

## Risk Premia in Volatility Markets: Exploiting Volatility Spillover and Clustering

- We find that we can enhance the performance of volatility carry strategies. These carry strategies exploit the difference between implied and realized volatility via trading variance swaps, delta-hedged straddles or similar payoffs.
- We improve their performance by accounting for the fact that volatility is persistent (clustering) and that different volatility markets are interconnected (spillover).
- These results apply to international equity markets and across asset classes and are robust to different estimates of volatility risk premium based on past realized and implied volatilities.

### Opportunities in volatility markets

Many investors looking for yield believe that there are currently **opportunities in equity volatility carry**. These carry strategies exploit the spread between implied and realized volatility by trading variance swaps, volatility swaps or delta-hedged straddles for instance. Many investors are now attracted to these strategies as the spread between implied and realized volatility has been large over the past year. However, other investors believe both implied and realized volatility are too low now given the potential downside risks that the global economy still faces. These two views summarize the main characteristics of carry strategies in the volatility space: **potentially large premia in good times but a likelihood of large losses when volatility spikes**, as these spikes can be quite significant.

**While spikes in equity volatility are not easily predictable, the effect of these spikes can be minimized** if we consider clustering and spillover, two of the main features of market volatility. **Clustering** implies that whenever volatility is above (below) average it is more likely that volatility will remain higher (lower) than average. The **spillover effect** implies that after an increase in volatility in one particular market, it is more likely that volatility will remain higher than average in related markets. Additionally, we can take advantage of structural differences across volatility markets due to different supply and demand profiles.

Here we show the benefit of **implementing strategies that continuously monitor the level of volatility premium and account for contagion** from one volatility market to others. We consider different ways of estimating the volatility risk premium, i.e. the expected difference between implied and future realized volatility, using the recent values of both implied and realized volatility. We also use forecasting models or trading rules that account for the interconnection between the volatility premium in different markets. We assume the premium in a particular market is persistent and a function of the past realization of both implied and realized in that market and also in related markets.

Here we show **evidence of volatility clustering and spillover in equity markets and also in other asset classes**, which is consistent with previous studies. We also **discuss the reasons why there is a volatility risk premium and how it changes over time** and study the importance of local and common risks in short volatility strategies.

A strategy which selects in which market to go short volatility and whether to go short, based on an econometric model that forecasts the probability of a positive risk premium, **outperformed simply being short S&P 500 volatility** by nearly 5%

#### Ruy Ribeiro<sup>AC</sup>

(44 - 20) 7134- 0626  
ruy.m.ribeiro@jpmorgan.com  
J.P. Morgan Securities plc

#### Marko Kolanovic

(1 - 212) 272 - 1438  
mkolanovic@jpmorgan.com  
J.P. Morgan Securities Inc.

#### Davide Silvestrini

(44 - 20) 7134- 4082  
davide.silvestrini@jpmorgan.com  
J.P. Morgan Securities plc

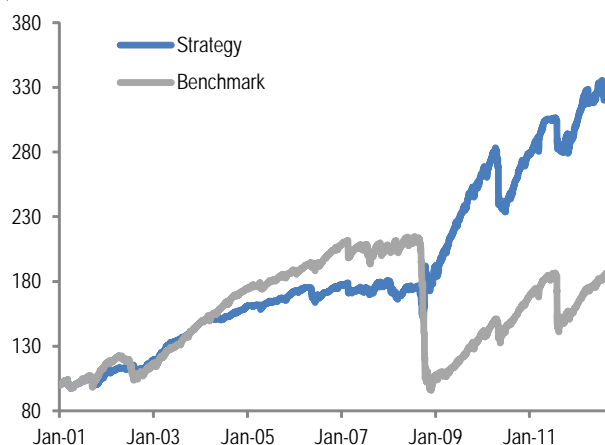
#### Tony Lee

(852) 2800 - 8857  
tony.sk.lee@jpmorgan.com  
J.P. Morgan Securities (Asia Pacific) Ltd.

The certifying analyst is indicated by an <sup>AC</sup>. See page 15 for analyst certification and important legal and regulatory disclosures.

[www.morganmarkets.com](http://www.morganmarkets.com)

**Chart 1: Exploiting Persistence and Spillover in Equities Markets**  
excess return index, (US, Europe and Japan)



Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs. These calculations are based on the model (described later on) where we trade US, Europe or Japan variance swaps based on the probabilities of a positive premium. Probabilities are based on a limited dependent variable model where probability of a positive premium depends on past values of realized and implied volatility in all the markets. Compared to a benchmark that is always short S&P 500 volatility with daily overlapping variance swaps.

annualized since 2001 (Chart 1). This outperformance is due to both the ability to rotate between markets and to underweight the position if the volatility premium (estimated using past realized and implied volatility) is not clearly positive.

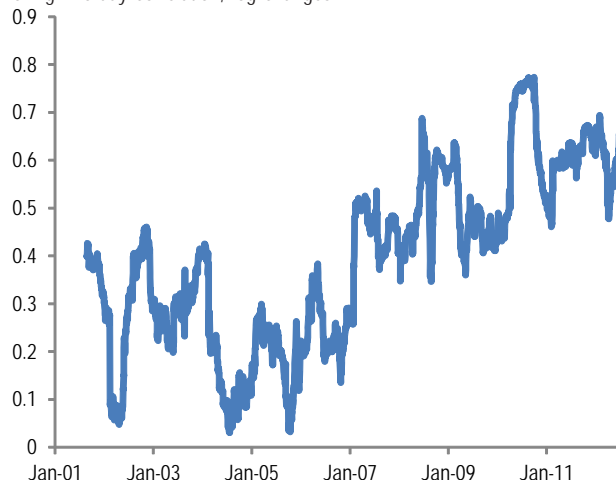
We take one step further and consider the **possible spillover between equities and other asset classes**. Here we focus on the interaction between equities and currency markets. But similar logic applies to other asset classes, particularly for markets that have a strong correlation (negative or positive) to equities (see Chart 2 for correlation between implied volatility in FX and Equity markets). Consistent with previous studies on volatility spillover between equities and FX, we find that it is possible to enhance a short FX volatility strategy if we use information on the past realized and implied volatilities of both FX and Equities.

The rest of the paper is organized as follows. First we review the reasons why there is a volatility/variance risk premium and why it varies over time. Second, we analyze the common and country-specific risks in short volatility positions. Third, we test volatility spillover in US, European and Japanese markets both in terms of realized volatility, implied volatility and their premium. Finally, we build strategies that exploit the spillover effect and time variation in the risk premium both with equities only and with equities and currencies.

## Volatility Risk Premium: why and when?

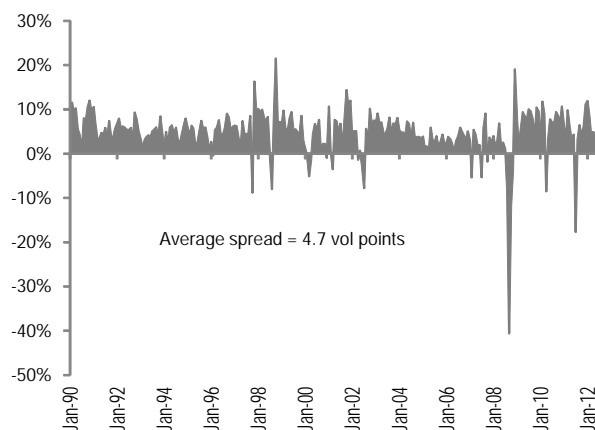
Equity index implied volatility tends to trade at a premium to subsequent realized volatility. Chart 3 shows the spread of 30-day S&P 500 implied volatility, as measured by the VIX index, to the subsequent 1M realised volatility of the index,

**Chart 2: Correlation between Equity and FX Implied Volatilities**  
Rolling 126-day correlation, log changes



Source: J.P. Morgan, Bloomberg. Currency pairs: EURUSD, USDJPY and EURGBP. Equities: Eurostoxx, S&P 500 and Nikkei. Currency is equally-weighted average of the implied volatility of the currency pairs, and Equity is equally-weighted average of the implied volatility of the equity indices.

**Chart 3: S&P 500 1M Implied vs 1M Realized Volatility Premium**



Source: J.P. Morgan, Bloomberg.

which has averaged 4.7 volatility points since Jan-1990.

**The volatility risk premium exists to compensate option traders for the risk they take in making a market in volatility.** In fact, market makers typically delta-hedge their option positions and have profit/losses linked to the difference between the implied volatility of the option they traded and the subsequent realised volatility of the index, rather than to the return of the index.

**When volatility levels are low, the volatility premium is typically elevated.** This fact is only apparently unintuitive once we consider the general dynamic behavior of volatility, which is to spike to the upside and revert to lower levels. The risk for an option market maker is therefore strongly skewed in one direction when volatility is low, as a surge in

volatility is much more likely than a large fall. The volatility risk premium reflects the asymmetric nature of the risk that option market makers are taking. In other words, short implied volatility positions can lead to infrequent but large losses, and risk averse traders require compensation for this risk (which is non-diversifiable and concentrated among few market players), therefore making the average volatility risk premium positive.

**When volatility is elevated (e.g. following a market crash) implied volatility often trades below short-dated realised volatility.** This low or even negative risk premium reflects the fact that the possible outcomes are more balanced, as sharp declines in realised volatility are substantially more likely when the volatility levels are high.

