Option-implied Skewness and the Cross Section of Foreign Exchange Returns

Ákos Török

WU Vienna University of Economics and Business & ZZ Vermögensverwaltung

37th AWG Workshop, September 23, 2022

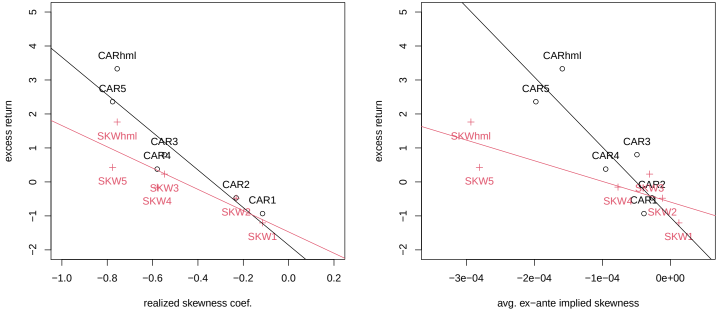
Intro

1. Carry is most prevalent factor in FX-literature and it is based on the fact that currencies tend to depreciate less than what is implied by their interest rate differential (Fama, 1984).
2. It is still debated what risks carry returns compensate. One popular explanation is crash risk:
    - Brunnermeier et al. (2008), Farhi et al. (2009) or Burnside et al. (2011) are often cited in this context.
    - All of them attribute a part of the carry risk premium to crash risk and argue/measure with the use of option prices (prices of risk reversals or skewness).
    - Jurek (2014) however, shows that crash-hedged portfolios still have statistically significant returns and estimates only 1/3 of the carry risk premium to be crash risk compensation.

Idea I ▸ table

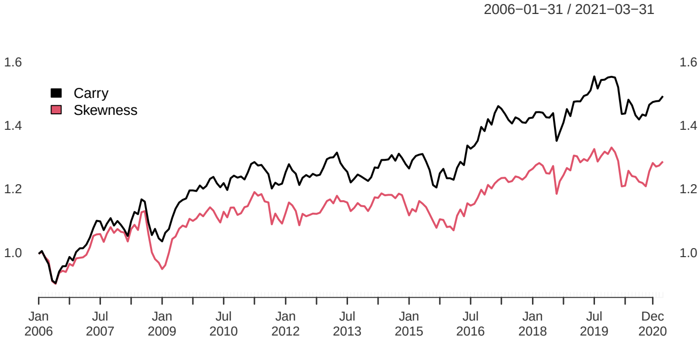
Risk and return of carry and model free option-implied skewness (Schneider and Trojani, 2015) ▸ formula ranked quintile portfolios:

- *CAR* and *SKW* portfolios seem to exhibit differrent returns for similar realized skewness coefficient.
- Ex ante, carry portfolios seem to be less risky, yet have higher returns
- Existing research looks at the *CAR* parts of the plots for inference.



Idea II

Portfolios constructed from opition-implied skewness (SKW) compared with carry (CAR): SKW and CAR are highly correlated with CAR performing better.



Contribution

Investigate the interplay of carry and option-implied skewness in the context of portfolio construction. Different to past literature this paper

1. uses option data only as signals as opposed to investments/hedges. (increased sample!)
2. Combining these signals with traditional carry, I construct two novel strategies:
   - a **'skew-neutral' carry** (RDF) where *high-risk, low-yielding* currencies are shorted and *high-yielding, low-risk* currencies are bought. When added to a pricing model, **this factor is priced during the sample period whereas carry is not**.
   - a **'crash-hedged' carry** (CAR_{hedged}) where *high-risk, low-yielding* currencies are shorted against the *long leg of the carry factor*. This strategy makes a **strong empirical argument against crash-based explanations for the carry risk premium**.

Idea III

High correlation of returns is to be expected, since the portfolios are very similiar (rank-correlation ▸ appendix of CAR and SKW ranking is high), but why are there differences?

- There seem to be currencies with high interest and comparatively low negative skewness and vice versa.
- Portfolios consisting of such currencies might have interesting properties. But how to construct them?
  - Double sorts are suboptimal because of high correlation/low number of assets some undesirable currencies are selected and these enter portfolios with equal weight. ▸ appendix
  - Solution: weighting scheme based on rank-difference (RDF):

$$w_{c,t}^{RDF} = \kappa_t \left[\text{rank}(CAR_{c,t}) - \text{rank}(-SKEW_{c,t}^{\mathbb{Q}}) \right] \tag{1}$$

Rank difference based weighting

table with example

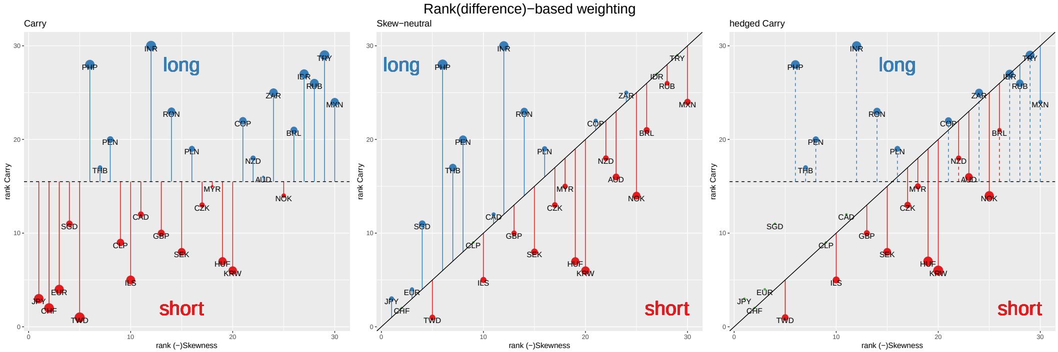


Figure: Illustration of weighting of different portfolios (March 2020). Left graph shows the Carry (*CAR*) portfolio with rank-based weights as in Asness et al. (2013). The middle graph shows the skew-neutral porfolio based on rank-differences (*RDF*) and the right graph illustrates the weights of the hedged carry, which is compromised of the long leg of *CAR* and short leg of *RDF*. Final weights are proportional to vertical lines. Blue dots represent positive weights an red dots negative weights.

