M O R G A N S T A N L E Y

Quantitative Solutions and Innovations (QSI)

Fixed Income Sales & Trading

Quantitative Solutions and Innovations (QSI)

Introduction and Overview

September 2014

Agenda

- Overview

1. Finding Alpha and Alternative Beta
   - Multi-Strategy FX Index
   - Momentum
   - FX Volatility as an Asset Class
   - Market timing (Correlation Regimes)
2. Hedging & Portfolio Construction
   - Conditional Hedging
   - Optimal Delta Hedging
   - Tail Risk
   - Optimiser
3. Retaining Alpha
   - TCA & Execution Benchmarks
   - Algorithmic Trading

- Appendix
  - Quant Digest
  - QSI
  - Matrix

Please see additional important information and qualifications at the end of this material.

Morgan Stanley

Quantitative Solutions and Innovations (QSI)

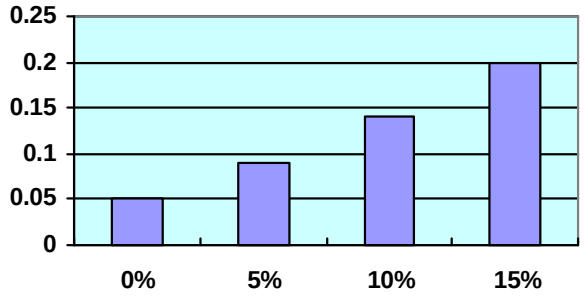
1. Alpha/Alternative Beta Generation

- Actively managed currencies, and their associated volatilities, are a potential source of alpha with very low correlation to other assets.
- Thus, as a diversifier, FX as an asset class can be a valuable part of any GAA/TAA mix.

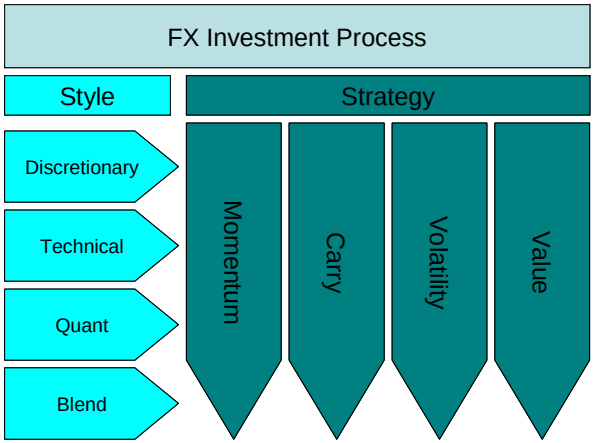
Products & Services

- Morgan Stanley's QSI Group runs a stable of models and processes designed to help investors exploit FX as an asset class with full transparency. Investors can customize these models and processes to meet the specific needs of their mandate
- FX index products, e.g. **Morgan Stanley Multi-Strategy FX Index**, provides simple, cost effective access to FX alpha sources
- In addition, QSI can provide a variety of global **risk indicators** that are valuable in the general context of forming strategic and tactical investment policies regarding asset class exposure and rebalancing.

Sharpe Ratio of Hypothetical Cross-Asset Class Portfolio (with increasing proportion allocated to FX)



•Source: Morgan Stanley QSI

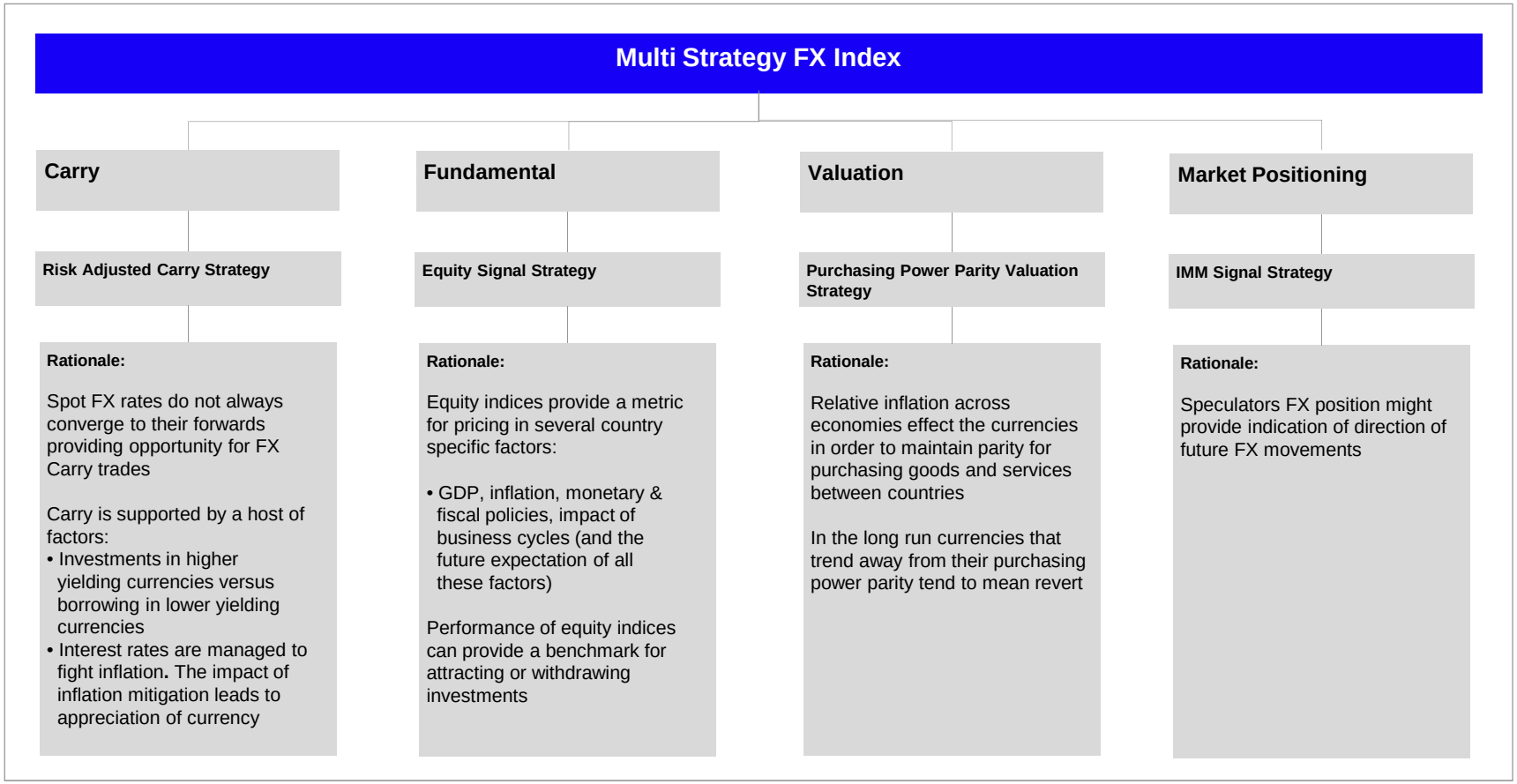


•Source: Morgan Stanley QSI

Please see additional important information and qualifications at the end of this material.

Multi Strategy FX Portfolio – Component Strategies

• Morgan Stanley Multi-Strategy FX Index is an investible excess return index that aims to capture returns by diversifying across a broad universe of currencies and diverse strategies, Sharpe of 1.99 over last 10 years



Source: Morgan Stanley Sales and Trading

Please see additional important information and qualifications at the end of this material.

Multi Strategy FX Portfolio – Performance

FX | Price Data 02 Sep 2014

Morgan Stanley Multi FX Enhanced Index (USD)

FLAGSHIP

Currency	USD	Return Type	ER	Rebalancing	Monthly
Asset Class	FX	Underlying	FX Forwards	Calculation	MS Research
Theme	Diversified	Index Sponsor	Morgan Stanley	Region	Global
Risk Class	Enhanced Beta	Bloomberg id	MSQTFXEI		

Index Level	1 day (%)	1m (%)	3m (%)	1y (%)
259.155	-0.54	-0.13	-1.23	-2.09

General Disclaimer

Description

The Multi FX Enhanced Index is a risk controlled, rules-based diversified investment strategy across 19 currencies.
The Index invests into EUR, GBP, JPY, CHF, AUD, NZD, CAD, SEK, NOK, INR, IDR, KRW, PHP, BRL, HUF, MXN, RUB, ZAR and TRY currencies.
The Index takes long/short positions in 1 month FX forwards of developed and emerging market currencies versus USD using a combination of

Charts*

Source: Morgan Stanley Sales and Trading

Please see additional important information and qualifications at the end of this material.

Multi Strategy FX Portfolio – Performance*

Historical Performance*

Metrics	1y	3y	5y	Full
Annualized Return (%)	-2.07	-2.48	1.68	7.82
Annualized Volatility (%)	4.25	4.53	4.68	4.99
Return/Vol	-0.49	-0.55	0.36	1.57
Max Drawdown (%)	4.46	11.79	11.79	20.34
Biggest Monthly Gain (%)	1.09	1.64	3.24	5.54
Biggest Monthly Loss (%)	-3.06	-3.68	-3.68	-5.42

Monthly Returns (%)*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	-2.25	1.02	1.09	-0.39	0.23	-0.50	-1.30	0.71	-	-	-	-
2013	0.81	-1.35	-0.70	0.18	-3.68	-1.24	0.36	-3.06	0.95	0.21	-0.52	-0.75
2012	1.64	1.53	-1.38	-0.18	-0.77	1.38	1.26	0.66	0.65	-0.80	0.31	0.03
2011	1.34	1.95	1.48	1.74	-0.47	-1.11	1.84	0.02	-0.29	1.09	-1.02	-1.01
2010	0.87	1.08	1.05	1.47	-1.52	-0.38	0.70	0.58	3.24	0.74	-1.84	1.41
2009	-1.99	0.14	1.41	1.50	1.10	-0.12	1.82	0.34	1.35	0.30	0.43	-0.38
2008	-0.03	2.79	-0.27	1.25	0.92	-0.92	-0.32	0.30	1.66	1.87	0.28	0.24

Correlation Analysis* (Based on last 5 years of rolling monthly returns)

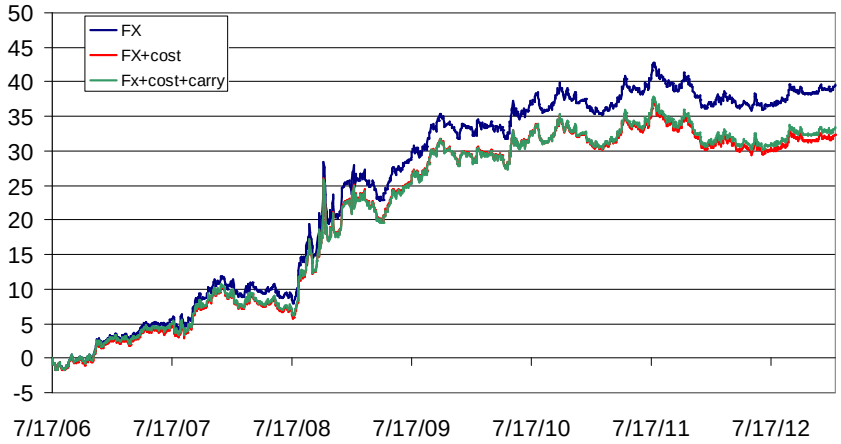
* As of 2nd Sep 2014

Source: Morgan Stanley Sales and Trading

Momentum – Regime Trading Model

- Momentum trading framework utilising:
  - Liquidity weighted prices
  - 2-state regime switching model
- Model fitting to 20d EWMA of liquidity weighted prices
  - If probability of positive return state > 0.9 model goes long
  - If probability of negative return state > 0.9 model goes short
  - Otherwise, model is flat
- Applied to G7 portfolio, generating out of sample Sharpe of 0.8 after costs
- Average monthly correlation with FX Carry, Value and Volatility investment stlyes of -4%
- Post crisis (Jan 09 onwards) model generates 0.5 Sharpe after costs vs 0.04 for simple momentum benchmark strategy
- Q2 13 performance: + 1.5%, Sharpe 1.3

Momentum Model Backtesting Results – G7 Portfolio



Avg Ret	4.9 (5.8)%
Avg Std	6.5 (6.5)%
Sharpe	**0.8 (0.9)**
Skewness	0.3 (0.3)
Max Drawdown	-3.3 (-3.3)%
Peak to Trough	-7.1 (-7.1)%
After-Crisis Sharpe	0.5 (0.6)
Hit Ratio	0.53 (0.53)

Table 1: Portfolio performance statistics of the momentum strategy including transaction costs and carry. The numbers in parenthesis are the same measures excluding cost and carry. Source: Morgan Stanley QSI.

Momentum Model – Daily Email Available

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QSI Momentum Trading Model

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This daily trading model uses intraday liquidity and spot return information to fit a regime-switching model to liquidity weighted daily returns, which estimates positive/negative trends.

Current Signals:

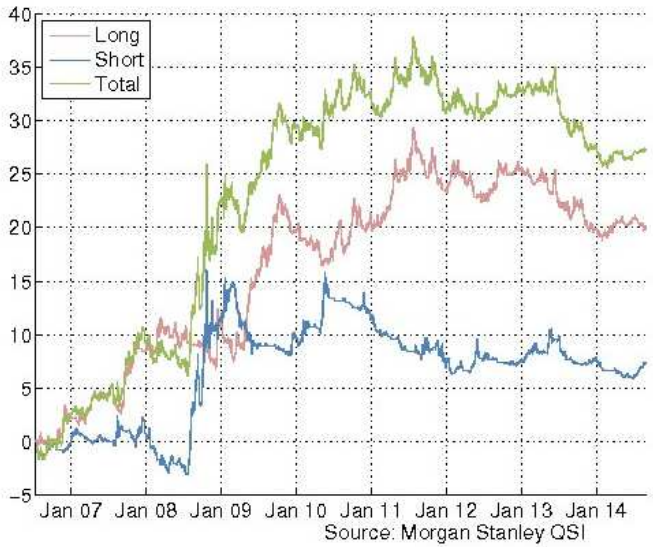
Long: AUDUSD, NZDUSD, USDCHF

Short: EURUSD, GBPUSD, USDJPY

Currency	Signal	Inception	Avg duration of long/short	Signal PnL (%) [1]	YTD PnL (%)	Sharpe (YTD)	Probability of Up Trend (%)	Probability of Down Trend (%)
EURUSD	Short	01 Jul 2014	(15, 12)	3.3%	1.6%	0.5	0.5%	99.5%
AUDUSD	Long	13 Aug 2014	(20, 11)	-0.0%	9.2%	1.7	0.0%	100.0%
GBPUSD	Short	01 Jul 2014	(15, 10)	3.3%	3.5%	1.2	0.0%	100.0%
NZDUSD	Long	16 Jun 2014	(13, 11)	-3.4%	-6.7%	-1.5	95.6%	4.4%
USDJPY	Short	01 Jul 2014	(15, 14)	-2.9%	-10.7%	-2.8	99.8%	0.2%
USDCHF	Long	01 Jul 2014	(18, 13)	2.7%	0.2%	0.0	0.5%	99.5%
USDCAD	Neutral	03 Sep 2014	(21, 11)	0.0%	-0.5%	-0.1	87.1%	12.9%

Source: Morgan Stanley QSI

Cumulative Percentage Return (Long, Short, Total):



Portfolio (Equally-Weighted)	
Sharpe	0.5
Return	3.2%
Std Dev	6.1%
Skew	0.3
Max Drawdown	-3.3%
Peak to Trough	-7.1%

FX Volatility as an Asset Class

- Return generation from FX volatility in a diversified, systematic manner

Volatility Style	Product/Model	Implementation
Premium Extraction (Implied vs Realised)	**FXVolNet** Bloomberg: MSQTFXVN and MSQTFXV1	Via index constructed from capped variance swaps, accessed via TRS/note etc
Forward Rate Bias (Forward Implied Carry)	**FVAlpha**	Traded directly via model signals, suggested implementation via Forward Volatility Agreements (FVAs)
Relative Value (Ccy Implied vs Ccy Implied)	**RVAlpha**	Traded directly via model signals, suggested implementation via Forward Volatility Agreements (FVAs)

Source: Morgan Stanley QSI

FXVolNet - Rationale

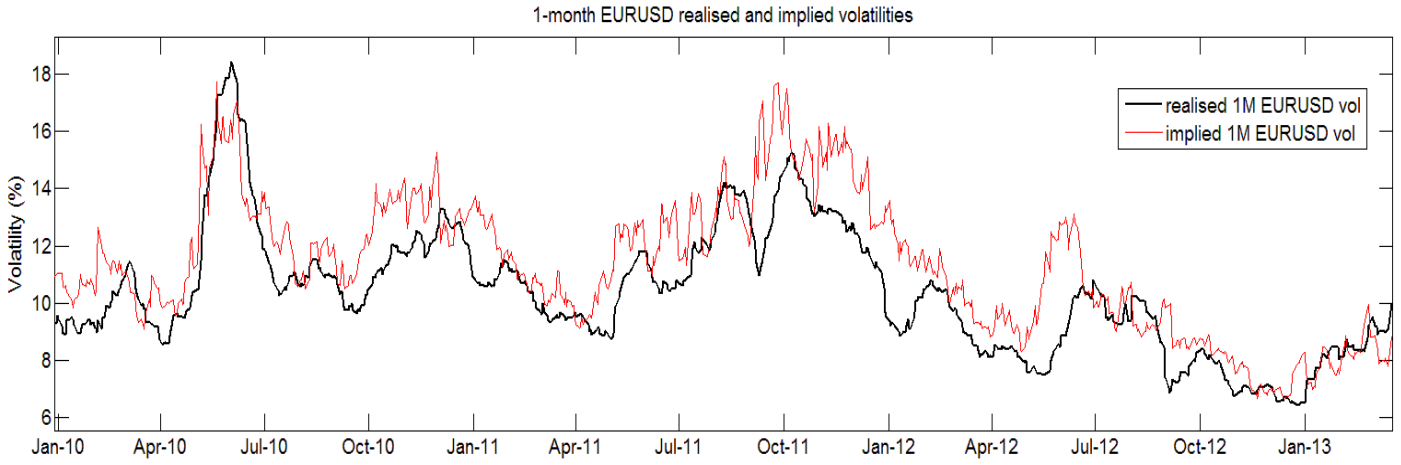
FXVolNet serves a variety of investment objectives:

