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J.P.Morgan

# FX Volatility: Cheap won't get cheaper (probably)

- **VXY Global heads into next year with the deepest cyclical undershoot on record, in excess of 3 % pts.**

- **Ultra-cheap vol valuations however need to be set in the context of less stressful global economic conditions next year. JPM baseline expectations of lukewarm moves from the big G3 FX, and the drip feed of USD strength in 2019 of the kind that erodes speculative interest in FX carry are other reasons to curb one's enthusiasm for a V-shaped vol rebound.**

- **The path of least resistance to higher FX vol next year runs through politics (US/China, US elections), not economics.**

- **Option themes for 2020: (a) favoring EM vol over DM vol; (b) betting on Euro strength through contained upside structures / RVs; (c) 2020 US elections: long USD/CHF forward volatility over the Democratic primaries; (d) systematic shorts in AUD and JPY risk-reversals as their risk-sensitivities have regime-shifted lower; (e) long GBP/USD 1Y1Y forward volatility for renewed back-ended Brexit disruption; and (f) model-based mean-reversion pair selections (NOK vs. SEK, PLN vs. HUF) – see next bullet.**

- **In the special section, we introduce a novel framework for trading mean reversion on FX volatility spreads, by providing plain vanillas, vol swaps and FVAs backtests for G10 and EM pairs.**

## What goes down must come up?

Having gone through the routine of writing year-ahead outlooks on FX volatility over the years, the act of penning one strikes us as Einstein's definition of insanity: doing the same thing over and over again – highlighting how cheap vols are at the turn of the year, only to see them inevitably trend lower – and expecting different results. Despite substantial movement on economic, policy and geopolitical fronts this year, the technical set-up for currency options heading into 2020 does not appear too dissimilar to that around this time last year, which at least superficially raises the prospect of another dreary year for option buyers. In what follows, we argue that while the bar for an upward adjustment to current vol levels is low, the path to a durable re-set higher runs through politics, not economics. Since the former is often binary and not readily amenable to informed "views" (c.f. the abrupt breakdown in US/China trade talks in May), the option/vol investment themes that we discuss later in the note necessarily have a greater risk management

**Exhibit 1. FX vols are entering 2020 with the deepest cyclical undershoot on record....**

Residual from regressing VXY Global on the level of JPM global composite PMI (business cycle indicator) , volatility of global PMI (proxy for growth surprises) and the average inter-quartile forecast dispersion of 4-qtr ahead US real GDP, unemployment and headline CPI provided by the Philadelphia Fed's Society of Professional Forecasters (SPF) quarterly survey (uncertainty proxy).
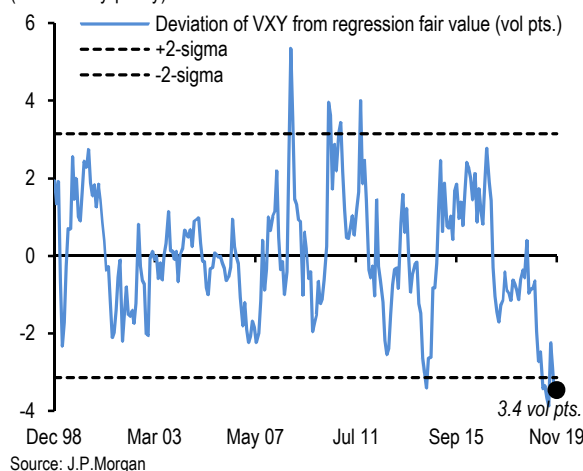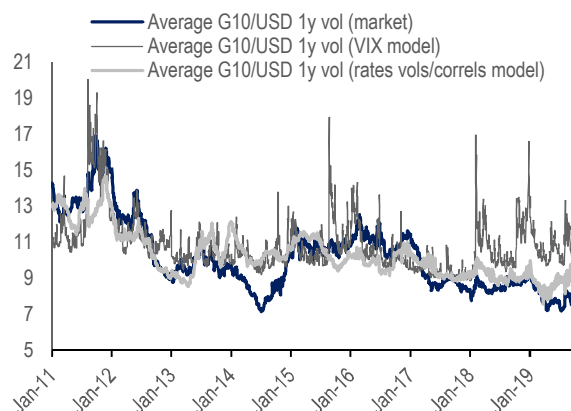


Source: J.P.Morgan

**Exhibit 2. ...and also screen cheap to varying degrees vs. interest rate and equity vols**

The two fair values vol models below are obtained by regressing individual FX vols against VIX and proxies of rates spread volatility, then averaging



Source: J.P. Morgan

element to them rather than high conviction modal thrust.

**In terms of valuations, VXY Global heads into next year with the deepest cyclical undershoot on record** based on our workhorse framework that takes into account the trajectory and surprises in Global PMIs and *ex-ante* forecast uncertainty surrounding key macro-economic variables (**Exhibit 1**). This is a significantly larger misalignment than in recent times, and owes mechanically to the 2.8 % pt. drop in VXY in the face of a steep manufacturing downturn this year (ΔPMI -1.6 pt. YTD). Alternative fair value for FX vol approaches also lead to qualitatively similar results. At

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present FX vols (1y, average of G10/USD crosses) appear cheap when benchmarked against both the underlying interest rates/correlations and VIX (**Exhibit 2**), with dislocations significant in z-score terms (1.7 σ and 3.9σ) but less dramatic on nominal levels (0.9 and 2.5 vols respectively; see *Two macro factors suppressing FX volatilities*, 4 October). Both regressions are also handy for scenario analyses; for instance, VIX at 15 should push average FX vols to 10, while holding swaption vols at current levels and assuming long-run averages on interest rate correlations delivers fair value ~9.0. The caveat is that while these cross-asset factors have tracked FX vol well in the post-GFC period, their explanatory power has declined over the past two years and the VIX model in particular has failed to describe recent FX vol dynamics. Precise mis-pricing magnitudes notwithstanding, current abnormally low vol levels present the strongest argument in favor of portfolios allocating greater-than-average risk budgets to option-based and/or long vol expressions next year.

**Ultra-cheap vol valuations however need to be set in the context of less stressful global economic conditions next year**. On the one hand, it is fair to argue that the macro context of a late-stage US economic expansion not only remains a constant from end-2018, but has even increased in urgency given the sharp rise in recession odds over the past year (12-mo change in 1-yr ahead recession probability +15 %pts., currently 47%). For 1H20 however, the JPM baseline of contained reflation is likely to relegate such chronic end-of-cycle worries to the backburner, and presents systematic vol sellers with a powerful counter-argument – that if a near-recession in global manufacturing could not dislodge FX vol from its coma in 2019, it is difficult to imagine how a moderate lift in PMIs under-written by dovish G3 central banks and their still-expanding balance sheets (on aggregate) delivers such an outcome in 2020. We are sympathetic to this line of reasoning, but are also mindful of the asterisk surrounding this year's fixed income price action: falling US real yields tend to hide a multitude of sins, and that the protective cover of this year's 100bp+ duration rally is almost certainly going to be unavailable going forward.

**Expectations of only lukewarm moves from the big G3 FX are another reason to curb one's enthusiasm for a V-shaped vol rebound.** Many investors have cited the sluggishness of the Euro and the Yen in particular as an important drag on FX vol, arguing that it is difficult for currencies as an asset class to pick up a meaningful head of steam when the two largest volume turnover engines are effectively parked in the shed. Our baseline projections of only mild Euro strength and a nearly flat Yen next year do not increase confidence that this picture is going to change materially; anecdotal accounts suggests an uptick in EUR call demand in 4Q19 and existence of a reasonable stock of

JPY puts among levered investors, but we remain skeptical of the ability of either of the G3 behemoths to trend its way out of the current vol funk, and attract macro participation via options on a scale approaching Abenomics'14 or ECB tapering'17 that lifts implied vol durably.

**As long-standing (and beaten-down) vol bulls, we are also not encouraged by the drip-feed of USD strength in 2019.** Slow burn dollar strength of the kind that we experienced this year – and indeed for most of the last five since the onset of Fed hikes, except in patches like 2H18 – has eroded financial investors' enthusiasm for classical USD-funded FX carry trades, as reflected in a general increase in speculative dollar longs and length reduction in traditional high-beta currencies. If volatility is the product of leverage intersecting with wrong-way shocks, and investor leverage in FX is generally thought of as being inversely correlated to dollar sentiment / positioning, then incremental investor acceptance of, and positioning for, trend USD strength in recent times suggests that currency markets have experienced precisely the *opposite* of the risk-seeking leverage build-up that is typically necessary for shocks to result in vol surges. In other words, the *investor* leverage cycle in currencies has run counter to the pattern of the go-go pre-Lehman years when large scale herding into carry trades created ripe conditions for the devastating GFC-collapse that followed. Of course, the flipside to greater speculative caution around dollar selling is that *corporate* balance sheets have levered up multi-fold on USD-funding since the GFC. This has created a structural vulnerability in the global financial system, turned the dollar into a semi-exogenous risk factor in its own right[4], and raised the tail risk of run on "global dollar shorts" during the next recession. The difference is that the threshold of dollar strength required to precipitate such a corporate crisis is significantly greater than that required to trigger de-leveraging of mark-to-market sensitive investor portfolios; hence within realistic bounds of market moves, less toxic speculative pre-positioning should dominate any balance sheet stress and cap runaway strength in USD vol.

**In our view, the path of least resistance to higher FX vol next year, if any, runs through politics, not economics.** A redux of 2019's implosion of US/China trade talks will do the trick, and the fallout will likely prove more severe than this fall's as the US political calendar will likely leave little or no room for the feuding parties to return to the negotiating table this side of the November elections. A progressive, market interventionist, Democratic nominee in the primaries will also likely put FX vol on a sustained track higher, not only due to higher realized volatility resulting

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[4] BIS has been particularly vocal on this issue, see for instance *The dollar exchange rate as a global risk factor: evidence from investment*, Avdjiev et al, January 2018

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from a knee-jerk stock market backlash, but also as option prices embed a heavier day-weight for the November election date and discount the possibility of high-frequency interim swings between equity market optimism and pessimism as polling fortunes gyrate through the campaign season. Finally, while all eyes will be on the systemically important US / China trade negotiations and the US elections, political tail risks around Hong Kong SAR – in terms of the passage of the pro-democracy bill in the US Congress and Beijing's response to the disruption on the ground – have the potential to infect the broader US/China dialogue and turn what is so far an idiosyncratic event into a systemic phenomenon.

## FX option themes for 2020

### Prefer owning EM vol over DM vol

For those looking to buy cheap FX vol in 2020, one encouraging development this year was that owning a basket of (VXY EM-weighted) EM straddles financed with a basket of (VXY G7-weighted) G10 straddles, delta-hedged, delivered ~ flat returns in 2019. This is heartening because it concords with one of our core contentions – that given the secular slowdown in Chinese growth, a potential secular downturn in global trade and explosion in USD-funding of EM balance sheets, the path to durably higher FX vol likely runs through weaker EM asset prices and higher EM FX vol relative to G7. Indeed, even a tepid year for currency vol such as 2019 was marked by periods of acute instability in Argentina and Turkey which also coincided with stress in other high-yielders, albeit briefly.

From a vol return standpoint, long EM vs. short DM as a relative value theme has not always been profitable due to typically high risk premia embedded in EM options. But this has begun to change over the past couple of years as vols have slid to multi-year lows even as geopolitical, economic and monetary policy uncertainty has increased. This new environment has particularly benefited the performance of high beta FX / EM options (**Exhibit 3** – black line). Recent optimism on a Phase-I US/China trade deal has pushed VXY below 5%-tile of long-run history, meaning that EM FX options today carry razor thin risk premium over delivered vol.

