The Dollar Variance Risk Premium

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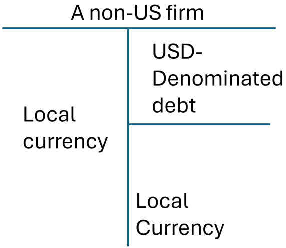
The US market and the US Dollar

- ▷ The financial market of the United States plays a crucial role in the world
  - US market cap of equity and bonds exceeds 40% of the world
  - USD is the world's principal reserve currency
  - USD is also the primary invoicing currency in international trade (e.g., Goldberg and Tile 2009, Gopinath 2015)
- ▷ The US has a high exposure to global risk
  - The US holds a net dollar carry position, which earns a risk premium, potentially for bearing global uncertainty risk. (e.g., Lustig, Roussanov, and Verdelhan 2014)
  - The value of USD moves against the global business cycle (e.g., Bruno and Shin 2017; Maggiori 2017)

The dollar factor and the business cycle

- Bruno and Shin 2017: The dollar factor generates a global business cycle
  - Non-US firms frequently issue dollar-denominated bonds.



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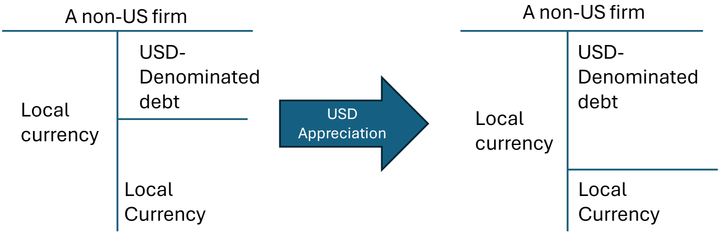


  - USD appreciation leads to tighter credit condition around the world. Hence, dollar fluctuation generates a global business cycle

    See also, Gopinath and Stein (2021), Bruno and Shin (2023), etc
  - Dollar appreciates when global uncertainty increases

The US has a high exposure to the global factor

- Maggiori 2017: US has high exposure to global risk
  - Developed countries (e.g., US) have a better financed intermediary who will invest in risky assets.

    $\rightarrow$ Since their funding ability is greater they have a better incentive to take more risk
  - Emerging markets are capital constrained. Hence, instead, they take precautionary savings in safer USD bonds
  - This pattern will strengthen when global uncertainty increases
- Developed markets have a greater exposure to the global uncertainty risk. They will earn more and consume more
- Gopinath and Stein (2024), for example, show that a *single* dominant currency will emerge

The risk premium on dollar uncertainty

How does the risk premium on dollar uncertainty affect the risk premium of dollar investments?

- The US investor may require a higher risk premium for investing in a non-US currency (standard view)
  - USD is a safe haven. Because dollar uncertainty represents global uncertainty, US (global) investors may require a higher risk premium for international investments.
- The non-US investor may require a higher risk premium for investing in USD assets (alternative view)
  - Despite investing in a safe currency, international investments are riskier than local investments

Local currency appreciation and depreciation

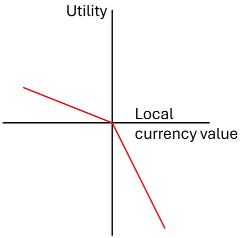
- Whether market participants prefer currency de/appreciation depends on their net position on foreign currency.
  - The US holds a net negative position in dollar-denominated debt (Gourinchichas and Rey 2007, Caballero, Frahi, and Gourinchas 2008, Jiang, Krishnamurthy, and Lustig 2021)

    → US prefers dollar depreciation and other countries prefers dollar appreciation (=local currency deprecation)
  - Local currency depreciation also stimulates economic growth by improving the current account (Rodrik 2008)
  - International investors suffer from local currency appreciation (e.g., Jansen, Shin, and von Peter 2024)

⇒ International investors dislike local currency appreciation

Asymmetric effects on marginal utility

- International investors dislike local currency appreciation
- Evidence shows that investors treat upside and downside risk differently



- Segal, Shaliastovich, and Yaron 2015; Feunou, Jahan-Parvar, and Okou 2018; Kilic and Shaliastovich 2019; Bollerslev 2022
- In the currency market, what corresponds to upside/downside risk is obscure.
- This implies that investors dislike local currency appreciation more than they like local currency depreciation.

