Currency Crashes and Sovereign Defaults: Insurance and Quanto

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Motivation

- Link between currency crashes and sovereign defaults

Figure 1: Russia Default on April 4, 2022

- During times of distress, exchange rates and sovereign credit markets begin to behave as if they were one market - i.e. currency crashes and sovereign defaults become one single state of the world

What is this paper about?

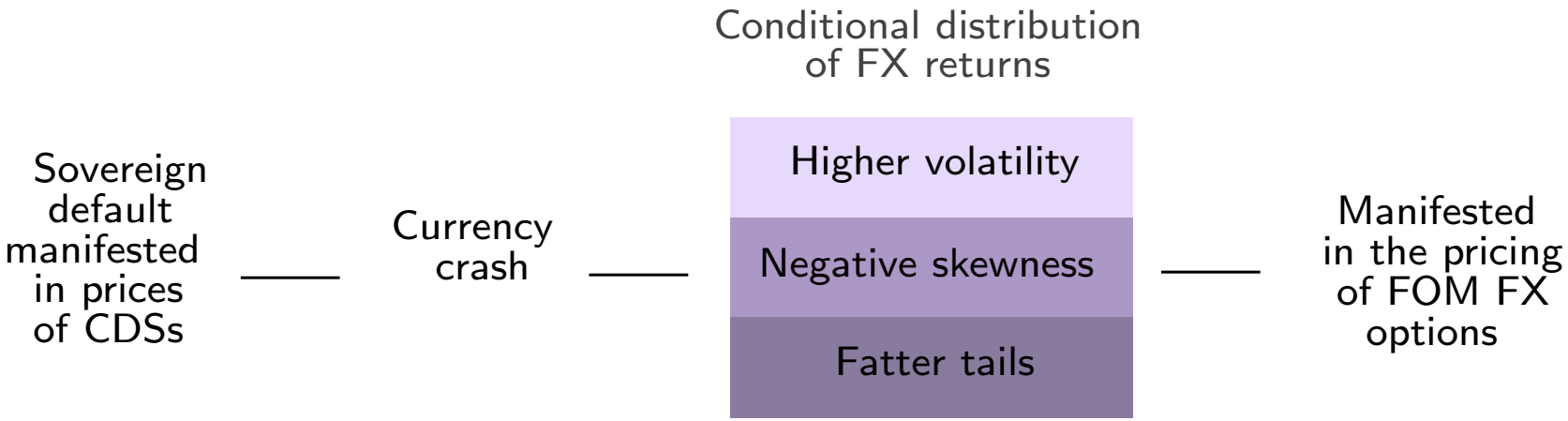
- Learn about currency crashes from prices of far out-of-the-money (FOM) FX options and about sovereign defaults from from credit default swaps (CDSs)

> *Definition:* A currency crash is defined as the FX rate reaching below the 10δ strike on an FX option

- Findings:
  - Strong relation between currency crashes and sovereign defaults - suggesting a new approach to insuring sovereign credit risk using FOM FX options
  - Implications for quanto spread via a developed distance to crash risk metric
  - Pricing discrepancies between FOM FX options and sovereign credit markets that yield a Sharpe Ratio in excess of 7.2 - suggestive evidence of market segmentation especially in tranquil times

The Big Picture Connection

Idea of the link between sovereign CDS and FOM FX options?



Related Literature

1. **Historical link between sovereign default and currency devaluation**
   e.g., Na et al. (2017) and Reinhart (2002)

2. **Asset pricing models of joint relationship**
   e.g., Hui & Fong (2015), Hui & Chung (2011), and Carr & Wu (2007)

3. **Sovereign credit and currency premia**
   - CDS premiums (Ait-Sahalia et al., 2014; Longstaff et al., 2011; and Pan & Singleton, 2008), sovereign bonds market dynamics (Chaieb et al., 2020 and Jean-Charles et al., 2015), and international stochastic discount factors and currency premia (Trojani et al., 2020; Lustig & Verdelhan, 2007)
   - Credit-implied risk premium (Della Corte et al., 2020), volatility risk premium (Della Corte et al. 2016), liquidity premium (Chaieb et al., 2020; Karnaukh et al 2015; Mancini et al. 2013), and portfolio-based currency factors (Menkhoff et al. 2012; Lustig et al., 2011)

