FX Derivatives Research Note

Predicting and Trading the Volatility Surface

Global Quantitative and Derivatives Strategy

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- We believe that the shape of term structure is both reactive and predictive, and that robust forecasts of the entire vol surface can ultimately lead to trading profits. In our previous analysis, we used a principal components approach to describe the vol surfaces of USD/G10 pairs, and employed a SVM to model the PnLs of delta hedged options using the values of the components.
- By extending our study to a total of 46 FX pairs across USD/EM, EUR and JPY crosses, we found that a parametric specification approach, which provides more structured descriptions of the surface, has outperformed the statistical factor decompositions, and consistently produced accurate predictions.
- Such parametric model captures IV skew, smile attenuation, and term structure of each surface on any given day in-sample, achieving an average of adjusted R^2 of over 89.2%. Furthermore, by modeling the time variation in the parameters via a VAR model, we can forecast the entire IVS out-of-sample.
- We find that the predictive accuracy is robust across different forecast horizons from 1 day to 1 year. EUR/DM and USD/EM appear more predictable than JPY crosses and high beta EMs (e.g. ZAR and TRY), likely due to liquidity and the idiosyncratic characteristics of EM paris.
- Finally, we developed a systematic trading strategy based on the ranking that derived from the deviation between forecast vs. current vol levels for each FX pair. This strategy showed promising results, with G10 pairs outperforming EM pairs. Additionally, an equal weighted portfolio aggregating all individual strategies produced a Sharpe ratio of 2.53.
- This model allows us to identify and quantify the most vulnerable vol surfaces within FX domain. In a July / Aug example (Figure 9), Latam dislocations dominate. JPY calls are also found to be vulnerable. Across the board, USD skew compression, particularly in USD/EM and USD/high beta G10, is noteworthy and aligns with the Fed's cutting cycle and the prospect of a soft landing.

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Introduction

The shape of term structure is reactive but also tends to be seen as carrying predictive information. Consequently, robust forecasts of the entire vol surface enable more informed positioning based on anticipated vol dynamics and fading dislocations, ultimately leading to trading profits.

In our previous analysis, we employed a framework that utilized the principal components forecasting method for USD/G10 vol surface. The method is based on a decomposition of the z-score transformation of the vol surface into latent, statistical factors that can directly produce out-of-sample forecasts of the implied volatility surface (IVS henceforth). Several studies have suggested that up to 3 factors are required to adequately capture the dynamics of the IVS. In our study, however, we leveraged market equivalents of the principal components to determine the number of components to retain, rather than using a variance threshold. Our findings indicated that the first five components can approximately explain the following five characteristics of a given IVS: parallel shift, skew, term structure slope, surface skew twist, and convexity. Subsequently, we modeled the 1M delta-hedged PnL of these first five principal components using a Support Vector Machine (SVM) model for each currency and each option structure. We used the model PnL predictions to build a portfolio of option structures. Such strategy had low correlations with a general vol selling strategy and outperformed the strategy by fitting into a linear model. Since the launch of the model, we have been reporting the predicted PnL for the option structures on a weekly basis (see, e.g., here).

In this report, we extend our study to USD/EM, EUR and JPY crosses. Despite the relative success of the above-mentioned principal component approach in USD/G10, adoption of the same framework more broadly faced challenges in terms of predictive power and model stability. Therefore, we adopt a parametric specification approach, which allows more structured descriptions of the surface, and by design should consistently produce accurate predictions in-sample. We subsequently examine the out-of-sample predictive ability by deploying a time series model on the coefficients of our parametric specification. Comparing the forecasting results across FX pairs in our universe, the IVS appears more predictable for G10 and liquid EM pairs. Finally, we show that such superior implied vol surface forecasts should support trading strategies that achieve positive profits.

Data and Methodology

Our data consists of vol pricing data from 2010 January to 2024 August for 46 FX pairs across USD/G10, USD/EM, EUR and JPY crosses. For each day and each FX pair, implied volatility data consists of vol marks for 7 expiries: 2 week, 1, 2, 3, 6, 9, and 12 months; and 5 strikes: 10 and 25 delta calls and puts, and ATM calls/puts. To mitigate the impact from a thinly-traded segments of an IVS, we exclude sample days in which 1) there are missing implied volatility surface prices, and 2) any one of the implied volatility smiles is identical to the previous day (aka stale).

