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QUANTWISE

Quantitative Investment Strategies

Quantitative Investment Strategies Research: Investing in Central Bank Momentum

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Markets react to policy decisions from central banks: Asset prices move as they anticipate changes in policy paths. We introduce the Short-Term Rates Trend strategy to capture these changes, leading to attractive risk-adjusted returns alongside our other Liquid Macro strategies.

Investing in Central Bank Momentum

Central banks exhibit inertia in their policy paths: consensus-building among decision makers is slow, and policy impact lags behind its application. To meet these conditions, we introduce a trend-following strategy that invests across six regions, using short-term interest rate futures. This simple, implementable, and transparent rule-based strategy is designed to achieve persistent and uncorrelated Trend/Momentum risk premia.

Conditioning on Volatility Forecasting

Trend-following strategies tend to underperform in volatile periods. To address this challenge, we use different look-back windows to estimate short-term interest rate trends and a parsimonious statistical model, GARCH, to capture the time-varying aspects of market volatility.

Robust Performance Across Monetary Policy Regimes

We compare strategy returns across easing, neutral, and tightening policy regimes and demonstrate how the strategy provides strong performance in each regime. In particular, the Short-Term Rates Trend strategy has had its best risk-adjusted performance in central bank rate-cutting cycles.

Liquid Macro Portfolio

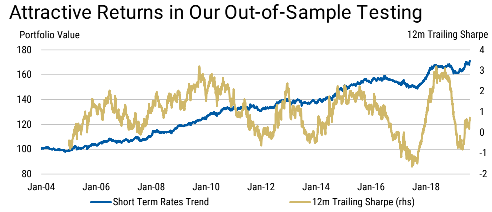
We construct a portfolio investing in the three QIS Research strategies for global Macro products – Rates Value, Short-Term Rates Trend, and FX Value. These strategies have achieved robust performance due to low correlations among the strategy returns.

Strategy Performance in Market Downturns

The Liquid Macro portfolio of strategies exhibit defensive qualities in periods of market stress. We present an update of these strategies and their conditional performance during equity drawdowns.

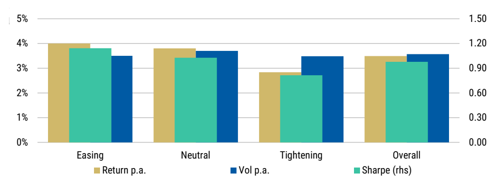
QuantWise highlights research that incorporates a robust quantitative approach in our investment analysis.

Exhibit 1: This Simple Framework Has Produced Attractive Returns in Our Out-of-Sample Testing



Source: Morgan Stanley Research, Bloomberg

Exhibit 2: Short-Term Rates Trend Provides Positive Returns in Different Monetary Policy Regimes



Source: Morgan Stanley Research, Bloomberg

Introduction

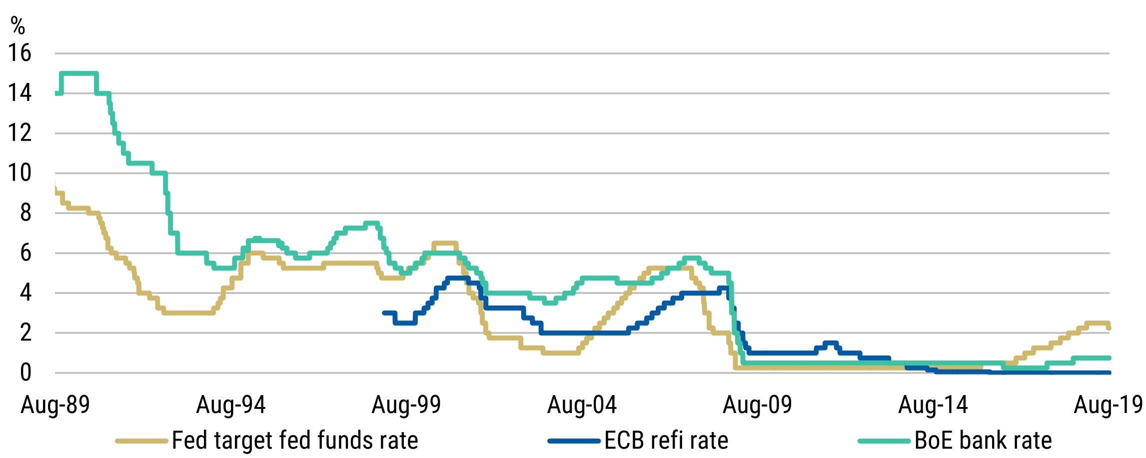
Central bank inertia: a central bank in motion tends to stay in motion

Even the most cursory glance at the history of major central bank policy rates confirms what investors would suspect: the rates are non-stationary. The mean and variance structure of each time series has changed over time clearly (see Exhibit 3). These central bank policy rates alter the behavior of related markets, such as the short-term interest rate (STIR) futures employed in this research. But at the core of these oscillations is an essential inertia: central bank rates in motion tend to stay in motion.

How can we explain the phenomenon of central bank policy inertia? Aren't central banks vested with the power to change policy quickly, as circumstance dictates? However, we find central banks to be inertial as a result of two factors - one economic and one social.

1. Monetary policy operates with a long and variable policy lag.
2. Consensus among diverse opinions is hard to build, but once built, is hard to change.

Exhibit 3: Fed, ECB, and BoE Policy Rate History



Source: Morgan Stanley Research, Bloomberg

The long and variable lag between policy implementation and effect has a way of ensuring that central banks overshoot. When a central bank tightens monetary policy with more than one rate hike during a given year, for example, it can't be sure it went too far with the first hike until the effects are observed.

In addition, the economy – which operates with a momentum of its own – tends to encourage the central bank to keep tightening policy. At some point, possibly well after the policy has been tightened too much, the economy will start displaying weakness in reaction to the initial rate hikes. This issue with long lags between changes in policy and changes in economic activity has contributed to policy inertia.

Some central banks, like the Fed, have tried to address these lags by hiking rates gradually – allowing more time to observe the effect of previous rate hikes and cuts. In our Interest Rate Strategy Team's view, such an approach to rate cuts, in particular, increases the chance that easing cycles remain inertial. If the Fed waits for coincident indicators of economic activity to turn down before easing aggressively, data will likely continue to weaken thereafter, encouraging further rate cuts.

Regarding consensus building, it can differ widely across rate-setting committees at central banks, and it is dependent on a variety of dynamics. In general, though, decisions made by consensus – while perhaps more thoughtful and informed – take longer. As such, once consensus settles on one direction, it is hard to alter its course.

Given inertial central bank policies, it's fair to anticipate inertia in STIR markets. It is with this anticipation that we investigate and try to capture the premia from trends in short-term interest rates.

For More Reading on Central Banks, please see:

FOMC Outlook: More Cuts Are Coming: Chair Powell's checklist suggests additional cuts are coming. We now expect successive cuts of 25bp at the September and October FOMC meetings. Our strategists believe the lack of more aggressive policy moves will drive UST yields lower and keep the USD supported against risk-sensitive currencies.

FOMC Reaction: And That's What a Hawkish Cut Looks Like: The FOMC delivered a 25bp cut to the funds rate and an earlier end to balance sheet normalization. We expect another cut in October, and our strategists turn neutral on rates and curves, and expect temporary USD strength.

What's Next in Global Macro The Balance of Evidence: Is the outlook, in the words of ECB President Mario Draghi, "getting worse and worse" or is there cause for optimism? Based on the evidence at hand and our assessment of the key drivers of the outlook, we think it is more the former than the latter, and we hold on to our base case prognosis of sub-par global growth.

Global Interest Rate Strategist: One Crazy Summer: A lack of investor confidence in the outlook for central bank policies, global growth, global trade, and the direction of bond markets gave way to higher volatility as the summer heat turned up a notch. We think the big picture trend remains toward lower yields as uncertainty increases further.

UK MPC Preview: Neutral for Now: With a flat 2Q, inflation at target and rising Brexit and external risks, we expect the MPC to drop its hawkish bias for now, but still to guide to some tightening over time on an orderly resolution of Brexit.