4. **Quanto**
   - Currency premia in a generalized model from Kremens & Martin (2019) in Della Corte et al. (2020) and Distress crash premia estimated in Augustin et al (2018) and Du & Schreger (2015)
   - Separation of distress vs. covariance risk in quanto spreads in Della Corte et al. (2021) and Lando & Nielsen (2018)

– Reinhart (2002): 0.84 historical annual probability of currency crash upon default
– Augustin et al. (2018): 0.75 risk-adjusted 1-week probability of crash upon default
– Na et al. (2017): default leads to an immediate devaluation in a crash jump way

Framework

- No-arbitrage between FOM FX options and sovereign CDS markets
- Construct normalized Arrow-Debrew Claims (ADCs)
- Idea: existence of an FX default corridor $[H, L]$
- Two FOM FX put options replicate a sovereign credit contract that pays off upon default

$$\boldsymbol{D^{fx}}\left(\boldsymbol{t}, \boldsymbol{T}\right) = E_t^{Q}[e^{-r\tau}1(\tau \leq T)] = \frac{P(K_1, T) - P(K_2, T)}{K_1 - K_2} = \boldsymbol{D^{cds}}\left(\boldsymbol{t}, \boldsymbol{T}\right)$$

$K_2 \in [H, L]$ and $K_1 \in [K_2, H]$ are two distinct strikes; $P(\cdot)$ is option premium in US dollars corresponding to K

- Assumptions:
  - flat CDS term structure
  - fixed & known sovereign recovery rate
  - deterministic interest rates

Added benefit: First study to separate the probability of currency crash from crash size as a result of standardizing ADC payoffs

Empirical Framework

- Further assumptions:
  - In the event of a default, the FX rate crosses the FX default corridor $[H, L]$
  - The marginal density function characterizing a currency crash in the event of a sovereign default and the one characterizing a currency crash in the event of a sovereign default are constant and equal to one
- Data: CDS (Markit) & FX options (Bloomberg) for G7 countries (August 2010 - May 2021)

$$\Delta D^{fx}_{i,t} = \alpha_i + \delta_{ty} + \beta \Delta D^{cds}_{i,t} + \varepsilon_{i,t}$$

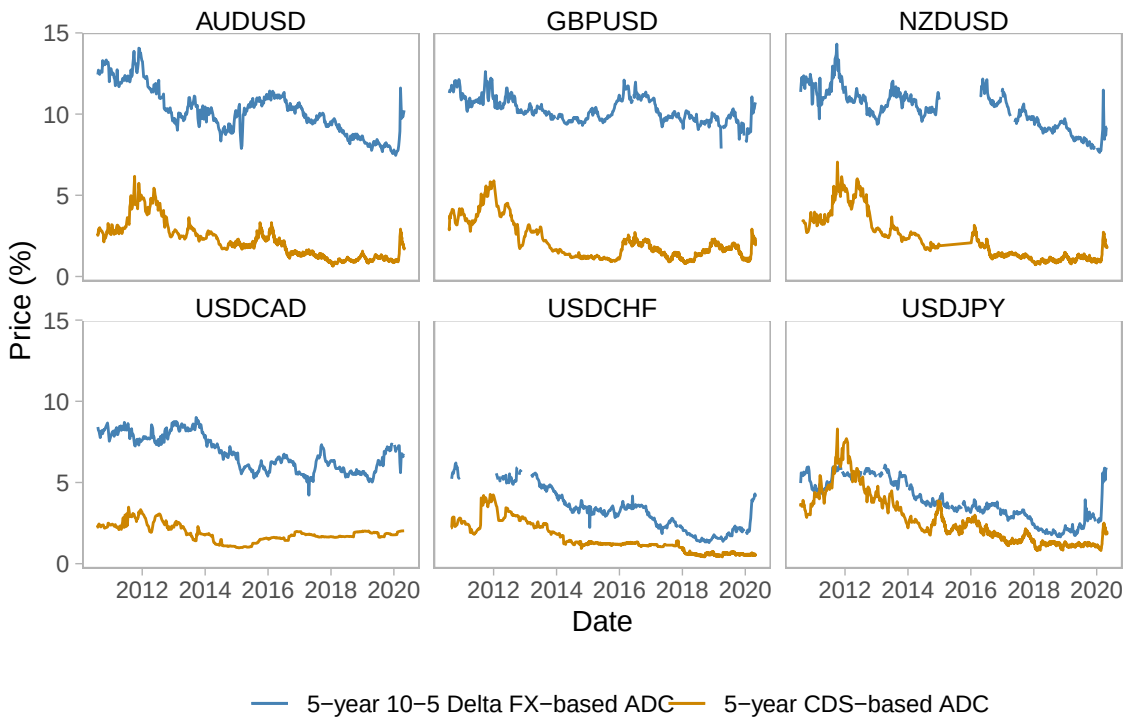
	6-month	1-year	2-years	5-years
Dep. Var.: Δ of claim on 10-5 delta FX puts		$\Delta D^{fx(10-5\delta)}$		
ΔD^{cds} (β)	1.13	0.94	0.69	0.58**
t-stat	(0.39)	(-0.27)	(-1.64)	(-2.47)
Within Adj-R^2	0.04	0.05	0.07	0.03
No. of Obs.	1,252	1,252	1,238	1,247

