Deutsche Bank
Research

Systematic Investing in Currency Markets

A framework for absolute return and hedging strategies.

[/] DB Cross Asset Quantitative Research

June, 2019

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Presentation Index

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1. Foreign exchange as an asset class

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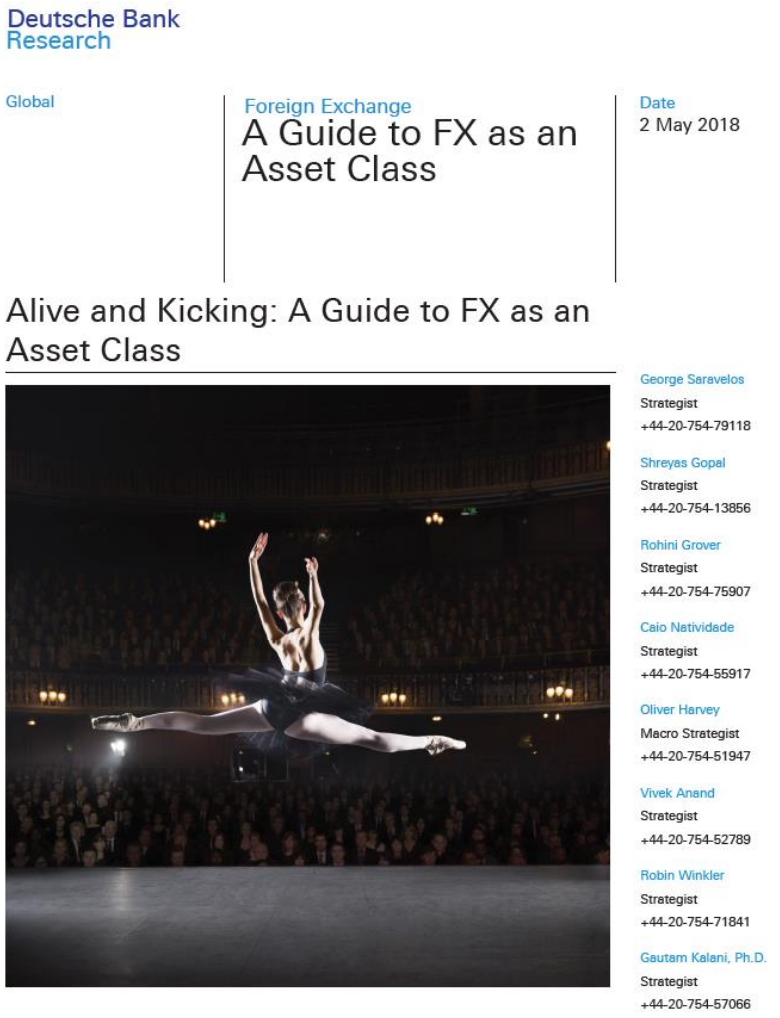
1. Foreign Exchange as an Asset Class

- Indisputably the world's largest and most liquid financial market
- FX is not an "efficient" market
- Existence of consistent positive returns
  - Forward rate bias
  - Technical-based rules
  - Macro-based models
- The FX market is evenly split between liquidity seekers and profit maximizers.
- FX is a good diversifier to the traditional equities/bond portfolios.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Global

Foreign Exchange

A Guide to FX as an Asset Class

Date
2 May 2018

Alive and Kicking: A Guide to FX as an Asset Class

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2. Drivers of FX Returns

2. Drivers of FX returns (1)

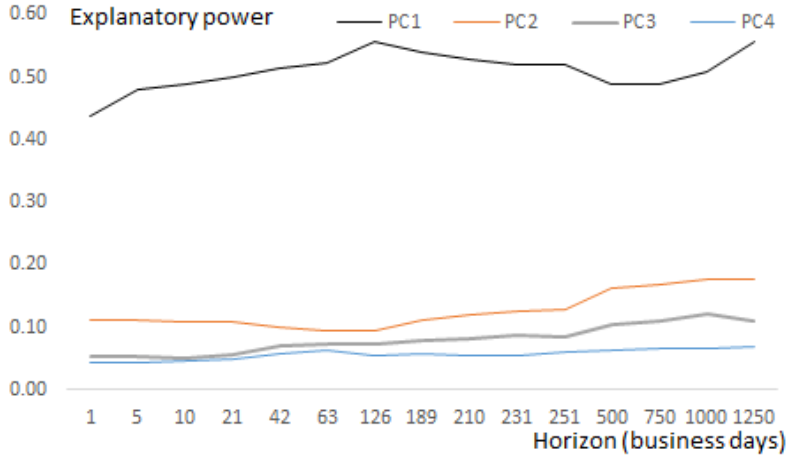
Our research dataset

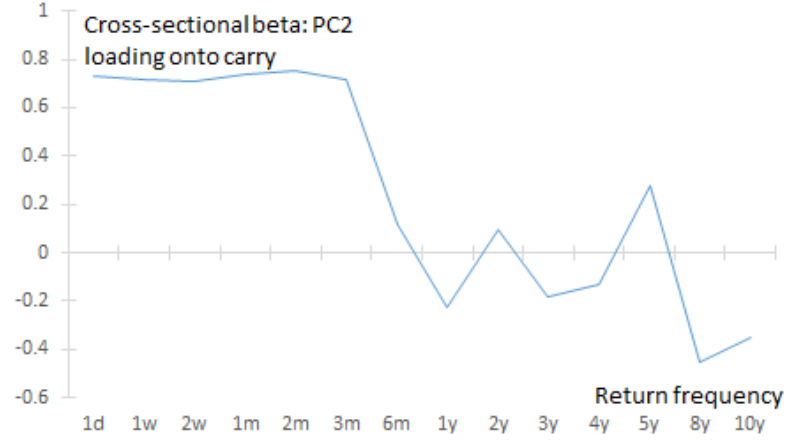
- 1-month forward contracts on 24 currency pairs.
- Macroeconomic variables: REER, GDP, CPI.
- Sources: DB, Bloomberg, Haver, IMF, BIS.

Regions	Currencies (vs. USD)
G10	AUD, CAD, CHF, EUR, GBP, JPY, NOK, NZD, SEK
LATAM	BRL, MXN
EMEA	CZK, HUF, ILS, PLN, RUB, TRY, ZAR
ASIA	INR, KRW, PHP, SGD, THB, TWD

Principal component analysis (PCA)

- The PC1 & PC2 explain around 52% and 13% of the total return variation respectively across frequencies.
- The PC1 is the Dollar factor and PC2 is the Carry factor.
- The sign of the PC2 loadings flips from short to long-term frequencies. This supports the validity of interest rate parity over the long run.
- PC1s of each currency basket have significant correlations to their respective USD-crosses. It allows to condense our study from currency baskets to USD/FX alone.





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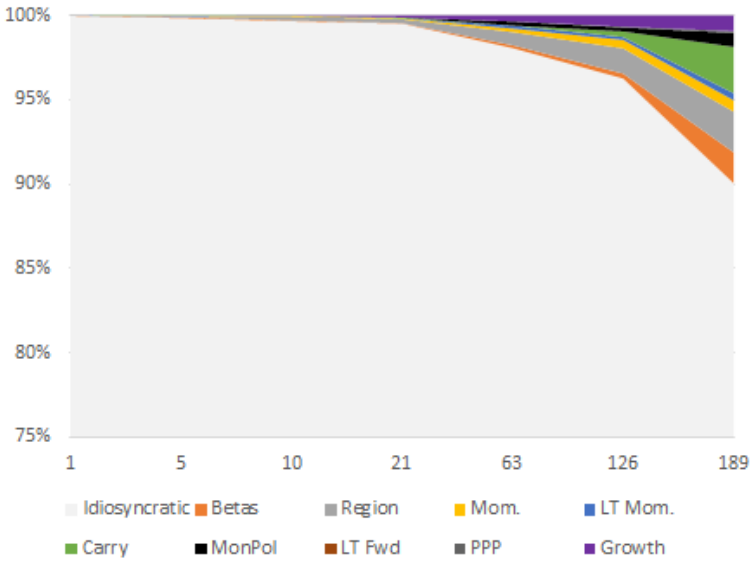
2. Drivers of FX returns (2)

Identify drivers through panel regressions

- To identify the drivers over short, medium and long-term horizons.
- The candidates are:
  - The market factor – represented by the PC1 of a USD/FX basket.
  - A sentiment factor – represented by a basket of USD/FX implied volatilities.
  - Region, and trade balance – represented by dummy variables.
  - A price action factor – currency returns orthogonal to the market factor.
  - A long-term price action factor – 5-year orthogonalised currency returns.
  - A carry factor – percentage distance between 6-month forward and spot.
  - A monetary policy factor – change in nominal 6-month rates.
  - The long-term forward – as a measure of currency valuation.
  - Purchasing Power Parity (PPP) – as estimated by BIS.
  - A macroeconomic growth factor – proxied by our Nowcast Beat indicators .
- Most of the systematic variations in the asset class is not predicted by the regressors chosen.
- The "Carry" factor is the important driver across horizons. Other drivers become increasingly relevant under longer horizons.

Marginal Explanatory power per driver



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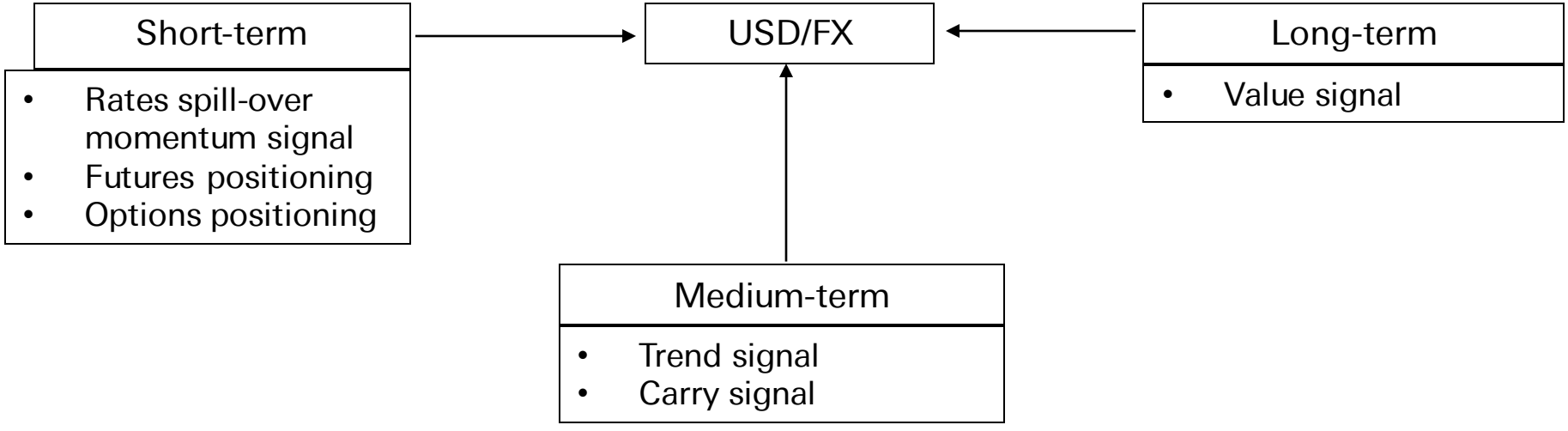
2. Drivers of FX returns (3)

Driving factors summarized

- Market, Sentiment and price-action factors - captured through our Momentum and Positioning signal using both price and non-price data.
- Carry factor - validated by both PCA and panel regressions. It would be captured through our Carry signal.
- Monetary policy factor - characterised as the spill-over from rates momentum into FX momentum. It is exploited through our Rates spill-over momentum signal.
- PPP, long-term interest rate parity and long-term past returns – captured through our Value signal.



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3. Dissecting Time-series vs. Cross-sectional drivers

3. Dissecting time-series vs. cross-sectional drivers (1)

- Inspired by the analytical framework by Hassan and Mano (2013) to better understand the source of predictability.

- Our metrics to estimate signal predictability
  - Cross-sectional predictability:
    - Go long in currencies with high value of signal relative to cross-sectional median in t.

$$\tilde{S}_t^i = S_t^i - median(S_t)$$

$$\tilde{S}_t^i = \frac{\tilde{S}_t^i}{\sum_{j=1}^{N}\left|\tilde{S}_t^j\right|}$$

$$IC^{CS} = E[rx_{t+1}^i \tilde{S}_t^i]$$

$$HR^{CS} = E[sign(rx_{t+1}^i) sign(\tilde{S}_t^i)]$$

  - Time-series predictability
    - Go long in currencies that have positive value of signal or short otherwise.

$$\tilde{S}_t^i = \frac{S_t^i}{\sum_{j=1}^{N}\left|S_t^j\right|}$$

$$IC^{TS} = E[rx_{t+1}^i \tilde{S}_t^i]$$

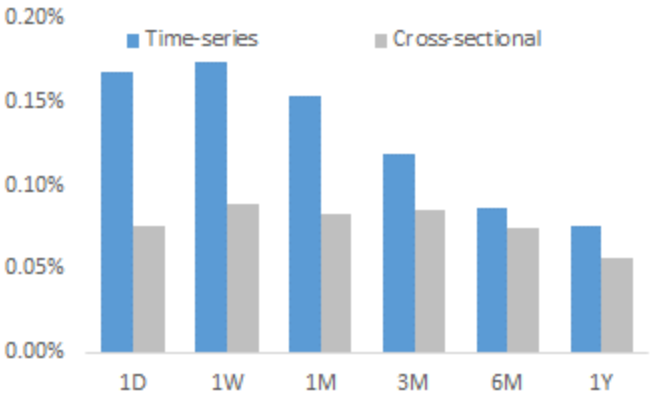
$$HR^{TS} = E\left[sign(rx_{t+1}^i) sign(\tilde{S}_t^i)\right]$$

rx_{t+1}^i: excess return on currency i over next period, *t+1*.

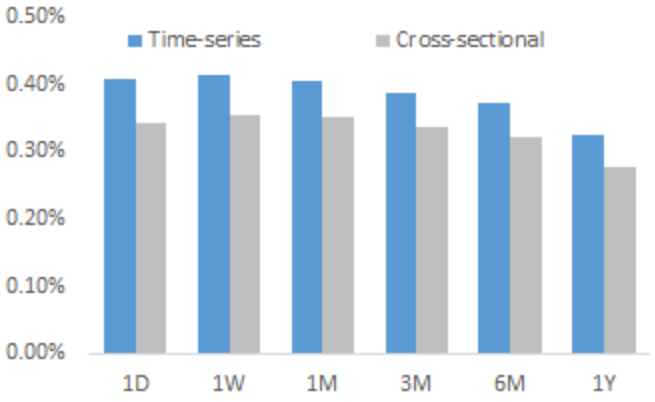
S_t^i: signal of currency *i* at time *t*.

