FX Carry via Options

Deploy premium and sleep well at night

- **Carry has been an investment theme in the FX market for several decades now, solidifying the latter's status as a distinct asset class.**
- **The recent washout in long FX Carry trades, which made global headlines this summer, highlights the need for a protection mechanism to avoid large drawdowns. Using options to extract delta-one carry seems a natural solution to this issue.**
- **As with any derivatives trades, several technical factors—most notably carry-to-vol ratios, the shape of vol curves, and vol smile pricing — affect the appeal of these trades.**
- **In this note, we review the empirical properties of various FX carry via options portfolios. We test different structures, tenors, base currencies, and weighting schemes. Additionally, we make use of liquidity indicators from JPMaQS that significantly improve the currency selection process.**
- **FX Carry via options can deliver risk-adjusted returns of up to 0.8 - 0.9 (Figure 1) against a 0.7 proxy for a delta-one portfolio, while displaying (Figure 2) low correlation properties with other popular investment styles, in FX and across markets.**
- **Additional benefits include improved skewness and kurtosis metrics (often positive or zero skewness), defined maximum loss at any given time, and drawdowns that are less sharp in time.**
- **We also find that FX Carry via options performs well when Carry-to-Vol ratios in the FX market are very elevated, as they are now.**
- **Currently, the USD-based portfolio would include USD puts/TRY calls, USD puts/INR calls, and USD calls/CNH puts. The EUR-portfolio EUR puts/TRY calls, EUR puts/INR calls and EUR puts/PLN calls. The JPY-portfolio would include JPY puts/TRY calls, JPY puts/ZAR calls and JPY puts/MXN calls.**

Global Quantitative and Derivatives Strategy

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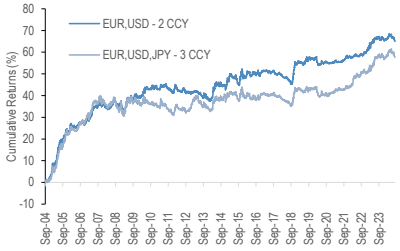
Figure 1: FX Carry via Options can deliver risk-adjusted returns of up to 0.8-0.9

PnL Time-Series for 3M ATMF FX Carry portfolios - one combining in equal weight 2 base-currency portfolios (EUR,USD) and one with 3 currency (EUR,USD,JPY). Costs included.



Source: J.P. Morgan.

Figure 2: Correlation of FXO Carry to Equities is lower than for FX Cash Carry

Asset	FX Cash Carry	Bond	FXO Carry	SPX
FX Cash Carry	100%	-22%	37%	32%
Bond	-22%	100%	-3%	-19%
FXO Carry	37%	-3%	100%	20%
SPX	32%	-19%	20%	100%

Source: J.P. Morgan.

See page 14 for analyst certification and important disclosures.

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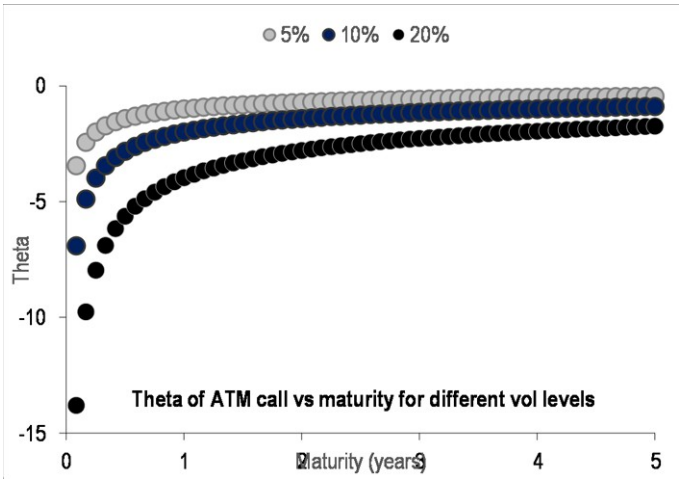
Introduction

Carry has been an investment theme applied to the FX market for several decades now and one which has cemented the latter's reputation of an actual asset class on its own. The recent washout of long FX Carry trades, related to the policy normalization in Japan, made it to global headlines this summer and, in our view, confirms the need of a protection mechanism in order to avoid the risk of (occasional) large drawdowns. Previous episodes of spectacular unwinds, well documented in finance history books, have been the 1997/98 Asian currency crisis which led to the demise of the hedge fund LTCM and then across 2007/2008 with GFC.

The use of options as way to extract delta-one carry appears a natural way to overcome the issue of the large possible drawdowns associated with the long FX carry trades, possibly making the theme attractive to multi-asset investors whose primary focus is not FX and who, while looking for diversification, are mindful of the left-hand side of the distribution. Therefore, the possibility of harvesting FX carry via options would necessarily broaden up the audience of interested clients beyond FX-dedicated players.