charts & stats

Advantages of rank-difference based weighting compared to double-sort

- No empty portfolios
- Currencies close to 45-degree line (low discrepancy) have very small impact.
- Currencies that have a particularly high discrepacy in their signals are overweighted.
- Currencies that have a low skewness but even lower carry are also added to shorts.
- High carry currencies that have even higher skewness are (partly) neutralized!

Summary statistics I ▸ performance graphs

Panel A: returns all currencies

	RDF	CAR_{hedged}	*CAR*	*SKW*	*VAL*	*MOM*	*VRP*	*USD*
mean	1.64	2.92	2.66	1.68	1.83	0.34	0.19	1.15
sd	5.07	5.42	6.57	7.26	5.40	5.95	4.62	7.93
skew	0.03	0.10	-0.15	-0.19	0.00	0.13	0.06	-0.13
kurt	-0.20	-0.14	0.08	0.13	0.03	0.18	0.08	-0.15
maxDD	-7.97	-10.11	-11.30	-16.08	-12.24	-23.43	-18.51	-24.33
SR	0.32	0.54	0.40	0.23	0.34	0.06	0.04	0.15

Panel B: spot returns all currencies

	RDF	CAR_{hedged}	*CAR*	*SKW*	*VAL*	*MOM*	*VRP*	*USD*
mean	-1.61	-3.45	-5.03	-4.12	1.78	-0.38	1.99	-1.39
sd	5.10	5.40	6.56	7.25	5.41	5.96	4.67	7.93
skew	-0.03	0.03	-0.18	-0.21	-0.00	0.21	0.08	-0.18
kurt	-0.22	-0.14	0.09	0.14	0.03	0.23	0.08	-0.13
SR	-0.32	-0.64	-0.77	-0.57	0.33	-0.06	0.43	-0.18

Panel C: correlations all currencies

	RDF	CAR_{hedged}	*CAR*	*SKW*	*VAL*	*MOM*	*VRP*	*USD*
RDF	1.00	0.62	0.10	-0.35	0.21	-0.36	-0.08	-0.47
CAR_{hedged}	0.62	1.00	0.79	0.46	-0.19	0.03	-0.13	0.08
CAR	0.10	0.79	1.00	0.88	-0.38	0.16	-0.15	0.50
SKW	-0.35	0.46	0.88	1.00	-0.45	0.32	-0.12	0.69
VAL	0.21	-0.19	-0.38	-0.45	1.00	-0.25	0.14	-0.32
MOM	-0.36	0.03	0.16	0.32	-0.25	1.00	0.09	0.23
VRP	-0.08	-0.13	-0.15	-0.12	0.14	0.09	1.00	0.24
USD	-0.47	0.08	0.50	0.69	-0.32	0.23	0.24	1.00

The table illustrates summary statistics for the skew-neutral strategy based on rank differentials (*RDF*), crash-hedged carry CAR_{hedged} (and various FX-factor strategies. *CAR*, *SKW*, *VAL* (Asness et al., 2013) *MOM* (Menkhoff et al., 2012) and *VRP* (Della Corte et al., 2016) are constructed with rank-based weights like in Asness et al. (2013) and *USD* is an equal weighted portfolio of all currencies against the US-Dollar. The statistics are annualized and include monthly returns from April 2006 until March 2021.

Summary statistics II

CAR_{hedged}:

- Is highly correlated to carry (0.79).
- Adds 0.14 to the Sharpe ratio of carry (lower volatility with slightly higher return).
- Has positive skewness coefficient, lower exc. kurtosis and maximum drawdown.
- Spot returns suggest that the initial forward discount of the portfolio is smaller but also the average loss in spot returns is smaller (and crucially, crashes in the spot seem to be avoided).

$\Rightarrow$ carry is not compensation for crash risk? Skew-neutral portfolio (RDF) is uncorrelated to carry, has similar dynamics as CAR_{hedged} but worse summary stats.

What about risk-adjusted returns?

Spanning regressions *RDF*

	RDF	*RDF*	*RDF*	*RDF*	*RDF*	*RDF*	*RDF*	*RDF*
(Intercept)	1.643	1.434	1.584	2.257^{*}	1.661	1.841^{*}	1.002	1.188
	(1.021)	(1.088)	(1.121)	(1.089)	(1.068)	(0.912)	(0.803)	(0.838)
CAR		0.079					0.353^{***}	0.437^{***}
		(0.066)					(0.065)	(0.057)
MOM			0.176^{*}					0.087^{*}
			(0.072)					(0.041)
VAL				-0.335^{***}				-0.259^{***}
				(0.083)				(0.069)
VRP					-0.093			0.194^{*}
					(0.084)			(0.077)
USD						-0.297^{***}	-0.445^{***}	-0.445^{***}
						(0.038)	(0.046)	(0.048)
R^2	0.000	0.010	0.043	0.127	0.007	0.218	0.373	0.489
Adj. R^2	0.000	0.005	0.037	0.123	0.002	0.213	0.366	0.475
Num. obs.	182	182	182	182	182	182	182	182

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

- *RDF* offers insignificant alpha compared to all factors jointly.
- More than half of the variation in *RDF*-returns remains unexplained in the full multivariate regression.
- *CAR* on its own is an insignificant explanatory variable but as *USD* is added it becomes highly significant.