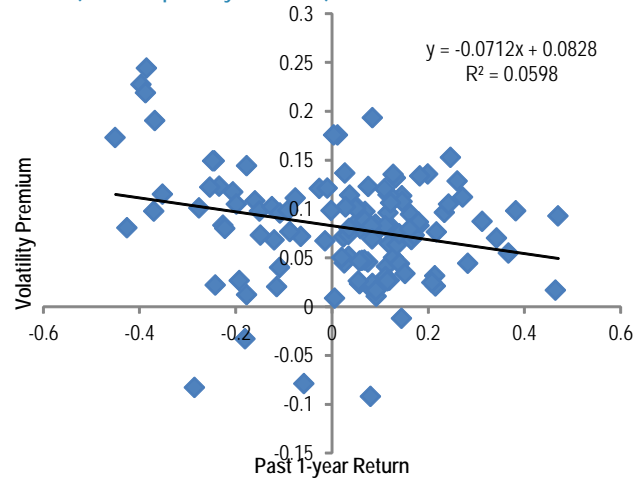
**Option supply and demand dynamics also affect the size of the volatility risk premium.** For example, in a market where investors are on aggregate net buyers of index options, market makers will on average be net short volatility. Having all a similar position, market makers will have reduced their ability to cover their volatility shorts, should markets correct, thus making the trade riskier and leading to a widening of the volatility premium.

In addition, the overall net short or long position of option market makers will also have another impact on realised volatility, as the market maker's **dynamic delta hedging activity will impact the realized volatility of the index.** This is referred to as 'gamma effect' ('gamma' describes how much the option delta changes with the index level) and has been discussed in detail in Kolanovic, M., *Market Impact of Derivatives Hedging*, J. P. Morgan, 2008.

**The implied volatility risk premium is a measure of the perceived risk that realized volatility will turn out to be higher than currently estimated.** It reflects the behaviour of volatility (mean reversion and propensity to spike), but also the perceived risk linked to an event. As the supply/demand dynamics and perception of idiosyncratic or event risk typically differ from market to market and across time, **different markets can display very different volatility risk premia** (different levels, but markets can be interconnected as we will discuss later). See Box 1 for a discussion on the Japanese market that illustrates how different market characteristics may affect volatility markets in general.

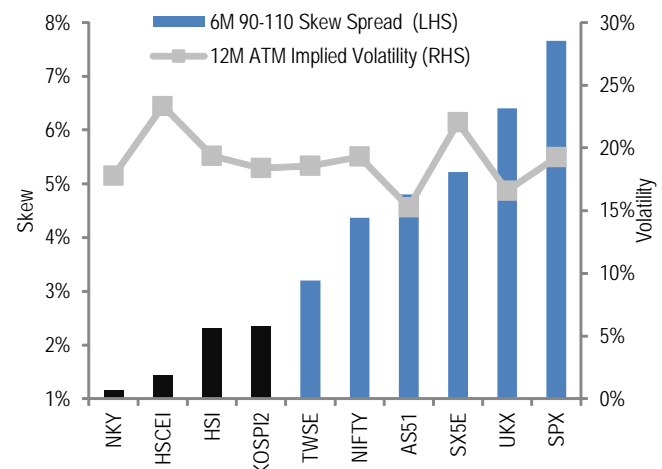
The implied volatility risk premium provides a potentially attractive source of returns for investors, but the risk of a sharp and unexpected loss is all very real, making risk management in short volatility positions an absolute necessity. But these risks are the reason that this risk premium can be attractive and why it varies over time. As we

Chart 4: S&P 500 Volatility Premium conditional on previous market moves (S&P 500 past 1-year return)



Source: J.P. Morgan, Bloomberg. Volatility premium based on Implied Volatility and 2-day Range Volatility. Only end of month data to make chart clearer, but results are similar for daily. Note that short lookbacks such as 1 month would lead to positive slopes. This is due to the short-term relationship between volatility and returns as discussed in Ribeiro and di Pietro, *Volatility Signals for Asset Allocation*, J.P. Morgan, 2008.

Chart 5: Skew across International Equity Markets



Source: J.P. Morgan, Bloomberg.

mentioned before, one of the empirical facts is that the premium tends to be higher after market losses (Chart 4) as market players look more actively for protection after they suffer losses, which changes the supply and demand balance.

## Volatility Risk Premium: Common and Country-Specific Risk

**Most of the movements in volatility and/or risk premium are common to multiple markets.** In an analysis of the three main markets (US, Europe and Japan), we find that the average correlation of the monthly changes in implied volatility is around 0.75. The same analysis for daily changes delivers a lower level of commonality implying that (i) most of the changes in volatility are of a global nature, but (ii) there are short-term deviations that do not persist (alterna-

### Box 1: Volatility markets in Japan

The peculiarities of the structured products market in Japan have been a major factor influencing Japanese equity volatility. Driven by the hunger for yield under a prolonged low interest rate environment, domestic retail investors flock to equity-linked structured notes for income generation, which offer considerably higher yield than fixed deposits but with a higher possibility of capital being at risk.

Structured products, notably those sold in the uridashi market, tend to be very homogenous, with a limited range of structures and underlyings representing the vast majority of the volume. The most common product being sold is the "auto-callable", also known as equity gain knock-outs (EGKs), linked to Nikkei, with maturities typically ranging from 3 to 5 years. The product is suitable for investors with a range bound view. Investor is essentially long a bond with a coupon that is funded by selling of an ATM put option with a down-and-in (DI) barrier of 50% to 70% of initial spot and / or an up-and-out (UO) barrier of 100% to 110% from initial spot, or a combination of both.

Due to the embedded put selling features for yield enhancement, investment banks supplying the EGKs are effectively buying options from the retail investors. The heavy issuance activities have resulted in EGKs becoming the most significant source of volatility supply in Japan. As the banks look to manage these positions, their collective hedging tends to suppress market volatility and skew. Without a consistent stream of demand from institutional investors buying options for hedging or directional purposes, the volatility supply and demand imbalance caused by the EGK issuance can persist for an extended period of time. Hence, it is not surprising to find that in Japan and other Asian equity markets with active structured product issuance, skews tend to be among the lowest in the world (see Chart 5, previous page).

Although heavy EGK issuance and related hedging initially suppress volatility and skew, the product vega concentration and discontinuity from the DI and UO barriers can provide volatility catalysts to the equity market. During sharp market sell-offs, if a put option is knocked-in, it is already deep in-the-money, hence there would be large discontinuity on the downside. Though discontinuity on the upside is generally smaller, the value of the put option lost in the case of the knock-out event can be large if the product is still far from maturity and volatility is high.

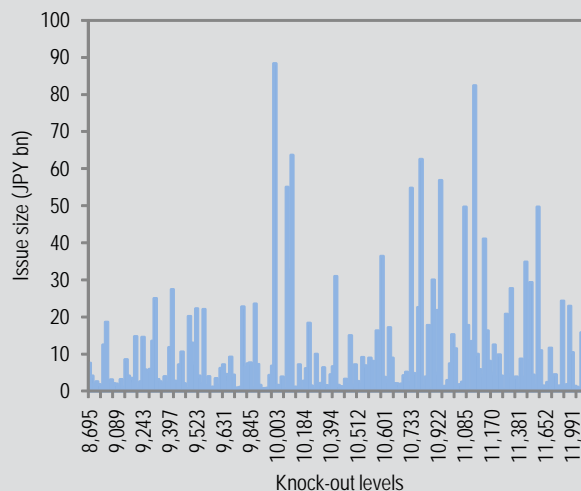
The delta of the knock-in put becomes more negative as it approaches the barrier and hence the Nikkei-linked EGK issuers would have to buy more index futures to hedge as the barrier approaches. However, as the barrier is breached the knock-in put becomes a vanilla option that is very much in the money.

With less negative delta exposure, the product issuers have to reduce their delta hedge quickly by selling index futures.

To hedge the long vega exposure from EGK issuance, the issuers have generally shorted volatility and skew. When the structure becomes knocked-in on the downside, the knock-in put becomes a vanilla option that is very much in the money with very little vega exposure. As a result, the issuers are forced to buy back their short volatility positions to re-hedge.

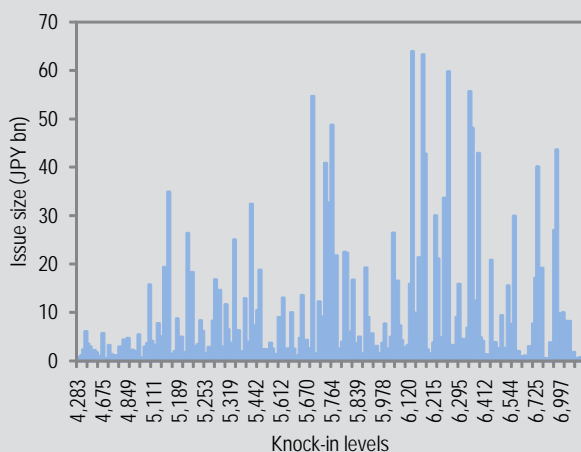
Charts 6 and 7 illustrate the concentration of the UO and DI barriers of the currently outstanding Nikkei-linked EGKs (data available in Nov 08 2012). We see that the current Nikkei level (around 9000) is far from those DI barrier levels (i.e. below Nikkei level of 7000), although the peak vega exposures from the EGKs are estimated to be slightly above 7000. On the upside, the risk of the UO barriers does not appear very significant until Nikkei reaches near the level of 10000.