- A source of **alternative risk premium**
- Simple access to FX volatility for **alpha** or **diversification benefits**
- Basic strategy without signal enhancement acts as a **benchmark of FX volatility bias**
- Functions as an analogous implementation in FX of a **well-known strategy in equities**

Average difference between one-month implied and realised volatility[1]

	EURUSD	USDJPY	GBPUSD	USDCHF	AUDUSD
Pre-Crisis Jan-99 to Aug-08	0.39%	0.73%	0.32%	0.00%	0.21%
Peak Crisis Sep-08 to Mar-09	1.54%	1.26%	0.96%	0.04%	-5.15%
Post-Crisis Apr-09 to Mar-13	1.38%	1.52%	1.39%	0.60%	0.69%

FX Volatility Premium



Source: Morgan Stanley QSI

- Implied volatilities in FX as well as equities have tended to trade at a **premium to realised volatility**. This volatility bias can be attributed in part to sellers of volatility demanding compensation for the higher risk of volatility jumps when markets are stressed
- small or absent pre-crisis
- measurable during peak crisis in markets that adjusted rapidly to the new conditions
- significant and tradable post-crisis

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FXVolNet - Performance

FX VolNet Basket
From 16-Jan-07 to 29-Aug-14

Basic Strategy	
Annual Return	7.19%
Volatility	8.60%
Sharpe Ratio	0.84
Max Drawdown	22.78%

Enhanced Strategy	
Annual Return	8.62%
Volatility	7.22%
Sharpe Ratio	1.19
Max Drawdown	10.94%

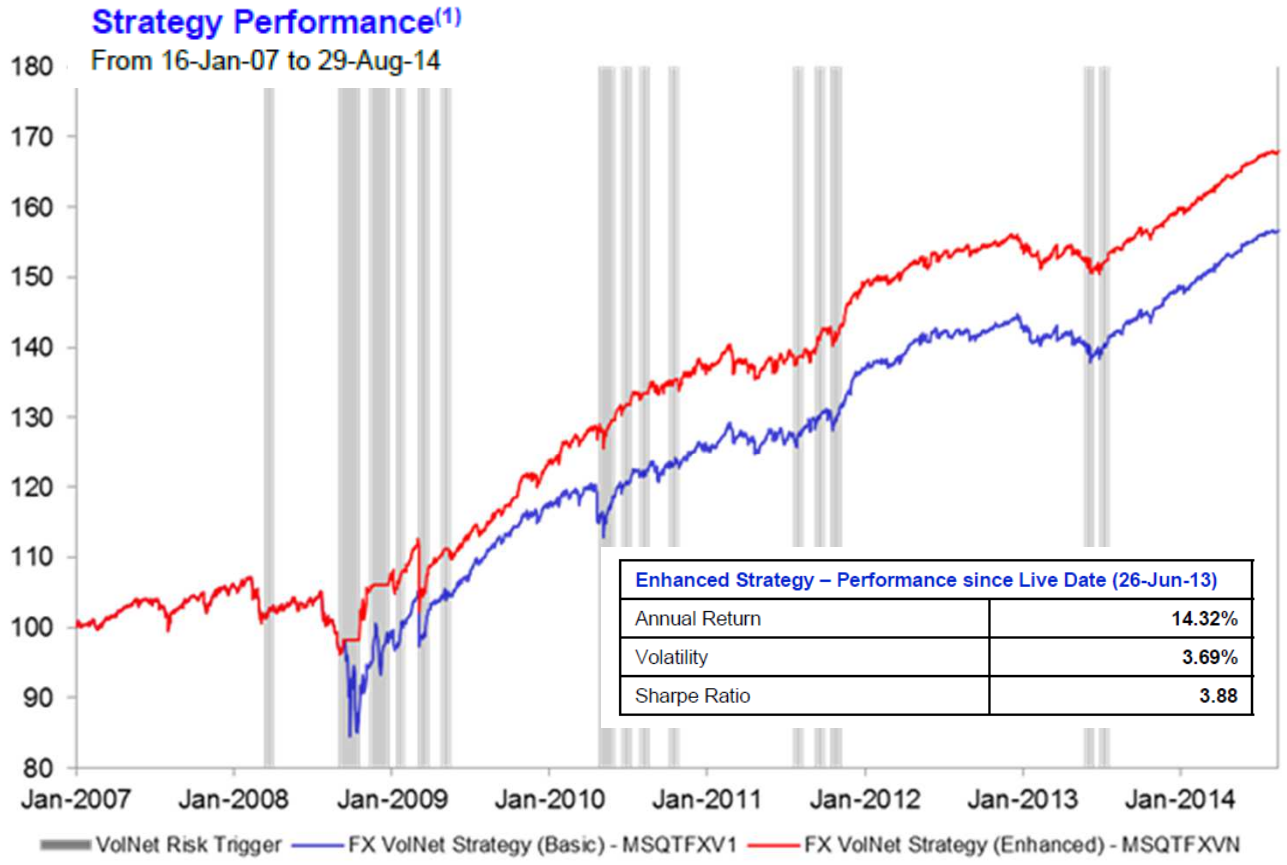
FX VolNet Basket

- weighted basket of the EURUSD, USDJPY, GBPUSDFX VolNet strategies

EURUSD	**50%**
USDJPY	**25%**
GBPUSD	**25%**

Source Morgan Stanley QSI

FX VolNet Basket – Diversified Index[1] (BBG: MSQTFXVN Index)



Enhanced Strategy – Performance since Live Date (26-Jun-13)	
Annual Return	14.32%
Volatility	3.69%
Sharpe Ratio	3.88

Source Morgan Stanley QSI

Notes
1. Past performance (actual or simulated) is not indicative of future performance. No representation is made that any results/returns indicated would be achieved or that all assumptions in achieving these returns have been considered or stated. Data for the Morgan Stanley Rates Volatility Premium Index is based on simulated historical performance.

Please see additional important information and qualifications at the end of this material.

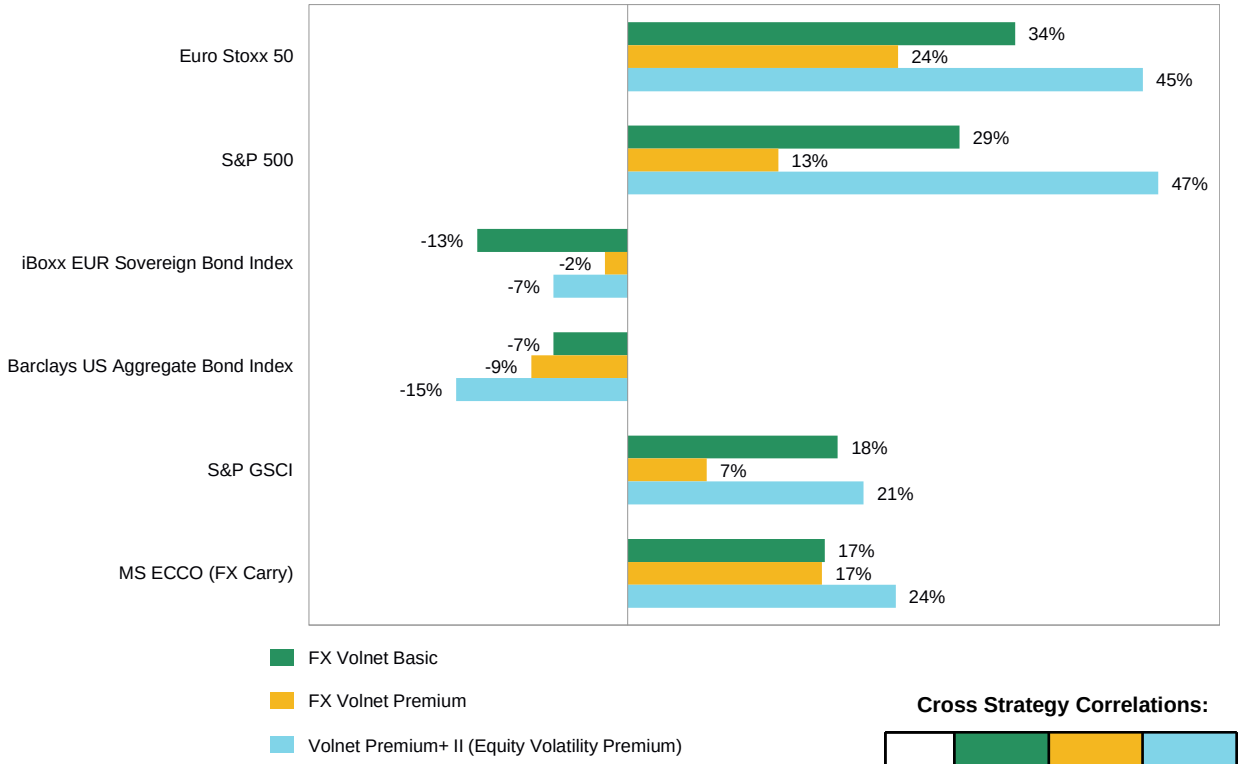
FXVolNet – Correlations

- The chart shows the correlation between the of the FX Volnet Strategies (Basic and Enhanced) as well as the Equity Volnet Strategy (extraction of S&P500 volatility premium) to other main indices.
- The FX Volnet Strategies have had lower correlations to equities and commodities than the Equity Volnet Strategy.

Correlations across Single Currency Strategies (Capped Var swaps – Basic)

	EUR	JPY	GBP
EUR	100%	11%	13%
JPY		100%	59%
GBP			100%

Correlations[1]



Cross Strategy Correlations:

	100%	73%	22%
		100%	21%
			100%

Source Bloomberg, Morgan Stanley

Notes

1. Past performance (actual or simulated) is not indicative of future performance. No representation is made that any results/returns indicated would be achieved or that all assumptions in achieving these returns have been considered or stated. Data for the Morgan Stanley Rates Volatility Premium Index is based on simulated historical performance.

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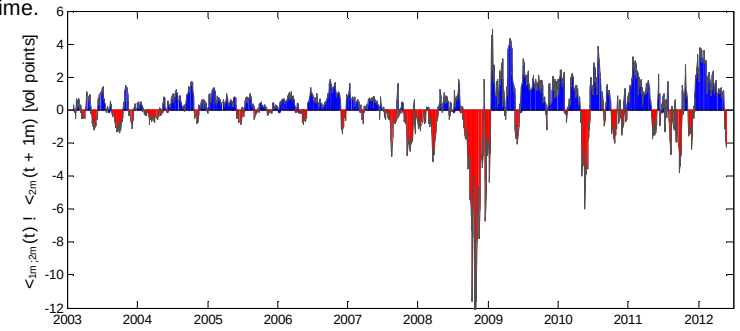
Forward Volatility Bias Model – FV Alpha

- Concept:
  - In normal market conditions, forward implied vol tends to over-estimate subsequent implied volatility ("fwd vol bias")
  - Model generates alpha by exploiting this bias and identifying periods where bias disappears (e.g. during stressed markets)
- Model
  - Uses 2 indicators (volatility momentum and volatility of volatility) to determine if fwd vol bias present
  - If present, short fwd fwd vol via FVA, otherwise stay flat
  - After costs, EURUSD and AUDUSD most profitable (in G10) with 12.8 and 13.2 volpts of PnL over the backtest period
- Signals available via email

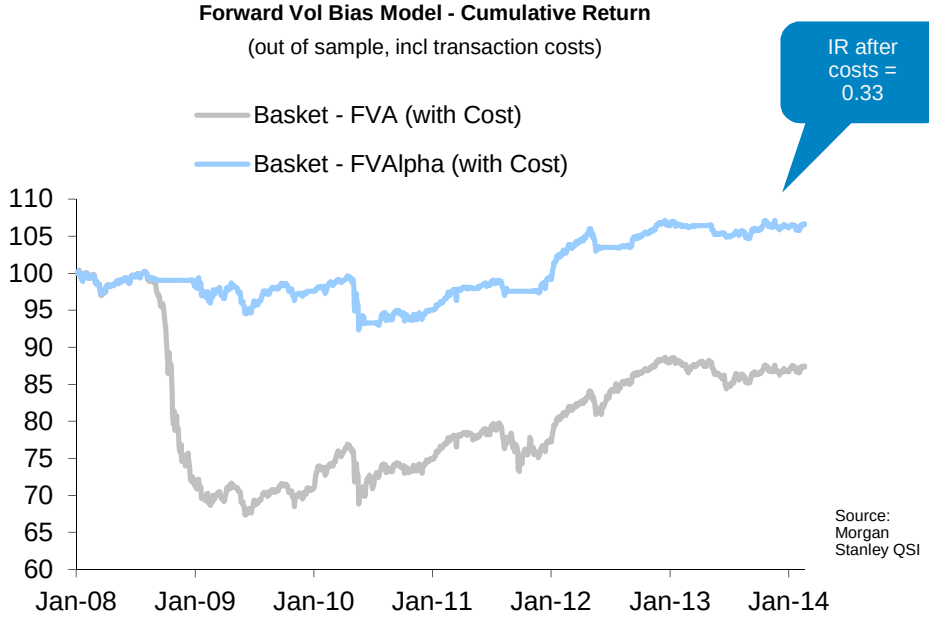
Difference between ATM (1m,2m) EURUSD forward implied volatility and 2m ATM implied volatility in 1 month's time

A positive difference corresponds to the forward implied volatility over-predicting the implied volatility in future. In this example, this is the case approximately 65% of the time.



Forward Vol Bias Model - Cumulative Return

(out of sample, incl transaction costs)

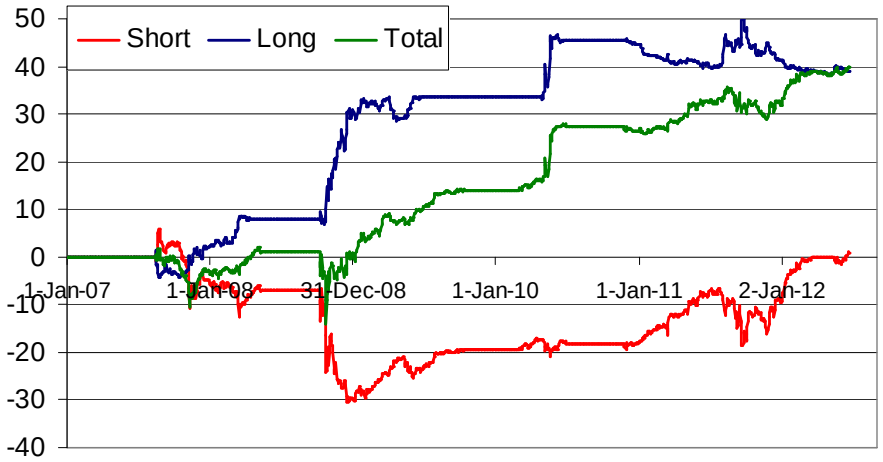


Source: Morgan Stanley QSI

G10 RV Volatility Model - RVAlpha

- Concept:
  - General market volatility factor drives majority of moves in currency implied volatilities
  - Specific ccy pair implied vols can lead/lag this factor, exhibiting mean reversion over time
- Framework
  - G10 currency pair volatilities, ATM 6m
  - AUDUSD, USDJPY, USDCAD, NZDUSD, EURUSD, GBPUSD, USDCHF, USDNOK, USDSEK
  - Apply PCA (Principal Component Analysis) to identify key factors driving the changes in volatility
  - Identify pairs where volatility appears out of line with that inferred from factors to generate relative value signals

RV Model Backtesting Results



Source: Morgan Stanley QSI

Information Ratio	From Feb 2007 (trans. costs)	From Jan 2009 (trans. costs)
FVAs: Long	0.8 (0.6)	0.3 (0.0)
FVAs: Short	0.3 (0,0)	0.9 (0.5)
FVAs: Total	1.0 (0.5)	1.2 (0.6)

Source: Morgan Stanley QSI

- Signal is based on out of sample 5 yr rolling window
- Trade only initiated if market vol spread at least 1.5 vol point away from model's implied.
- Transaction costs based on multiple of vanilla option spreads, ranging from 0.33 – 0.63 vol points depending on the ccy pair
- New signals based on a 2nd day confirmation

2012 performance: +5.4 vol points before costs (approx 1.1 after costs)

FX Derivatives Backtester available

- Morgan Stanley's FX Derivatives Backtester is a tool to evaluate the historical mid-market performance of an FX derivatives strategy, or portfolio of strategies.
- The application uses Morgan Stanley's proprietary pricing analytics and historical market data to provide a rigorous evaluation of trading performance.
- For each historical day in the life of a derivatives trade, the application takes the end-of-day market data and calculates the risk-neutral mid-market MTM value.
- The application is intended to be used for a number of purposes, including:

