J.P.Morgan

Global Quantitative & Derivatives Strategy
09 December 2021

Building FX Vol portfolios

Practical takeaways for hedging and trading purposes

- **Portfolio construction techniques are nowadays a core feature that investable funds and indices are directly associated with. The impact on the performance of the strategies after applying the algos is such that the resulting boundary between risk-management and alpha generation can be sometimes blurred.**

- **In this report, we test a number of portfolio construction tools that can be applied to FX vol strategies, ranging from some of the well-established techniques for multi-asset portfolios to others that rely on J.P. Morgan proprietary algorithms. Volatility strategies sometimes escape the latter applications on a systematic basis, given the higher complexity they are associated with.**

- **We first test the applicability of a set of well-established portfolio construction tools to the universe of short-vol and long/short mean-reversion trades within the FX vol space. We find that equal Vega across legs is a reasonable starting point as an allocation tool. From the standpoint of yield-enhancement, Markowitz optimization applied to short-volatility trades would generally support a higher allocation towards the EMFX segment.**

- **We then expand on the applications of in-house sentiment indicators, originally devised for managing short-Gamma risk, towards the generation of RV long/short volatility trades. The resulting RV portfolios possess the desirable features of granting a positive correlation with long volatility strategies, while reducing considerably the negative time decay. As such, the RV strategy allows a significant diversification benefit, by leading to higher Sharpe ratios for multi-strategy portfolios including the RV strategy.**

- **The added value of applying the sentiment indicators for filtering exotic option trades, taking a view on vol- and vol-of-vol premia, is tested and confirmed.**

- **Future applications would naturally look at the cross-asset vol space for testing the stability of the results. A deeper analysis on the interplay between Greeks-sensitivity of a portfolio and risk management rules, depending on the strategy considered, could bring additional benefits. Finally, one could think of combining the two RV vol strategies that are reviewed throughout the report.**

Global Quantitative and Derivatives Strategy

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See page 14 for analyst certification and important disclosures, including non-US analyst disclosures.

Introduction

The first purpose of this note is that of shedding light on a rather important topic in the investment community, namely that of applying risk management & portfolio construction techniques to option portfolios. The increased difficulty of dealing with the non-linear features as embedded in options typically prevents a full applicability of the whole range of portfolio construction techniques that are normally suitable to other investable strategies. Risk parity/ERC, Markowitz, minimum variance are amongst the most popular portfolio allocation tools applied to linear cross-asset portfolios.

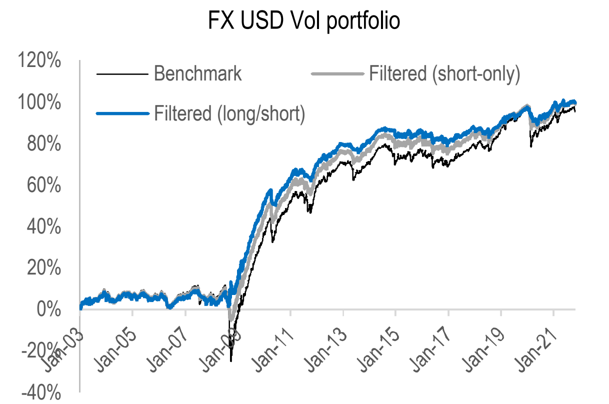
On the one hand, the path-dependence of the Greeks for an options book requires a dynamic approach when it comes to manage risk. On the other hand, the feasibility of unwinding/rebalancing option portfolios is challenged by the potentially significant (although, market-dependent) impact of trading costs, which limits the flexibility of adjusting portfolios' compositions relative to models' needs. One needs to strike a balance between the two instances, and adjusting just the new trades that enter a portfolio is a popular compromise.

The applications of risk-management tools to short-volatility (*Quantitative Perspectives on Cross-Asset Risk Premia*, July 2020, Tzotchev) and cross-asset risk premia (*Quantitative Perspectives on Cross-Asset Risk Premia*, May 2020, Tzotchev) strategies were already the subject of previous research notes by the J.P. Morgan Global Quantitative and Derivatives Strategy team.

A separate challenge is the possibility of a synthetic replication of long-volatility strategies with contained time decay. The theoretical appeal of systematic long-volatility strategies for hedging and diversification purposes is unquestioned, and so is their heavy cost of carry. On the other hand, short-volatility strategies are typically profitable in the long-run, but their occasional large drawdowns are not suitable to all investors. Long/short vol portfolios can offer a suitable compromise (*in medio stat virtus* as per the Latin proverb) and, depending on their features, proxy long- or short-vol exposure.

Previous research has described the use of *sentiment indicators* for adopting a tactical approach towards volatility trades. Exhibit 1 displays the added value of such filters to a portfolio of USD short-volatility trades. Using such indicators for portfolio construction purposes appears as a natural extension of the existing framework.

Exhibit 1. Sentiment indicators can significantly reduce the drawdowns associated with short-volatility trades



Source: J.P. Morgan

This note will address the two aforementioned topics. The first part will test directly the use of a number of standard risk-management/portfolio construction techniques to volatility portfolios. The second section will dig more into the use of tactical sentiment indicators for building volatility portfolios and for filtering exotic trades. While the analysis is of potential wider breadth, the note will restrict its coverage to the FX volatility market.

Risk managing vol portfolios

Vol as an asset class is typically offered to institutional clients into two main formats: in a systematic long-vol format as a tail hedge or via diversified short-vol portfolios for yield enhancement/carry generation purposes. On the latter topic, a proxy of a diversified portfolio of FX short-vol trades was introduced in the earlier report *Timing FX short-vol strategies: A systematic approach* (Ravagli and Duran-Vara, March 2019).

The first section of this note addresses the sensitivity of these results to the choice of the risk-management rules applied to each leg within the portfolio. In the earlier reports on short-vol portfolios, a simple equal vega allocation across currencies was assumed. We also review the impact of portfolio construction rules on a portfolio of long/short trades, setup to capture mean-reversion properties of FX vols (*Pair trading with FX vols*, Ravagli and Duran-Vara, February 2020).

We leave the door open to future, more in-depth analyses on cross-asset vol portfolios and on the interplay between risk-management and path-dependence of the Greek letters that are most relevant to the portfolios.