- Unable to reject the null that $\beta = 1$ at the 1% significance level for all maturities except the 5-year maturity (rejected but at the 5% level)

Empirical Findings

- Returns of the two claims appear to be highly correlated, but not their price levels since FX claim > CDS claim

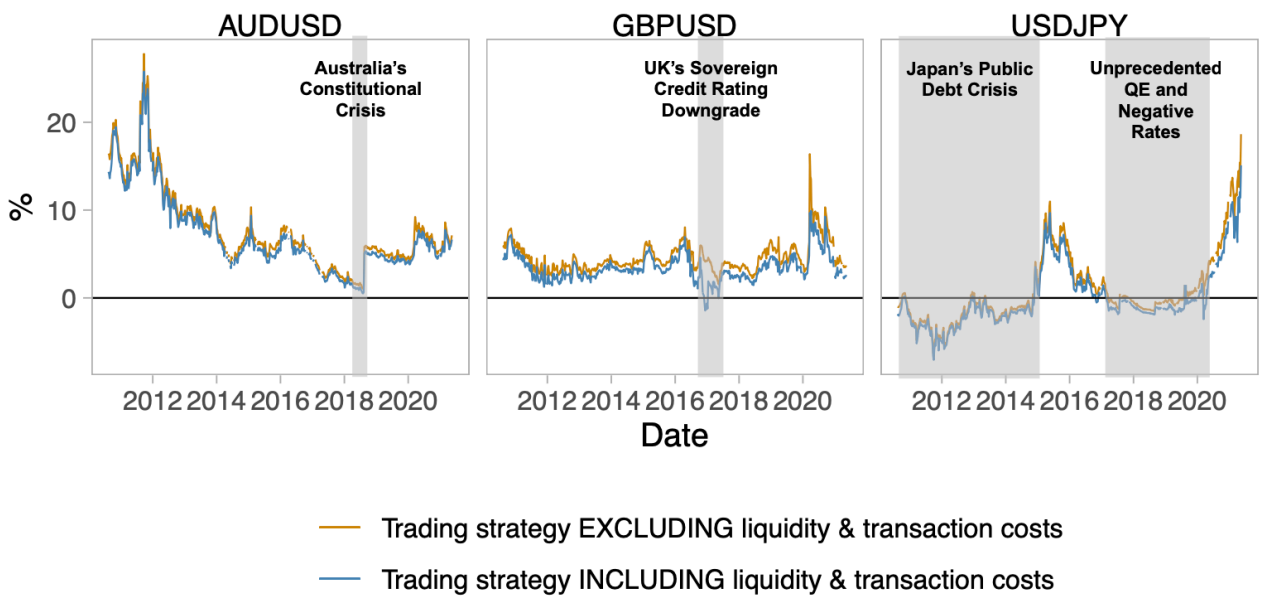
Figure 2: Time-series properties of price levels of an Arrow-Debreu claim on a portfolio of 10-5 delta FX options vs. an Arrow-Debreu claim on a CDS (ADCs)