Modeling the Surface

We describe the implied vol surface by fitting a parametric specification $F(\tau_i, \Delta_i)$ in the cross-section of option implied volatilities available at any given period, following

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Chalamandaris and Tsekerokos (2011) [1]:

$$\sigma_{i,t} = \beta_{0,t} + \beta_{1,t}\, 1_{\{\Delta_i>0\}}\Delta_i^2 + \beta_{2,t}\, 1_{\{\Delta_i<0\}}\Delta_i^2 + \beta_{3,t}\frac{1-e^{-\lambda\tau_i}}{\lambda\tau_i} + \beta_{4,t}\left(\frac{1-e^{-\lambda\tau_i}}{\lambda\tau_i} - e^{-\lambda\tau_i}\right) + \beta_{5,t} 1_{\{\Delta_i>0\}}\Delta_i\tau_i + \beta_{6,t} 1_{\{\Delta_i<0\}}\Delta_i\tau_i + \varepsilon_{i,t}$$

where $\sigma_{i,t}$ denotes the implied vol for option *i* at time *t*, i.e. $\sigma_{i,t}$ is one point on a vol surface given at time *t*. τ_i is the time to maturity measured in years. Δ_i is the measure of moneyness, where we transform the Garman-Kohlhagen delta of the call option *i* to $\Delta_i = (\Delta_i^{GK} - 0.5) * 100$. By doing so, we scaled Δ_i to a range of [-50, 50], while it is set as 0 for ATM options, and > 0 (< 0) for OTM puts (calls). Based on Chalamandaris and Tsekerokos (2011), this measure conserves the shape of the IVS and reduces the flattening effect, making the smile more consistent across different maturities.

Coefficients β_1 and β_2 capture skew, while β_5 and β_6 are responsible for attenuation of the smile with time to maturity. Asymmetry due to risk aversion prompts that calls and puts are modeled separately, as specified above with $1_{\{x\}}$ which is 1 if x is true and 0 otherwise. The coefficients β_3 and β_4 capture the average short-end and medium part of the term structure, where parameter lambda determines the exponential decay rate of the term structure.

In order to optimally choose the value of λ for each surface, we first apply nonlinear estimation to all parameters, including λ, by minimizing the daily sum of squared errors. Following this, we fix λ to the median estimated value and re-estimate the model for the beta coefficients. This results in-sample fit for the daily IVS that exhibits the averaged adjusted R^2 that is above 89.2% (Figure 1).

1. How important is the term structure in implied volatility surface modeling? Evidence from foreign exchange options

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Figure 1: The in-sample adjusted R^2 levels from fitting the model

Pair	min	lower quantile	mean	median	upper quantile	Median lambda
USDCNH	76.7%	96.5%	97.0%	97.6%	98.4%	0.136
USDILS	56.1%	95.6%	95.8%	97.2%	98.1%	0.123
USDHUF	52.4%	97.0%	96.5%	98.0%	98.4%	0.071
CADJPY	45.7%	95.5%	95.4%	97.5%	98.2%	0.189
USDBRL	44.0%	96.1%	95.5%	97.8%	98.5%	0.009
BRLJPY	43.1%	96.1%	95.6%	97.7%	98.4%	0.114
GBPJPY	42.9%	95.0%	94.3%	97.4%	98.1%	0.172
USDJPY	38.2%	91.1%	92.7%	96.9%	98.1%	0.144
EURBRL	35.7%	95.7%	94.8%	97.5%	98.3%	0.008
EURJPY	32.8%	94.3%	94.7%	97.3%	98.1%	0.157
EURUSD	32.2%	89.1%	90.7%	94.8%	96.9%	0.147
CHFJPY	30.4%	92.6%	93.0%	96.6%	97.7%	0.154
USDMXN	30.2%	96.5%	94.5%	98.1%	98.5%	0.070
EURAUD	30.0%	92.6%	92.0%	96.3%	97.6%	0.133
EURZAR	29.8%	96.6%	94.3%	97.9%	98.5%	0.049
AUDJPY	29.6%	96.6%	94.9%	97.9%	98.4%	0.130
USDZAR	26.5%	97.3%	94.8%	98.3%	98.7%	0.036
GBPUSD	25.4%	92.6%	91.3%	96.4%	97.6%	0.137
NZDUSD	25.4%	94.0%	92.6%	96.8%	97.7%	0.182
EURCAD	25.4%	88.4%	90.4%	94.6%	96.9%	0.144
USDPLN	25.0%	94.8%	93.5%	97.7%	98.4%	0.078
NZDJPY	24.6%	96.2%	94.5%	97.7%	98.3%	0.143
USDCHF	24.6%	89.1%	89.2%	94.5%	96.9%	0.138
USDSEK	24.5%	91.2%	91.3%	96.0%	97.6%	0.105
USDCAD	24.3%	91.5%	90.8%	95.8%	97.5%	0.136
AUDUSD	23.9%	94.9%	92.5%	97.0%	97.9%	0.167
USDNOK	23.9%	91.7%	91.3%	96.2%	97.7%	0.106
EURNOK	23.6%	93.4%	93.3%	97.0%	98.0%	0.138
EURNZD	23.6%	91.9%	91.2%	95.9%	97.3%	0.114
EURPLN	23.4%	97.0%	94.8%	98.1%	98.6%	0.090
USDKRF	23.1%	96.1%	92.3%	98.0%	98.6%	0.094
EURKRW	23.0%	95.8%	96.1%	97.4%	98.2%	0.112
USDINR	21.8%	96.6%	92.3%	98.1%	98.7%	0.106
EURINR	19.2%	91.4%	91.1%	96.0%	97.6%	0.114
EURGBP	19.2%	91.1%	91.3%	95.9%	97.6%	0.147
USDSGF	16.4%	93.5%	89.4%	97.0%	98.0%	0.148
USDTWF	16.0%	95.3%	90.0%	97.3%	98.2%	0.135
EURMXN	14.5%	96.2%	94.4%	97.7%	98.3%	0.069
JPYKRW	14.2%	95.6%	91.6%	97.9%	98.5%	0.076
EURTRY	13.2%	97.0%	94.1%	98.1%	98.6%	0.011
EURHUF	12.5%	97.6%	96.5%	98.3%	98.7%	0.068
EURKRF	12.2%	93.3%	92.5%	96.9%	98.1%	0.113
EURSEK	10.0%	92.8%	91.9%	96.6%	98.0%	0.153
ZARJPY	9.4%	96.8%	93.8%	98.0%	98.6%	0.079
MXNJPY	7.5%	95.9%	94.4%	98.0%	98.5%	0.126
TRYJPY	4.3%	96.4%	89.9%	98.1%	98.6%	-0.061