Spanning regressions RDF_{short}

	RDF_{short}	RDF_{short}	RDF_{short}	RDF_{short}	RDF_{short}	RDF_{short}	RDF_{short}	RDF_{short}
(Intercept)	-1.178	-2.507	-1.021	-1.979	-1.263	-1.945^{**}	-1.271^{*}	-1.255^{*}
	(2.522)	(2.369)	(2.435)	(2.478)	(2.465)	(0.763)	(0.666)	(0.639)
CAR		0.499^{***}					-0.283^{***}	-0.331^{***}
		(0.135)					(0.051)	(0.044)
MOM			-0.467^{**}					-0.016
			(0.166)					(0.029)
VAL				0.436^{*}				0.069
				(0.203)				(0.040)
VRP					0.448^{*}			-0.157^{**}
					(0.191)			(0.056)
USD						1.151^{***}	1.270^{***}	1.296^{***}
						(0.034)	(0.031)	(0.035)
R^2	0.000	0.115	0.083	0.060	0.046	0.901	0.928	0.934
Adj. R^2	0.000	0.110	0.078	0.054	0.041	0.900	0.927	0.933
Num. obs.	182	182	182	182	182	182	182	182

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

- RDF_{short} offers significant alpha compared to all factors jointly although it does not always produce significant alpha individually.
- *USD* is the most important explanatory variable as it explains most of the variation. The coefficient is larger (> 1) than for the long part.
- i.e. shorting RDF_{short} against the long leg of CAR would (over)hedge its USD exposure while adding Carry exposure and (significant) alpha.

Systematic crash-risk

1. Kraus and Litzenberger (1976) and Harvey and Siddique (2000) argue that investors care about systematic skewness.
2. Lettau et al. (2014) show that carry trades exhibit systematic downside-risk. They are also connected to coskewness (Dobrynskaya, 2014).
3. For equities, Schneider et al. (2020) show that exposure to coskewness can explain low-risk anomalies using option-implied skewness as a proxy for coskewness.

CAR_{hedged} **and** RDF **could be explained by systematic skewness?**

Crash-risk regressions

	CAR	RDF	CAR_{hedged}	CAR	RDF	CAR_{hedged}
(Intercept)	0.003	0.005*	0.004	0.001	0.003**	0.002*
	(0.004)	(0.002)	(0.004)	(0.001)	(0.001)	(0.001)
Mkt_{down}	0.226**	-0.047	0.060			
	(0.081)	(0.050)	(0.078)			
Mkt				0.176***	-0.107^{***}	0.021
				(0.030)	(0.027)	(0.031)
e^2_{Mkt}				-0.251	-0.220	-0.056
				(0.361)	(0.215)	(0.281)
R^2	0.164	0.015	0.017	0.199	0.099	0.005
Adj. R^2	0.150	-0.001	0.000	0.190	0.089	-0.007
Num. obs.	62	62	62	182	182	182

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

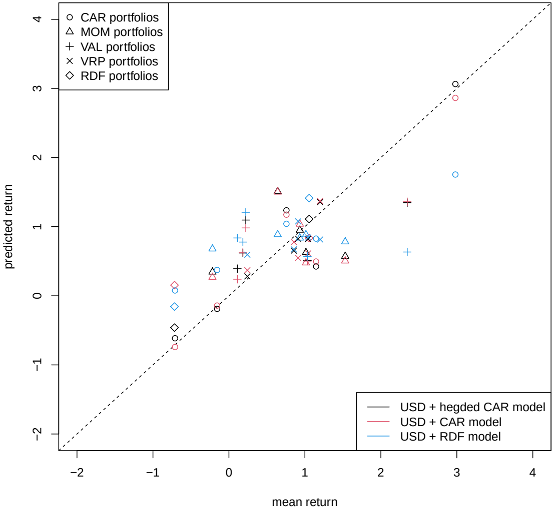
- *CAR* has (downside) equity market exposure.
- *RDF* has negative (downside) market exposure.
- CAR_{hedged} has neutral (downside) market exposure.

Asset pricing models with *RDF* and CAR_{hedged}

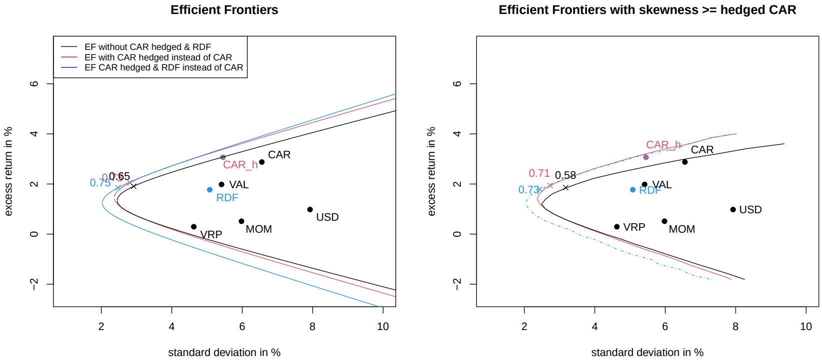
Table: This table includes results from estimating asset pricing models of the form $E_t[M_{t+1}R^i_{t+1}] = 0$ with a linear stochastic discount factor $M_{t+1} = 1 - b(f_{t+1} - \mu)$ via GMM. Test assets are quintile portfolios of CAR_i, MOM_i, VAL_i, VRP_i and the long and short portfolio of *RDF*. As factors *USD*, *CAR*, *RDF* and CAR_{hedged} are used. Estimates for market prices of risk λ and factor loadings b, as well as R^2, square-root of mean squared errors, and p-values of χ^2 tests are reported. The models include annualized monthly excess returns from January 2006 until March 2021. Standard errors are adjusted according to Newey and West (1987) using an optimal number of lags according to Andrews (1991).