Chart 6: Concentration of the UO barriers



Source: J.P. Morgan, Bloomberg.

Chart 7: Concentration of the DI barriers



Source: J.P. Morgan, Bloomberg.



tively, there are spillover effects, as we will discuss later on). A similar pattern applies to realized volatility independently of the measure. Above we looked at the correlation of the changes, but the correlation of the level of the implied (or realized) volatility is much higher in the 0.80-0.90 range.

But there is **important idiosyncratic variation in volatility**. In the case of the Japanese market, we find that 49% of the variation in implied volatility is due to idiosyncratic variation. This calculation is based on a contemporaneous regression of the log changes in Japanese implied volatility on the equivalent variables for the European and US markets. To be clear, that does not imply that 49% of the changes are Japan-specific, as they can be common to other Asian countries. Thus, there may be information that is common to other markets in those residuals. They are just not common to the US and Europe. (We will test that idea later on). Also, note that residuals are negatively serially correlated (-0.17). We tend to see large negative residuals after large positive ones, as in the case of events such as the 2011 Tohoku earthquake. This is consistent with the view that most of the deviations are short-term and that there may be spillover effects.

### Volatility Spillover and Clustering: can we forecast drawdowns in variance swaps?

In this section, we analyze the autocorrelation/persistence/clustering of different volatility measures, but we also introduce the possibility that there is cross autocorrelation (spillover) between markets. We focus on the US, Europe and Japan using data since 2001.

In economic terms, we **test whether there are spillover effects between markets** in the sense that a change in any of the measures of volatility/variance (realized volatility, implied volatility, ex-ante and realized premium) in a particular market today implies a move in the same direction later in all other related markets<sup>1</sup>.

At the same time, we **test the persistence of these volatility measures, i.e. their serial correlation or clustering**. In the specific case of the volatility premium, we test if changes in the volatility premium in a certain market have any effect in the same direction on the future level of volatility in another market or the same market.

These linkages in volatility markets have been analyzed exhaustively in the academic literature and we do not aim to

### Box 2: Measuring Volatility

We considered the following measures:

- **Measures of Realized Volatility:**

1) Average Daily Squared Returns: Standard measure. We considered both 30-calendar day or 21-business day daily squared returns. We use the square root of that calculation.

2) Range Volatility: There are many types of range-based volatility that we considered from the traditional Parkinson (based on high and lows only) and Garman-Klass (also account for open and close levels) to other methods that try to address downward biases of the above measures in the presence of drift and jumps. We leave these variations for the reader and focus on one particular model. We use the Yang-Zhang estimator (Yang and Zhang (2000)) which is a price range estimator that is unbiased, independent of any drift, and consistent in the presence of opening price jumps. We use a 10-day window.

- **Measures of Implied Volatility:**

1) Average Implied Volatility: to minimize the effect of outliers/noise, we also compute monthly rolling averages (Average 30-calendar day or 21-business day). This measure matches the same range of days used to estimate the relevant measure of realized volatility (Average 30-calendar day or 21-business day Daily Squared Returns).

2) Lagged Implied Volatility: we use the 30-calendar day or 21-business day lagged value.

review the literature here<sup>2</sup>. We test spillover and clustering using three different measures: implied volatility, realized volatility and the volatility premium<sup>3</sup>.

1 In econometric terms: In the cross-country case, if a particular volatility measure in country  $i$  Granger-causes the same volatility measure in country  $j$ , but with a positive direction and not any direction.

2 The main differences in approach are that: a) we do not use GARCH-like models or multivariate versions; b) we focus on the implications for the trading of variance swaps and related instruments. Therefore, we want to forecast squared daily returns even if they are not the best measures of realized volatility (in terms of efficiency, relative to range volatility measures for instance). However, we consider both past daily squared returns and past range-based volatility measures when forecasting future volatility (we ignore models based on intraday pricing here).

3 Note that finding that both implied and realized volatilities are persistent and that they present spillover effects does not necessarily imply that the premium (difference between implied and realized) will also have the same properties. It is possible that implied and realized share a common persistent component, while the difference is not persistent at all. Empirically, we do find that the difference (premium) is persistent as well.

**Table 1: Implied Volatility - Vector Autoregression**

regression coefficients and t-stats, constants are not reported

	VIX(t)	VSTOXX(t)	VNKY(t)
	Daily		
VIX(t-1)	0.81	0.26	0.55
(t-stat)	5.27	1.70	2.31
VSTOXX(t-1)	0.01	0.70	-0.15
(t-stat)	0.17	7.12	-1.44
VNKY(t-1)	0.01	-0.13	0.43
(t-stat)	0.13	-1.74	3.99
R-sqr	0.67	0.67	0.60
	Monthly		
VIX(t-1)	0.66	0.13	0.56
(t-stat)	4.99	0.88	3.10
VSTOXX(t-1)	0.11	0.82	-0.17
(t-stat)	1.26	8.03	-1.36
VNKY(t-1)	0.00	-0.16	0.41
(t-stat)	0.03	-1.57	3.28
R-sqr	0.73	0.73	0.59

Source: J.P. Morgan, Bloomberg. We use 21-day lagged info on both cases. We also tested the monthly case using end-of-month data only. We also tested Granger causality in that case and found that VIX Granger-causes all three indices at a 10% level.

We first consider a VAR approach<sup>4</sup> using both implied volatility and measures of realized volatility, so we estimate a vector autoregressive model with our three selected countries. We present the results of monthly and daily VAR's. By using monthly regressions, we minimize the effect of different time zones in our analysis.

Table 1 presents the results for implied volatility. Overall, we find coefficients that are **consistent with positive autocorrelation (persistence) in the changes in implied volatility and also positive cross autocorrelation (spillover)**, even though the interaction between Europe and Japan is not consistent.

**Table 2 presents the results when using realized volatility instead, showing that we do find some spillover effects.** In the case of realized volatility, we present the results using measures based on Yang-Zhang range volatility using 10-day windows<sup>5</sup>. We find similar results when using other volatility measures, but these are not reported here. We do not find a strong effect coming from Japanese volatility in the full sample.

<sup>4</sup> VAR (Vector Autoregression) is a statistical model used to capture the linear interdependencies among multiple time series, where the evolution of each series depends on the past realizations of the same variable and other variables in the system. We use VAR(1) here implying that only one lag is used.

<sup>5</sup> There is no overlap in the data used to compute lagged and forward volatility in the monthly regressions. There are no biases in our monthly tests, but standard errors can still be biased in daily regressions. In order to address these concerns, we use Newey-West adjusted standard errors.

**Table 2: Range Volatility - Vector Autoregression**

regression coefficients and t-stats, constants are not reported

	US(t)	Europe(t)	Japan(t)
	Daily		
US(t-1)	0.22	0.21	0.11
(t-stat)	1.60	1.30	0.74
Europe(t-1)	0.44	0.59	0.26
(t-stat)	5.38	5.83	4.29
Japan(t-1)	0.12	-0.13	0.19
(t-stat)	1.37	-1.04	1.69
R-sqr	0.61	0.45	0.39
	Monthly		
US(t-1)	0.39	0.36	0.26
(t-stat)	3.38	2.26	2.19
Europe(t-1)	0.32	0.58	0.17
(t-stat)	4.64	6.01	2.44
Japan(t-1)	-0.01	-0.28	0.12
(t-stat)	-0.11	-1.58	0.96
R-sqr	0.56	0.48	0.39

Source: J.P. Morgan, Bloomberg. Based on Yang-Zhang range volatility estimates using 10 business days.

**Table 3: Forecasting Volatility Premium - Selected Model**

regression coefficients and t-stats, constants are not reported

	US(t)	Europe(t)	Japan(t)
	Daily		
US(t-1)	0.42	0.51	0.44
(t-stat)	2.57	5.45	1.52
Europe(t-1)	0.18	0.08	0.11
(t-stat)	1.80	0.97	0.88
Japan(t-1)	0.04	-0.09	0.25
(t-stat)	0.33	-1.56	1.31
R-sqr	0.12	0.14	0.14
	Monthly		
US(t-1)	0.59	0.93	0.40
(t-stat)	3.26	6.04	1.83
Europe(t-1)	0.19	-0.04	0.01
(t-stat)	1.30	-0.36	0.07
Japan(t-1)	-0.06	-0.26	0.36
(t-stat)	-0.41	-2.11	2.06
R-sqr	0.13	0.23	0.13

Source: J.P. Morgan, Bloomberg. Premium is measured as the difference between implied volatility at the beginning of the period and the average squared daily returns over the next month. Regressors are based on the monthly average of the implied volatility and range volatility computed using 10 business days.

**Table 4: Correlation between Realized and Forecast Vol Premium**

Daily models

	Average Implied	Lagged Implied
Range Volatility	0.37	0.32
Squared Returns	0.29	0.28

Source: J.P. Morgan, Bloomberg.

Interestingly, we also find similar, but weaker, pattern for the volatility premium. In the case of the volatility premium, we change the set of explanatory variables and depart from the VAR framework. While the left-hand side of the equation should represent the payoff of an actual strategy (payoffs are usually based on realized squared daily returns or similar), it may still be best to measure the ex-ante premium using range-based measures or measures that include more granular intraday price information.