In a previous study (Special Section of _FX Volatility: Wading into rough waters_), we found that using a rule-based approach to systematically selecting EM currencies to buy 1Y ATM straddles drastically improves the risk-reward of a long EM vol strategy. Specifically, we found that a composite signal comprised of (a) high z-scores of carry / premium ratios of ATMF straddles, (b) high realized / ATM vol ratio, and (c) strong momentum (% monthly change) in ATM vol delivered good outcomes in _ex-ante_

**Exhibit 3. Long EM vol vs. short DM vol as a thematic RV has held in well over the past 2-yrs, and selecting the long EM vega leg with a rule based approach outperforms owning a blind all-currency basket**
6M expiry options, hedged daily using smile forward deltas and rolled into fresh strikes monthly. Long USD/EM (12 liquid EM pairs) vs short USD/G10 is sized in vega neutral notionals. EM strategy designates 2 EM pair selection based on 3 market indicator (zscore of carry/vol, ratio of realized / ATM vol, and monthly changes in ATM vol), as per previously published model for systematically buying EM vega – see special section of _FX Volatility: Wading into rough waters_.



Source: J.P.Morgan

selections of EM vols to buy. In Exhibit 3, we adapt this same heuristic to systematically buying EM vega, but this time also alongside selling G10 vega. Encouragingly, returns from such a long EM / short DM vol strategy (blue line) have been trending higher since 2014 and have bettered long only EM vol (grey line) courtesy decay savings. 6M strikes us as good choice of tenor as a compromise between responsiveness to market shocks and decay costs.

At current market, **ZAR** screens as the top EM vega candidate due to favorable carry/vol and realized / implied vol ratios (6M USD/ZAR vol is nearly flat to trailing 1-mo realized vol); **KRW** and **HUF** are next in line. While the framework in Exhibit 8 does not specifically screen for G10 vols to sell, based on the implied – realized premium and curve shapes, we favor **a basket of short 6M AUD, NZD and CAD vols to fund ZAR, KRW and HUF 6M vega**.

_Buy an equally weighted basket of 6M ATM straddles across USD/ZAR, USD/KRW and USD/HUF (indic. vols 13.35/13.75, 6.4/6.6, 7.1/7.6 respectively) vs. sell an equally weighted basket of 6M ATM straddles on AUD/USD and NZD/USD (6.7 and 7.25 change vols respectively)_

### Positioning for higher EUR/USD via options

**The directional view on the Euro into next year is moderately constructive**, predicated on cheap valuations, an element of global reflation, looser fiscal policy that helps a belated return of growth towards potential, and structural

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support from a solid balance of payments (see *Euro* section). However positioning for this baseline in cash can prove challenging, given a still steep negative carry hurdle. We propose three option constructs for expressing contained Euro strength in increasing order of exoticity:

**EUR/USD digitals**: Call spreads and digitals are the obvious port of call given both the limited nature of the expected spot move as well as the flip of risk-reversals into positive territory (for EUR calls) in recent weeks. In contrast to riskies that have already re-priced to near-2018 bull-highs, ATM vols are significantly lower so that despite stiff negative carry, EUR call digitals are priced near multi-year lows in premium (**Exhibit 4**). For instance, *4M 1.15 strike digital EUR calls / USD puts* cost ~15% (spot ref. 1.1080). A call spread (or a levered version of it i.e. digital) structure is also supported by our rule-based hedging scorecard that suggests notional allocations across instruments, and currently OWs call spreads over competing structures (call spreads (50%), seagulls (29.2%), riskies (16.7%) and forwards (4.2%), see *FX Hedging Scorecard*, 18 November update).

**EUR/USD vs. EUR/satellite European FX call spread switch**: An empirical regularity within the European currency bloc is the inverse correlation between EUR/USD and EUR/ satellite currency crosses (NOK, SEK, HUF, PLN), which has its roots in the hub-spoke relationship between core Europe and the rest of the continent and the latter's greater than 1 growth beta to the former. If Euro strength is likely to be accompanied by lower EUR/Scandinavia crosses – especially NOK which boasts of the stronger cyclical backdrop and a more hawkish central bank – then it stands to reason that one way of reducing premium outlay on EUR/USD calls is to fund them by **selling EUR/NOK calls**. This pair trade comes with the advantage of decent entry levels in relative spot rates as well as option prices; and an episode of serious flush-out of crowded NOK longs already in the rear-view mirror that reduces the likelihood of an encore. Still, for risk management prudence, we prefer the bounded nature of call spreads on both legs. For instance, *off spot refs 1.1075 and 10.12 respectively, long 4M EUR/USD 1.12/1.15 call spreads vs. short EUR/NOK 4M 10.25 / 10. 50 call spreads is ~ zero-cost* (vs. 72bp EUR for the EUR call spread)

**[EUR/Asia ↑, USD/Asia↓] dual digitals**: The most esoteric of the lot, the idea of this class of option structure is to reduce premium outlay / increase gearing by splitting EUR/USD into a EUR-cross and a USD-pair off the same common currency – and betting on their simultaneous divergence. Not all pivot currencies are suitable however; intuitively, one requires a low/mid-beta currency that such that broad Euro strength can drag its Euro-cross higher, yet

with individual macro good enough so that it can strengthen vs. USD in an environment of Euro-fueled USD weakness.

**Exhibit 4. EUR call/USD put digitals are at multi-year lows in premium thanks to ultra-low ATM vols and skews bid for EUR calls**

Spot-barrier distance (%) of 3M 20% price EUR call/USD put call at-expiry digitals
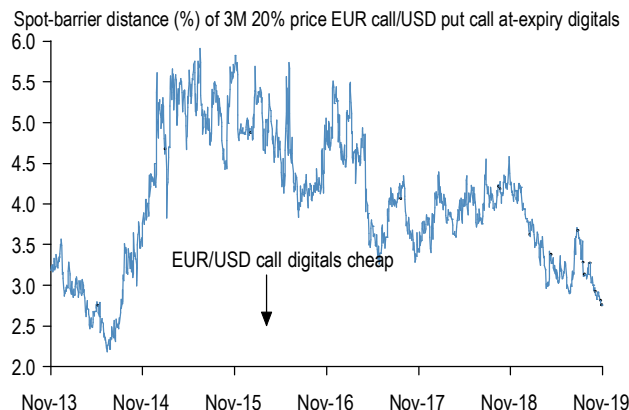


Source: J.P. Morgan

**Exhibit 5. Low beta Asian currencies are best placed to exploit contained Euro strength next year via [EUR/x↑, USD/x↓] dual digitals**

Current price of 3M ATMS strike [EUR/x↑, USD/x↓] dual digital options
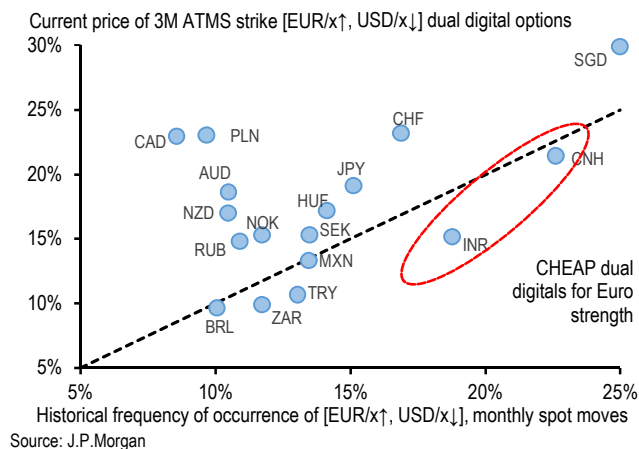


Source: J.P.Morgan

**Exhibit 5** suggests that Asian currencies like **CNH, INR** and **SGD** are generally the best placed to be the pivot currencies judging from the *unconditional* historical propensity of their EUR- and USD-pairs to diverge; if one has reasonable conviction on a US/ China Phase-I deal being eventually signed, [EUR/INR↑, USD/INR↓] is currently well-priced and INR is a reasonable currency to buy given the improvement in BoP and potential inflows chasing stressed credit assets created by the NBFC crisis. *3M [EUR/INR > ATMS, USD/INR < ATMS] dual digitals cost ~ 16.5%* vs. 66% and 38% for the two individual digitals.

### 2020 US elections: 3M3M USD/CHF forward vol to own event risk over Democratic primaries

The upcoming 2020 US election is gearing to be one of the most eventful in history, in large part because President

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Trump's unconventional, market-moving approach is going to face off against a different but potentially equally unconventional Democratic alternative. A notable uptick in FX options pricing of the election risk came at the 13-month mark before Election Day when the Ukraine story surfaced, which is well ahead of any previous election timeline. JPY, EUR and CHF are already at 30+ overnight (O/N) vol for the day, and based on a rough framework for peak premium based on previous political events (details *here*) now have only ~10 pts of additional headroom. Election O/Ns for EM high-yielders that had previously trailed the surge in safe-haven G10 event premium (TRY, BRL, ZAR and RUB) have jumped by ~10pts since early October, but **RUB** and **BRL** still look attractive to own as relative laggards. Also, at ~19vol, Gold O/N should be of particular interest given that gold has historically had one of the highest betas to US political developments (see *here*).

Meanwhile FX option pricing of the **Democratic primaries** remains comparatively quite modest. The landscape of average daily G10 forward vols over the next year clearly indicates high day-weights for the US election and FOMC meetings next year, but key Democratic primary dates like Super Tuesday (March 3rd) are buried within noise (**Exhibit 6**). Polls still indicate that Biden is in the lead, but his edge over the rest of the field has narrowed significantly over the summer. A significant percentage of poll support currently favors "smaller" candidates / undecided, a group that has strong negative correlation with Warren (**Exhibit 7**) indicating that Warren could draw a fair number of votes from that camp once the field narrows. The reliance on those "hot" votes is also reflected in the larger standard deviation (3.2) of Warren's polling numbers, which is starkly different from Sander's (0.9) and reflects his reliance on a highly loyal core. Using these statistics, we run a simulation of the Democratic Primaries voting (**Exhibit 8**). The coin flip outcome (when accounting for the high transferability between other/undecided group and Warren) should be reflected to a greater degree in FX option pricing of the primaries considering the widely different running platforms of the candidates and their potential dollar impact (see *here*).

Within the majors, EUR/USD and USD/CHF 3M3M forward vols are at multi year lows that have been realized only twice in recorded history (2008, 2014). Hence we recommend owning Democratic primary event risk premium though USD/CHF forward volatility (FVAs).