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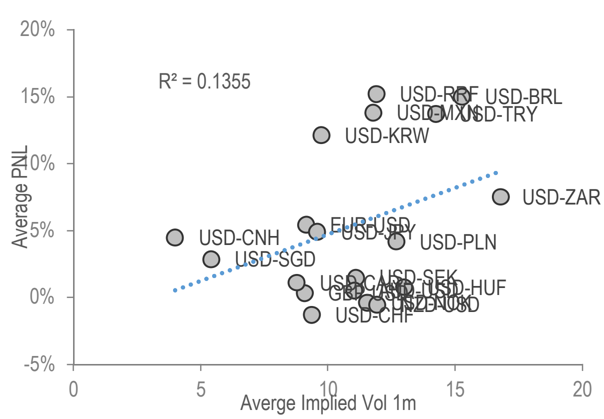
Basic risk management tools for vols

The first risk-management rules we test on short-vol portfolios are those where currency weights are scaled by the inverse of volatility. The intuition behind this approach is to diversify PnL generation and balancing the exposure to high-vol currencies (Exhibit 2). The creation of these portfolios is done in two different ways: a) scaling across currencies by the inverse implied volatility (1m ATM); and b) scaling by the inverse of the PnL volatility (estimated over different time windows) of the equal Vega strategy. In the following, *original* will stand for equal Vega scaling, as applied in the [earlier note](#) on vol-filtering.

The *benchmark* portfolio relies on the passive strategy always selling 1M 25delta strangles, with notionals chosen to ensure that options have the same Vega at inception across time/currencies (i.e., no filters are applied). On a daily basis, we cumulate positions by entering a new trade, kept in the book until expiry. We include 19 liquid US dollar pairs (9 G10 and 10 EM). FX options backtests herein presented refer to J.P. Morgan's internal pricing system. Starting dates for the backtests refer to January 2003, with the exception of TRY (Jan 05) and CNH (Jan 11), while final date September 2021.

In the following, we also refer to the *filtered* strategy, i.e. the portfolio that scales down Vega notionals when the sentiment indicators point to a higher-risk market. Finally, the so-called *filtered long* version, outlined [*here*](#), allows long gamma trades when, based on the indicators, risk-aversion is acute. When not specified, case studies below will refer to the benchmark case.

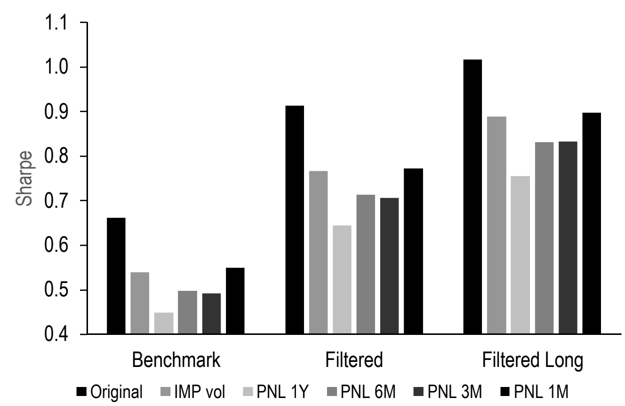
Exhibit 2. Correlation between average implied ATM volatility (1m), and average ann. PnL of the original strategy by currency.



Source: J.P. Morgan

Scaling by volatility is then done at inception for the three portfolios: when cumulating positions by entering a new trade on a daily basis, notionals are scaled by the inverse of volatility across currencies (by imposing that weights across currencies add up to 100%), rather than assigning an equal Vega weight, as in the original version.

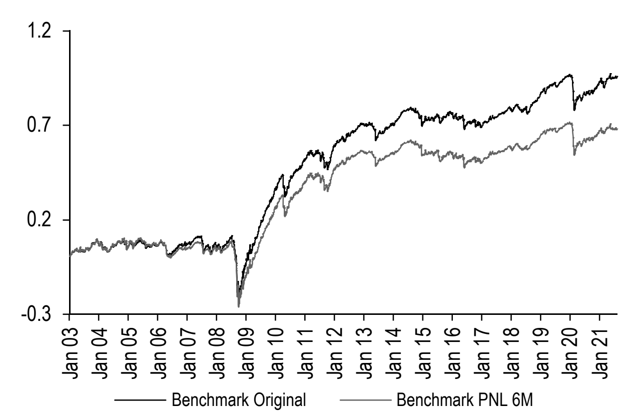
Exhibit 3. Sharpe ratios of the different portfolio construction techniques analyzed



Source: J.P. Morgan

In Exhibit 3, we compare the Sharpe ratios of the original short gamma strategies (benchmark, filtered and filtered long), versus the same strategies after 1/vol scaling. As mentioned previously, we consider volatility in different versions: 1m ATM implied volatility, and volatility of the PnL of the benchmark strategy (3m, 6m and 1y rolling standard deviations).

Exhibit 4. PnL of equal Vega and 6M PnL vol scaled strategies

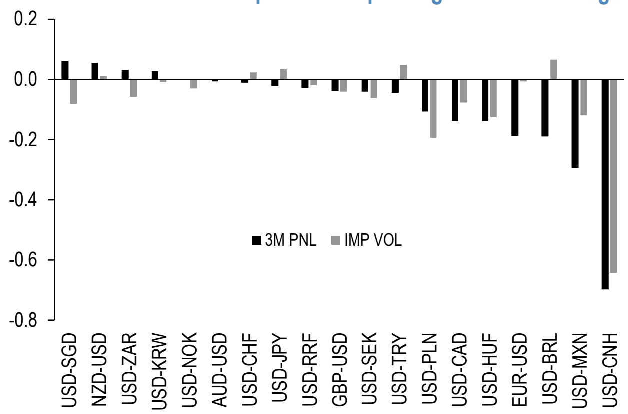


Source: J.P. Morgan

As one can see for illustrative purposes in Exhibit 4, 1/vol scaling leads to a reduction of Sharpe ratios. The greatest underperformance, in the benchmark case, comes from scaling by the inverse of the 1y PnL volatility (-32%), the lowest by scaling by the inverse 1m PnL volatility (-17%);

when scaling by implied volatility the drop is -18%. We now analyze a few case studies for better understanding such an impact on performance.

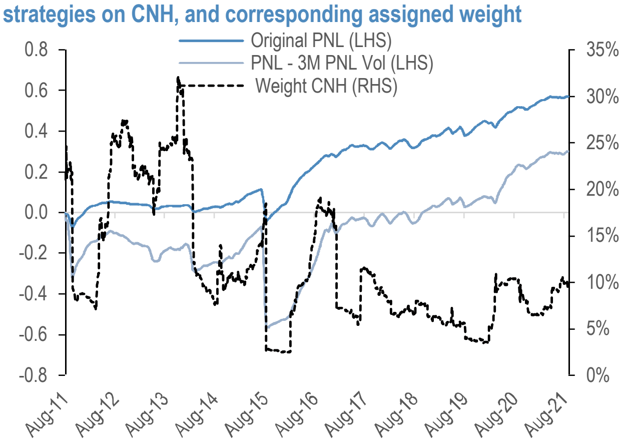
Exhibit 5. Difference in Sharpe ratios: equal Vega vs. 1/vol scaling



Source: J.P. Morgan

The difference in Sharpe ratio by currency for equal Vega vs. 1/vol scaling (implied vol and 3m PnL vol – Exhibit 5), shows a high degree of correlation between both sources of underperformance. We consider a few case studies for better understanding the reason for such a mismatch; for each currency considered, we apply a relative adjustment to the original benchmark strategies in agreement with the 1/vol scaling algo as applied at the portfolio level.

