Systematically trading Euro rates gamma

A machine-learning model calibrated on fundamentals, technicals, and valuations

- **Our new random forest ML model strongly outperforms the baseline of always being short gamma and our previous 2016 model. With short gamma being generally favourable, the model has a short gamma bias, but correctly recognises long-vol environments, such as the Lehman crisis in 2008, the Taper Tantrum in 2013, Covid-19 in 2020, and the hiking cycle of 2022.**
- **We use JPMaQS indices for our macro signals, which are specifically constructed with the purpose of ensuring fair backtests with no information leakage. We use a total of eight macroeconomic and technical indicators to capture known drivers of gamma returns: inflation, manufacturing confidence, momentum and delivered volatility in rates, and positioning.**
- **Fundamentals matter. We find the JPMaQS inflation and manufacturing confidence signals to be the most important for trading 6Mx10Y Euro rates gamma.**
- **Our model outputs a daily long/neutral/short gamma signal, along with its conviction.**
- **The model is currently biased towards being short gamma, though risks are broadly balanced. Declining manufacturing confidence and still-elevated core inflation support being long, but this is offset by inflation declines and rich valuations on implieds.**

Rates Strategy

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Previously, we created a systematic strategy for trading EUR gamma (delta-hedged daily with monthly rebalancing) that used macro and technical indicators to generate long and short signals (see *here*). While this strategy outperformed a typical always-short gamma strategy, it was still biased towards short gamma and could not fully capture the high volatility period during the 2022-2023 hiking cycle. Incorporating lessons learned from the recent hiking cycle, we have built a new model that outperforms this previous strategy and short gamma benchmarks (**Figure 1**), with notably strong performance in the recent quarters, by flipping more frequently between long- and short-gamma positions (**Figure 2**). This new model also improves on the 2016 one by giving an ex-ante conviction level on each trade and gives a better idea of true performance by backtesting using separate training and testing samples (as opposed to our 2016 model). Our new model is based on a "random forest" ML approach where we train with all data up to the start of the month and then generate out-of-sample signals for that month, before re-training once we roll to the start of the next month.

This note is structured as follows:1) model performance versus benchmarks, 2) intuitive explanation of our feature variables, 3) technical details around the model and a stylised example of a decision tree, 4) investigating the impact of the model's conviction, 5) performance with transaction costs, and 6) the current signal and factors driving this decision.

See page 7 for analyst certification and important disclosures.

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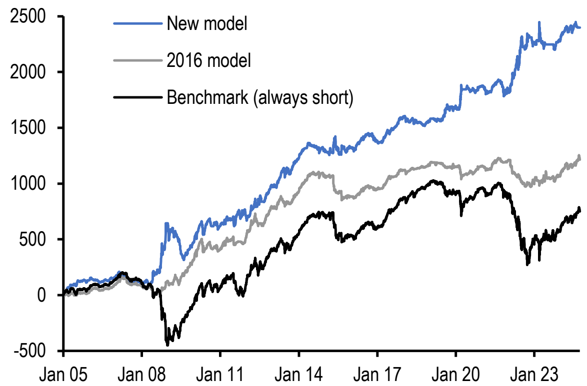
Figure 1: Our new systematic gamma trading strategy outperforms the benchmark (always short gamma) and our previous strategy, which was calibrated using in-sample parameters

Cumulative PnL from our systematic gamma trading strategy versus always-short benchmark and 2016 baseline strategy; since 2005; bp of notional on 6Mx10Y swaptions



Source: J.P. Morgan.
Note: These strategies are backtested using J.P.Morgan volatility indices, which can be found in DataQuery. These indices assume daily delta-hedging and zero transaction costs. We keep the option maturity dates and strikes fixed for an entire month and then re-strike these options into a new ATMF option with original expiry.

Figure 2: The model has successfully recognised notable long-vol environments, such as the Lehman crisis in 2008, Taper Tantrum in 2013, Covid-19 in 2020, and the 2022 hiking cycle

Yearly information ratios from EUR gamma short/long/overall positions and % of time long or short (calculated across days), and the success ratio, average PnL, and max downside (calculated across trades); since 2005

