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Implied volatility term structure and exchange rate predictability

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Main idea

Can the currency implied volatility term structure (IVTS) predict exchange rate returns?

- Analysis from a time-series and cross-sectional perspective

Main Result

Relationship between implied volatility
term structure and returns
DEPENDS ON THE MARKET

- Developed markets: negative relationship
- Emerging markets: positive relationship

Motivation

- Exchange rate predictability is of interest to academics and market players, who can benefit from new currency investment strategies
- Different results have been computed in the literature, regarding the predictability of currency VRP (perhaps due to different option maturities)

Literature

- The term structure of option-implied volatilities has been studied for a long time
 - Poterba and Summers (1986)
 - Stein (1989)
 - Diz and Finucane (1993)
 - Heynen et al. (1994)
 - Xu and Taylor (1994)

Literature

- More recent papers attempt to predict the future shape of the volatility surface
 - Chalamandaris and Tsekrekos (2010, 2011)
 - Guo et al. (2014)
 - Buetow and Hendenrson (2016)
 - Luo and Zhang (2012)
 - Fassas (2012)

Literature

- Our paper is also related to the volatility risk premium (VRP) literature
 - Bollerslev et al. (2009, 2014)
 - Ornelas (2017)
 - Londoño and Zhou (2017)
 - Della Corte et al. (2016)
 - Ornelas and Mauad (2017)

What we do

- We build IVTS using three types of IV: ATM and 10-delta IV for the left and right tails (indirect quote)
- For each type, we use options with ten different maturity periods, ranging from one week to ten years
- We calculate each day the slope of the IVTS for these three types of IV, and for each of the 18 currencies in our sample (10 developed and 8 emerging markets)

Sample

- We obtain IV from over-the-counter (OTC) exchange rate options (estimates from JP Morgan data query application)
- Daily data from 2002 to 2016
- The following currencies against the US dollar:
- G10 currencies:
 - AUD, EUR, GBP, NZD, CAD, CHF, DKK, JPY, NOK and SEK
- Emerging market currencies:
 - BRL, CLP, CZK, HUF, MXN, PLN, THB and ZAR.

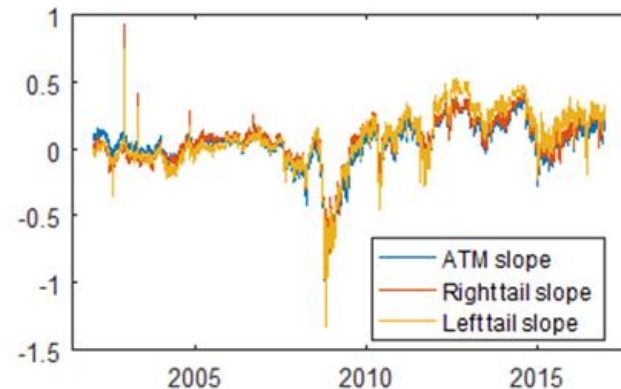
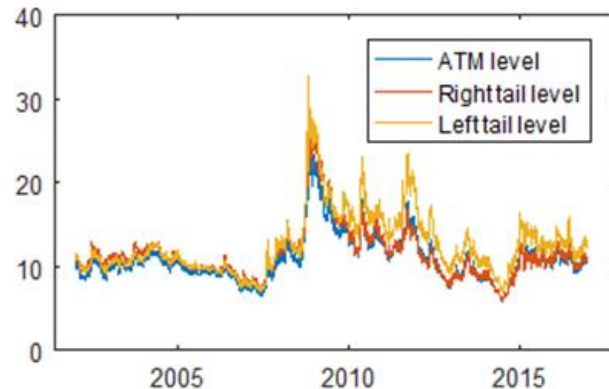
Implied volatility term structure