3. Dissecting time-series vs. cross-sectional drivers : Results (2)

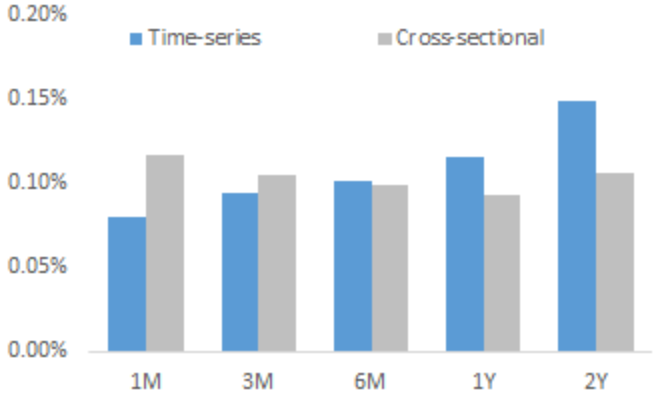
Momentum



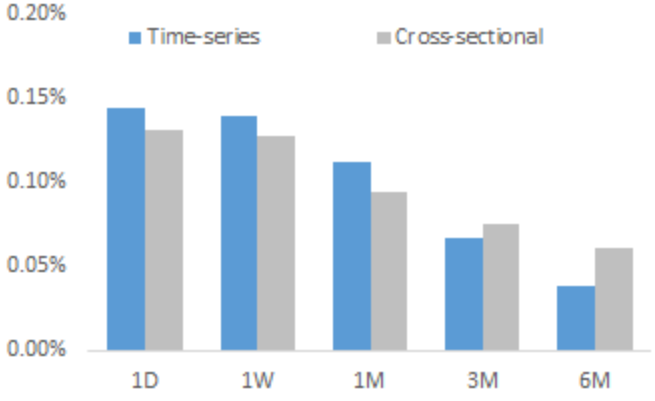
Carry



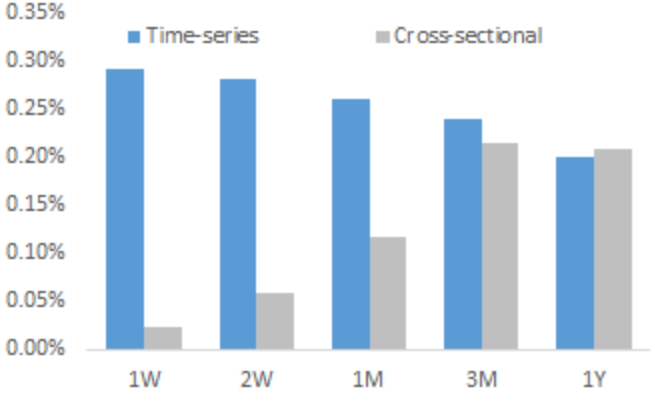
Value



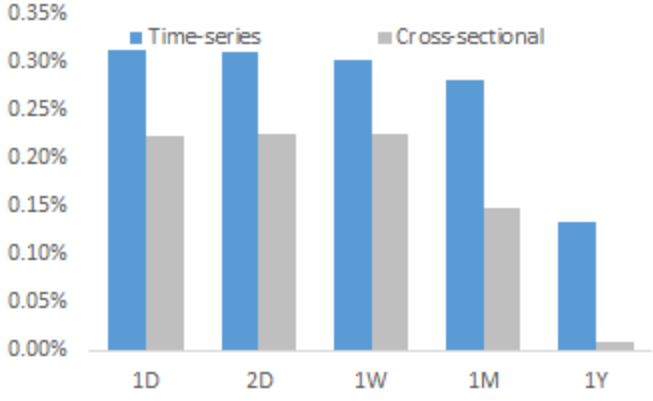
Rates spill-over momentum



Positioning- Futures



Positioning- Options



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3. Dissecting time-series vs. cross-sectional drivers : Results (3)

- "Carry" has the highest predictive power across horizons and implementation approach.
- Predictive power of the signals declines with horizon except in "Value".
- The "Trend" signal has better predictive power in time-series approach than in cross-sectional approach.
- The predictive power of Rates spill-over momentum, Futures and Options positioning signals decay faster relatively to other signals.
- Non-price based signals have better predictive power than that of price-based momentum signal.

4. FX Trend

4. FX Trend (1)

- Captures price continuation over multi-week, multi-month periods.

- Signal: aggregates the sign (+1 or -1) of changes in asset price over each day from 1-month to 1-year, i.e., 232 days.

$$s_{h,t}^{i} = sign\left(r_{t-h,t}^{i}\right)$$

$$S_{i}^{Tr} = \frac{\sum_{h=21}^{h=252} s_{h,t}^{i}}{232}$$

- The sign of the returns is more valuable than its size.

- Represents trends from short, medium and long term.

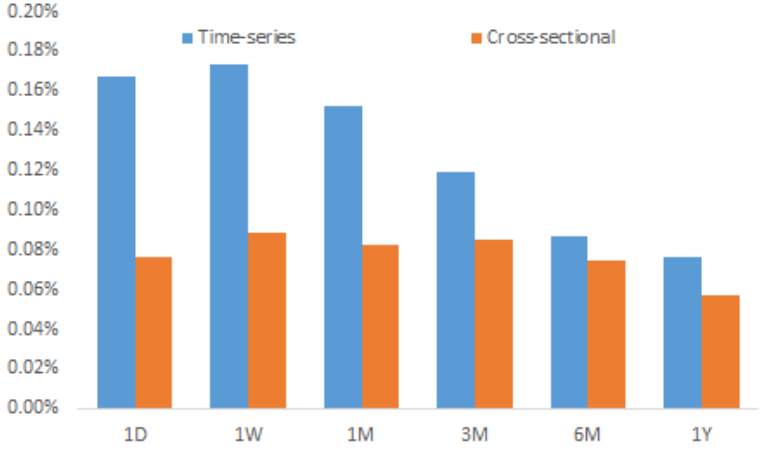
- Noise control:
  - Hysteresis-based threshold mechanism

$$S_t^i = S_{t-1}^i, if \left|S_t^i\right| < 1/3$$

  - Deflating the positions by its dispersion

$$w_t^i = \frac{w_t^i}{\sigma s_t^i}, \sigma s_t^i = std(s_{h,t}^i)$$

Modified information coefficient



4. FX Trend (2)

- Impulse-response function applied to the US dollar.

$r_{t+h1} = \alpha + \beta * r_{t-h2} + \epsilon, where\ h1, h2\ \epsilon [1w, 5y]$

$t\_stat = \beta / se_{\beta}$

r_{t+h1}: return on the dollar over look-ahead horizon *h1*

r_{t-h2}: return on the dollar over look-back window *h2*

  - The dollar exhibits trend across short and medium term horizon.
  - Exhibits reversal properties when the moves are evaluated relative to a long term history.

	1W	2W	3W	1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M	1Y	2Y	3Y	4Y	5Y
1W	1.19	1.3	1.96	2.3	3.14	2.68	2.91	2.26	2.22	2.01	1.47	1.65	1.66	1.77	1.93	1.71	1.23	1.14	0.78
2W	0.91	1.44	1.89	2.36	2.78	2.63	2.63	2.15	2.07	1.79	1.43	1.48	1.58	1.75	1.84	1.73	1.21	1.06	0.73
3W	1.16	1.54	2.03	2.37	2.51	2.66	2.46	2.06	1.94	1.6	1.38	1.41	1.55	1.77	1.74	1.72	1.22	0.99	0.69
1M	1.11	1.64	2.02	2.27	2.27	2.54	2.29	1.87	1.79	1.37	1.32	1.32	1.5	1.71	1.6	1.66	1.19	0.89	0.62
2M	1.07	1.37	1.51	1.61	1.89	1.95	1.64	1.43	1.2	0.99	0.99	1.1	1.3	1.37	1.28	1.5	1.03	0.64	0.43
3M	0.77	1.1	1.34	1.49	1.6	1.51	1.31	1.05	0.91	0.79	0.86	1.02	1.13	1.14	1.05	1.35	0.87	0.46	0.33
4M	0.74	0.96	1.1	1.21	1.21	1.18	0.96	0.76	0.68	0.68	0.79	0.88	0.95	0.94	0.86	1.2	0.71	0.33	0.22
5M	0.56	0.76	0.91	1	1.03	0.88	0.69	0.57	0.56	0.61	0.7	0.78	0.82	0.79	0.72	1.11	0.62	0.22	0.13
6M	0.48	0.63	0.7	0.76	0.76	0.71	0.57	0.51	0.55	0.57	0.63	0.68	0.7	0.68	0.61	1.02	0.53	0.13	0.07
7M	0.42	0.56	0.62	0.63	0.61	0.6	0.58	0.55	0.54	0.54	0.56	0.58	0.6	0.59	0.54	0.94	0.45	0.07	0
8M	0.29	0.42	0.48	0.53	0.55	0.58	0.56	0.52	0.52	0.52	0.54	0.56	0.57	0.56	0.56	0.87	0.41	0.05	-0
9M	0.34	0.39	0.42	0.47	0.53	0.65	0.66	0.65	0.65	0.64	0.65	0.64	0.61	0.6	0.58	0.83	0.41	0.05	-0.1
10M	0.29	0.39	0.47	0.52	0.57	0.58	0.54	0.51	0.49	0.49	0.51	0.53	0.57	0.57	0.57	0.74	0.38	0.02	-0.2
11M	0.3	0.41	0.47	0.53	0.56	0.59	0.56	0.54	0.55	0.54	0.55	0.58	0.59	0.59	0.58	0.68	0.37	-0	-0.3
1Y	0.26	0.38	0.43	0.48	0.53	0.54	0.49	0.46	0.46	0.46	0.5	0.55	0.59	0.62	0.63	0.61	0.34	-0	-0.3
2Y	0.23	0.29	0.32	0.37	0.42	0.47	0.44	0.42	0.4	0.37	0.34	0.33	0.31	0.27	0.24	0.12	-0.2	-0.5	-0.9
3Y	0.12	0.18	0.18	0.19	0.22	0.25	0.25	0.23	0.24	0.22	0.22	0.22	0.21	0.21	0.21	-0.1	-0.5	-0.8	-1
4Y	0.09	0.12	0.13	0.11	0.06	0.05	0.03	0	-0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.5	-0.7	-0.9
5Y	0.01	-0	-0	-0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.4	-0.4	-0.5	-0.7

- Impulse-response function applied to the residual returns.

$res_t^i = r_t - (\beta_t r_t^d + \alpha_t)$

β_t, α_t: slope and constant estimated by regressing daily return on a currency with the dollar over 1-year look-back on a rolling-basis

  - Existence of slight idiosyncratic momentum in FX.

	1W	2W	3W	1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M	1Y	2Y	3Y	4Y	5Y
1W	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.5	0.4	0.5	0.6	0.4	0.3	0.1	0.0	-0.1	0.1	-0.1	-0.3
2W	0.8	0.9	0.8	0.8	0.9	0.9	0.7	0.5	0.5	0.5	0.5	0.4	0.3	0.0	0.0	0.0	0.1	-0.2	-0.2
3W	0.8	0.8	0.8	0.8	0.9	0.9	0.6	0.5	0.4	0.5	0.5	0.4	0.2	0.0	-0.1	-0.1	0.1	-0.2	-0.2
1M	0.9	0.8	0.8	0.9	0.9	0.8	0.6	0.5	0.5	0.6	0.4	0.4	0.2	0.0	0.0	0.0	0.1	-0.2	-0.2
2M	0.9	0.9	0.9	0.9	0.9	0.7	0.6	0.6	0.6	0.6	0.5	0.4	0.2	0.1	0.0	0.0	0.1	-0.1	-0.2
3M	0.9	0.9	0.9	0.9	0.8	0.7	0.6	0.6	0.7	0.6	0.5	0.4	0.2	0.1	0.0	0.0	0.2	-0.1	-0.1
4M	0.9	0.9	0.9	0.9	0.8	0.7	0.7	0.7	0.6	0.6	0.4	0.3	0.2	0.1	0.0	0.0	0.2	-0.1	0.0
5M	0.9	0.9	0.9	0.9	0.8	0.7	0.7	0.6	0.6	0.5	0.4	0.3	0.2	0.0	0.0	0.0	0.2	-0.1	0.0
6M	0.9	0.9	0.9	0.8	0.7	0.7	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0	-0.1	0.1	0.1	-0.2	0.0
7M	0.9	0.9	0.9	0.8	0.7	0.7	0.6	0.5	0.4	0.4	0.3	0.2	0.1	0.0	-0.1	0.1	0.1	-0.2	0.0
8M	0.9	0.9	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.3	0.2	0.2	0.1	-0.1	-0.1	0.2	0.1	-0.1	0.1
9M	0.9	0.9	0.8	0.8	0.7	0.6	0.5	0.5	0.4	0.3	0.2	0.1	0.0	-0.1	-0.1	0.2	0.1	-0.1	0.0
10M	0.9	0.8	0.8	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.0	-0.1	-0.1	0.2	0.1	0.0	0.0
11M	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.3	0.3	0.1	0.0	-0.1	-0.1	0.0	0.2	0.1	0.1	0.0
1Y	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.4	0.3	0.2	0.1	0.0	-0.1	-0.1	0.0	0.3	0.0	0.1	0.0
2Y	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
3Y	0.5	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.4
4Y	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.2
5Y	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.2	0.2	0.0

4. FX Trend - Weighting schemes (3)

Time-series implementation

- Initial weight of a currency is estimated by adjusting the sign of signal by its volatility and signal dispersion

$$w_i = sign(s_i^{Tr})/(\sigma s_i * \sigma_i)$$

- Final weight of the currency is obtained by normalising the weights so that the gross sum is 100%.

$$w_i = w_i / \sum_{j=1}^{N} |w_j|$$

Cross-sectional implementation

- Rank the currencies on basis of the trend signals estimated from their residual returns.
- Long top half and sell bottom half, and assign equal weights so that gross sum is 100%.
- Re-adjust the weights such that net beta to the dollar is zero.

$$Arg_w^{min}(\tilde{w} - w)'(\tilde{w} - w)$$

$$s.t\ w'\beta_{USD} = 0$$

$\tilde{w}$ is Nx1 vector of currencies initial weights

β_{USD} is Nx1 vector of currencies beta to the dollar

4. FX Trend – Portfolio rebalancing and tranching (4)

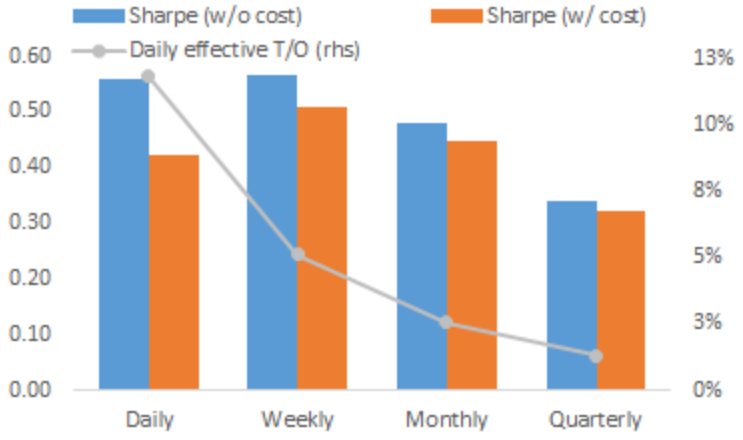
- Signal predictive power vs. Turnover (or cost)

- Portfolio
  - Rebalance frequency: Daily, Weekly, Monthly, and Quarterly
  - Tranching: Daily

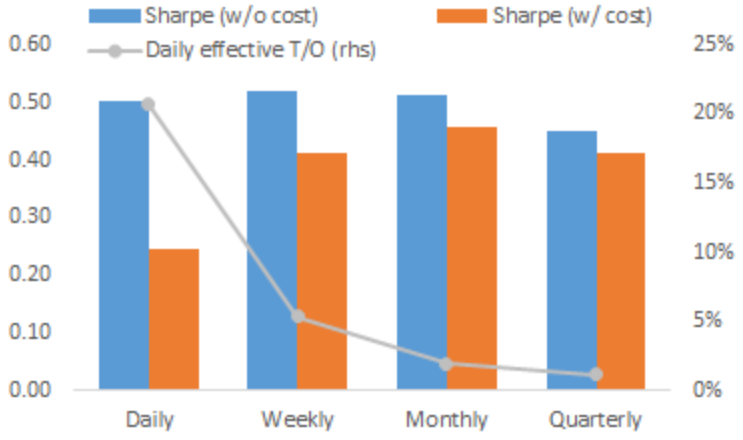
- Time-series: Monthly.

- Cross-sectional: Monthly. To reduce the turnover costs.

