Distributional asymmetries and currency risk

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Outline

- Motivation
- Data
- Results
- Conclusions

Interest rate parity

Uncovered interest rate parity (UIP):

$$s_{t+1}^k - s_t^k = i_t - i_t^k \tag{1}$$

Covered interest rate parity (CIP):

$$f_t^k - s_t^k = i_t - i_t^k \tag{2}$$

where k denotes currency k, s_t^k is the spot exchange rate between USD and currency k, f_t^k is the 1-period forward exchange rate between USD and currency k, and i_t denotes the US nominal interest rate, and i_t^k denotes the nominal interest rate in country k.

Forward rate bias puzzle

CIP empirically holds, hence we can express UIP as

$$s_{t+1}^{k} - s_{t}^{k} = \alpha + \beta^{k}(f_{t}^{k} - s_{t}^{k}) + u_{t+1}, \tag{3}$$

Equation (3) can be estimated, and if UIP holds we expect that $\alpha = 0$, $\beta = 1$, and $E(u_{t+1}) = 0$. Empirically $\beta << 1$, in majority of the cases β is negative.
Such phenomenon is called the **Forward rate bias puzzle** (Fama 1984).

Explaining the Forward rate bias puzzle

- Sample specific phenomenon
  - Developed countries
  - Small sample bias
  - Global vs. local performance discrepancies
- Investment horizon
  - Significant especially in short-run horizon
- Peso problems
- Carry trade
  - Strategy exploiting the Forward premium puzzle
- Risk neutrality assumption

Risk based approach

- UIP is derived assuming a risk neutral investor.
- Part of the excess returns from exploiting the Forward rate bias puzzle should be perceived as risk premia.
- We should be able to find risk factors contributing to explanation of the Forward rate bias puzzle.
    - Majority of traditional risk factors priced in the stock returns are not able to explain the currency risk premia, and are generally uncorrelated with the currency returns.
    - Momentum, business cycles or global imbalances have partial success in pricing the currency returns.
- Events with an extreme impact that occur infrequently play an important role in investor's decision making
- Distributional asymmetries are a candidate to be a good predictor of FX returns.

Volatility and currency returns

Volatility factor

- Menkhoff et al. (2012) propose volatility as a risk factor in FX, specifically volatility innovations resulting from the following estimate of monthly global FX volatility

$$\sigma_t^{FX} = \frac{1}{T}\sum_{\tau=1}^{T}\left(\sum_{k=1}^{N}\frac{\mid r_{k,\tau}\mid}{N}\right), \tag{4}$$

  where $\tau \in \{1, ..., T\}$ denotes day τ, T denotes the number of days in a month, $k \in \{1, ..., N\}$ denotes k-th currency pair, and N is the number of currency pairs.
- Returns to carry trade strategy are largely dependent on the global FX volatility state (high global volatility x low global volatility).

Estimation of global FX volatility risk

We estimate volatility using the Realized Variance (RV)

$$RV_{k,t} = \sum_{j=1}^{M} r_{j,k,t}^2, \qquad VOL_{k,t} = \sqrt{RV_{k,t}}, \tag{5}$$

where $r_{j,k,t}$ denotes j-th intraday return of currency pair k on day t, $j \in \{1, ..., M\}$, where M is the number of intraday observations on day t.

Then, we can estimate global FX volatility risk as average idiosyncratic volatility risk (Jondeau, Zhang, and Zhu 2019) as

$$VOL_t^{(I)} = \frac{1}{N} \sum_{k=1}^{N} VOL_{k,t}, \tag{6}$$

where $VOL_t^{(I)}$ represent average idiosyncratic volatility on FX markets at time t, $k \in \{1, ..., N\}$ denotes k-th currency pair.

Extreme Volatility risk

- We want to estimate the effect of **Extreme** volatility risk on subsequent currency returns.
- We define two volatility states based on the asymmetries in the of volatilities cross-section.
  - Extreme Low Volatility State
  - Extreme High Volatility State
- These are approximated as the corresponding cross-sectional quantiles $Q_t^\tau\left(\{VOL_{k,t}\}_{k=1}^N\right)$, specifically,

$$\begin{aligned} VOL_t^{(I,Low)} =& Q_t^{0.1}\left(\{VOL_{k,t}\}_{k=1}^N\right), \\ VOL_t^{(I,High)} =& Q_t^{0.9}\left(\{VOL_{k,t}\}_{k=1}^N\right). \end{aligned} \tag{7}$$

Extreme volatility risk and currency returns

Using the discussion above, we can estimate currency returns as

$$r_{t+1}^{k} = \alpha + \beta_1^k VOL_t^{(I,Low)} + \beta_2^k VOL_t^{(I,High)} + \sum_{j=1}^{J} \gamma_j^k Z_t^j + u_{t+1}, \quad (8)$$

where Z_t^j is the j-th control variables, $j \in \{1, ..., J\}$ and J is the number of control variables. The control variables include carry trade, momentum, etc.

Data

- 5-minute spot rates of 19 currencies denominated against USD from Kibot.com.
- Australia, Brazil, Canada, Switzerland, Czech republic, Denmark, Euro, Great Britain, Hungary, Japan, South Korea, Mexico, Norway, New Zealand, Poland, Sweden, Singapore, Turkey, South Africa.
- We don't use Taiwanese Dollar because of data issues.
- 2012-2020

Preliminary results

Portfolio sorts

- Stocks are sorted into tercile portfolios based on exposures to individual risk factors
- The exposures are obtained as the coefficients from following univariate regressions

$$r_{t+1}^{k} = \alpha + \beta^{k} X_{t,j} + u_{t+1},$$

where $k \in \{1, ..., N\}$ denotes currency k, $\mathbf{X_t} = \{X_{t,1}, ..., X_{t,J}\} = \left\{RDM_t^{(I)}, RDM_t^{(I,Low)}, RDM_t^{(I,High)}\right\}$, and $RDM = \{RVOL, RS, RK\}$.

- The estimation window is 3 (6) months.
- The post ranking average portfolio returns are recorded over the next week.

Results

Variable	**1**	**2**	**3**	**High - Low**
RVOL	3.39	2.95	3.74	0.36
	(3.65)	(3.27)	(3.58)	(0.45)
RVOL low	3.76	3.49	2.76	-1
	(3.99)	(3.89)	(2.63)	(-1.19)
RVOL high	3.02	2.49	4.62	1.6
	(3.36)	(2.87)	(4.24)	(1.97)
RS	2.99	3.78	3.38	0.4
	(3.75)	(3.98)	(2.94)	(0.45)
RS low	2.75	3.46	3.97	1.22
	(3.4)	(3.59)	(3.52)	(1.43)
RS high	3.59	3.39	3.06	-0.52
	(4.46)	(3.53)	(2.71)	(-0.61)
RK	4.5	2.25	3.14	-1.36
	(4.64)	(2.5)	(3.09)	(-1.66)
RK low	4.72	2.4	2.74	-1.98
	(4.8)	(2.67)	(2.84)	(-2.61)
RK high	4.44	2.22	3.25	-1.19
	(4.62)	(2.41)	(3.2)	(-1.38)

Conclusions

- Large part of the Forward rate bias is attributable to risk premia.
- Traditional risk factors are insufficient, asymmetries in distribution are a good candidate to explain currency risk premia.
- Average idiosyncratic volatility is not priced, but Extreme Volatility is priced in the cross-section of currency returns.

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THANK YOU!