Source: J.P. Morgan

Time Series Properties of Parameters

Estimating the model on a daily basis, as we do, produces sets of dynamic factors β_t. Since the shape of IVS at time t+h depends on β_{t+h}, forecasting the factors and proxies forward allows us to produce forecasts of the entire surface over time.

Figure 2 shows the evolution of the coefficients estimated for the past year for EUR/USD options. This demonstrates that the coefficients are not constant over time, with some even alternating between positive and negative states throughout a single year. Therefore, we investigate the time series properties of these parameters, including a cross-correlation matrix and the autocorrelation functions of each coefficients, in order

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to decide which time series processes to adopt to model the evolution of the factors.

Figure 2: EURUSD options estimated coefficients

August 2023 ~ August 2024

λ is fixed at the reported level in Figure 1. IV Level has an offsetting interplay vs short & med-term coefficients while right and left smile are closely reflecting call and put vol spread to ATM vols (ie. call and put skew). The attenuation coefficient correspond to riskies (skew or smile) decay.

Source: J.P. Morgan

As shown in Figure 3, the high autocorrelation function values are observed across the series, which bodes very favorably for forecasting prospects. The findings indicate that a simple autoregressive (AR) process should be able to model the evolution. In Figure 4, linear relationship exist between the coefficient estimates, which suggests a multivariate time series approach should capture these interacting dynamics. For this reason, we also specify a VAR model. To be more complete, we also experimented several other models such as BVAR and ECM but ended up choosing the VAR model as it outperforms the simple AR specification across a few accuracy measures, and is adequate for most currency pairs (i.e. there is little to be gained from more complex alternatives).

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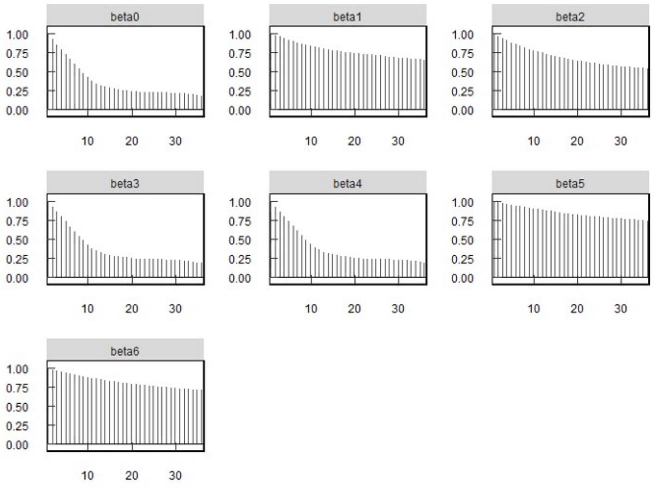
Figure 3: Autocorrelation function of coefficients for EUR/USD options

beta0, beta1, beta2, beta3, beta4, beta5, beta6 refer to the variables of implied vol level, right smile, left smile, short-term structure, medium-term structure, right smile attenuation, and left smile attenuation, respectively.