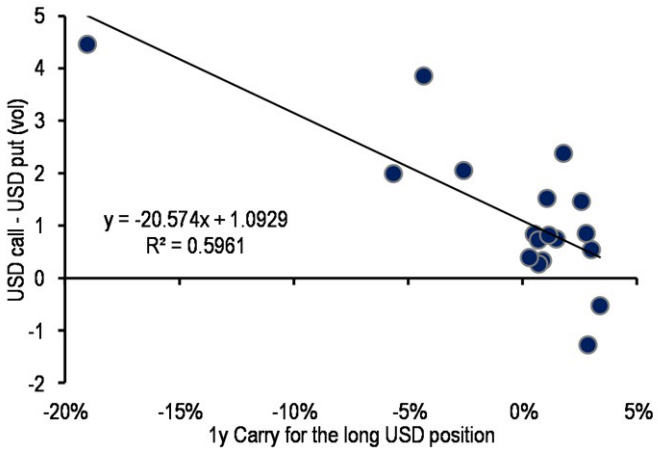
The purpose of the note is therefore that of proposing realistic backtests of carry via FX vols portfolios, while introducing some innovation on the selection process within portfolios. The downside (or advantage, depending on the point of view) of dealing with derivatives products is that a few technical inputs come into play for addressing the appeal of the trades.

Figure 3: Time decay of an option carry trade as a function of the vol level



Source: J.P. Morgan.

Figure 4: FX carry and of the skew tend to be negatively correlated



Source: J.P. Morgan.

A few previous JPM notes approached the topic of carry trades with options. A first note (see here) introduced the idea of monitoring carry-to-vol ratios as a measure of the appeal of the carry via options theme. A subsequent note (see here) discussed how to contain the time decay of carry trades via options as a function of pricing parameters, such as vols/vol curves (Figure 3) and skews (Figure 4). Carry and skew tend to be negatively correlated (i.e., it typically costs an extra premium to hedge a drop in the high-carry currency), both cross-sectionally and over time - see here. This suggests that playing carry trades with OTM options (i.e., buying OTM calls on the high-yielding currency) could receive an extra support thanks to the risk premium on the skew

parameter (see a comprehensive note here). In the case of ATMF/ATMS spreads, the appeal of the structure would result from an interplay of carry and pricing of the skews, as such, monitoring the relative interplay of skews vs. vols and carry can highlight opportunities for playing the spread structures.

At the start of the summer, we had presented some results on the recent performance of carry via options portfolios (see here). A recent note (see here) considered the added value of momentum indicators applied to live option trades. Momentum, along with other technical indicators, was relied upon for defining a "value" metric to be used jointly with carry-to-vol ratios towards carry via options trades in a recent note (see here). A relationship between implied skew and cross section of FX returns has been established (see here), hinting at the possibility of using the former as an input towards the portfolio construction process. Finally, the team has published a primer on cross-asset carry trades, introducing innovation on the portfolio construction process (see here).

Methodology

The back-tests start in 2004, thus providing 20-years of data, and multiple economic regimes. Unless stated otherwise, we consider 30 currencies in both G10 and EM (BRL, MXN, CLP, COP, HUF, TRY, PLN, ILS, ZAR, CZK, IDR, INR, CNH, THB, MYR, KRW, PHP, SGD, TWD, and RUB). We also consider 3 base currencies - the USD, EUR and the JPY. This is done separately, so a portfolio is created for USD pairs, and separate ones for EUR- and JPY- crosses. For the JPY-based portfolio we consider only G10 currencies and BRL, MXN, TRY, ZAR, SGD and CNH - given lack of liquidity in the rest of EM/JPY. Transaction costs are taken into account for all backtests - details of which are given in the appendix.

We consider two types of strategies for FXO carry, one considering a long ATMF strike call strategy in the higher-yielding currency vs the low-yielding currency. The other strategy goes long ATMF strike call in the high-yielding currency vs the low yielding currency, while simultaneously short ATMS strike call in the high-yielding currency vs the low yielding currency - thus creating a call spread. Both strategies are kept live - that is, not delta-hedged.

In both strategies we are deploying option premium to enter long carry trades in a limited downside format. The ATMF strategy is more comparable to standard FX delta-1 carry strategies than the spread strategy because it has full exposure to the high-yielding currency's appreciation, not only to the rates differential between the currencies. The ATMF/ATMS spread strategy on the other hand limits exposure to the high-yielding currency's appreciation, given that the max payoff is capped in moves above the current spot. However, it has the benefit that the premium paid (and the costs - see costs section) are also substantially reduced. Both strategies are simple and common ways of trading the FX Carry theme via options. In neither of the two strategies, do we consider selling optionality outright, given that it would remove the limited downside benefits of the strategy. Thus the "short" positions that would normally appear in an FX delta-1 portfolio are better represented by considering both puts and calls of the base currency rather than selling optionality.

