E}_t - \mathbb{E}_{t-1})\, x_t^{\text{Treas}}}{(1-\phi_a)(1-\beta^*)} + (\mathbb{E}_{t-1} - \mathbb{E}_{t-1}) \sum_{\tau=0}^{\infty} \left(y_{t+\tau}^{\$} - y_{t+\tau}^{*} \right) \\ &- (\mathbb{E}_t - \mathbb{E}_{t-1}) \sum_{\tau=0}^{\infty} rp_{t+\tau}^{*} + (\mathbb{E}_t - \mathbb{E}_{t-1}) \lim_{T\to\infty} s_{t+T}\end{aligned} \tag{13}$$

Test Proposition 1(c): Treasury Basis and Exchange Rate

- Two step regression Approach:
  - Step 1: Calculate innovation on annualized treasury basis each quarter : $\bar{x}_t^{\text{Treas}}$ (bar denote cross-sectional average of non-US G10 Countries)

$$\bar{x}_t^{\text{Treas}} - \bar{x}_{t-1}^{\text{Treas}} \mapsto^{OLS} \bar{x}_{t-1}^{\text{Treas}}, \ (y_{t-1}^{\$} - \bar{y}_{t-1}^{*}). \quad \text{Residual} \equiv \Delta \bar{x}_t^{\text{Treas}} \tag{14}$$

  - Step 2: Regress contemporary log exchange rate change $\Delta \bar{s}_t \equiv \bar{s}_t - \bar{s}_{t-1}$ on innovation on treasury basis : $\bar{x}_t^{\text{Treas}}$

$$\Delta \bar{s}_t \equiv \bar{s}_t - \bar{s}_{t-1} \mapsto^{OLS} \Delta \bar{x}_t^{\text{Treas}}, \text{Controls } [\Delta(y^{\$} - \bar{y}^{*}), \text{VIX}] \tag{15}$$

- Interpretation:
  - Estimated beta of $\Delta \bar{x}_t^{\text{Treas}}$ on Step 2 should be $-\frac{1}{(1-\phi_a)(1-\beta^*)}$
  - ϕ_a can be estimated using AR(1) model $\Rightarrow$ A estimation of β^*
  - ??: Can we get consistent estimation without control on $rp_{t+\tau}^{*}$?

Test Proposition 1(c): Treasury Basis and Exchange Rate

	1988Q1–2017Q2					1988Q1–2007Q4		2008Q1–2017Q2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta\bar{x}^{Treas}$	-10.20^{***}		-10.23^{***}		-9.81^{***}	-8.48^{***}		-14.93^{***}	
	(2.09)		(1.98)		(1.73)	(2.62)		(3.20)	
$\Delta\bar{x}^{Libor}$		-2.85					4.63		-13.51^{***}
		(3.09)					(4.22)		(4.05)
Lag $\Delta\bar{x}^{Treas}$			-6.92^{***}		-6.47^{***}				
			(1.97)		(1.73)				
$\Delta(y^{\$} - \bar{y}^{*})$				3.76^{***}	3.57^{***}				
				(0.71)	(0.60)				
Observations	117	117	116	117	116	80	80	37	37
R^2	0.17	0.01	0.25	0.20	0.43	0.12	0.02	0.38	0.24

Figure: Table III: $\Delta\bar{s}_t \equiv \bar{s}_t - \bar{s}_{t-1} \mapsto^{\text{OLS}} \Delta\bar{x}_t^{\text{Treas}}$, Controls

Test Proposition 1(c): 4 Main Findings

- **Proposition 1(c) supported**: 10 bp decreases in treasury basis associate with 1.02% simultaneously appreciate in USD

- **Source of Convenience Yield:** Given that $\hat{\phi}_a = (0.47)^4$, $\hat{\beta}^* = 0.90$ $\Rightarrow$ 90% of convenience yield comes from dollar dominance and 10% comes from treasury (Why? Who invest in dollar?)

- **Convenience Yield Estimation**: Given that average treasury basis $\hat{\mu}_{x^{\text{Treas}}} = -22\text{bp}$, convenience gap $\lambda_t^{\$,*} - \lambda_t^{*,*} = -\frac{\hat{\mu}_{x^{\text{Treas}}}}{1-\hat{\beta}^*} = 2.2\%$. [Very large comparing to Krishnamurthy & Vissing-Jorgensen's (2012) 0.75% treasury-AAA corporate bond convenience yield gap.]

- **Solution to Disconnection Puzzle**: High R^2 after adding $\Delta \bar{x}^{\text{Treas}}$.