	λ_{USD}	λ_{CAR}	λ_{RDF}	λ_{CAR_h}	b_{USD}	b_{CAR}	b_{RDF}	b_{CAR_h}	R^2_{adj}	RMSE	χ^2
Model 1	0.77	2.9			-0.18	0.67*			71.42	0.53	
	(3.49)	(2.89)			(0.31)	(0.37)					93.19%
Model 2	0.83		1.57*		0.34		0.75*		41.97	0.67	
	(1.28)		(0.71)		(0.31)		(0.45)				91.65%
Model 3	0.82			2.99*	0.06			0.83*	77.68	0.5	
	(2.19)			(1.5)	(0.27)			(0.39)			96.52%

Asset pricing models with *RDF* and CAR_{hedged} II



Ex-post Efficient Frontiers I



The graphs show the ex-post mean-variance efficient frontiers for various combinations of currency factors. The lines of the right graph represent efficient frontiers restricted to a skewness coefficient of $> CAR_{hedged}$ (simulated weights). When skewness is considered, the economic value added (in terms of Sharpe ratio) is greater than in the unrestricted, simple mean-variance case.

Ex-post Efficient Frontiers II

Weights of tangency portfolios:

Tangency portfolios

	CAR_{hedged} swap	old factors	all factors except CAR
CAR_{hedged}	0.43		0.22
RDF			0.22
CAR		0.43	
MOM	0.21	0.25	0.16
VAL	0.29	0.32	0.30
VRP	0.04	0.12	0.00
USD	0.04	-0.11	0.10
Sharpe ratio	0.73	0.65	0.75

Tangency portfolios skewness ≥ 0.1 (CAR_{hedged})

	CAR_{hedged} swap	old factors	all factors except CAR
CAR_{hedged}	0.43		0.16
RDF			0.29
CAR		0.54	
MOM	0.18	0.13	0.13
VAL	0.25	0.20	0.32
VRP	0.09	0.35	-0.02
USD	0.04	-0.22	0.12
	0.71	0.58	0.73

- Adding new portfolios yields slight improvement in terms of mean-variance considerations but major value when adding skewness to the consideration.
- CAR_{hedged} is responsible for majority of increase in Sharpe ratio.

Robustness

- Robust to different samples of FX:
  - Resampling many different combinations of 24 FX shows that the result from the whole sample of 30 is not an outlier ▸ graph
- Robust to variation in weighting methodology:
  - Only taking top and bottom 3 (=deciles) currencies according to rank-difference and equal weighting them or
  - Setting all weights with $|w| < 0.05$ to 0 both show similar results. ▸ graph
- Variation of signal ▸ table
  - Implying skewness from different option maturities: 1M is the best, 3M/6M/12M worse but similar.

Summary

- Option-implied skewness seems to be superior predicting risk than interest rates.
- You can earn the carry risk premium without negative skewness/downside exposure to the equity market. This is good news for explanations of carry which are not crash-risk based.
- You should probably use the crash hedged carry portfolio instead of traditional carry as a factor in AP.
- Also, rank-difference based weighting is a nice solution if you want "corner-portfolios" in a low-dimensional asset class

References I

Andrews, D. W. (1991). Heteroskedasticity and autocorrelation consistent covariance matrix estimation. *Econometrica: Journal of the Econometric Society*, pages 817–858.

Asness, C. S., Moskowitz, T. J., and Pedersen, L. H. (2013). Value and momentum everywhere. *The Journal of Finance*, 68(3):929–985.

Brunnermeier, M. K., Nagel, S., and Pedersen, L. H. (2008). Carry trades and currency crashes. *NBER macroeconomics annual*, 23(1):313–348.

Burnside, C., Eichenbaum, M., Kleshchelski, I., and Rebelo, S. (2011). Do peso problems explain the returns to the carry trade? *The Review of Financial Studies*, 24(3):853–891.

Della Corte, P., Ramadorai, T., and Sarno, L. (2016). Volatility risk premia and exchange rate predictability. *Journal of Financial Economics*, 120(1):21–40.

Dobrynskaya, V. (2014). Downside market risk of carry trades. *Review of Finance*, 18(5):1885–1913.

Fama, E. F. (1984). Forward and spot exchange rates. *Journal of monetary economics*, 14(3):319–338.

Farhi, E., Fraiberger, S. P., Gabaix, X., Ranciere, R., and Verdelhan, A. (2009). Crash risk in currency markets. Technical report, National Bureau of Economic Research.

Harvey, C. R. and Siddique, A. (2000). Conditional skewness in asset pricing tests. *The Journal of finance*, 55(3):1263–1295.

Jurek, J. W. (2014). Crash-neutral currency carry trades. *Journal of Financial Economics*, 113(3):325–347.

Kraus, A. and Litzenberger, R. H. (1976). Skewness preference and the valuation of risk assets. *The Journal of finance*, 31(4):1085–1100.

Lettau, M., Maggiori, M., and Weber, M. (2014). Conditional risk premia in currency markets and other asset classes. *Journal of Financial Economics*, 114(2):197–225.

Lustig, H., Roussanov, N., and Verdelhan, A. (2011). Common risk factors in currency markets. *The Review of Financial Studies*, 24(11):3731–3777.