1. analysis of FX hedging strategies, allowing a user to compare the hedging performance of different hedge ratios, products and tenors
2. analysis of derivative trading ideas and strategies
3. testing of volatility trading strategies, including allowing the user to import systematic trading signals

- Products include vanillas, FVAs, Var/vol swaps

Available on QSI Page of Morgan Stanley's Matrix platform

Source: Morgan Stanley QSI

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FX Derivatives Backtester on Matrix
3 simple steps

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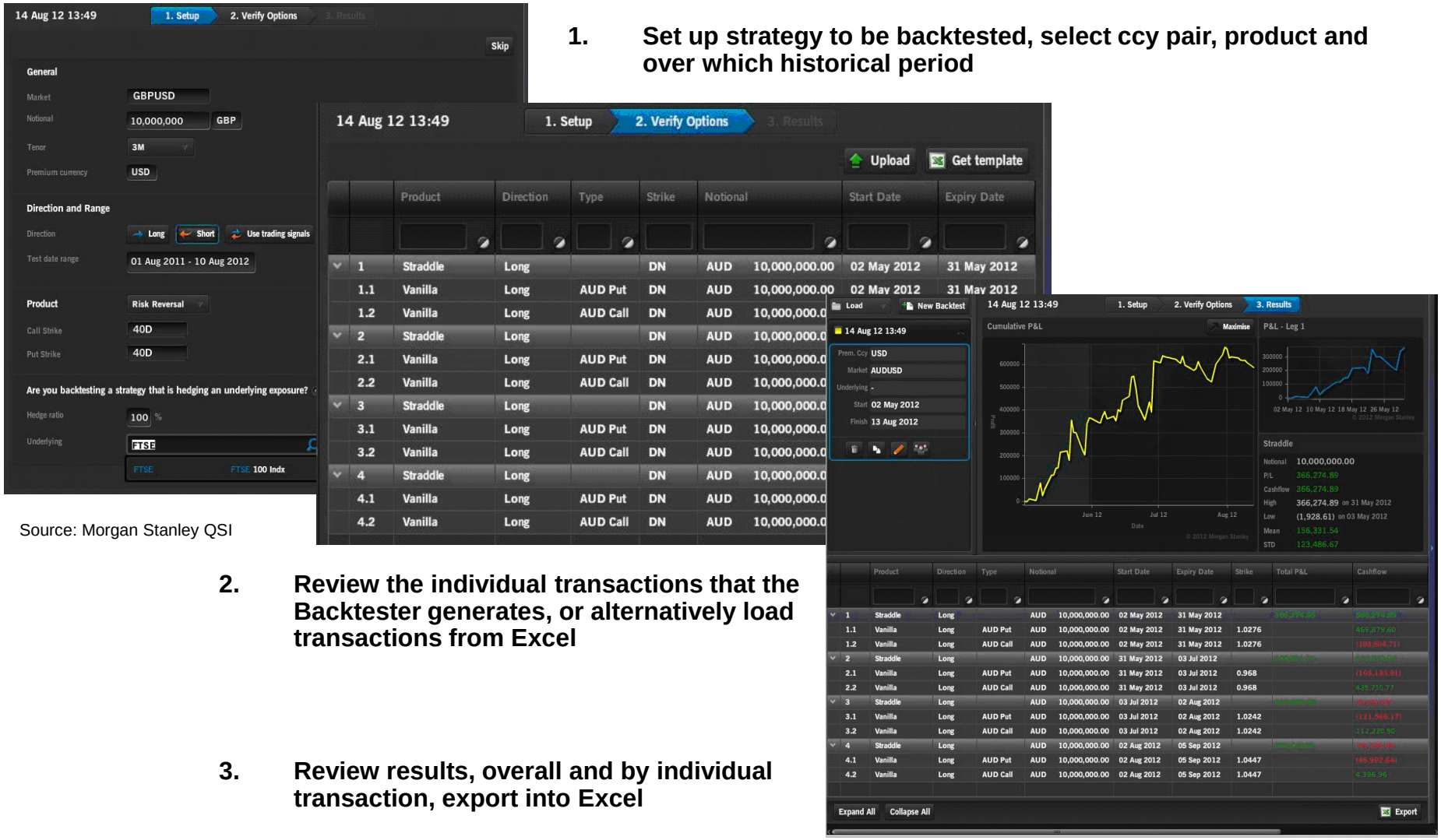

Source: Morgan Stanley QSI

1. **Set up strategy to be backtested, select ccy pair, product and over which historical period**

2. **Review the individual transactions that the Backtester generates, or alternatively load transactions from Excel**

3. **Review results, overall and by individual transaction, export into Excel**

Please see additional important information and qualifications at the end of this material.

Correlation Regime Model

- Concept:
  - Correlations have empirical evidence of memory effects and structural breaks
  - *Timely* identification of such breaks is difficult
  - Idea is to apply regime switching models to short-term correlation with the objective of identifying a clearer picture of changes in structure by viewing correlation in 'state space'
  - Different measures of correlation are explored based on daily realised estimates:
    - USDCAD-SEKJPY, AUDJPY-Gold, US Treasury futures - SPX
  - In addition, research into the regime behaviour of the overall correlation structure of a multi-asset portfolio is ongoing using factor models
- Potential applications
  - Improved risk management, allowing re-hedging/tactical asset allocation in a more timely, and hopefully cheaper, fashion
  - Conditional hedging for high yielding ccys, e.g. identify risk-off periods for hedging, whilst allowing yield pick-up during unhedged, risk-on periods
- Daily output available via email

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QSI Correlation Regime Model

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Correlation	Probability of Low-Correlation Regime	Probability of High-Correlation Regime	Low-Correlation Average Level	High-Correlation Average Level
USDCAD-SEKJPY	100.0%	0.0%	-0.065	-0.383
10Y T-Note Fut-SPX	96.6%	3.4%	-0.118	-0.527
AUDJPY-Gold	99.8%	0.2%	0.011	0.285
DAX-EuroBund	82.6%	17.4%	-0.122	-0.476
FTSE-Gilt	44.7%	55.3%	-0.096	-0.378

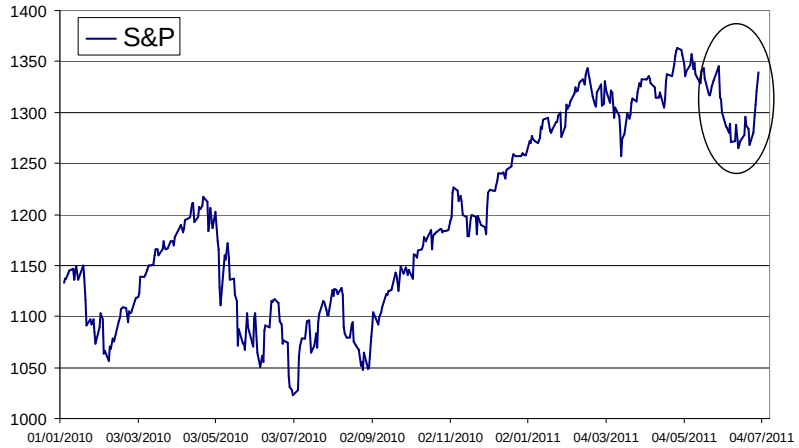
Low Correlation: 3
Neutral: 2
High Correlation: 0

As of 2nd Sept 2014

Source: Morgan Stanley QSI

Example: Risk Off triggered, 4th May 2011

Source:Bloomberg

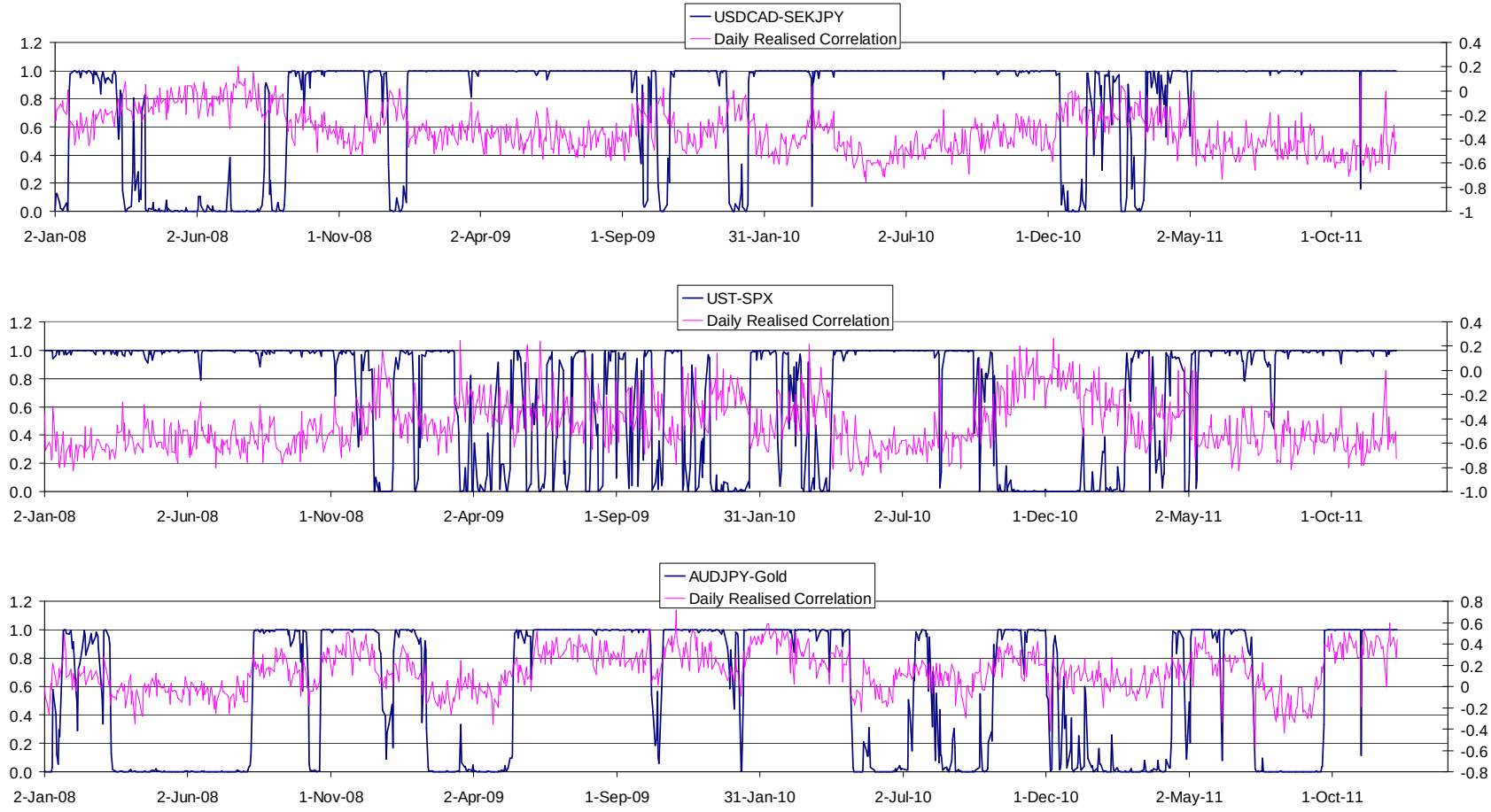


Source: Bloomberg, Morgan Stanley QSI

- The model switched into a risk-averse state on Wed 4th of May (using information up to 3rd of May), ahead of the equity and commodities drawdowns
- The major trigger for the model's regime shift on 4th of May was a pick-up in magnitude of the short-term correlations between AUDJPY-Gold and SEKJPY-USDCAD. E.g. gold, AUD, S&P were all on a decline on May 2-3rd
- In the risk-seeking environment, the model signals that risky assets have a low probability of exhibiting heavy drawdowns.
- This is related to the carry trade (or similarly a short volatility position) which may normally exhibit low stable gains in a low volatility environment and rapid significant drawdowns as risks spike up.
- The shift into risk-aversion can be used to signal, for example, going long volatility

Out of Sample State Probabilities

- Fitted to **daily realised correlation** calculated using 5 min observations In sample period, Jan 05-Dec 07, out of sample Jan 08-Dec 11:
- Blue line: Model Output: State probability for Risk aversion. Pink line: Model Input: Daily Realised Correlation



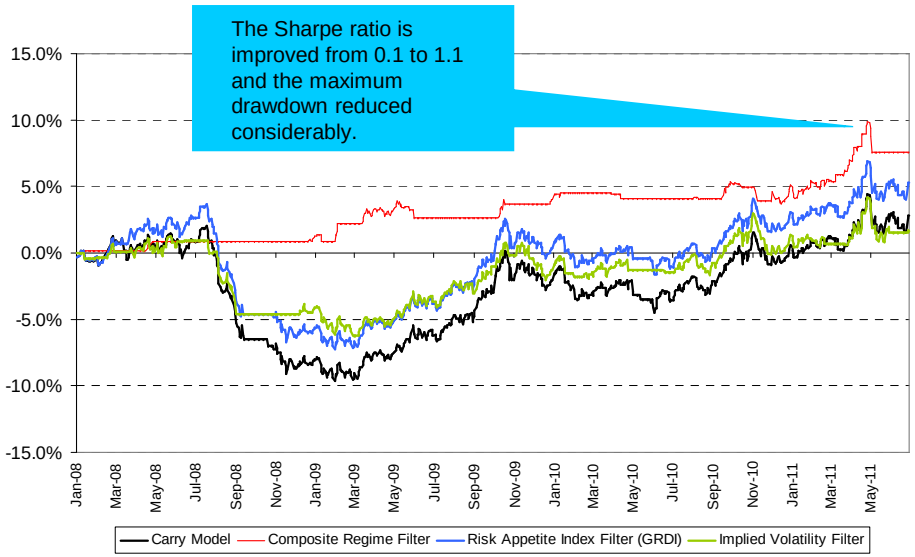
Source: Morgan Stanley QSI

Applications: Overlay to Carry & Trading Interest Rates

1. Overlay to FX Carry Portfolios

- Wide variety of risk indicators used as filters to help time strategies such as carry, including risk appetite indices and implied volatility
- Objective: test using the regime model as filter to better time the carry trade, and compare results to other filters typically employed in the market,
- Use the correlation regime probability as a signal to enter/exit carry:
  - Correlation Regime 1 (lower correlation for S&P-UST and Gold-AUDJPY) may correspond to a more risk seeking environment, 'risk on'
  - When higher correlation, Correlation Regime 2, may indicate a move to a more risk averse environment, 'risk off'
- Example trading strategy:
  - Exit carry trade when probability of correlation regime 2 > 90%
  - Only re-enter carry trade when probability < 90%

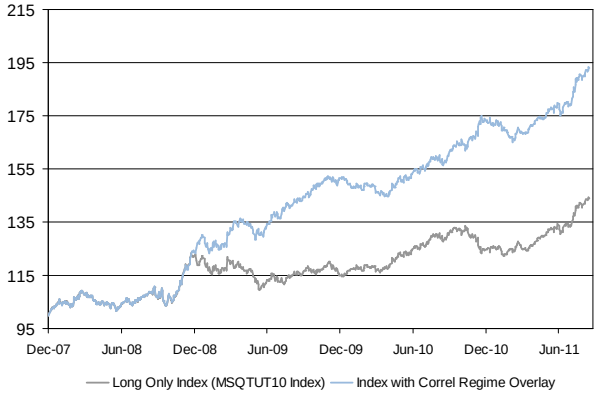
For the period Jan 08-Jun 11, a filter based on the identification of risk averse environments using a combination of signals from the regime model enhances the performance of the carry portfolio.



2. Trading Interest Rate Futures

- The underlying positions are the Morgan Stanley UST & bond Indices. Strategy uses the risk-seeking/risk-averse signals from the correlation regime model to time a long/short strategy in the long-only index.
- The IR for the overlay strategy is 2.0 for the 10y UST note future and 1.8 for the 30y UST bond future from end Dec07 to mid Sep11.
- Benchmark = long-only position in the 10y UST and 30y UST, producing an IR of 1.1 and 0.7, respectively.

Performance of Long UST 10yr Index, with/without the regime overlay, Dec 07 – Sep 11



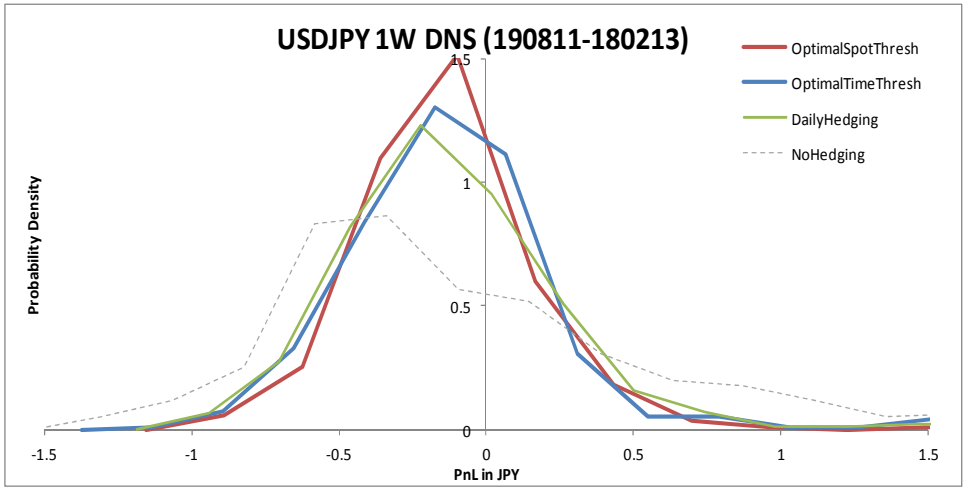
Source: Morgan Stanley QSI, EBS, Reuters, Bloomberg

Please see additional important information and qualifications at the end of this material.