Table 3 shows the results for our selected model, indicating that, also for the volatility premium, **there may be useful information in the past volatility premium in other countries** (particularly from the US).

**Overall, all the models are useful in forecasting future volatility premia.** Table 4 shows the range of correlation between fitted and actual realized premia (the square roots of the regression's R-squares, the average of the three regressions) obtained with different forecasting models for daily observations. We look at all the combinations of measures as described in Box 2.

We should note that the models above are trying to forecast the precise level of the volatility premium. This is challenging as coefficients may become distorted due to extreme events. From a trading point of view, it is more important to forecast the sign of the premium than the level itself. Below we will focus on estimating the probability of a positive premium and not on its level.

## Exploiting Volatility Spillover and Clustering

Given the empirical evidence of spillover and persistence/clustering, we can now design strategies that exploit these features. Therefore, we introduce the following modifications to a traditional short volatility strategy:

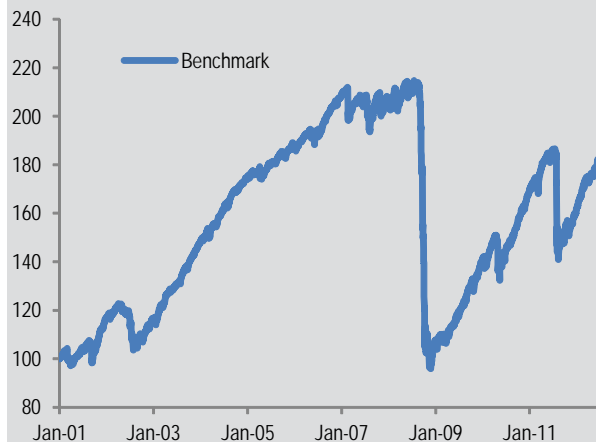
- **Frequent monitoring and trading:** instead of trading once a month and praying for nothing to happen over the next 30 days as in the case of a single variance swap, we will use overlapping positions<sup>6</sup>, trading a fraction of the notional invested every day (rebalancing fully over the course of the month).
- **Conditional on the expected premium:** we only go short volatility at any day if the probability of a positive realized premium over the next 30 days is larger than a pre-

<sup>6</sup> Note that using overlapping positions on a daily basis per se does not add value as our benchmark already has that feature (Box 3), but the combination of these two features does add value as we respond to changes in the expected premium more effectively.

### Box 3: Short Volatility Benchmark

In our analysis, we compare returns of our strategies to the ones of a benchmark short volatility strategy. In our strategies, we exploit two features: a) time variation in risk premium; and b) spillover effects. So our benchmark will ignore both features by being systematically (always) short volatility and by focusing only on one market (US market). Chart 8 shows the payoff of our benchmark based on a transparent calculation methodology (using VIX Index to determine the strike). Every day, we go short this synthetic 30-day S&P 500 variance swap. The sizing of the position is such that we fully rebalance our allocation over the course of a month (1/20 of the allocation is implemented everyday, with same vega). The performance chart has some features to note: large losses after the Lehmann debacle and in 2011; decreasing return from 2001 to 2007 as the curve looks concave (lower return near 2007 than earlier); and steep premium after large losses (steeper after large losses in 2008).

Chart 8: Synthetic Short S&P 500 Variance



Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs. Excess Returns

determined level (for example, 85%), doing nothing otherwise. An example of long-short version is to go short if the probability of a positive premium is larger than 85%, go long volatility if the probability is less than 65% and do nothing otherwise. In this case, there is a neutral region between 65% and 85% where we do not trade that day. We want to make sure the probability of a positive premia is high, as losses can be quite high in magnitude.

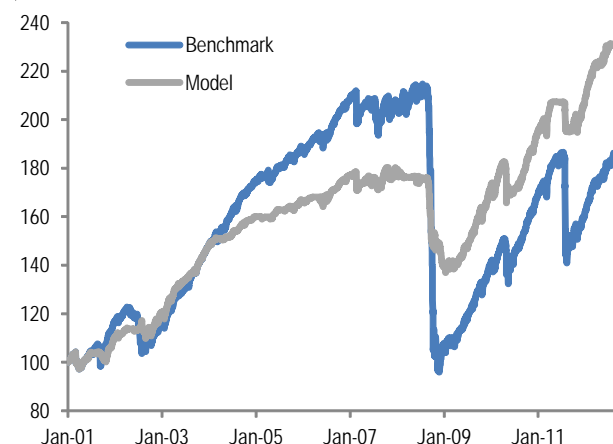
How do we estimate these probabilities? In the previous section, we considered a model where we estimate the future realized premia for each country based on forecasting variables from all three countries analyzed here. We do not change the right-hand side of the equation but replace the left-hand side with 0's or 1's where the dependent variable becomes 1 if the realized premium is positive and 0

**Table 5: S&P 500 Short Volatility vs Predictive Model**  
Summary Statistics

	S&P Short Vol	S&P Vol (Predictive model)
Avg Excess Return	5.3%	7.2%
Standard Deviation	13.7%	6.6%
Sharpe Ratio	0.39	1.09
T-stats	1.34	3.78
Correlation (S&P 500)	0.59	0.40
Max Drawdown	-55.3%	-24.0%

Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs. Sharpe ratio is not necessarily a good performance measure due to the convexity of the payoff, but it is useful for comparison across models.

**Chart 9: Performance of S&P 500 Short Volatility vs Model**  
Excess Return Index



Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs.

otherwise. This is what is called a limited dependent variable model, where the dependent variable is 1 if the realized premium is positive and 0 otherwise. We do not present results with Probit or Logit models here, but they are also alternatives.

To make sure the strategy is feasible, we re-estimate the model everyday using only information prior to each day. Therefore, we never use future information to estimate regressions. We use the estimated parameters (with the appropriate lag) and the actual past realizations of the independent variables to compute the predicted probability for the coming month at each point in time.

Given this forecasting model, everyday we have an estimated probability of a positive premia for each country for the coming 30 calendar days. Hence, we can use these estimates to build trading strategies.

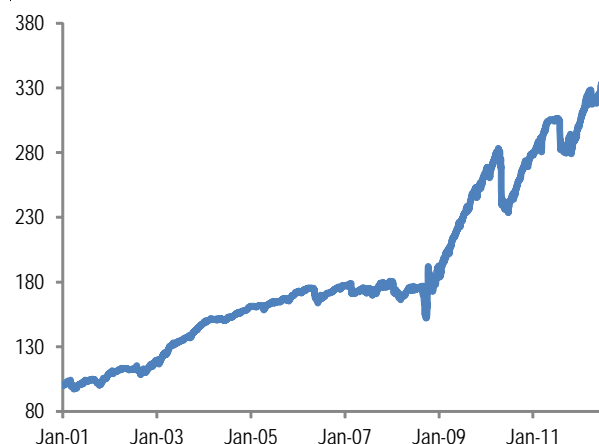
In order to test this strategy, we will **trade on publicly available data** using implied volatilities as an indication of

**Table 6: International vs US Model**  
Summary Statistics

	US Only	US, Europe and Japan
Avg Excess Return	7.2%	10.2%
Standard Deviation	6.6%	8.6%
Sharpe Ratio	1.09	1.19
T-stats	3.78	4.14
Correl (MSCI World)	0.35	0.23
Max Drawdown	-24.0%	-17.4%

Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs. Sharpe ratio is not necessarily a good performance measure due to the convexity of the payoff, but it is useful for comparison across models.

**Chart 10: Trading US, Europe and Japan**  
Excess Return Index



Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs.

the actual variance swap quotes as these are bank-specific OTC quotes. We ignore the differences between these two measures (ignoring skew, for example), but our analysis based on JPM internal variance swap quotes lead to similar qualitative results. In order to evaluate performance, we also use transparent and publically available implied volatility levels and compare those to the realized volatility over the next 30 calendar days according to swap conventions.

### Trading S&P500 volatility on spillover

**First, we test the spillover idea trading only one market (S&P 500) but we use all countries to estimate the probability of a positive premium.** We compare this new model to the benchmark version that is always short US volatility (Box 3). Chart 9 shows that our S&P 500 volatility premium model outperforms the benchmark case. Table 5 shows the performance statistics of both strategies.

**We manage to improve average returns while reducing the volatility and the drawdowns of the strategy.** This strategy will be more conservative than a pure strategy that is always



Table 7: Simpler Rules

Summary Statistics

	Rule 1 (largest deviation)	Rule 2 (common conditions)
Avg Excess Return	12.4%	10.2%
Standard Deviation	9.9%	8.5%
Sharpe Ratio	1.25	1.21
T-stats	4.34	4.19
Correlation (MSCI World)	0.22	0.15
Max Drawdown	-21.7%	-12.2%

Source: J.P. Morgan, Bloomberg. Sharpe ratio is not necessarily a good performance measure due to the convexity of the payoff, but it is useful for comparison across models.

short volatility, so it will tend to underperform in ex-post “bullish” periods.

In these calculations, we apply a rule that is short volatility if the probability of a positive premium is above 85%, but goes long volatility if it is lower than 65%. If we are between those two levels, we do nothing that day. Note that results are robust to changes in both cut-off points. Note that the choice of 85% was not arbitrary as it is roughly the average probability of a positive premium.