Menkhoff, L., Sarno, L., Schmeling, M., and Schrimpf, A. (2012). Currency momentum strategies. *Journal of Financial Economics*, 106(3):660–684.

Newey, W. K. and West, K. D. (1987). A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica*, 55(3):703–708.

Schneider, P. and Trojani, F. (2015). Fear trading. *Swiss Finance Institute Research Paper*, (15-03).

Schneider, P., Wagner, C., and Zechner, J. (2020). Low-risk anomalies? *The Journal of finance*, 75(5):2673–2718.

End

Thank you for your attention!

summary stats quartile-pfs ▸ back

	CAR1	CAR2	CAR3	CAR4	CARhml	SKW1	SKW2	SKW3	SKW4	SKWhml
mean	-1.69	-0.25	-0.44	1.50	3.22	-0.80	0.31	-0.67	0.30	1.25
sd	6.78	7.80	8.44	10.43	7.31	6.01	7.31	8.58	11.57	8.23
skew	-0.04	-0.07	-0.23	-0.18	-0.13	0.03	-0.08	-0.21	-0.18	-0.17
kurt	0.04	0.05	0.20	0.10	0.07	0.13	0.07	0.19	0.12	0.14
SR	-0.25	-0.03	-0.05	0.14	0.44	-0.13	0.04	-0.08	0.03	0.15
HS2000	-0.01	0.03	-0.09	-0.10	-0.09	-0.06	0.00	-0.03	-0.09	-0.09
KL1976	-0.03	0.08	-0.23	-0.33	-0.24	-0.13	0.00	-0.10	-0.31	-0.12
COV(Rm^2,Ri)	-10.15	-13.02	-20.08	-24.12	-13.09	-10.16	-13.50	-16.80	-27.08	-15.79

Skewness formula of Schneider and Trojani (2015)

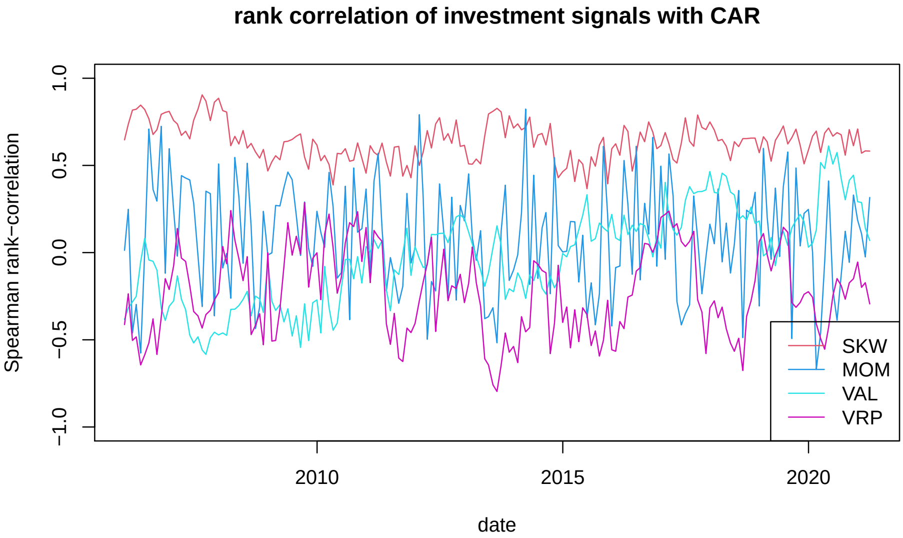
$$SKEW^{\mathbb{Q}}_{t,T} = \frac{6}{p_{t,T}} \int_{F_{t,T}}^{\infty} \log(\frac{K}{F_{t,T}}) \frac{\sqrt{\frac{K}{F_{t,T}}} C_{t,T}(K)}{K^2} dK -$$

$$-\frac{6}{p_{t,T}} \int_{0}^{F_{t,T}} \log(\frac{F_{t,T}}{K}) \frac{\sqrt{\frac{K}{F_{t,T}}} P_{t,T}(K)}{K^2} dK.$$

- Not standardized = better single measure for tail-risk. Most empirical work focusses on skewness coefficients or risk-reversals. Both are imperfect measures of disaster/tail-risk as they disregard volatility.
- Upper and lower skewness can be separated.
- Suits application to FX: far out of the money options are weighted very small and these are extrapolated in my case (only 10-delta options are actually quoted)

back

Similarity of investment signals



back

Example weighting RDF ▸ back

FX	CAR	CARrank	SKEW * 10^5	SKEWrank	rankdif	weights
TWD	-7.08	1	-0.11	5	-4	-0.046
CHF	-1.96	2	0.16	2	0	0.000
JPY	-1.93	3	0.83	1	2	0.023
EUR	-1.48	4	-0.05	3	1	0.011
ILS	-1.26	5	-0.50	10	-5	-0.057
KRW	-1.18	6	-1.45	20	-14	-0.161
HUF	-0.96	7	-1.05	19	-12	-0.138
SEK	-0.92	8	-0.68	15	-7	-0.080
CLP	-0.91	9	-0.36	9	0	0.000
GBP	-0.84	10	-0.65	13	-3	-0.034
SGD	-0.59	11	-0.08	4	7	0.080
CAD	-0.43	12	-0.56	11	1	0.011
CZK	-0.31	13	-0.96	17	-4	-0.046
NOK	-0.26	14	-3.36	25	-11	-0.126
MYR	-0.21	15	-0.99	18	-3	-0.034
AUD	-0.20	16	-2.43	23	-7	-0.080
THB	0.23	17	-0.26	7	10	0.115
NZD	0.30	18	-2.24	22	-4	-0.046
PLN	0.32	19	-0.81	16	3	0.034
PEN	1.57	20	-0.30	8	12	0.138
BRL	2.34	21	-5.02	26	-5	-0.057
COP	2.51	22	-1.56	21	1	0.011
RON	3.37	23	-0.66	14	9	0.103
MXN	5.56	24	-15.75	30	-6	-0.069
ZAR	5.80	25	-3.36	24	1	0.011
RUB	6.51	26	-6.29	28	-2	-0.023
IDR	7.82	27	-5.32	27	0	0.000
PHP	10.42	28	-0.13	6	22	0.253
TRY	11.02	29	-6.69	29	0	0.000
INR	12.67	30	-0.60	12	18	0.207