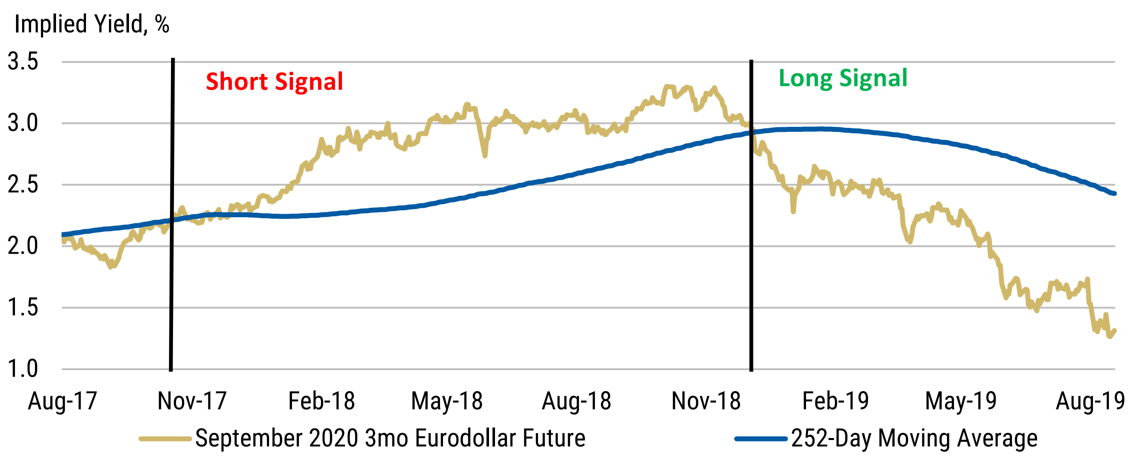
ECB Reaction: Working on an Easing Package: The central bank said that policy rates could be reduced further and announced that technical work is ongoing on reinforcing the guidance, designing a tiering system and restarting QE, if needed. We expect a 10bp depo rate cut to -0.50% in September and a new buying programme in 4Q. By stressing the symmetry of its inflation aim, the ECB is likely to implement extra stimulus for longer.

Investing in Short-Term Rates Trends

We studied the inertia in interest rates through a trend-following strategy investing in STIR futures markets. We focused on six liquid STIR markets, covering the US, Canada, the UK, the Euro area, Switzerland, and Australia. The most liquid market we studied – the Eurodollar[1] futures market – allows investors to express views on upcoming Fed policy.

As of August 2018, the September 2020 three-month Eurodollar future was priced to yield 3%. This figure implied that the market expected roughly three interest rate hikes over the two-year term. Today, the very same contract is priced at a yield of approximately 1.3%, which indicates that the market anticipates about three interest rate cuts over the next year. This remarkable shift, shown in Exhibit 4, has caused market pricing to remove the equivalent of six 25-basis-point rate hikes from its forecast for September 2020. Looking at this scenario from a risk-adjusted vantage point, an investor who purchased that Eurodollar contract outright has performed nearly as well as the 10-year US Treasury.

Exhibit 4: Market Implied Yield on September 2020 3-month Eurodollar Future



Source: Morgan Stanley Research, Bloomberg

It is important to recognize that this 180-degree turn did not happen overnight. The market outlook for the US economy changed gradually as new data, news headlines, and speeches from central bankers shaped expectations. This gradual, but significant shift inspired our team to develop a trend-following strategy focused on STIR futures capable of achieving returns throughout the change cycle in policy positions.

Our strategy takes a global approach, studying the front four contracts of the six most liquid three-month STIR futures. Using moving average trend, the strategy allocates to each of these STIR futures. The goal is to efficiently and consistently harvest this alternative source of risk premia across the full sweep of volatility conditions.

The strategy has produced attractive risk/return statistics in our out-of-sample testing since 2004, generating a 1.0 Sharpe ratio after accounting for standard transaction, financial, and roll costs. A strategy like this exhibits low correlations to market betas as well as other types of risk premia. All of these factors have in testing resulted in consistent performances across countries and monetary policy regimes.

Strategy Construction

From the outset, our goal has been to design an adaptive trend-following strategy that is responsive to different levels of market volatility. When the market is volatile and when a trend is not especially pronounced, we usually need a longer look-back window in order to estimate drift. On the other hand, when the market is calm, a shorter look-back window is more desirable to capture the time-varying trend. We wanted to create one synthesized approach that could accommodate both market situations.

Our first challenge centered on how to predict whether the market was going to be in a high- or normal-volatility regime. We determined that the best approach was to apply a powerful, parsimonious statistical model to help us forecast the actual volatility of underlying interest rates: Generalized Autoregressive Conditional Heteroskedasticity[2] (GARCH). The GARCH model is capable of capturing the two key features we associate with volatility: time variance and clustering (high volatility is followed by high volatility, and, conversely, low followed by low).

Each week, we apply GARCH to forecast actual volatility in each of the underlying futures. Then, we compare the forecasted volatility to the past three years of fitted GARCH realized volatility. If the forecast is higher than the median, we classify the upcoming week as High Vol regime, and vice versa.

Next, we determine the optimal look-back windows for the moving average. After experimenting with a wide range of look-back windows, the in-sample data proved that using two look-back windows, conditional on GARCH forecast volatility, delivered the most robust performance. These two look-back windows include a three-month average for low-volatility regimes, and a one-year moving average for high-volatility regimes. This result bolstered the risk takers' conviction that it is important to consider longer-term trends in especially volatile markets, as opposed to relying on sharp turns in futures prices.

From here, our strategy embraces simplicity: the model buys contracts that are trading above the moving average, and sells those which are below. This approach generated robust returns during in-sample testing, and subsequent applications to out-of-sample data have been equally encouraging.

To construct the strategy, we studied in-sample data from 2000 to 2003 and used it to fit the initial GARCH models. Then, we used a rolling 3-year window to fit the GARCH on the most recent data during out-of-sample testing.

Short-Term Rates Trend Strategy, Step by Step:

1. For each futures contract, forecast the next day's volatility using a GARCH(1,1) with past three years' daily return.

2. Compare the forecast to the trailing three years' fitted GARCH volatility; if the forecast is above the median, use High Vol Regime; otherwise, use Low Vol Regime.

3. Compare the current contract price to the moving average price that corresponds to the current volatility regime (Low, use 66 days; High, use 252 days).

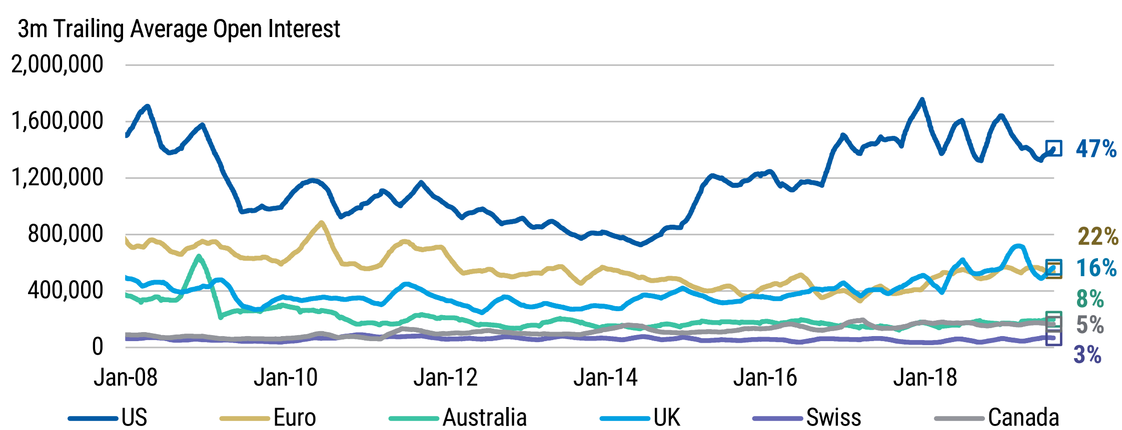
4. If the contract price is above the moving average price, the strategy generates a "Long" signal—buy the contract (or hold if already long) at the close on the next business day. If the contract is below the moving average price, the strategy generates a "Short" signal—sell the contract (or hold if already short).

5. Repeat process for each of the four contracts in each region, equally weighting the four contracts and weighting the regions proportionally to open interest.

Strategy Weights

In order to invest proportionately to liquidity, we allocate to the different regions relative to their trailing Open Interest. As a result, roughly half of the strategy is invested in Eurodollar futures.