A preview of the main findings

- ▷ The dollar variance risk premium (DVP) estimated from currency options (controlling for the US equity VRP) predicts USD appreciation.
  - suggest that non-US investors take dollar investments as "risky" even though a dollar position can hedge global risk.
- ▷ The risk premium required by US and non-US investors can be separated: we decompose the variance into appreciation and depreciation risk:
  - We find that a high risk premium on appreciative currency variance leads to future currency depreciation (for both USD and non-US currencies)
- ▷ The upside variance premium of safe (Japan and Switzerland) currencies and the downside variance risk premium of others risky currencies contains information on global/US risk premium.

Model setup

- When the market is complete, currency returns is represented by:

$$\Delta q^i_{t+1} = m^i_{t+1} - m_{t+1}$$

  - Higher q^i means appreciation for currency i
  - m^i_{t+1} is the domestic SDF, m_{t+1} is the US SDF
  - US is close to the world

- $m^i_{t+1} - E_t[m^i_{t+1}] = \delta^i \sqrt{\frac{z^i_t}{2}}(v^i_{t+1} - 1) + \lambda^i \sqrt{\frac{z_t}{2}}(v_{t+1} - 1),$
  - v^i_{t+1} and v_{t+1} are i.i.d with Chi-square 1 (shocks to z)
  - US SDF is denoted without superscript i
  - We assume $\delta^i > \delta$ and $\lambda^i < \lambda$

Model setup

$$\Delta q^i_{t+1} - E_t[\Delta q^i_{t+1}] = \underbrace{(\delta^i - \delta)}_{\text{Positive}} \sqrt{\frac{z^i_t}{2}}(v^i_{t+1} - 1) + \underbrace{(\lambda^i - \lambda)}_{\text{Negative}} \sqrt{\frac{z_t}{2}}(v_{t+1} - 1),$$

- ▷ A higher q^i denotes higher currency value for i relative to USD
- ▷ Because shocks to v^i and v_t are positively skewed:
  - A positive US/global variance shock appreciates USD and is likely to matter more to US investors
  - A positive foreign variance shock depreciates USD and is likely to be important for non-US investors

Model solution

- The risk premium of investing in a non-US currency for the US investor:

$$\text{Cov}_t(-m_{t+1}, \Delta q^i_{t+1}) = \delta \underbrace{(\delta - \delta^i)}_{\text{Negative}} z^i_t + \lambda \underbrace{(\lambda - \lambda^i)}_{\text{Positive}} z_t$$

- The foreign (non-US) currency will appreciate following periods of low non-US variance (z^i_t) and high US variance (z_t).

- The two components cannot be identified by the variance risk premium on dollar because the dollar variance is positively related to both components:

$$\text{Cov}_t(-m_{t+1}, Var_{t+1}(\Delta q^i_{t+2})) = (\delta^i - \delta)^2 z^i_t + (\lambda^i - \lambda)^2 z_t$$

Two components of the variance risk premium

- Since uncertainty shocks are positively skewed, we can obtain the risk premium on z_i and z separately, using semi-variance and out-the-money option prices

  (e.g., Fenuou et al 2017, Kilic and Shaliastovich 2019)

  - z^i is related to the risk of foreign currency appreciation (upside DVP) and represents risk premium on USD investment.
  - z is related to the risk of USD appreciation (downside DVP) and represents risk premium on non-USD investment.