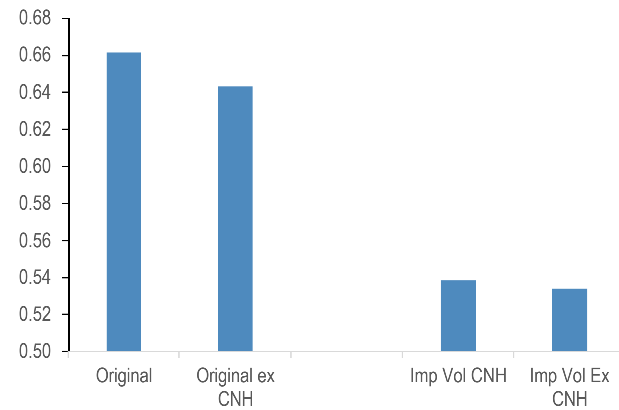
Exhibit 6. PnL time series for equal Vega and 3m PnL vol scaled strategies on CNH, and corresponding assigned weight



Source: J.P. Morgan

CNH tops the list of currencies most negatively impacted by the algo. The reason for the underperformance is that the (inverse) volatility portfolio was assigning a high weight to CNH before the August 2015 crash: almost 30% for implied vol, 20% for 3M PnL vol (Exhibit 6) vs. the equal weight of 5.3%. Such an elevated weight was due to the fact that, at the start of Aug 2015, 1m implied ATM vol for USD/CNH was as low as 1.95 vol pts, also implying a depressed PnL vol. This figure jumped to 10.25 vol pts by Aug 12th, causing a significant loss to the portfolio.

Exhibit 7. Sharpe ratios for equal Vega vs. implied vol scaled strategies, with and without CNH in the portfolio of currencies

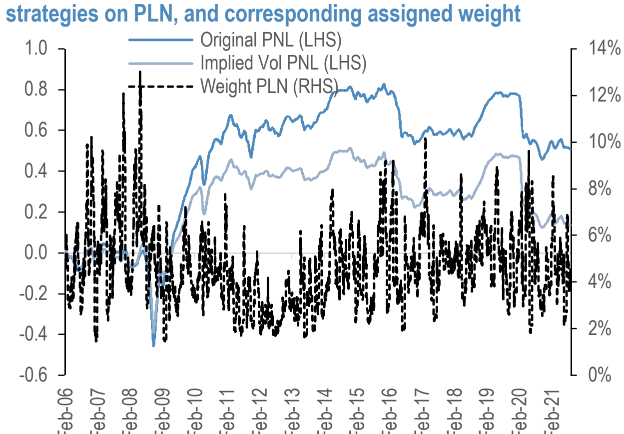


Source: J.P. Morgan

The case study highlighted shows that scaling by the inverse of volatility, without additional constraints, can be overly sensitive to abrupt shifts in volatility regimes, with a currency moving from a low-vol mode to a high-vol one.

However, not all the underperformance comes from CNH. In fact, by removing CNH from the portfolios, the difference in Sharpe ratio between the original and inverse implied vol scaling is reduced by around 16% (Exhibit 7). A significant reduction, but not enough to explain the whole reduction in the portfolio's Sharpe ratio.

Exhibit 8. PnL time series for equal Vega and implied vol scaled strategies on PLN, and corresponding assigned weight



Source: J.P. Morgan

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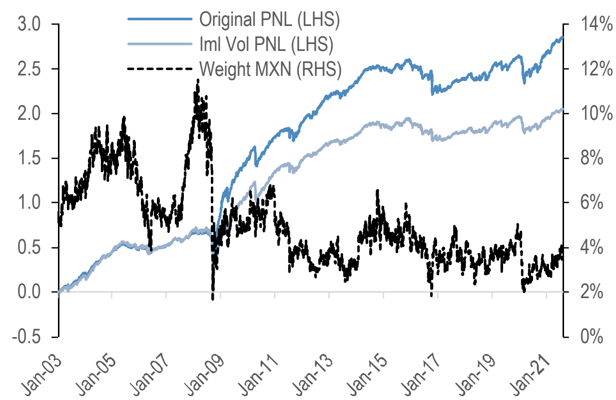
In Exhibit 8, we can see the other major reason for such an underperformance: after a volatility shock, such as the one seen in the GFC in 2008, the strategy underinvested in high-volatility assets (in this case PLN gamma), which rallied significantly from 2009 to 2015. Over that period, the average weight on PLN was around 3.8% versus a 5.4% equal weight allocation, thus missing out in the short-vol rally. A similar dynamic is at play with other high-vol assets, such as MXN (Exhibit 9).

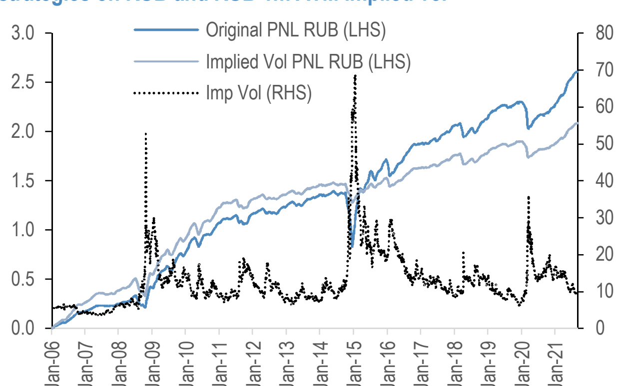
Exhibit 9. PnL time series for equal Vega and implied vol scaled strategies on MXN, and corresponding assigned weight



Source: J.P. Morgan

However, inverse vol scaling does not always underperform the benchmark strategy, as seen in the RUB (Exhibit 10). If a volatility shock is less sudden and more prolonged in time, such as the 2015 Crimea/Oil crisis in RUB, then the strategy manages to scale down the allocation in the currency and to reduce the drawdown.

Exhibit 10. PnL time series for equal Vega and inverse implied vol strategies on RUB and RUB 1m ATM implied vol



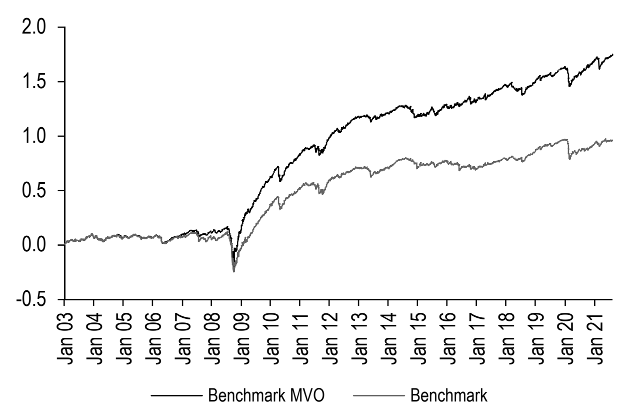
Source: J.P. Morgan

Mean-Variance Optimization (MVO)

We next move on to applying a mean-variance optimization (MVO) technique to the same portfolio of options of the previous section. We first apply an extending window mean-variance optimization to the PnL time series of the equal-weighted benchmark strategy including the 19 currencies in the previous section. This means that every day (from July 2006 to Sept 2021) we sample the expected returns and covariance matrix of the different currencies (from the historical time-series) and plug it into the optimizer. From there, we obtain the weight allocation to each currency on a daily basis, which is used to scale the new short-vol portfolios (benchmark, filtered and filtered long), also allowing for a 1-day lag (for removing the risk of relying on future data).