In terms of signal, and portfolio construction, we rank all considered pairs/crosses by the carry-to-vol ratios (see here) for both calls and puts for the base currency in question vs the other 30 pairs, therefore allowing us to buy or sell the base currency depending

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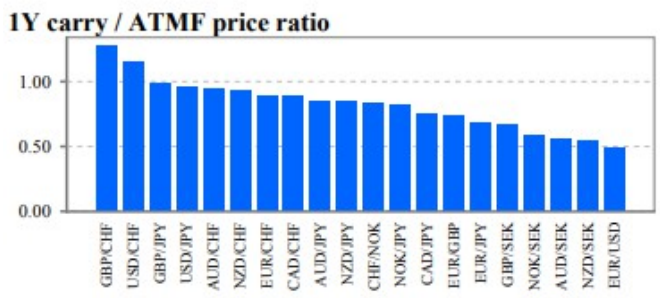
on the sign of the carry for each pair. This is done for each base currency universe separately. We then take the Top 3 currencies/crosses in terms of carry-to-vol. For the carry-to-vol signal, we make use for that purpose of the nominal carry calculated from the N-month yield implied in the FX forward. For the volatility we take the N-month ATM vol.

Carry-to-vol ratios are selected because for the ATMF strategy they are a proxy of the payout over cost ratio, i.e. the implied leverage. This is for the limit case in which the spot does not move from inception to expiry. A more accurate representation, particularly for the spreads, of this implied leverage would be to consider the Carry to Price ratio for the structure in question (see Figure 5and Figure 6). This is true because the spread structures are by themselves sensitive to other pricing parameters (interplay of vol, carry and smile). However, we decided to use carry-to-vol ratios for both ATMF and ATMF/ATMS spreads as the data is more widely available and it is easier to track for the average investor.

Figure 5: Carry/price for ATMF structures in G10

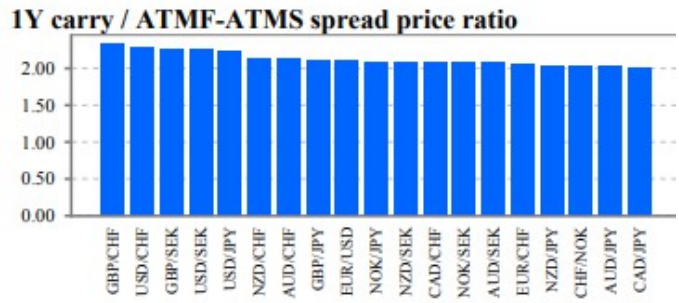
FX Derivatives Analytics Chartpack



Source: J.P. Morgan.

Figure 6: Carry/price ATMF/ATMS spread structures in G10

FX Derivatives Analytics Chartpack



Source: J.P. Morgan.

After taking the ranking, and unless stated otherwise, we take each of the Top 3 trades and we allocate ⅓ of the portfolio to each, thus assuming an equal underlying notional for each of the trades - but different leverage ratios, given that each trade has a different premium paid. New trades are all entered in the portfolio every N-months at the same time for all currency/crosses considered. All the trades are then kept in the portfolio until expiry. At any given time there should be 3 trades in the portfolio, with a few exceptions when there is a small time overlap between the prior trades expiring and the rebalance of the portfolio. The PnL of the portfolio is calculated by taking the weighted PnL of each of the trades. It is calculated in bps. For the spread strategy we assume equal notional allocation to the ATMF and ATMS.

In terms of liquidity and tradability of the currencies / crosses considered, not all of them have been tradable and liquid throughout the 20 years of the backtest, for instance, TRY has been mostly illiquid since 2020 and RUB since 2022. In order to remove the untradable currencies in question in a systematic way, we make use of the JPMaQS FX tradability time-series, a binary variable used to show the feasibility of trading in a currency. Hence, when the index shows that a currency in untradable, this currency is removed from the ranking process described above.

This methodology is a simple way of spotting carry trades via options and also assembling the portfolio; future work might consider more sophisticated ways, such as an optimization algorithm that may consider the correlation structure, and which

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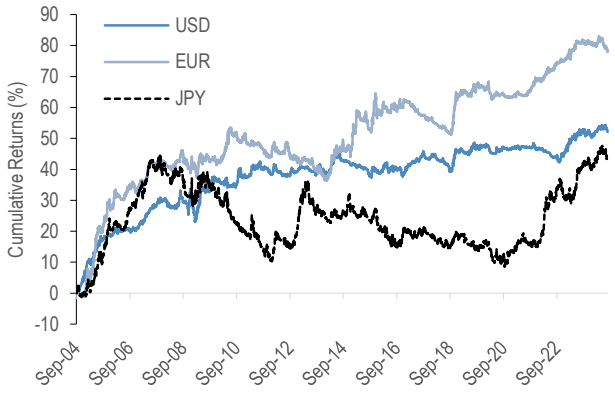
penalizes the higher vol. It may also be useful to consider in future work the inclusion of the trading costs as a penalty; for instance, the costs in bps (see following section) should naturally be compared to the carry in %.