### Trading US, European and Japanese volatility

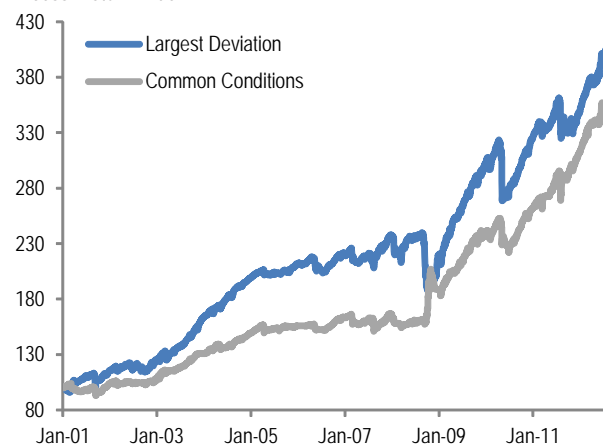
Second, we look at a **version of the strategy that can trade all markets**. This generalized version goes short the market (US, Europe or Japan) with the highest probability of a positive premium (or goes long the one with lowest probability of a positive premium). We choose the position that is the most extreme.

For example, let us assume that our benchmark probability is 75%, which was the mid-point of the S&P 500 volatility strategy analyzed before. Let us also assume that the US market has a probability of a positive premium of 90%, Europe has a probability of a positive premium of 30% and Japan is 60%. Hence, we choose to trade Europe as the 30% probability is the most extreme relative to 75%. Obviously we will be long volatility in Europe as the probability of a positive premium is very low. The larger difference relative to the benchmark probability may imply that the information in this particular market is more significant in some sense.

We manage to **improve performance even further by adding additional markets** (Chart 10 and Table 6). All performance statistics improve with the exception of the volatility of the strategy. The main reason we manage to improve the

Chart 11: Performance of Simple Short Volatility Strategies

Excess Return Index



Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs.

performance is that we increase the dispersion in the range of premia (in part due to structural differences).

### Two Simple Rules

Third, we look at **simpler versions of this idea that do not depend on any parameter estimation**, avoiding regression models. We estimate the volatility premium for each market independently using the measures described in Box 2, so that the volatility premium is a function of the recent spread between implied and realized volatilities. However, we use a rule that considers the interaction between markets. The main advantage is that we reduce the potentially large impact of estimation error, but not without a cost as we ignore the actual relationship between each market.

We considered two simple (not simplistic) rules:

#### Rule 1

- To estimate the premium, we use the difference between Average Monthly Implied Volatility and Range Volatility.
- We select a benchmark premium. We use 2% in our example.
- Identify the market with largest deviation from the benchmark premium and trade that market accordingly (if above the benchmark premium, go short volatility and if below, go long volatility).
- If the premium is within a band, do not trade that day. In our example, we use a range between 1% and 3%.
- Sizing of each position is based on a fixed vega (2.5bps per day).
- Note that each daily position is never unwound or offset.

#### Rule 2

- To estimate the premium, use the difference between Average Monthly Implied Volatility and Average Monthly

Table 8: Simpler Rules (No Long positions)

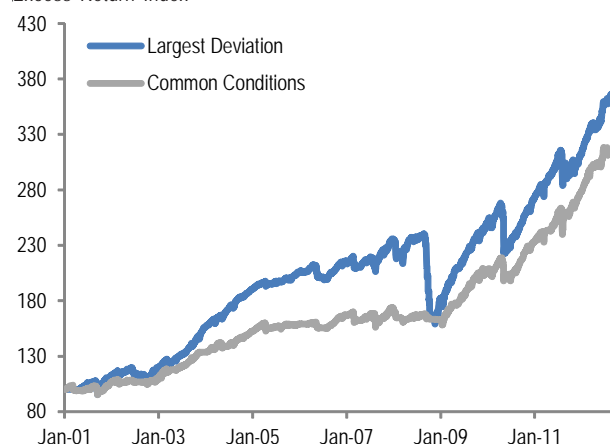
Summary Statistics

	Rule 1 (largest deviation)	Rule 2 (common conditions)
Avg Excess Return	11.4%	9.9%
Standard Deviation	9.3%	7.1%
Sharpe Ratio	1.22	1.39
T-stats	4.24	4.83
Correlation (MSCI World)	0.40	0.32
Max Drawdown	-33.8%	-9.5%

Source: J.P. Morgan, Bloomberg. Sharpe ratio is not necessarily a good performance measure due to the convexity of the payoff, but it is useful for comparison across models.

Chart 12: Performance of Simple Short Volatility Strategies (no long positions)

Excess Return Index



Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs.

Realized Volatility based on squared daily returns .

- If the volatility premium is positive in all three markets, go short the one with the most positive premium that day.
- If the volatility premium is negative in all three markets, go long the one with the most negative premium that day.
- If the volatility premium is not consistent (two negatives/one positive or two positives/one negative), do nothing that day.
- The sizing of each position is based on a fixed vega (2.5bps per day).
- Note that each daily position is never unwound or offset.

#### Even these simpler versions deliver strong performance.

Chart 11 and Table 7 show the performance statistics of these two strategies. Rule 1 focus on the market with the largest deviation while Rule 2 tries to identify market conditions when the sign of premia is common across markets as this makes us more confident that the volatility premia is positive or negative. In both cases, we are using information on all markets but we only trade a single market per day.

Table 9: Asian Markets (Japan, HK and Australia)

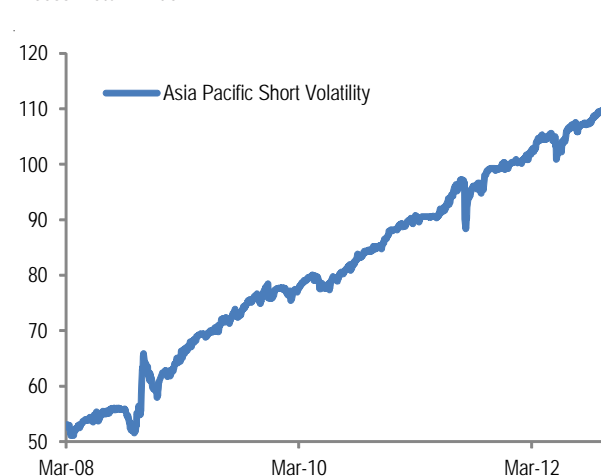
Summary Statistics

	Asia-only Strategy
Avg Excess Return	17.2%
Standard Deviation	10.6%
Sharpe Ratio	1.62
T-stats	3.28
Correlation (MSCI Asia Pac)	0.12
Max Drawdown	-12.0%

Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs. Since March 2008, Sharpe ratio is not necessarily a good performance measure due to the convexity of the payoff, but it is useful for comparison across models.

Chart 13: Performance of Asian Short Volatility Strategy

Excess Return Index



Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs.

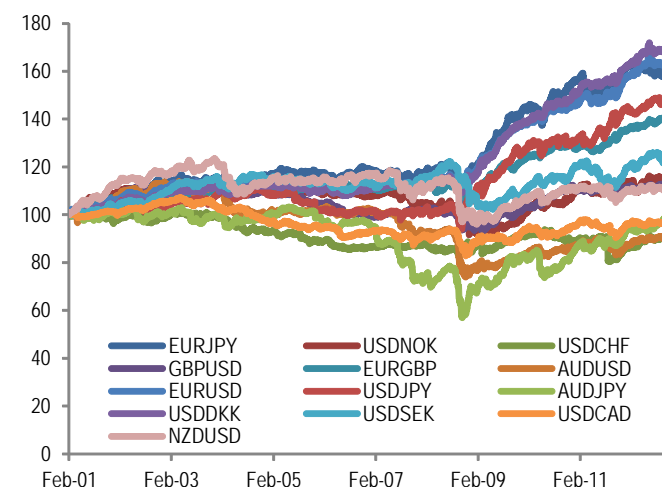
Chart 12 and Table 8 show the performance of short-only versions of the same strategies. Therefore, we never take long volatility positions. We see that that return-risk profile remains interesting.

#### Other International Markets

We also find that this **approach has paid off even if we restrict ourselves to particular regions such as Asia**. One point that we made earlier is that some of the Japan-specific shocks in a regression of Japanese volatility on US and European volatility were not necessarily Japan-specific and potentially broad Asia shocks. If this is the case, there could be Asian spillover effects.

A lot of academic papers have analyzed spillover in Asian equity markets, so here we focus only on the strategy side. We test a model where we trade Japan, HK and Australia. Chart 13 and Table 9 shows the performance of a version of the simple model (no regression, Rule 2) using those markets. Sample is shorter due to data limitations.

Chart 14: Performance of Systematic FX Short Volatility Strategies  
Excess Return Index



Source: J.P. Morgan, Bloomberg. Gross of transaction costs.

## Cross-asset Volatility Spillover

A natural extension of this idea is to **exploit spillover to similar volatility carry strategies in other asset classes or the persistence in their premium**. Other asset classes such as FX may be subject to similar spillover effects in the sense that large moves in equity markets could anticipate similarly large moves in currencies and vice versa. It is well known that there are common risks across asset classes and that the common risks become more pronounced in high-volatility periods. Then, it is not surprising that different volatility processes in different asset classes would also be correlated both contemporaneously or with lags.