Down and up currency variance risk premuim

$$CVRP = CVRP_t^U + CVRP_t^D,$$

where

$$CVRP_t^U = \mathrm{Cov}_t(m_{t+1}, (\delta - \delta^i)^2 z_{t+1}^i) = \delta(\delta^i - \delta)^2 \sigma z_t^i$$
$$CVRP_t^D = \mathrm{Cov}_t(m_{t+1}, (\lambda - \lambda^i)^2 z_{t+1}) = \lambda(\lambda - \lambda^i)^2 \sigma z_t.$$

Empirically, these two components will be estimated from option prices and intraday trading data.

extension

Data sources

- ▷ Data on currency options from Bloomberg
- ▷ Intraday data from histdata.com
- ▷ Daily currency returns from Bloomberg
- ▷ AUD, CAD, CHF, EUR, GBP, JPY, and NZD against USD (2006-2022) – restricted by the availability of intraday data
- ▷ Show robustness using daily data using seven additional currencies – DKK, KRW, NOK, PLN, SEK, THB, and ZAR

Estimation

- ▷ The currency variance risk premium ($CVRP_i$) of the currency pair between country i and USD

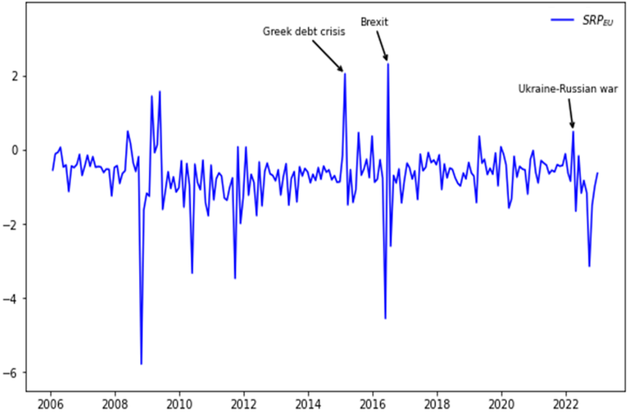
$$CVRP_{i,t} = E_t^Q[QV_{i,t}] - E^P[QV_{i,t}], \quad (1)$$

  - Q component from option prices, P component using HAR-RV
- ▷ The dollar variance risk premium (DVP) is the cross-currency average of CVRP
- ▷ We also measure DVPU (related to foreign currency appreciation) and DVPD (related to dollar appreciation) from the semi-variance and define the skewness risk premium as

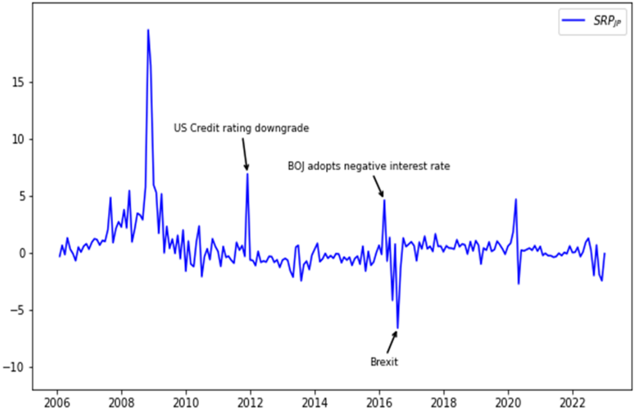
$$SRP = DVPU - DVPD$$

SRP = DVPU (USD depreciation) – DVPD (USD appreciation)

SRP using only European/USD pairs

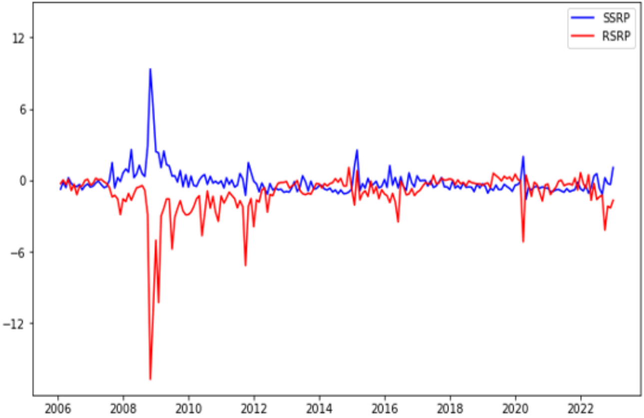


SRP using only JPY/USD



extension

SRP for safe (JPY, CHF) vs other currencies



extension

DVP and Equity VRP (Londono and Zhou 2018)

- Prediction: Unconditionally, the direction of the predictability of the DVP is unclear
- However, controlling for the global/US VRP, the dollar VP should represent the risk premium on US dollar investment for non-US investors (leads to dollar appreciation).