Test Proposition 1(c): Robustness on Identification

- **Alternative Identification**:
  - Assume long-run exchange rate stationary, the authors use foreign investment records to show that:

$$\lambda^{\$,*} - \lambda^{*,*} = -\left(R^{\$,*} - R^{*,*}\right) = 4.66\% - 2.77\% = 1.89\% \qquad (16)$$

  - **Term structure of Treasury basis**: Longer-term Treasury-G10 basis and use the first two principle component.
  - **IV**: Unexpected monetary policy shock as IV and estimate that $\hat{\beta^*}_{IV} = 0.91$

$$\text{Unexp } R_t^{\text{US}} \uparrow \Rightarrow \text{BS of US bank} \downarrow \Rightarrow \text{US Safe Deposit} \downarrow \Rightarrow \lambda_t^{\$,*} \uparrow$$

Term structure of Treasury basis

	1991Q2–2017Q2					1991Q2–2007Q4		2008Q1–2017Q2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta PC1$	−9.29***		−8.19***		−5.13***	−7.92**	−4.39*	−7.18**	−3.47
	(2.06)		(2.13)		(1.75)	(3.10)	(2.44)	(3.51)	(3.19)
$\Delta PC2$		7.69***	4.76*		7.09***	3.27	5.91**	8.61	9.09*
		(2.70)	(2.65)		(2.14)	(3.25)	(2.52)	(5.82)	(5.01)
$\Delta(y^{\$} - \bar{y}^{*})$				4.86***	4.60***		4.34***		10.57***
				(0.66)	(0.60)		(0.64)		(2.94)
Observations	104	104	104	105	104	67	67	37	37
R^2	0.17	0.07	0.19	0.35	0.49	0.11	0.48	0.38	0.56

Figure: Table V: $\Delta\bar{s}_t \equiv \bar{s}_t - \bar{s}_{t-1} \mapsto^{\text{OLS}} \Delta PC1(\text{level}), \quad \Delta PC2(\text{slope})$

IV: Unexpected Monetary Policy Shock

Panel A: First Stage		
	(1)	(2)
Monetary Policy Shock	-0.58^{**}	-0.58^{**}
	(0.25)	(0.25)
Observations	96	96
R^2	0.05	0.05
Panel A: Second Stage		
	(1)	(2)
$\Delta\bar{x}^{Treas}$	-13.93^{***}	-11.98^{***}
	(2.71)	(2.89)
$\Delta(y^{\$} - \bar{y}^{*})$	0.71	1.00^{*}
	(0.55)	(0.57)
ΔVIX		0.08^{*}
		(0.05)
Observations	96	96
R^2	0.25	0.27

Figure: Table VI: $\Delta\bar{s}_t \equiv \bar{s}_t - \bar{s}_{t-1} \overset{\text{IV}}{\mapsto} \bar{x}_t^{\text{Treas}}$ (IV: Unexp R_t^{US}), Controls

Test Proposition 1(b): Predictability of Exchange Rates

- Proposition 1(3): Dollar expected to depreciated later if convenience yield increase ($x_t^{\text{Treas}} \downarrow$):

$$\mathbb{E}_t\left[\Delta s_{t+1}\right] \downarrow + \left(y_t^{\$} - y_t^{*}\right) = \frac{1}{1-\beta^*} \downarrow x_t^{\text{Treas}} + rp_t^* \tag{17}$$

- The author conduct the following regression:

$$rx_{t\to t+k} = \alpha^k + \beta_x^k \bar{x}_{t-1}^{\text{Treas}} + \beta_y^k \underbrace{\left(y_{t\to t+k}^{\$} - \bar{y}_{t\to t+k}^{*}\right)}_{\text{measurement of rp } \textbf{(??)}} + \epsilon_{t+k}^k \tag{18}$$

  - Annualized log excess return is defined as:
    $rx_{t\to t+k} \equiv \frac{4}{k}\left(\Delta s_{t\to t+k} + y_{t\to t+k}^{\$} - \bar{y}_{t\to t+k}^{*}\right)$

Test Proposition 1(b): Predictability of Exchange Rates

Panel A: 1988Q1–2017Q2				
	(1) Three Months	(2) One Year	(3) Two Years	(4) Three Years
Lag $\overline{x}^{Treas}$	−1.46	4.15	4.41	4.44*
	(5.89)	(6.42)	(3.19)	(2.30)
$y^{\$}_{t\to t+k} - \overline{y}^{*}_{t\to t+k}$	0.47	0.83	1.72	1.59
	(0.92)	(1.04)	(1.13)	(1.02)
Observations	117	117	117	115
R^2	0.004	0.03	0.13	0.14

Figure: Table VIII: $rx_{t\to t+k} \mapsto^{\text{OLS}} \bar{x}^{\text{Treas}}_{t-1}, (y^{\$}_{t\to t+k} - \bar{y}^{*}_{t\to t+k})$

VAR Analysis

- Quarter VAR(1) is chose based on BIC:
  - **Variable order**: 1. Basis x^{Treas}, Real interest rate difference $i_{t-1} = y^{\$}_{t-1} - \pi^{US}_t - y^*_{t-1} + \pi^*_t$, Log of the real exchange rate q_t
  $$\boldsymbol{z}_t = \boldsymbol{\Gamma}_0 + \boldsymbol{\Gamma}_1 \boldsymbol{z}_{t-1} + \boldsymbol{a}_t, \quad \boldsymbol{z}'_t = \begin{bmatrix} x_t & i_t & q_t \end{bmatrix} \tag{19}$$
- Annual 0.2% $\uparrow$ in x^{Treas} (quarterly 0.1% in dynamic response figure):
  - $\Rightarrow$ 3% depreciate in USD next two quarter (consistent with Table III)
  - $\Rightarrow$ Long USD $rx_t = q_t - q_{t-1} + i_{t-1}$ suffers loss in two quaters, and higher than average over the next 15 to 18 quarters (consistent with Table VIII)