Exhibit 5: Open Interest by Region, Front Futures Contract and Strategy Weight (10y Avg)



Source: Morgan Stanley Research, Bloomberg

To reduce turnover and transaction costs, we generate the volatility regime on a weekly basis, then split the portfolio into five portions, executing signals at the following daily close. We lever the strategy to target 3.5% annualized volatility, using the trailing 12 months of daily returns to guide the target. To factor in transaction costs, we consider the rebalancing, rolling exposure, and margin costs. In fact, this strategy has higher leverage due to volatility targeting, and higher turnover as a result of frequent signal switches from long to short allocations.

In total, we assume 110 basis points a year of transaction costs for the strategy, applying approximately 100 basis points for trading and rolls, along with 10 basis points in margin costs. For more details on transaction costs, please see the Appendix.

Strategy Performance Summary

Strategy Performance

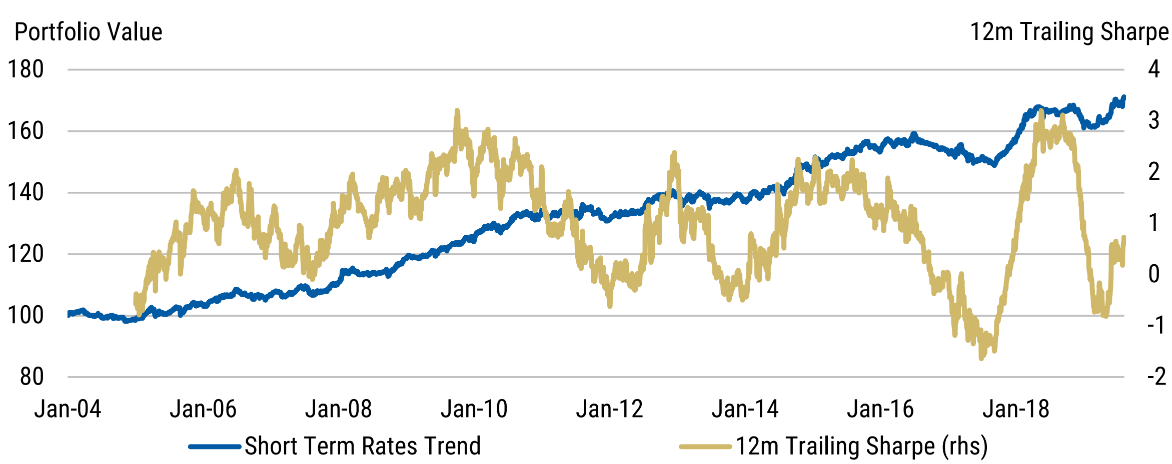
The Short-Term Rates Trend strategy has robust performance in our out-of-sample testing, generating consistent returns across varying market scenarios. The strategy has had stronger results recently, generating a 1.41 Sharpe ratio since 2018. One challenging period for the strategy was in 2011 because there was no clear trend in the underlying futures prices. We used data from 2001 to 2003 to fit the initial GARCH models, and then used a rolling 3-year window from 2004 on.

Exhibit 6: Out-of-Sample Performance Summary

Year	Return	Vol	Sharpe	Sortino	Max Drawdown
2004	-1.6%	2.5%	-0.63	-0.76	-3.7%
2005	5.4%	4.0%	1.37	1.95	-0.6%
2006	3.1%	3.4%	0.90	1.20	-1.5%
2007	3.4%	3.6%	0.95	1.25	-0.3%
2008	7.3%	3.8%	1.92	2.86	-0.2%
2009	4.4%	2.9%	1.55	2.03	-1.2%
2010	8.0%	3.7%	2.16	3.15	-0.3%
2011	-2.2%	3.6%	-0.60	-0.85	-3.8%
2012	6.2%	3.0%	2.06	3.57	-1.0%
2013	-1.6%	3.7%	-0.44	-0.46	-2.3%
2014	7.5%	4.1%	1.82	3.05	-1.2%
2015	3.9%	3.4%	1.13	1.72	-2.2%
2016	0.1%	2.9%	0.02	0.01	-3.7%
2017	2.0%	3.7%	0.55	0.80	-6.4%
2018	4.0%	3.7%	1.07	1.35	-3.4%
2019	8.3%	4.0%	2.06	3.53	-0.3%
2004-2019	3.5%	3.5%	1.00	1.39	-6.4%

Source: Morgan Stanley Research, Bloomberg

Exhibit 7: This Simple Framework Has Produced Attractive Returns in Our Out-of-Sample Testing

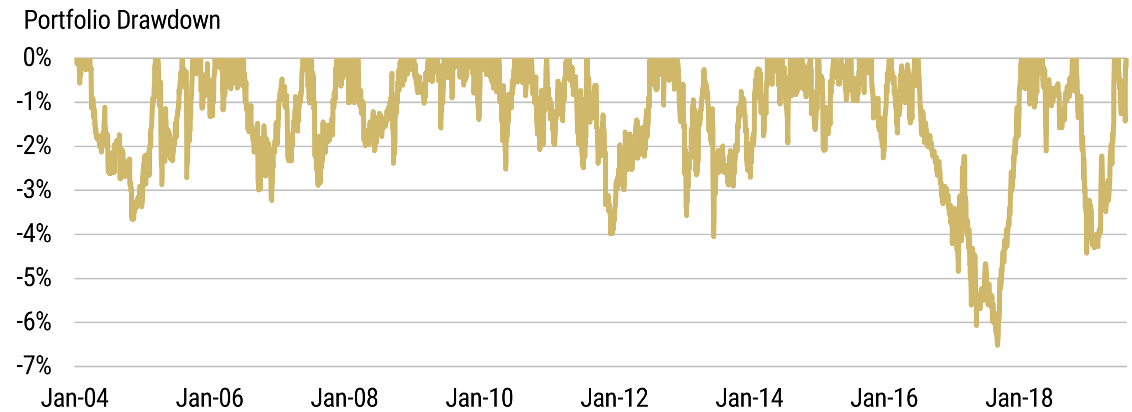


Source: Morgan Stanley Research, Bloomberg

Strategy Drawdowns

Over our testing period, we observed contained strategy drawdowns, consistent with other research around trend-following strategies. The strategy's maximum drawdown of 6.4%, which occurred between 2016 and 2017, is 1.8 times annualized volatility. This multiple is lower than other factors we have studied, where drawdowns can approach 4 times annualized volatility.

Exhibit 8: Portfolio Drawdowns Over Time

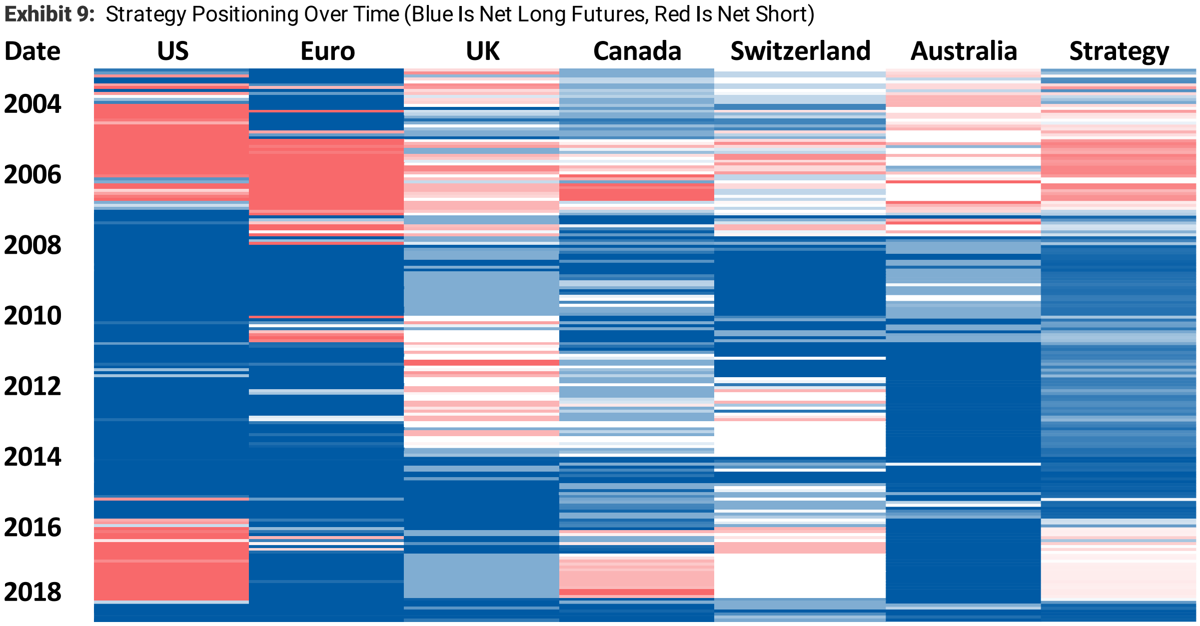


Source: Morgan Stanley Research, Bloomberg

Strategy Positioning

The Short-Term Rates Trend strategy has been net long for 63% of the time during our back-testing period from January 2004 to August 2019. Notably, following the Global Financial Crisis, the strategy was long across all six regions we studied, in line with global central bank easing (Exhibit 9).