$$IV_{i,j,t} = \alpha_{i,t} + \beta_{i,t} * Mat_j + \varepsilon_{i,t}$$

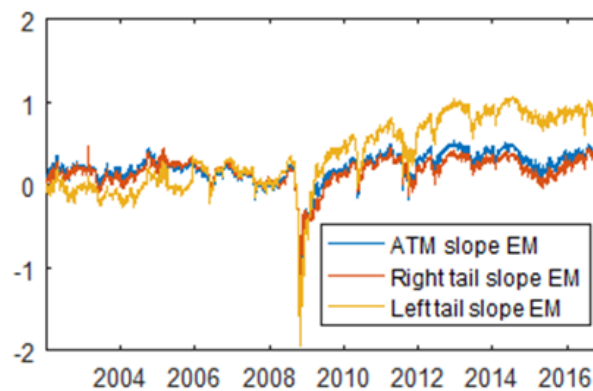
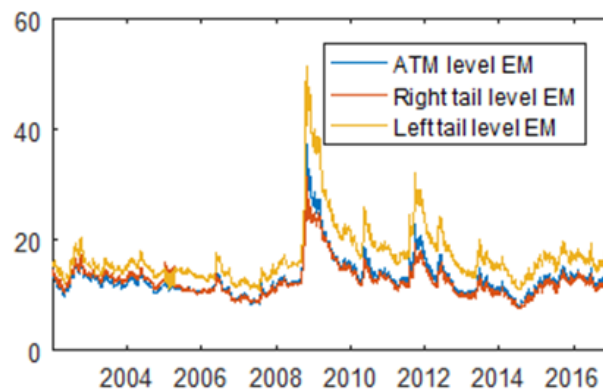
- Where
- $IV_{i,j,t}$ is the implied volatility for currency i , maturity Mat_j on date t
- Mat_j is the j^{th} maturity in years
- $\alpha_{i,t}$ is estimated the average level of the volatility term structure for currency i on date t
- $\beta_{i,t}$ is estimated the slope of the volatility term structure for currency i on date t
- We use the three aforementioned types of IV in this regression: ATM, right and left tail with delta 10

Implied volatility term structure

- G10 currencies



- Emerging market currencies

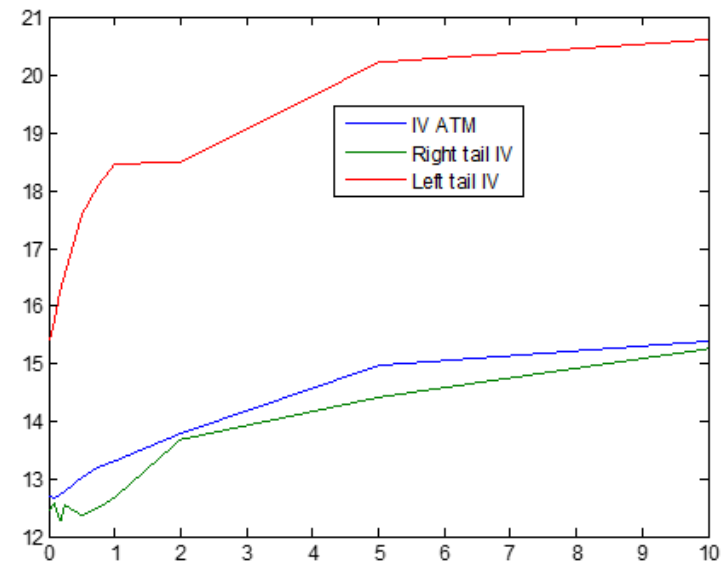
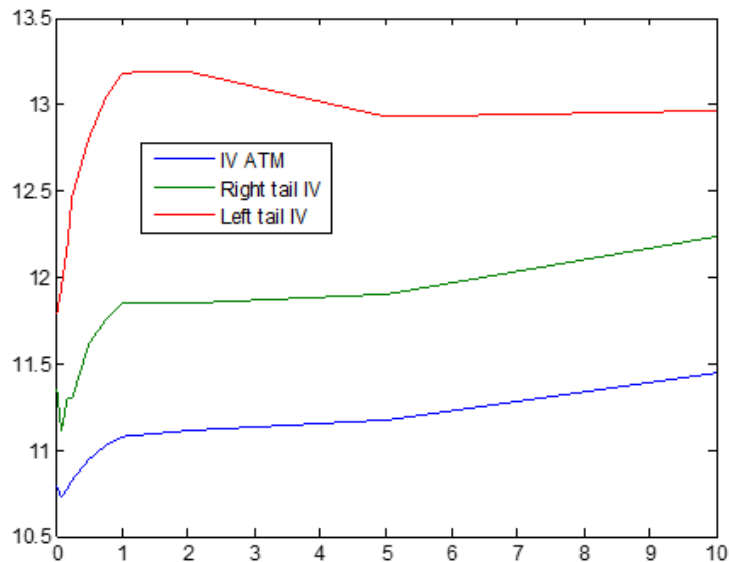