	Dependent variable: currency returns					
	1-month		6-month		12-month	
DVP	-12.532***	-12.509***	-4.834***	-4.815***	-2.278***	-2.281***
	(3.866)	(3.862)	(4.651)	(4.700)	(3.955)	(4.077)
EVRP	1.643***	1.696***	1.368***	1.435***	0.929***	0.976***
	(3.175)	(3.296)	(4.725)	(5.000)	(4.441)	(4.797)
$y_{US} - y_i$	1.223**	1.963***	1.425**	2.402***	1.139**	1.892***
	(2.011)	(2.554)	(2.252)	(2.855)	(2.247)	(3.019)
Country FE	N	Y	N	Y	N	Y
Adj R^2	0.034	0.032	0.068	0.086	0.077	0.106

Up and downside DVP

- If we decompose DVP into up (dollar depreciation) and downside components,
  - A high DVPU should lead to future dollar appreciation.
  - A high DVPD should lead to future dollar depreciation.

	Dependent variable: currency returns					
	1-month		6-month		12-month	
DVP^U	-79.351***	-83.062***	-40.511***	-44.085***	-24.437***	-26.971***
	(5.926)	(6.223)	(5.587)	(6.212)	(5.763)	(6.766)
DVP^D	52.996***	56.789***	33.237***	36.85***	21.916***	24.417***
	(5.271)	(5.639)	(5.415)	(6.108)	(5.602)	(6.623)
$y_{US} - y_i$	1.899***	3.235***	1.760***	3.073***	1.344***	2.314***
	(3.431)	(4.748)	(2.887)	(3.745)	(2.795)	(3.882)
Country FE	N	Y	N	Y	N	Y
Adj R^2	0.070	0.072	0.109	0.137	0.107	0.147

Skewness risk premium

- We can replace the DVPU and DVPD by the difference between the two

	Dependent variable: currency returns					
	1-month		6-month		12-month	
DVP^U	-77.268***		-36.742***		-21.724***	
	(5.865)		(5.150)		(5.419)	
DVP^D	48.951***		25.921***		16.655***	
	(4.527)		(4.180)		(4.534)	
SRP		-60.886***		-30.512***		-18.822***
		(5.306)		(4.669)		(4.978)
DVP		-13.214***		-5.180***		-2.496***
		(4.264)		(5.479)		(4.861)
$y_{US} - y_i$	1.903***	1.917***	1.768***	1.772***	1.348***	1.350***
	(3.407)	(3.411)	(2.843)	(2.846)	(2.781)	(2.784)
EVRP	0.397	0.333	0.717***	0.710***	0.515***	0.521***
	(0.812)	(0.681)	(2.914)	(2.894)	(3.001)	(3.042)
Adj R^2	0.070	0.068	0.119	0.118	0.118	0.119

Safe (JPY/CHF) vs risky currencies

- Much of the variation in USD valuation is driven by global risk
- We expect the downside component of non-safe CVRP to be the strongest predictor of non-US currency returns.