	Calculated across days					Calculated across trades		
	Overall IR	Short IR	Long IR	Time spent long; %	Time spent short; %	Success ratio; %	Average PnL; bp of notional	Max downside; bp of notional
2005	3.6	4.5	1.9	34%	54%	86%	19	0
2006	1.2	2.3	-3.8	17%	80%	50%	6	-16
2007	-1.5	-1.2	-2.9	14%	67%	25%	-15	-58
2008	3.8	2.3	4.1	74%	17%	100%	140	0
2009	-1.6	1.9	-4.3	41%	50%	25%	-45	-140
2010	1.4	1.4	-	0%	91%	50%	71	-1
2011	0.9	1.0	0.8	18%	57%	80%	15	-50
2012	3.8	4.0	2.3	8%	81%	100%	71	0
2013	2.4	2.0	7.2	8%	92%	100%	82	0
2014	0.9	2.1	-4.0	23%	64%	33%	9	-31
2015	-0.8	-2.5	0.1	53%	24%	67%	-14	-97
2016	0.7	0.8	-0.8	12%	86%	50%	14	-15
2017	4.0	4.7	-3.9	8%	82%	67%	73	-15
2018	-0.6	0.9	-8.8	26%	74%	43%	-5	-35
2019	1.7	1.9	1.8	76%	14%	75%	33	-16
2020	1.9	4.0	1.5	58%	25%	75%	46	-36
2021	-0.2	-0.7	1.2	17%	81%	67%	-5	-72
2022	2.4	-	2.4	83%	0%	67%	141	-43
2023	-0.1	1.3	-0.5	24%	20%	67%	-1	-36
YTD	2.2	2.2	-	0%	70%	100%	60	0
Overall	1.2	1.5	1.0	30%	56%	64%	32	-140

Source: J.P. Morgan.
Note: We train our new model using data from 1 Jan 2000. We reserve the first five years of data for the initial training, and conduct a monthly retraining from then on. We forecast the next month's returns, before rolling to re-train and forecast the month after in an interative process to prevent look-ahead bias.

We use a combination of macroeconomic and technical signals to generate long, short, and neutral signals for trading 6Mx10Y EUR gamma. These feature signals were chosen based on economic and fundamental intuition, insights from our previous research and the latest hiking cycle, and rigorous stress-testing of different possible signals. Importantly, as historical macroeconomic data is often revised with hindsight, which can distort backtest performance, we use data vintages created by JPMaQS to prevent any look-ahead bias. The features we use in our model, in order of importance are:

1. **Change in manufacturing confidence** (seasonally-adjusted, z-score, 3m/3m diff; JPMaQS): With the Euro area having a relatively large manufacturing sector, a drop in manufacturing confidence is a leading indicator that the ECB may need to reduce policy rates. Empirically, we have found easing cycles to be supportive of long gamma positions. Conversely, high levels of confidence are typically accompanied by a stable macro environment that is supportive of short gamma positions (**Figure 3**).
2. **Core inflation level** (seasonally and jump-adjusted annual core CPI; JPMaQS) **and change** (% 3m/3m oya; JPMaQS): High and increasing inflation are both typically supportive of long gamma positions as these may require rapid and unpredictable

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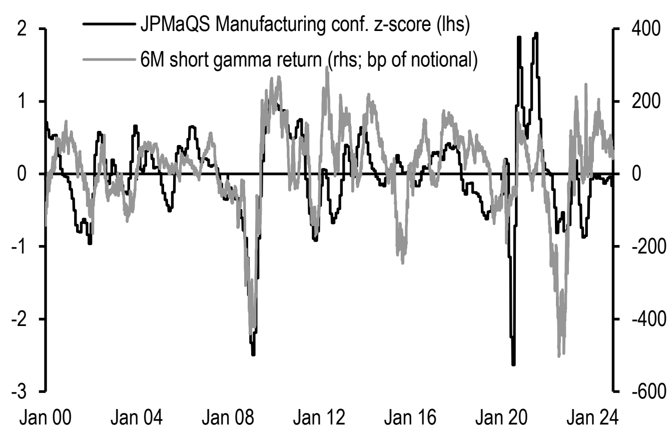
adjustments of policy rate higher, as was the case in 2022-2023.

3. **1M change in 1Yx1Y €STR**: Large and aggressive yield moves are typically supportive of long gamma positions. Small absolute changes in yields are supportive of short gamma positions.
4. **6Mx10Y Implied Volatility**: In our multi-factor model, we use the implied as a measure of valuation, with the model finding cheap valuations to be almost universally supportive of long gamma positions (**Figure 4**). Rich valuations on the other hand are generally supportive of short gamma, albeit to a smaller extent.
5. **Positioning in Euro rates** (by single-currency investors, duration deviation from the benchmark in years, from J.P.Morgan's *Client Survey*): Single-currency investors have a systematic tendency to be long-duration, with crowded (light) positioning in duration supportive of long (short) gamma positions.
6. **Leverage ratio of vol-targeted duration position in 10Y swaps** (assumes a 10% annualised vol target and is inversely proportional to delivered vol; JPMaQS): High uses of leverage are supportive of long gamma returns as yield shocks are multiplied and thus can cause large wipeouts and positioning clean-ups.
7. **Annualised carry-to-risk on 10Y swaps**: Large carry-to-risk signifies a steep swap curve and a low-vol environment, both of which are supportive of short gamma returns.