Results

Having described the steps for constructing the portfolios, we now move on to presenting the results. Figure 7 shows the cumulative PnLs generated by the option-based portfolios for USD-, EUR- and JPY-pairs, in the ATMF format. The three time - series show in all cases a positive cumulative PnL and in general a similar behaviour over time; however, there are market regimes where the strategies' PnLs do diverge markedly. For instance, over the past four years EUR- and JPY-funded carry trades (selected trades did sell the base currency over the period) largely outperformed the USD-based one. All portfolios suffered declines from 2010 to 2013 on the European financial crisis, with the JPY-based strategy suffering the largest declines on JPY outperformance. Interestingly, the drawdown suffered by the JPY-based carry trade strategy with options was very contained throughout the summer 2024. This is the main added value of the vol-implementation of the carry trades, in that the maximum loss is set at inception.

Figure 7: PnL Time-Series for 3M ATMF FX Carry portfolio for USD-,EUR- and JPY- pairs



Source: J.P. Morgan.

The performance statistics for the portfolios (Figure 8) are decent if not excellent, with risk-adjusted returns in the region between 0.3 (for the JPY-based portfolios) to 0.7 (for the USD- and EUR-based portfolios). It is notable how the skewness of the returns is very contained, even positive for the EUR-portfolio, something which contrasts with the "risk-on" nature of the strategy when implemented in the delta-1 space.

Figure 8: Statistics for 3M ATMF FX Carry portfolio for USD-pairs and EUR- and JPY- crosses

		Benchmark						
Index	Start year	Ret (%)	Vol (%)	RA Ret	Skew	Kur	Max DD	Max DD/Vol
USD	2004	2.56	3.90	0.66	0.00	7.45	-10.47	-2.69
EUR	2004	3.74	5.56	0.67	0.31	5.41	-17.21	-3.10
JPY	2004	2.07	7.12	0.29	-0.20	3.95	-35.99	-5.06

Source: J.P. Morgan.

Similar conclusions are found when testing the ATMF/ATMS portfolios (Figure 9).

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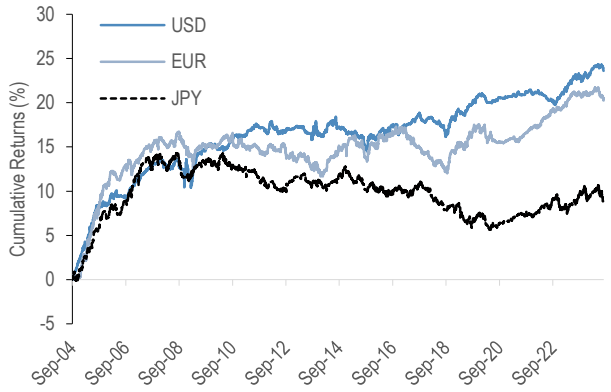
Figure 9: PnL Time-Series for 3M ATMF/ATMS FX Carry portfolio for USD-pairs and EUR- and JPY-crosses



Source: J.P. Morgan.

The performance metrics for the spread strategies (Figure 10) show an outperformance over the outright ATMF trades, as far as the risk-adjusted metric is concerned, while the maximum drawdown over vol ratios are comparable, the skewness of the returns is more negative, and the kurtosis is larger.

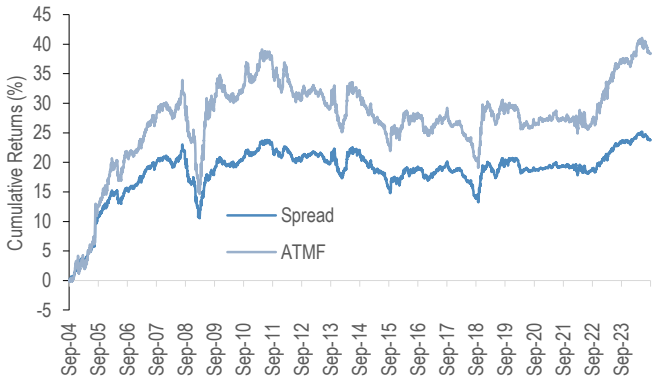
Figure 10: Statistics for 3M ATMF/ATMS FX Carry portfolio for USD-pairs and EUR- and JPY-crosses

		Benchmark						
Index	Start year	Ret (%)	Vol (%)	RA Ret	Skew	Kur	Max DD	Max DD/Vol
USD	2004	1.19	1.31	0.91	-0.82	21.20	-3.90	-2.97
EUR	2004	0.96	1.63	0.59	-0.06	4.22	-5.24	-3.22
JPY	2004	0.41	1.58	0.26	-0.33	6.87	-8.67	-5.47

Source: J.P. Morgan.