Time-series



Cross-sectional



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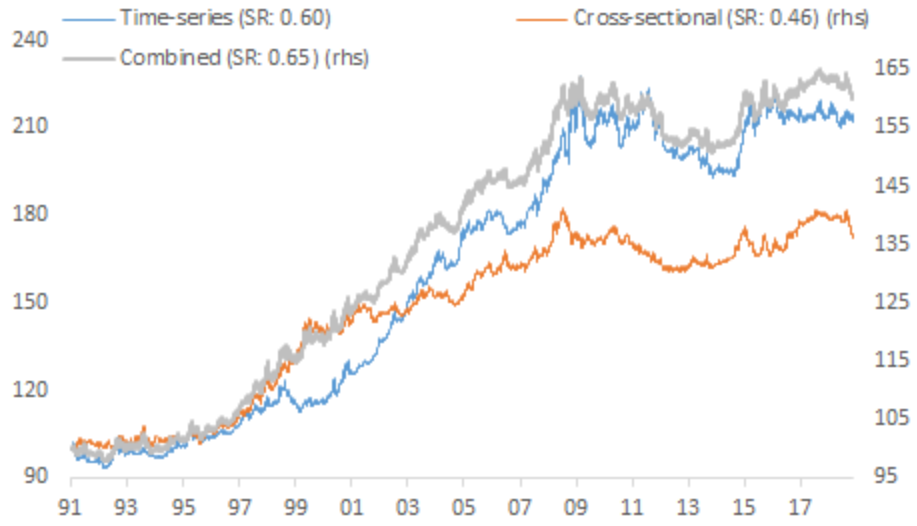
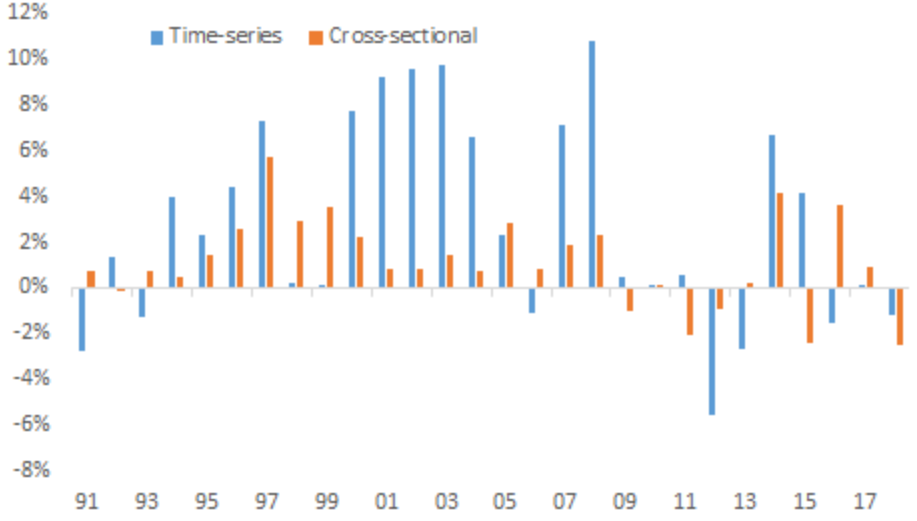
4. FX Trend – Results (5)

Performance

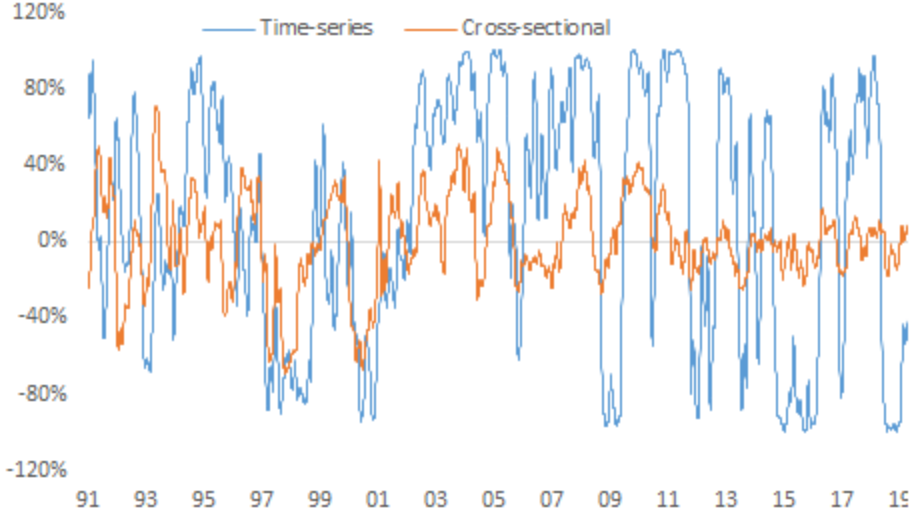


Correlations to the dollar

Yearly returns



Net positions



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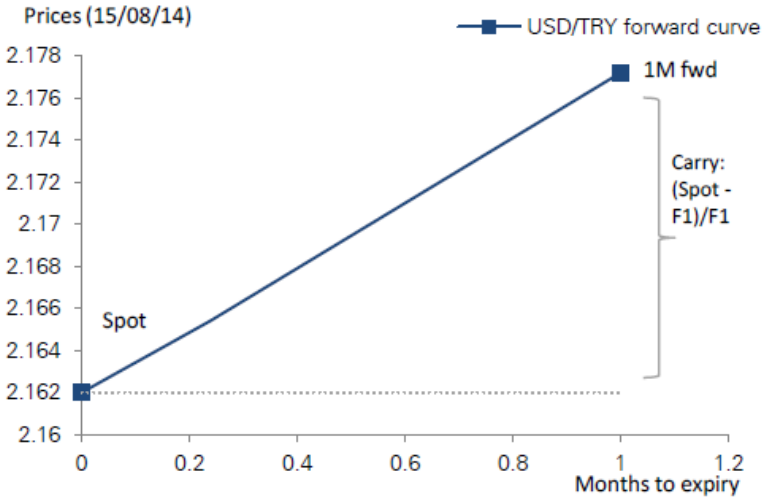
5. FX Carry

5. FX Carry (1)

- Captures the empirical failure of the uncovered interest-rate parity (UIP).

- Signal: Interest rate differentials implied from 1M forward contract.

$$s_t^i = (S_t^i - F_t^i)/F_t^i$$
$$S_i^{Cr} = \sum_{h=0}^{N-1} s_{t-h}^i / N$$
$$S_i^{Cr} = S_i^{Cr}/\sigma_i$$



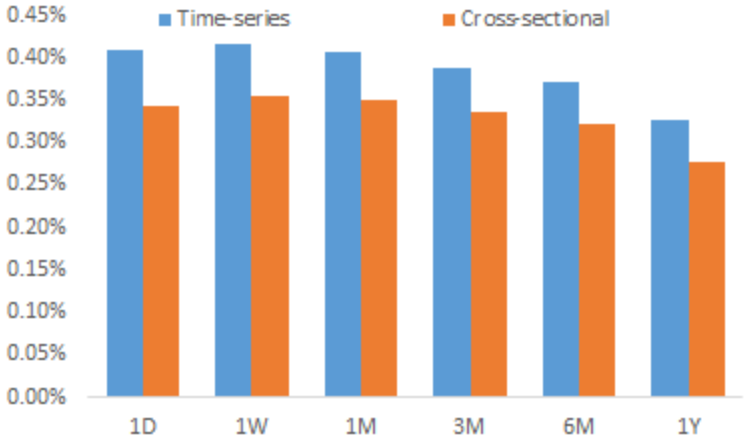
- Both sign and size of the signal are valuable.

- Good predictive power across horizons

- Noise control:
  - Average of carry estimates over 1-month

$$S_i^{Cr} = \sum_{h=0}^{N-1} s_{t-h}^i / N$$

Modified information coefficient



5. FX Carry - Weighting scheme (2)

Time-series implementation – buy currencies that have positive carry w.r.t the dollar and sell that have negative carry w.r.t the dollar.

- Initial weight of a currency is risk-adjusted carry

  $w^i = s_i^{Cr}$

- Final weight of the currency is obtained by normalising the weights so that the gross sum is 100%.

  $w_t^i = w_t^i / \sum_{j=1}^{N} |w_t^j|$

Maximum risk-adjusted carry implementation- buy and sell currencies such that the risk-adjusted carry of the portfolio is maximised with a condition that its dollar-beta is zero.

$$Arg_w^{max} w'C / w'\Sigma w$$

$$w'\beta_{USD} = 0$$

$$\sum_{i=1}^{N} |w^i| = 1$$

$$w^L \leq w^i \leq w^U$$

$\tilde{C}$ is Nx1 vector of carry estimates

β_{USD} is Nx1 vector of currencies beta to the dollar

5. FX Carry – Portfolio rebalancing and tranching (3)

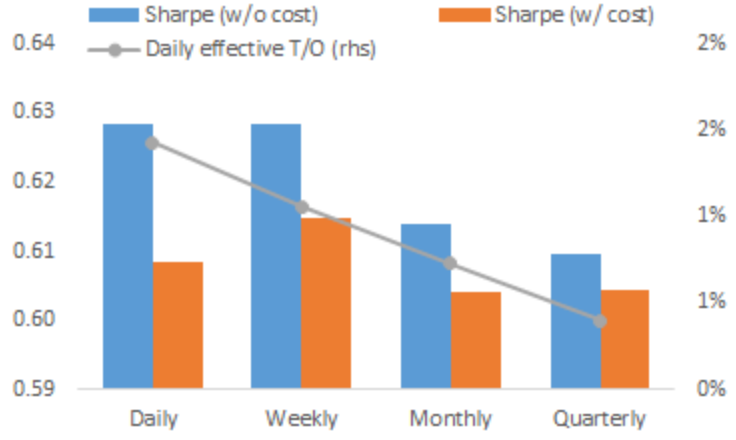
- Signal predictive power vs. Turnover (or cost)

- Portfolio
  - Rebalance frequency: Daily, Weekly, Monthly, and Quarterly.
  - Tranching: Daily.

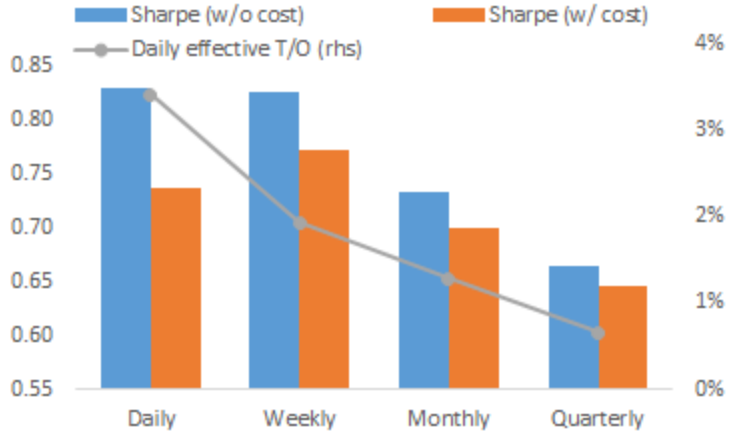
- Time-series: Monthly. Primarily to reduce the costs associated with turnovers.

- Max Sharpe portfolio: Monthly. Primarily to reduce the effect of noise.

Time-series



Max Sharpe Portfolio



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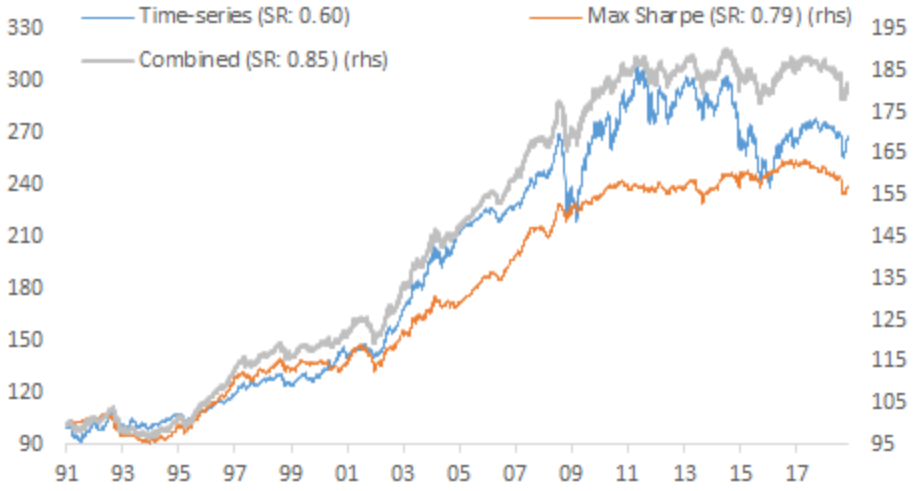
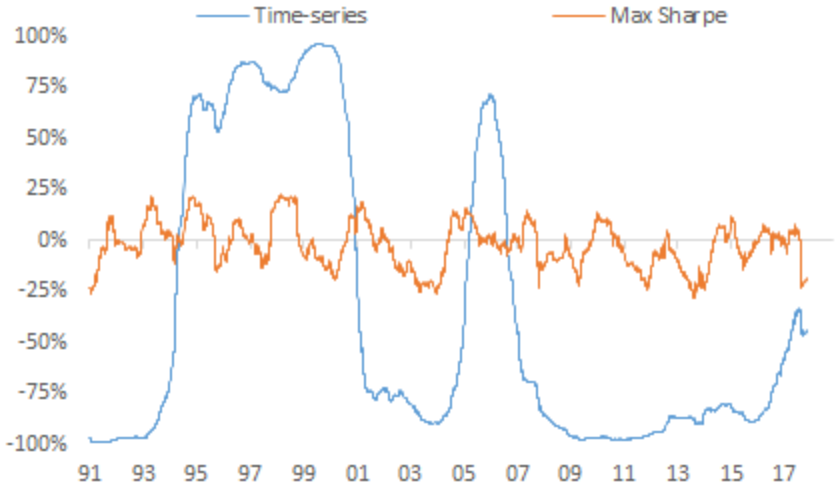
5. FX Carry – Results (4)

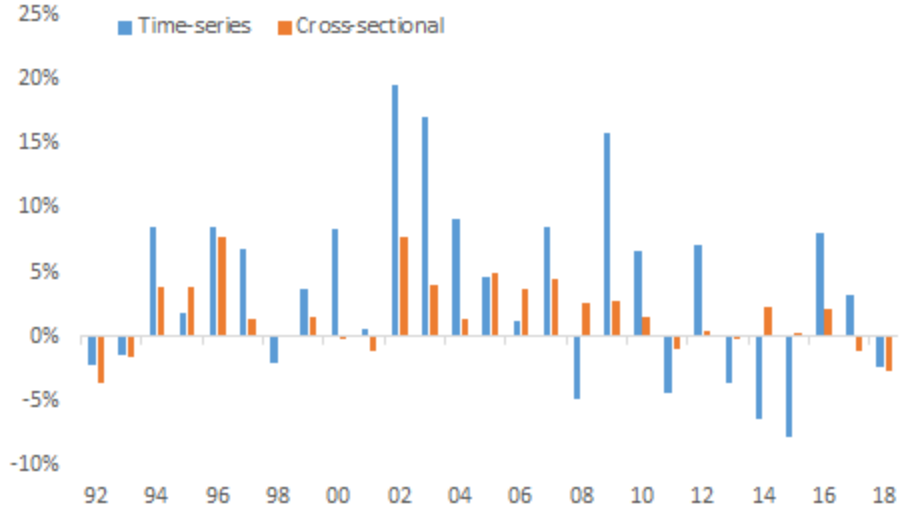
Performance



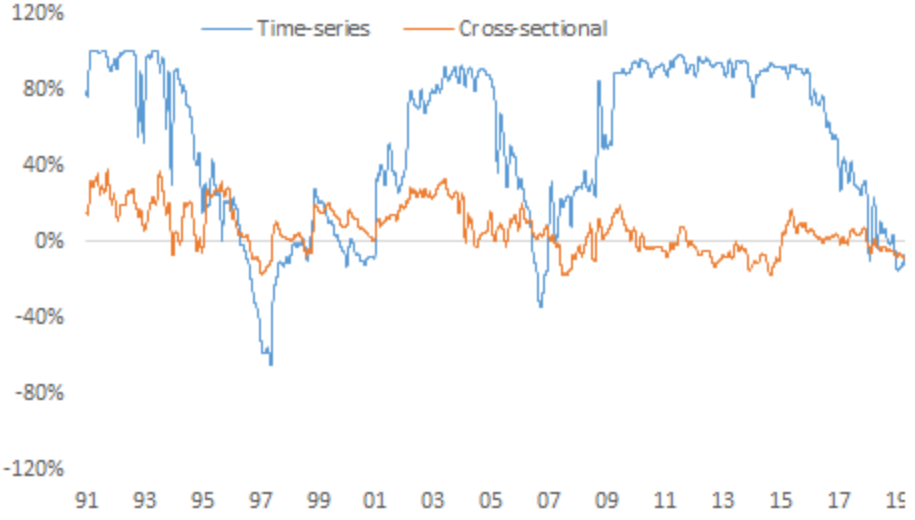
Correlations to the dollar



Yearly returns



Net positions



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6. FX Value

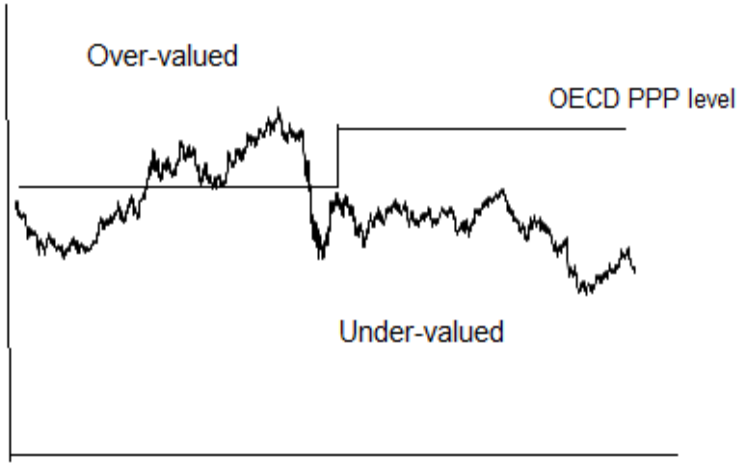
6. FX Value (1)

- Captures the reversals to a fundamental fair value over the long term.