Unconditional double-sort

back

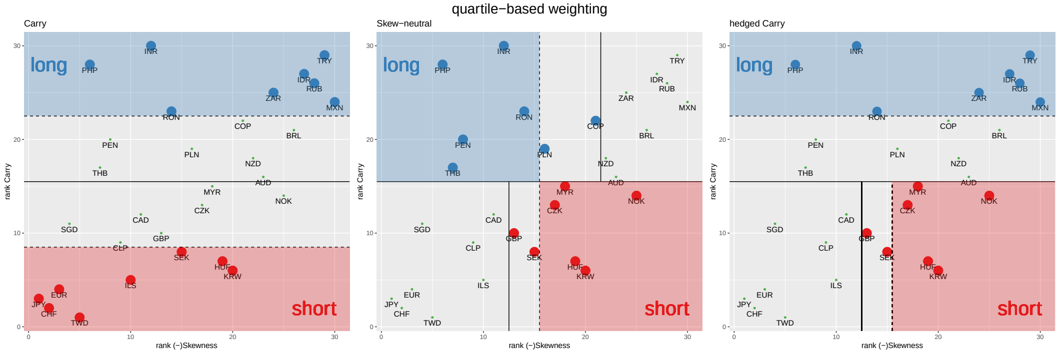


Figure: Illustration of weighting of different portfolios (March 2020). Left graph shows the quartile-based Carry *CAR* portfolio with equal weights. The middle graph shows the skew-neutral porfolio based an (un)conditional double-sort (unconditional is the colored area, conditional are the coloured dots/currencies) and the right graph illustrates the hedged carry, which is compromised of the long leg of *CAR* and short leg of the skew-neutral portfolio. Blue dots represent positive an red dots negative (equal) weights.

Unconditional double-sort stats

▸ back

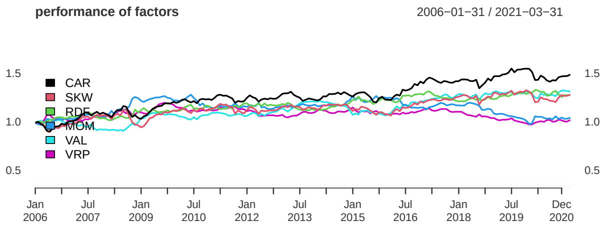
	CAR_{long}	CAR_{short}	SN_{long}	SN_{short}	CAR	SN	CAR_{hedged}
mean	2.11	-0.96	1.09	-0.02	3.13	1.66	2.92
sd	10.60	6.81	7.60	10.25	7.37	6.68	7.14
SR	0.20	-0.14	0.14	-0.00	0.42	0.25	0.41
skew	-0.18	-0.04	-0.14	0.06	-0.13	0.14	-0.02
kurt	0.11	0.04	0.16	0.06	0.07	0.17	0.03
HS2000	-0.03	0.03	-0.15	-0.04	-0.15	-0.12	0.02
KL1976	-0.08	0.06	-0.38	-0.14	-0.46	-0.30	0.03
$\text{COV}(R_m^2, R_i)$	-17.19	-7.28	-18.80	-19.69	-18.78	-0.24	1.95
CAR_{long}	1.00	0.72	0.84	-0.76	0.77	-0.22	0.37
CAR_{short}	0.72	1.00	0.77	-0.90	0.11	-0.50	-0.23
SN_{long}	0.84	0.77	1.00	-0.76	0.49	-0.04	0.15
SN_{short}	-0.76	-0.90	-0.76	1.00	-0.26	0.68	0.32
CAR	0.77	0.11	0.49	-0.26	1.00	0.14	0.74
SN	-0.22	-0.50	-0.04	0.68	0.14	1.00	0.65
CAR_{hedged}	0.37	-0.23	0.15	0.32	0.74	0.65	1.00