Figure 11 shows the time series of the 1yr (held 3M) USD portfolios, for both ATMF and ATMF/ATMS structures. First, we can see that the ATMF structure delivers higher and more volatile returns and lower max drawdowns if scaled by the corresponding vols (Figure 12), while the skewness is better for the spread structures over the outright longs, and the kurtosis is higher.

Figure 11: PnL Time-Series for 12M ATMF and ATMF/ATMS FX Carry portfolios for USD-pairs



Source: J.P. Morgan.

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Further, comparing the 12M maturity (held 3M) vs the 3M maturity, we see substantially lower risk-adjusted returns, a more positive skewness, more kurtosis, and a higher drawdown over vol. In principle, longer dated vols could allow enjoying positive roll-up in premia, with passing of time, when carry-to-vol ratios are elevated and vol curves sufficiently flat, while being exposed to higher costs (in bps) due to the higher Vegas. At the aggregated level, there is no evident added value of using the longer dated instruments, which calls for an additional tactical monitoring of specific trades when certain conditions are met (see for instance an analysis of the premium of the carry trades as a function of the tenor here).

Figure 12: Statistics for 12M ATMF and ATMF/ATMS FX Carry portfolio for USD-pairs

		Benchmark						
Index	Start year	Ret (%)	Vol (%)	RA Ret	Skew	Kur	Max DD	Max DD/Vol
ATMF	2004	1.84	4.47	0.41	0.86	22.80	-20.01	-4.47
Spread	2004	1.14	2.52	0.45	2.64	74.98	-12.46	-4.95

Source: J.P. Morgan.

We would like to highlight that what we show in the note is just a glimpse of what could be tested in the space of carry trades with options. For instance, the relative preference of spread over outright structures would necessarily have to be filtered by technical factors in the vol space and, even more importantly, scenario analysis. For instance, in the note we have not covered at all the topic of strike optimization, which could provide further benefits after technical parameters and scenarios are taken into account. Still, we hope that the results herein presented are sufficiently appealing for digging further into the space of FX carry trades via options.

We include a few words on possible alternatives to the allocation method as pursued throughout the note. Compared to the equal allocation, an alternative could reward the better rankings via a proportional allocation to the inverse of the rankings, resulting in 50%, 33.3% and 16.7% weights from first to third asset.

The motivation for this is, if carry-to-vol ratios determine the best ex-ante measures of future performance by the trades, it can make sense to over-allocate the outperformers in this space. For a unit allocation to the carry space, higher ranked currencies should correspond to lower returns than lower-ranked choices. Therefore, the method could offer a way to under-allocate the least attractive vol carry trades in terms of lower ranking (which could be exposed to higher PnL vol on the back of the higher premium paid for same unit of carry).

More sophisticated allocation methods would need to take into account the full covariance structure of the cross-sectional returns, as below (more details in the team's report on cross-asset carry trades, see here):

$$\max f(\boldsymbol{w}) = \frac{\boldsymbol{w}'\boldsymbol{c}}{\sqrt{\boldsymbol{w}'\boldsymbol{\Sigma}\boldsymbol{w}}}$$

where $\boldsymbol{W}$ are weights, $\boldsymbol{c}$ the vector of carry returns and $\boldsymbol{\Sigma}$ the covariance structure of the returns. The optimization problem can be subject to additional constraints. However, for options trades the covariance structure would need to be obtained from the options PnLs, a harder task than computing simple metrics like carry-

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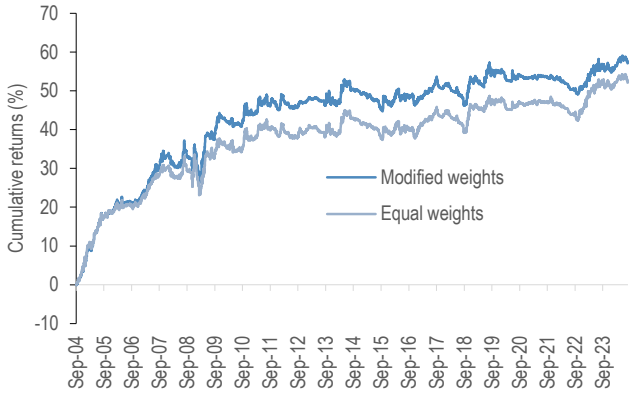
to-vol ratios. In a nutshell, the proposed "modified weights" allocation algo could be a seen as a proxy attempt to impose constraints on the desired portfolios which optimise certain desired metrics. The topic will be covered in future research notes dedicated to the portfolio construction properties of options portfolios.