- Signal: distance between the fair price, $\tilde{P}$, and the current market price, P.

$$S_i^{Vl} = \frac{\tilde{P}^i}{P^i} - 1$$

$$S_i^{Vl} = S_i^{Vl}/\sigma_i$$



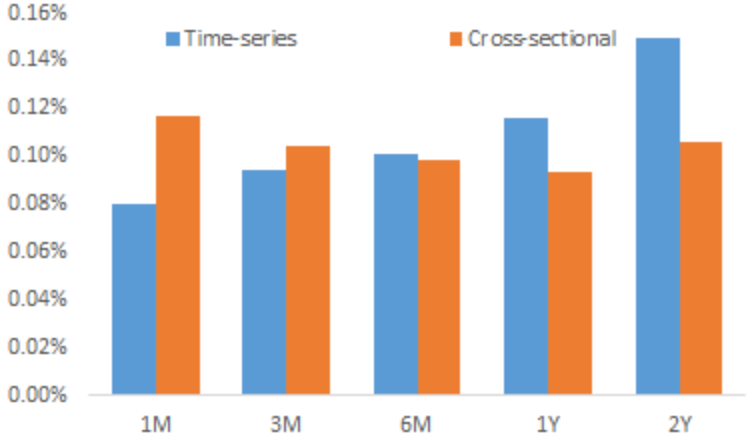
- Both sign and size of the signal are valuable.

- Slow signal and its predictive power improves with horizon.

- Noise control: not on the signal but on the current estimate of the market price.
  - Average of spot price over 1-month

$$P_i = \sum_{h=0}^{N-1} P_{t-h}^i / N$$

Modified information coefficient



6. FX Value (2)

- Purchasing Power Parity (PPP). It is based on Law of One Price which states that all products must sell at the same prices in a frictionless world.

- Reality: Exchange rate deviate widely and persistently from the ratio of prices. PPP has some validity in the context of developed countries but not in EM currencies.

- Key reason of divergence from PPP: Productivity differentials between countries. As per the "Balassa-Samuelson" effect, countries with faster productivity growth experience real appreciation via non-tradables inflation.

- Current approach: OECD-PPP levels to estimate under- or over-valuations. Applied to G10 currencies only.

- Proposed approach: Productivity-adjusted PPP to estimate valuations. EM currencies are included in the portfolio.

6. FX Value (3)

- Estimate a reduced-form long-run relationship between the real effective exchange rate (REER) and the productivity ratio.

- Model: Panel co-integration regressions with country fixed effects.

$$REER_{i,t} = \alpha_i + \beta_r * PROD_{i,t} + \epsilon_{i,t}$$

for country i, group r, and time t.

$REER_{i,t}$: BIS real broad trade weighted exchange rate (REER)

$PROD_{i,t}$: Ratio of domestic productivity to foreign (trade weighted) productivity. It is proxied by real GDP per capita.

- Fair value of a currency: estimated by plugging the latest value of its productivity ratio in the regression model for the panel that country belongs to.

$$\widehat{REER}_{i,t} = \alpha_i + \beta_r * PROD_{i,t}$$

- Current misalignment: The difference between the fair value and the current price.

$$M_{i,t} = \widehat{REER}_{i,t} - REER_{i,t}$$

- Conversion of REER misalignment to USD-cross misalignments: using average of those obtained using the matrix inversion method and least squares method.

6. FX Value - Weighting scheme (4)

Time-series implementation

- Initial weight of a currency is risk-adjusted currency misalignment.

  $w_i = S_i^{Vl}$

- Final weight of the currency is obtained by normalising the weights so that the gross sum is 100%.

  $w_i = w_i / \sum_{j=1}^{N} |w_j|$

Cross-sectional implementation

- Rank the currencies on the dollar misalignments.
- Long top half and sell bottom half, and assign equal weights so that gross sum is 100%.
- Re-adjust the weights such that net beta to the dollar is zero.

  $Arg_w^{min}(\tilde{w} - w)'(\tilde{w} - w)$

  $s.t\ w'\beta_{USD} = 0$

  $\tilde{w}$ is Nx1 vector of currencies initial weights

  β_{USD} is Nx1 vector of currencies beta to the dollar

6. FX Value – Portfolio rebalancing and tranching (5)

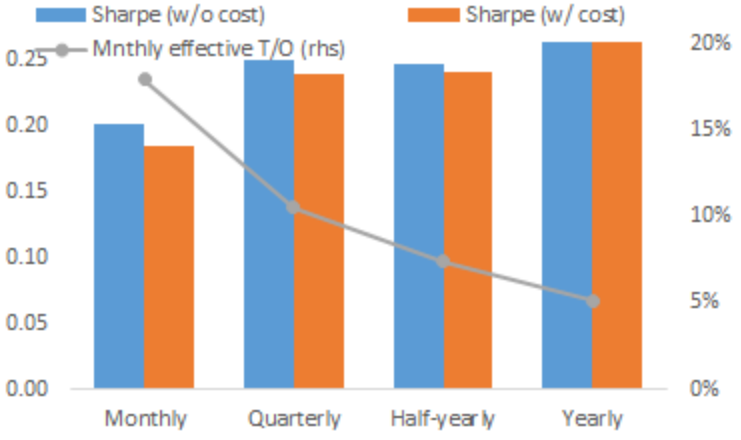
- Signal predictive power vs. Turnover (or cost)

- Portfolio
  - Rebalance frequency: Monthly, Quarterly, Half-yearly, and Yearly.
  - Tranching: Monthly.

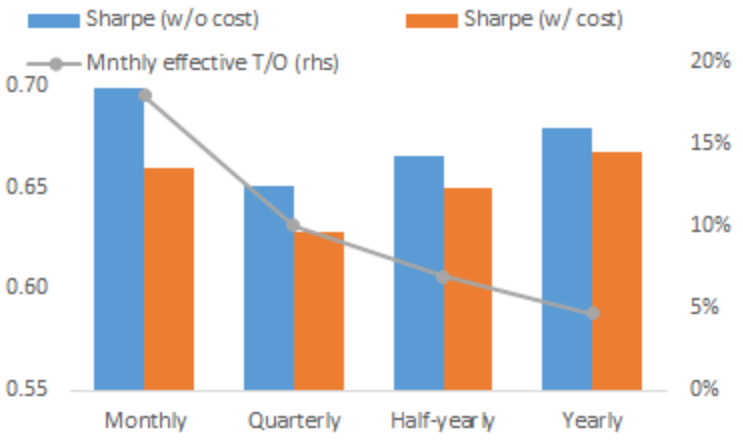
- Time-series: Yearly. Slow signal and closer to its half-life.

- Cross-sectional: Monthly. Primarily to maintain dollar-neutrality.

Time-series



Cross-sectional



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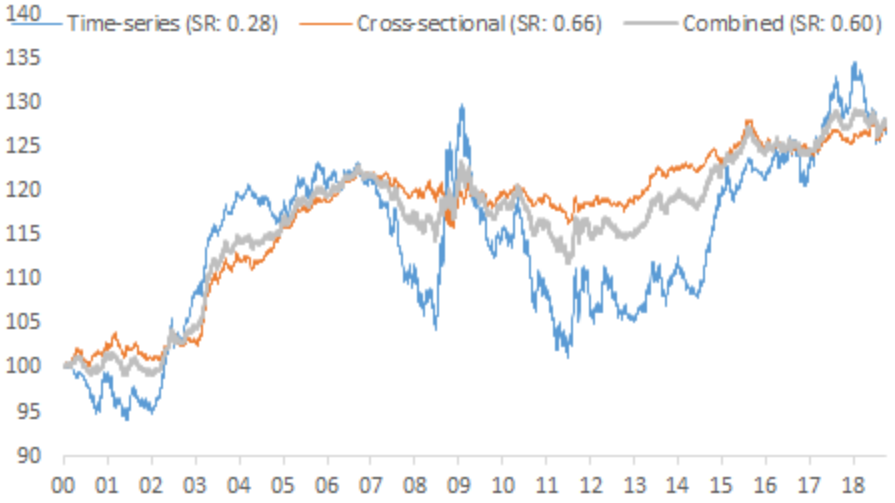
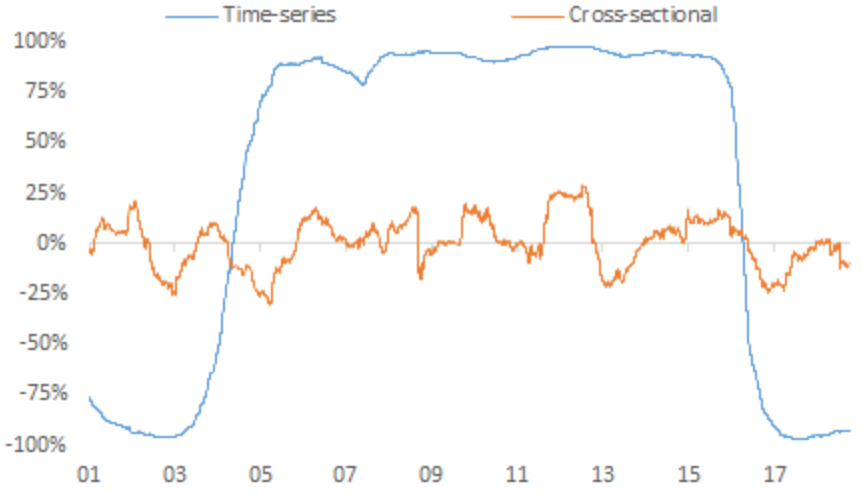
6. FX Value – Results (6)

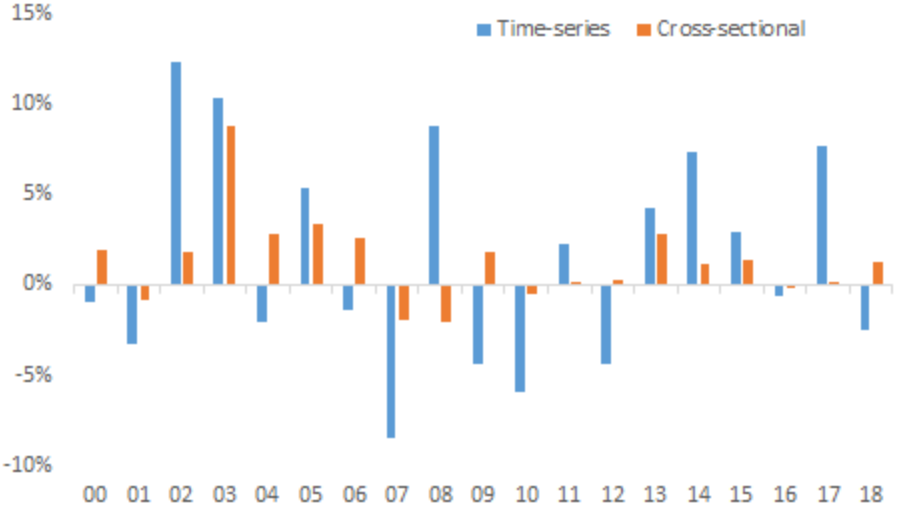
Performance



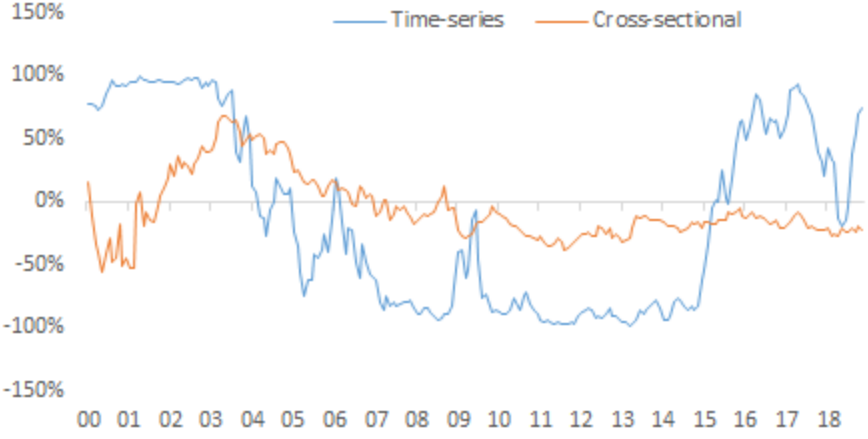
Correlations to the US dollar



Yearly returns



Net positions



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7. Rates spill-over momentum

7. Rates spill-over momentum (1)

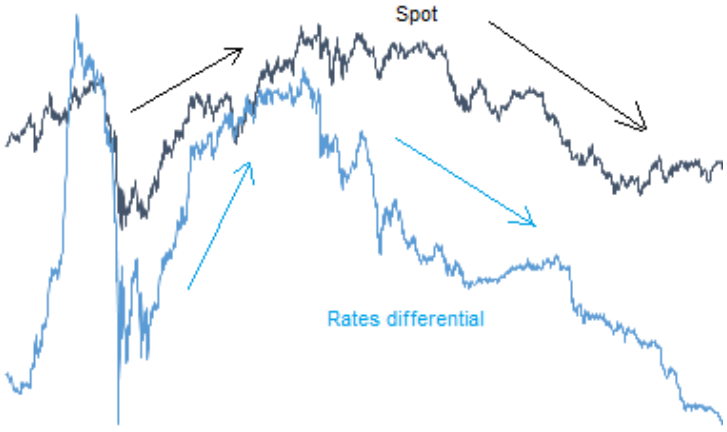
- Captures divergence in monetary policies of different countries.

- Signal: average of volatility-adjusted changes in the 6-month carry of a currency (vs. USD) over one, two, and three months.

$$S_{t,h}^{i} = (C_{t}^{i} - C_{t-h}^{i}) / std(\Delta C_{t \to t-h}^{i}); h = 21,42,63$$

$$S_{i}^{MP} = Avg(S_{t,h}^{i})$$

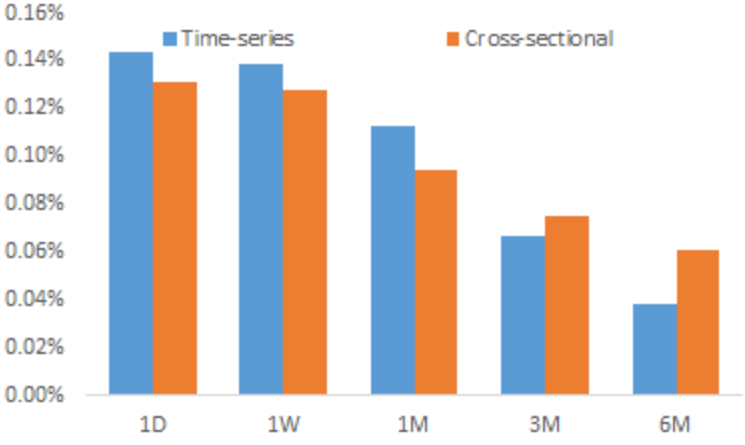
- Fast signal. Its predictive power declines as the horizon grows.



Signal information coefficient

- Filter: To address the effect of country risk premia.

$$if\ \rho_{lag1}^{i}(\Delta C_{t \to t-1Y}^{i}, \Delta s_{t \to t-1Y}^{i}) < 0, S_{i}^{MP} = NaN$$



- Noise control: Average of the signal estimates over 1-month.

$$S_{i}^{MP} = \sum_{h=0}^{T-1} s_{t-h}^{i} / T$$

6. Rates spill-over momentum- Weighting scheme (2)

Time-series implementation

- Initial weight of a currency is risk-adjusted currency misalignment.

  $w^i = sign(S_i^{MP}) x \frac{1}{\sigma_i})$

- Final weight of the currency is obtained by normalising the weights so that the gross sum is 100%.

  $w_i = w_i / \sum_{j=1}^{N} |w_j|$, N is total number of qualified signals.

Cross-sectional implementation

- Rank the ***qualified*** currencies on the rates spill-over momentum signal.
- Long top half and sell bottom half, and assign equal weights so that gross sum is 100%.
- Re-adjust the weights such that net beta to the dollar is zero.