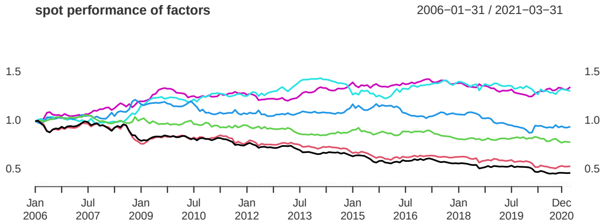
Weight statisics

back

FX	RDF mean	RDF sd	RDF % > 0	RDF % < 0	CAR mean	CAR sd	CAR % > 0	CAR % < 0
CZK	-12.9	7.5	6	92	-7.6	4.1	5	95
HUF	-8.7	6.8	3	91	1.5	7.0	58	42
SEK	-8.3	5.9	10	90	-7.8	3.4	1	99
PLN	-7.9	6.4	6	91	0.3	3.1	48	46
COP	-5.1	6.7	14	78	4.8	5.8	83	17
CLP	-4.1	8.9	37	57	2.1	5.8	74	23
KRW	-3.1	9.4	37	56	-2.2	3.8	29	69
CHF	-2.8	4.9	21	63	-12.0	1.3	0	100
NOK	-2.8	7.2	28	66	-2.7	3.0	19	80
RON	-2.5	9.6	37	57	3.6	6.1	73	26
ILS	-2.5	6.7	32	62	-5.6	3.6	7	93
ZAR	-1.9	3.0	22	68	10.1	1.8	100	0
MYR	-0.8	9.5	46	48	-0.8	6.2	50	50
PEN	-0.5	8.1	44	49	3.3	5.3	78	22
TWD	-0.2	7.1	32	59	-9.5	5.4	9	90
EUR	0.1	5.5	47	40	-8.7	2.5	0	100
BRL	0.5	5.1	54	39	9.9	2.9	99	1
MXN	1.8	5.9	58	29	7.0	3.5	100	0
JPY	2.3	5.5	81	9	-10.8	2.3	0	100
AUD	3.3	7.2	72	25	2.5	3.9	81	18
CAD	3.3	4.9	70	18	-4.3	2.4	3	97
GBP	3.3	7.4	71	23	-5.1	3.3	13	84
IDR	3.8	7.8	69	22	7.2	5.7	88	11
RUB	3.9	7.4	60	25	8.1	5.4	89	10
NZD	4.4	5.2	78	16	3.4	3.9	82	16
THB	4.6	7.8	72	26	1.1	5.1	53	46
TRY	5.0	5.8	68	3	12.0	2.2	100	0
SGD	5.5	6.9	76	18	-5.3	4.1	11	87
PHP	7.9	10.0	77	21	0.5	7.1	64	36
INR	16.0	7.8	96	4	8.6	4.5	97	3

Performances of factors ▸ back





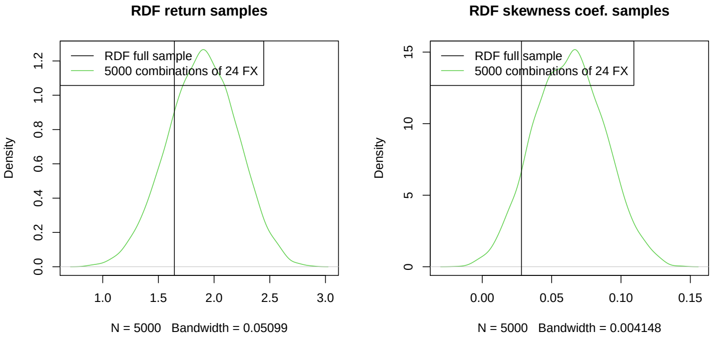
Robustness to signal (option-maturity)

RDF returns are a bit worse if longer tenors are used for skewness calculations but longer tenors seem to hold similar information):

	1-month	3-month	6-month	1-year
mean	1.643	1.280	1.069	1.151
sd	5.067	5.383	5.157	5.319
Sharpe Ratio	0.324	0.238	0.207	0.216
skew	0.028	0.106	0.041	0.114
kurt	0.053	0.139	0.071	0.187

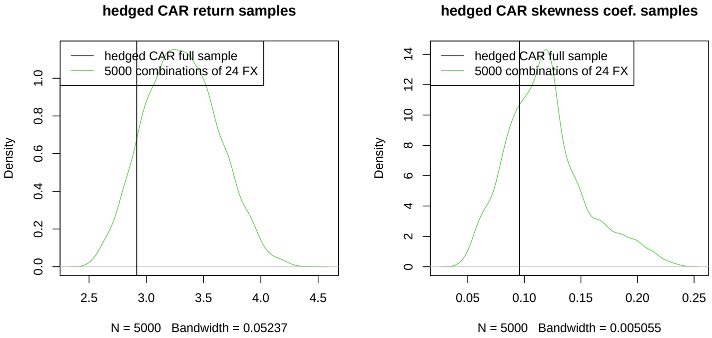
back

Robustness to variation in FX-sample: RDF



back

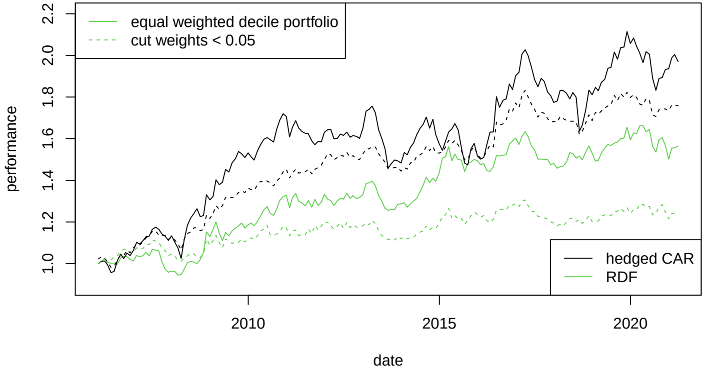
Robustness to variation in FX-sample: hedged CAR



back

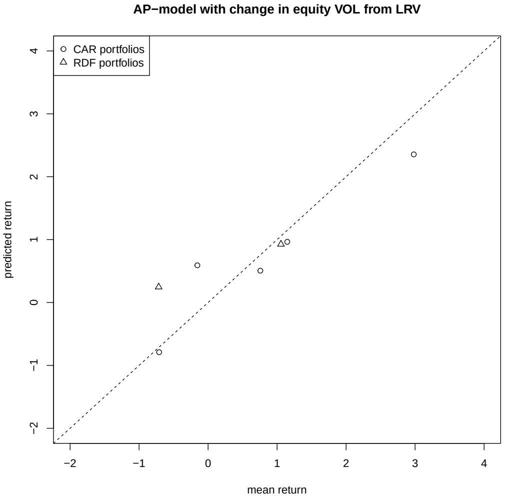
Robustness in varying weighting methodology

back



	RDF cut $\|w\| < 0.05$	hedged CAR cut $\|w\| < 0.05$	RDF ew decile pf	hedged CAR ew decile pf
mean	1.41	3.57	2.95	4.47
sd	5.59	5.68	7.38	9.61
SR	0.25	0.63	0.40	0.47
skewness	0.03	0.14	0.02	0.01
kurtosis	0.06	0.14	0.06	0.09