Source: J.P. Morgan

Figure 4: Correlation matrix of coefficients for EUR/USD options

	beta0	beta1	beta2	beta3	beta4	beta5	beta6
beta0	1	0.029	0.001	-0.722	-0.789	-0.295	-0.078
beta1	0.029	1	-0.692	-0.026	-0.030	0.388	0.237
beta2	0.001	-0.692	1	-0.003	-0.002	-0.256	-0.159
beta3	-0.722	-0.026	-0.003	1	0.779	0.298	0.080
beta4	-0.789	-0.030	-0.002	0.779	1	0.297	0.078
beta5	-0.295	0.388	-0.256	0.298	0.297	1	0.794
beta6	-0.078	0.237	-0.159	0.080	0.078	0.794	1

Source: J.P. Morgan

Out-of-sample Forecasting

On any given day and for each currency, we make forecasts of the implied volatility of option *i*, *h* trading days ahead, denoted as $\widehat{\delta_{i,t+h}}$ by using:

$$\widehat{\sigma_{i,t+h}} = \widehat{\beta_{0,t+h}} + \widehat{\beta_{1,t+h}}\, 1_{\{\Delta_i>0\}}\Delta_i^2 + \widehat{\beta_{2,t+h}}\, 1_{\{\Delta_i<0\}}\Delta_i^2 + \widehat{\beta_{3,t+h}}\frac{1-e^{-\lambda\tau_i}}{\lambda\tau_i} + \widehat{\beta_{4,t+h}}\left(\frac{1-e^{-\lambda\tau_i}}{\lambda\tau_i} - e^{-\lambda\tau_i}\right)$$

$$+\widehat{\beta_{5,t+h}}\, 1_{\{\Delta_i>0\}}\Delta_i\tau_i + \widehat{\beta_{6,t+h}}\, 1_{\{\Delta_i<0\}}\Delta_i\tau_i + \widehat{\varepsilon_{i,t+h}}$$

where $\widehat{\beta_{t+h}} = [\widehat{\beta_{0,t+h}}, \dots, \widehat{\beta_{6,t+h}}]$ are forecasted by a VAR model using 100 observations (although the choice is largely arbitrary) on a rolling basis.

We construct both short-term and long-term forecasts of the implied volatility surface (IVS) by adjusting the forecast horizon (*h*) from 1 day to 1 year, and assess the predictive ability across different forecast horizons by computing out-of-sample average root mean square error (RMSE), mean absolute error (MAE), and adjusted (R^2) across all surface segments. The results are shown in Figure 5. We highlight below:

1) The predictive accuracy is robust across different forecast horizons. Very short-term predictions (up to *h* = 1 week) perform slightly better than medium- to long-term predictions.

2) EUR/DM and USD/EM appear more predictable than JPY crosses and high beta EMs (e.g. ZAR and TRY). We believe liquidity plays a role in EM, and by the same token lower predictability for JPY crosses and high beta EM is also due to their inherently more explosive and/or idiosycratic changes in vol levels which AR processes are unable

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to foresee.