With these caveats in mind, the time series of equal and modified weight portfolios are displayed in the following chart (Figure 13) the two time series follow each other fairly closely over time, with the modified version outperforming between 2008 and 2010 and over the summer of 2024.

Figure 13: PnL Time-Series for 3M ATMF FX Carry portfolio for USD-pairs - equal weighted and modified weights



Source: J.P. Morgan.

The performance statistics for the two allocation methods are fairly close to each other (Figure 14): the "modified" allocation method outperforms the "standard" one in terms of higher returns (i.e., the selection method works), but does so at the expense of higher volatility (perhaps as a result of the higher concentration / reduced diversification of the "modified" portfolios). The other metrics are comparable between the two methods, with a slight improvement on the skew for the new allocation method. These preliminary results are shown for illustrative purposes only; from here on we will move back to the equal weights portfolios throughout this note.

Figure 14: Statistics for 3M ATMF FX Carry portfolio for USD-pairs - equal weighted and modified weights

		Benchmark						
Index	Start year	Ret (%)	Vol (%)	RA Ret	Skew	Kur	Max DD	Max DD/Vol
Modified weight	2004	2.78	4.08	0.68	0.16	8.38	-11.04	-2.71
Equal weight	2004	2.56	3.90	0.66	0.00	7.45	-10.47	-2.69

Source: J.P. Morgan.

Given that each of the considered portfolios include only three option trades at any time, it is not unreasonable to test the diversification benefits which can be reaped allocating across the different portfolios.

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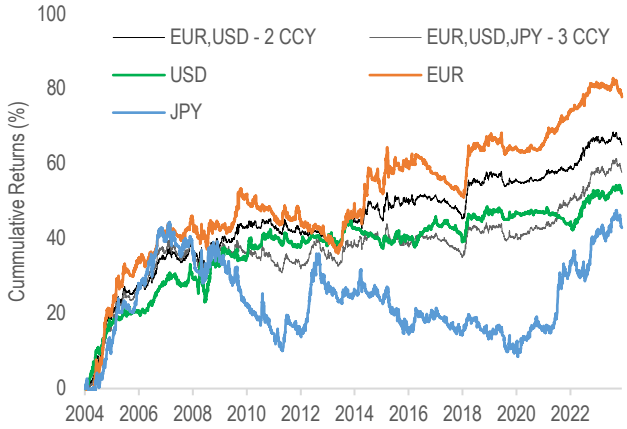
Figure 15: PnL Time-Series for 3M ATMF FX Carry portfolios combined 2 currency (EUR,USD) and 3 currency (EUR,USD,JPY)



Source: J.P. Morgan.

An equal (50% and 50%) allocation of the two best ex-post portfolios (USD- and EUR-, Figure 15) offers some diversification benefits relative to the individual portfolios in terms of an improved Sharpe ratio and a reduced vol (Figure 16). However, the inclusion of the JPY trades makes the performance in terms of risk-adjusted returns be in line with the individual USD- and EUR-portfolios due to the lower performance metrics of the JPY-portfolios. In order to stay away from the risk of overfitting results, results are displayed for illustrative purposes only.

Figure 16: Statistics for 3M ATMF FX Carry portfolios combined 2 currency (EUR,USD) and 3 currency (EUR,USD,JPY)

		Benchmark				
Index	Start year	Ret (%)	Vol (%)	RA Ret	Skew	Kur
2 CCY EUR,USD	2004	3.15	3.88	0.81	0.26	4.25
3 CCY EUR,USD,JPY	2004	2.80	4.22	0.66	0.01	3.36

Source: J.P. Morgan.

In terms of comparing the performance of an FX Carry via Options portfolio to that of FX Carry via Cash, we can see both PnL time-series in Figure 17. In that chart, we can clearly notice that the drawdowns are much more drastic in time in FX Cash Carry than in FX Carry via Options, while the risk adjusted returns and the Max-Drawdowns / Vol are very much in line. Further, we can see the reduced skewness (in fact skewness is zero for the options portfolio) and the much lower kurtosis (Figure 18) for the options portfolio.

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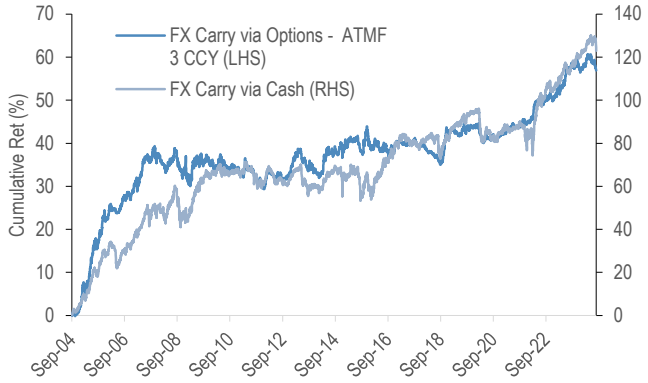
Figure 17: PnL Time-Series for 3M ATMF combined 3 Currency FX Carry portfolio vs a FX Cash Carry portfolio



Source: J.P. Morgan.