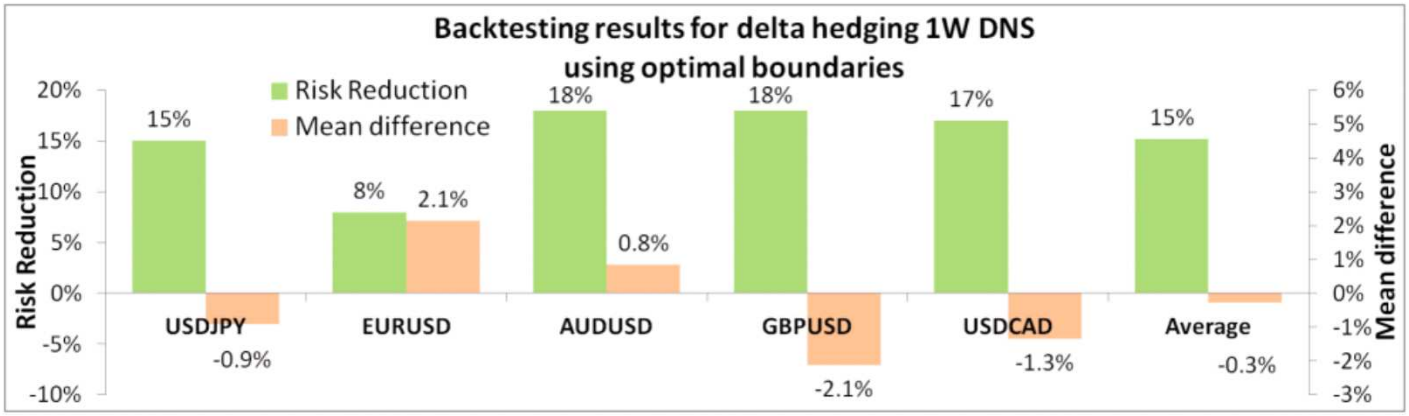
Optimal Delta Hedging

- Methodology developed to determine optimal spot levels and optimal frequencies for delta hedging
- Optimal spot boundaries outperforms time-based strategies
- For majors, optimal frequency approx 0.5-3 hrs
- Outperforms daily delta hedging in terms of risk reduction:
  - Avg risk reduction in P&L is 15% & 10% for 1w and 1m straddles respectively with no tradeoff in P&L mean

Backtesting results for 1W USDJPY DNS. This graph shows the P&L distributions for delta hedging a long DNS position.



Source: Morgan Stanley QSI

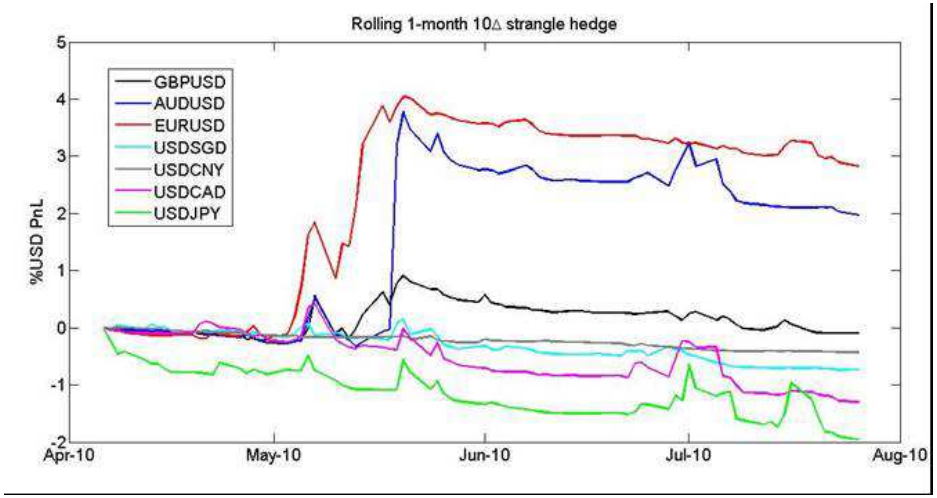


Source: Morgan Stanley QSI

Tail Risk Hedging

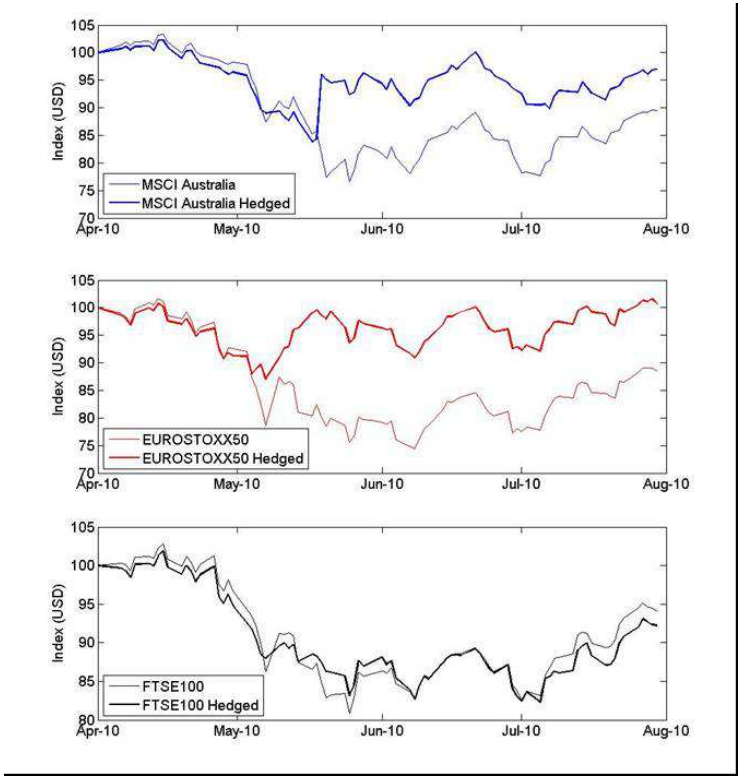
- Analysis conducted investigating the effectiveness of tail risk hedging using 10 delta FX strangles
- Tail risk events of major equity indices hedged using rolling 1m 10 delta strangle strategies

Mid-market performance of a rolling 1-month strangle hedge during the May-2010 sovereign crisis. All option PnL is in percent of USD notional. The options are marked to market daily using the QSI FX Options back-tester and Morgan Stanley's FX EOD pricing engine



Source: Morgan Stanley QSI

Performance of local equity indices during the May-2010 sovereign crisis with and without a rolling 10Δ strangle hedge. The hedged portfolio performance includes estimated transaction costs for the period.



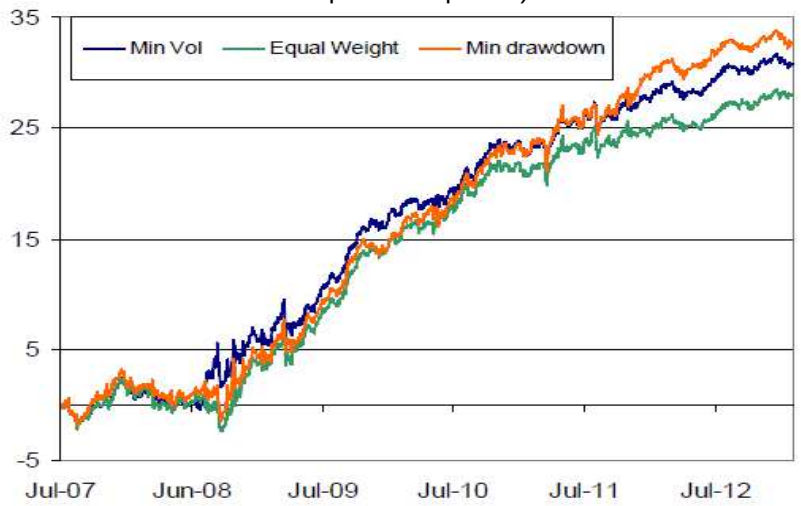
Source: Bloomberg, Morgan Stanley QSI

Constructing Minimum Tail Risk Portfolios

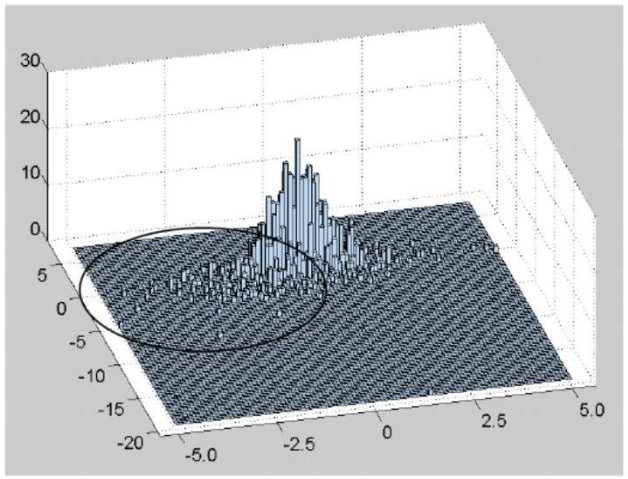
- Analysis conducted investigating alternative approaches to portfolio construction using copula
- Addresses dependence across investment styles beyond linear correlation and focuses on joint tail risk
- Example based on Carry, Momentum and Volatility and alternative construction methods investigated to outperform an equally-weighted benchmark
- Momentum appears to offer diversification benefits to Carry and Volatility during periods of market turbulence

Performance of individual strategies and equally weighted portfolio

% Portfolio Returns (based on Equal Weights, Min Vol, Min Drawdown for previous quarter)



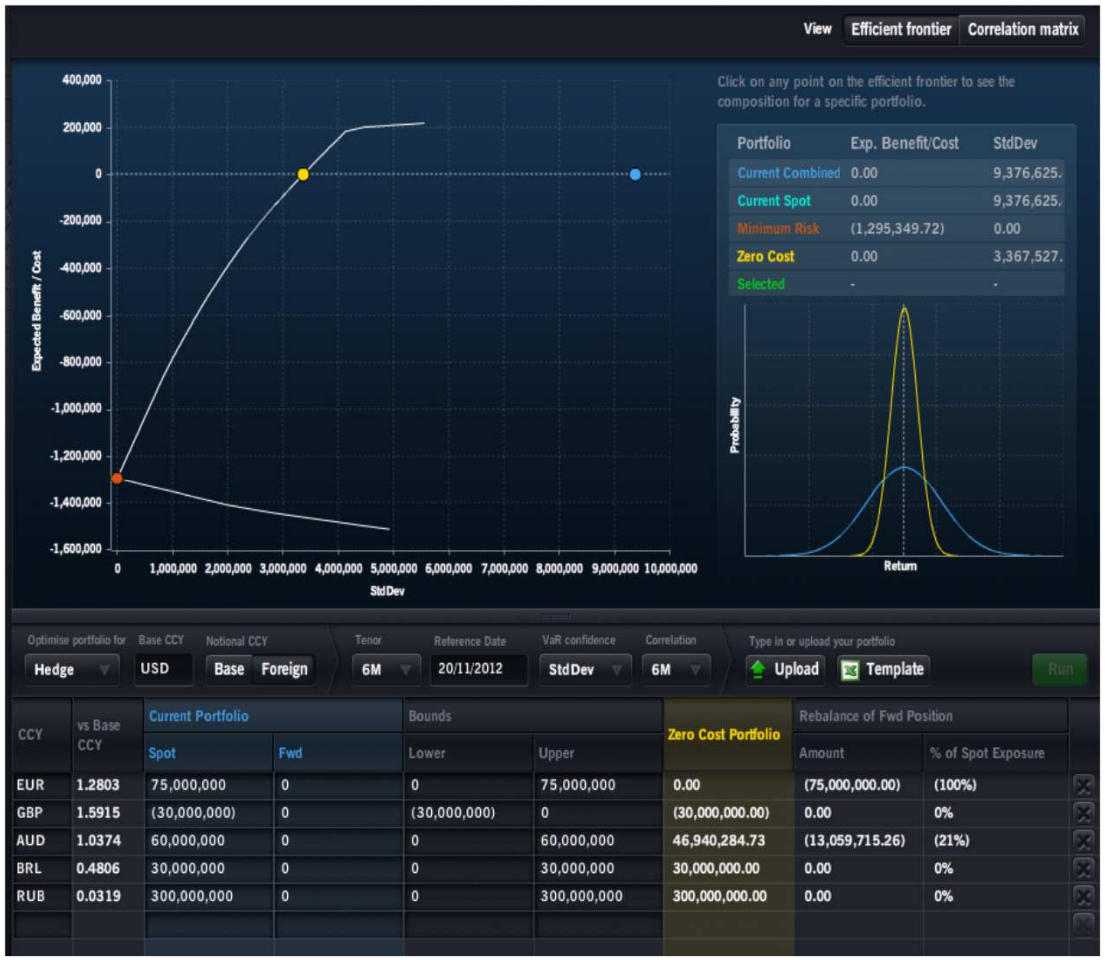
Empirical bivariate histogram of Carry and Volatility strategies



Source: Morgan Stanley QSI

Portfolio Optimiser

- Morgan Stanley's FX Optimizer allows clients to analyze currency exposures and generate optimal portfolios, that can be designed to meet different objectives, e.g:
  - can be used to generate the optimal currency weights that generate the ***minimum portfolio risk,*** and allow inspection of the portfolio to see how the risk changes as portfolio weights are adjusted.
  - alternatively, optimal portfolios can be constructed that seek to generate the ***maximum risk adjusted return*** from the currency exposure
- Key features:
  - Simple and intuitive to use
  - based on well-established portfolio theory (mean-variance)
  - allows existing portfolio exposures to be loaded from Excel
  - generates the efficient frontier of portfolio solutions, allowing clients to select the preferred risk/return characteristics for the portfolio, and comparing the existing portfolio to the optimal solution



Source: Morgan Stanley QSI

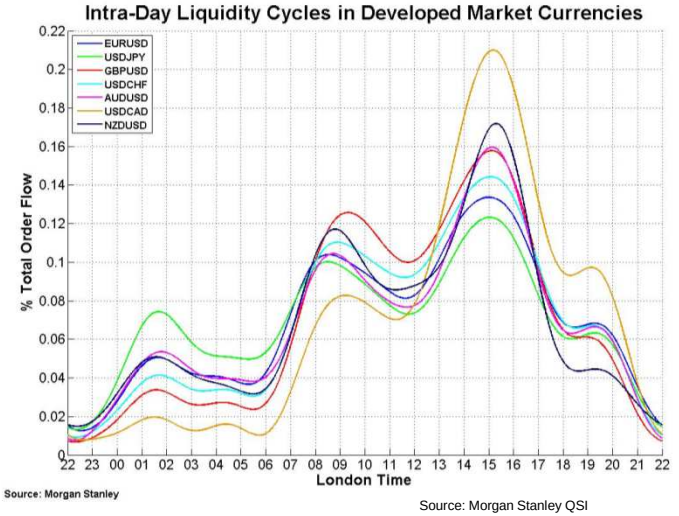
Please see additional important information and qualifications at the end of this material.