We assume an overall 100% cumulative allocation across currencies, and impose the additional constraint that the weights in each currency can lie between 0 and 20%. The risk-free rate is assumed to be 0%. The optimization aims to maximize the Sharpe ratio using a Sequential Least Squares Programming optimizer, and the initial weights for the algorithm are set to be 10% for all currencies.

Exhibit 11. Time series of PnL for equal Vega vs. MVO strategies



Source: J.P. Morgan

The resulting MVO portfolio sharply outperforms equal-Vega allocation over time in terms of cumulative returns (Exhibit 11). The added-value of the portfolio construction algo over the passive short-volatility strategy appears particularly marked in the wake of major volatility events, like September 2008 and March 2020.

After MVO, Sharpe ratios are 1.12 for benchmark, 1.39 for filtered and 1.51 for filtered long (which we recall can allow the possibility of long-volatility trades when markets risk-aversion is marked) cases. MVO improves Sharpe ratios by a significant amount (Exhibit 12): +68% for the

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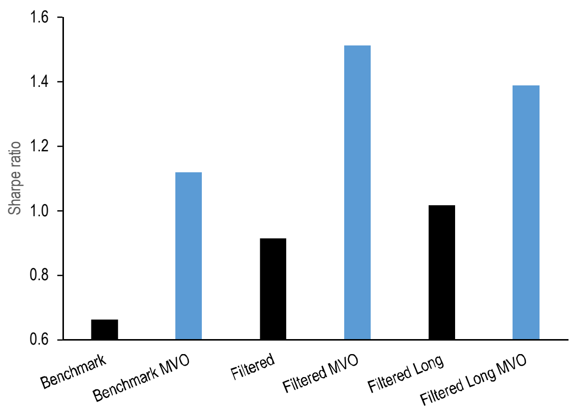
benchmark portfolio strategy, +55% for the filtered portfolio, +34% for the long filtered version. The higher improvement for the benchmark case is probably due to the fact that the optimizer is run directly on it. Overall, results are satisfactory and compare favorably with those obtained with inverse implied vol/PnL vol scaling.

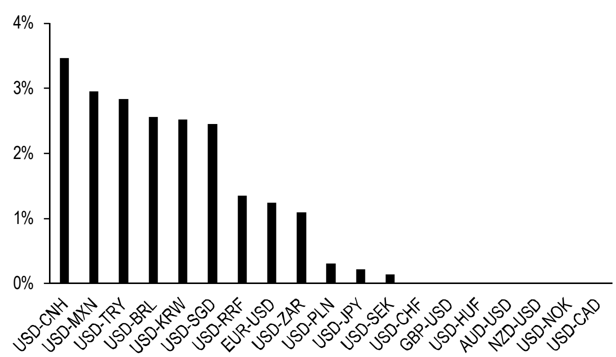
Exhibit 12. Sharpe ratios of the different portfolio construction techniques (MVO vs equal-Vega strategies)



Source: J.P. Morgan

The improvement on the results introduced by the MVO algorithm naturally calls for pinpointing the source of such an added-value when selling-vol. Exhibit 13 shows the average weights over time after MVO is applied: the tilt towards high-beta EM assets (MXN, TRY, BRL, KRW, RUB) for the portfolio implies that the algorithm is not reducing EM weights as the inverse vol scaling algorithm did post-GFC. On the contrary, it is very biased towards EM and has only minimal exposure towards G10 vols.

Exhibit 13. Average (over time) weight allocation by currency in the MVO portfolio



Source: J.P. Morgan

In this respect, future work could consider adding further constraints to increase G10 exposure for more realistic index implementations. With this caveat in mind, a practical takeaway from this analysis points to the appeal of looking at the EMFX space for carry generation purposes via short-vol trades, keeping in mind the improved liquidity on EM options of the past few years.

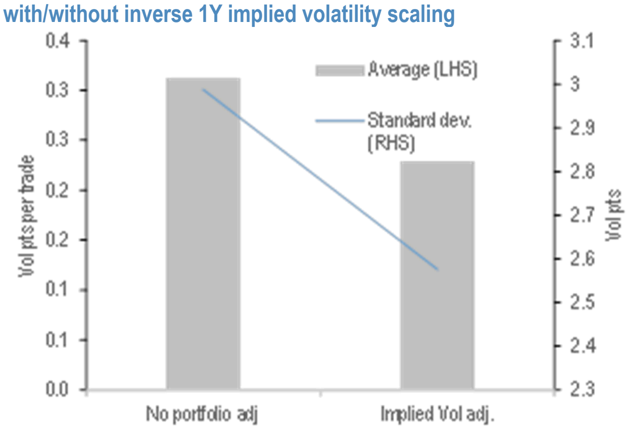
Risk-managing long/short vol trades

Finally, we test the use of the 1/vol scaling scheme to the RV trades as introduced in our *Vol Mean Reversion framework.* The simpler algorithm is tested for the sake of simplicity, given the technicalities related to a long/short options trading model.

In its simplest form, and the one we monitor in the following, trading signals were generated when a volatility spread dislocates in either direction from its most recent price range. The setup below is the same as in the earlier report: trading instruments are Vol Swaps 1Y held 3M, time period considered 2007 to 2019, buy and sell signal are based on the +/- 1.5 2y z-score of the nominal spread between 1y ATM volatilities. Also, we monitor the same group of currencies. Given the illustrative purpose of the study, costs are not taken into account in the below.

Exhibit 14 shows the average PnL/standard deviation of PnL per trade (in vol points) generated by the strategy with and without adjusting each leg of the trade by the inverse of its 1y implied volatility. Average PnL drops from 0.31 to 0.23 vol pts per trade when applying the scaling by volatility, although standard deviation of the PnL drops as well, from 2.99 to 2.58 vol points.

Exhibit 14. Average and standard deviation of vol points per trade with/without inverse 1Y implied volatility scaling



Source: J.P. Morgan

At a minimum, we can interpret the result via the higher likelihood of the system sourcing vol carry via rich vols rather than by banking on cheap vols that deliver on vol

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spikes. The interplay between risk-management and Greeks exposure for an RV vol system is rather delicate. Most commonly, the Vega-neutrality constraint makes the RV trade long-Gamma, hence exposed to spikes in spot realized volatility: scaling down the higher vol leg might increase the resulting long-Gamma bias. A more in-depth analysis on the latter aspect is definitely required.