Empirical Findings

- Zero-cost Trading strategy: sell FOM FX option spread and buy a CDS
- Sharpe ratio of 8.7 (7.2 with trading costs or 3.5% profit per week) - (e.g., momentum strategy offers a Sharpe Ratio $\approx$ 1.7)

Figure 3: Potential weekly profitability ($\mathcal{R}$) of a cross-market trade strategy including versus excluding liquidity and transaction costs



Note: During times of crisis, such as Japan's public debt crisis in 2012, the UK's sovereign credit rating in 2012, or Australia's constitutional crisis in 2017-18, the cross-market market deviation (profit opportunity) disappears

Empirical Findings

- Properties of the cross-market deviation profitability $\mathcal{R}$:
  - $\mathcal{R}$ captures the unexplained non-CDS-driven variation in FOM FX puts
  - Risk premia is time–varying: i.e., correlation increases in times of distress since markets start behaving as one
  - The more FOM the FX put, the smaller the cross-market deviation $\mathcal{R}$
- Where is this profitability coming from?

Table 1: Panel regressions of weekly changes in the cross-market deviations ($\Delta\mathcal{R}$) on changes in the quanto spread (ΔQ) and other variables

	6-month	1-year	2-years	5-years
$\mathcal{R}$ uses 10-5 delta FX puts	$\Delta\mathcal{R}_{i,t} = \Delta(D_{i,t}^{fx(10-5\delta)} - D_{i,t}^{cds})$			
$\Delta Q_{i,t}^{(D^{i,cds}-D^{usd,cds})}$ (ψ)	1.62*	1.28**	1.27***	0.72**
	(0.85)	(0.64)	(0.35)	(0.31)
$\Delta FX_{i,t}^{spot}$ (δ)	-0.02	0.00	-0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.03)
$\Delta IV_{i,t}^{ATM}$ (υ)	0.01***	0.00	0.01	0.01
	(0.00)	(0.00)	(0.01)	(0.02)
$\Delta US_{i,t}^{OIS}$ (ρ_1)	-0.02**	-0.01***	-0.00*	-0.01*
	(0.01)	(0.00)	(0.00)	(0.00)
$\Delta Local_{i,t}^{OIS}$ (ρ_2)	0.04**	0.02***	0.00	0.01
	(0.02)	(0.00)	(0.00)	(0.01)
$\Delta Basis_{i,t}^{xccy}$ (γ)	0.00	0.00	0.00**	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)
Within Adj-R^2	0.35	0.12	0.28	0.19
No. of Obs.	1,252	1,252	1,238	1,247

- Significant link (almost one-for-one) with the quanto spread - large R^2 of up to 35%
- No dependence on delta and vega shows NO major violation of assumption of default corridor (zero delta and vega)

Empirical Findings

- Why are investors not profiting from these cross-market deviations? Is this implementable in practice?
- In reality, markets are likely incomplete and not frictionless
- Still, the price discrepancies are large and persistent. Why?
  - Bid-Ask costs - not necessarily
  - Limits-to-arbitrage type of financial frictions? e.g., Regulatory constraints, margin and collateral requirements are possible, but they affect both CDS and FX options equally
  - Different risk factors (local vs. global) - Both CDS and FX prices incorporate both local and global risk premia
  - Peso Risk: Currency crash risk not associated with sovereign default?
    - ★ Because profitability from cross-market deviations disappears during times of crisis, there is less support for this scenario because the probability of a currency crash, whether in the absence or presence of sovereign credit deterioration, should not decrease but rather increase during times of crisis.
    - ★ By shifting the FX Default barrier option strike, the correlation in returns between FOM FX-based and CDS-based ADCs decreases and the cross-market deviation in levels increases - however, any FX default barrier above 10*delta* violates the model assumption, and thus is likely outside the real FX default corridor, so we can't really test for this scenario by assessing the sensitivity to FX default barrier movement.
  - Market segmentation - Evidence from institutional details suggests that different marginal investors participate in the FX options markets and in the CDS market during tranquil times
    - ★ In times of crisis, however, the marginal investor becomes a single marginal so-called multi-asset "hedger" (think insurance companies or global investment banks' CVA desks).