In this note, we test this hypothesis using FX, which has been the most common subject of the academic studies of volatility spillover including multiple asset classes. First, we test spillover effects and analyze the contemporaneous correlation in implied and realized volatility. Then, we test spillover-based ideas using a FX volatility carry strategy constructed by going short at-the-money straddles or synthetic variance swaps based on at-the-money implied volatility (note that this will underestimate the actual performance as the premium will be biased downwards).

### Relation between FX and Equity Volatility

Not surprisingly, we find that **equity and FX volatility markets are related on a contemporaneous basis**. Chart 2 (second page) shows the rolling correlation between the average log change in equity implied volatility (our 3 selected markets) and the average log change in FX implied volatility (average across our selected 3 pairs and also the broad list). We see positive and upward-trending correlation between changes in Equity and FX implieds over the whole

Table 10: FX and Equities Spillover  
Regression statistics

	FX(t)	Equities(t)
	Implied Volatility	
FX(t-1)	0.80	0.21
(t-stat)	11.90	0.82
Equities(t-1)	0.00	0.68
(t-stat)	0.18	8.74
R-sqr	0.75	0.65
	Realized Volatility	
FX(t-1)	0.61	0.79
(t-stat)	9.63	4.44
Equities(t-1)	0.09	0.62
(t-stat)	4.35	10.07
R-sqr	0.57	0.59

Source: J.P. Morgan, Bloomberg. Monthly regressions.

sample (see Kolanovic, *Rise in Cross Asset Class Correlations*, J.P.Morgan). Moreover, Diebold and Yilmaz, *Better to Give than to Receive*, *International Journal of Forecasting* (2012) argue that volatility spillover among different asset classes has become stronger after the global financial crisis, particularly from equities to other asset classes.

In order to test spillover, we use the same approach as in previous sections, but we limit the number of variables that we use. On the equities side, we use an equally-weighted average of the three markets (US, Europe and Japan). On the FX side, similarly we use an equally-weighted average of selected pairs.

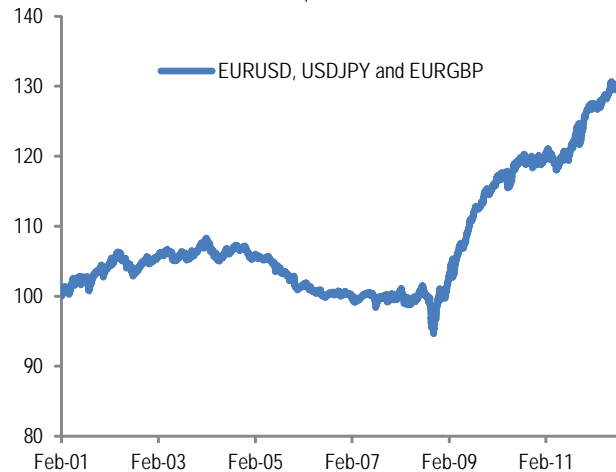
First, we test spillover in the volatility measures using average implied volatility and average realized volatility. Table 10 shows the result of this analysis. Overall, we find spillover in both directions. We should note that the spillover effect in variance swap returns is less evident, but the next step is to consider the implications for trading.

### FX Volatility Carry

We leave more details for future publications, but here we take a quick look at the potential benefit of considering FX volatility carry strategies and combinations with Equity volatility carry.

**Systematic short volatility FX strategies have overall been profitable over the full available sample** (Chart 14). Note that periods of underperformance would not necessarily be profitable for long volatility positions after accounting for transaction costs. We exclude two of the outliers in the

**Chart 15: Performance of Systematic FX Short Volatility Strategies**  
Excess Return Index, Net-of-costs performance.



Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs. Risk-weighted portfolio for EURUSD, USDJPY and EURGBP.

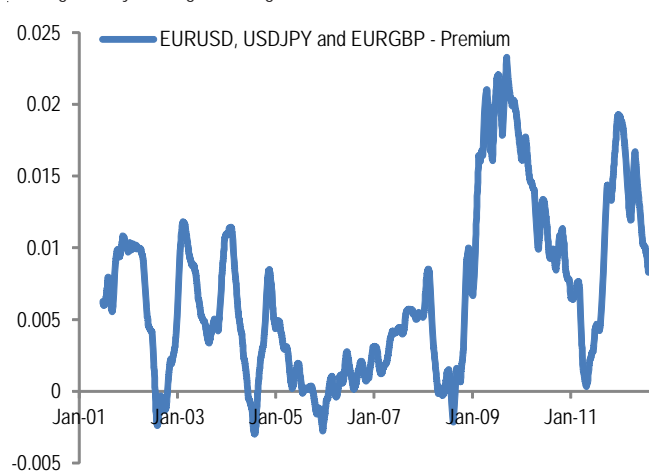
analysis (USDPLN and USDMXN) as they distort the scale of the chart but these were actually the best performers. These calculations are based on the return of short straddles (delta-hedged) with a constant vega (2.5bps per day).

We did our best to account for the likely transaction costs. All our calculations are based on mid 1M implied vols available on Bloomberg. But we included a spread dependent on the level of volatility to account for the likely transaction costs. Based on these numbers and the price evolution of each pair, we computed the return of being short delta-hedged straddles. In the rest of the note we focus on major pairs where we feel comfortable our cost assumptions are reasonable for the overall sample (Chart 15). Anyway, these are markets where on average the risk premium has been positive (Chart 16). Due to their liquidity and risk characteristics, the impact of transaction costs is smaller than in the case of EM currencies for example.

Overall we find **evidence of positive realized premia in FX volatility markets**<sup>7</sup>. According to our FX strategist Arindam Sandilya, there are no natural buyers of volatility that can exacerbate the premium, but the premium is overall positive due to market makers demanding a premium for writing options. As a general rule of thumb though, selling liquid options (e.g. EUR/USD) is more beneficial than highly correlated but less liquid alternatives (e.g. USD/NOK or USD/SEK). The latter seem to display bigger jumps, and it is worth paying the small premium that option markets demand

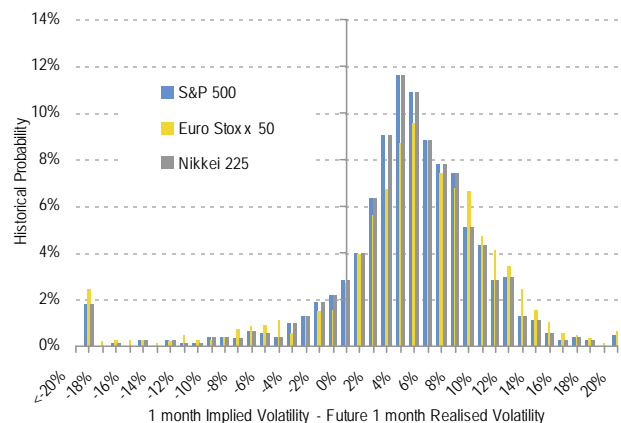
<sup>7</sup> See Chart 18 for empirical distribution of risk premia for our three selected pairs (separately) and Chart 19 for a joint cross-sectional and time series distribution including all 15 pairs we analysed. For comparison, Chart 17 shows the same calculation for Equities. Chart 20 shows the same calculation for Gold. We analyze Gold in a future publication.

**Chart 16: Average Implied vs Realized Premium**  
Rolling 63-day average, average across currencies



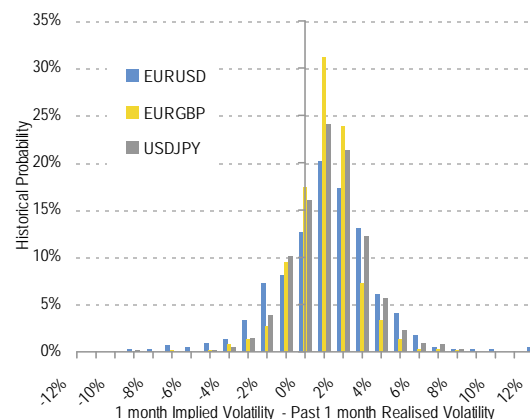
Source: J.P. Morgan, Bloomberg.

**Chart 17: Empirical Distribution of Equity Volatility Risk Premium**  
Histogram, Realized Risk Premia



Source: J.P. Morgan, Bloomberg.

**Chart 18: Empirical Distribution of FX Volatility Risk Premium**  
Histogram, Realized Risk Premia



Source: J.P. Morgan, Bloomberg.

over EUR vols. Therefore, there can be interesting opportunities across pairs.

There can also be interesting opportunities across asset classes. For instance, it is common to see crossover players (equity/credit) looking to buy FX options as portfolio hedges against shorts/carry trades in their core asset classes, particularly when premium is relatively smaller.

### Diversification Benefits

Another question is whether it **makes sense to combine both equity and FX volatility carry strategies**. We consider a simple risk-weighted allocation into FX and Equity simple volatility carry and compare to the simple versions of each strategy (Table 11). In this analysis, we ignore the benefit of timing volatility carry. By combining these strategies we improve the main performance characteristics. In particular, Sortino ratio is significantly improved.

### Timing FX Volatility Carry

**Equity volatility can help us in timing the FX volatility carry strategy.** We use our probability forecasting model to trade FX based on regressions estimated with 3-year rolling windows. We estimate a separate model per currency. Table 12 compares the Sharpe ratio of our strategy pair by pair to a case where we are always short volatility.