*Buy 3M3M USD/CHF FVA @5.45/5.8indic*

### Continue to sell USD/JPY risk-reversals as Yen strength capped by sustained Japanese outflows

**USD/JPY** risk-reversals have been persistently bid through the back half of last year and most of this, so much so that **RR/ATM ratios have now reached levels reminiscent of**

**GFC era extremes (in favor of JPY calls**, **Exhibit 9)** despite nominal pricing of Yen options being orders-of-

**Exhibit 6. The US election and FOMC meetings dominate the daily fwd vols landscape. The democratic primaries underpriced but that is bound to change once the field of nominees narrows.**

average of EUR, CHF and JPY / USD daily fwd vols
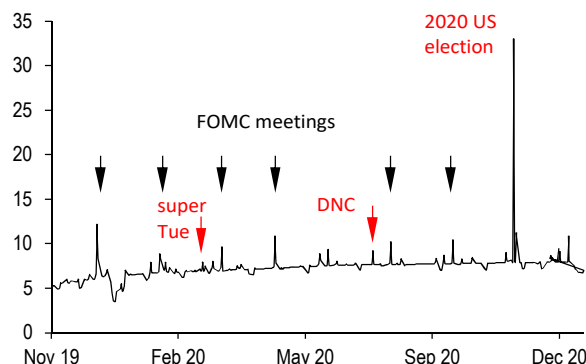


Source: J.P.Morgan

**Exhibit 7. Poll number correlations suggest a potential uptick in support for Warren from undecided voters**

Based on the last 3-mo of polling. Polling average on diagonal; correlations between candidates polling numbers on off-diagonal.

|  | Warren | Biden | Buttigieg | Sanders | Harris | Other |
|---|---|---|---|---|---|---|
| Warren | 20.8 | (36.2) | 38.1 | (37.5) | (78.3) | (74.3) |
| Biden | (36.2) | 26.0 | (35.5) | (11.4) | 46.1 | (11.1) |
| Buttigieg | 38.1 | (35.5) | 8.0 | 24.8 | (54.5) | (54.8) |
| Sanders | (37.5) | (11.4) | 24.8 | 17.8 | 3.7 | 5.0 |
| Harris | (78.3) | 46.1 | (54.5) | 3.7 | 5.3 | 49.7 |
| Other | (74.3) | (11.1) | (54.8) | 5.0 | 49.7 | 22.1 |
| St Dev | 3.2 | 1.3 | 1.0 | 0.9 | 1.2 | 2.4 |

Source: J.P.Morgan

**Exhibit 8. Monte-Carlo simulation implies only a modest advantage for Biden for the Democratic Party nomination.**

Results of 10000 runs using latest poll, actual correls and 2x actual std dev.

Probability of winning the primaries
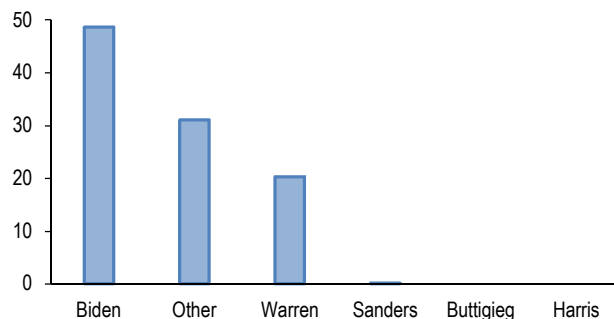


Source: J.P.Morgan

magnitude more benign today. This apparent "distortion" owes to the currency hedging preferences of Japanese institutions and corporates as the Fed – BoJ policy rate gap widened over the past 12-18 months. Instead of incurring the steep 250-300bp of negative carry of selling USD/JPY forwards to cover FX risks of USD receivables /US bond

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exposures, Yen buying flows have increasingly taken the form of purchasing USD puts/JPY calls on risk-reversals that were judged to be relatively cheap vis-a-vis forwards.

However with the US – Japan rate gap shrinking by more than 100bp from its 2018 peak and USD/JPY skews richening 0.6 - 0.8 %pts. across the curve over the same period, it is no longer clear that the forward points vs. risk-reversal relative value calculus that initially motivated the switch in hedging instruments is valid. Indeed, the simplest measure of relative attractiveness between the two from a cost-of-carry standpoint – the net static carry of a delta-hedged long risk-reversal position – has turned from materially positive in mid-2018 to decisively unfavorable for riskies recently (**Exhibit 10**), which in turn can inform a return to forward based FX hedging and trigger a correction in skews to more normal levels.

Even if such vol surface normalization does not imminently materialize, we still see value in fading this extreme skew set-up by **systematically selling *delta-hedged* riskies** (selling USD puts/JPY calls vs. buying USD calls/JPY puts) in sub-3M expiries. Limiting such constructs to short dates ensures not only a faster pace of theta accretion, but also results in mark-to-market P/Ls being more sensitive to dGamma/dSpot as opposed to dVega/dSpot. The advantage is that we have greater confidence that Yen strength, if any, can remain a crawl in the presence of persistent importer bids for dollars and sustained unhedged domestic outflows – courtesy of negative BoJ rates – that have altered the Yen's traditional anti- risk sensitivity in recent years. We have been running this position for the past couple of months and have had no cause for complaint so far, but take profits now with a view to re-opening in the new year when US/China trade uncertainty and year-end (il)liquidity issues would hopefully have been resolved.

### Sell AUD vol risk premium as boom-bust cycles have become history with RBA ZLB in sight

**From a volatility perspective, AUD has become a pale shadow of the uber-risk sensitive asset it used to be**. The shift has been a number of years in the making, as the Australian business cycle has gradually decoupled from the global cycle in phases – initially led by the cliff edge in mining capex as the China-led commodity boom tailed off, and then due to strained household balance sheets and the constraints they imposed on domestic consumption. From a financial market standpoint, the 400 bp of RBA rate cuts alongside the secular slowdown in Australian growth this decade have resulted in a U-turn in investor interest in AUD; IMM positions have trended one way lower since the GFC and have now turned substantially short as the zero lower bound has come into sight (**Exhibit 11**). This has proven severely punitive for FX volatility – 1Y ATM vols have compressed ~50% from their pre-RBA cycle norms – as the absence of healthy rate differentials and spec length

**Exhibit 9. Risk-reversal / ATM ratios in USD/JPY risk-reversals are historically stretched, bested only by the GFC era in the past 15-yrs**

USD/JPY 3M 25D risk-reversal / 3M ATM ratio
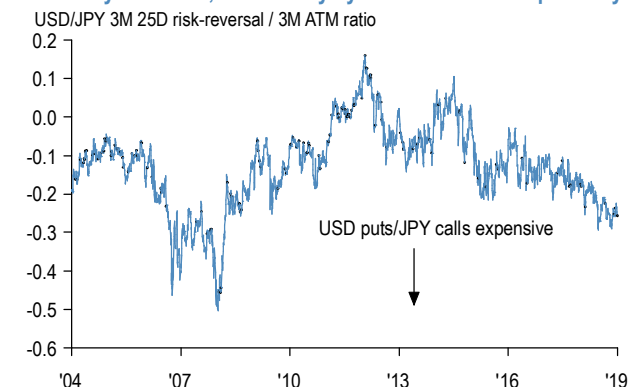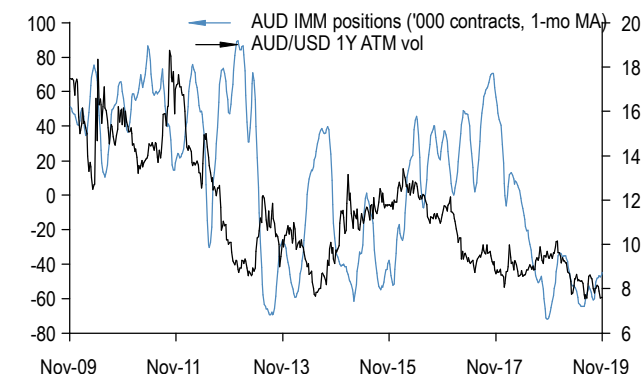


Source: J.P.Morgan

**Exhibit 10. The delta-hedged carry of long USD calls/JPY puts vs. short USD puts/JPY calls has improved significantly in 2019 as the US – Japan rate gap has narrowed and riskies have richened**

Static 3-mo delta-hedged carry (vol pts.) of USD/JPY 6M 25D risk-reversals (long USD calls vs. short USD puts). Assumes option-expiry matched smile forward delta overlaid on the option structure, and the entire package aged by 3-months holding spot, forward curve and the vol surface unchanged. No transaction costs.



*Preferable to buy USD puts/JPY calls vs. sell USD calls/JPY puts instead of selling USD/JPY forwards*
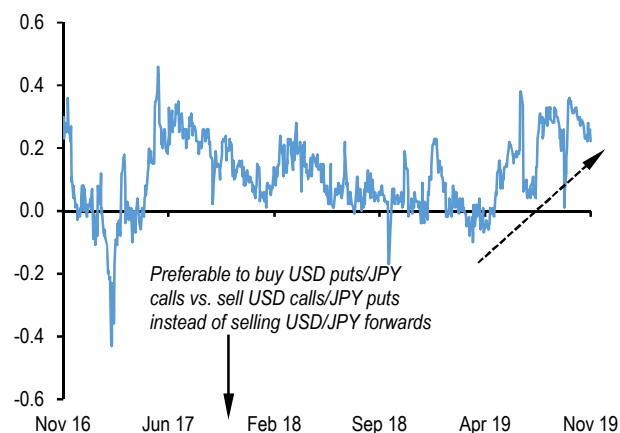
Source: J.P.Morgan

**Exhibit 11. Speculative investor interest in AUD has trended lower as Australia's interest rate edge shrunk, and with it AUD FX vol**



Source: J.P. Morgan

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has sharply dampened, if not entirely eliminated the boom-bust cycles of carry-related re- and de-leveraging that gave AUD vols their erstwhile potency.

As is the norm in option markets, the structural compression of rate carry and neutering of realized AUD volatility have been exacerbated by feedback loop from flow effects in option markets: leveraged participation in AUD weakness have taken the form of limited upside structures such as put spreads / digitals / reverse knock-outs etc.; Australian exporter hedging of foreign currency receivables has increasingly taken the form of risk-reversal selling; and yield-enhancing Japanese Uridashi structures that used to be a major source of negative convexity for FX option dealers in AUD/JPY have increasingly migrated to higher-yielding EM currencies in recent years. The fallout of these flow shifts is that negative vol / convexity "holes" on dealer books have become conspicuously absent of late, and there is little or no scramble to cover short gamma/vega risk in spot sell-offs that used to be the case in the past. As a result there has been a sharp de-coupling of AUD vol returns from spot trends in recent years, evidenced by the surge in short delta-hedged straddle P/Ls since 2Q18 even as spot experienced a 17% drawdown (**Exhibit 12**). In a world starved of vol risk premium, **selling AUD/USD risk-reversals systematically to monetize this potentially permanent spot-vol decoupling can be a durable source of alpha.**

### Long 1Y1Y forward volatility in GBP/USD on "no-deal" scenario in December 2020

The looming December 12 UK election is obviously going to be the key short-term deciding factor in terms of Brexit outcome and, consequently, for GBP directionality and outlook for vols. While we stay away from commenting on trades on the very front end of the curve, over the elections period, one possible opportunity might emerge on farther segments of the curve.  As currently configured, the transition period established by the Withdrawal Agreement runs until end of 2020 (*Brexit after the election, Barr*, 8 November). A decision for a possible one-time extension, by mutual EU-UK agreement, would need to be made by 1 July. One of the possible scenarios under a Conservative majority government would rule out such an extension, with an increased likelihood of a "no-deal" on EU-UK future relationship by Dec 2020.