  $Arg_w^{min}(\tilde{w} - w)'(\tilde{w} - w)$

  $s.t\ w'\beta_{USD} = 0$

  $\tilde{w}$ is Nx1 vector of currencies initial weights

  β_{USD} *is Nx1 vector of currencies beta to the dollar*

7. Rates spill-over momentum – Portfolio rebalancing and tranching (3)

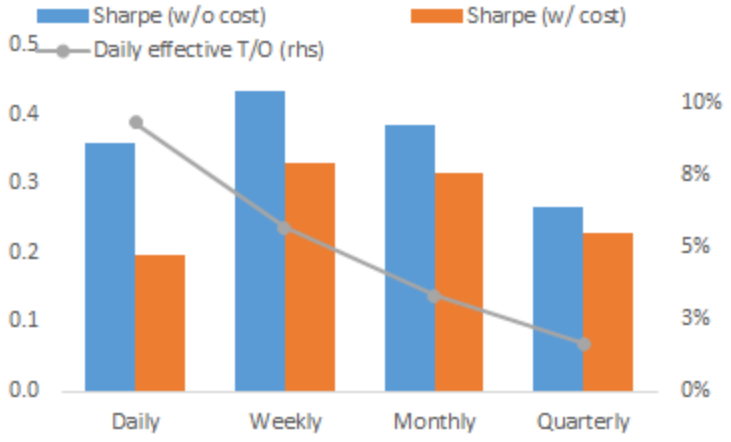
- Signal predictive power vs. Turnover (or cost).

- Portfolio
  - Rebalance frequency: Daily, Weekly, Monthly, and Quarterly.
  - Tranching: Daily.

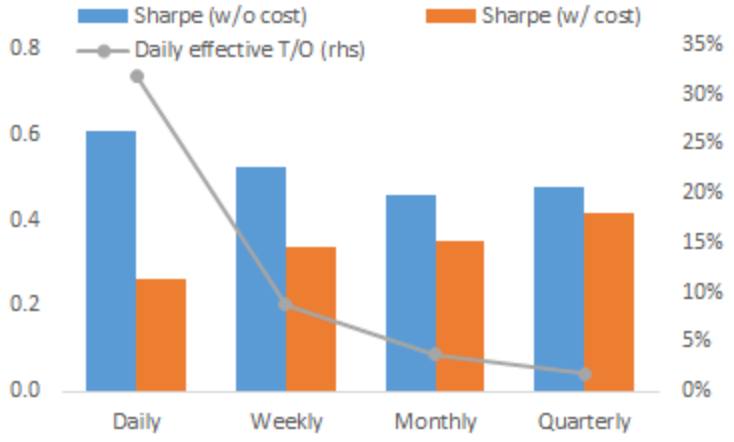
- Time-series: Weekly. Faster signal.

- Cross-sectional: Weekly. Primarily to maintain the dollar-neutrality.

Time-series



Cross-sectional



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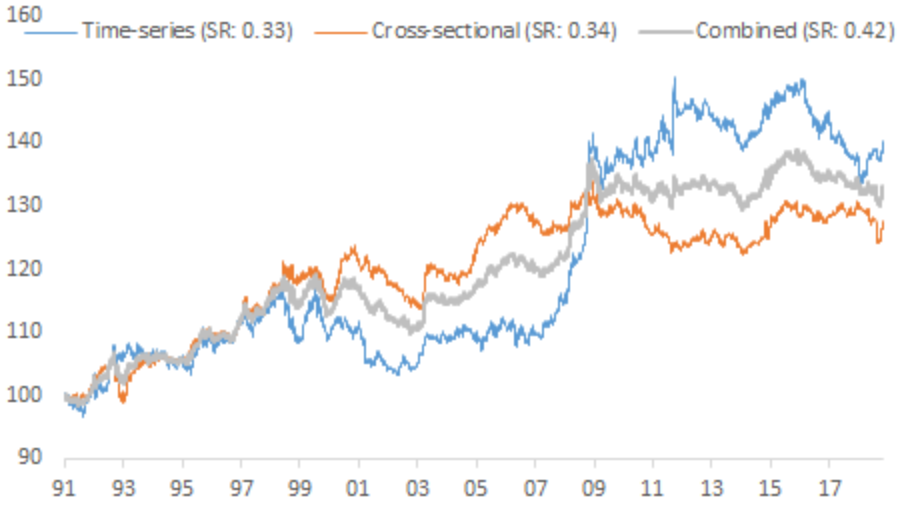
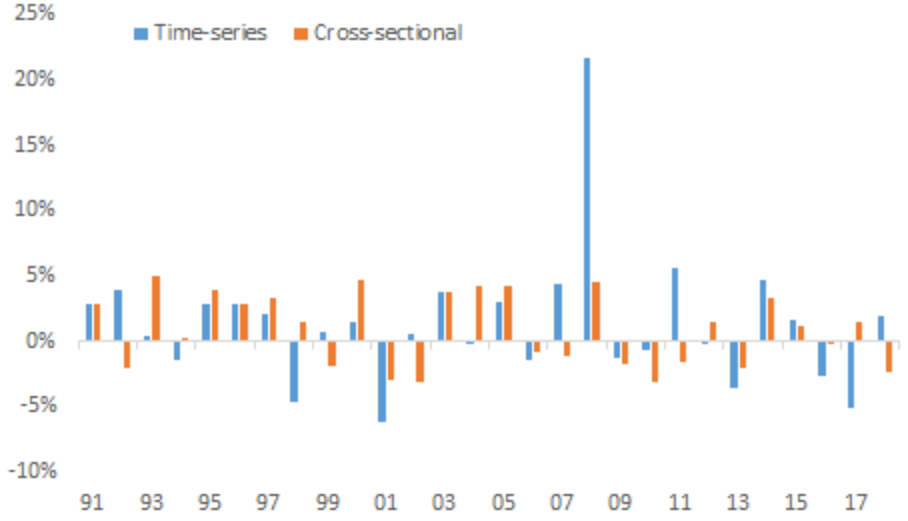
7. Rates spill-over momentum – Results (4)

Performance

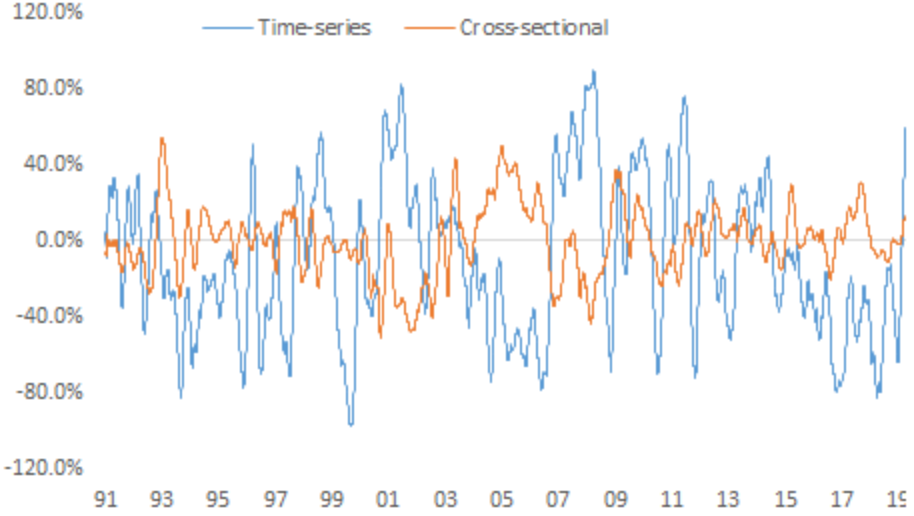


Correlations to the dollar

Yearly returns



Net positions



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8. Positioning- Futures (CFTC)

8. Positioning- Futures (1)

- Captures continuation of price as suggested by net positioning of Non-Commercial participants in futures markets.

- Signal is based on open interest data on exchange-traded currency futures contracts as logged by the Commodity Futures Trading Commission (CFTC)

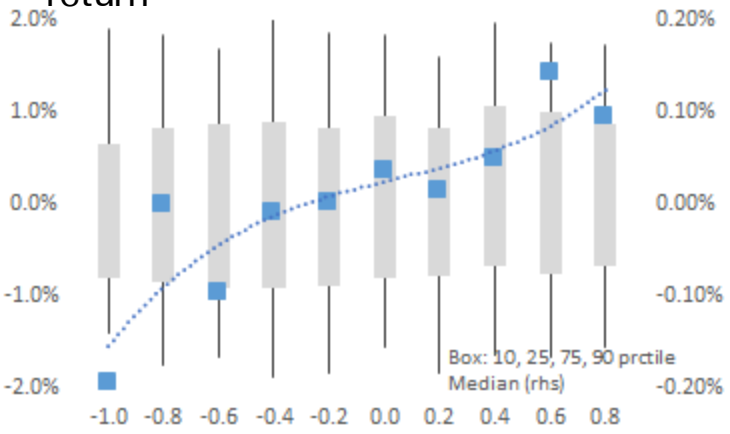
- Signal: Net long positions of Non-Commercial market participants.

$$S_i^{CFTC} = \frac{L_i^{NC} - S_i^{NC}}{L_i^{NC} + S_i^{NC}}$$

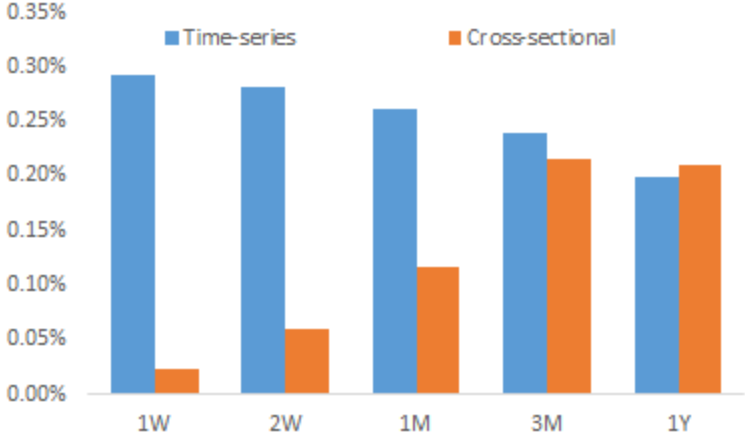
- The predictive power of the signal decays slowly over time in a time-series version, while it improves in the cross-sectional version.

- Noise control: Average of the long and short open interests over 4-weeks.

Relationship: Signal– 1M future return



Modified information coefficient



8. Positioning- Futures: Weighting scheme (2)

Time-series implementation

- Initial weight of a currency is risk-adjusted currency misalignment.

  $w^i = sign(S_i^{CFTC}) x \frac{1}{\sigma_i})$

- Final weight of the currency is obtained by normalising the weights so that the gross sum is 100%.

  $w^i = w^i / \sum_{j=1}^{N} |w^j|$, N is total number of qualified signals.

Cross-sectional implementation

- Rank the currency pairs based on the CFTC signals.
- Long top half and sell bottom half, and assign equal weights so that gross sum is 100%.
- Re-adjust the weights such that net beta to the dollar is zero.

  $Arg_w^{min}(\tilde{w} - w)'(\tilde{w} - w)$

  $s.t\ w'\beta_{USD} = 0$

  $\tilde{w}$ is Nx1 vector of currencies initial weights

  β_{USD} *is Nx1 vector of currencies beta to the dollar*

8. Positioning- Futures: Portfolio rebalancing and tranching (3)

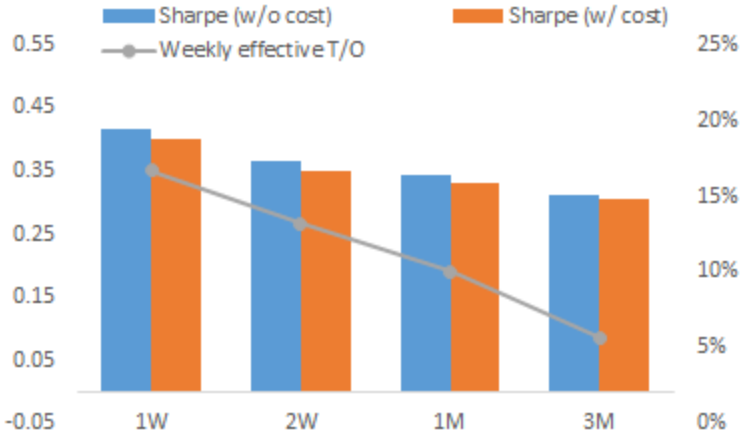
- Signal predictive power vs. Turnover (or cost).

- Portfolio
  - Rebalance frequency: Weekly, Bi-weekly, Monthly, and Quarterly.
  - Tranching: Weekly.

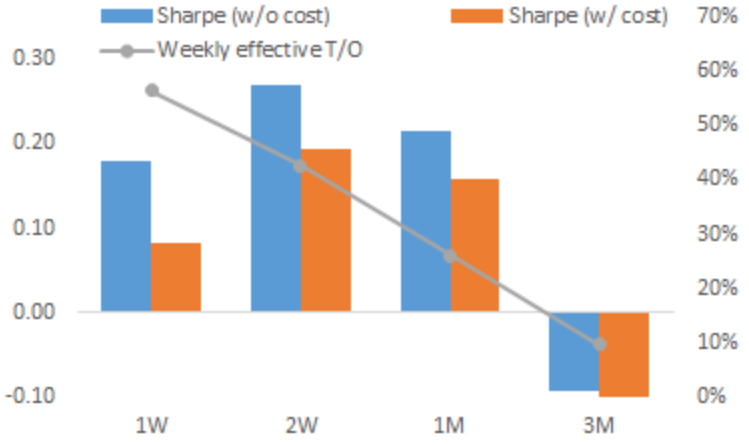
- Time-series: Weekly. Faster signal.

- Cross-sectional: Weekly. Primarily to maintain the dollar-neutrality.

Time-series



Cross-sectional



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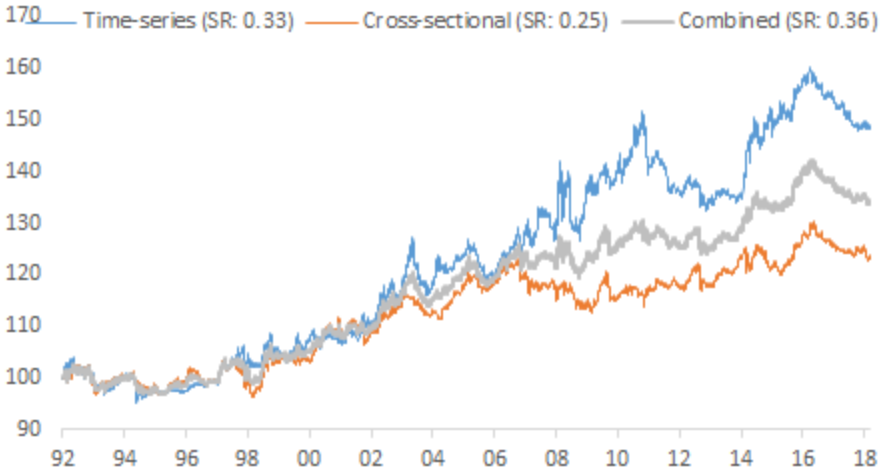
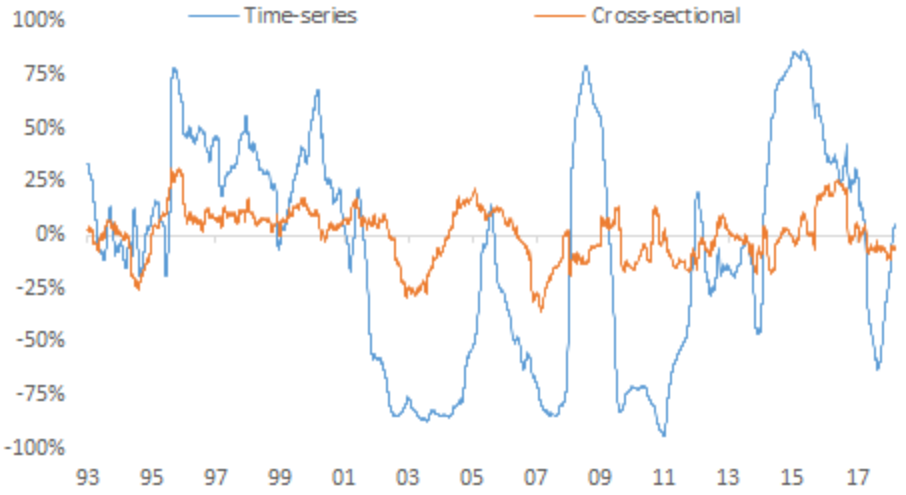
8. Positioning- Futures: Results (4)