Average level and slope for each IV

Currencies		Implied Volatility Level			Implied Volatility Slope			Realized Volatility
		ATM	Left tail delta 10	Right tail delta 10	ATM	Left tail delta 10	Right tail delta 10	
Panel A								
Developed economies	AUD	11,05	13,66	10,86	0,02	0,14	0,01	11,78
	CAD	8,69	10,01	9,01	0,05	0,10	0,05	8,54
	CHF	9,83	10,83	10,86	0,01	0,00	0,05	10,96
	DKK	9,58	11,09	9,99	0,03	0,05	0,03	9,18
	EUR	9,55	11,00	10,01	0,03	0,06	0,03	9,22
	GBP	8,74	10,31	9,03	0,10	0,13	0,10	8,40
	JPY	9,72	9,89	12,18	0,08	0,05	0,32	9,44
	NOK	11,28	12,90	11,58	0,00	0,02	-0,01	11,52
	NZD	12,09	14,79	11,91	0,01	0,12	0,00	12,28
SEK	11,18	12,79	11,50	0,01	0,03	0,00	11,30	
Panel B								
Emerging markets	BRL	15,21	20,81	14,09	0,38	0,44	0,37	15,70
	CLP	11,02	14,73	10,76	0,22	0,35	0,14	9,38
	CZK	11,23	13,44	11,49	0,03	0,12	-0,03	11,54
	HUF	13,40	17,69	13,06	0,14	0,29	0,09	13,69
	MXN	10,76	14,33	10,08	0,28	0,43	0,33	9,85
	PLN	12,93	16,36	12,90	0,04	0,16	-0,02	12,93
	THB	6,29	8,16	6,67	0,25	0,39	0,21	4,62
	ZAR	16,23	21,86	15,44	0,19	0,53	0,09	16,68

Term Structure of Implied Volatility

- G10 currencies
- Emerging market currencies



Time-series predictability

$$Ret_{i,h,t} = \alpha + \gamma_1 * \beta_{i,t} + \gamma_2 * Ret_{i,h,t-h}$$

- Where
- $Ret_{i,h,t}$ is the return for each holding period h (three or six months), for each currency i , starting at time t ;
- $\beta_{i,t}$ is the coefficient previously estimated for each currency, each day.
- Results are shown in the next slide

Exchange rate return regression results

Dependent Variable		ATM		Left tail		Right tail	
(Currency Returns)		Coefficients					
		3 Mo	6 Mo	3 Mo	6 Mo	3 Mo	6 Mo
		Panel A					
Developed economies	AUD	-6.83**	-14.22***	-5.61***	-11.87***	-7.65***	-15.99***
	EUR	-2.80	-5.52	-2.98	-5.91	-4.66**	-9.51*
	GBP	1.03	0.42	-0.04	-1.33	-0.92	-4.22
	NZD	-4.78	-13.38***	-4.16*	-10.15***	-6.03	-16.23***
	CAD	-5.62*	-13.32**	-4.70**	-11.54***	-5.76*	-13.90***
	CHF	-0.44	-2.29	-0.72	-2.94	-1.64	-4.39
	DKK	-3.57	-6.54	-4.45**	-8.39*	-5.72***	-10.70**
	JPY	-2.65	-6.10	-2.47	-5.83	-2.52	-5.71*
	NOK	-4.52	-8.42	-5.09**	-9.65**	-6.88***	-13.04**
	SEK	-5.18*	-8.99	-5.21**	-9.61**	-7.48***	-13.73***
		Panel B					
Emerging markets	BRL	3.99	3.40	3.14***	5.88*	1.86	-0.31
	CLP	-2.19	-6.49	1.64	2.33	-2.07	-7.93
	CZK	3.29	5.24	2.82	5.91**	4.04	6.08
	HUF	2.75	5.30	1.86	4.02*	3.12	6.53
	MXN	-1.46	2.12	0.04	3.24	-2.19	-3.39
	PLN	1.02	2.90	1.15	3.14	2.77	5.33
	THB	1.64	2.46	1.97**	4.09***	1.46	1.89
	ZAR	7.17***	16.36***	3.44***	7.38***	8.22***	18.60***

Economic Intuition

- Volatility risk premium is important for emerging markets, but not for developed
- Developed: negative (positive) slope would mean physical volatility above (below) long-term equilibrium, and future volatility would decrease (increase)
- EM: high (low) slope would mean a higher (lower) risk premia. This means currencies are under (over) valued, and then should recover (go down) in the future