At present, cable's vol curve is highly inverted in the 1M-9M segment, and remarkably flat in the 1y-2y segment. While the Dec20 "no-deal" scenario is contingent upon other events, so difficult to anticipate or trade one year in advance, such risk is currently not priced in by the market. With most of market attention possibly on the incoming election, the 1y1y forward vol, covering the Dec 2020 date, currently trades at the lowest level since April (**Exhibit 13**)

**Exhibit 12. Short AUD/USD vol returns have surged over the past two years even in the face of a substantial drawdown in spot**
Cumulative returns of selling delta-hedged AUD/USD 3M ATM straddles. Options delta-hedged daily at close of business (~4pm LDN) using smile forward deltas and option-expiry matched forwards, and rolled into fresh strikes monthly. No transaction costs.
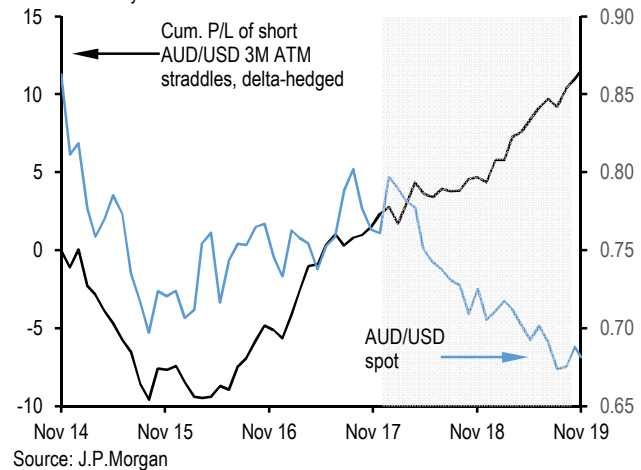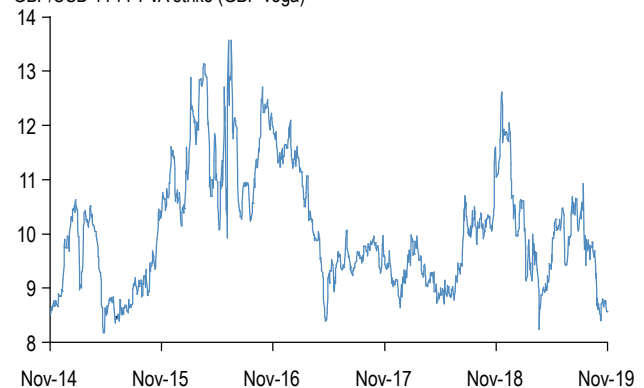


Source: J.P.Morgan

**Exhibit 13. 1y1y forward vol in cable is the lowest since April**
GBP/USD 1Y1Y FVA strike (GBP vega)



Source: J.P. Morgan

and offers good liquidity.

*Buy long GBP/USD 1y1y FVA at 8.1/8.5 vols indic*

### Systematic pair mean-reversion in FX vol

In this section, we summarize current recommendations from mean-reversion analysis on FX vol pairs introduced as a special section later in this note. Underlyings considered are 1y ATM vols for G10/EM USD-crosses. Spreads are beta-adjusted and dislocations are measured as 2yr z-scores (threshold for trading signals is set at 1.5). When looking at dislocations for G10 (**Exhibit 14**) and EM (**Exhibit 15**) vols and spreads, the first thing we notice is that while vols appear as undervalued (given the steady drop of vols over the past two years), most spreads are more fairly valued: L/S plays are naturally hedged against generalized trends in vol, opening the way for capturing relative dislocations. We

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recall that good candidates for mean reversion pair trades via vols should fulfill two pre-requisites, one related to the current mispricing on the spread and one related to its property to mean revert (as expressed by short half-life and low ADF statistics).

Within G10, USD/NOK vol stands out as cheap, and especially against USD/CAD, EUR/USD, AUD/USD, NZD/USD and USD/SEK vols. All NOK spreads pass the tests of short half-lives / low ADF statistics supporting the strong mean reversion properties. Long vol trades on NOK would be supported were the Norges Bank hiking bias to continue into 2020 (expectation from the Economics team is that rates will stay unchanged for next year). The strategy team supports a long NOK/SEK view into 2020 which, based on the signal above, could be expressed as a RV between USD put spreads. Otherwise, given the tightening of USD/NOK riskies to near zero, a repricing of vols could also occur as NOK appreciates, allowing to implementing the trade via delta-hedged USD/NOK puts instead.

*Long 1y USD/NOK 25delta put @ 8.25/8.85 vols indic / short 1y USD/SEK straddle @ 8.1 vols choice, both legs delta-hedged*

In Asia, KRW vol is modestly undervalued against SGD vol, in beta-adjusted terms. Within EM, a long USD/HUF / short USD/PLN vol spread in CEEMEA is also supported from a mean reversion angle. The EM team is currently running a long call spread trade on USD/HUF (*EMEA EM Local Markets Compass*, Siddiqui et al, 12 September) and maintains a better outlook on PLN than HUF into 2020. However, they recently recommended increased caution on PLN given the large outstanding CHF-denominated mortgages exposing the currency to possible spikes in vols (*Poland's CHF loan issue: It ain't over till it's over*, Christovova et al, 4 November).

*Long 1y USD/HUF ATM straddle @ 7.8/8.5 vols indic / short 1y USD/PLN straddle @ 7.4 vols choice, both legs delta-hedged*

### Changes to our FX vol model portfolio

**We close all our existing trades in the portfolio**: a USD/PLN vs EUR/PLN 2M vol spread; a short USD 3M USD/JPY risk-reversal delta-hedged; a long EUR/INR 2y put; a short 6wk EUR/CNH at-expiry digital range; a short 1M / long 3M delta hedged straddles on USD/BRL.

**Exhibit 14. Dislocations (2yr z-score) within G10 1Y ATM vol space**

| | EUR-USD | USD-NOK | USD-SEK | GBP-USD | USD-CAD | AUD-USD | NZD-USD | USD-CHF | USD-JPY |
|---|---|---|---|---|---|---|---|---|---|
| EUR-USD | -1.78 | 1.99 | 1.41 | 0.29 | -1.11 | 0.43 | 0.36 | -0.14 | 0.51 |
| USD-NOK | -1.99 | -1.10 | -1.05 | -0.31 | -2.02 | -1.81 | -1.83 | -1.51 | -0.77 |
| USD-SEK | -1.41 | 1.05 | -1.27 | -0.04 | -1.47 | -0.80 | -0.83 | -0.80 | -0.29 |
| GBP-USD | -0.29 | 0.31 | 0.04 | -0.63 | -0.45 | -0.22 | -0.24 | -0.30 | -0.09 |
| USD-CAD | 1.11 | 2.02 | 1.47 | 0.45 | -1.94 | 0.94 | 1.09 | 0.48 | 1.21 |
| AUD-USD | -0.43 | 1.81 | 0.80 | 0.22 | -0.94 | -2.00 | -0.28 | -0.35 | 0.15 |
| NZD-USD | -0.36 | 1.83 | 0.83 | 0.24 | -1.09 | 0.28 | -1.87 | -0.34 | 0.27 |
| USD-CHF | 0.14 | 1.51 | 0.80 | 0.30 | -0.48 | 0.35 | 0.34 | -1.58 | 1.01 |
| USD-JPY | -0.51 | 0.77 | 0.29 | 0.09 | -1.21 | -0.15 | -0.27 | -1.01 | -0.99 |

Source: J.P. Morgan

**Exhibit 15. Dislocations (2yr z-score) within EM 1Y ATM vol space**

| | USD-BRL | USD-MXN | USD-TRY | USD-ZAR | USD-HUF | USD-SGD | USD-PLN | USD-KRW |
|---|---|---|---|---|---|---|---|---|
| USD-BRL | -1.04 | -0.06 | -0.71 | -0.12 | 0.73 | 0.46 | 0.42 | 0.53 |
| USD-MXN | 0.06 | -1.61 | -0.66 | -0.05 | 1.33 | 1.12 | 0.94 | 1.28 |
| USD-TRY | 0.71 | 0.66 | -0.78 | 0.72 | 0.74 | 0.71 | 0.71 | 0.71 |
| USD-ZAR | 0.12 | 0.05 | -0.72 | -1.00 | 0.70 | 0.44 | 0.43 | 0.51 |
| USD-HUF | -0.73 | -1.33 | -0.74 | -0.70 | -1.46 | -0.71 | -2.06 | -0.38 |
| USD-SGD | -0.46 | -1.12 | -0.71 | -0.44 | 0.71 | -1.46 | -0.28 | 0.46 |
| USD-PLN | -0.42 | -0.94 | -0.71 | -0.43 | 2.06 | 0.28 | -1.83 | 0.68 |
| USD-KRW | -0.53 | -1.28 | -0.71 | -0.51 | 0.38 | -0.46 | -0.68 | -1.60 |

Source: J.P. Morgan

**We open the following new trades**:

*Buy an equally weighted basket of 6M ATM straddles across USD/ZAR, USD/KRW and USD/HUF (indic. vols 13.35/13.75, 6.4/6.6, 7.1/7.6 respectively) vs. sell an equally weighted basket of 6M ATM straddles on AUD/USD and NZD/USD (6.7 and 7.25 change vols respectively)*

*Buy 3M3M USD/CHF FVA @5.45/5.8indic*

*Buy long GBP/USD 1y1y FVA at 8.1/8.5 vols indic*

*Long 1y USD/NOK 25delta put @ 8.25/8.85 vols indic / short 1y USD/SEK straddle @ 8.1 vols choice, both legs delta-hedged*

*Long 1y USD/HUF ATM straddle @ 7.8/8.5 vols indic / short 1y USD/PLN straddle @ 7.4 vols choice, both legs delta-hedged*

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# Special topic: Playing mean reversion in FX vol pairs

- **We introduce a novel framework whose goal is that of assessing the long-term systematic value of playing the mean reversion theme on FX volatility spreads.**

- **Well-known statistical methods are introduced for assessing why and when given FX vol spreads prove as good candidates for mean-reversion plays.**

- **We provide substantial factual evidence supporting our hypotheses, in the form of backtests involving plain vanillas, vol swaps and FVAs.**

- **Future studies will investigate more in detail the impact of trading costs and the potential of a class of filters with proven track record on vol strategies.**

## Should mean reversion be your friend?

The mean-reversion theme is usually looked after as the holy grail of the investment process. Its low correlation with other well-established investment strategies makes it a powerful ally for reducing volatility and drawdown of diversified portfolios. Its typically good performance during high-vol markets makes it an appealing candidate for implementing risk-off strategies. In the volatility space, successful mean-reversion strategies prevented trading books from being hurt by the secular bearish trend experienced by vol levels (especially FX ones) post-GFC.

**Exhibit 1. High correlations for 1 year ATM volatilities**
Correlation matrix for daily changes in 1Y ATM vols in both G10 (above) and EM (below). Time period considered between 2004 and 2019

| | EUR-USD | USD-NOK | USD-SEK | GBP-USD | USD-CAD | AUD-USD | NZD-USD | USD-CHF | USD-JPY |
|---|---|---|---|---|---|---|---|---|---|
| EUR-USD | 100% | 89% | 94% | 68% | 53% | 55% | 50% | 93% | 52% |
| USD-NOK | 89% | 100% | 92% | 64% | 53% | 54% | 50% | 83% | 50% |
| USD-SEK | 94% | 92% | 100% | 66% | 53% | 55% | 51% | 89% | 50% |
| GBP-USD | 68% | 64% | 66% | 100% | 47% | 49% | 45% | 62% | 44% |
| USD-CAD | 53% | 53% | 53% | 47% | 100% | 59% | 54% | 51% | 46% |
| AUD-USD | 55% | 54% | 55% | 49% | 59% | 100% | 88% | 51% | 60% |
| NZD-USD | 50% | 50% | 51% | 45% | 54% | 88% | 100% | 47% | 55% |
| USD-CHF | 93% | 83% | 89% | 62% | 51% | 51% | 47% | 100% | 50% |
| USD-JPY | 52% | 50% | 50% | 44% | 46% | 60% | 55% | 50% | 100% |

| | USD-BRL | USD-MXN | USD-TRY | USD-ZAR | USD-HUF | USD-SGD | USD-PLN | USD-KRW |
|---|---|---|---|---|---|---|---|---|
| USD-BRL | 100% | 55% | 29% | 28% | 24% | 16% | 29% | 27% |
| USD-MXN | 55% | 100% | 35% | 36% | 28% | 18% | 36% | 32% |
| USD-TRY | 29% | 35% | 100% | 48% | 28% | 19% | 37% | 21% |
| USD-ZAR | 28% | 36% | 48% | 100% | 27% | 28% | 37% | 30% |
| USD-HUF | 24% | 28% | 28% | 27% | 100% | 18% | 52% | 20% |
| USD-SGD | 16% | 18% | 19% | 28% | 18% | 100% | 30% | 47% |
| USD-PLN | 29% | 36% | 37% | 37% | 52% | 30% | 100% | 27% |
| USD-KRW | 27% | 32% | 21% | 30% | 20% | 47% | 27% | 100% |

Source: J.P. Morgan

Cross-asset volatility premia typically exhibit large and positive correlations with each other. This is confirmed when looking at the FX vol space (Exhibit 1, daily

correlations, using 15yrs of data), suggesting higher correlations with G10 than for EM. This suggests that, when considering vol spreads (differences of vol levels), directional sensitivities might offset each other, opening the way for isolating and trading the mean-reverting component associated with volatility dynamics. A direct inspection of Exhibit 2, focusing on the USD/NOK - USD/CAD 1y ATM vol spread, suggests its mean-stationary and heteroscedastic properties.