Figure 18: PnL Time-Series for 3M ATMF combined 3 Currency FX Carry portfolio vs a FX Cash Carry portfolio

		Benchmark						
Index	Start year	Ret (%)	Vol (%)	RA Ret	Skew	Kur	Max DD	Max DD/Vol
FX Cash	2004	6.22	9.48	0.66	-0.24	10.11	-21.76	-2.30
FX Options	2004	2.80	4.22	0.66	0.01	3.36	-10.01	-2.35

Source: J.P. Morgan.

In Figure 19, we also have the correlation of daily total returns of FX Carry via Options to FX Cash Carry and other asset classes, namely bonds and equities. We notice a number of things, one is that the correlation of FX Carry via Options to FX Cash Carry is high - 37% - but contained, thus providing some degree of diversification. Further, another positive element to highlight is that the correlation of FX Carry via Options to the S&P 500 is lower - 20% vs 32% - than that of FX Cash Carry. Finally, FX Carry via Options is less negatively correlated than FX cash carry to bonds.

Figure 19: Correlation of daily total returns of FX Carry via Options to FX Cash Carry and other asset classes

Asset	FX Cash Carry	Bond	FXO Carry	SPX
FX Cash Carry	100%	-22%	37%	32%
Bond	-22%	100%	-3%	-19%
FXO Carry	37%	-3%	100%	20%
SPX	32%	-19%	20%	100%

Source: J.P. Morgan.

Looking to analyze the composition of the portfolio, in Figure 20, we can see the top average weights in the FX Carry portfolio (3M ATMF USD) in terms of instrument and currency. We can observe that TRY and INR calls both get average weights above 15%, followed closely by BRL calls and TWD puts, which both get an average weight above 10%. In general, most of the top weights are currency calls/USD puts, thus biasing the portfolio in a USD bearish direction - something that could be amended in future version of the portfolio.

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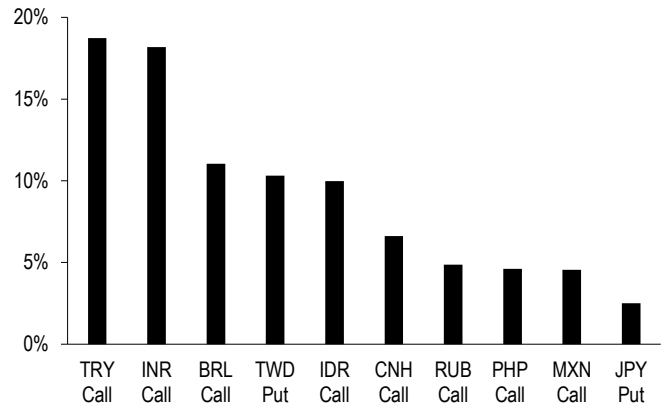
Figure 20: Top 10 average weight of FX Carry via Options portfolio

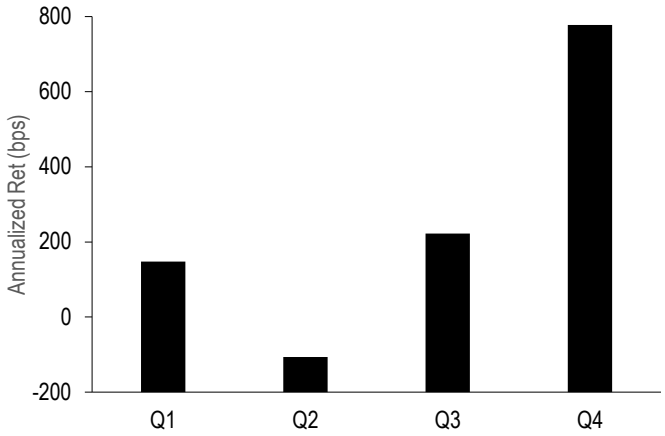


Source: J.P. Morgan.

The weights above correspond to the currencies that historically have had the highest carry-to-vol ratios out of the currency universe considered, given that this is the main signal in order to assemble the portfolio. Indeed, prior studies have linked the relationship between high carry-to-vol ratios (overall in the market, not just pairwise) and the performance of the carry trade (see here).