Cross-Section predictability

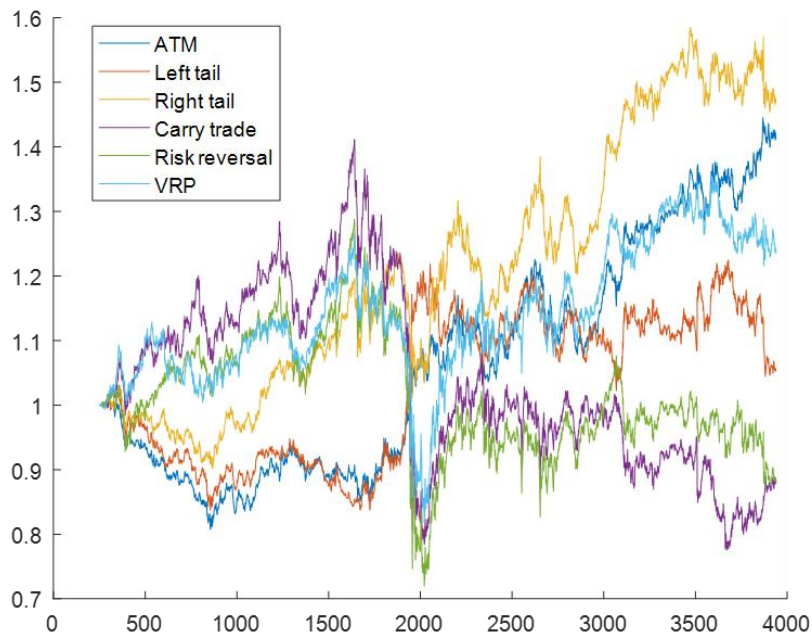
- We build long-short (cash neutral) portfolios based on the slopes of the volatility term structure
- Developed countries: short on top 20% slopes and long on bottom 20%
- Emerging markets: long on top 25% slopes and short on 25% bottom
- We form these portfolios on a daily basis and hold them for three months (63 overlapping business days) – each has a weight of $1/63$.

Cross-Section predictability

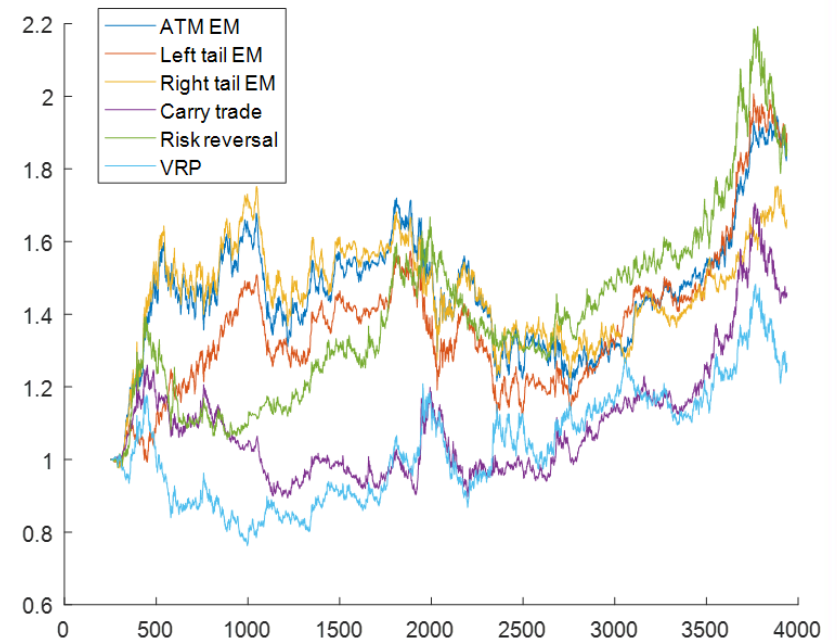
- To benchmark this exchange rate investment strategy, we use three other types of strategy:
 - Carry trade (based on interest rates)
 - Risk-reversal average level for the 10-delta
 - One-year VRP