RDF_{short} also outlier in model of Lustig et al. (2011)

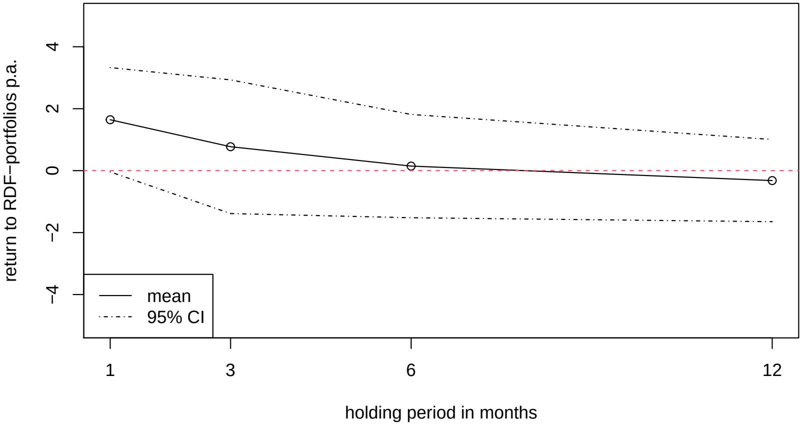


back

Further properties of RDF

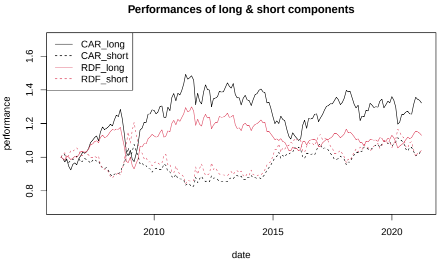
- RDF only works on 1M-horizon ‣ graph
  - The strategy does not offer significant returns when the holding period is extended from 1 month to multiple.
- Return contribution is roughly equal parts short and long leg
  - However, they really only work as a team! ‣ graph & table
- There seems to be time variation in the risk premium
  - Returns following months that see an increase in similarity between CAR and SKW have higher returns than months with decreases in similarity. ‣ regression & graph

Risk Premium only on 1-month horizon



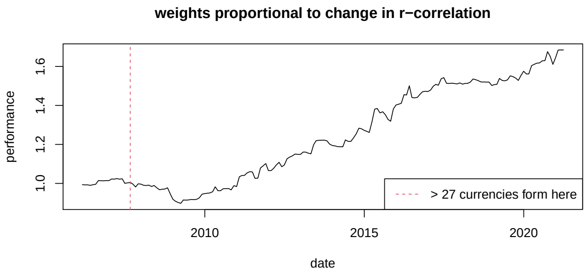
back

Performances of long and short legs ▸ back ▸ back 2



	CAR_{long}	CAR_{short}	RDF_{long}	RDF_{short}	CAR	RDF	CAR_{hedged}
mean	1.84	-0.76	0.81	-1.18	2.66	1.64	2.92
sd	10.16	6.80	7.11	9.66	6.57	5.07	5.42
SR	0.18	-0.11	0.11	-0.12	0.40	0.32	0.54
skew	-0.20	-0.03	-0.21	-0.15	-0.15	0.03	0.10
kurt	0.11	0.04	0.20	0.11	0.08	0.05	0.11
HS2000	-0.08	-0.05	-0.16	-0.06	-0.11	-0.11	-0.03
KL1976	-0.25	-0.12	-0.36	-0.19	-0.25	-0.22	-0.06
COV.Rm.2.Ri.	-22.42	8.18	-18.25	-20.46	-12.33	1.36	-1.88
CAR_{long}	1.00	0.77	0.92	0.85	0.75	-0.33	0.36
CAR_{short}	0.77	1.00	0.85	0.94	0.14	-0.59	-0.23
RDF_{long}	0.92	0.85	1.00	0.86	0.53	-0.23	0.19
RDF_{short}	0.85	0.94	0.86	1.00	0.34	-0.69	-0.19
CAR	0.75	0.14	0.53	0.34	1.00	0.10	0.79
RDF	-0.33	-0.59	-0.23	-0.69	0.10	1.00	0.62
CAR_{hedged}	0.36	-0.23	0.19	-0.19	0.79	0.62	1.00

Timing ▸ back



- Greater returns and better Sharpe ratio by weighing returns proportional to the changes in rank-correlation between CAR and SKW.
- Explanation: If similarity increases, the signal for those currencies that are dissimilar is stronger?

	RDF
(Intercept)	0.00
	(0.00)
corch	0.03**
	(0.01)
R^2	0.05
Adj. R^2	0.04
Num. obs.	182

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

	timed RDF
mean	3.44
sd	4.91
SR	0.70
skew	0.17
kurt	0.19

	RDF post 2007
(Intercept)	0.00
	(0.00)
corch	0.04***
	(0.01)
R^2	0.09
Adj. R^2	0.08
Num. obs.	147

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

	timed RDF post 2007/10
mean	4.95
sd	5.09
SR	0.97
skew	0.18
kurt	0.16