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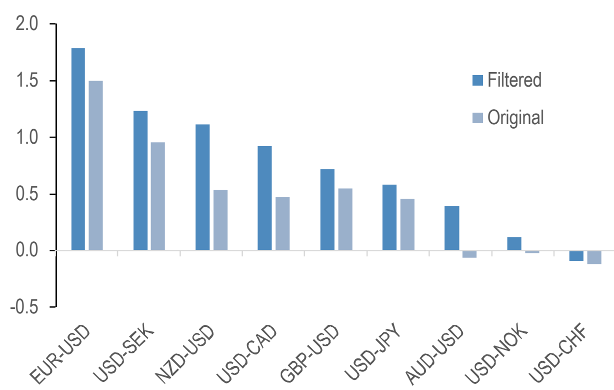
Sentiment indicators-based allocation of vol portfolios

In this section, we broaden the scope of applications of our vol-filtering models. The systematic methodology was introduced to optimize the timing of short-volatility trades, aiming to reduce the drawdowns of the strategies while preserving their long-term returns. We relied on a set of global and vol-surface indicators for each currency, scaling down risk during risk-averse markets. The filtering approach allowed a reduction of the volatility and drawdown for the strategies, with higher Sharpe ratios.

We start by applying our in-house sentiment indicators to filter exotic vol trades. We then move on to discuss how the sentiment approach can be applied for entering RV vol trades with a long volatility bias: we will introduce a portfolio construction algorithm that buys volatility on assets where the sentiment is risk averse and sells where it is more risk supportive. We limit our Relative Value (RV) Long/Short Vol trades to days when the cross sectional dispersion of sentiment indicator is high enough. We later combine this RV methodology with our total-return version of tactical filter allowing long gamma trades and investigate whether we can outperform the existing results.

Exhibit 15. Vol-of-vol strategy: Sharpe filtered vs original



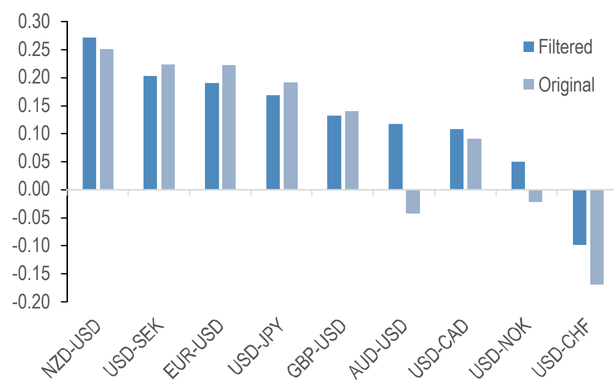
Source: J.P. Morgan

Sentiment indicators for exotic trades

In this section, we test application of the filtering method above to vol-of-vol trades using Var and Vol swaps: in there, Var vs. Vol swap RV constructs were tested for their ability to capture the volatility of volatility premium, related to the richness of implied vs. realized vol convexity. Long Vol vs. short Var swap RVs are a standard construct for trading the vol convexity premium. We apply our filtering to the benchmark RV strategy long Vol/short Var swap, with equal Vega notionals. We enter new trades on a daily basis (Feb 2007-Oct 2021) and hold them until expiry (1M). We use a matching tenor and currency pair for the Vol and Var Swaps (the 9 USD/G10 pairs are tested). Costs are not accounted for in the present application.

Ex-post results prove that the filtering approach has a positive effect in the Var/Vol strategy too. Average Sharpe across currencies rises from 0.47 to 0.75 (Exhibit 15): we also stress that the Sharpe also improves in all currencies tested. A similar effect is noticed in terms of Vol pts. per trade, from 0.10 to 0.13 on average (Exhibit 16).

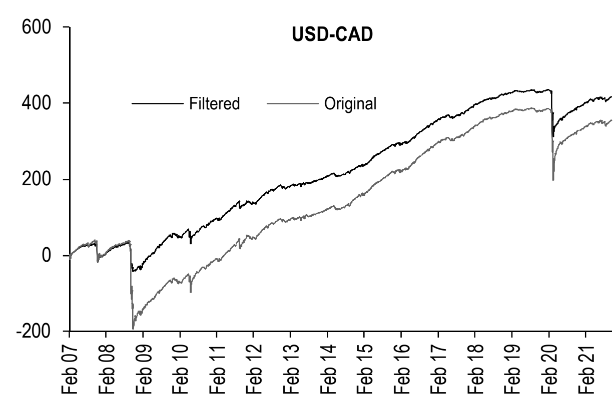
Exhibit 16. Vol-of-vol strategy: Vol pts per trade filtered vs original



Source: J.P. Morgan

A case study on USD/CAD (Exhibit 17) shows that the use of the filters allowed a large reduction of the two main drawdown episodes (i.e., 2008 and 2020), which is consistent with the previous analyses on plain vanillas.

Exhibit 17. Filtering USD/CAD Var/Vol trades (cumulative vol pts)



Source: J.P. Morgan

For completeness, we also apply the filters to one-legged short vol strategies via Vor or Vol swaps, by keeping all

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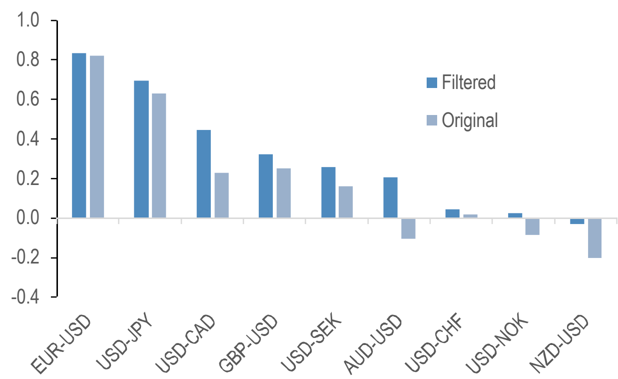
other parameters (like, 1M maturity) unchanged. We note that the Sharpe ratio of the strategy, before any filtering is applied, is higher if using Var rather than Vol Swaps: 0.29 vs 0.19, after averaging across currencies. This is also consistent with the higher exposure to vol-of-vol premium for Var than Vol swaps.