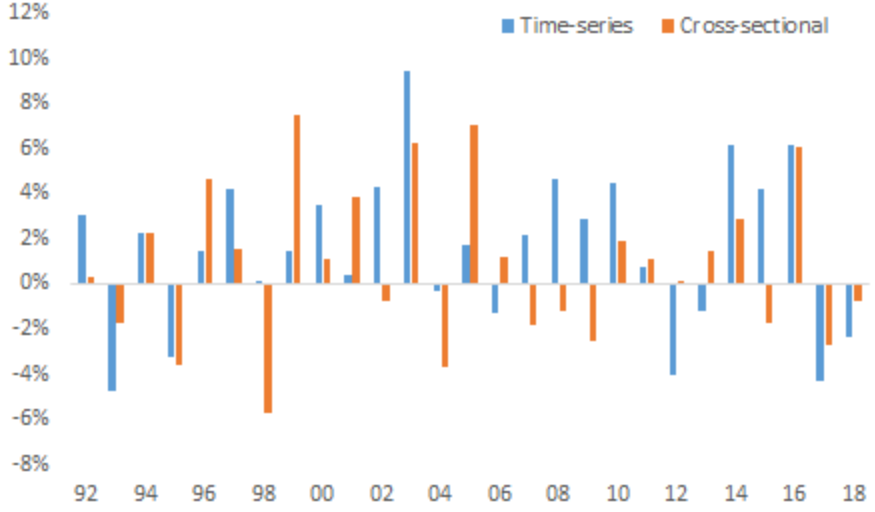
Performance



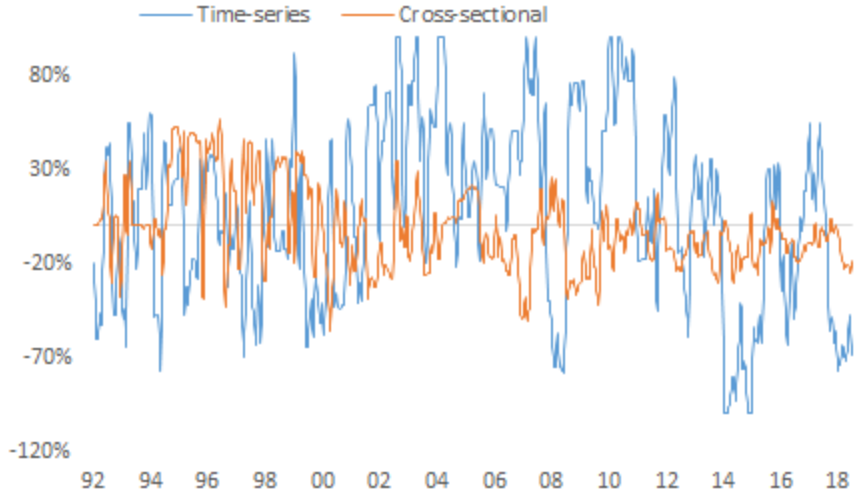
Correlations to the dollar



Yearly returns



Net positions



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9. Positioning- Options (DTCC)

9. Positioning- Options (1)

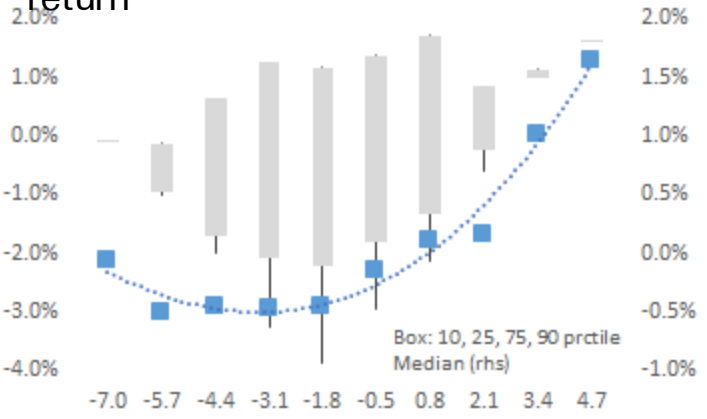
- Captures continuation of price as suggested by net imbalance in positioning of "Speculators" in options markets.

- Signal is based on DTCC options flow data. We base the signals on two key assumptions:
  - "Speculators" favor higher delta strikes (25- 75), while "Hedgers" tend to prefer lower delta options.
  - Most investors are net buyers rather than sellers of options.

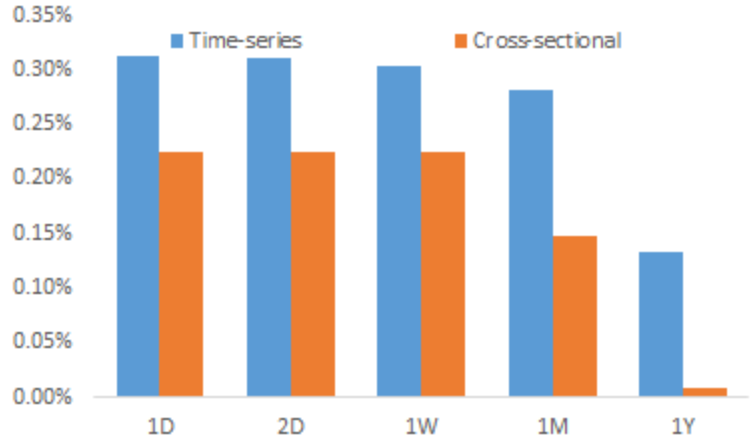
- Signal: Net difference between notional volumes of the calls and puts whose (absolute) deltas range between 0.25 and 0.75 and maturity is less than a year.

- The predictive power of the signal is quite powerful. It is stable over a month-horizon but drops sharply within a year.

Relationship: Signal– 1M future return



Modified information coefficient



9. Positioning- Options: Weighting schemes (2)

Time-series implementation

- Initial weight of a currency is risk-adjusted currency misalignment.

$$w^i = sign\left(S_i^{DTCC}\right)x\frac{1}{\sigma_i})$$

- Final weight of the currency is obtained by normalising the weights so that the gross sum is 100%.

$w^i = w^i / \sum_{j=1}^{N}|w^j|$, N is total number of currencies

Cross-sectional implementation

- Rank the currencies on the DTCC signals.
- Long top half and sell bottom half, and assign equal weights so that gross sum is 100%.
- Re-adjust the weights such that net beta to the dollar is zero.

$$Arg_w^{min}(\tilde{w} - w)'(\tilde{w} - w)$$

$$s.t\ w'\beta_{USD} = 0$$

$\tilde{w}$ is Nx1 vector of currencies initial weights

β_{USD} is Nx1 vector of currencies beta to the dollar

9. Positioning- Options: Portfolio rebalancing and tranching (3)

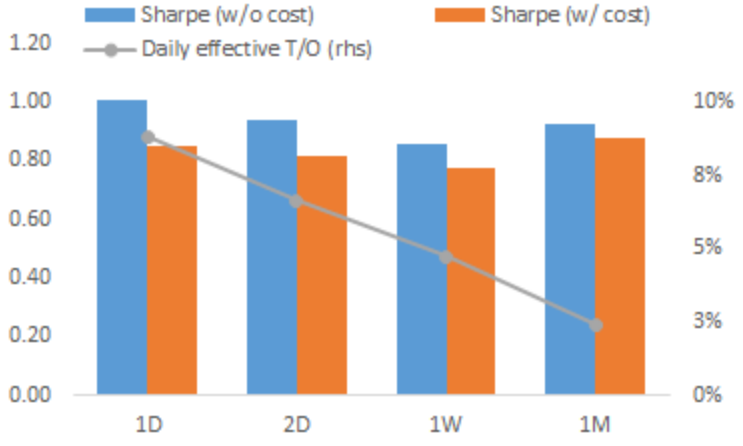
- Signal predictive power vs. Turnover (or cost).

- Portfolio
  - Rebalance frequency: Daily, 2-Day, weekly, and Monthly.
  - Tranching: Daily.

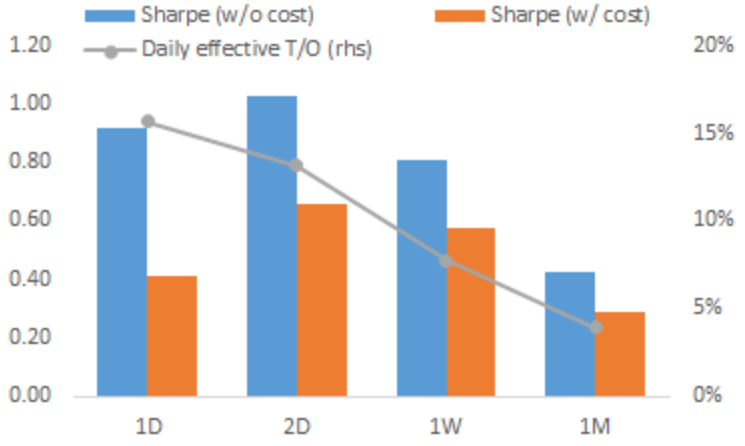
- Time-series: Weekly. Faster signal.

- Cross-sectional: Weekly. Primarily to maintain the dollar-neutrality.

Time-series



Cross-sectional



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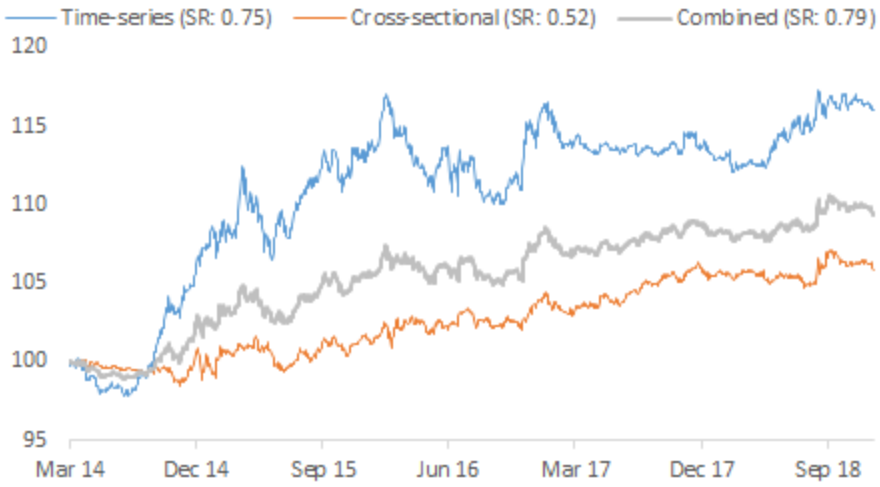
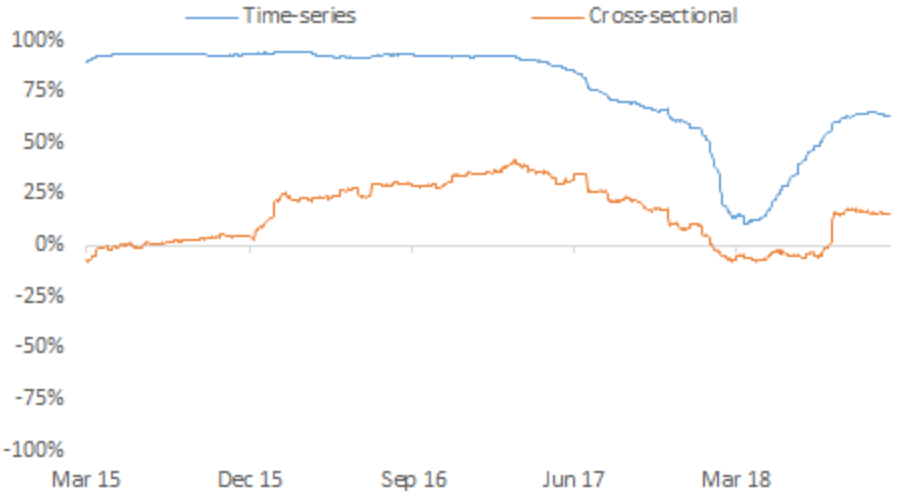
9. Positioning- Options: Results (4)

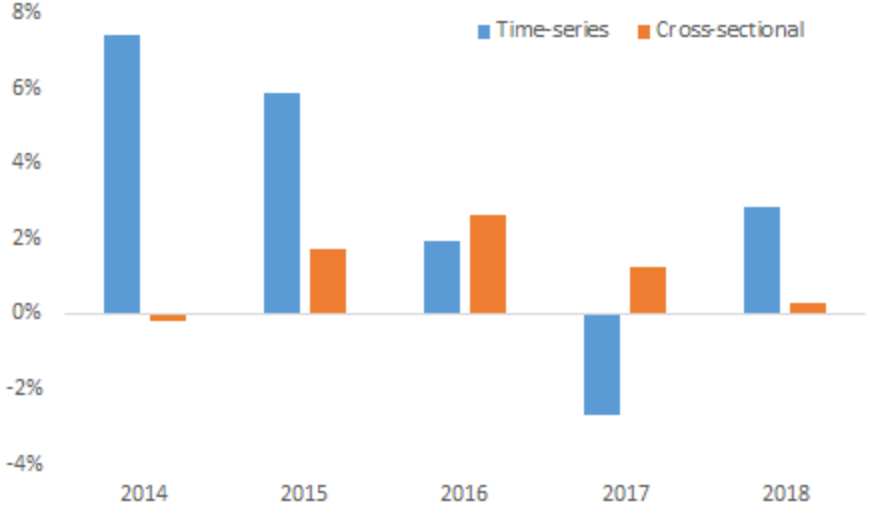
Performance



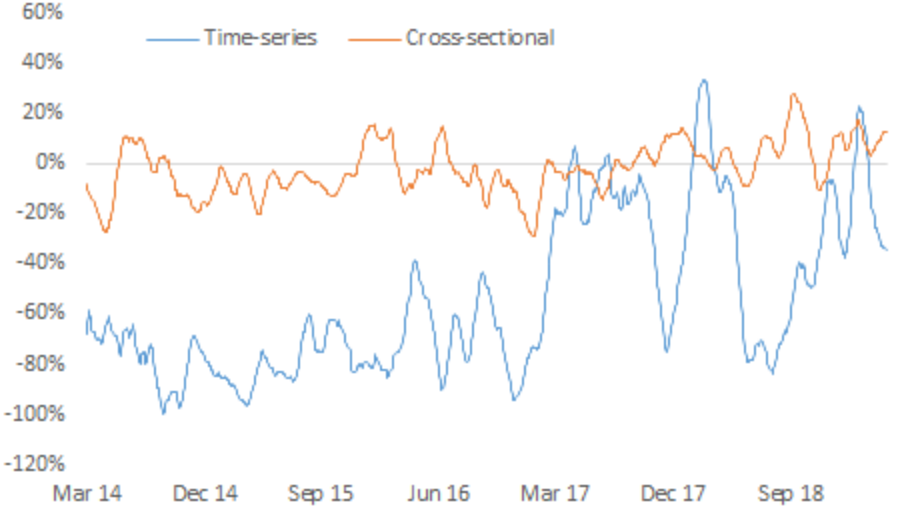
Correlations to the dollar



Yearly returns



Net positions



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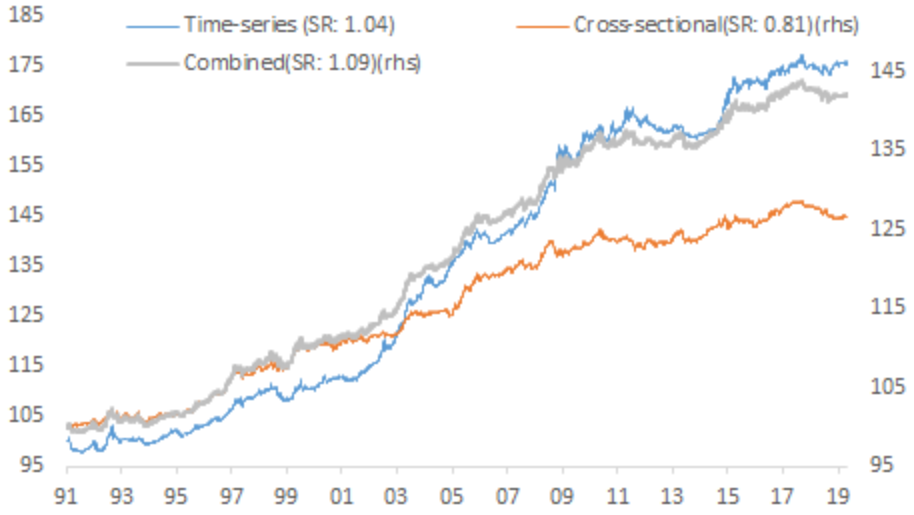
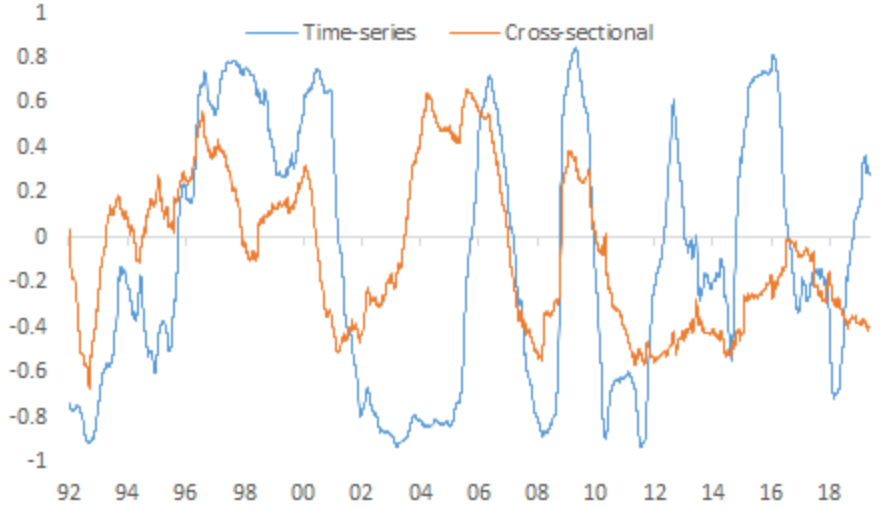
10. Multi-factor FX portfolio