Exhibit 9: Strategy Positioning Over Time (Blue Is Net Long Futures, Red Is Net Short)



Source: Morgan Stanley Research, Bloomberg
Note: Data Aggregated Monthly

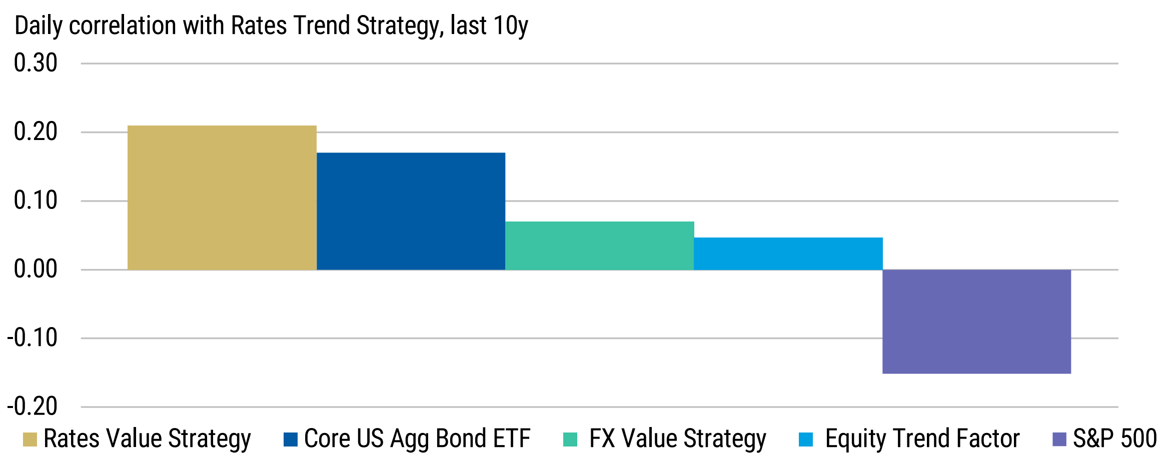
However, in recent years central banks' policies have diverged. As economies have recovered from the Global Financial Crisis at different rates, each bank's policy rate for its individual domestic economy reflects differences in circumstance and policy disposition. The strategy meets this situation by investing in region-specific trends, resulting in consistent performance across different policy regimes. Since 2018, the strategy has held a net long position only 35% of the time. Currently, the strategy is net long in each region.

Overall, the strategy has similar positioning across the regions we studied, taking a long position most frequently in Euribor futures, while taking a short position most frequently in Australian Bank Bills futures.

Strategy Correlations

Over the past 10 years, the strategy has exhibited low correlations to major benchmarks, including strategies we have developed in previous publications.

Exhibit 10: Correlations to Major Asset Classes and Factors



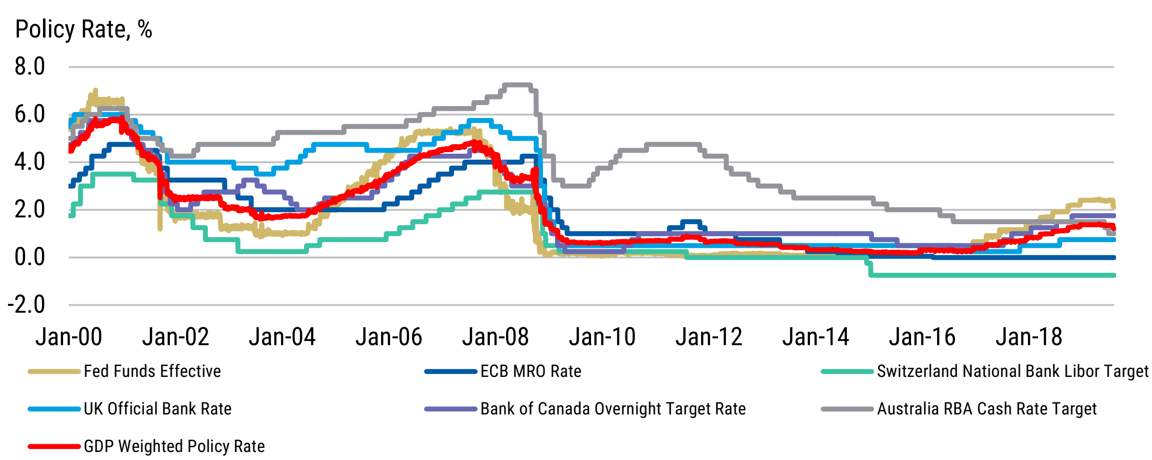
Source: Morgan Stanley Research, Bloomberg

Performance Across Monetary Policy Regimes

Our goal for the Short-Term Rates Trend strategy is consistent performance regardless of whether central banks are hiking or cutting rates, or taking a neutral stance. When the market expects a central bank to cut rates, the STIR futures tend to rally (as they have recently), while the futures prices fall when the market is expecting hikes. Through trend-following, the strategy aims to profit in both cases as the market prices in a clear direction for central bank policy.

To test the strategy for robust performance across regimes, we considered observable changes over the history of central bank policy rates as well as market-implied changes in monetary policy rates. In crafting the strategy, we looked to the MSPOKE index[3] (for more details, see the introductory report). MSPOKE gauges market-implied probability for Fed rate hikes using STIR futures. We have constructed a similar index using commensurate futures in all six markets to achieve a detailed, granular understanding of how the strategy performs in various cycles and under different regimes.

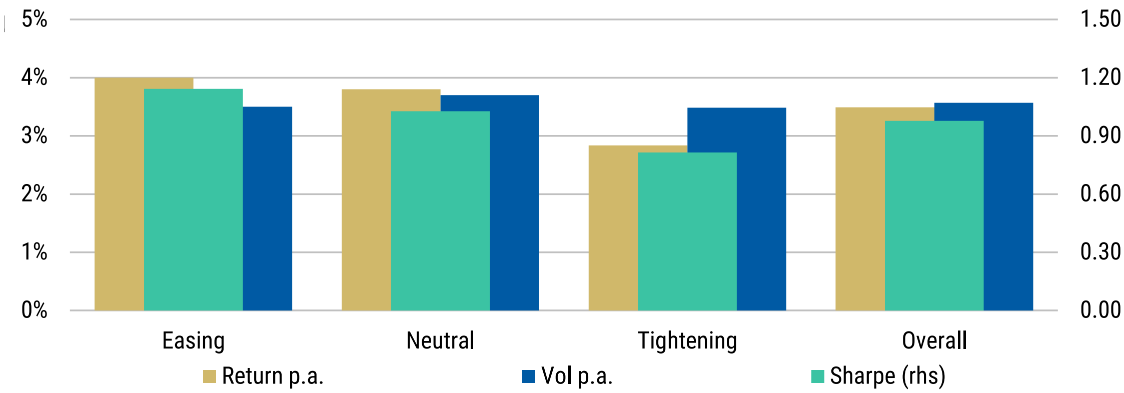
Exhibit 11: Central Bank Policy Rates Over Time