Figure 5: Out-of-sample forecast accuracy

Constructed forecasts of IVS by adjusting *h* from 1 day to 1 year

	RMSE							MAE						
Pair \ Days ahead (h)	1D	1W	1M	3M	6M	9M	1Y	1D	1W	1M	3M	6M	9M	1Y
AUDJPY	0.01	0.04	0.09	0.09	0.17	0.03	0.08	0.48	0.92	1.42	1.50	1.46	1.39	1.40
AUDUSD	0.02	0.11	0.12	0.05	0.03	0.01	0.07	0.35	0.67	1.03	1.09	1.09	1.15	1.13
BRLJPY	0.00	0.09	0.20	0.04	0.00	0.00	0.07	0.64	1.24	1.94	2.00	2.09	2.02	1.94
CADJPY	0.02	0.07	0.11	0.07	0.13	0.11	0.05	0.40	0.77	1.19	1.26	1.24	1.21	1.19
CHFJPY	0.03	0.11	0.12	0.12	0.01	0.07	0.01	0.37	0.71	1.06	1.17	1.18	1.17	1.13
EURAUD	0.02	0.11	0.09	0.03	0.01	0.02	0.14	0.29	0.59	0.95	0.96	0.98	1.00	1.01
EURBRL	0.09	0.03	0.09	0.05	0.03	0.05	0.06	0.86	1.29	1.75	1.80	1.86	1.95	1.86
EURCAD	0.02	0.09	0.09	0.08	0.07	0.09	0.10	0.24	0.52	0.81	0.84	0.84	0.84	0.84
EURGBP	0.02	0.08	0.10	0.07	0.08	0.08	0.04	0.32	0.61	1.04	1.13	1.12	1.12	1.04
EURHUF	0.03	0.08	0.11	0.12	0.03	0.07	0.00	0.29	0.55	0.95	1.03	1.03	1.04	0.99
EURINR	0.02	0.08	0.11	0.08	0.02	0.13	0.04	0.30	0.60	0.98	0.98	1.07	1.05	0.98
EURJPY	0.02	0.10	0.13	0.12	0.02	0.06	0.00	0.42	0.78	1.15	1.25	1.25	1.23	1.24
EURKRF	0.01	0.10	0.16	0.05	0.09	0.08	0.01	0.31	0.64	1.00	1.05	1.03	1.00	1.07
EURKRW	0.01	0.10	0.16	0.05	0.09	0.08	0.01	0.31	0.64	1.00	1.05	1.03	1.00	1.07
EURMXN	0.00	0.13	0.18	0.11	0.16	0.02	0.18	0.47	0.95	1.60	1.76	1.82	1.74	1.87
EURNOK	0.02	0.09	0.08	0.01	0.01	0.04	0.02	0.23	0.52	0.82	0.92	0.89	0.87	0.88
EURNZD	0.02	0.10	0.07	0.07	0.02	0.02	0.07	0.30	0.59	0.95	0.98	0.98	0.98	0.97
EURPLN	0.04	0.13	0.16	0.01	0.07	0.04	0.01	0.26	0.51	0.86	0.92	0.93	1.07	0.94
EURSEK	0.01	0.04	0.03	0.06	0.05	0.00	0.03	0.19	0.39	0.61	0.65	0.65	0.63	0.63
EURTRY	0.07	0.26	0.63	0.17	0.51	0.38	0.22	0.84	1.80	3.17	3.32	3.51	3.42	3.23
EURUSD	0.01	0.09	0.10	0.10	0.07	0.08	0.05	0.31	0.60	0.92	0.94	0.95	0.98	0.94
EURZAR	0.01	0.06	0.17	0.04	0.05	0.07	0.04	0.45	0.90	1.42	1.39	1.46	1.54	1.55
GBPJPY	0.02	0.06	0.13	0.06	0.12	0.07	0.10	0.46	0.88	1.47	1.58	1.57	1.52	1.52
GBPUSD	0.03	0.09	0.10	0.10	0.05	0.06	0.10	0.36	0.71	1.24	1.30	1.30	1.35	1.29
JPYKRW	0.01	0.08	0.16	0.07	0.13	0.12	0.05	0.44	0.87	1.33	1.35	1.37	1.34	1.32
MXNJPY	0.03	0.14	0.22	0.18	0.23	0.01	0.20	0.53	1.06	1.78	1.98	1.95	1.87	1.89
NZDJPY	0.02	0.03	0.08	0.10	0.18	0.03	0.03	0.48	0.92	1.43	1.48	1.47	1.41	1.37
NZDUSD	0.02	0.10	0.12	0.05	0.02	0.02	0.05	0.35	0.68	1.03	1.06	1.07	1.13	1.06
TRYJPY	0.05	0.21	0.58	0.12	0.70	0.34	0.27	1.01	2.02	3.54	3.43	3.71	3.48	3.59
USDBRL	0.03	0.09	0.07	0.06	0.12	0.01	0.02	0.92	1.36	1.83	1.86	1.89	1.91	1.89
USDCAD	0.01	0.07	0.10	0.04	0.11	0.10	0.04	0.24	0.52	0.79	0.79	0.81	0.81	0.80
USDCHF	0.02	0.08	0.07	0.06	0.03	0.10	0.01	0.29	0.60	0.91	0.92	0.96	1.01	0.96
USDCNH	0.01	0.04	0.03	0.00	0.06	0.12	0.01	0.25	0.51	0.81	0.81	0.79	0.83	0.81
USDHUF	0.03	0.15	0.12	0.16	0.11	0.07	0.03	0.44	0.85	1.33	1.40	1.43	1.43	1.33
USDILS	0.01	0.04	0.04	0.00	0.04	0.02	0.03	0.20	0.39	0.65	0.67	0.65	0.70	0.69
USDINR	0.02	0.09	0.16	0.07	0.03	0.13	0.06	0.26	0.52	0.88	0.88	0.91	0.93	0.96
USDJPY	0.02	0.06	0.07	0.04	0.01	0.03	0.08	0.36	0.71	1.04	1.08	1.04	1.11	1.11
USDKRF	0.02	0.09	0.10	0.02	0.11	0.09	0.03	0.35	0.71	1.10	1.12	1.11	1.10	1.04
USDMXN	0.12	0.18	0.14	0.31	0.13	0.01	0.29	0.66	1.10	1.66	1.94	1.91	1.73	1.88
USDNOK	0.01	0.09	0.18	0.08	0.05	0.02	0.04	0.33	0.68	1.01	1.12	1.12	1.09	1.10
USDPLN	0.01	0.13	0.18	0.14	0.18	0.08	0.04	0.38	0.78	1.23	1.34	1.32	1.35	1.27
USDSEK	0.00	0.05	0.08	0.11	0.05	0.01	0.05	0.31	0.65	0.97	1.06	1.03	1.06	1.01
USDSGF	0.01	0.04	0.08	0.01	0.06	0.05	0.06	0.20	0.40	0.68	0.68	0.73	0.71	0.68
USDTWF	0.01	0.05	0.04	0.01	0.06	0.01	0.08	0.21	0.45	0.71	0.74	0.73	0.76	0.76
USDZAR	0.02	0.07	0.14	0.04	0.05	0.06	0.02	0.47	0.92	1.42	1.39	1.40	1.51	1.60
ZARJPY	0.00	0.07	0.10	0.06	0.11	0.02	0.14	0.55	1.03	1.65	1.67	1.68	1.66	1.85

Source: J.P. Morgan

Trading the implied vol surface forecasts

In order to assess the economic significance of our IVS forecasts, in this section, we examine a systematic trading strategy by constructing a portfolio of options based on the model predictions / selections.