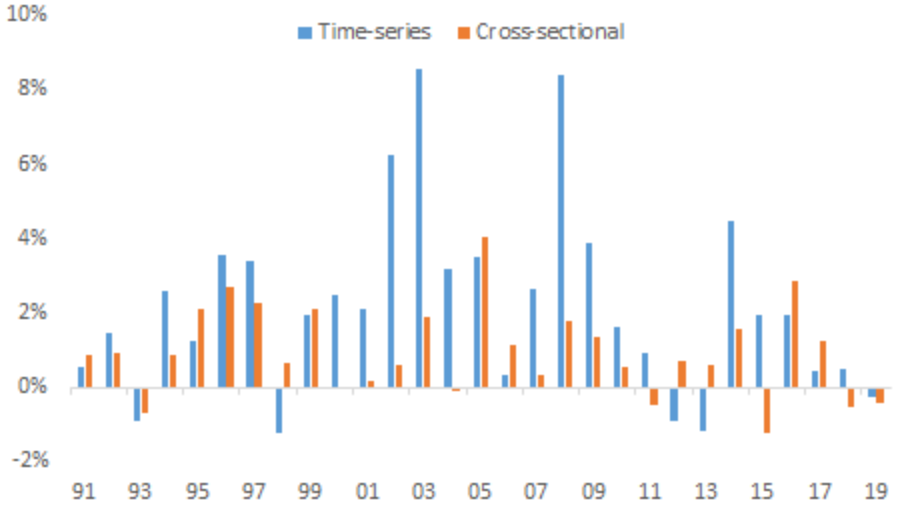
10. Multi-factor portfolio –Results (1)

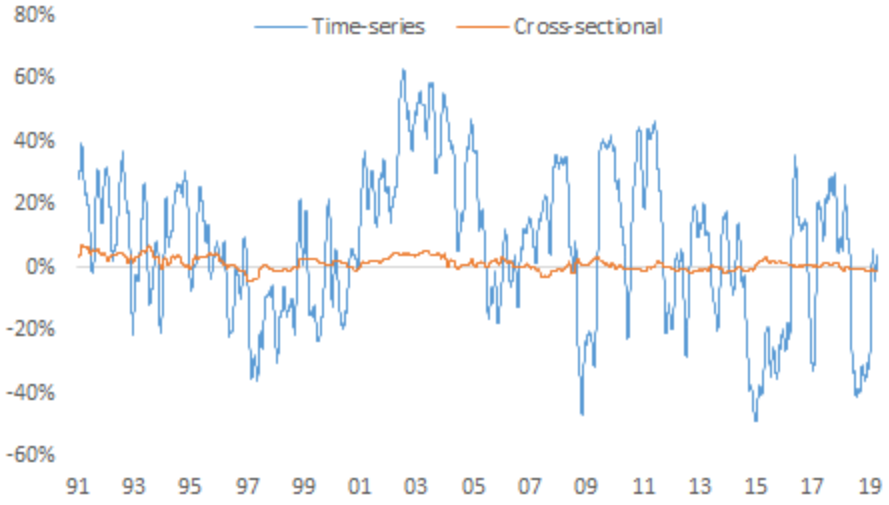
Performance



Correlations to the dollar







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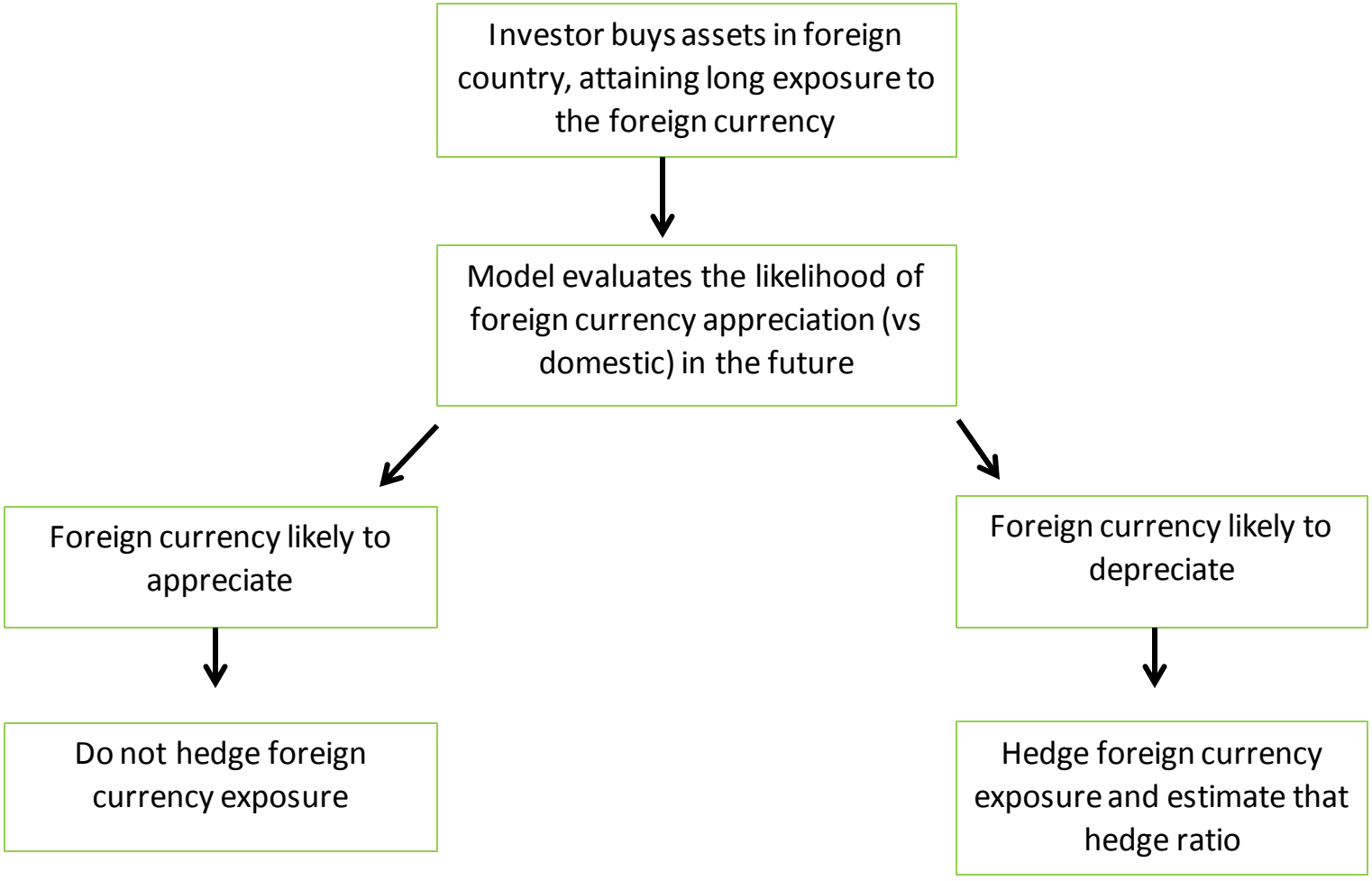
11. Dynamic Currency Hedging

11. Dynamic currency hedging (1)

- Investors buying foreign assets also attain long exposure to the foreign currency.
- Managing currency is of key interest, but it is not so straightforward.
- Japan-based investor
  - Yen, being a safe-haven currency, has a negative correlation with the global equities. This adds implicit leverage to the investment and hence encourages hedging.
  - Yen is a funding currency, and therefore hedging is generally not cheap. This discourages hedging.
- Australia-based investor
  - AUD, being a risky currency, has a positive correlation with the global equities. This acts as a natural hedge and hence discourages hedging.
  - AUD is generally a high-yielding currency, and therefore hedging adds an income through "carry".
- We propose a dynamic approach to hedge currency risk in which we form a view (bullish or bearish) on the foreign currency from the drivers described earlier.

Source of all images: Deutsche Bank Research.

11. Dynamic currency hedging - Our approach (2)



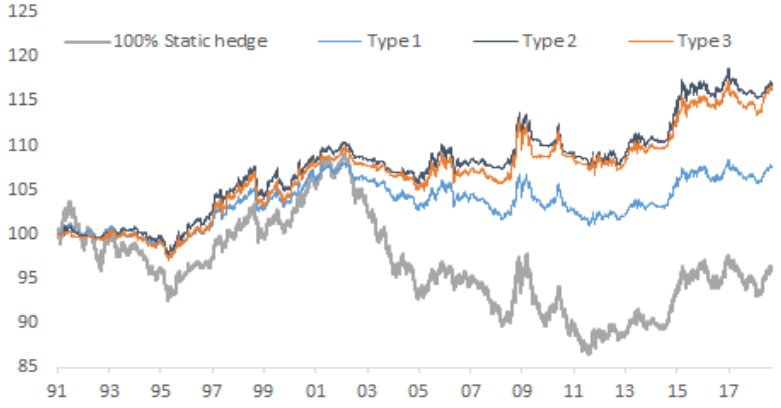
Source of all images: Deutsche Bank Research.

11. Dynamic currency hedging - MSCI World index (3)

Following ways to hedge currency risk on MSCI World risk for a US-based investor.

- 100% Static Hedge: Short foreign currency forward contracts with hedge ratio of 100%.
- Type 1: The hedge ratio is ratio of number of bearish signals to the total number of signals.
- Type 2: The hedge ratio is 0 if the foreign currency is expected to appreciate w.r.t the USD, otherwise the hedge ratio is 100%.
- Type 3: The hedge ratio is 0 if the foreign currency is expected to appreciate w.r.t the USD. Otherwise, the hedge ratios are determined by solving an objective function that maximizes risk-adjusted return of the total portfolio.

Performance of the hedge leg

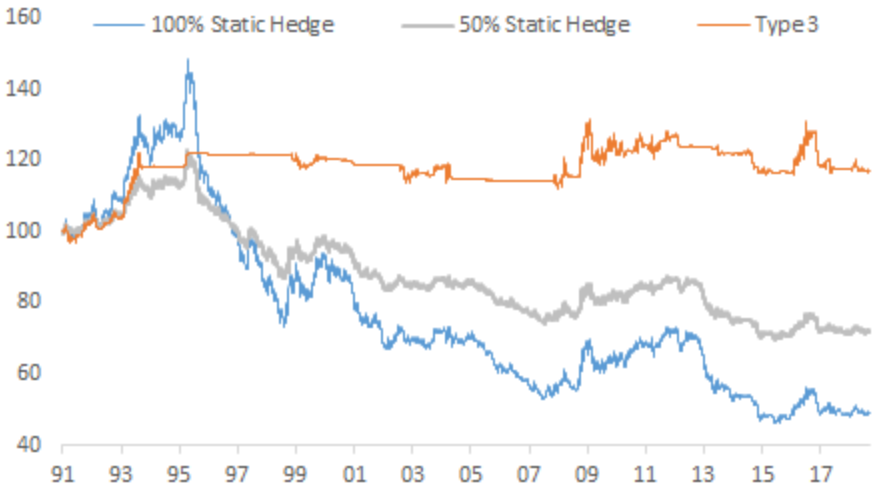


	Static Hedge	Type 1	Type 2	Type 3
Ann. Returns	-0.14%	0.27%	0.57%	0.55%
Ann. Volatility	2.72%	1.48%	1.68%	1.70%
Sharpe ratio	-0.05	0.18	0.34	0.32
Max DD	-20.9%	-6.5%	-6.0%	-5.6%

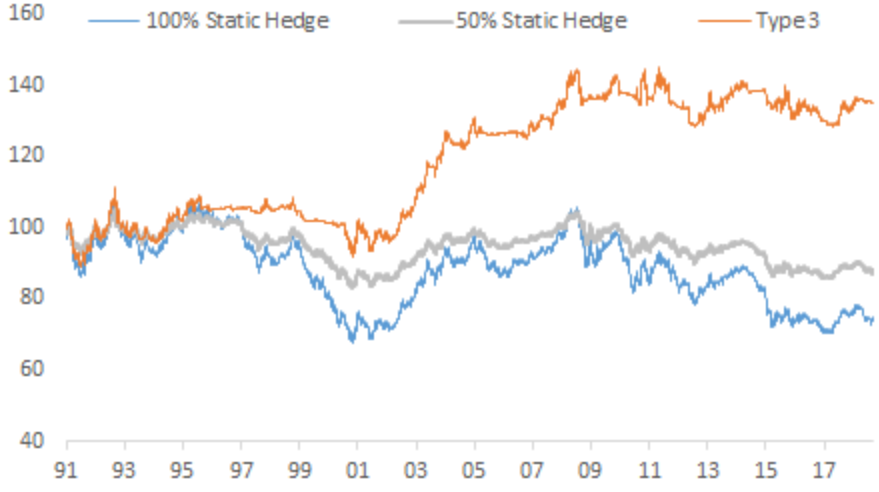
Source of all images: Deutsche Bank Research.

11. Dynamic currency hedging- Non-US based Investors (4)

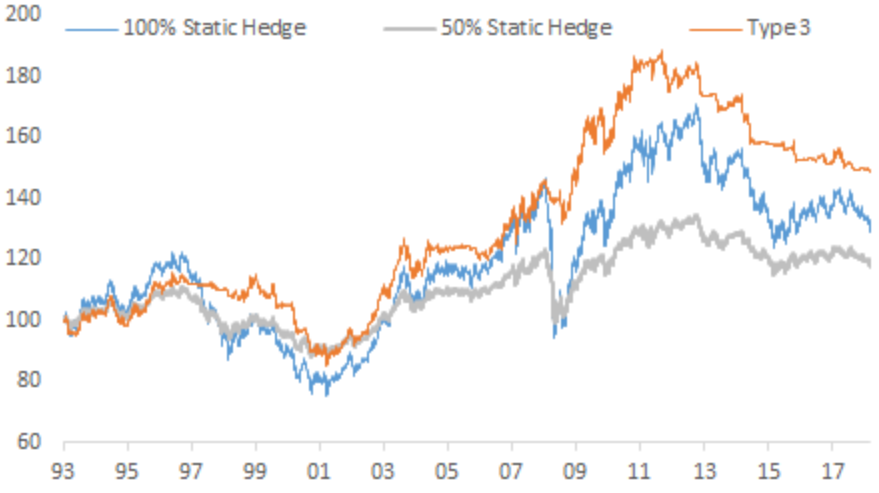
Base country- Japan



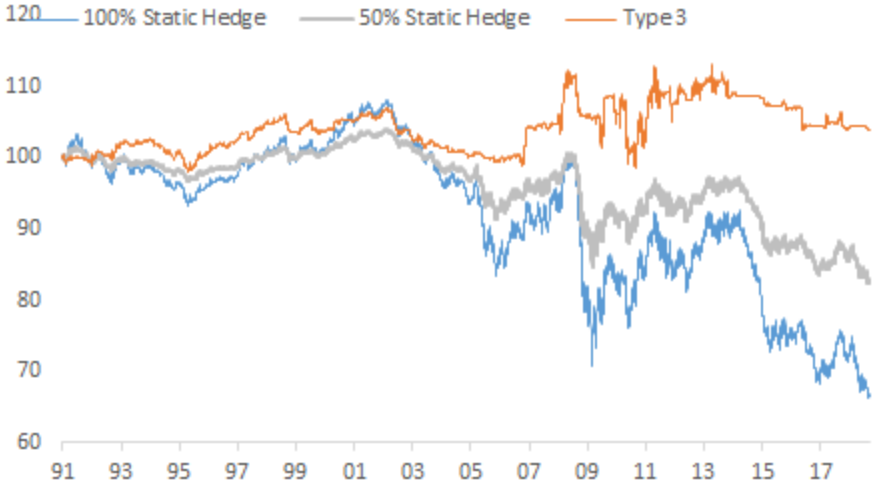
Base country- Europe



Base country- Australia



Base country- Sweden



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12. FX Behavior Under Different Sentiment Regimes

12. Our Global Sentiment Indicator: An Introduction (1)

- The Deutsche Bank's Global Sentiment Indicator (GSI <DBQSGSI Index>, introduced in 2012, points to the current state of market sentiment.