Transaction Cost Analysis

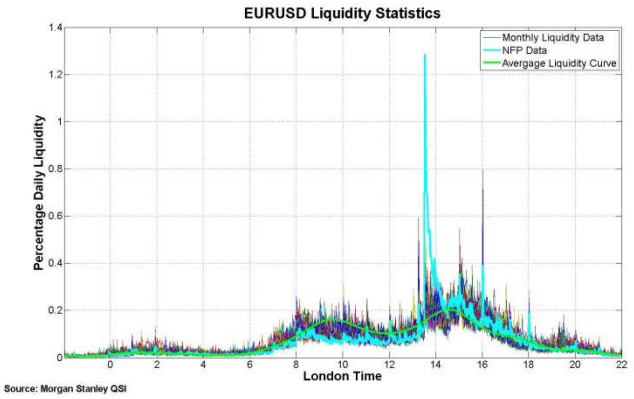
- All managers have a fiduciary responsibility to seek and deliver best execution to investors, where best execution is defined as "the trading process Firms apply that seeks to maximize the value of a client's portfolio within the clients stated investment objectives and constraints..." *(source: CFA's Trade Mgmt Guidelines)*
- As such, every manager must have an appropriate systematic process in place, to audit, analyze and evaluate the quality of execution being received and attribute the costs being charged to investors in each asset class and security managed.
- Since FX is an OTC market, few holistic and robust solutions exist to audit FX transactions to ensure best FX execution

Products & Services

- Morgan Stanley's QSI group has developed a sophisticated FX TCA framework which provides investors with the ability to:
  a) calculate transaction costs and market impact ex-ante (pre-trade)
  b) identify the fair-value benchmark price against which the effective price received should be measured,
  c) attribute transaction costs to key underlying market factors such as order size, depth of market liquidity, order flows and volatility and;
  d) generate comprehensive TCA reports on every transaction done with Morgan Stanley and other counterparties



Source: Morgan Stanley QSI



Source: Morgan Stanley QSI

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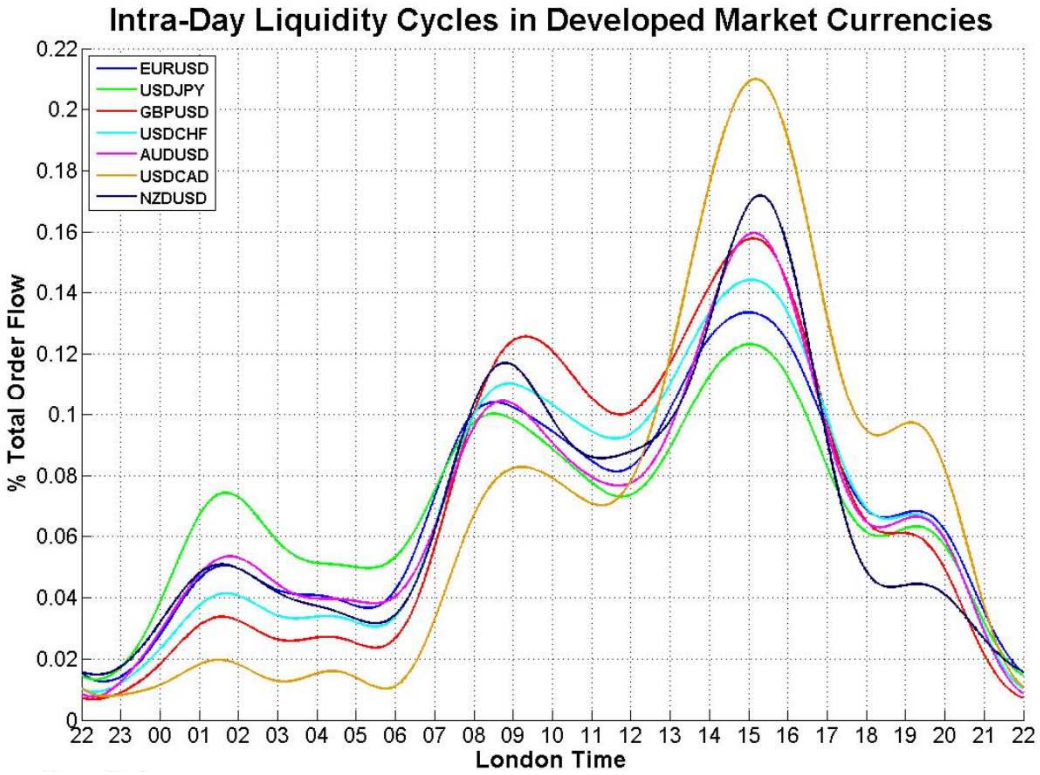
QSI Transaction Cost Framework - Overview

Robust, analytical framework for FX TCA developed using market microstructure and options theory

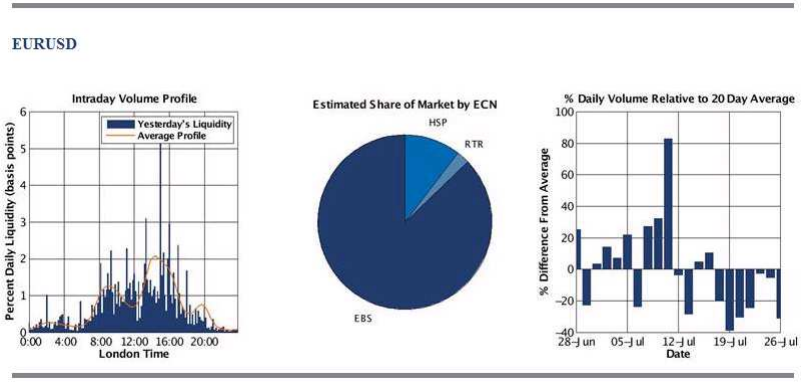
- Framework developed to provide indications of transaction costs:
  - Based on microstructure of limit order books and order priority rules
  - Uses option theory to estimate hidden elements of costs
  - Allows execution strategy to be optimised pre-trade to minimise costs
- Flow-weighted average price provides representative, transparent benchmark for currency execution (MS FIX TM)



Source: Morgan Stanley QSI

FX Liquidity and Volumes
Daily Report available via email

- Daily report available providing summary of previous day's liquidity based on major ECNs
- Market share per ccy displayed
- Trends in relative volumes plotted
- Actual intraday volumes plotted vs average liquidity profile



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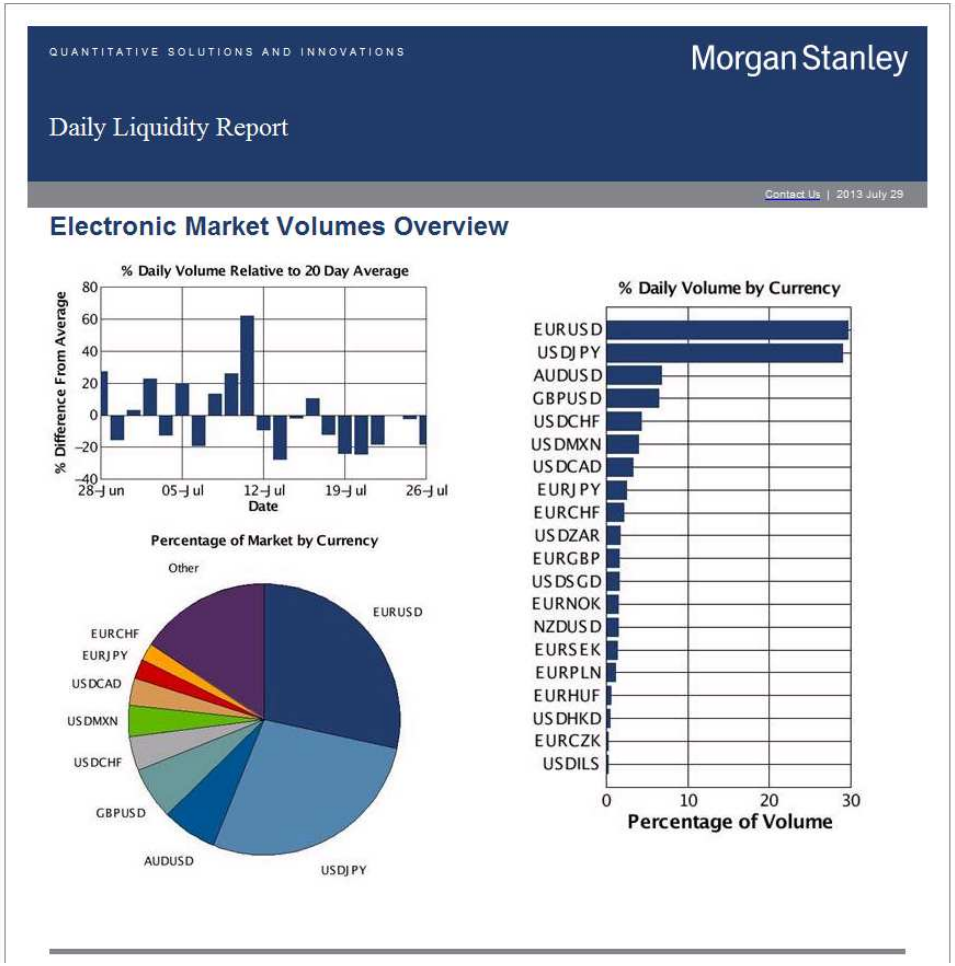

Source: Morgan Stanley QSI

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FX Liquidity and Costs
Monthly Report Available

- Monthly update produced that summarises estimated costs per ccy pair, highlighting times that correspond to the cheapest and most expensive times of day, on average, to trade
- Liquidity, volatility and costs compared month on month
- Includes charts per ccy pair with updated liquidity and estimated cost curves (also available on-line via Pre-Trade TCA Calculator on Matrix)

Summary of Estimated Costs, Sep 2014

	Implied Volatility	Average Cost (bps)	Max Cost (bps)	Corresponding London Time	Min Cost (bps)	Corresponding London Time
AUDUSD	6.07%	3.46	6.08	21:27:00	2.42	15:07:00
EURUSD	4.93%	1.88	2.81	21:43:00	1.32	14:29:00
GBPUSD	4.81%	2.53	3.39	21:32:00	1.96	9:50:00
NZDUSD	7.05%	5.10	7.41	20:54:00	3.55	14:50:00
USDCAD	5.05%	3.84	5.36	22:27:00	2.66	14:11:00
USDCHF	5.28%	4.75	6.92	22:08:00	3.14	15:18:00
USDHKD	0.34%	0.18	0.20	17:42:00	0.17	8:26:00
USDJPY	5.48%	2.51	4.31	21:42:00	1.86	15:12:00
EURNOK	6.06%	19.83	35.97	20:46:00	5.33	8:39:00
EURSEK	5.51%	15.68	28.91	20:41:00	5.14	8:19:00
EURCHF	1.91%	4.31	5.88	21:52:00	3.06	15:02:00
EURGBP	5.01%	5.08	7.79	21:43:00	3.37	15:31:00
EURJPY	5.36%	2.24	3.69	21:44:00	1.56	15:21:00
USDZAR	9.77%	26.84	50.51	21:15:00	9.98	14:53:00
USDMXN	6.48%	10.73	20.60	22:01:00	3.01	14:51:00
USDTRY	9.33%	14.60	23.10	20:05:00	7.20	14:33:00
USDILS	5.46%	54.20	96.25	20:28:00	17.16	15:09:00
USDSGD	3.15%	3.43	4.22	19:12:00	3.00	7:26:00
EURCZK	3.15%	36.51	60.81	17:33:00	12.03	11:33:00
EURHUF	6.82%	31.03	45.47	19:05:00	18.16	14:32:00
EURPLN	5.32%	17.51	27.10	19:09:00	9.87	14:02:00

Source: Morgan Stanley QSI

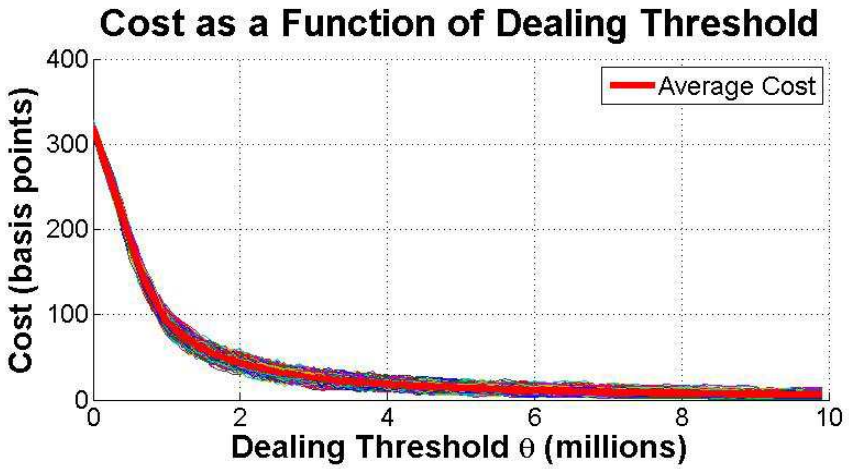
Comparison of Costs, Sep vs Aug 14

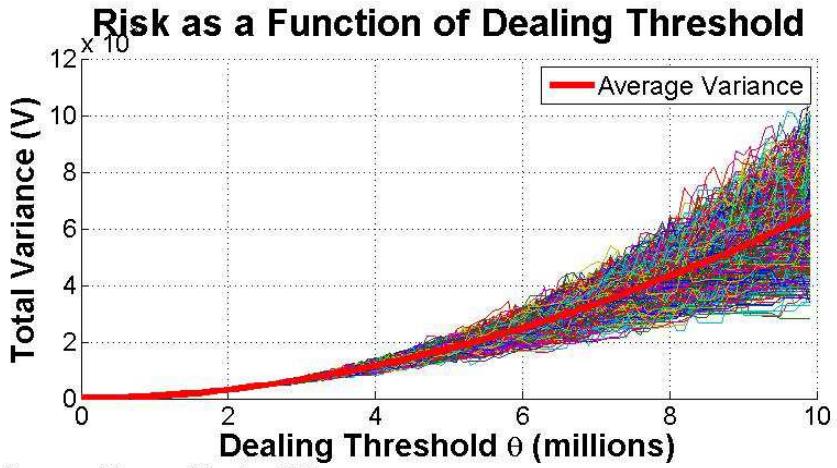
	Average Daily Volume (% Change)	Implied Volatility (% Change)	Average Cost (% Change)	Max Cost (% Change)	Min Cost (% Change)
AUDUSD	0.7%	-1.6%	-11.4%	-7.2%	0.1%
EURUSD	18.5%	8.3%	2.9%	5.4%	0.0%
GBPUSD	7.8%	3.2%	-10.0%	-12.8%	-2.7%
NZDUSD	3.6%	0.9%	-6.8%	3.2%	16.8%
USDCAD	9.2%	9.4%	-5.6%	-6.6%	-0.2%
USDCHF	17.7%	5.8%	4.8%	3.0%	3.7%
USDHKD	0.8%	11.4%	-0.2%	0.5%	2.5%
USDJPY	38.9%	11.7%	-13.3%	-6.9%	-1.4%
EURNOK	21.4%	-1.6%	8.4%	12.4%	-1.8%
EURSEK	-4.8%	-5.7%	13.9%	15.6%	-2.4%
EURCHF	22.7%	12.0%	83.5%	81.6%	2.9%
EURGBP	7.3%	6.8%	14.9%	12.5%	-2.0%
EURJPY	38.2%	6.2%	-10.0%	-2.9%	-0.4%
USDZAR	6.5%	0.0%	-5.4%	-2.8%	-0.6%
USDMXN	48.3%	9.0%	-19.6%	-14.5%	-0.6%
USDTRY	37.9%	15.0%	-2.8%	-1.3%	10.6%
USDILS	67.7%	27.1%	22.0%	29.0%	16.3%
USDSGD	34.1%	15.8%	2.0%	4.2%	7.1%
EURCZK	56.2%	60.0%	81.7%	88.3%	2.3%
EURHUF	22.6%	11.7%	13.1%	12.8%	8.3%
EURPLN	36.6%	5.2%	11.1%	13.1%	2.3%

Source: Morgan Stanley QSI

Quantifying Cost vs Risk

- Framework allows informed decisions to be made with regards to optimal trading sizes, waiting times etc
- Trade off between opportunity cost (arising from waiting to execute, either to net transactions or to access better liquidity pools) and cost
- Trading instantaneously may be beneficial to minimise implementation shortfall, but may be sub-optimal from cost perspective
- TCA framework allows impact of cost vs risk to be quantified
- Illustrates that may be beneficial to aggregate small trades over shorter horizons, that can 'overpay' transaction costs, but generally not worthwhile to wait for several hours to net given likely cost savings vs volatility





Source: Morgan Stanley QSI

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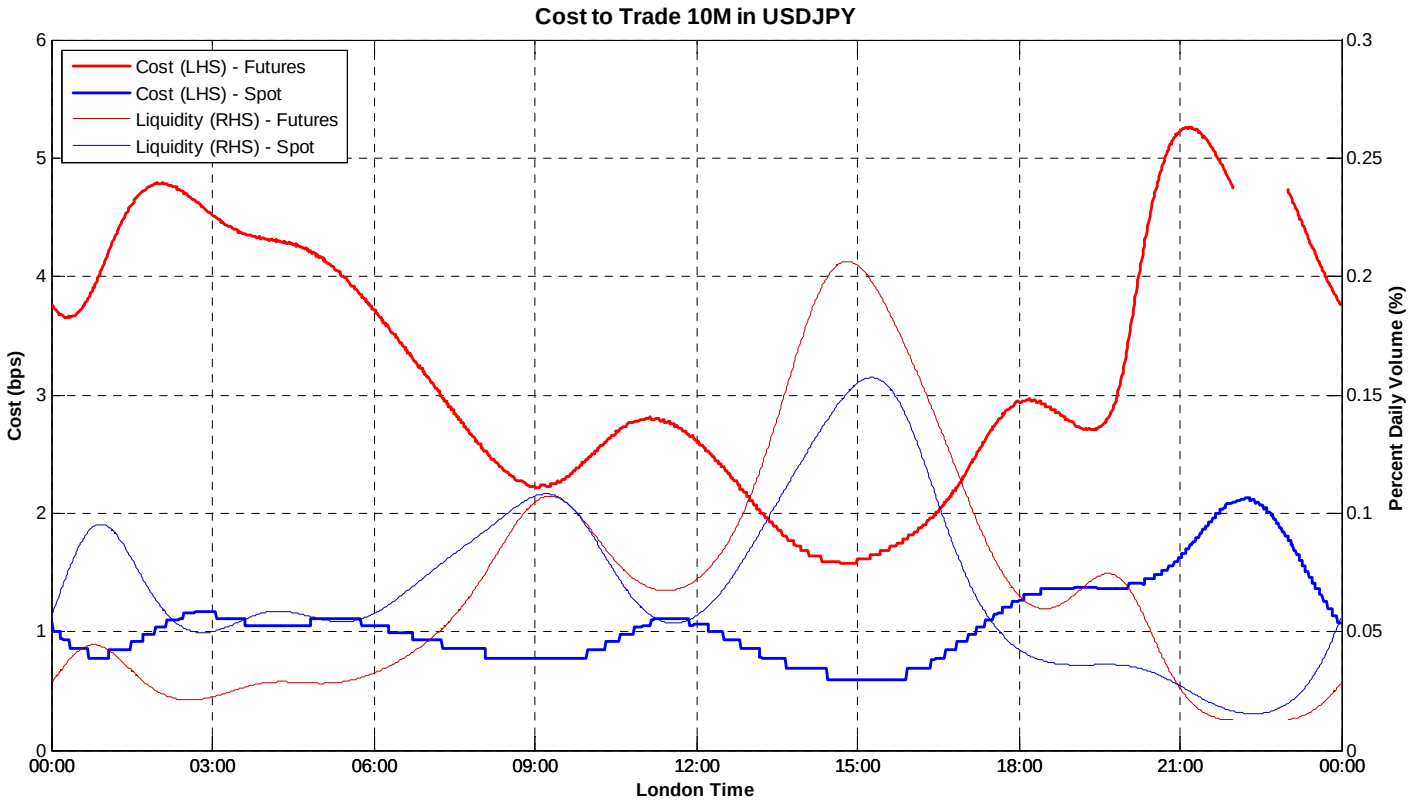
Comparing costs for FX Futures with OTC