For each currency and for a given forecast horizon *h*, on any given day, we rank all the options based on the difference between the h-day-ahead implied vol forecast and the current implied vol level in ascending order (i.e. the largest forecast - current spread has a high rank). Therefore, a low (high) rank suggests a potential sell (buy) signal.

Next, we define P- and P+ to be the set of top p and bottom p ranks, and AVG_{low} and AVG_{high} to be the average of the deviations for each set, respectively. The more negative AVG_{low} is, the stronger the sell signal for the options in set P-; conversely, the more positive of AVG_{high} is, the stronger the buy signal for the options in set P+.

On each trading day and for each currency, we implement a long-only or short-only strategy based on the following rules:

- When $AVG_{low}> 0$, all options have a higher forecasted implied vol than the current level, indicating there are no sell signals and thus we go long the options that screen the cheapest (those under P+).
- When $AVG_{high}< 0$, all options have a lower forecasted implied vol than the current level, indicating there are no buy signals and thus we go short the options that screen the richest (those under P-).
- When $AVG_{low}< 0$ and $AVG_{high}> 0$,
    - If $|AVG_{low}| > |AVG_{high}|$, there are more deviations in P+, thus we go long the options in P+.
    - If $|AVG_{low}| < |AVG_{high}|$, there are more deviations in P-, thus we go short the options in P-.

Once the trading universe and the positions are determined, the weight of each option is scaled by the degree of the deviation: the larger the deviation, the higher the weight.

We run the portfolio in an idealized fashion, holding each position for only one trading day, delta-hedged daily and closed on the next day. We then repeat that for h days, in the process collecting the corresponding daily MTM PNLs. By delta-hedging the position, we ensure that any trading PNL are not related to the movements in the underlying assets but solely from the accuracy of the volatility forecasts (i.e. we remove delta 1 pricing impact). And while holding a position for only 1-day is not how the actual vol surface trading would be executed, it allows us to test the prediction accuracy from trading perspective while keeping the P/L linked to vol surface dynamic as much as practically feasible.

Below we report the strategy performance for h = 1 month forecast horizon and p = 5 options. Figure 6 and Figure 7 display the results for each surface. The signaling value appears most promising for USD/G10, with all deliver a >1 Sharpe pre t-cost. A few Euro/EM crosses also outperform, such as EUR/INR, EUR/KRF and EUR/KRW. By aggregating and equal weighting all individual strategies, the portfolio produces an annualized PNL of 8.2 vega and a Sharpe of 2.5 (Figure 8) which proves that the vol surface forecasting in isolation materially contributes to returns.

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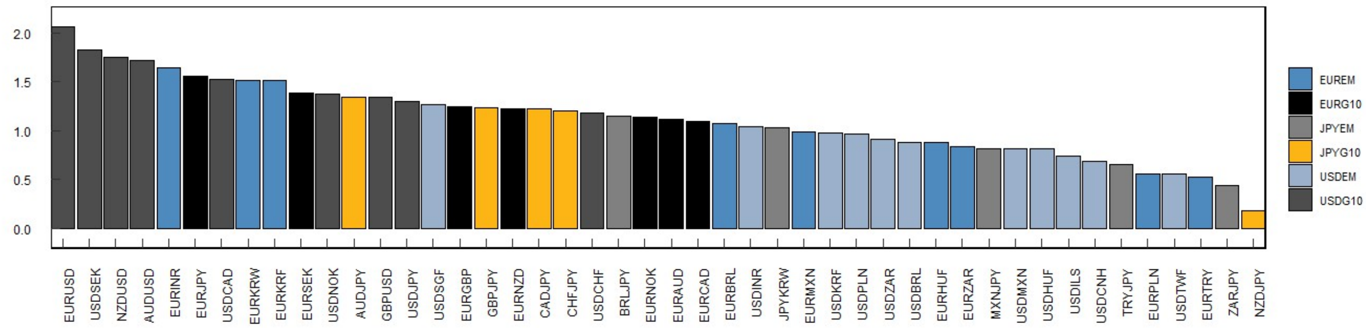
Figure 6: Sharpe ratio by currency

pre t-cost



Source: J.P. Morgan

Figure 7: Strategy metrics

PNL is taken as the average HTM PNL pre t-cost. PNL, vol, Sharpe and Sortino ratios are annualized.