VAR Analysis

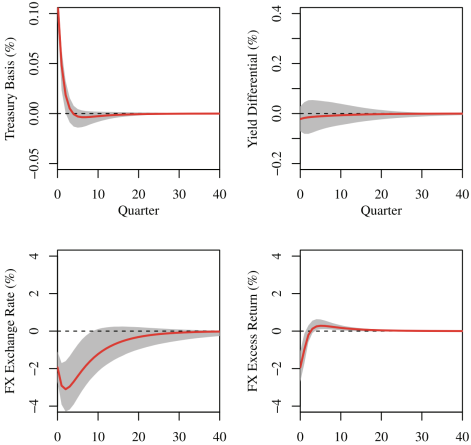


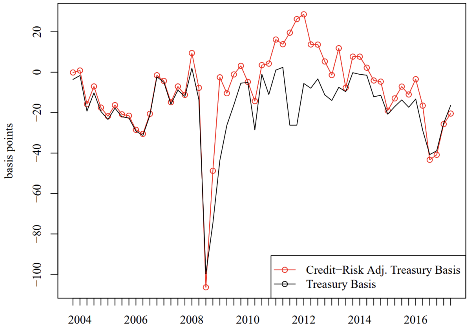
Figure: Dynamic Response to Treasury Basis Shocks

Discussion 1: How Much can We Trust the Estimation?

- $\lambda_t^{\$,*} - \lambda_t^{*,*} = -\frac{\hat{\mu}_x \text{ Treas}}{1-\hat{\beta}^*} = 2.2\%$ is very large (it shocks me)
  ‘
- How much can we trust the estimation?
  - Robustness on estimation method: OLS and VAR;
  - Robustness on (key) assumption: log-normality, AR(1) basis, etc;
  - Robustness on **interpretation**: Is fight to USD really due to convenience ("client demand") but not default risk that can be hedged by CDS?

$$x_t^{\text{Treas, CDS Adj}} \equiv \left(y_t^{\$} - cds_t^{\$}\right) + \left(f_t^1 - s_t\right) - \left(y_t^* - cds_t^*\right) \qquad (20)$$

Discussion 1: CDS Adjusted Basis



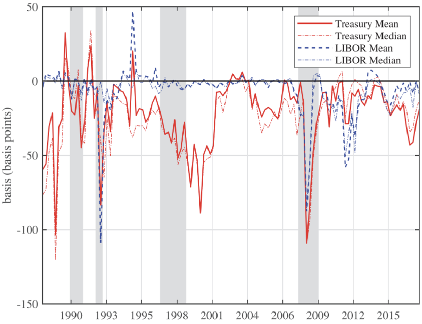


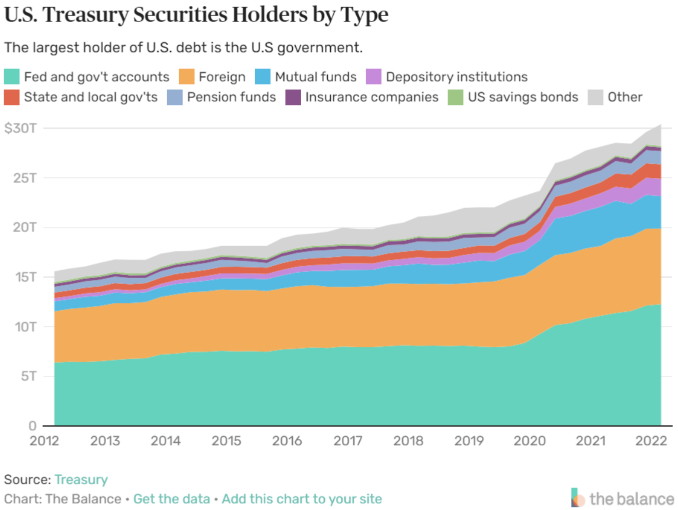
Figure: CDS Adjusted Basis (Figure IA.3) and Unadjusted Basis (Figure 1)

Discussion 2: What Prevent Investment in Foreign?

- Why foreign, mutual fund, pension does not invest in foreign bond?
  - **Author's answer:** 90% USD dominance in global financial market

  - Does the convenience yield exist in other assets (i.e. corporate bond)?
  - The long-term treasury basis after GFC (Du & Schreger, 2022):
    - 1. Disconnect with LIBOR basis;
    - 2. Largely diminished and even become negative.

Discussion 2: What Prevent Investment in Foreign?



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Thanks for listening!
Wish You Happy New Year!