- TCA framework also applied to FX Futures markets to compare costs – **in general, transaction costs are found to be approximately 2-3 times greater in futures than spot OTC**



Source: Morgan Stanley QSI/EBS/Bloomberg

Execution Services & Products: Pre-Trade

Execution Dashboard

Real-time analytics to help execution decision making:

- **Volumes**
- **Orderbook**
- **Pressure Indicator**
- **Volatility**
- **Price Momentum**

Notifications available:

- Set levels per indicator or combination of indicators
- User notified when levels are met
- E.g. tell me when the EURUSD market moves into a low volatility, high volume regime

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Source: Morgan Stanley QSI

Pre-Trade TCA available

- Framework provides investors with ability to estimate total cost of execution, including impact cost, on a pre-trade basis
- Application on Matrix provides updated intra-day liquidity profiles and allows users to input specific trade parameters and perform 'what-if' analysis to determine cost efficient execution strategies
- Pre-calculated intraday cost curves for a given 50m size available, together with ability to calculate curves for specific sizes as required

Source: Morgan Stanley QSI

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Pre-Trade TCA available

- Effect of changing time of execution during the day can be analysed, together with the relationship between cost and size of trade

Source: Morgan Stanley QSI

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Pre-Trade TCA available for Algo execution

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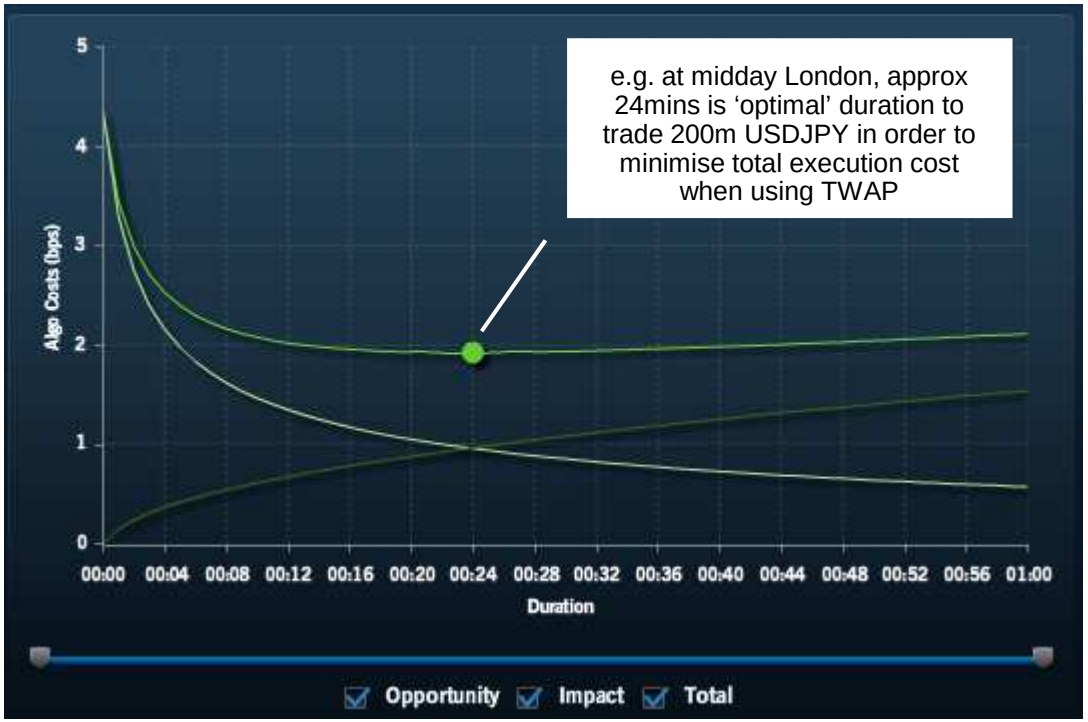
- Pre-trade application also provides estimates of algo (TWAP/VWAP) execution
- Impact and opportunity costs available for:
  - Different notionals
  - Different times of day
  - Different durations
- Helps choose algo trade parameters to meet specific objectives
- Allows comparison of estimated algo costs with point in time execution costs, thereby helping decision making process



	CCY Pair	Type	Amount (LHS)	Date	Start	Interval/Duration	Volatility		Cost (bps)	Cost (pips)
☑	USDJPY	TWAP	200,000,000	10/02/2014	12:00	01:00	9.15	Calculate	1.92 - 4.35	1.97 - 4.44

Source: Morgan Stanley QSI

Algo Product Summary

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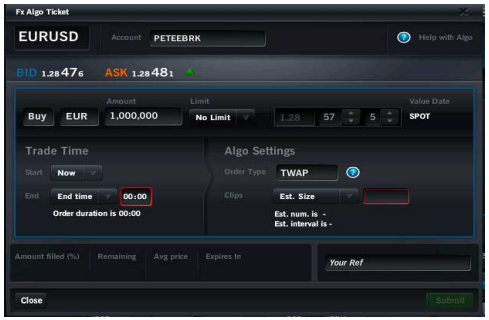
Fixed Income Sales & Trading

Product	Strategy Objective	When to use	Availability
TWAP	Execute trades evenly over a specified time period. Ability to set a price limit, which can be used to either pause/terminate an order or as an order activate trigger	Orders that require equal quantity and time slices over the day.	MS Matrix Bloomberg, FX Connect Trading Screen, FXall Portware, FlexTrade
VWAP	Executes trades according to an estimate of intraday volume. Ability to set a price limit, which can be used to either pause/terminate an order or as an order activate trigger	When seeking to access more liquid parts of trading day, resulting in receiving a central tendency price weighted by liquidity. Reduces execution volatility, helps minimise impact	MS Matrix Bloomberg, FX Connect Trading Screen, FXall Portware, FlexTrade
MS Radar	Opportunistic algo with no fixed participation schedule. Executes within specified cost, price and liquidity constraints	For trading over shorter horizons, where the trade objective is cost control as opposed to a price or benchmark target	MS Matrix Bloomberg, FX Connect Trading Screen, FXall Portware, FlexTrade
MS Seeker	Algo that seeks liquidity across range of venues, including MS and ECNs, via a combination of passive and aggressive orders	For orders where goal is to access market liquidity efficiently. Urgency level determines length of time orders will wait passively.	MS Matrix Bloomberg, FX Connect Trading Screen, FXall FlexTrade
MS Arrival Price	Algo that seeks to minimise slippage relative to the market mid price at the instant the order is received (implementation shortfall benchmark)	For orders where the priority is to achieve the mid-market price at order inception, whilst balancing the trade off between impact cost and risk (opportunity cost)	MS Matrix Bloomberg, FX Connect FlexTrade, FXall

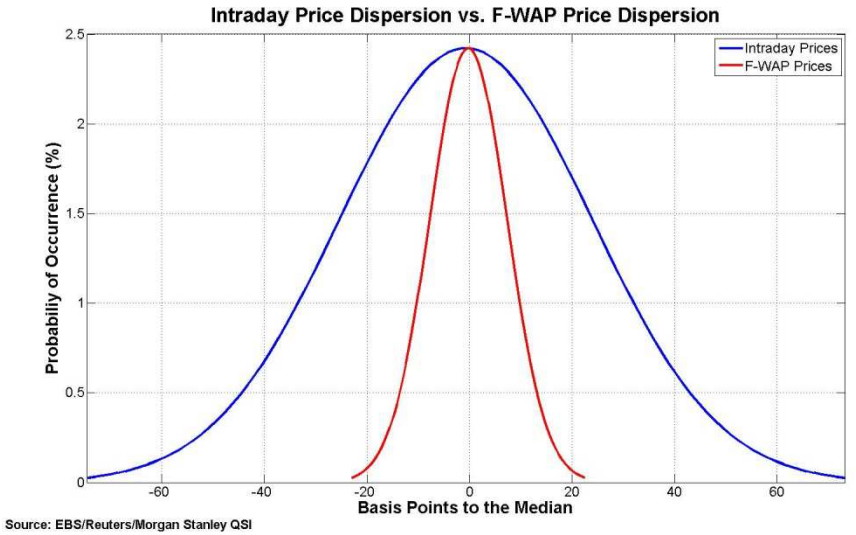


Source: Morgan Stanley QSI

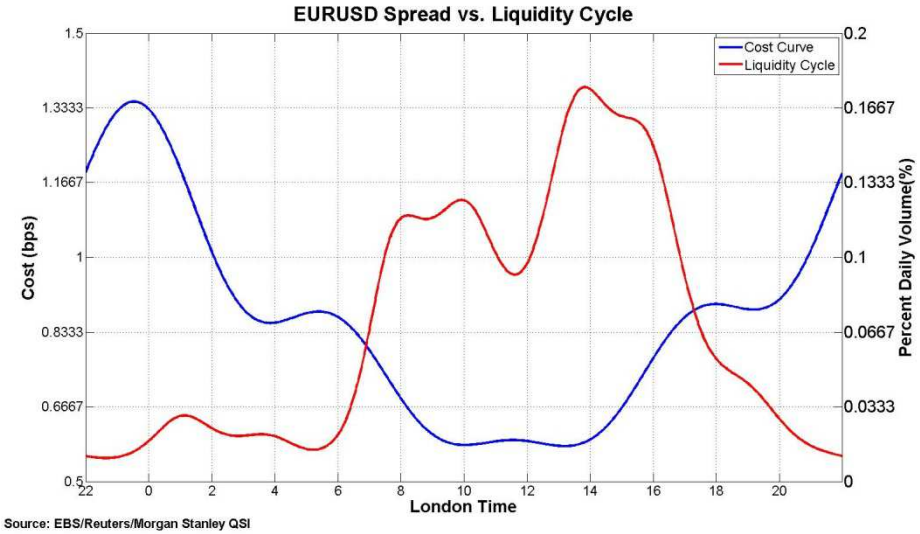
Algorithmic Trading - Reducing Market Impact
Stylised VWAP – "Flow-Weighted Average Price"

- Matching FX transactions with the intra-day liquidity cycle results in a *flow-weighted average price* (F-WAP).
- Morgan Stanley Fix provides investors with the ability to trade a F-WAP directly
- Incorporates 'event day' liquidity curves
- The F-WAP is a fair value benchmark price:
  - It represents a central tendency price over an execution window, avoiding trades at extreme prices
  - It represents the price a passive trader would obtain by trading on every tick in the market
  - F-WAP exhibits less dispersion around the median price than point-in-time prices
- F-WAP helps minimize transaction costs by executing during the most liquid times of the day
- Using Morgan Stanley Fix investors can:

1. Reduce average execution volatility
2. Avoid high/low prices of day
3. Ensure access to deepest liquidity during execution window
4. Minimise 'regret'



Source: EBS/Reuters/Morgan Stanley QSI



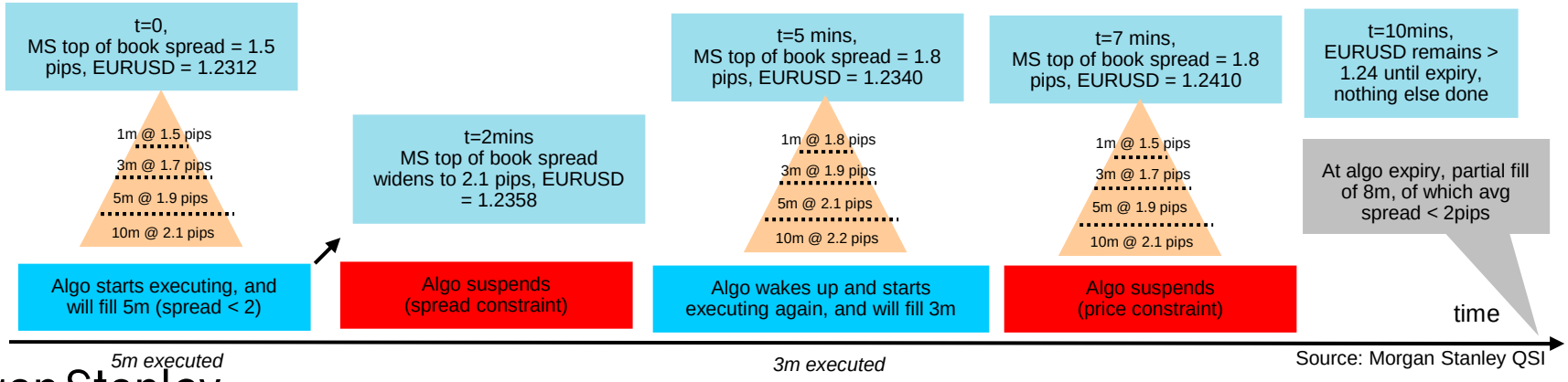
Source: EBS/Reuters/Morgan Stanley QSI

Please see additional important information and qualifications at the end of this material.

Algorithmic Trading – Cost Control
MS Radar

- Simple algo that allows a client to specify:
  - Trade time, ccy pair, notional size, max slice size (optional)
  - Max spread
  - A price limit (optional)
- Algo only executes within constraints, thereby providing client with control over acceptable spread cost, although no longer guaranteed to return a complete fill of the order
- Prevents clients experiencing 'spread decay' as they execute successive orders and consume rungs of the liquidity ladder, i.e. once spread widens through order placement, algo will pause and wait for spread to move back within defined threshold

- E.g. client submits order to buy EURUSD 10m over next 10 minutes, and does not want pay spreads greater than 2 pips, and does not want to participate in the market if EURUSD goes above 1.24



Source: Morgan Stanley QSI

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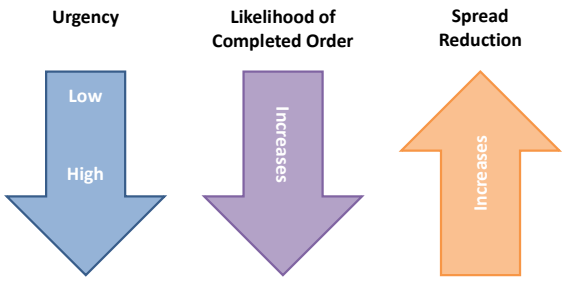
Algorithmic Trading – Opportunistic Liquidity Seeking
MS Seeker

- Opportunistic liquidity seeking algo
  - Intelligently places orders to capture spread and minimise signaling risk
  - Uses real-time and historical trade data to estimate optimal participation level, whilst minimising market footprint
- Trade parameters:
  - Ccy pair, start/end time (or duration), limit price (optional), notional, buy/sell, urgency
- Designed for shorter trading horizons, and may not complete depending on urgency setting and order duration
- Urgency: 4 levels (Low, Medium, High, Ultra High), determine speed/aggressiveness of execution



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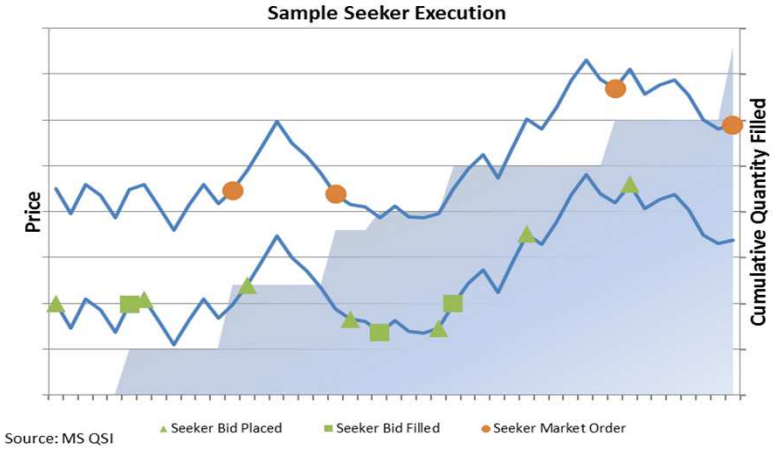
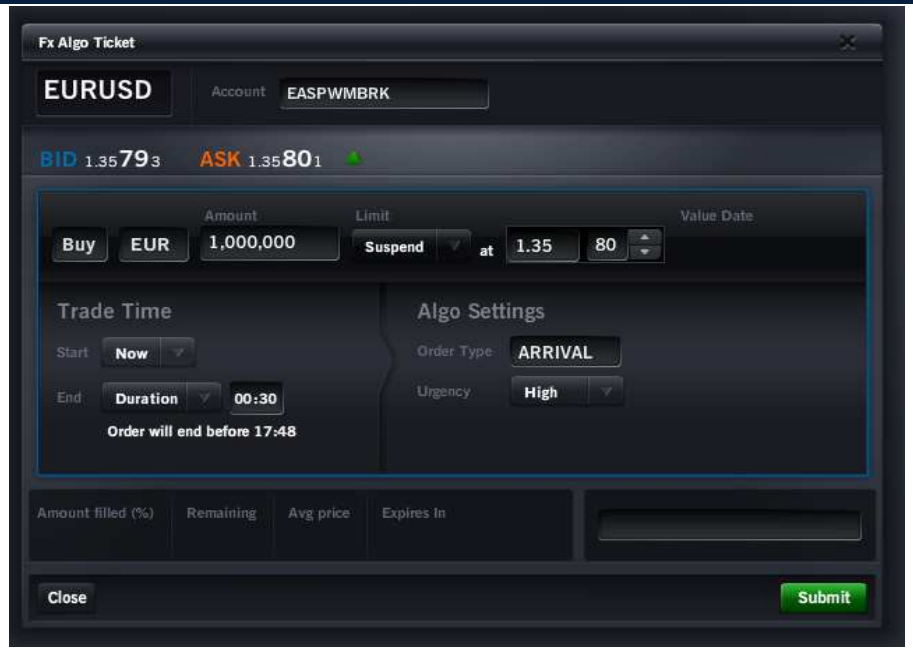


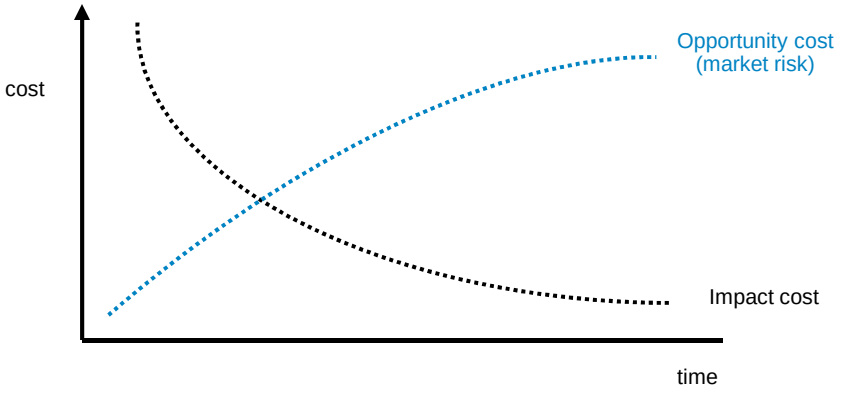
Source: Morgan Stanley QSI

Please see additional important information and qualifications at the end of this material.