Pair	PNL (Vega)	Vol (Vega)	Sharpe	Down.Dev. (Vega)	Sortino	Skewness	MDD (Vega)
EURUSD	0.19	0.09	2.06	0.06	3.06	1.48	-0.13
USDSEK	0.2	0.11	1.83	0.09	2.37	0.03	-0.17
NZDUSD	0.22	0.12	1.75	0.09	2.34	1.4	-0.28
AUDUSD	0.23	0.13	1.72	0.09	2.5	4.53	-0.29
EURINR	0.17	0.1	1.64	0.08	2.12	-0.93	-0.17
EURJPY	0.22	0.14	1.55	0.1	2.26	3.37	-0.23
USDCAD	0.13	0.09	1.52	0.06	2.31	3.22	-0.13
EURKRF	0.17	0.11	1.51	0.08	2.1	0.86	-0.16
EURKRW	0.17	0.11	1.51	0.08	2.1	0.8	-0.16
EURSEK	0.09	0.07	1.38	0.05	1.71	-0.37	-0.1
USDNOK	0.24	0.18	1.37	0.11	2.09	7.68	-0.47
AUDJPY	0.25	0.18	1.35	0.13	1.96	5.28	-0.33
GBPUSD	0.16	0.12	1.34	0.1	1.56	-1.2	-0.23
USDJPY	0.21	0.16	1.29	0.13	1.65	4.45	-0.31
USDSGF	0.08	0.07	1.26	0.05	1.55	-1.57	-0.11
GBPJPY	0.2	0.16	1.24	0.14	1.45	0.55	-0.29
EURGBP	0.13	0.1	1.24	0.09	1.44	-3.13	-0.23
EURNZD	0.16	0.13	1.22	0.08	1.89	13.18	-0.36
CADJPY	0.2	0.16	1.22	0.11	1.76	5.98	-0.37
CHFJPY	0.2	0.16	1.2	0.17	1.17	-9.64	-0.44
USDCHF	0.22	0.18	1.18	0.24	0.92	-35.73	-0.67
BRLJPY	0.27	0.24	1.15	0.15	1.86	10.9	-0.65
EURNOK	0.16	0.14	1.14	0.09	1.79	9.48	-0.38
EURAUD	0.13	0.11	1.12	0.11	1.19	-4.16	-0.24
EURCAD	0.1	0.09	1.09	0.07	1.47	0.89	-0.12
EURBRL	0.18	0.17	1.07	0.14	1.27	-0.7	-0.38
USDINR	0.08	0.08	1.04	0.05	1.74	2.86	-0.1
JPYKRW	0.18	0.18	1.03	0.12	1.53	5.05	-0.34
EURMXN	0.17	0.17	0.99	0.11	1.49	7.84	-0.47
USDKRF	0.12	0.12	0.98	0.1	1.14	-1.89	-0.25
USDPLN	0.12	0.12	0.97	0.09	1.38	1.17	-0.26
USDZAR	0.16	0.18	0.91	0.15	1.07	-0.46	-0.32
USDBRL	0.22	0.25	0.88	0.14	1.57	21.65	-0.83
EURHUF	0.07	0.08	0.88	0.05	1.29	3.27	-0.13
EURZAR	0.15	0.18	0.84	0.15	1.01	-0.13	-0.42
MXNJPY	0.2	0.24	0.82	0.15	1.34	13.04	-0.67
USDMXN	0.15	0.18	0.82	0.15	1.02	2.82	-0.52
USDHUF	0.12	0.15	0.81	0.1	1.23	8.21	-0.39
USDILS	0.06	0.09	0.74	0.08	0.79	-1.11	-0.15
USDCNH	0.09	0.13	0.68	0.06	1.39	30.85	-0.47
TRYJPY	0.55	0.83	0.66	0.32	1.69	29.82	-2.46
EURPLN	0.05	0.08	0.56	0.06	0.81	5.16	-0.21
USDTWF	0.03	0.06	0.55	0.04	0.81	1.92	-0.1
EURTRY	0.3	0.57	0.52	0.19	1.54	39.67	-1.96
ZARJPY	0.68	1.54	0.44	0.57	1.2	32.99	-5.05
NZDJPY	0.1	0.54	0.19	0.72	0.14	-34.91	-1.86

Source: J.P. Morgan

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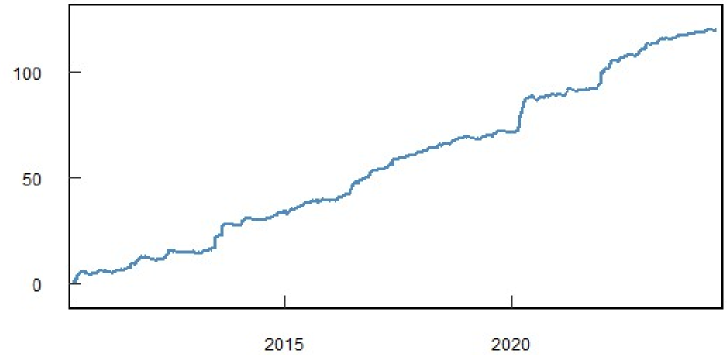
Figure 8: Portfolio performance

Aggregating all individual strategies and equal weighting them. Y axis: cumulative P/L in vol pts.