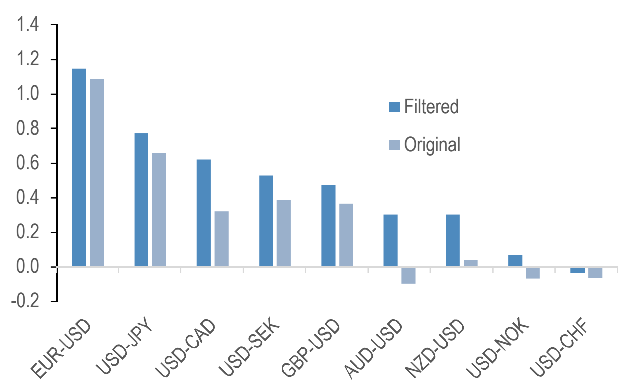
Exhibit 18. Short Vol swap strategy: Sharpe filtered vs original



Source: J.P. Morgan

In both cases Sharpe ratios improve significantly after filtering is applied: from 0.19 to 0.31 for Vol swaps, from 0.29 to 0.46 for Var swaps. Finally, we see that for both Vol swap (Exhibit 18) and Var swap (Exhibit 19) the added value is rather homogeneous across currencies.

Exhibit 19. Short Var swap strategy: Sharpe filtered vs original



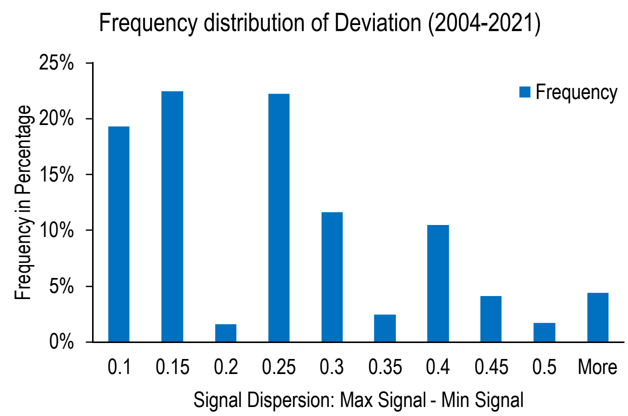
Source: J.P. Morgan

Setting up a RV Vol Trading Strategy

We now apply our tactical indicators towards building long/short volatility portfolios. In our previous work, or in the section above on exotics, the sentiment indicators were first applied to the PnL of each individual currencies and then aggregated after filtering. The related diversification benefit is a combination of the correlation between different currencies benchmark PnLs and of the asset-specific sentiment indicators.

Here, we propose a strategy that can fully leverage on the dispersion properties of the sentiment indicators across currencies. The RV approach herein proposed centers around the cross-sectional distribution of our sentiment based indicator and assigns long- or short- vol trades to currencies if the difference between their respective signal values, at any point in time, is sufficiently strong.

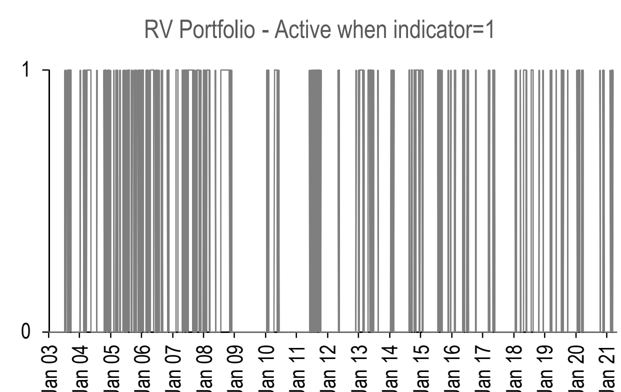
Exhibit 20. Frequency distribution of signal dispersion



Source: J.P. Morgan

We aim to proceed by favoring an intuitive and transparent approach over technicalities. We first calculate signal dispersion across currencies on each day. We rely on a rather simple measure to quantify dispersion, i.e. the difference between Maximum Signal Value – Minimum Signal value. Our Relative Value Long/Short Portfolio assigns trades only on days when this dispersion is high enough. Exhibit 20 shows the frequency distribution of this measure of dispersion from 2004-2021.

Exhibit 21. Days on which RV portfolio is active



Source: J.P. Morgan

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We then pick the 75th percentile value as our threshold signal dispersion, which corresponds to ~0.29. This arbitrary but, we think, rather sensible choice should allow a reduction in the risk of overfitting. Our RV portfolio trades when the difference between Maximum and Minimum signal value exceeds our pre-defined threshold 0.29. Exhibit 21 displays the days when RV portfolio takes on new trades.

Exhibit 22. Relative Volatility Portfolio Construction

1. We define the following variables:

$$Filter_{ER}^{c} : Short\ Vol\ Filter\ for\ currency\ c$$
$$Filter_{TR}^{c} : 1 - 2 \times\ Filter_{ER}^{c}$$
$$Max = \max_{c} Filter_{ER}$$
$$Min = \min_{c} Filter_{ER}$$
$$R = Max - Min$$

2. We define $Signal$ -1, 1 and 0 as per below:

$$Signal^{c} = \begin{cases} -1\ if\ (Max\ -\ Filter_{ER}^{c}) \geq T(p) \\ 1\ if\ (Filter_{ER}^{c} - Min) \geq T(p) \\ 0\ o.w. \end{cases}$$
$$T(p) = p^{th}\ percentile\ of\ R$$

3. We define normalization parameters $A, M\ and\ L$ as:

$$A = \frac{\sum_{i}^{N} Filter_{TR}^{c}}{N}\ ;\ N = number\ of\ currencies$$
$$M = \frac{1 - A}{2}$$
$$L = 1 - M$$
$$Short = \sum_{i}^{N} Signal^{c}\ \ \forall\, c\ s.t. Signal^{c} = 1$$
$$Long = \sum_{i}^{N} Signal^{c}\ \ \forall\, c\ s.t. Signal^{c} = -1$$

4. We calculate positions as:

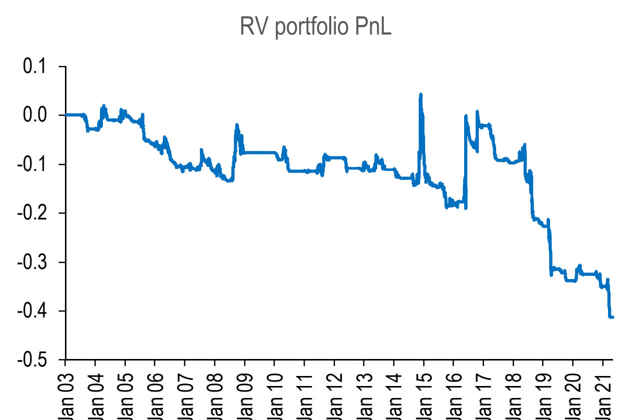
$$Position^{c} = \begin{cases} \dfrac{Filter_{TR}^{c}}{Short} \times M\ \forall\, c\ s.t. Signal^{c} = 1 \\ \dfrac{Filter_{TR}^{c}}{Long} \times L\ \forall\, c\ s.t. Signal^{c} = -1 \\ 0\ o.w. \end{cases}$$

Source: J.P. Morgan

Next, we assess whether a currency's signal value is at least 0.29 points lower than the maximum value for long vol position, and 0.29 point higher than the minimum value for short vol position: if such a condition is met, we trade the currency on that day. Further, we use the average total return tactical filter (introduced here, allowing long-Gamma trades when tested at the single-currency level) to adjust the relative importance of long vs. short volatility trades: the relevance of the former vs. the latter becomes more and more significant as the average level of market sentiment points to stronger risk-aversion (and vice-versa). Exhibit 22 summarizes the adopted set of rules.