For that reason, we should also analyze our PnL results in terms of carry-to-vol ratios in the FX market. In Figure 21, we average the daily return (annualized in bps) by historical quartile of the carry-to-vol ratio - taking for this metric the 30 day average of the outright yield level for Global FX cash carry portfolio (%) divided by the JPM VXY-Global index (FX Vol index). We used this metric in this previous publication, see here. Now, this has a backward looking bias given that the carry-to-vol quartiles are calculated ex-post. Nonetheless, we can see that the returns are almost 9x higher in the top quartile (777 bps) than in the average of the three lower quartiles (88 bps). For the other quartiles, there is no clear trend, given that the second quartile has a lower performance (-107 bps) than the lowest quartile (148 bps), and the third quartile has a performance equivalent to the first quartile.

Figure 21: Annualized PnL in bps for each quartile of Carry-to-Vol ratios



Source: J.P. Morgan.

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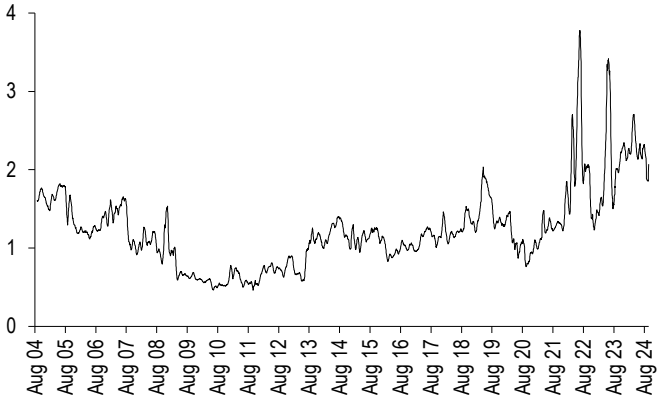
Current carry-via-options portfolio signals

Carry-to-vol ratios remain very elevated (see Figure 22) despite falling yields in Global FX portfolios, as a result of the fall in FX Volatility in both G10 and EM since 2022. In fact, in terms of percentiles, the carry-to-vol ratios are currently in the 96th percentile in historical terms (2004-today), thus pointing towards strong future returns according to our prior analysis.

Figure 22: Carry-to-vol ratios remain elevated

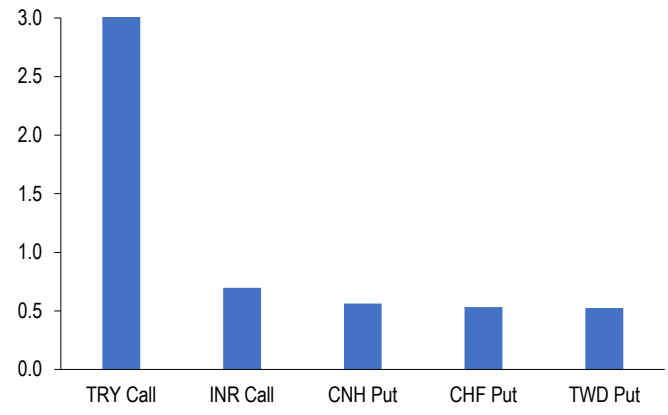
30 day average of the outright yield level for Global FX cash carry portfolio(%) divided by the JPM VXY-Global index (FX Vol index)



Source: J.P. Morgan.

In terms of current signals for the 3M portfolio, the Top 3 Carry-to-Vol metrics for the USD-based portfolio are **USD puts/TRY calls, USD puts/INR calls, and USD calls/ CNH puts** (see Figure 23). For EUR-pairs, the portfolio would include **EUR puts/TRY calls, EUR puts/INR calls and EUR puts/PLN calls.** For JPY-pairs, the portfolio would include **JPY puts/TRY calls, JPY puts/ZAR calls and JPY puts/MXN calls.** Finally, the liquidity metrics also point towards the tradability of all pairs considered in our portfolio except RUB and MYR.

Figure 23: Top absolute Carry-to-vol ratios by USD-pair



Source: J.P. Morgan.

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Appendix: costs

Transaction costs are taken into account in the following way - at inception of the trade a cost is charged from mid (expressed in vol pts). Results in bps are obtained after accounting for the Vega of each trade.

For the ATMF trades, the costs for USD-pairs are between 0.2 and 0.6 vol pts, for EUR-crosses between 0.2 and 0.75 vol pts and for JPY-crosses between 0.35 and 0.75 vol pts. Where a particular trade falls within those ranges depends on the liquidity and tradability of the pair / cross in question. Please note that, for the ATMF/ATMS spreads, the charge is 80% of the charge of the outright options, given it is easier to risk manage the former structure. The ranges are consistent with JPM pricing data, except for the RUB, MYR and TRY options, which, given the lack of tradability as of late, are moved (conservatively) to the higher end of the range, even though in the past they were probably in a more liquid spectrum.

The trading costs are assumed to be constant in time, and the costs are applicable for 3m and 1y options considered in the backtests. For the ATMF/ ATMS the charge is applied to the ATMF leg (the one with the most vega).

These prices are conservative in the assumptions on the trading costs, which would allow a full replication of the results.

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