Source: J.P. Morgan

Conclusion

In this report, we discuss a framework to forecast implied vol surface of 46 FX pairs across USD/G10, USD/EM, EUR and JPY crosses. For each currency, there are at most 35 points across the surface, covering 7 expiries and 5 strike levels, from 2010 January to 2024 August. We find a parametric descriptions of the IVS can lead to superior out-of-sample forecasts and more profitable trading strategies than statistical factor decompositions, mainly due to the fact that the former allow a more structured description of the surface, as opposed to the non-structured, principal components approach.

The developed vol surface model allows us to identify and quantify the most vulnerable vol surfaces within FX domain. **Figure 9**shows an output from the model, depicting a snapshot of dislocations (forecast vs current) across various tradeable axes. Unsurprisingly Latam dislocations dominate. The persistency of those dislocations since the carry blowup in July / Aug surprises a bit considering almost complete deleveraging, but is understandable in light of a fragile market sentiment. JPY calls are also found to be vulnerable, highlighting the inherent mean-reverting nature of the model. Across the board USD skew compression, particularly in USD/EM and USD/high beta G10 is interesting and consistent with Fed cutting cycle & soft landing.

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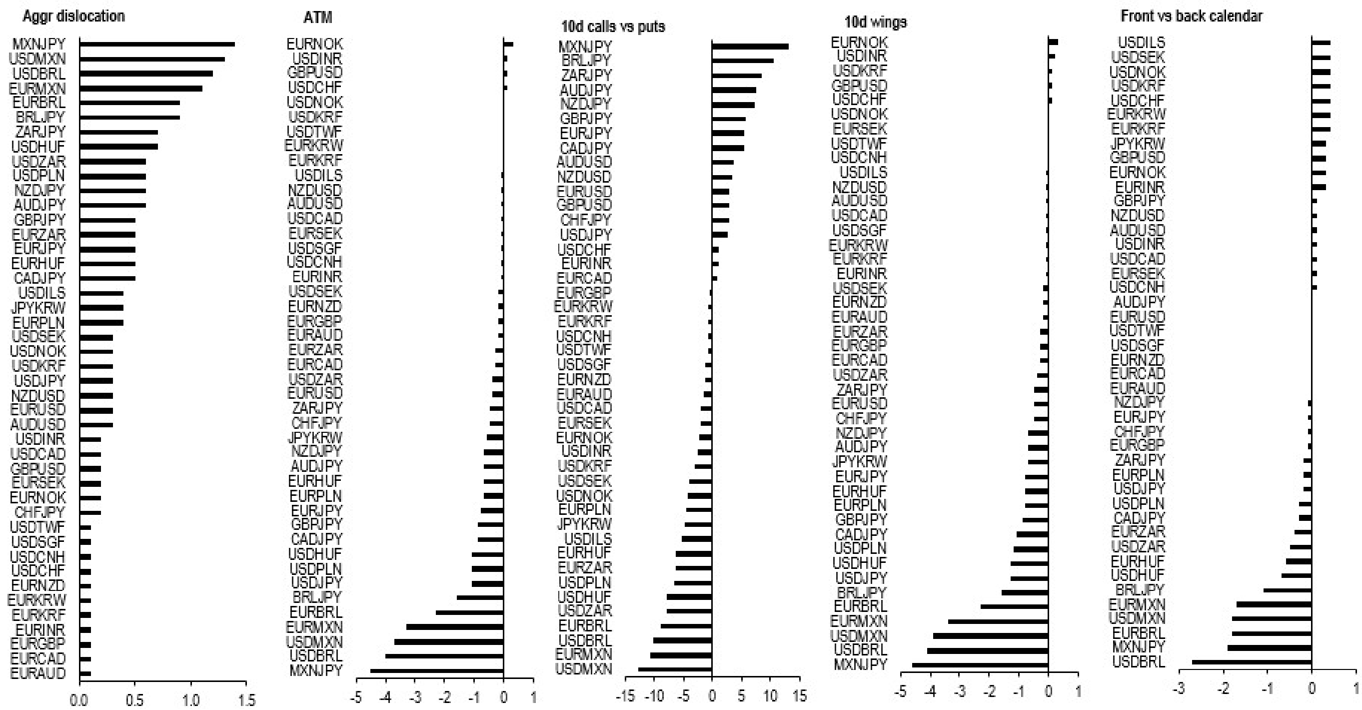
Figure 9: The model projection - dislocations across vol surface dimensions most notable in Latam; USD skew broadly to underperform.

1M, 3M, 6M and 12M tenor only. Units: vols.



Source: J.P. Morgan.

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