Thus, on any day, we consider going long vol on currencies whose signal values are sufficiently low and short vol on ones with sufficiently high values: the above appears as the most natural extension towards portfolio construction of the earlier sentiment tools, capitalizing on the empirical findings that declines in sentiment indicators are associated with drawdowns for short-vol strategies.

Exhibit 23. Time Series of the RV Portfolio and its Performance



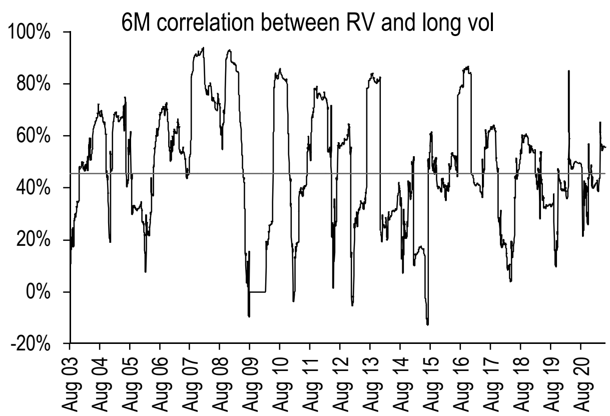
RV Portfolio	
Mean Return	-2.18%
Mean Vol	6.20%
Risk Adjusted Return	-0.35
Skewness	19.56
Kurtosis	817.88
Max DD	-20.8%
Max DD/Vol	-3.35

Source: J.P. Morgan

The time-series of the daily return from RV portfolio is displayed in Exhibit 23. The RV strategy is associated with a negative average return, and especially so over the past three/four years, and with a positive skewness.

However, we note how the PnL profile of the RV strategy enjoys large gains during market risk-aversion episodes (a byproduct of its positive skewness), a feature which deserves a more careful investigation. Before assessing the efficacy of our RV as a viable trading strategy, as covered later in the report, we start by investigating the correlation between RV and our long volatility benchmark portfolio. The benchmark long vol portfolio is the one which, on a daily basis, takes a systematic long volatility position on each currency, all with the same Vega notional. It essentially mirrors our short-vol benchmark portfolio.

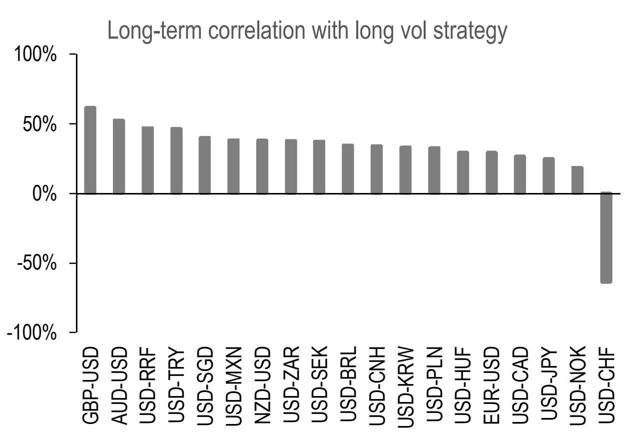
Exhibit 24. 6M Rolling Correlation b/w RV & Long-Vol Benchmark



Source: J.P. Morgan

The running 6M correlation between RV and the systematic Long Vol strategy for each currency is shown in Exhibit 24: the grey line shows the ~0.45% average correlation calculated using the full 17 yrs time series. We can clearly see that the correlation between RV and Long Vol is structurally positive, having barely dipped in <0 territory on just a few occasions over almost 20 years.

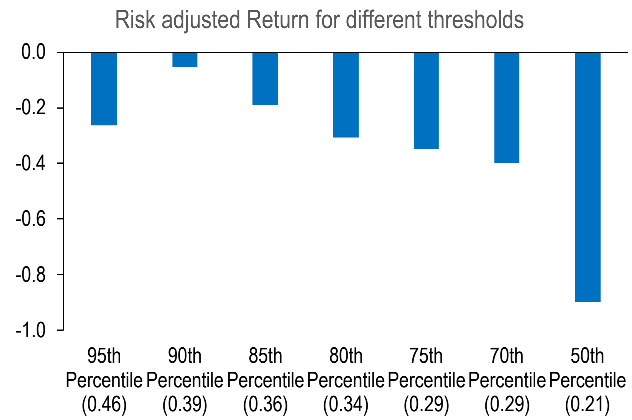
Exhibit 25. Long-Term Correlation b/w RV & Long-Vol Benchmark



Source: J.P. Morgan

Exhibit 25 shows the long-run correlation between RV and long-Vol strategies across pairs. On all cases except USD-CHF (due to the 2015 SNB de-pegging of CHF to EUR), this correlation is positive. The previous charts support the understanding that the RV strategy can thus be a good proxy of long-vol on the long run.

Exhibit 26. Risk-adjusted returns of RV portfolio corresponding to different threshold values of signal dispersion



Source: J.P. Morgan

We have arbitrarily considered the 75th percentile value of the "Max-Min: range" as our threshold signal dispersion in this note. Exhibit 26 shows the risk-adjusted returns of RV portfolio constructed using different levels of threshold. Less negative Sharpe ratios could be reached by choosing tighter thresholds (of 85-90%), yet at the expense of trading less frequently and of taking the risk of overfitting.

A hybrid directional + RV vol strategy

One limitation of the RV portfolio presented in the earlier section is that it only trades on days when the threshold condition is met. We now present a modified trading rule that allows trading every day and boosts diversification further: we are combining our RV strategy with the (more directional) Long/Short total-return version (or TR below) of the tactical filter. We modify the 4th step of Exhibit 22 and define the new rules in Exhibit 27.