Figure 4breaks down the individual impact of these variables on the model's daily long (+1), short (-1), or neutral (0) signal. The color of the dots denotes the magnitude of the indicator's values (with dark and light blue showing increases and decreases, respectively, in, for example, manufacturing confidence) and the position of the dot on the x-axis showing the impact on model output (RHS meaning long gamma and LHS short gamma). All features impact model output with the correct economic intuition we describe above.

Figure 3: We find the evolution of manufacturing confidence to be a significant driver of gamma returns, a driver that will be key to watch in 2025 for its response to tariff risks

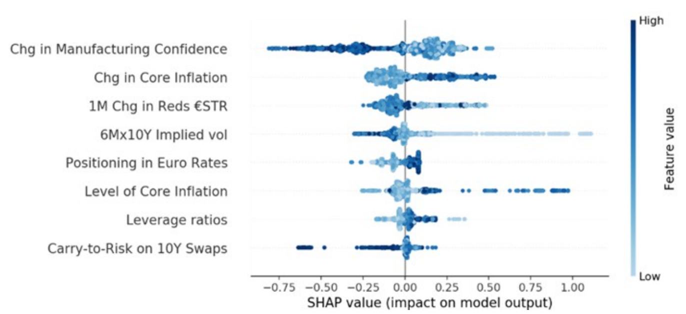
Change in z-score of manufacturing confidence (seasonally-adjusted, 3m/3m diff, JPMaQS; lhs) versus rolling 6M returns from selling 6Mx10Y gamma (rhs; bp of notional); since 1 Jan 2000



Source: J.P. Morgan and JPMaQS.

Figure 4: Macro fundamentals matter: over the long term, changes in growth and inflation are front and center for gamma trading

Impact of indicator's value (dark blue denotes a high value and light blue denotes low) on the model's gamma trading signal (+1 means be long gamma with max conviction, 0 neutral, and -1 short with max conviction); since 1 Jan 2005



Source: J.P. Morgan and JPMaQS.
Note: The chart plots *Shap* values to show the contribution of each feature on the model's signal. Shap values are additive by definition such that the signal on a given day can be fully decomposed into its's unconditional expected value (close to -0.2 since 2000) and the contributions from each feature.

Armed with a set of signals, we now use a random forest of 1,000 decision trees to determine the thresholds to go long/short, where each tree gets a subsample of the overall feature and data sets. Each tree iteratively determines a threshold on the features that would best split the target variable (*ideal* long or short gamma signal), into two separate buckets of long versus

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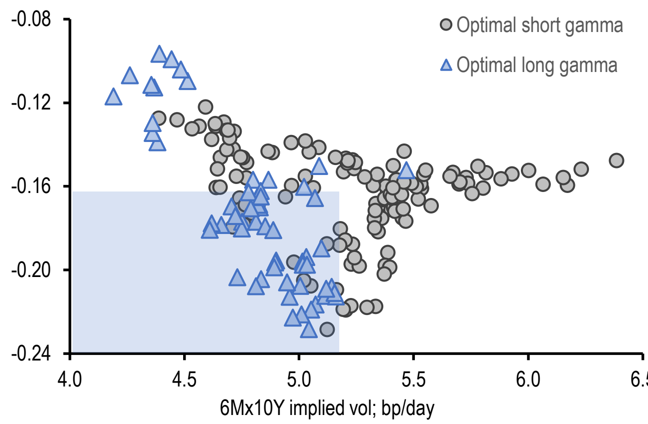
short gamma. **Figure 5** shows a stylized example of a decision tree for 2024 gamma returns if we only used two features as inputs and limited the tree's maximum depth to two. The first split would be done at an implied vol around 5.1bp/day, with implieds trading below this threshold resulting in a long gamma signal and above in a short gamma one. Since the tree has a depth of two, it is allowed to split each of these two buckets once more. While there is no possible split to the right of 5.1bp/day to improve performance, on the left the decision tree would make the second split on a carry-to-risk value of close to -0.16. The final result, is that feature values in the bottom-left quadrant (shaded blue) would result in long gamma signals from the model, and short otherwise.