Algorithmic Trading – Implementation Shortfall
MS Arrival Price

- Benchmark algo seeking to minimise implementation shortfall:
  - Optimises trade-off between market impact cost and market risk (opportunity cost)
  - Benchmark is the mid-market price at the time the order is received (the “arrival price”)
- Trade parameters:
  - Ccy pair, start/end time (or duration), limit price (optional), notional, buy/sell, urgency
- Will always aim to complete by order expiry (unless constraints such as limit price preclude this)
- Urgency:
  - 4 levels (Low, Medium, High, Ultra High), determine speed/aggressiveness of execution
  - High indicates user is risk averse and is willing to trade faster, incurring more impact cost but less risk
  - Low indicates user is happier to accept higher risk as algo will trade slower, thereby creating less impact cost





Source: Morgan Stanley QSI

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TCA Benchmarker on Matrix

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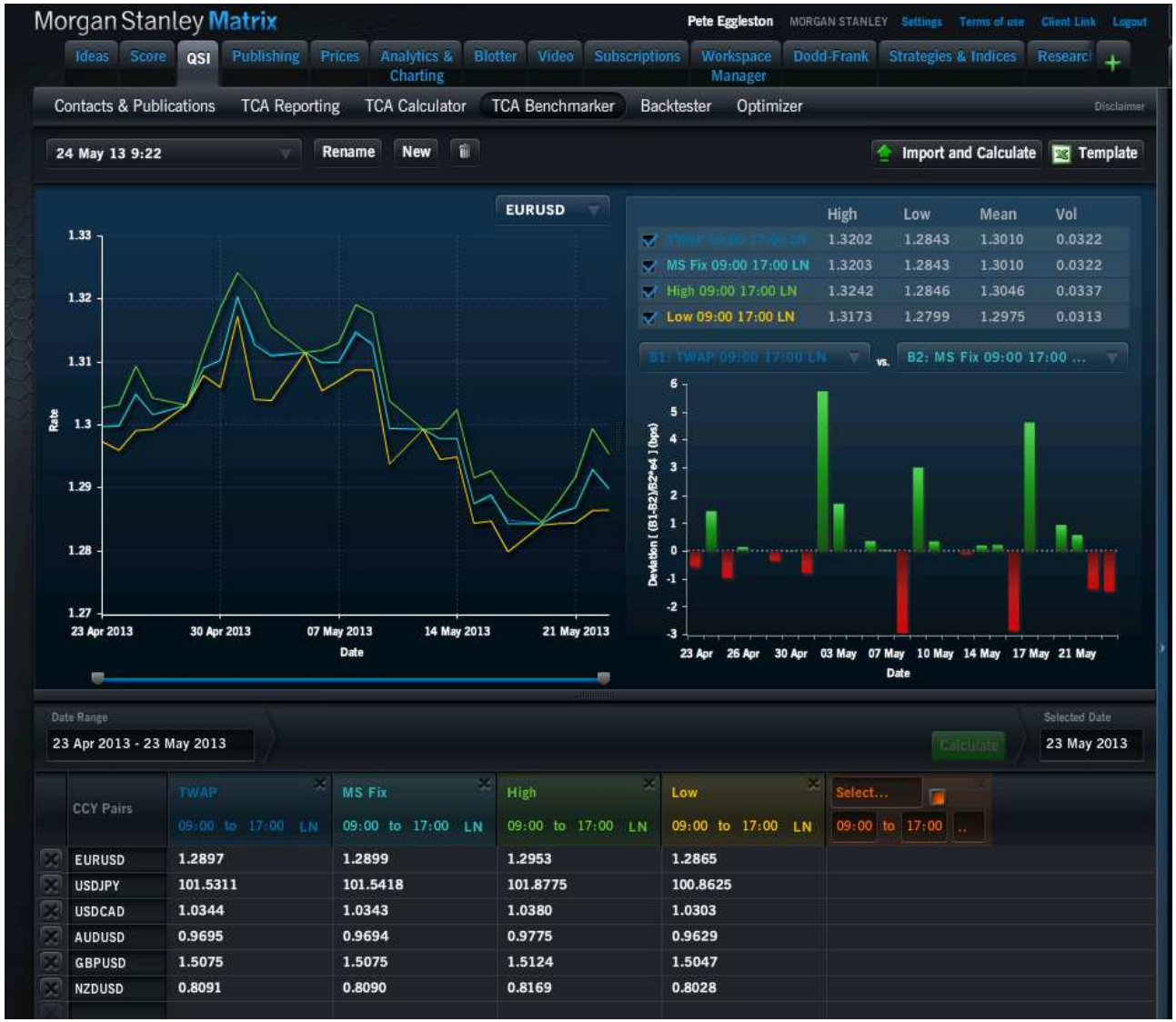
- New application on Matrix provides ability to construct and analyse custom benchmarks for FX
- Includes:
  - TWAP
  - VWAP
  - Arrival Price
  - High/Low
  - Close
  - WM Fix
- Client can load historical trade records and compute specific, tailor-made benchmark values



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Source: Morgan Stanley QSI

MS FWAP– also available on Bloomberg as a benchmark

- Morgan Stanley Fix rates, computed over a 24hr window, are updated and published daily on Bloomberg:
  - type **FXOM<GO>** and select MSST -> MSFIX.
- Calculated from 5pm – 5pm NY time and available on t+1 at 7am London time
- Representative (computed using ECN trade data)
- Currently available for G10 and crosses

Currency	USD	EUR	JPY	GBP	CHF	CAD	AUD	NZD	NOK	SEK
1) USD		0.7719	82.15	0.6238	0.9298	0.9929	0.9551	1.2164	5.6744	6.6589
2) EUR	1.2955		106.48	0.8080	1.2043	1.2854	1.2374	1.5759	7.3502	8.6269
3) JPY	0.0120	0.0090		0.0080	0.0110	0.0120	0.0120	0.0150	0.0690	0.0810
4) GBP	1.6031	1.2376	131.72		1.4905	1.5915	1.5310	1.9500	9.0968	10.6779
5) CHF	1.0755	0.8304	88.39	0.6709		1.0674	1.0274	1.3085	6.1037	7.1660
6) CAD	1.0072	0.7780	82.76	0.6283	0.9369		0.9624	1.2257	5.7208	6.7147
7) AUD	1.0470	0.8081	86.02	0.6530	0.9733	1.0391		1.2735	5.9348	6.9586
8) NZD	0.8221	0.6346	67.53	0.5128	0.7642	0.8159	0.7852		4.6606	5.4659
9) NOK	0.1762	0.1361	14.49	0.1099	0.1638	0.1748	0.1685	0.2146		1.1738
10) SEK	0.1502	0.1159	12.33	0.0937	0.1395	0.1489	0.1437	0.1830	0.8519	

The MSFix Benchmark Fixings

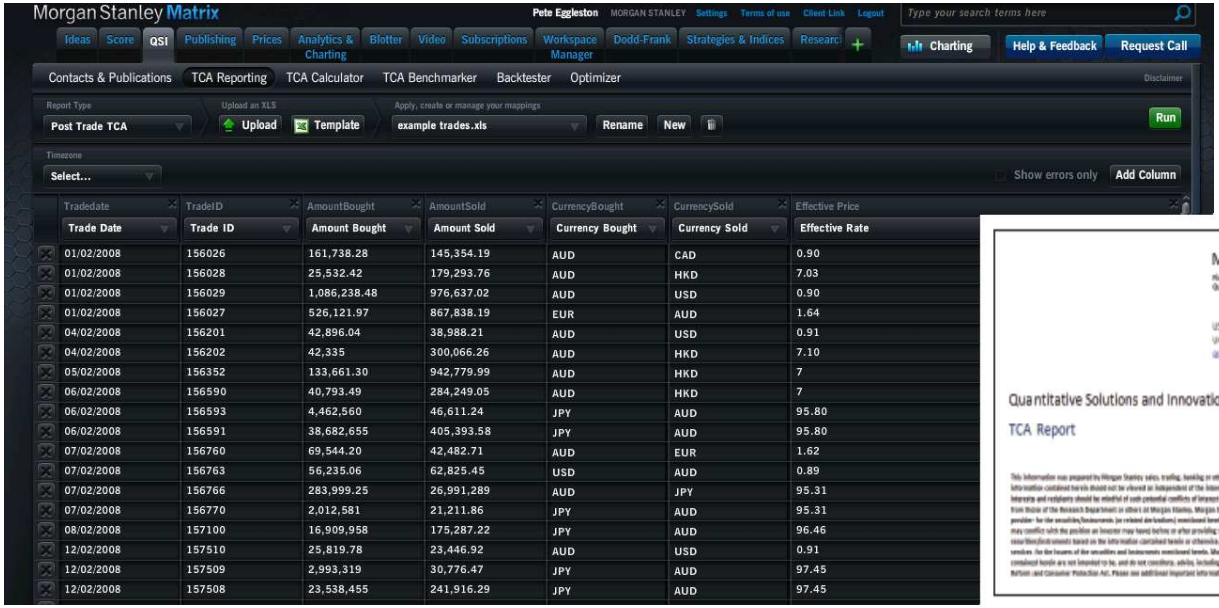
Source: Morgan Stanley QSI/Bloomberg

History of the MSFix EURUSD fixing plotted against BGN Last Price
Source: Morgan Stanley QSI, Bloomberg

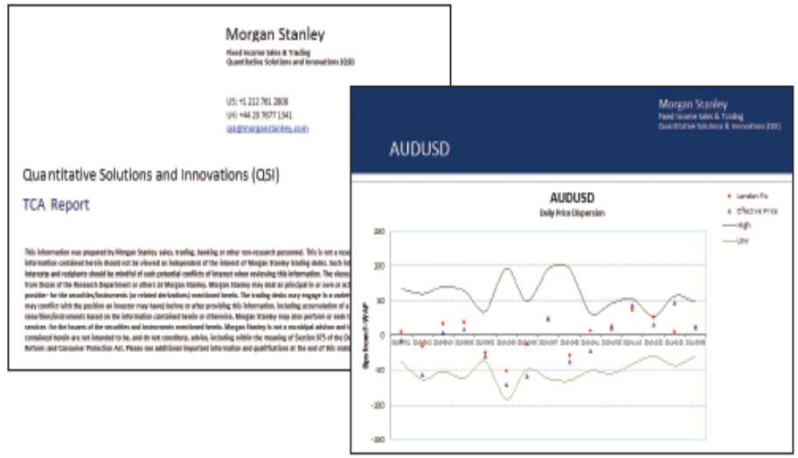
Please see additional important information and qualifications at the end of this material.

Post-Trade TCA available

- Framework provides investors with access to TCA framework, providing rigorous and detailed post-trade analysis
- Trade data can be loaded directly into Matrix via an intuitive, simple interface. N.B. no data is stored on the Morgan Stanley web servers
- Rigorous trade by trade analysis based on price data aggregated from major ECN platforms, i.e. it is not based on Morgan Stanley prices and provides a representative, unbiased analysis



Tradedate	TradeID	AmountBought	AmountSold	CurrencyBought	CurrencySold	Effective Price
Trade Date	Trade ID	Amount Bought	Amount Sold	Currency Bought	Currency Sold	Effective Rate
01/02/2008	156026	161,738.28	145,354.19	AUD	CAD	0.90
01/02/2008	156028	25,532.42	179,293.76	AUD	HKD	7.03
01/02/2008	156029	1,086,238.48	976,637.02	AUD	USD	0.90
01/02/2008	156027	526,121.97	867,838.19	EUR	AUD	1.64
04/02/2008	156201	42,896.04	38,988.21	AUD	USD	0.91
04/02/2008	156202	42,335	300,066.26	AUD	HKD	7.10
05/02/2008	156352	133,661.30	942,779.99	AUD	HKD	7
06/02/2008	156590	40,793.49	284,249.05	AUD	HKD	7
06/02/2008	156593	4,462,560	46,611.24	JPY	AUD	95.80
06/02/2008	156591	38,682,655	405,393.58	JPY	AUD	95.80
07/02/2008	156760	69,544.20	42,482.71	AUD	EUR	1.62
07/02/2008	156763	56,235.06	62,825.45	USD	AUD	0.89
07/02/2008	156766	283,999.25	26,991,289	AUD	JPY	95.31
07/02/2008	156770	2,012,581	21,211.86	JPY	AUD	95.31
08/02/2008	157100	16,909,958	175,287.22	JPY	AUD	96.46
12/02/2008	157510	25,819.78	23,446.92	AUD	USD	0.91
12/02/2008	157509	2,993,319	30,776.47	JPY	AUD	97.45
12/02/2008	157508	23,538,455	241,916.29	JPY	AUD	97.45



Source: Morgan Stanley QSI

Please see additional important information and qualifications at the end of this material.

A New Approach to TCA Reporting

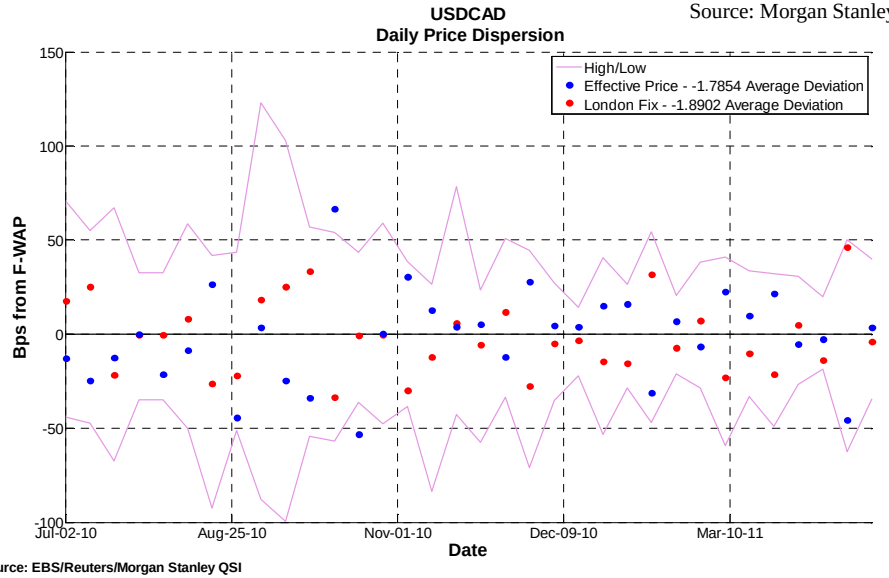
MORGAN STANLEY
Quantitative Solutions and Innovations (QSI)
Fixed Income Sales & Trading

- Ex-Ante Transaction Cost Estimates:
  - Transaction cost estimates grounded in Black-Scholes option pricing

- Uses a high-frequency tick database to provide snapshot of the market at trade inception and throughout the implementation period:
  - Prevailing mid market, bid and offer prices
  - Depth of market liquidity
  - Trading opportunity set

- Measures the execution quality of each transaction:
  - Effective vs. expected spread
  - Effective vs. expected market impact
  - Value-added/Regret relative to the execution benchmark price over the implementation period
  - Percentile rank of effective price over all prices observed in the trading opportunity set