Panel A. DVP relative to risky currencies

	Dependent variable: currency returns			
	1-month		12-month	
$RDVP^U$	-43.056***		-14.843***	
	(4.889)		(5.537)	
$RDVP^D$	21.293***		10.429***	
	(2.826)		(4.567)	
RSRP		-30.974***		-12.392***
		(4.042)		(5.115)
RDVP		-10.174***		-2.116***
		(3.903)		(4.633)
$y_{US} - y_i$	1.933***	1.924***	1.386***	1.385***
	(3.266)	(3.252)	(2.830)	(2.824)
EVRP	0.259	0.222	0.433***	0.435***
	(0.527)	(0.453)	(2.672)	(2.686)
Adj R^2	0.055	0.053	0.126	0.126

Panel B. DVP relative to safe currencies

	Dependent variable: currency returns			
	1-month		12-month	
$SDVP^U$	-10.660		8.392***	
	(1.202)		(2.663)	
$SDVP^D$	-22.383*		-11.656***	
	(1.954)		(3.381)	
SSRP		3.841		9.952***
		(0.424)		(3.110)
SDVP		-16.610***		-1.924***
		(3.922)		(2.770)
$y_{US} - y_i$	0.920	0.977	1.181**	1.183**
	(1.500)	(1.601)	(2.274)	(2.281)
EVRP	1.415***	1.438***	0.561***	0.589***
	(3.061)	(3.094)	(4.148)	(4.268)
Adj R^2	0.030	0.031	0.082	0.084

Predicting Dollar Index returns

- Much of the variation in USD valuation is driven by global risk
- Therefore, we would expect an identical pattern using the dollar index

	Dependent variable: Negative dollar index returns					
	1-month		6-month		12-month	
DVP^U	-47.281***		-25.185***		-15.614***	
	(3.421)		(3.812)		(3.110)	
DVP^D	28.342**		19.848***		13.257***	
	(2.144)		(3.463)		(2.807)	
SRP		-28.342**		-19.848***		-13.257***
		(2.144)		(3.463)		(2.807)
DVP		-18.939***		-5.336***		-2.357***
		(7.003)		(4.740)		(3.700)
Adj R^2	0.081	0.081	0.083	0.083	0.073	0.073

Conclusion

- We provide an alternative explanation why a high DVP could lead to a dollar appreciation.
- The DVP contains information on the currency risk premium required by US and non-US investors
- Controlling for US risk, the DVP contains a risk premium required by the non-US investor
- Decomposing the DVP into upside and downside components, the downside DVP contains information on the risk premium of the US investor, and the upside contains non-US investor's risk premium
- For safe currencies, the upside and downside variance risk premiums are switched.

Extended Model

$$m_{t+1}^i - E_t[m_{t+1}^i] = \sum_{j \in \mathscr{I}} \delta_j^i \sqrt{\frac{z_t^j}{2}}(v_{t+1}^j - 1) + \lambda^i \sqrt{\frac{z_t}{2}}(v_{t+1} - 1),$$

- ▷ Each country has the highest exposure to own country's uncertainty risk (i.e., $\delta_j^j > \delta_j^k$ for all $k \neq j$)
- ▷ Some countries (e.g., Japan) has a high exposure to global risk (λ^{Japan} is high).

Extended Model

$$m^i_{t+1} - E_t[m^i_{t+1}] = \sum_{j \in \mathscr{I}} \delta^i_j \sqrt{\frac{z^j_t}{2}}(v^j_{t+1} - 1) + \lambda^i \sqrt{\frac{z_t}{2}}(v_{t+1} - 1),$$

Case 1 : Most countries

$$CVRP^U_t = \delta_i(\delta^i_i - \delta_i)^2 \sigma z^i_t + \sum_{j \neq i} \delta^i_j 1_{\delta^i_j > \delta_j}(\delta^i_j - \delta_j)^2 \sigma z^j_t$$

$$CVRP^D_t = \lambda(\lambda - \lambda^i)^2 \sigma z_t + \sum_{j \neq i} \delta^i_j 1_{\delta^i_j < \delta_j}(\delta^i_j - \delta_j)^2 \sigma z^j_t$$

Case 2 : Safe country

$$CVRP^U_t = \delta(\delta^i - \delta)^2 \sigma z^i_t + \lambda(\lambda - \lambda^i)^2 \sigma z_t + \sum_{j \neq i} \delta^i_j 1_{\delta^i_j > \delta_j}(\delta^i_j - \delta_j)^2 \sigma z^j_t$$

$$CVRP^D_t = \sum_{j \neq i} \delta^i_j 1_{\delta^i_j < \delta_j}(\delta^i_j - \delta_j)^2 \sigma z^j_t$$

back graph

Does USD appreciate more to positive US variance shocks?