Source: Morgan Stanley Research, Bloomberg

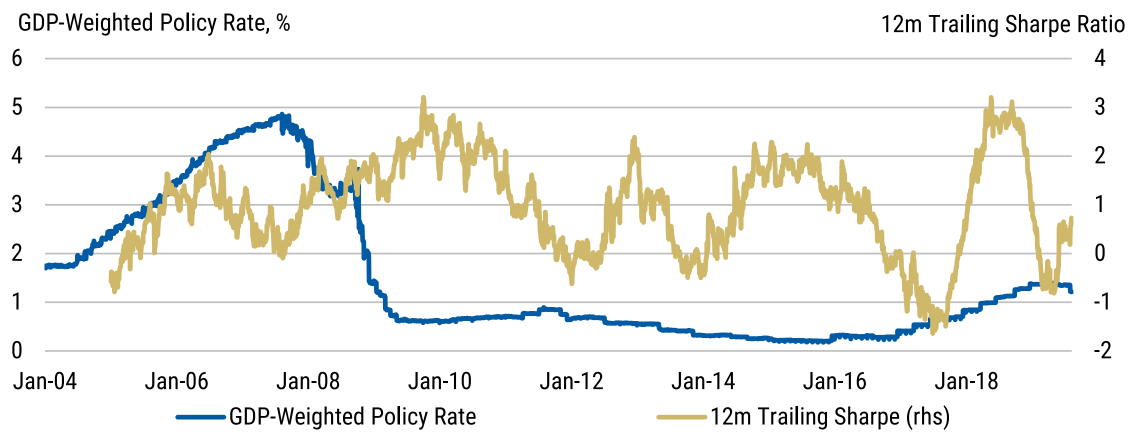
While the central banks we studied change their respective interest rate targets independently to manage their domestic economies, we notice similarities in their rates movements due to shifts in the global economy (Exhibit 11). Combining each bank's policy rate changes into one monetary policy calendar allows for a simple summary of our strategy's performance across economies. The strategy achieves fairly balanced results across monetary policy regimes, and it is most successful during cycles of easing (Exhibit 12).

Exhibit 12: Short-Term Rates Trend Provides Positive Returns in Different Monetary Policy Regimes



Source: Morgan Stanley Research, Bloomberg

Exhibit 13: Strategy Performance Including Effective Federal Funds Rate



Source: Morgan Stanley Research, Bloomberg

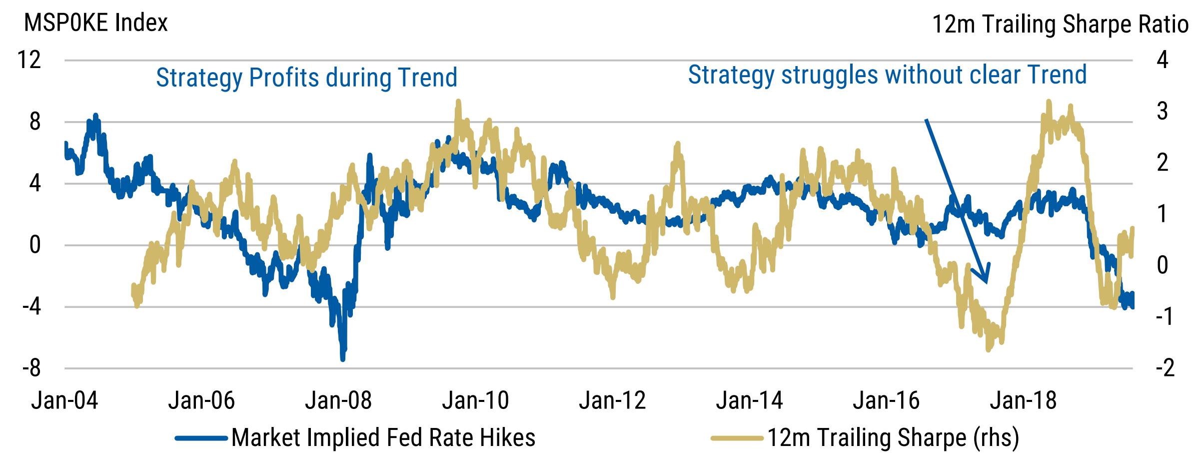
However, judging strategy performance by central bank target rates alone does not tell the whole story. The value of the STIR futures is driven by market anticipation of future policy rate decisions. To account for this, we subjected our strategy returns to market expectations of Fed policy looking out over the next 12 months. We found that the strategy has positive returns in most environments, and it performs best when the markets expect the Fed to cut rates. The MSPOKE index is currently at -4, which bodes well historically for Short-Term Rate Trend Strategy performance.

Exhibit 14: Strategy Performance by Fed Hikes Priced In

Hikes Priced In	Average	Vol	Sharpe
Over 3 Cuts	7.3%	4.6%	1.61
-3 to -2	17.1%	4.0%	4.26
-2 to -1	2.6%	3.2%	0.80
-1 to 0	-2.7%	3.6%	-0.73
0 to 1	-7.9%	3.0%	-2.59
1 to 2	4.9%	3.5%	1.39
2 to 3	4.9%	3.5%	1.39
Over 3 Hikes	2.7%	3.4%	0.79

Source: Morgan Stanley Research, Bloomberg

Exhibit 15: Strategy Performance vs Market-Pricing of Fed Rate Hikes



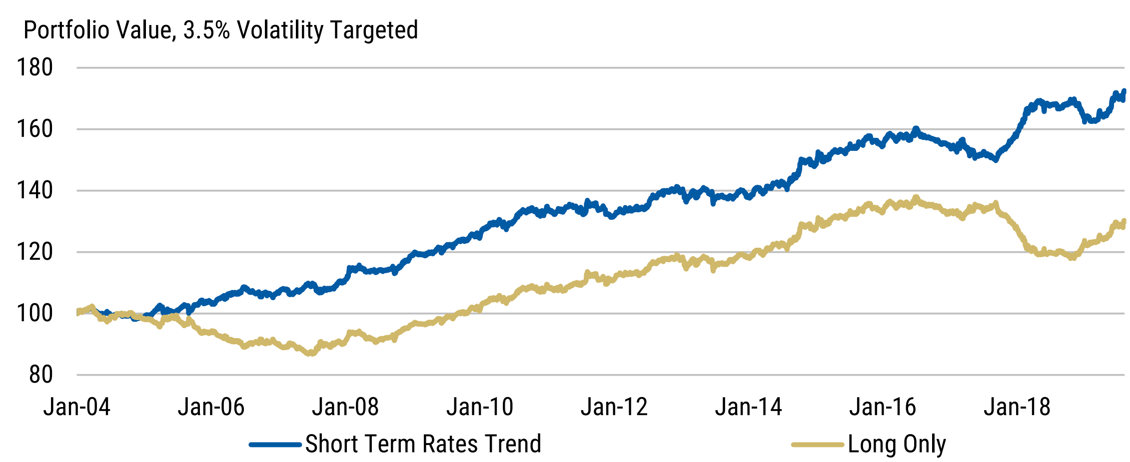
Source: Morgan Stanley Research, Bloomberg

Addressing the Government Bond Bull Market

The strategy invests in interest rates across six regions, which have been falling for decades. To test where the strategy adds value over a naïve buy-and-hold approach, we compare the returns of the strategy to those of a long-only portfolio of traded contracts in Exhibit 16. The long-only benchmark has generated positive returns since 2004 and would have achieved a Sharpe ratio of 0.49, but it underperforms Short-Term Rates Trend strategy.

That strategy tends to underperform in periods of uncertainty about central bank policy actions, such as in late 2016 and early 2017, or at the beginning of dovish policy shifts like those of late 2018. The strategy has outperformed in periods when the market expects central banks to hike, as the contracts will decrease in value as markets imply higher rates.

Exhibit 16: Performance Comparison vs Long Only Signal



Source: Morgan Stanley Research, Bloomberg

Liquid Macro Strategies

We have presented three strategies so far investing in global Macro products – Rates Value and FX Value – presented in the Introduction to Quantitative Investment Strategies Research: Rule-Based Value Investing (March 2019), and Short-Term Rates Trend, presented in this report. Taken together, a simple and equally weighted portfolio based on these strategies has performed well, in part due to low correlation among strategy returns. Each strategy invests across the globe in different segments of the markets with the common goal to provide consistent, uncorrelated risk premia.

The strategies take on different approaches to achieving this goal, using robust statistical approaches and out-of-sample validation techniques endorsed by academia and market practitioners alike. A summary of each strategy's underlying instruments and rules can be found below, with more detailed analysis in our published reports. For this analysis, we construct a portfolio with equal allocation to each strategy.