**Exhibit 2. Some spreads show high stationarity**
Time series of the volatility spread between USD/NOK 1Y ATM vol and USD/CAD 1Y ATM vol. The scale of the graph is Vol points.
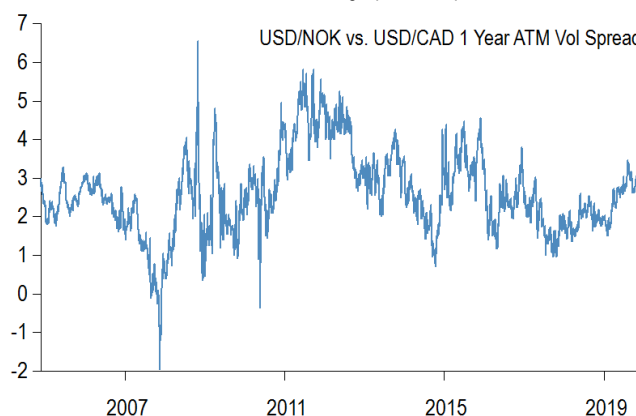


Source: J.P. Morgan

The goal of this paper is that of turning the empirical observations above into a well-defined framework for measuring and trading mean-reversion properties displayed by FX volatilities. We will start by introducing a statistical model for defining these properties more precisely, before showing actual trading implementations.

## A statistical framework for assessing FX vol mean-reversion properties

We now introduce more precise statistical analyses relating to mean-reversion properties of (financial) time series. The first concept we introduce is that of stationarity, i.e. whether an asset displays the property of oscillating around long-term reference levels. For the purpose, we introduce an augmented Dickey-Fuller (ADF) test. Without entering into technicalities here, low levels of the corresponding statistics support the hypothesis that an asset satisfies mean-reversion properties. If we take a look at Exhibit 3 we can see that most FX volatility spreads in both G10 and EM pass the stationarity test (88% of cases for G10 and 92% for EM, at the 5% significance level). By using the same metric, only 29% of the vol levels would pass the same test, thus highlighting the advantage of playing with volatility spreads instead of volatility levels.

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**Exhibit 3. FX volatility spreads show significant mean reversion**
p–values obtained when fitting an augmented Dickey–Fuller test (ADF) to beta-adj. 1Y ATM Volatilities (diagonal elements) and spreads of those volatilities (non-diagonal elements). Note that if the horizontal currency is X1 and the vertical currency X2, then X1-X2 is definded as the spread. The top table is for G10 currencies and the bottom table for EM currencies. Time period considered between 2004 and 2019

| | EUR-USD | USD-NOK | USD-SEK | GBP-USD | USD-CAD | AUD-USD | NZD-USD | USD-CHF | USD-JPY |
|---|---|---|---|---|---|---|---|---|---|
| EUR-USD | 38% | 1% | 11% | 20% | 2% | 0% | 1% | 0% | 0% |
| USD-NOK | 1% | 36% | 5% | 2% | 0% | 0% | 0% | 2% | 0% |
| USD-SEK | 11% | 5% | 35% | 6% | 1% | 0% | 0% | 3% | 0% |
| GBP-USD | 20% | 2% | 6% | 7% | 0% | 0% | 4% | 27% | 0% |
| USD-CAD | 2% | 0% | 1% | 0% | 22% | 0% | 0% | 3% | 1% |
| AUD-USD | 0% | 0% | 0% | 0% | 0% | 15% | 3% | 1% | 3% |
| NZD-USD | 1% | 0% | 0% | 4% | 0% | 3% | 33% | 1% | 2% |
| USD-CHF | 0% | 2% | 3% | 27% | 3% | 1% | 1% | 23% | 1% |
| USD-JPY | 0% | 0% | 0% | 0% | 1% | 3% | 2% | 1% | 24% |

| | USD-BRL | USD-MXN | USD-TRY | USD-ZAR | USD-HUF | USD-SGD | USD-PLN | USD-KRW |
|---|---|---|---|---|---|---|---|---|
| USD-BRL | 1% | 9% | 1% | 0% | 3% | 1% | 2% | 0% |
| USD-MXN | 9% | 1% | 1% | 2% | 7% | 1% | 4% | 0% |
| USD-TRY | 1% | 1% | 0% | 1% | 1% | 1% | 1% | 1% |
| USD-ZAR | 0% | 2% | 1% | 0% | 3% | 0% | 0% | 1% |
| USD-HUF | 3% | 7% | 1% | 3% | 22% | 1% | 0% | 4% |
| USD-SGD | 1% | 1% | 1% | 0% | 1% | 9% | 2% | 0% |
| USD-PLN | 2% | 4% | 1% | 0% | 0% | 2% | 15% | 0% |
| USD-KRW | 0% | 0% | 1% | 1% | 4% | 0% | 0% | 2% |

Source: J.P. Morgan

The second question we tackle is that of measuring the expected time interval over which we could expect a dislocation to correct. For the purpose, we rely on a simple autoregressive AR(1) model, already introduced in the context of vol strategies for linking mean-reversion properties on the underlying asset with an optimal delta-hedging strategy (*Optimal option delta-hedging – Uncovering the link between mean-reversion and options strategies across markets*, Ravagli et al, November 2018):

$$\sigma_t - \mu_p = \rho \left( \sigma_{t-\Delta t} - \mu_p \right) + \varepsilon_t \quad (1)$$

where $\sigma_t$ is the value of the time series process at time t, $\mu_p$ is the mean of the time series process, $\rho$ is the autoregressive coefficient and $\varepsilon_t$ is the noise term at time t. Without entering into technicalities, dislocations within the AR(1) model framework, can be measured via standard z-scores. The autoregressive coefficient, responsible for the serial correlation properties, can be traded for the more "hands-on" half-life one, which measures the typical time horizon over which a dislocation corrects back by half.

Empirical analysis shows that vol spreads tend to have shorter half-lives than vol levels (Exhibit 4, 5) and also have lower p-values in the ADF test (Exhibit 5), thus reinforcing the view that the former are more mean reverting than the latter and, thus, a better vehicle for vol trading from this standpoint. The combination of Exhibit 3 and 4 - ADF tests and half-lives - highlight opportunities in spreads that are not only statistically mean-reverting, but also have a short half-live, thus making it appealing from a trading perspective. It would be of little use to have a very

mean reverting volatility spread with a half-life spanning years.

**Exhibit 4. Half-lives of volatility levels and spreads**
Half-lives for 1Y ATM Volatilities (diagonal elements) and beta- adj. spreads of those volatilities (non-diagonal elements). If the horizontal currency is X1 and the vertical currency X2, then X1-X2 is defided as the spread. Time period considered between 2004 and 2019

| | EUR-USD | USD-NOK | USD-SEK | GBP-USD | USD-CAD | AUD-USD | NZD-USD | USD-CHF | USD-JPY |
|---|---|---|---|---|---|---|---|---|---|
| EUR-USD | 310 | 118 | 200 | 173 | 90 | 43 | 49 | 88 | 67 |
| USD-NOK | 118 | 328 | 95 | 118 | 52 | 22 | 26 | 95 | 55 |
| USD-SEK | 200 | 95 | 359 | 147 | 72 | 34 | 37 | 116 | 58 |
| GBP-USD | 173 | 118 | 147 | 255 | 73 | 69 | 81 | 176 | 77 |
| USD-CAD | 90 | 52 | 72 | 73 | 345 | 40 | 27 | 94 | 59 |
| AUD-USD | 43 | 22 | 34 | 69 | 40 | 257 | 59 | 58 | 60 |
| NZD-USD | 49 | 26 | 37 | 81 | 27 | 59 | 235 | 54 | 57 |
| USD-CHF | 88 | 95 | 116 | 176 | 94 | 58 | 54 | 199 | 81 |
| USD-JPY | 67 | 55 | 58 | 77 | 59 | 60 | 57 | 81 | 161 |

| | USD-BRL | USD-MXN | USD-TRY | USD-ZAR | USD-HUF | USD-SGD | USD-PLN | USD-KRW |
|---|---|---|---|---|---|---|---|---|
| USD-BRL | 90 | 66 | 100 | 38 | 75 | 38 | 67 | 45 |
| USD-MXN | 66 | 100 | 115 | 52 | 69 | 33 | 53 | 22 |
| USD-TRY | 100 | 115 | 111 | 104 | 126 | 114 | 126 | 113 |
| USD-ZAR | 38 | 52 | 104 | 130 | 95 | 56 | 95 | 58 |
| USD-HUF | 75 | 69 | 126 | 95 | 414 | 51 | 25 | 46 |
| USD-SGD | 38 | 33 | 114 | 56 | 51 | 238 | 46 | 30 |
| USD-PLN | 67 | 53 | 126 | 95 | 25 | 46 | 498 | 37 |
| USD-KRW | 45 | 22 | 113 | 58 | 46 | 30 | 37 | 144 |

Source: J.P. Morgan

**Exhibit 5. Spreads are more mean revering than volatility levels**
Half-lives (left) and p–values (right) obtained when fitting an AR (1) model and augmented Dickey–Fuller test (ADF) repectively to 1Y ATM volatility spreads in EM and G10. Time period considered between 2004 and 2019
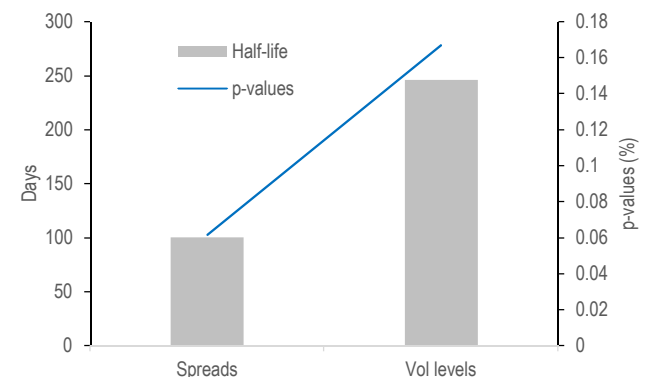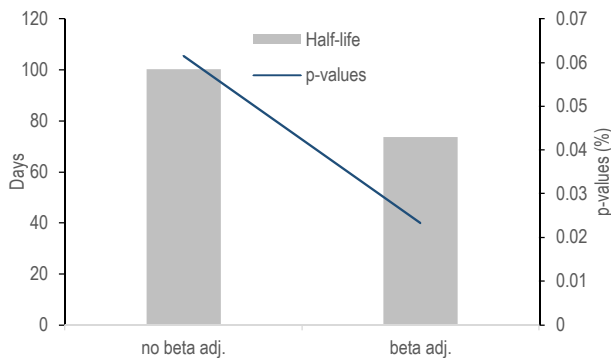


Source: J.P. Morgan

In Exhibits 3-5 the reader may notice that we are not calculating the ADF tests and half-lives on volatility spreads but on "beta adjusted" volatility spreads. This adjustment consists in first running a PCA on the all the volatilities in the question, and subsequently measuring the individual volatilities' betas on the first principal component. This first principal component can be interpreted as the common market risk to which all volatilities are exposed. The beta adjustment then consists in scaling each volatility by the inverse of the coefficient obtained in this regression, before calculating the spread. This adjustment, further reducing the directionality element associated with a spread, helps isolating its idiosyncratic

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component, thus making it significantly more mean revering – as it can be seen in Exhibit 6.