Table A1: Testing for asymmetric reaction to variance shocks

This table provides the results of the regression

$$\Delta q^i_{t+1} = \alpha_i + \beta_i \Delta VIX^2_{t+1} + \gamma_i 1_{\Delta VIX^2_{t+1}>0} \Delta VIX^2_{t+1} + \epsilon_{i,t+1},$$

where q^i is the log currency value of country i, VIX is the volatility index of the S&P 500 Index, and $1_{\Delta VIX^2_{t+1}>0}$ is an indicator variable that takes a value of 1 if the condition in the subscript is true. The regression is estimated currency-by-currency, using weekly returns and the index. The regression coefficients and the Newey-West adjusted standard errors (with a lag of 15) are reported in the table.

Currency	β_i	γ_i	Adj-R^2	Currency	β_i	γ_i	Adj-R^2
AUD	-14.182***	-14.991***	0.322	DKK	-1.656	-6.682**	0.041
	(3.781)	(3.403)			(0.619)	(2.392)	
CAD	-8.933***	-10.531***	0.269	KRW	-11.392***	-7.697***	0.258
	(4.076)	(5.451)			(2.757)	(2.638)	
CHF	0.722	-4.353	0.003	NOK	-6.356***	-14.027**	0.135
	(0.269)	(1.452)			(2.815)	(2.276)	
EUR	-1.412	-6.979**	0.041	PLN	-10.013**	-12.747***	0.166
	(0.527)	(2.479)			(2.179)	(2.853)	
GBP	-2.279	-11.602***	0.101	SEK	-5.853**	-7.976**	0.084
	(0.984)	(4.150)			(1.968)	(1.992)	
JPY	5.414***	7.183**	0.094	THB	-0.245	-3.482**	0.018
	(3.018)	(2.540)			(0.195)	(2.435)	
NZD	-10.711***	-13.246***	0.194	ZAR	-16.223**	-8.885	0.160
	(2.895)	(3.343)			(2.245)	(1.096)	

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	(2.895)	(3.343)			(2.245)	(1.096)	

Predicting EUR/USD returns

Panel A. Using upside and downside CVRP

	Dependent variable: EUR/USD			
	1-month		12-month	
$CVRP_{EU}^{U}$	-108.996**	-126.469***	-8.635	-14.080**
	(2.386)	(2.824)	(1.226)	(2.027)
$CVRP_{EU}^{D}$	63.563*	64.248**	10.856*	11.057**
	(1.895)	(2.461)	(1.798)	(1.994)
$CVRP_{JP}^{U}$		23.407**		6.507**
		(1.976)		(2.032)
$CVRP_{JP}^{D}$		-21.115**		-5.328
		(2.023)		(1.321)
$y_{US} - y_{EU}$	0.618	1.445	2.129**	2.319**
	(0.425)	(0.874)	(2.118)	(2.087)
Adj R^2	0.066	0.085	0.085	0.103

Panel B. Using skewness measures

	Dependent variable: EUR/USD			
	1-month		12-month	
SRP_{EU}	-86.783**	-93.516***	-10.598	-12.967**
	(2.222)	(2.782)	(1.613)	(2.080)
$CVRP_{EU}$	-22.886***	-29.851**	0.814	-1.609
	(2.964)	(2.470)	(0.746)	(1.313)
SRP_{JP}		20.719**		6.002*
		(2.111)		(1.751)
$CVRP_{JP}$		0.763		0.523
		(0.210)		(0.507)
$y_{US} - y_{EU}$	0.796	1.445	2.103**	2.319**
	(0.559)	(0.874)	(2.107)	(2.087)
Adj R^2	0.081	0.083	0.073	0.103