Liquid Macro Portfolio:

Rates Value

•Rates Value is a strategy for investing in global 10y government bond futures.

•The strategy considers a series of market and macroeconomic variables to drive investment decisions.

•Rates Value makes use of LASSO regression to help perform variable selection and make robust out-of-sample forecasts.

•**Note:** Incorporating investor feedback, we have decided to replace Spain with France in the Rates Value Strategy. France has had more liquid 10-year government bond futures than Spain. We evaluated France using the same procedure as the other 8 countries in the model, and the substitution had limited impact on strategy returns.

FX Value

•The FX Value strategy invests in G10 foreign exchange forward contracts.

•The strategy combines two models: (1) A two-factor mean variance model and (2) a long-run mean-reversion model to determine investment decisions around G10 currencies.

Short Term Rates Trend

•The Short-Term Rates Trend invests in global Short-Term Interest Rate (STIR) futures

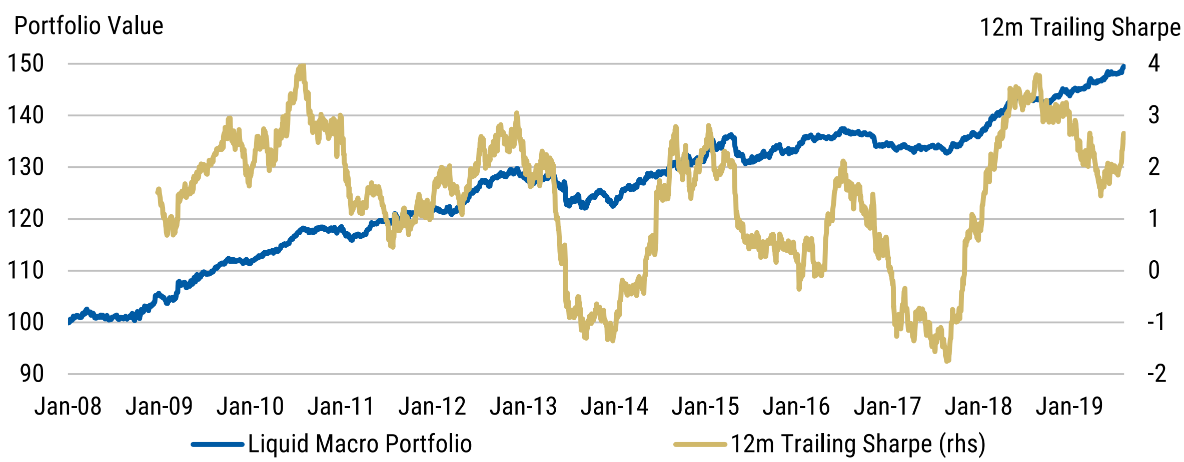
•The strategy engages in trend-following by using different look-back windows to generate long and short signals.

•The strategy incorporates GARCH, a parsimonious statistical model, to capture the time-varying and clustering aspects of market volatility

Performance Summary

The Liquid Macro strategies have achieved robust performance in out-of-sample testing. The strategy has had particularly strong risk-adjusted returns since 2018.

Exhibit 17: Liquid Macro Strategies Combined Performance



Source: Morgan Stanley Research, Bloomberg

Exhibit 18: Liquid Macro Portfolio Performance Summary

Year	Return p.a.	Vol p.a.	Sharpe
2008	5.6%	3.5%	1.61
2009	5.4%	3.2%	1.66
2010	6.2%	2.0%	3.11
2011	2.8%	2.5%	1.11
2012	5.7%	2.3%	2.48
2013	-4.9%	3.6%	-1.35
2014	7.4%	2.9%	2.51
2015	1.0%	3.2%	0.32
2016	1.3%	1.7%	0.74
2017	0.8%	1.8%	0.48
2018	6.0%	1.9%	3.12
2019	5.1%	1.7%	2.90
2008-2019	3.5%	2.7%	1.31

Source: Morgan Stanley Research, Bloomberg

Strategy Correlations to Major Asset Classes

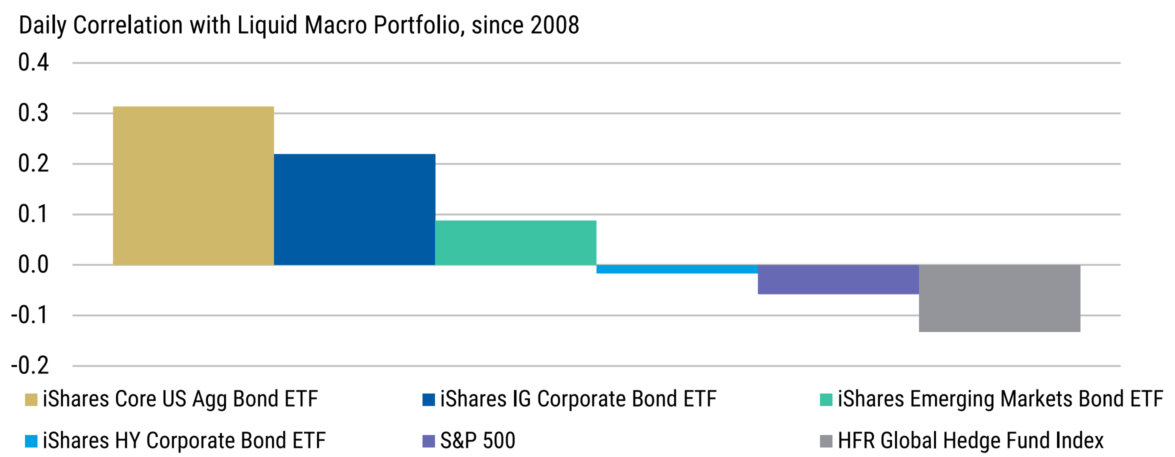
Combining the three strategies has had a positive diversification effect, as the strategies have low correlations to each other and other major asset classes (Exhibit 19 and Exhibit 20). Overall, the strategies are most correlated with fixed income, as both Rates Value and Short-Term Rates Trend have had net long duration exposure over our testing period.

Exhibit 19: Liquid Macro Strategies, last 10y daily correlation

	Rates Trend	Rates Value	FX Value
Rates Trend	1.00		
Rates Value	0.21	1	
FX Value	0.07	0.04	1

Source: Morgan Stanley Research, Bloomberg

Exhibit 20: Portfolio Correlation to Major Asset Class Daily Returns



Source: Morgan Stanley Research, Bloomberg, HFR

Strategy Positioning in 2019

Liquid Macro allocations can be found in the exhibits below, aggregated monthly.

Exhibit 21: FX Value Strategy Positioning in 2019

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
AUD	4%	-12%	17%	-13%	-14%	-2%	-13%	0%
CAD	10%	-12%	-13%	-13%	-14%	-14%	-13%	-13%
EUR	-11%	-12%	-13%	-13%	-14%	-14%	-13%	-13%
JPY	-11%	-12%	-13%	-13%	-14%	-14%	-13%	-13%
NZD	11%	12%	13%	13%	14%	25%	13%	26%
NOK	2%	-12%	-13%	-13%	-14%	-14%	-13%	-13%
SEK	-11%	12%	15%	10%	0%	-2%	10%	0%
CHF	-11%	-12%	-13%	-13%	6%	-14%	-13%	-13%
GBP	5%	24%	-13%	22%	5%	3%	21%	3%
USD Position	12%	24%	33%	33%	45%	46%	34%	36%

Source: Morgan Stanley Research, Bloomberg

Exhibit 22: Short-Term Rates Trend Strategy Positioning (Average Position of 4 Contracts)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Weight
US	-4	1	4	4	4	4	4	4	47%
Euro	4	4	4	4	4	4	4	4	22%
UK	4	4	4	3	4	4	4	3	16%
Canada	4	2	4	4	4	4	4	4	5%
Switzerland	2	4	2	2	4	3	2	2	2%
Australia	4	4	2	1	4	4	4	4	8%
Strategy	0	2	4	4	4	4	4	4	

Source: Morgan Stanley Research, Bloomberg

Exhibit 23: Rates Value Strategy Allocation in 2019

Country	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Australia	22%	22%	22%	-22%	-22%	-22%	22%	22%
Canada	-15%	-17%	-17%	-16%	-16%	-15%	-16%	-14%
France	22%	22%	22%	22%	-21%	-22%	19%	19%
Germany	20%	22%	22%	21%	20%	22%	20%	20%
Italy	7%	-9%	10%	11%	12%	13%	11%	13%
Japan	22%	22%	22%	22%	22%	22%	22%	22%
Korea	20%	-22%	22%	-22%	22%	-22%	-22%	-20%
UK	-14%	15%	17%	-17%	17%	-17%	16%	16%
US	-19%	20%	19%	-19%	-22%	-20%	-19%	21%
Net Duration Exposure	65%	75%	139%	-20%	12%	-61%	53%	99%

Source: Morgan Stanley Research, Bloomberg

Strategy Performance in 2019

All three Liquid Macro strategies have had positive returns in 2019, led by the Rates strategies, which have each held net long duration positions. The time series of returns and individual performance statistics can be found below, in Exhibit 24 and Exhibit 25. This year, the strategies have proved to add diversity, showing low to negative correlations (Exhibit 26).