In our strategy, we use a random forest of 1,000 trees and limit the maximum depth of each tree to five, to prevent overfitting. In the training process, we also place more weight on recent observations (linear weights) to increase the model's responsiveness to shifts in market regimes. Each trained tree from the 1,000 works as a classifier and casts a vote on whether to be long (+1) or short (-1) gamma, with the forest's overall signal calculated as the average vote (with a greater absolute value indicative of higher conviction). We have found the model's conviction, as measured by the strength of the signal, to have modest predictive power on the probability of a trade succeeding (**Figure 6**) – particularly when selling gamma.

Figure 5: Decision trees iteratively determine the optimal thresholds on feature variables, until separate long and short gamma buckets are determined. We use 1,000 trees and limit the depth to five, to prevent overfitting

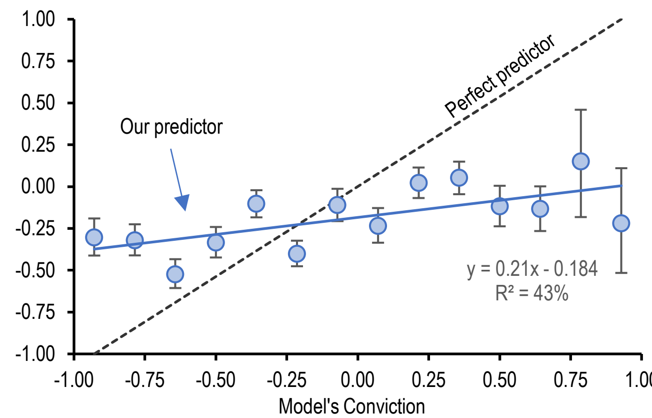
Decision tree boundaries on long (blue) and short (grey) gamma rules if using carry-to-risk on 10Y swaps and implied/delivered volatility differential (bp/day) as the only two feature variables; since 1 Jan 2024



Source: J.P. Morgan.
Note: The blue shaded area denotes the combination of carry-to-risk and implied vols for which the decision tree will output a long gamma signal. White areas denote a short gamma signal.

Figure 6: The strength of the signal on gamma is useful as a proxy of conviction, and has been empirically important for short-gamma trades, in particular

Ex-post optimal conviction signal that should have ideally been shown versus our model's *ex-ante* conviction signal in an out-of-sample backtest; since 1 Jan 2005



Source: J.P. Morgan.
Note: Model conviction is calculated as the average signal across the 1,000 trees; for example, conviction is +1 if all 1,000 trees give a long signal, 0 if 500 trees give a long signal (and 500 short), and -1 if all 0 trees give a long signal (and 1,000 short). For a given model conviction, we look at the ex-post proportion of optimal buy and sell signals and back out the conviction our model should have *ideally* had. In the case of a perfect predictor, when ex-ante conviction was between say +0.85 and + 1, we would expect between 92.5% and 100% of signals in this subsample to be long gamma. This relationship is from Optimal conviction for subsample = 2 * (Proportion of optimal long signals in subsample – 0.5). This means that the optimal conviction is defined as +1 when all trees are long gamma, +0 when 50% are long, and -1 when 0% are long.

To initially train the classification model, we need a set of optimal buy and sell signals. We define these as the *ex-ante* signal that would first result in an *ex-post* profit of at least 20bp of notional; in other words, whether one should buy or sell gamma today to more quickly earn a minimum PnL of 20bp of notional (**Figure 7**). This PnL becomes the implicit target when using the model out of sample, but, clearly, it is not guaranteed and the signal could potentially be flipping daily between long and short. To prevent excessive trading, we force a minimum one-month holding period for trades and a hurdle conviction threshold of 25% (absolute

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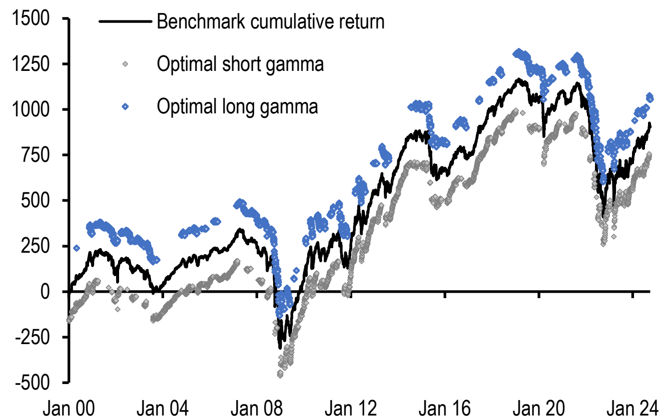
value) to enter a new trade. This also improves the model's robustness to trading costs. We assume conservative transaction costs equal to 30% of bpvega at trade entry, exit, and monthly re-strike. Factoring in transaction costs, our model still strongly outperforms the benchmark (**Figure 8**).