Portfolio comparison with benchmark strategies

- G10 currencies



- Emerging Markets



Portfolio return statistics- Currency

		Currency Returns						
Types of portfolios		Mean	Mean	Volatility	Skewness	Kurtosis	Sharpe	Sharpe
		(Geo)	(Ari)				Ratio	Ratio
		Returns	Returns				(Geo)	(Ari)
Panel A - Developed markets								
Developed economies	ATM Slope	2,39%	2,33%	7,00%	0,095	6,4	0,34	0,33
	Left Tail Slope	0,37%	0,38%	7,63%	1,090	17,5	0,05	0,05
	Right Tail Slope	2,67%	2,80%	8,36%	-0,481	14,7	0,32	0,33
	Carry Trade	-0,88%	0,13%	12,49%	-0,930	19,2	-0,07	0,01
	Risk-Reversal	-0,86%	0,22%	12,63%	-0,670	17,4	-0,07	0,02
	VRP	1,46%	2,02%	11,20%	-0,456	15,4	0,13	0,18
Panel B - Emerging Markets								
Emerging markets	ATM Slope	4,31%	4,67%	10,74%	-0,026	5,8	0,40	0,43
	Left Tail Slope	4,48%	4,59%	9,79%	-0,023	5,6	0,46	0,47
	Right Tail Slope	3,52%	4,00%	10,96%	-0,086	6,7	0,32	0,36
	Carry Trade	2,62%	3,05%	11,42%	0,251	9,0	0,23	0,27
	Risk-Reversal	4,38%	4,56%	11,50%	0,377	7,6	0,38	0,40
	VRP	1,62%	2,19%	12,97%	0,507	6,9	0,13	0,17

Portfolio return statistics - Total

		Total Return						
Types of portfolios		Mean (Geo) Returns	Mean (Ari) Returns	Volatility	Skewness	Kurtosis	Sharpe Ratio (Geo)	Sharpe Ratio (Ari)
Panel A - Developed markets								
Developed economies	ATM Slope	2,34%	2,29%	7,00%	0,098	6,3	0,33	0,33
	Left Tail Slope	-0,69%	-0,61%	7,63%	1,080	17,4	-0,09	-0,08
	Right Tail Slope	4,16%	4,18%	8,36%	-0,469	14,7	0,50	0,50
	Carry Trade	3,41%	4,14%	12,49%	-0,923	19,2	0,27	0,33
	Risk-Reversal	2,68%	3,53%	12,63%	-0,659	17,4	0,21	0,28
	VRP	3,51%	3,93%	11,20%	-0,444	15,4	0,31	0,35
Panel B - Emerging Markets								
Emerging markets	ATM Slope	7,29%	7,42%	10,74%	-0,027	5,8	0,68	0,69
	Left Tail Slope	6,68%	6,64%	9,79%	-0,040	5,6	0,68	0,68
	Right Tail Slope	6,35%	6,61%	10,96%	-0,086	6,7	0,58	0,60
	Carry Trade	13,42%	13,07%	11,42%	0,267	9,0	1,18	1,15
	Risk-Reversal	12,08%	11,71%	11,50%	0,389	7,6	1,05	1,02
	VRP	8,03%	8,17%	12,97%	0,517	6,9	0,62	0,63

Correlation matrices

		ATM Slope	Left Tail Slope	Right Tail Slope	Carry Trade	Risk-Reversal	VRP
		Panel A - Developed markets					
Developed economies	ATM Slope		59%	67%	18%	22%	41%
	Left Tail Slope	59%		18%	-35%	-25%	-10%
	Right Tail Slope	67%	18%		56%	62%	67%
	Carry Trade	18%	-35%	56%		91%	74%
	Risk-Reversal	22%	-25%	62%	91%		84%
	VRP	41%	-10%	67%	74%	84%	
		Panel B - Emerging Markets					
Emerging markets	ATM Slope		75%	92%	13%	22%	-26%
	Left Tail Slope	75%		61%	6%	14%	-25%
	Right Tail Slope	92%	61%		9%	16%	-31%
	Model-Free Slope	97%	75%	90%	17%	26%	-21%
	Carry Trade	13%	6%	9%		78%	70%
	Risk-Reversal	22%	14%	16%	78%		72%
	VRP	-26%	-25%	-31%	70%	72%	

Final remarks

- This paper provides new empirical evidence that the slopes of currency IVTS have predictive power for the exchange rates behavior from both cross-section and time-series perspectives
- Intriguingly, the direction of the prediction is not the same for developed and emerging markets.
- The proposed strategy performs better than common currency based on the Sharpe ratio, considering currency returns