Exhibit 24: Liquid Macro Strategies Performance

	Rates Trend	Rates Value	FX Value	Liquid Macro
Return (annualized)	8.1%	5.9%	0.8%	4.9%
Vol (annualized)	4.0%	2.6%	2.3%	1.7%
Sharpe	2.04	2.26	0.37	2.90

Source: Morgan Stanley Research, Bloomberg

Exhibit 25: Liquid Macro Strategies Performance Year to Date (Aug 9)

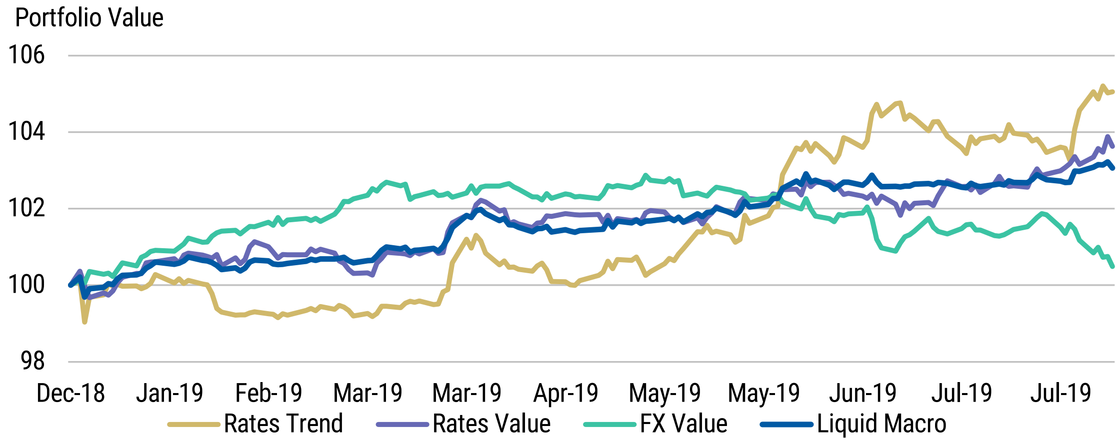


Exhibit 26: Strategy Correlations on Daily Returns, Year to Date

	Rates Trend	Rates Value	FX Value
Rates Trend	1		
Rates Value	0.11	1	
FX Value	-0.21	0.09	1

Source: Morgan Stanley Research, Bloomberg

Performance in Drawdown Scenarios

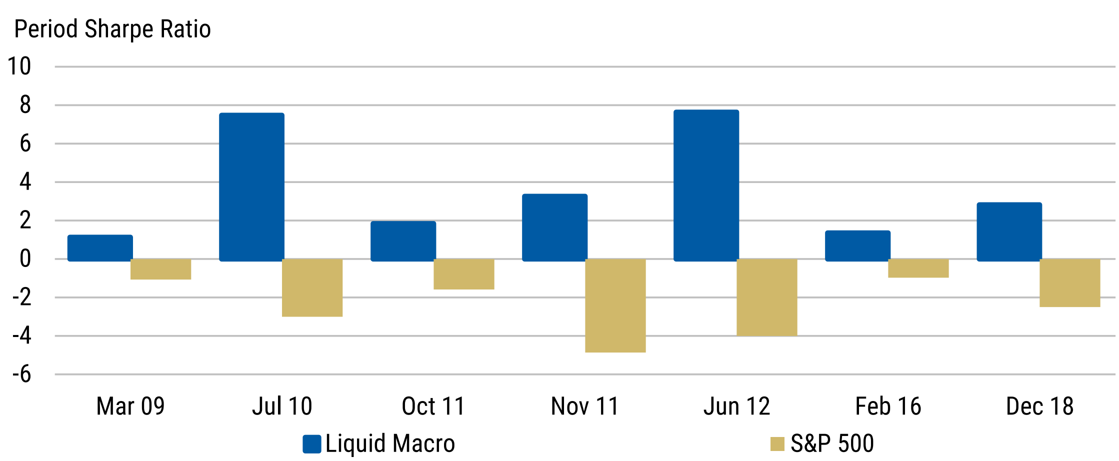
The Liquid Macro portfolio has exhibited defensive qualities, performing well in equity market drawdowns. For example, in periods in which the S&P 500 had a drawdown of over 10% (as discussed in The Bear Market Almanac), the Liquid Macro portfolio would have had positive performance. In each of the drawdowns we studied, the Liquid Macro portfolio has demonstrated positive performance, as shown in Exhibit 27 and Exhibit 28.

Exhibit 27: Liquid Macro Performance in S&P 500 Drawdowns

	Total Return		Vol p.a.		Vol Adjusted Return p.a.	
Drawdown Period	**Liquid Macro**	**S&P 500**	**Liquid Macro**	**S&P 500**	**Liquid Macro**	**S&P 500**
Jan 08 - Mar 09	5%	-54%	5%	41%	1.1	-1.1
Apr 10 - Jul 10	3%	-16%	3%	27%	7.5	-3.0
Apr 11 - Oct 11	2%	-19%	2%	27%	1.8	-1.6
Oct 11 - Nov 11	1%	-10%	1%	24%	3.3	-4.9
Apr 12 - Jun 12	3%	-10%	3%	16%	7.6	-4.0
May 15 - Feb 16	3%	-13%	3%	18%	1.4	-1.0
Sep 18 - Dec 18	1%	-20%	1%	21%	2.8	-2.5

Source: Morgan Stanley Research, Bloomberg

Exhibit 28: Performance in S&P 500 Drawdowns over 10%



Source: Morgan Stanley Research, Bloomberg

Q&A

Why did you use GARCH, rather than realized volatility or other measures of volatility regime?

In our in-sample testing, we found that the GARCH model added value over other methods such as trailing realized volatility, or option-implied volatility. This result confirmed our intuition that GARCH would aid in forecasting volatility in these futures, as it provides a forward-looking, asset-specific volatility forecast. This allows for dynamic volatility regimes by country and by expiry, so that the first future (referencing a rate to expire at the end of the quarter) and the fourth future (referencing a rate in 4 quarters) can have different volatility regimes.

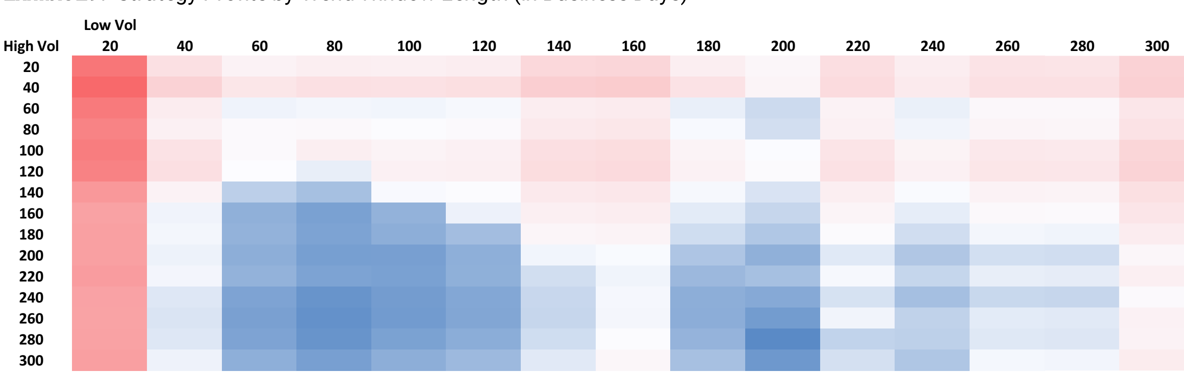
Every week, we estimate a new GARCH model for each contract in the strategy using the past 3 years of daily return data. Then, we compare the forecasted volatility for the upcoming week and compare it to the past 3 years of forecasted volatility, with observations above the median being classified as High Volatility, and forecasts below the median as Low Volatility.