#### Exhibit 6. Beta adjusting significantly improves stationarity
AR(1) model half-lives (left) and ADF test p–values (right) applied repectively to beta and non-beta adjusted 1Y ATM volatility spreads in EM and G10. Time period considered between 2004 and 2019



Source: J.P. Morgan

We stress a small forward looking bias in the procedure above, as the betas are calculated using the principal component calculated over the full back test. This bias will be amended in future work, given that this paper constitutes some sort of preliminary analysis on the matter. Nonetheless, the betas tend to be stable and the bias is somewhat indirect so we do not expect a large change in results by removing such bias in the future. We also stress the lack of other in sample biases throughout the piece – i.e. no parameters or rules were optimized.

#### Exhibit 7. There are more opportunities currently in G10 than EM
Current 2-year z-score of the to beta- adj. 1Y ATM Volatilities and spreads for G10 and EM. If the horizontal currency is X1 and the vertical currency X2, thwn X1-X2 is defided as the spread.

| | EUR-USD | USD-NOK | USD-SEK | GBP-USD | USD-CAD | AUD-USD | NZD-USD | USD-CHF | USD-JPY |
|---|---|---|---|---|---|---|---|---|---|
| EUR-USD | -1.78 | 1.99 | 1.41 | 0.29 | -1.11 | 0.43 | 0.36 | -0.14 | 0.51 |
| USD-NOK | -1.99 | -1.10 | -1.05 | -0.31 | -2.02 | -1.81 | -1.83 | -1.51 | -0.77 |
| USD-SEK | -1.41 | 1.05 | -1.27 | -0.04 | -1.47 | -0.80 | -0.83 | -0.80 | -0.29 |
| GBP-USD | -0.29 | 0.31 | 0.04 | -0.63 | -0.45 | -0.22 | -0.24 | -0.30 | -0.09 |
| USD-CAD | 1.11 | 2.02 | 1.47 | 0.45 | -1.94 | 0.94 | 1.09 | 0.48 | 1.21 |
| AUD-USD | -0.43 | 1.81 | 0.80 | 0.22 | -0.94 | -2.00 | -0.28 | -0.35 | 0.15 |
| NZD-USD | -0.36 | 1.83 | 0.83 | 0.24 | -1.09 | 0.28 | -1.87 | -0.34 | 0.27 |
| USD-CHF | 0.14 | 1.51 | 0.80 | 0.30 | -0.48 | 0.35 | 0.34 | -1.58 | 1.01 |
| USD-JPY | -0.51 | 0.77 | 0.29 | 0.09 | -1.21 | -0.15 | -0.27 | -1.01 | -0.99 |

| | USD-BRL | USD-MXN | USD-TRY | USD-ZAR | USD-HUF | USD-SGD | USD-PLN | USD-KRW |
|---|---|---|---|---|---|---|---|---|
| USD-BRL | -1.04 | -0.06 | -0.71 | -0.12 | 0.73 | 0.46 | 0.42 | 0.53 |
| USD-MXN | 0.06 | -1.61 | -0.66 | -0.05 | 1.33 | 1.12 | 0.94 | 1.28 |
| USD-TRY | 0.71 | 0.66 | -0.78 | 0.72 | 0.74 | 0.71 | 0.71 | 0.71 |
| USD-ZAR | 0.12 | 0.05 | -0.72 | -1.00 | 0.70 | 0.44 | 0.43 | 0.51 |
| USD-HUF | -0.73 | -1.33 | -0.74 | -0.70 | -1.46 | -0.71 | -2.06 | -0.38 |
| USD-SGD | -0.46 | -1.12 | -0.71 | -0.44 | 0.71 | -1.46 | -0.28 | 0.46 |
| USD-PLN | -0.42 | -0.94 | -0.71 | -0.43 | 2.06 | 0.28 | -1.83 | 0.68 |
| USD-KRW | -0.53 | -1.28 | -0.71 | -0.51 | 0.38 | -0.46 | -0.68 | -1.60 |

Source: J.P. Morgan

To summarize, we have defined three conditions for defining an appealing mean-reversion trade: an established mean-reversion property, a short half-life and a current dislocation. Beta-adjustment of spreads should strengthen the first two conditions. Current 2yr z-scores for 1y ATM

vols and spreads are reported in Exhibit 7: at present, there are more dislocations in the G10 than EM spaces.

#### Exhibit 8. Front end of volatility curve is more mean reverting
Half-lives (left) and p–values (right) for different maturities of the EUR/USD ATM volatility curve. Time period considered between 2004 and 2019
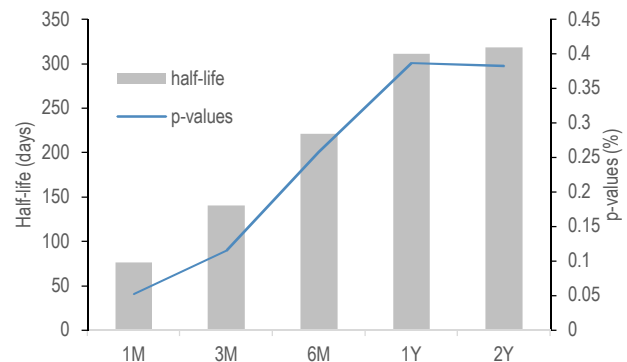


Source: J.P. Morgan

Results shown so far point to the observation that FX vols and spread display good mean reverting properties. Another very legitimate question could be, which segment of the vol curve is more mean reverting. A case study on EUR/USD (Exhibit 8) points to front-end of the curve as displaying stronger mean-reversion properties, and opens the way for investigating the potential (not covered in this piece) of vol curve mean reversion strategies.

## Trading FX vol spreads mean reversion

The next question is how to build a trading system that profits from the results above. In order to achieve that, we implement a back-testing strategy that trades when the difference between the current vol spread level and its historical average is high (in either direction). As discussed, we measure such dislocations via z-scores. We use an arbitrary (albeit common) z-score threshold of 1.5 (both ways), and a look-back period of 2-years, which is a compromise between having sufficient data (long window) to measure dislocations and enough reactivity (short window). Such an underfitted approach should deliver more stable results when running the system live. The z-score signal is monitored on a daily basis, meaning that if it breaches the threshold for a given day, a new trade is initiated that day regardless of what is in the book already.

We start by implementing the strategy on 1yr vols. This offers a good tradeoff between higher Vega sensitivity on the farther end of the curve, allowing the trades to be pure bets on vol levels, and stronger mean-reversion on the front end (as seen in Exhibit 8). To start with, we consider a holding period of 1 month for all trades. The low holding period to time to maturity ratio should permit to keep a clean Vega sensitivity for the trades before other

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sensitivities (i.e., Gamma) kick in. We'll come back to the choice of an optimal holding period later, especially when taking into account trading costs.

The next question regards the choice of the instruments for trading the mean reversion strategy described above. For simplicity, and for ensuring a good liquidity for both G10 and EM USD pairs, we start looking at plain vanillas. In order to track the performance of our strategy we introduce a benchmark we refer to as "Layman's test" (LMT). This test mimics the strategy described above, assuming that the change in rolling, fixed maturity ATM vol, was a tradable quantity. So for instance, if we look at Exhibit 7 we could say that, using that data, the Layman's test would bet on a higher USD/HUF 1Y vol and a lower USD/PLN 1Y vol – given the z-score of the spread. The final PNL for that trade would be the difference in the levels of the vols for both legs of the trade at the end of the 1 month holding period. This Layman's test is by no means a tradable strategy and is solely introduced as a proxy strategy, useful for assessing the potential of each mean reversion trade by isolating the Vega component that might otherwise be overshadowed when using real securities; for instance, with vanillas one would be exposed to other Greeks, with volatility swaps to realized vol, and with FVAs to the roll- down in the vol curve.

The spreads considered in the back-test include all the possible combinations for all the 9 volatilities in the USD/G10 crosses, as well as 5 USD/EM crosses (TRY, PLN, MXN, SGD and BRL). The period considered was January 2007 to November 2019. As a starting point, we do the back-test without considering the beta adjustment. The PNL is reported in vol points for both the Layman's test and the actual securities strategy. As a starting test, trading costs are not taken into account in the following back-tests. The inclusion of the average PNL per trade in the reported statistics might offer some guidance of how this might affect the final performance. We also stress that all PNLs as shown in this piece are not marked-to-market, i.e., we only consider PNL at time trades are unwound.

Looking at the results (Exhibit 9) we first note that the mean-reversion framework performs well on non-beta adjusted spreads. LMT achieves almost a 95% hit ratio, that is, the proportion of the trades that end up with a positive PNL, it also averages about 0.31 vol points per trade, and it scores about an average of 240 vol points per spread over the entire 12.5 years. However, when looking at the results on the plain vanillas, we see that the performance is more modest; the hit ratio drops to 70%, the average vol points per trade is 0.145, and the average final PNL per spread is just 103.8 vols over the same horizon. That means we only "capture" 43% of the Layman's test benchmark PNL. Both

the vanilla strategy and the Layman's test perform best on spreads involving MXN, BRL, NOK and SEK.

**Exhibit 9. Vanilla strategy 'captures' 43% of the Layman's test PNL**
Total PNL (left) and PNL per trade (right) for non-beta adj. LMT and plain vanilla strategy on 1Y ATM vols. Averaging over all spreads considered.
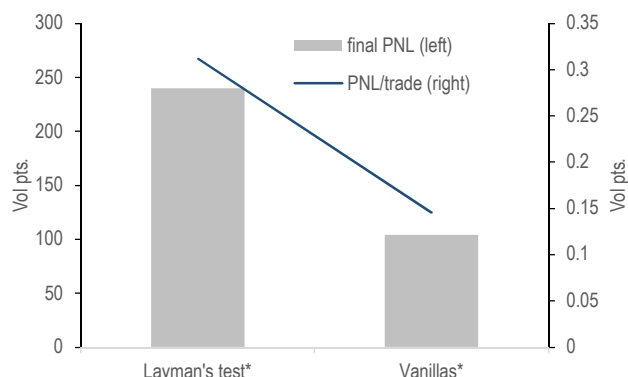


*USD/SGD not included in this back-test for ensuring homogeneous data set
Source: J.P. Morgan

The daily difference in performance between the vanilla strategy and LMT can be to a large extent explained by the difference between realized and implied vol at that time. The R-square for such relationship reaches values of up to 80% for some spreads. For the case in Exhibit 10, the R-square is 40%. Another factor affecting the difference in PNL is the roll down in the curve, although its impact is more modest in terms of R-square.