Source: Morgan Stanley QSI

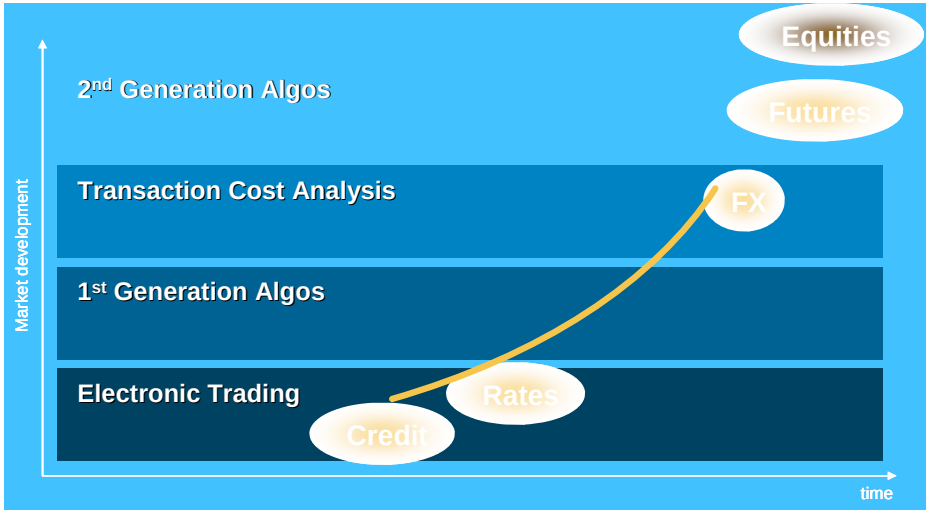


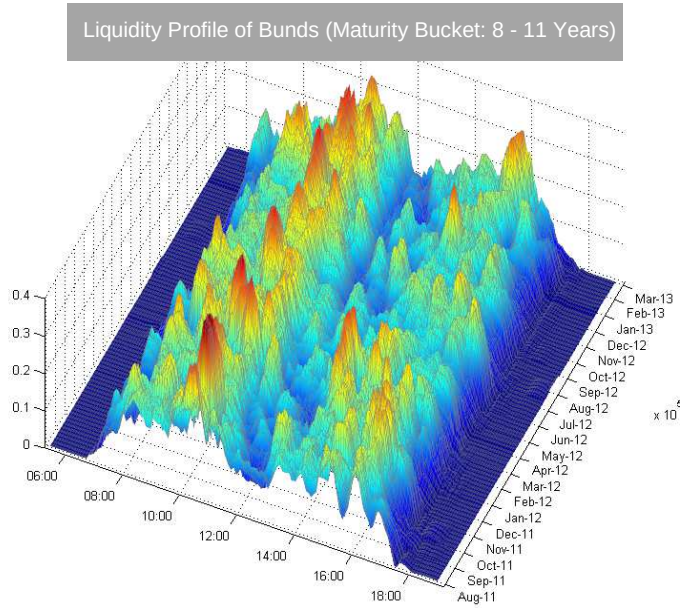
Source: EBS/Reuters/Morgan Stanley QSI

Product Development

Transaction Costs for Fixed Income markets

- Transaction Cost Analysis available in pre- and post-trade formats for all listed markets since the 1990's due to availability of trade data from exchanges
- Now also available for spot FX due to electronification of the market, resulting in rich data source of transaction data
- Combination of increasing electronficiation of liquid parts of Fixed Income markets, together with regulatory developments, means TCA becoming increasingly viable
- Initial step is to model and understand intraday liquidity and market structure
  - Develop pre-trade TCA tool for liquid sovereign bond markets
  - Investigate algorithmic execution products





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Source: Morgan Stanley QSI

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M O R G A N S T A N L E Y

Quantitative Solutions and Innovations (QSI)

Fixed Income Sales & Trading

Appendix

Quantitative Solutions and Innovations (QSI)

Overview

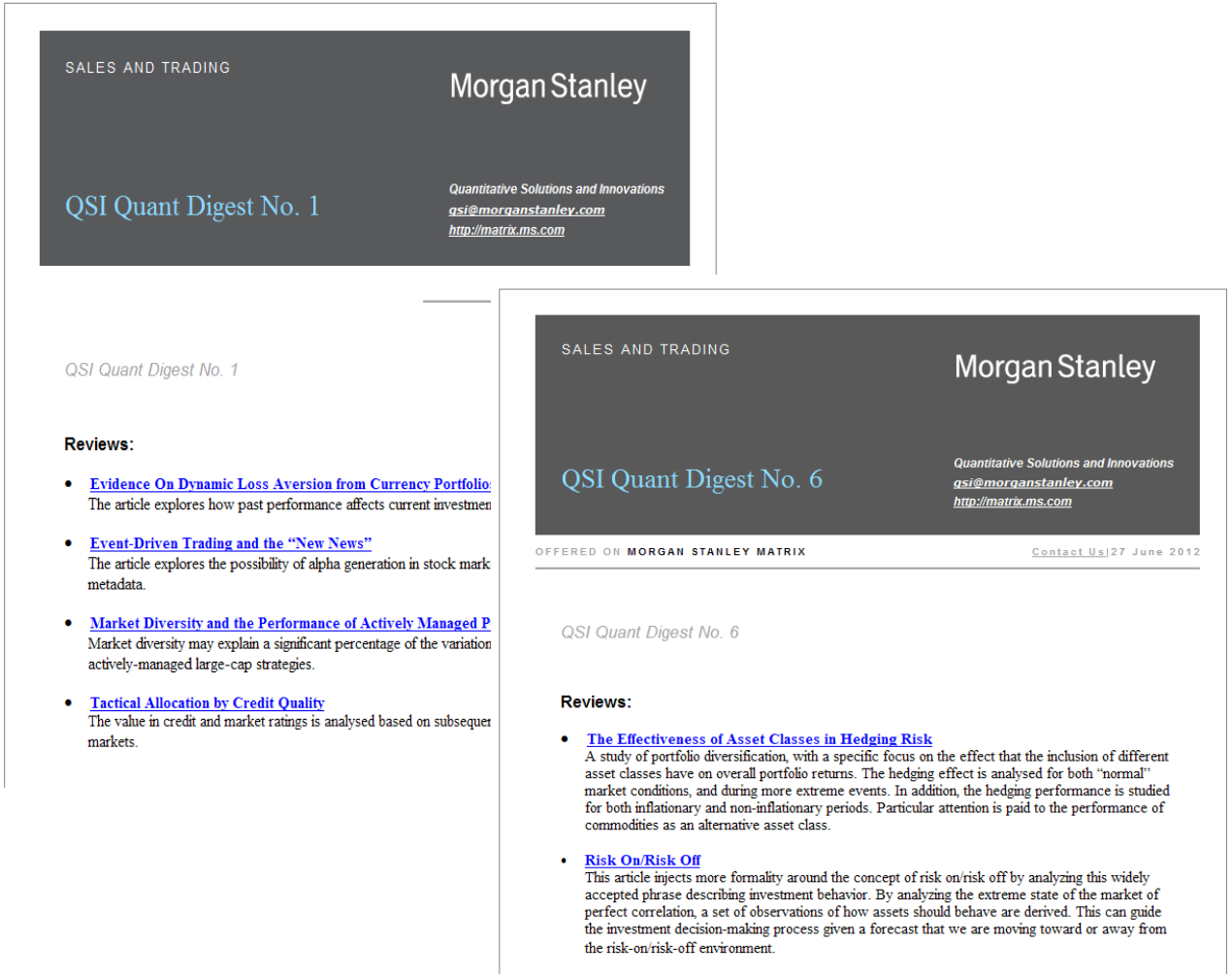
- Client facing quant group:
  - team of 5 professionals
  - located in NY, London and HK
- Cross-product focus
- QSI Mandate:
  - Provide tailor made quant solutions
  - Deliver products and services that can help our customers effectively and efficiently achieve specific investment, trading and performance objectives
  - Innovative and strategic analysis
  - Add value to our customers investment processes

Topics currently under investigation include:

- Volatility trading signals for FX & Rates
- Optimal delta hedging
- Enhanced momentum strategies
- Implied vs realised covariance
- Tail risk hedging
- High frequency price regime identification
- High frequency correlations and basket algo products
- Dynamic execution rescheduling with limits
- Govt bond intraday liquidity and algo strategies

Quant Digest

- Regular publication reviewing the academic literature to highlight relevant and interesting articles
- Journals included:
  - Journal of Portfolio Management
  - Journal of Derivatives
  - Journal of Risk
  - Quantitative Finance
  - Journal of Trading
- Circulated via email



SALES AND TRADING

Morgan Stanley

QSI Quant Digest No. 1

Quantitative Solutions and Innovations
qsi@morganstanley.com
http://matrix.ms.com

QSI Quant Digest No. 1

Reviews:

- Evidence On Dynamic Loss Aversion from Currency Portfolio
  The article explores how past performance affects current investmen
- Event-Driven Trading and the "New News"
  The article explores the possibility of alpha generation in stock mark metadata.
- Market Diversity and the Performance of Actively Managed P
  Market diversity may explain a significant percentage of the variation actively-managed large-cap strategies.
- Tactical Allocation by Credit Quality
  The value in credit and market ratings is analysed based on subsequer markets.

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Morgan Stanley

QSI Quant Digest No. 6

Quantitative Solutions and Innovations
qsi@morganstanley.com
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Contact Us | 27 June 2012

QSI Quant Digest No. 6

Reviews:

- The Effectiveness of Asset Classes in Hedging Risk
  A study of portfolio diversification, with a specific focus on the effect that the inclusion of different asset classes have on overall portfolio returns. The hedging effect is analysed for both "normal" market conditions, and during more extreme events. In addition, the hedging performance is studied for both inflationary and non-inflationary periods. Particular attention is paid to the performance of commodities as an alternative asset class.
- Risk On/Risk Off
  This article injects more formality around the concept of risk on/risk off by analyzing this widely accepted phrase describing investment behavior. By analyzing the extreme state of the market of perfect correlation, a set of observations of how assets should behave are derived. This can guide the investment decision-making process given a forecast that we are moving toward or away from the risk-on/risk-off environment.

Source: Morgan Stanley QSI

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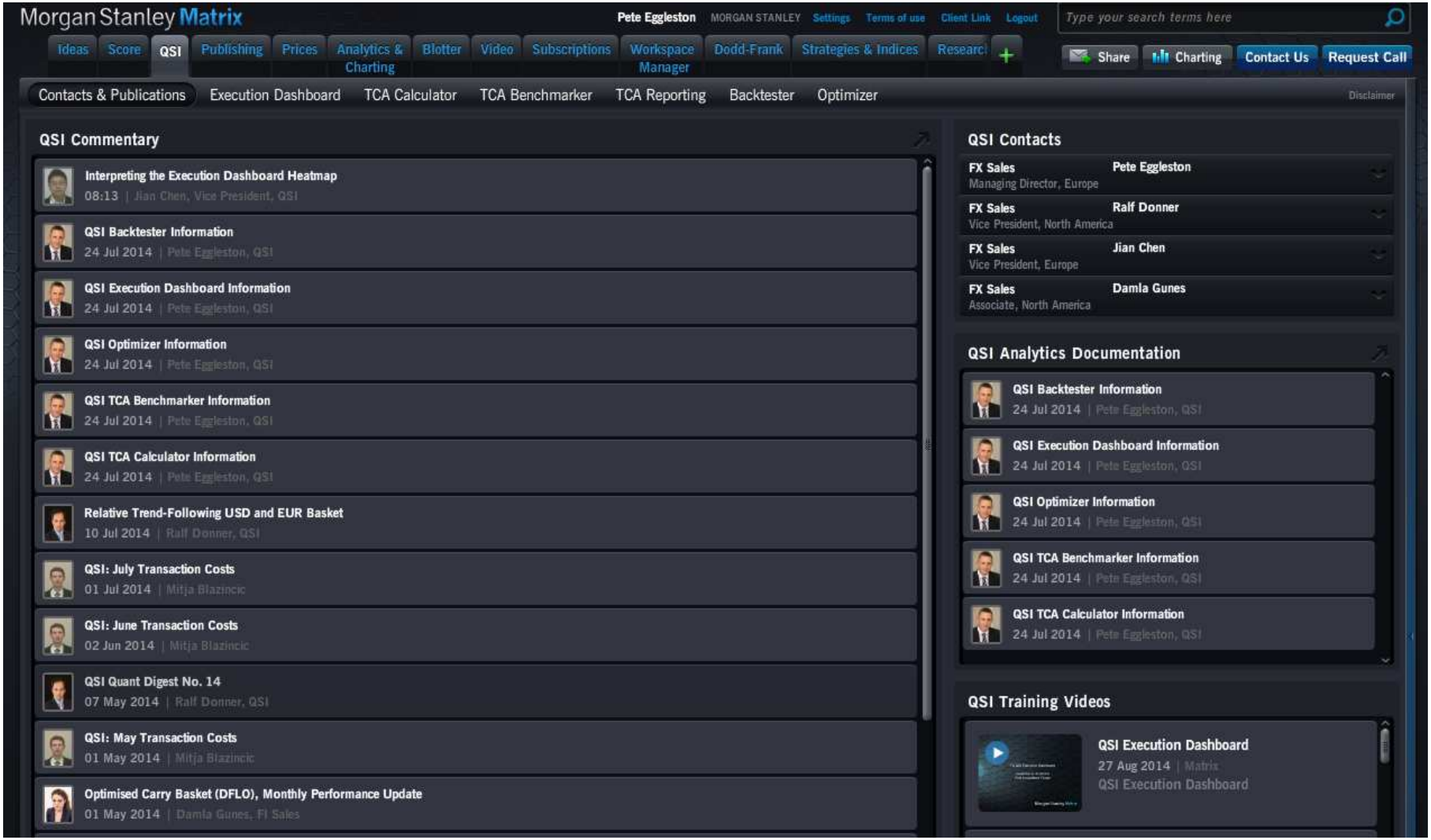
QSI on Matrix



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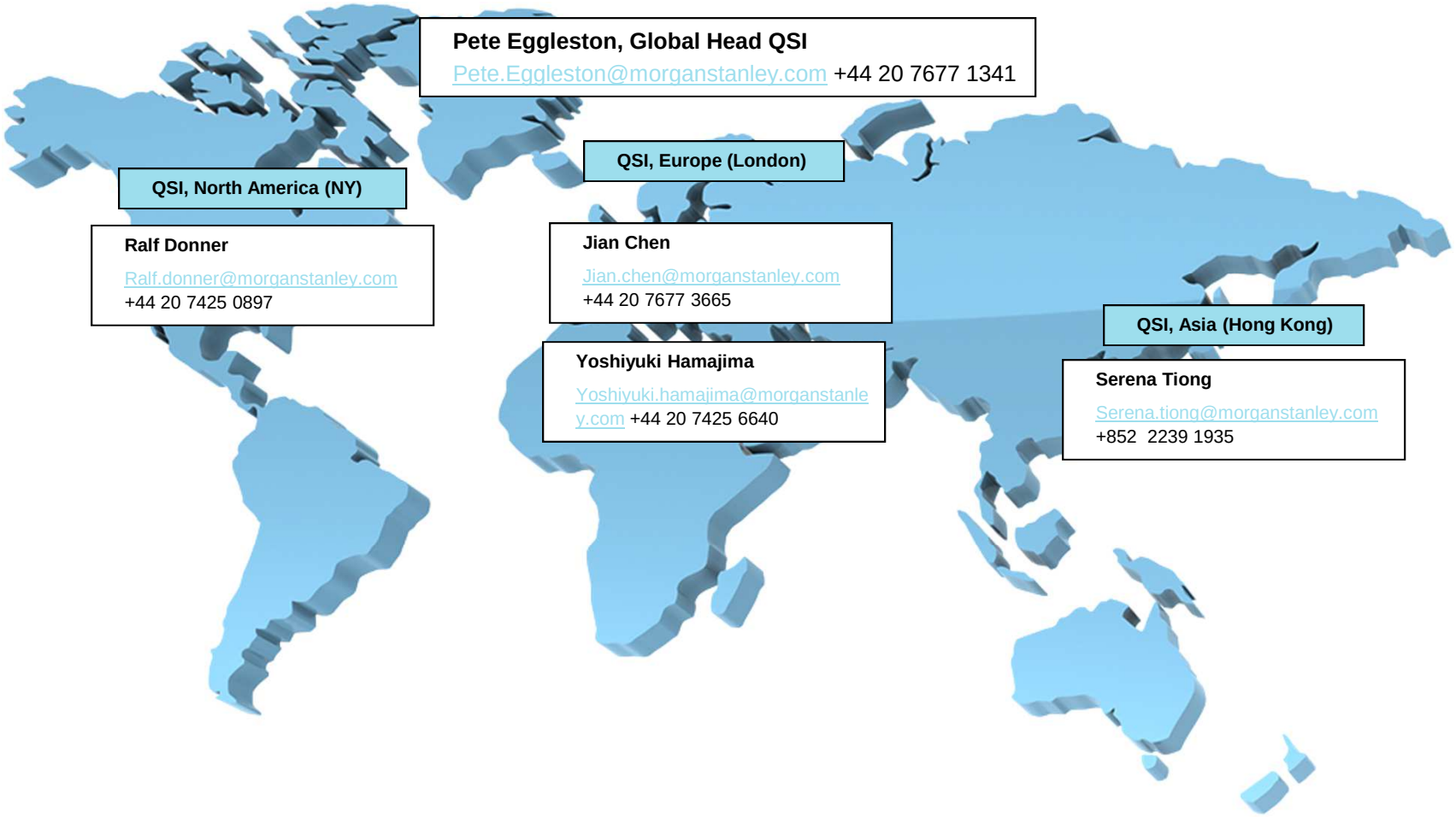
Contact Details
(qsi@morganstanley.com)



Pete Eggleston, Global Head QSI
Pete.Eggleston@morganstanley.com +44 20 7677 1341

QSI, North America (NY)

Ralf Donner
Ralf.donner@morganstanley.com
+44 20 7425 0897

QSI, Europe (London)

Jian Chen
Jian.chen@morganstanley.com
+44 20 7677 3665

Yoshiyuki Hamajima
Yoshiyuki.hamajima@morganstanley.com +44 20 7425 6640

QSI, Asia (Hong Kong)

Serena Tiong
Serena.tiong@morganstanley.com
+852 2239 1935

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