Why do you only use two volatility regimes to determine your strategy look-back window?

We tested numerous methods during our in-sample period, and found that using a 3-month and 12-month window to be the most stable solution compared to one constant look-back window, or adding in additional volatility regimes.

To confirm these windows successfully captured the trend, we sampled a wide range of look-back windows (Exhibit 29), and experimented with a window that expanded linearly with forecasted volatility from the GARCH model. We also note that the combination of two 200+ day moving average windows (the bottom right of Exhibit 29) produced strong profitability in backtesting.

Exhibit 29: Strategy Profits by Trend Window Length (in Business Days)



Source: Morgan Stanley Research, Bloomberg

Which regions performed best using this strategy?

All six countries we studied generated positive returns in our out-of-sample testing. Eurodollar, Euribor, and Sterling Libor futures had the highest Sharpe ratios, while Canadian Bank Acceptances had the lowest, as shown in Exhibit 30.

Exhibit 30: Performance by Region, 2004 to July 2019, without Vol Targeting

	Return	Vol	Sharpe
Canada	0.7%	2.2%	0.30
UK	1.6%	2.0%	0.77
Switzerland	1.1%	1.6%	0.67
Australia	1.5%	2.6%	0.56
Euro Area	1.4%	1.8%	0.77
US	2.0%	2.5%	0.78

Source: Morgan Stanley Research, Bloomberg

Have you considered extending this analysis to other countries?

Yes, though we focused on the front four contracts' 6 most liquid 3-month Futures, it would be possible to invest in other countries using a similar methodology. Some countries we considered, but ultimately did not include in this strategy, are Japan, Korea, Mexico, Sweden, and New Zealand.

Could you extend this analysis further down the Futures Curve?

We tested the same methodology on longer-dated expiries of the same contracts, but found little value-add to our strategies. For example, we tested a strategy using the same methodology on the 5th through 8th Eurodollar contracts, which did not produce better risk-adjusted returns in in-sample testing. We think the front 4 contracts are the best expression of trend in central bank rate expectations, but look forward to further analysis down the curve.

Appendix

Transaction Costs Analysis

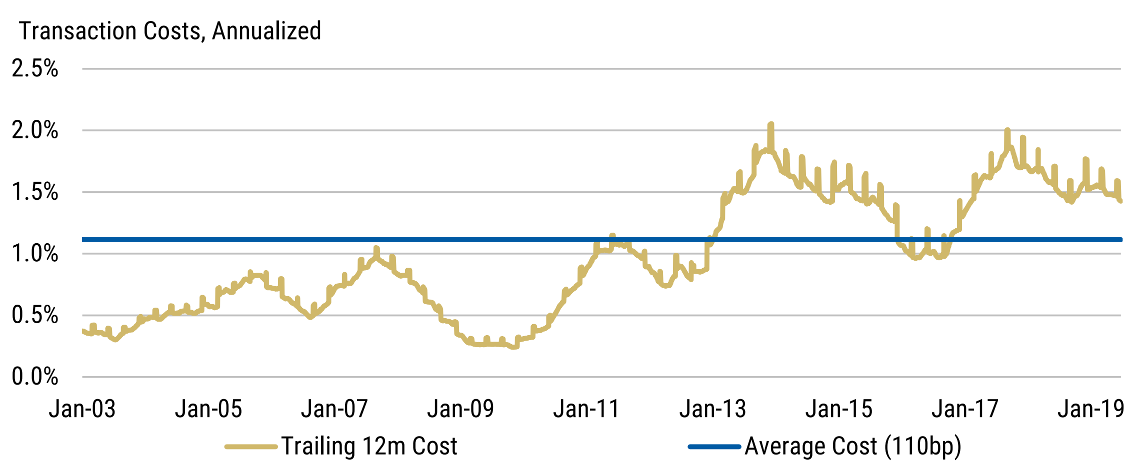
Liquid Macro Transaction Cost Assumptions
We present these strategies including hypothetical realistic cost assumptions. Each strategy's cost assumptions are detailed below:

Rates Value
We assume annual costs of 55 basis points, factoring in margin, roll, and rebalancing costs. The strategy executes trades monthly based on updated LASSO regression model forecasts**.**

FX Value
We assume annual costs of 25 basis points, factoring in rebalancing positions and rolling FX Forward contracts. The strategy rebalances monthly

Short-Term Rates Trend
We assume annual costs of 110 basis points, factoring in margin, roll, and rebalancing costs. The strategy rebalances weekly. The spikes in the cost structure occur due to rolls, which we assess quarterly.

Exhibit 31: Short-Term Rates Trend Transaction Cost Analysis

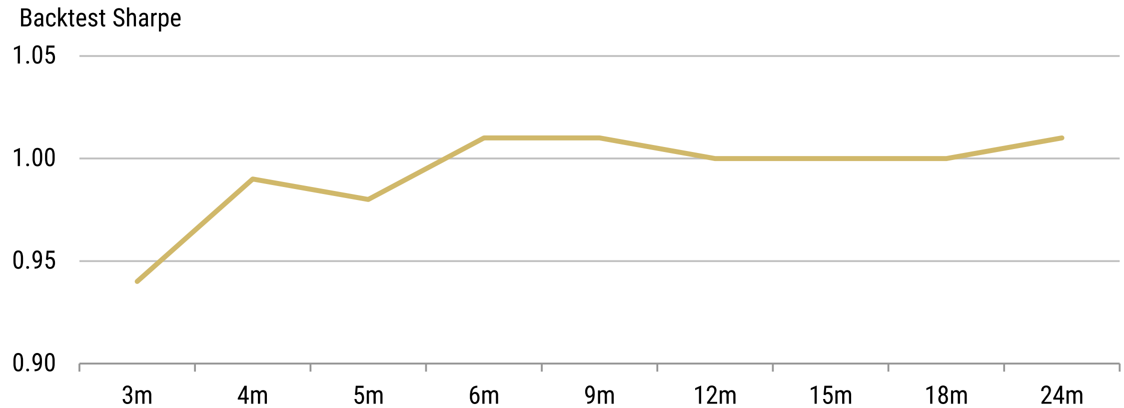


Source: Morgan Stanley Research, Bloomberg

Volatility Targeting in Detail
STIR futures are much less volatile than equities or even government bonds, due to their limited duration exposure (3 months). To achieve a similar volatility profile to other strategies our team has developed, this strategy needs to take on more leverage.

For our back-test, we leveraged the portfolio to target 3.5% annualized volatility based on the trailing 12 months of returns. We found only minor sensitivity in terms of portfolio performance subject to the duration of the look-back window, as shown in Exhibit 32.

Exhibit 32: Sensitivity Analysis of Volatility Target Look-back Period



Source: Morgan Stanley Research, Bloomberg

Endnotes

1 A Eurodollar future is a cash-settled futures contract which moves with the interest rate offered on US dollar-denominated deposits held in European banks.

2 The GARCH(1,1) employed in the strategy is the simplest model among the GARCH families. It uses only four parameters to describe the dynamics of return and its volatility. Robert Engle first introduced the model with time-varying volatility (ARCH) in his 1982 seminal paper "Autoregressive Heteroscedasticity with Estimate of the Variance of United Kingdom Inflation," Econometrica 50 (4), page 987-1008. Tim Bollerslev generalized it to GARCH in his 1986 paper, "Generalized Autoregressive Conditional Heteroskedasticity," Journal of Econometrics, pages 307-327.

3 For Access to MSP0KE Index on Bloomberg, please contact iedeglobal@morganstanley.com

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Not-Rated/Hold	**1**	**0%**	**0**	**0%**	**0%**	**1**	**0%**
Underweight/Sell	**577**	**19%**	**77**	**12%**	**13%**	**233**	**16%**
TOTAL	**3,107**		**667**			**1413**	

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