Exhibit 27. Modification of Rule 4 for the TR+RV strategy

5. We calculate positions as:

On days when RV is active i.e. if $R \geq T(p)$:

$$Position^c = \begin{cases} \dfrac{Filter^c_{TR}}{Short} \times M \;\forall\, c\; s.t.\, Signal^c = 1 \\ \dfrac{Filter^c_{TR}}{Long} \times L \;\forall\, c\; s.t.\, Signal^c = -1 \\ 0\; o.w. \end{cases}$$

On days when RV in inactive i.e. if $R < T(p)$:

$$Position^c = Filter^c_{TR}$$

Source: J.P. Morgan

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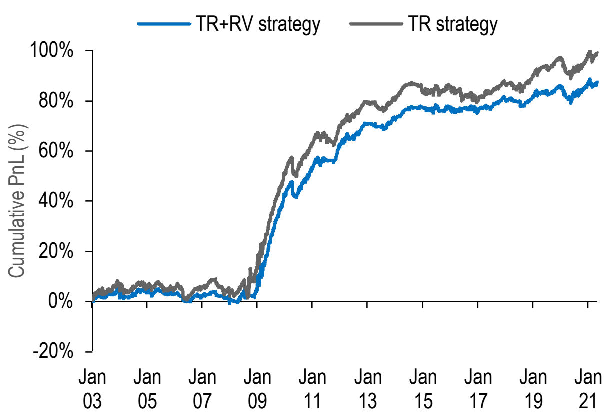
On a daily basis, the hybrid strategy trades the RV strategy if the RV condition is fulfilled, namely when the dispersion of the signals across currencies is large enough, and otherwise it follows the TR strategy. We remind readers that the TR strategy is the version related to the "filtering by currency" approach that allows buying Gamma when the corresponding sentiment-indicator flashes sufficient risk-aversion. It is directional in the sense that, at the portfolio level, it does not impose any constraints across currencies: the average L/S indicator is reflective of the overall positioning of the model (short-Gamma most of the time, occasionally long-Gamma), and is aimed at tracking a proxy of overall market sentiment.

Exhibit 28. PnL time Series of TR + RV hybrid vol strategy and its Performance Statistics



Strategy	RV	TR	TR+RV
Mean Return	-2.18%	5.24%	4.61%
Mean Vol	6.20%	5.08%	3.95%
Risk Adjusted Return	-0.35	1.03	1.17
Skewness	19.56	-2.39	-3.93
Kurtosis	817.88	29.93	53.25
Max DD	-20.8%	-8.6%	-6.2%
Max DD/Vol	-3.35	-1.70	-1.57

Source: J.P. Morgan

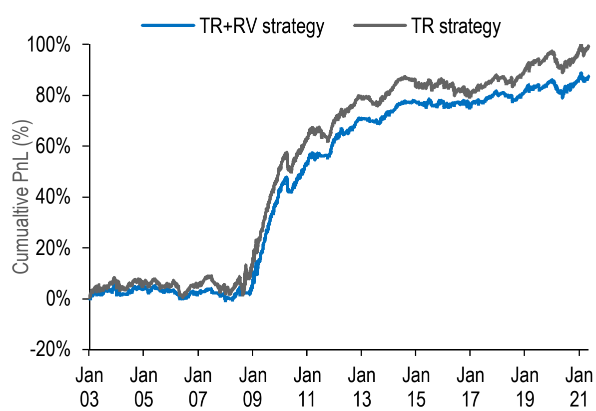
We now summarize the results for the combined TR+RV vol strategy: its PnL time series and performance statistics are displayed in Exhibit 28. The negative average return, as associated with RV, entails a lower return for the hybrid TR+RV vol strategy relative to TR alone. However, we can see that the combined strategy delivers a higher Sharpe ratio (1.03 for TR up to 1.17 for TR+RV) as it has lower volatility than the earlier Total Return strategy. The associated maximum drawdown is also reduced. Such attractive features can be attributed to the natural hedging properties as embedded in the RV strategy. The resulting diversification benefit is therefore the main added value of considering RV within a portfolio of strategies.

Choosing different instruments for buying vs. selling volatility

In this final sub-section, we consider introducing an asymmetry in terms of instrument used between long- and short-vol trades. The earlier report on vol-convexity trades is supportive of the choice of strangles over strangles for vol carry purposes (and *vice versa*) given the amount of vol-of-vol risk premium.

In the following, we continue to use strangles for short volatility trades but shift to straddles in all instances with buying volatility; the changes are applied to both TR and RV strategy and, consequently, to the hybrid TR+RV one. Thus, all returns from short vol positions remain unchanged, while those from long positions are adjusted.

Exhibit 29. Back-test Results of RV, TR and TR+RV "asymmetric" strategies using strangles and straddles for short, long vol trades



Strategy	RV	TR	TR+RV
Mean Return	-1.89%	5.17%	4.64%
Mean Vol	6.53%	5.01%	3.95%
Risk Adjusted Return	-0.29	1.03	1.17
Skewness	25.36	-2.63	-3.92
Kurtosis	1217.52	28.99	53.27
Max DD	-24.44%	-7.48%	-6.21%
Max DD/Vol	-3.74	-1.49	-1.57

Source: J.P. Morgan

Exhibit 29 shows the backtested performance of RV, TR and RV+TR strategies in which we use straddles to buy vol. The introduction of such an asymmetry in the instruments has improved the performance of RV strategy; the Sharpe ratio, though still negative, has increased by 0.06 from -0.35 to -0.29. By trading rather frequently and across different market regimes, the added value of using straddles over strangles for long-vol trades is confirmed.

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However, the impact of using straddles for long vol trades for TR and TR+RV strategies is rather minimal in the overall performance (for instance, the TR+RV strategy, the Sharpe ratio barely rises from 1.166 to 1.174). This is understood as, in deep risk-aversion episodes, long vol convexity trades also deliver, reducing the added value of straddles over strangles on such (rather infrequent) occurrences. Furthermore, it is precisely during extreme risk-aversion episodes that the TR system buys volatility. In any case, as per the earlier report, the long-term benefit of using strangles over straddles for vol-selling purposes is confirmed over the ~18yr period overviewed in the report.

Conclusion

In this report, we have first tested a set of portfolio construction algos as applied to short-vol and long/short vol trades, within the liquid FX space. Vega scaling appears as a reasonable first candidate as an allocation tool when it comes to aggregating multi-legged trades. For yield-enhancement purposes, the Mean-Variance optimization tool supports a higher tilt towards short EMFX vols, allowing a significant outperformance vs. G10 short-vol portfolios.

The second section focuses on the application of in-house sentiment indicators for setting up RV long/short vol trades. The introduced algo for trading RV in the vol space allows a positive correlation with long volatility trades while reducing time-decay normally associated with the latter. We show how the inclusion of the resulting RV vol strategy within a portfolio brings significant diversification benefits. The multi-strategy portfolio including our earlier total return Gamma strategy and the RV one largely outperforms the previous system thanks to the inclusion of the latter input. The sentiment indicators also proved effective for smoothing the PnL profile of exotic trades capturing vol and vol-of-vol risk premia.

Results as presented in this report covered the FX vol market only. Future studies could naturally expand the analysis to cross-asset short-volatility portfolios and to RV trades between different markets. A deeper understanding of the interplay between Greek letter sensitivity of an options strategy and portfolio construction algos might lead to further insights in terms of optimal allocations, depending on the strategy considered. Finally, a natural follow-up would regard the combination of the mean-reversion and sentiment analyses towards RV portfolios construction into a unified framework.

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