**Exhibit 10. Plain vanillas don't always match the Layman's test**
PNL of the Layman's test and of the strategy using plain vanillas for the EUR/USD vs. USD/JPY 1Y ATM vols. The vol spreads are not beta-adj.
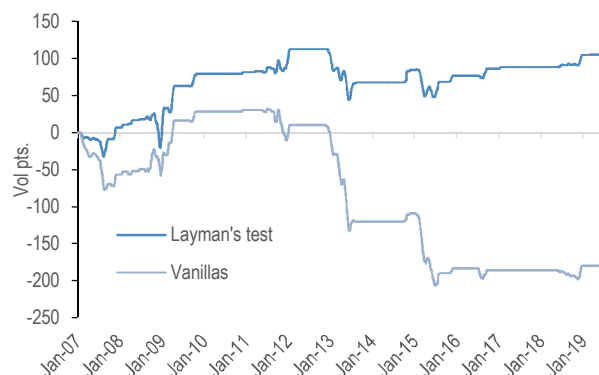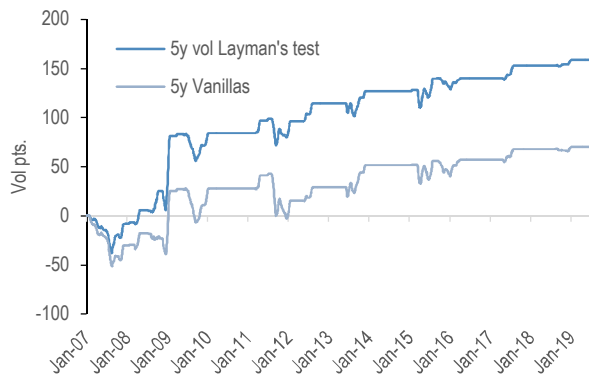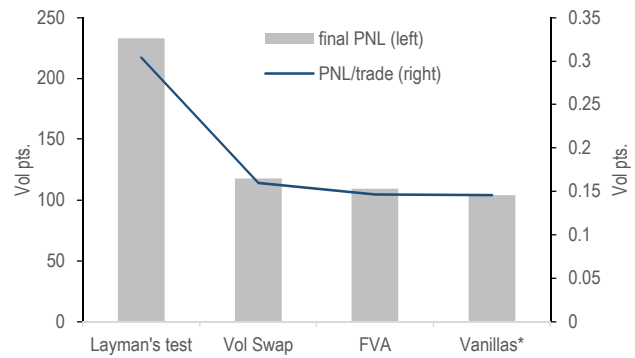


Source: J.P. Morgan

The fact that the difference between realized and implied vol explains the bulk of the difference in PNL (i.e., between actual strategy and LMT) means that if we implement the back-test using longer dated instruments, we could hope to obtain a better profile match between Layman's test and the vanilla strategy. This is because, the longer the maturity, the

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more vanillas become more of a pure Vega play, less sensitive to other factors. This is indeed the case when the compare Exhibit 11 to Exhibit 10. We can see there that by using 5Y vols instead of 1Y vols we would obtain a much closer profile match. Indeed the R-squared for the correlation between the vanilla strategy returns and Layman's test returns are only 60% with 1Y vols but 82% with 5Y vols. However, given the reduced liquidity for such long-dated vols, making them unsuitable for systematic trading purposes, such comparisons are drawn for illustrative purposes only.

**Exhibit 11. Longer dated vanillas behave similarly to LMT**
PNL of the Layman's test and of the strategy using 5Y vanillas for the EUR/USD vs.USD/JPY 5Y vols. The vol spreads are not beta-adj.



Source: J.P. Morgan

The scarce liquidity of 5Y vanillas naturally calls for the use of suitable exotic products for implementing the trades, with the goal of outperforming plain vanillas. The path sensitivity of the Greeks of plain vanillas could also play a role in determining the mismatch in PNLs referred to above (this could cause an asymmetric sensitivity PNL-wise to widening vs. tightening of the spreads). In the following, we will rely on 1Y Volatility Swaps (Vol Swaps) and 1Y x 1M Forward Volatility Agreements (FVAs). While Vol Swaps are naturally exposed to realized volatility, FVAs they are pure Vega instruments, although they differ with respect to LMT given their direct an exposure to the roll down of the curve. Both instruments resolve the issue of the Gamma/Vega path sensitivity associated with plain vanillas. For the back-test, the Vol Swaps are held for 1 month, and in the case of the FVAs they are held until expiry, which coincides with the 1 month holding period set for the strategy.

**Exhibit 12. Exotics capture mean reversion better than vanillas**
Final PNL (left) and PNL per trade (right) for the non-beta adj. Layman's test, FVA strategy and Vol Swap strategy for the 1Y ATM vols and averaging over all spreads considered



*USD/SGD not included in this back-test for ensuring homogeneous data set

Source: J.P. Morgan

Indeed, in Exhibit 12 we see that the difference in performance between the strategy and the Layman's test is reduced when we use FVAs and Vol Swaps (albeit just modestly). For the 1Y vanillas we saw that we capture 43% of the LMT PNL across spreads. In the case of FVAs this is increased to 47%, and for Vol Swaps to 51%. The hit ratio also rises from 70% in the case of the 1Y vanillas to 78% in FVAs – however it remains 70% in the case of the Vol Swaps. FVAs perform best on spreads involving MXN, BRL, SEK and NOK. Vol Swaps perform best on spreads involving MXN, BRL, EUR and GBP.

**Exhibit 13. FVAs profile closely matches that of the Layman's test**
PNL of Layman's test and of the strategy using FVAs for the USD/CAD vs. USD/NOK 1Y vols. The vol spreads are not beta-adj.
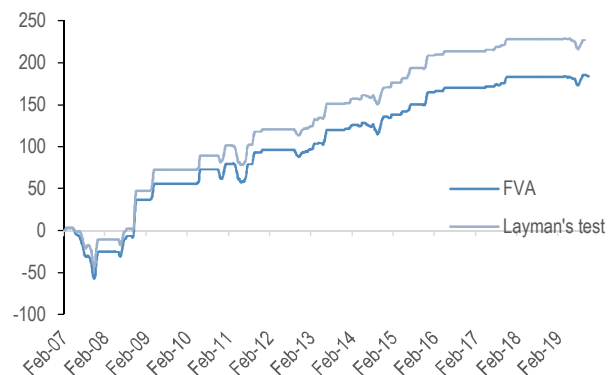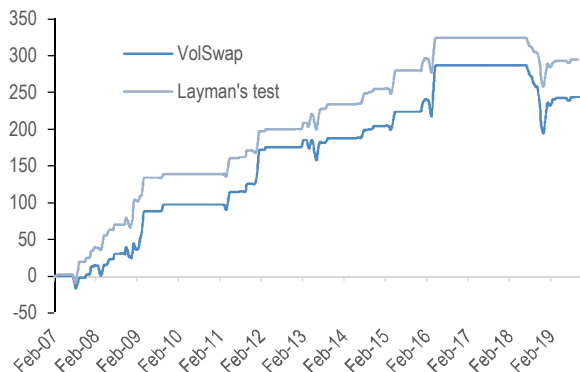


Source: J.P. Morgan

Exhibit 13, 14 display two case studies, USD/CAD vs USD/NOK with vol swaps and GBP/USD vs USD/JPY with FVAs, where actual PNLs match nicely LMT PNLs.

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**Exhibit 14. Vol Swap profile also closely matches the LMT one**
PNL of Layman's test and of the strategy using Vol Swaps for the GBP/USD vs. USD/JPY 1Y vols. The vol spreads are not beta-adj.
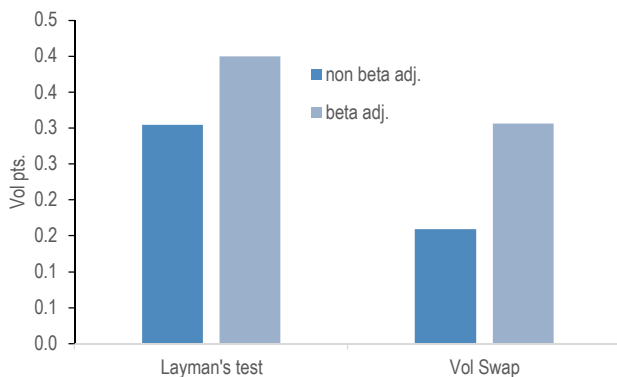


Source: J.P. Morgan

We now address whether or not the beta-adjustment described before can actually improve the potential of the mean-reversion trades. We do so by relying on the instruments whose non-beta adjusted back-tests looked more promising – Vol Swaps. Exhibits 15 and 16 suggest that such added value is significant. As it can be seen in Exhibit 15, the average PNL per trade in the case of LMT is increased by 31%, while that of the Vol Swaps by 92% - narrowing the gap between LMT and Vol Swap strategy performance. For the Vol Swap, the captured 51% of the potential set by LMT with no beta-adjustment rises to 78% after beta-adjustment. The hit ratio increases from 94% to 100% for LMT and from 70% to 85% for Vol Swaps. Beta-adj. LMT performs best on MXN, PLN, GBP and KRW spreads. Beta adj. Vol Swaps perform best on spreads involving MXN, CHF, PLN, EUR and GBP.

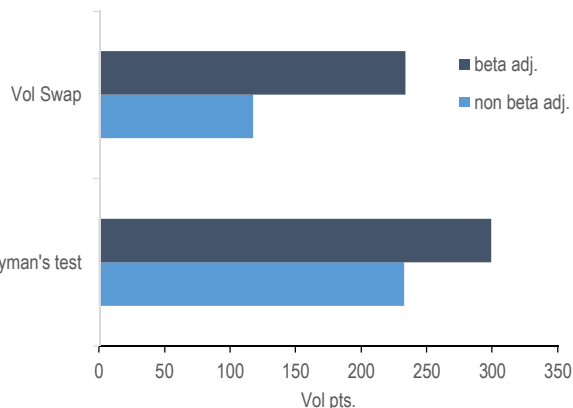**Exhibit 15. Beta adjustment increases mean-reversion potential**
Average PNL per trade across spreads for beta adj. and non-beta adj. Layman's test and Vol Swap strategy for 1Y vols



Source: J.P. Morgan

**Exhibit 16. Beta adjustment also reduces the gap between Layman's test and Vol Swap strategy**
Final PNL for beta adj. and non-beta adj. Layman's test and Vol Swap strategy



Source: J.P. Morgan

## Concluding remarks

In this piece we have introduced a novel methodology for tackling FX vol mean reversion, whose potential appears significant. Inclusion of MtM PNL allowing to rank strategies by Sharpe ratios, a more homogeneous coverage of EM vols and a proper assessment of the impact of trading costs top the list of topics worth additional analysis. In this respect, Exhibit 17 shows how the PnL of the trades would benefit from increasing the holding period, allowing the strategy to stand the impact of costs, while calling for additional work on the system's risk-management rules. A systematic assessment of the profitability of a set of trading indicators (short-dated Carry, long-term performance of the L/S legs, steepness of the curve etc.) should also be covered in future studies.