The FX strategy only goes short the pair if probability of a positive premium is higher than a certain level (e.g. 60% probability of positive premium). We use lower cut-off points in the FX case as the predicted probability of a positive premium is on average around 60% in our sample (since 2001). Hence, it is lower than the level found in equities. Note that this is partially due to the bias in our measure of variance swap rates. Also note that the spikes in FX volatility are less pronounced so we feel more comfortable using a lower cut-off point than in the equities case.

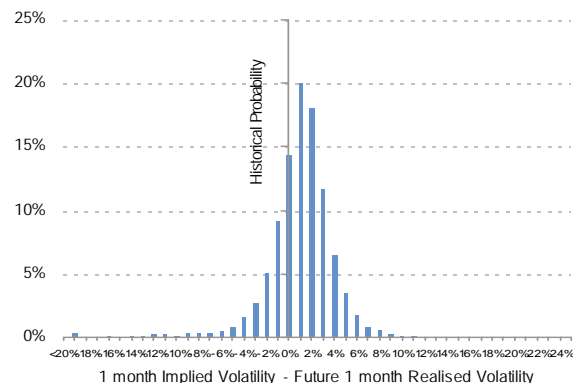
These calculations are based on variance swap return approximations and underestimate the actual performance for both strategy and benchmark. We also considered short ATM straddles (delta-hedged) where this bias is eliminated with similar qualitative results. The spillover/clustering rule improved the performance of all these short FX volatility positions, but this is not the only model that does well. We leave other variations for a future publication.

## Conclusions

We find supporting evidence that there are spillover effects between international equity markets and that these effects extend into other asset classes. These results are consistent with the previous results in the academic literature. We

**Chart 19: Empirical Distribution of FX Volatility Risk Premium**

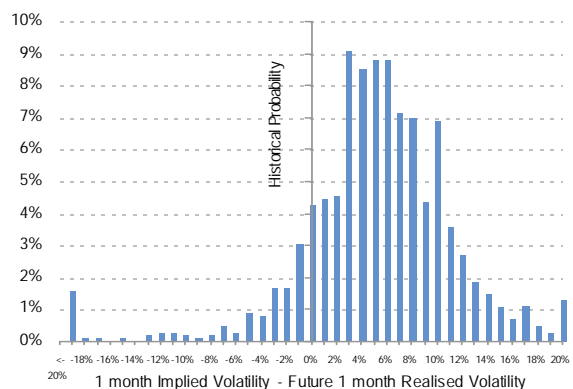
Histogram, All 15 pairs at the same time, both times series and cross-section, Realized Risk Premia



Source: J.P. Morgan, Bloomberg.

**Chart 20: Empirical Distribution of Gold Volatility Risk Premium**

Histogram, Realized Risk Premia



Source: J.P. Morgan, Bloomberg.

**Table 11: Combining Simple FX and Equity Volatility Carry**

Performance Statistics

	FX	S&P 500 Only	Risk-Weighted
Exc. Return	2.5%	5.4%	3.4%
Volatility	4.1%	13.8%	4.4%
Sharpe	0.61	0.39	0.79
Down Volatility	5.4%	21.9%	5.9%
Sortino	0.47	0.24	0.58
Max Drawdown	-17.8%	-55.3%	-21.3%

Source: J.P. Morgan, Bloomberg. Calculations are net of transaction costs. Sample one month shorter than Table 5, starting Feb 2001. FX is risk-weighted portfolio of EURUSD, USDJPY and EURGBP short volatility.

**Table 12: FX Short Volatility Strategy - Sharpe Ratio**

Model estimated separately for each pair

	EURUSD	EURGBP	USDJPY
Always Short	0.71	0.61	0.18
Spillover/Clustering	0.83	0.66	0.41

Source: J.P. Morgan, Bloomberg.



extended these well-known results by showing that both spillover and clustering are quite important when implementing short volatility strategies. We design a range of strategies that benefit from the spillover and persistence in volatility markets. These strategies have outperformed simple systematic short-only volatility strategies.

Many investors are aware there is a premium in volatility markets (implied vs realized is one of the examples and our focus here). Here we show that volatility markets are interconnected and that we can enhance our allocation by acknowledging these empirical relationships between different equity markets and between equities and other asset classes.

## Disclosures

**Analyst Certification:** The research analyst(s) denoted by an "AC" on the cover of this report certifies (or, where multiple research analysts are primarily responsible for this report, the research analyst denoted by an "AC" on the cover or within the document individually certifies, with respect to each security or issuer that the research analyst covers in this research) that: (1) all of the views expressed in this report accurately reflect his or her personal views about any and all of the subject securities or issuers; and (2) no part of any of the research analyst's compensation was, is, or will be directly or indirectly related to the specific recommendations or views expressed by the research analyst(s) in this report.

**Analysts' Compensation:** The research analysts responsible for the preparation of this report receive compensation based upon various factors, including the quality and accuracy of research, client feedback, competitive factors, and overall firm revenues.

## Other Disclosures

J.P. Morgan ("JPM") is the global brand name for J.P. Morgan Securities LLC ("JPMS") and its affiliates worldwide. J.P. Morgan Cazenove is a marketing name for the U.K. investment banking businesses and EMEA cash equities and equity research businesses of JPMorgan Chase & Co. and its subsidiaries.

**Options related research:** If the information contained herein regards options related research, such information is available only to persons who have received the proper option risk disclosure documents. For a copy of the Option Clearing Corporation's Characteristics and Risks of Standardized Options, please contact your J.P. Morgan Representative or visit the OCC's website at <http://www.optionsclearing.com/publications/risks/riskstoc.pdf>

## Legal Entities Disclosures

**U.S.:** JPMS is a member of NYSE, FINRA, SIPC and the NFA. JPMorgan Chase Bank, N.A. is a member of FDIC and is authorized and regulated in the UK by the Financial Services Authority. **U.K.:** J.P. Morgan Securities plc (JPMS plc) is a member of the London Stock Exchange and is authorized and regulated by the Financial Services Authority. Registered in England & Wales No. 2711006. Registered Office 25 Bank Street, London, E14 5JP. **South Africa:** J.P. Morgan Equities Limited is a member of the Johannesburg Securities Exchange and is regulated by the FSB. **Hong Kong:** J.P. Morgan Securities (Asia Pacific) Limited (CE number AAJ321) is regulated by the Hong Kong Monetary Authority and the Securities and Futures Commission in Hong Kong. **Korea:** J.P. Morgan Securities (Far East) Ltd, Seoul Branch, is regulated by the Korea Financial Supervisory Service. **Australia:** J.P. Morgan Australia Limited (ABN 52 002 888 011/AFS Licence No: 238188) is regulated by ASIC and J.P. Morgan Securities Australia Limited (ABN 61 003 245 234/AFS Licence No: 238066) is a Market Participant with the ASX and regulated by ASIC. **Taiwan:** J.P.Morgan Securities (Taiwan) Limited is a participant of the Taiwan Stock Exchange (company-type) and regulated by the Taiwan Securities and Futures Bureau. **India:** J.P. Morgan India Private Limited, having its registered office at J.P. Morgan Tower, Off. C.S.T. Road, Kalina, Santacruz East, Mumbai - 400098, is a member of the National Stock Exchange of India Limited (SEBI Registration Number - INB 230675231/INF 230675231/INE 230675231) and Bombay Stock Exchange Limited (SEBI Registration Number - INB 010675237/INF 010675237) and is regulated by Securities and Exchange Board of India. **Thailand:** JPMorgan Securities (Thailand) Limited is a member of the Stock Exchange of Thailand and is regulated by the Ministry of Finance and the Securities and Exchange Commission. **Indonesia:** PT J.P. Morgan Securities Indonesia is a member of the Indonesia Stock Exchange and is regulated by the BAPEPAM LK. **Philippines:** J.P. Morgan Securities Philippines Inc. is a member of the Philippine Stock Exchange and is regulated by the Securities and Exchange Commission. **Brazil:** Banco J.P. Morgan S.A. is regulated by the Comissao de Valores Mobiliarios (CVM) and by the Central Bank of Brazil. **Mexico:** J.P. Morgan Casa de Bolsa, S.A. de C.V., J.P. Morgan Grupo Financiero is a member of the Mexican Stock Exchange and authorized to act as a broker dealer by the National Banking and Securities Exchange Commission. **Singapore:** This material

is issued and distributed in Singapore by J.P. Morgan Securities Singapore Private Limited (JPMSS) [MICA (P) 088/04/2012 and Co. Reg. No.: 199405335R] which is a member of the Singapore Exchange Securities Trading Limited and is regulated by the Monetary Authority of Singapore (MAS) and/or JPMorgan Chase Bank, N.A., Singapore branch (JPMCB Singapore) which is regulated by the MAS. **Malaysia:** This material is issued and distributed in Malaysia by JPMorgan Securities (Malaysia) Sdn Bhd (18146-X) which is a Participating Organization of Bursa Malaysia Berhad and a holder of Capital Markets Services License issued by the Securities Commission in Malaysia. **Pakistan:** J. P. Morgan Pakistan Broking (Pvt.) Ltd is a member of the Karachi Stock Exchange and regulated by the Securities and Exchange Commission of Pakistan. **Saudi Arabia:** J.P. Morgan Saudi Arabia Ltd. is authorized by the Capital Market Authority of the Kingdom of Saudi Arabia (CMA) to carry out dealing as an agent, arranging, advising and custody, with respect to securities business under licence number 35-07079 and its registered address is at 8th Floor, Al-Faisaliyah Tower, King Fahad Road, P.O. Box 51907, Riyadh 11553, Kingdom of Saudi Arabia. **Dubai:** JPMorgan Chase Bank, N.A., Dubai Branch is regulated by the Dubai Financial Services Authority (DFSA) and its registered address is Dubai International Financial Centre - Building 3, Level 7, PO Box 506551, Dubai, UAE.