Quanto Price and Distance to Crash Risk Measure

- If currency crashes occur concurrently with a sovereign defaults, the quanto price should be related to a distance to currency crash and default intensity
  - The higher the FX tail risk insurance cost (skewness and kurtosis), the higher is the sovereign credit insurance cost

Definition: I measure the distance to crash risk by the proximity of the higher barrier of the FX default corridor, H_t, to the spot exchange rate, S_t which is measured by taking the ratio H_t/S_t (denoted as $\mathcal{DC}$)

- What contributes to the Quanto price?

Table 2: Panel regressions of weekly changes in the quanto discount price (ΔQ) on changes in the distance to crash ($\Delta \mathcal{DC}$) and other variables

	(1)	(2)	(3)	(4)
	$\Delta Q_{i,t}^{(D^{i,cds}-D^{usd,cds})}$			
$\Delta \mathcal{DC}_{i,t}$ (ψ)	0.15***	0.14***	0.14***	0.21***
	(0.05)	(0.05)	(0.05)	(0.07)
$\Delta D_{i,t}^{usd,cds}$ (ξ)		-0.38***	-0.38***	-0.41***
		(0.11)	(0.11)	(0.12)
$\Delta s_{i,t}^{UIP}$ (ω)			0.00	0.00
		.	(0.91)	(0.57)
$\Delta FX_{i,t}^{spot}$ (δ)				0.00
				(0.22)
$\Delta IV_{i,t}^{ATM}$ (υ)				0.01
				(0.09)
$\Delta US_{i,t}^{OIS}$ (ρ_1)				0.00
				(0.76)
$\Delta Local_{i,t}^{OIS}$ (ρ_2)				-0.00
				(0.32)
$\Delta Basis_{i,t}^{xccy}$ (γ)				0.01
				(0.25)
Within Adj-R^2	0.11	0.13	0.13	0.16
No. of Obs.	3,122	3,122	3,122	2,856

Empirical Findings

- Where does price discovery originate from?

Table 3: Demeaned PVAR for weekly changes of an Arrow-Debreu claim on US dollar CDS and weekly changes of an Arrow-Debreu claim on a portfolio of 10-5 delta FX options for different maturities

	6-month		1-year		2-year		5-year	
	$\Delta D^{fx}_{i,t}$	$\Delta D^{cds}_{i,t}$	$\Delta D^{fx}_{i,t}$	$\Delta D^{cds}_{i,t}$	$\Delta D^{fx}_{i,t}$	$\Delta D^{cds}_{i,t}$	$\Delta D^{fx}_{i,t}$	$\Delta D^{cds}_{i,t}$
$\Delta D^{fx}_{i,t-1}$	0.22***	0.01	0.13***	0.01	0.30***	0.04	0.42***	0.05
	(0.05)	(0.01)	(0.05)	(0.02)	(0.05)	(0.03)	(0.05)	(0.04)
$\Delta D^{cds}_{i,t-1}$	0.68***	0.16***	0.43***	0.17***	0.33***	0.16***	0.21***	0.24***
	(0.25)	(0.05)	(0.16)	(0.05)	(0.10)	(0.05)	(0.06)	(0.05)
No. of Obs.	1,247		1,247		1,236		1,244	

- The sovereign credit market informs (leads) the FX options market and has a significant impact on market expectations of exchange rates even at a weekly frequency

Conclusions

An empirical test of a no-arbitrage model that connects two seemigly unrelated markets: FOM FX options and Sovereign credit

- New approach to insuring sovereign credit risk using FOM FX options
- Suggestive evidence of market segmentation
- Cross-market trading profit opportunity is related to quanto spread
- Sovereign CDS market informs the FX options market

THANK YOU