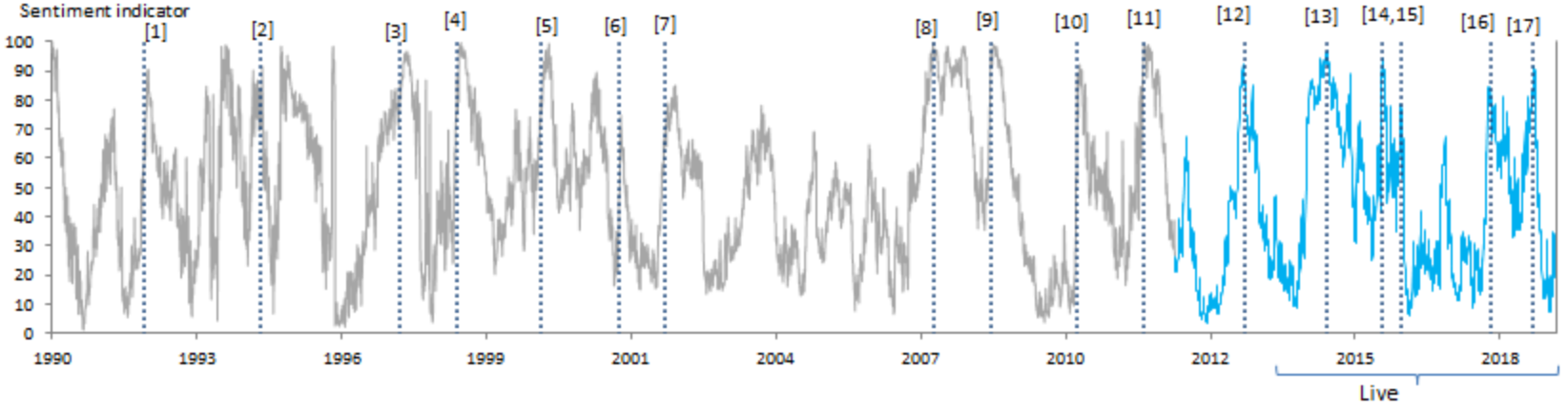
- The GSI aggregates 9 barometers of risk across asset classes.

  Equity implied volatility — Financial sector risk (Equity and Rates perspective)

  Interest-rate implied volatility — Short-term interest rate liquidity risk

  Non-financial CDS spreads — FX implied volatility

  FX volatility slope — FX volatility skew



[1] Black Wednesday, [2] Mexican devaluation, [3] Asian crisis, [4] Russian crisis, [5] Dot-com bubble, [6] 9/11, [7] Market crash, [8] Credit crunch starts, [9] Lehman Brothers, [10] Greek downgrade, [11] European debt woes, [12] Taper Tantrum, [13] Greek debt woes, [14] Oil Price Shock, [15] British EU Referendum, [16] US Inflation concerns, [17] Global Growth concerns.

Source of all images: Deutsche Bank Research.

Predictive Power of the GSI: Experiment set-up (2)

To understand the efficacy of the GSI in predicting returns of 3 markets – Global FX, DM FX (ex JPY, CHF), and EM FX- over 1-week, 2-week, and 1-month horizons.

Experiment set-up:

- Transform the GSI levels to a signal that is bounded between -1 and 1.

$$S_t = 1 - \frac{2}{100} * GSI_t$$

- The positive (negative) correlation between the signal and the future return indicates a momentum (reversal).

- Divide the signal in 5 buckets and calculate the average of returns of a given market over different time horizons. The returns associated with a bucket is:

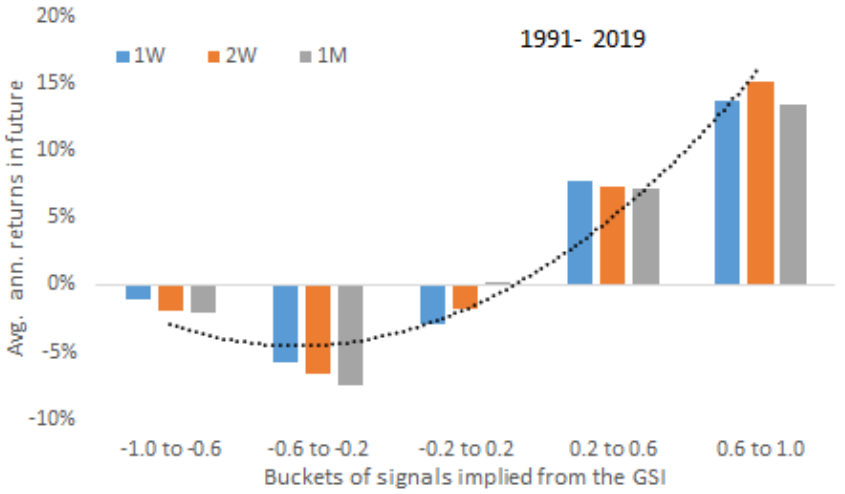
$$r^{B_i} = r_{t+h} | GSI_t \in B_i$$

Where B_i is the i^{th} bucket, r_{t+h} is the return of an asset over time-horizon *h.*

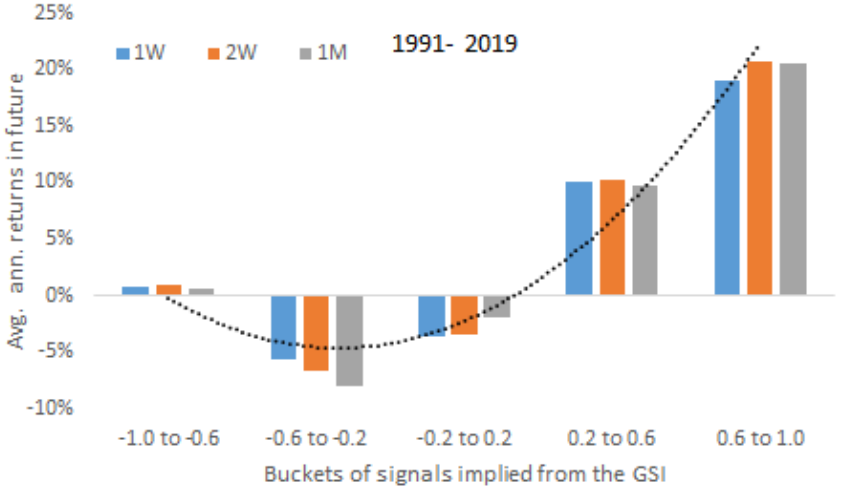
12. Predictive Power of the GSI: Global FX (2)

- Linear (or directional) relationship with the GSI.
- Tendency to rally after the GSI indicates a low-risk zone.
- Propensity to sell-off after the GSI indicates a high-risk zone.
- Points towards momentum at both high and low risk zones.
- Sign of the slope has remained unchanged in both pre-crisis and post-crisis period.

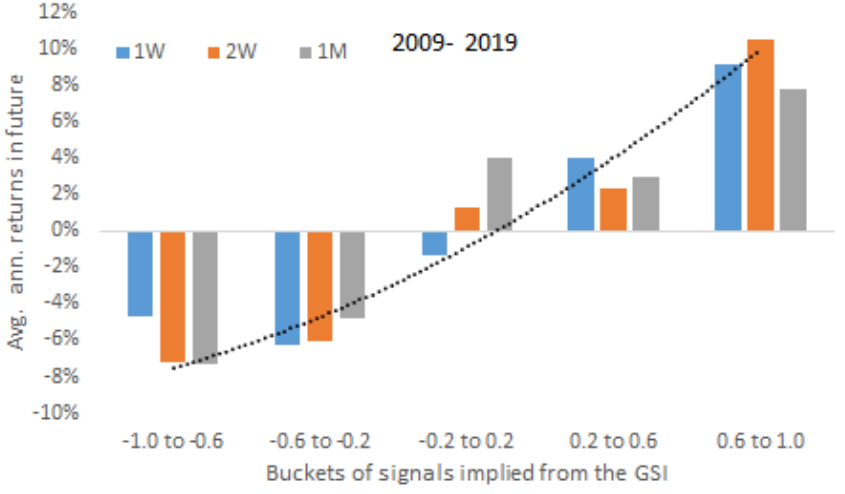
Average future returns per bucket



Average future returns per bucket

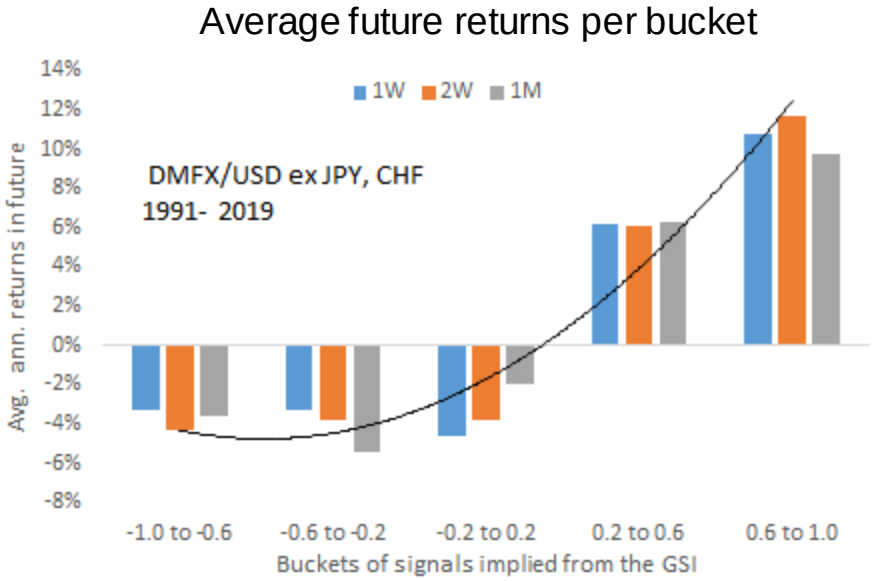


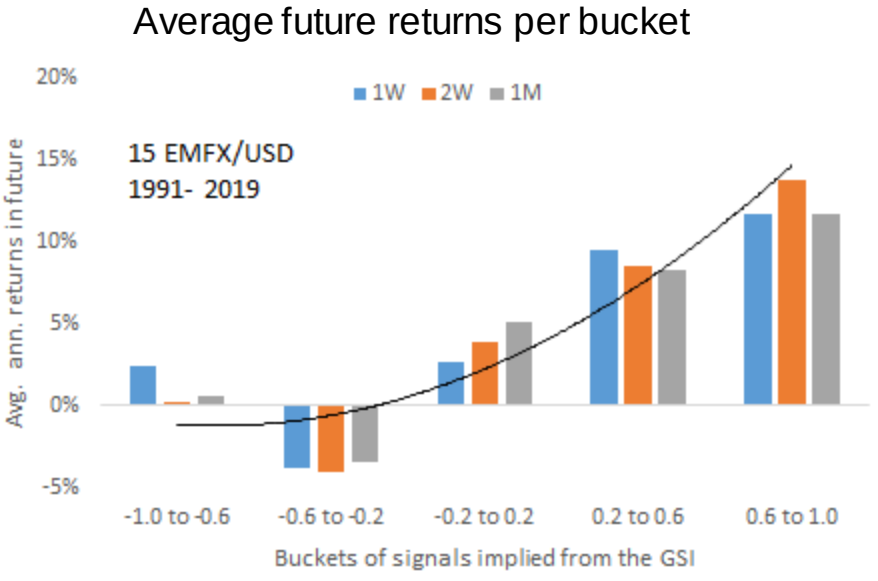
Average future returns per bucket

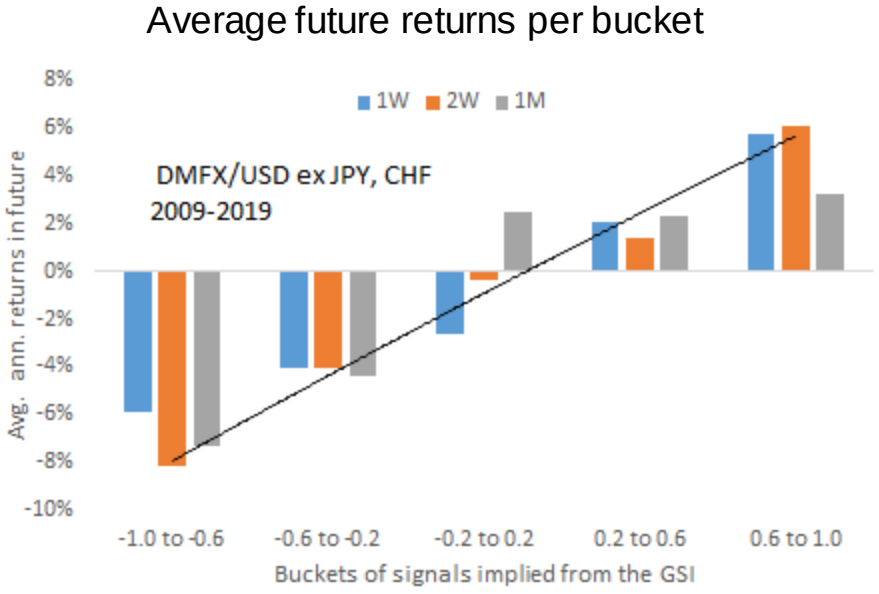


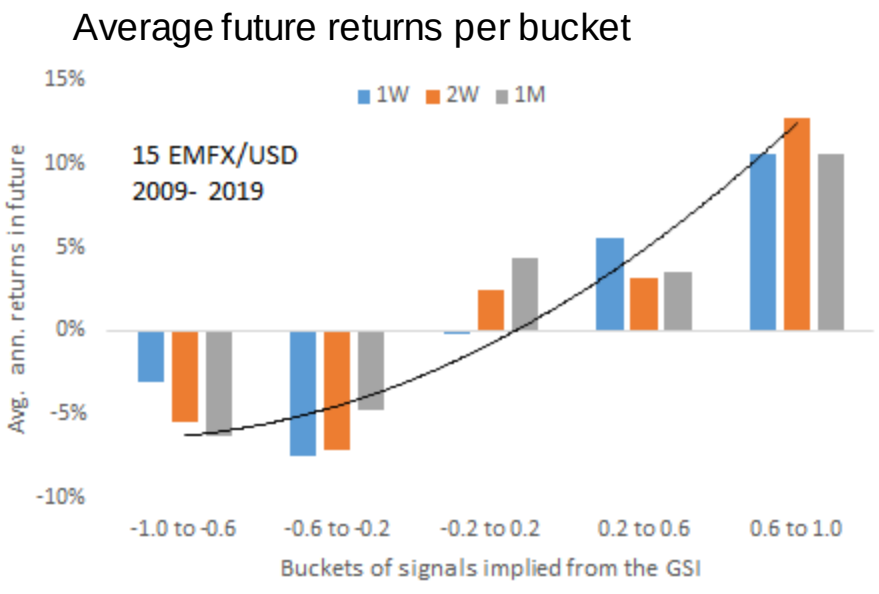
Source of all images: Deutsche Bank Research.

12. Predictive Power of the GSI: DM and EM FX (3)









Source of all images: Deutsche Bank Research.

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Appendix 1
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*Other information available upon request

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