Figure 7: We determine the ex-ante optimal long and short signals for training our model by targeting an ex-post PnL of 20bp of notional (or more)

Cumulative PnL from baseline of always being short gamma with markers denoting the optimal ex-ante long (blue) and short (grey) gamma signals for each day that would first deliver at least 20bp of notional in PnL; bp of notional; since 1 Jan 2000



Source: J.P. Morgan.

Figure 8: Even with conservative transaction cost estimates, performance strongly outperforms the benchmark

Information ratio***, average returns across trades (bp of notional), and success ratio across trades (%) for our new model, with and without trading costs, versus the benchmark of always being short gamma; since 1 Jan 2005

	Across days	Across trades			
	Information ratio	Avg Return; bp of notional	Avg Long Return; bp of notional	Avg Short Return; bp of notional	Success ratio; %
Trading costs*	0.8	22	20	24	58%
No trading costs	1.2	32	29	34	64%
Always short**	0.3	11	0	11	-

Source: J.P. Morgan.
Note: * We assume conservative transaction costs equal to 30% of bpvega at trade entry, exit, and monthly re-strike. ** To ensure comparability, the average return of the benchmark is calculated as the cumulative PnL since 2005 divided by the number of trades done in our model. We apply the re-striking cost of being always short. *** We define information ratio as the average return over the return volatility (both annualised).

So what is the current signal? The model took profit on its short gamma position at the end of July and has remained neutral since (**Figure 9**), although it currently has a short gamma bias and is near the conviction threshold to sell gamma (**Figure 10**). It finds risks on gamma to be broadly balanced with declining manufacturing confidence, still-elevated core inflation, crowded long positioning and low carry-to-risk all pointing towards being long gamma, but declining inflation and elevated valuations on implieds supporting the short gamma bias. Current leverage ratios and the 1M change in Reds are close to their historical averages and do not sway the model's signal in either direction. Going forward, we believe the evolution in core inflation and manufacturing confidence will be the key determinants to watch for trading gamma.

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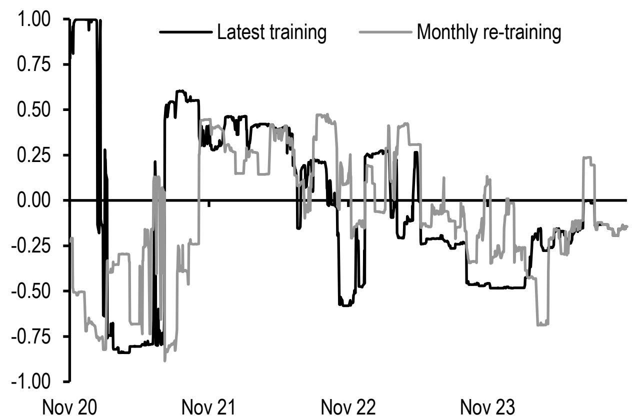
Figure 9: Our model was short gamma earlier this year, taking profit in late July and switching to a long gamma bias in August…

Evolution of the model signal when re-trained monthly and predicting out-of-sample and when trained with the full sample now and classifying in-sample; past 2Y



Source: J.P. Morgan.

Figure 10: … the model has remained neutral since, but with a short gamma bias and conviction signal relatively close to the -0.25 threshold to sell gamma

Latest feature values and their contributions to the model's current short gamma bias signal

	Feature value	Contribution to trading signal
Baseline	-	-0.19
Chg in Manufacturing Confidence	-0.2	0.10
Core Inflation; %oya	2.5	0.07
Positioning in Euro Rates; years	0.5	0.02
Carry-to-Risk on 10Y Swaps	-0.1	0.01
Leverage ratios	1.9	0.00
1M Chg in Reds €STR; bp	-7.3	0.00
6Mx10Y Implied vol; bp/day	4.6	-0.06
Chg in Core Inflation; %oya	-0.1	-0.10
Model's Signal	-	-0.14
Conclusion	Short Gamma Bias	

Note: Data as of COB 25th Nov 2024.
Source: J.P. Morgan and JPMaQS.

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Completed 02 Dec 2024 10:46 AM GMT   Disseminated 02 Dec 2024 10:46 AM GMT