**Exhibit 17.  Longer holding periods might lead to higher PnLs**
PNL of Layman's test for the USD/NOK vs. USD/CAD 1Y vols for different holding periods. The vol spreads are not beta-adj.
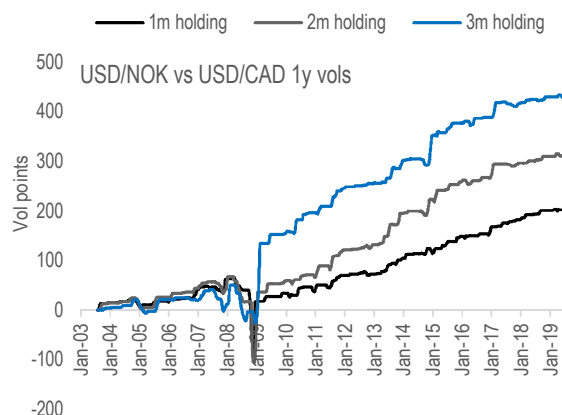


Source: J.P. Morgan

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**Global FX Strategy**
26 November 2019

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## Implied Volatilities

| | Current Implied Vols | | | Avg. Implied Vols | | | Z-Score Implied Vols | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1M | 3M | 1Y | 1M | 3M | 1Y | 1M | 3M | 1Y |
| AUDJPY | 8.5 | 8.9 | 10.7 | 12.7 | 13.0 | 13.5 | -1.4 | -1.7 | -1.6 |
| AUDUSD | 7.5 | 7.8 | 9.0 | 10.0 | 10.4 | 11.1 | -1.4 | -1.6 | -1.6 |
| CADJPY | 8.8 | 8.9 | 10.1 | 12.2 | 12.3 | 12.4 | -1.3 | -1.6 | -1.5 |
| CHFJPY | 6.9 | 7.2 | 8.5 | 9.8 | 10.2 | 10.8 | -1.5 | -2.0 | -2.0 |
| EURAUD | 7.3 | 7.5 | 8.6 | 10.1 | 10.4 | 10.9 | -1.2 | -1.5 | -1.5 |
| EURCAD | 7.2 | 7.1 | 7.9 | 9.7 | 9.9 | 10.2 | -1.2 | -1.5 | -1.5 |
| EURCHF | 5.5 | 5.8 | 6.4 | 5.7 | 6.2 | 7.0 | -0.1 | -0.4 | -0.6 |
| EURGBP | 8.1 | 7.8 | 8.4 | 9.7 | 9.9 | 10.0 | -0.6 | -1.1 | -1.3 |
| EURJPY | 8.0 | 8.1 | 9.8 | 10.6 | 11.0 | 11.3 | -1.1 | -1.7 | -1.5 |
| EURNOK | 6.1 | 6.1 | 6.5 | 8.1 | 8.3 | 8.6 | -1.2 | -1.5 | -1.6 |
| EURNZD | 8.2 | 8.0 | 9.0 | 10.9 | 11.2 | 11.6 | -1.1 | -1.5 | -1.6 |
| EURSEK | 5.8 | 5.7 | 6.1 | 6.3 | 6.6 | 7.0 | -0.6 | -1.2 | -1.3 |
| EURUSD | 7.1 | 6.9 | 7.5 | 8.8 | 9.1 | 9.3 | -1.0 | -1.6 | -1.6 |
| GBPJPY | 9.7 | 9.8 | 10.9 | 13.0 | 13.1 | 13.1 | -0.8 | -1.1 | -1.3 |
| GBPUSD | 8.6 | 8.5 | 8.8 | 9.9 | 10.2 | 10.3 | -0.4 | -0.7 | -1.1 |
| NZDUSD | 9.0 | 8.7 | 9.6 | 11.2 | 11.5 | 11.9 | -1.1 | -1.5 | -1.6 |
| USDCAD | 7.0 | 7.0 | 7.6 | 8.7 | 8.7 | 8.9 | -1.1 | -1.2 | -1.2 |
| USDCHF | 6.7 | 7.0 | 7.8 | 8.3 | 8.7 | 9.3 | -1.0 | -1.3 | -1.3 |
| USDCNH | 5.5 | 5.6 | 6.0 | 4.9 | 5.6 | 6.8 | 0.4 | -0.1 | -0.6 |
| USDJPY | 8.5 | 8.7 | 9.6 | 10.6 | 10.6 | 10.5 | -1.0 | -1.2 | -0.9 |
| USDNOK | 8.1 | 8.1 | 8.9 | 10.3 | 10.7 | 11.2 | -1.4 | -1.8 | -1.7 |
| USDSEK | 8.2 | 8.1 | 8.7 | 9.3 | 9.7 | 10.2 | -0.8 | -1.4 | -1.4 |
| USDBRL | 10.3 | 11.3 | 14.3 | 16.3 | 16.4 | 16.7 | -1.6 | -1.6 | -1.0 |
| USDCLP | 8.6 | 8.7 | 9.0 | 10.6 | 10.6 | 10.8 | -1.2 | -1.2 | -1.3 |
| USDMXN | 11.0 | 11.4 | 13.9 | 13.4 | 13.4 | 13.8 | -0.8 | -1.0 | 0.0 |
| EURCZK | 4.3 | 4.0 | 3.8 | 3.3 | 3.8 | 4.5 | 1.0 | 0.2 | -1.1 |
| EURHUF | 4.0 | 4.3 | 5.6 | 5.4 | 5.9 | 6.9 | -1.2 | -1.5 | -1.2 |
| EURPLN | 5.0 | 5.4 | 6.4 | 6.5 | 6.9 | 7.6 | -1.2 | -1.4 | -1.2 |
| EURRUB | 10.0 | 11.2 | 13.3 | 16.6 | 17.2 | 18.0 | -1.3 | -1.3 | -1.1 |
| USDRUB | 9.6 | 10.6 | 12.8 | 16.0 | 16.5 | 17.5 | -1.4 | -1.4 | -1.2 |
| USDTRY | 11.4 | 12.0 | 13.9 | 12.3 | 12.9 | 14.2 | -0.3 | -0.5 | -0.3 |
| USDZAR | 14.4 | 17.6 | 17.2 | 17.7 | 18.0 | 18.4 | -1.3 | -0.2 | -0.7 |
| USDIDR | 5.3 | 6.1 | 8.3 | 8.2 | 9.1 | 10.9 | -1.1 | -1.2 | -1.2 |
| USDINR | 5.0 | 5.5 | 6.9 | 5.5 | 6.2 | 7.6 | -0.7 | -0.9 | -0.8 |
| USDKRW | 7.7 | 8.4 | 9.9 | 10.3 | 10.7 | 11.3 | -2.2 | -2.2 | -1.6 |
| USDPHP | 4.3 | 4.5 | 5.2 | 4.4 | 4.6 | 5.1 | -0.2 | -0.2 | 0.3 |
| USDSGD | 4.5 | 4.6 | 5.1 | 6.0 | 6.2 | 6.4 | -1.2 | -1.3 | -1.4 |
| USDTWD | 4.4 | 4.6 | 5.6 | 6.3 | 6.5 | 6.8 | -1.8 | -1.9 | -1.5 |

## Biggest 3M Implied Volatility Movers
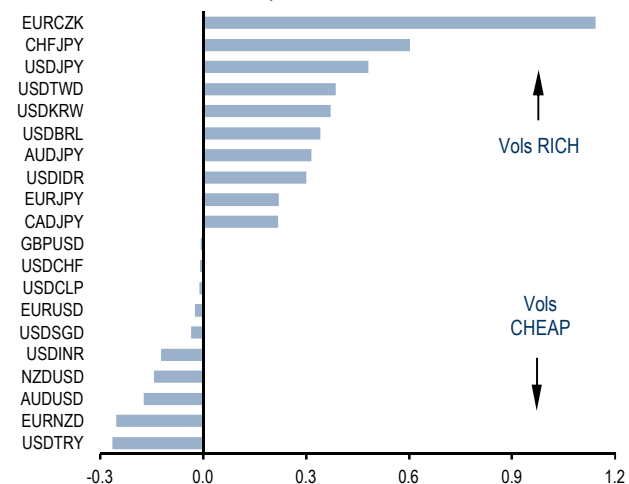
### Weekly Changes
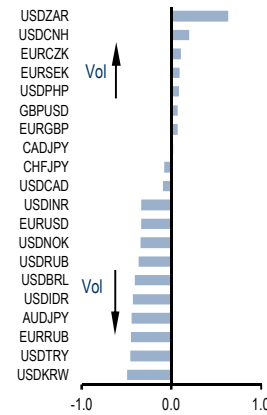


### Monthly Changes
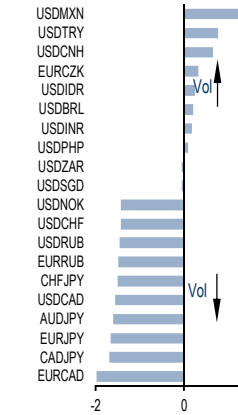


Source: J.P. Morgan

## Front-End Vol Rankings

In order of Normalized Volatility Risk Premium*



*Normalized Volatility Risk Premium = 1M Implied Vol / 1M Realized Vol − 1
Source: J.P. Morgan

## Current trade recommendations and P/L

| Description | Entry date | Entry | Current mid | P/L | P/L units | Remarks |
|---|---|---|---|---|---|---|
| Buy an equally weighted basket of 6M ATM straddles across USD/ZAR, USD/KRW and USD/HUF vs. sell an equally weighted basket of 6M ATM straddles on AUD/USD and NZD/USD | 26-Nov-19 | 2.3 | 2.0 | -0.4 | vol pts | Favoring EM vols vs.DM vols |
| Buy 3M3M USD/CHF FVA | 26-Nov-19 | 5.8 | 5.6 | -0.2 | vol pts | Owning Democratic primary event risk |
| Buy long GBP/USD 1y1y FVA | 26-Nov-19 | 8.5 | 8.3 | -0.2 | vol pts | Back-ended Brexit risk in 2020 |
| Long 1y USD/NOK 25delta put / short 1y USD/SEK straddle, both legs delta-hedged | 26-Nov-19 | 0.8 | 0.5 | -0.3 | vol pts | Systematic mean-reversion in vol |
| Long 1y USD/HUF ATM straddle / short 1y USD/PLN straddle, both legs delta-hedged | 26-Nov-19 | 1.1 | 0.8 | -0.4 | vol pts | Systematic mean-reversion in vol |
| Sell 6wk EUR/CNH 7.78-7.95 at-expiry digital range | 25-Oct-19 | 46.0 | 72.3 | -26.3 | % EUR | Take loss |
| Sell 1M vs. buy 3M USD/BRL delta-hedged straddles | 25-Oct-19 | 0.5 | 2.7 | -2.2 | vol pts | Take loss |
| Sell 3M25D USD/JPY risk reversals, delta-hedged | 27-Sep-19 | 1.7 | 2.1 | 0.4 | vol pts | Take profit |
| Buy 2M USD/PLN - EUR/PLN vol spread | 27-Sep-19 | 3.5 | 2.8 | -0.7 | vol pts | Take loss |
| Buy USD 33.33mio each of 7.05 strike USD/CNH call, 31.70 strike USD/TWD call and 1215 strike USD/KRW call vs. sell USD 75mio of 70.50 strike USD/INR call | 02-Aug-19 | 0 | -18 | -18 | bp USD | Take loss |
| Buy a 76.63 strike 2y EUR/INR put (spot ref.: 76.94) | 26-Jul-19 | 65 | 46 | -19 | bp EUR | Take loss |

Trades marked to market at 2:00pm BST Friday. High-conviction trades are starred. All other recommendations are moderate-conviction.

For delta-hedged straddles and vol products, P/L is in vol points; for directional trades, bp of notional; negative entry price indicates a net credit at inception

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