#### Country and Region Specific Disclosures

**U.K. and European Economic Area (EEA):** Unless specified to the contrary, issued and approved for distribution in the U.K. and the EEA by JPMS plc. Investment research issued by JPMS plc has been prepared in accordance with JPMS plc's policies for managing conflicts of interest arising as a result of publication and distribution of investment research. Many European regulators require a firm to establish, implement and maintain such a policy. This report has been issued in the U.K. only to persons of a kind described in Article 19 (5), 38, 47 and 49 of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005 (all such persons being referred to as "relevant persons"). This document must not be acted on or relied on by persons who are not relevant persons. Any investment or investment activity to which this document relates is only available to relevant persons and will be engaged in only with relevant persons. In other EEA countries, the report has been issued to persons regarded as professional investors (or equivalent) in their home jurisdiction. **Australia:** This material is issued and distributed by JPMSAL in Australia to "wholesale clients" only. JPMSAL does not issue or distribute this material to "retail clients". The recipient of this material must not distribute it to any third party or outside Australia without the prior written consent of JPMSAL. For the purposes of this paragraph the terms "wholesale client" and "retail client" have the meanings given to them in section 761G of the Corporations Act 2001. **Germany:** This material is distributed in Germany by J.P. Morgan Securities plc, Frankfurt Branch and J.P.Morgan Chase Bank, N.A., Frankfurt Branch which are regulated by the Bundesanstalt für Finanzdienstleistungsaufsicht. **Hong Kong:** The 1% ownership disclosure as of the previous month end satisfies the requirements under Paragraph 16.5(a) of the Hong Kong Code of Conduct for Persons Licensed by or Registered with the Securities and Futures Commission. (For research published within the first ten days of the month, the disclosure may be based on the month end data from two months prior.) J.P. Morgan Broking (Hong Kong) Limited is the liquidity provider/market maker for derivative warrants, callable bull bear contracts and stock options listed on the Stock Exchange of Hong Kong Limited. An updated list can be found on HKEx website: <http://www.hkex.com.hk>. **Japan:** There is a risk that a loss may occur due to a change in the price of the shares in the case of share trading, and that a loss may occur due to the exchange rate in the case of foreign share trading. In the case of share trading, JPMorgan Securities Japan Co., Ltd., will be receiving a brokerage fee and consumption tax (shouhizei) calculated by multiplying the executed price by the commission rate which was individually agreed between JPMorgan Securities Japan Co., Ltd., and the customer in advance. Financial Instruments Firms: JPMorgan Securities Japan Co., Ltd., Kanto Local Finance Bureau (kinsho) No. 82 Participating Association / Japan Securities Dealers Association, The Financial Futures Association of Japan, Type II Financial Instruments Firms Association and Japan Investment Advisers Association. **Korea:** This report may have been edited or contributed to from time to time by affiliates of J.P. Morgan Securities (Far East) Ltd, Seoul Branch. **Singapore:** JPMSS and/or its affiliates may have a holding in any of the securities discussed in this report; for securities where the holding is 1% or greater, the specific holding is disclosed in the Important Disclosures section above. **India:** For private circulation only, not for sale. **Pakistan:** For private circulation only, not for sale. **New Zealand:** This material is issued and distributed by JPMSAL in New Zealand only to persons whose principal business is the investment of money or who, in the course of and for the purposes of their business, habitually invest money. JPMSAL does not issue or distribute this material to members of "the public" as determined in accordance with section 3 of the Securities Act 1978. The recipient of this material must not distribute it to any third party or outside New Zealand without the prior written consent of JPMSAL. **Canada:** The information contained herein is not, and under no circumstances is to be construed as, a prospectus, an advertisement, a public offering, an offer to sell securities described herein, or solicitation of an offer to buy securities described herein, in Canada or any province or territory thereof. Any offer or sale of the securities described herein in Canada will be made only under an exemption from the requirements to file a prospectus with the relevant Canadian securities regulators and only by a dealer properly registered under applicable securities laws or, alternatively, pursuant to an exemption from the dealer registration requirement in the relevant province or territory of Canada in which such offer or sale is made. The information contained herein is under no circumstances to be construed as investment advice in any province or territory of Canada and is not tailored to the needs of the recipient. To the extent that the information contained herein references securities of an issuer incorporated, formed or created under the laws of Canada or a province or territory of Canada, any trades in such securities must be conducted through a dealer registered in Canada. No securities commission or similar regulatory authority in Canada has reviewed or in any way passed judgment upon these materials, the information contained herein or the merits of the securities described herein, and any representation to the contrary is an offence. **Dubai:** This report has been issued to persons regarded as professional clients as defined under the DFSA rules.

**General:** Additional information is available upon request. Information has been obtained from sources believed to be reliable but JPMorgan Chase & Co. or its affiliates and/or subsidiaries (collectively J.P. Morgan) do not warrant its completeness or accuracy except with respect to any disclosures relative to JPMS and/or its affiliates and the analyst's involvement with the issuer that is the subject of the research. All pricing is as of the close of market for the securities discussed, unless otherwise stated. Opinions and estimates constitute our judgment as of the date of this material and are subject to change without notice. Past performance is not indicative of future results. This material is not intended as an offer or solicitation for the purchase or sale of any financial instrument. The opinions and recommendations herein do not take into account individual client circumstances, objectives, or needs and are not intended as recommendations of particular securities, financial instruments or strategies to particular clients. The recipient of this report must make its own independent decisions regarding any securities or financial instruments mentioned herein. JPMS distributes in the U.S. research published by non-U.S. affiliates and accepts responsibility for its contents. Periodic updates may be provided on companies/industries based on company specific developments or announcements, market conditions or any other publicly available information. Clients should contact analysts and execute transactions through a J.P. Morgan subsidiary or affiliate in their home jurisdiction unless governing law permits otherwise.

"Other Disclosures" last revised September 29, 2012.

**Copyright 2012 JPMorgan Chase & Co. All rights reserved. This report or any portion hereof may not be reprinted, sold or redistributed without the written consent of J.P. Morgan.**

## Investment Strategies Series

*This series aims to offer new approaches and methods on investing and trading profitably in financial markets.*

25. *Momentum in Commodities*, Ruy Ribeiro, Jan Loeys and John Normand, September 2006
26. *Equity Style Rotation*, Ruy Ribeiro, November 2006
27. *Euro Fixed Income Momentum Strategy*, Gianluca Salford, November 2006
28. *Variance Swaps*, Peter Allen, November 2006
29. *Relative Value in Tranches I*, Dirk Muench, November 2006
30. *Relative Value in Tranches II*, Dirk Muench, November 2006
31. *Exploiting carry with cross-market and curve bond trades*, Nikolaos Panigirtzoglou, January 2007
32. *Momentum in Money Markets*, Gianluca Salford, May 2007
33. *Rotating between G-10 and Emerging Markets Carry*, John Normand, July 2007
34. *A simple rule to trade the curve*, Nikolaos Panigirtzoglou, August 2007
35. *Markowitz in tactical asset allocation*, Ruy Ribeiro and Jan Loeys, August 2007
36. *Carry-to-Risk for Credit Indices*, Saul Doctor and Jonny Goulden, September 2007
37. *Learning Curves – Curve Trading Using Model Signals*, Jonny Goulden and Sugandh Mittal, October 2007
38. *A Framework for Credit-Equity Investing*, Jonny Goulden, Peter Allen and Stephen Einchcomb, November 2007
39. *Hedge Fund Alternatives*, Ruy Ribeiro and Vadim di Pietro, March 2008
40. *Optimizing Commodities Momentum*, Ruy Ribeiro and Vadim di Pietro, April 2008
41. *Momentum in Global Equity Sectors*, Vadim di Pietro and Ruy Ribeiro, May 2008
42. *Cross-momentum for EM equity sectors*, Vadim di Pietro and Ruy Ribeiro, May 2008
43. *Trading the US curve*, Grace Koo and Nikolaos Panigirtzoglou, May 2008
44. *Momentum in Emerging Markets Sovereign Debt*, Gerald Tan and William Oswald, May 2008
45. *Active Strategies for 130/30 Emerging Markets Portfolios*, Gerald Tan and William Oswald, June 2008
46. *Hedging Illiquid Assets*, Peter Rappoport, July 2008
47. *Alternatives to standard carry and momentum in FX*, John Normand and Kartikeya Ghia, August 2008
48. *Global bond momentum*, Grace Koo and Nikolaos Panigirtzoglou, August 2008
49. *Hedging Default Risk in Portfolios of Credit Tranches*, Peter Rappoport, September 2008
50. *Timing carry in US municipal markets*, Manas Baveja, Ruy Ribeiro and Vadim di Pietro, September 2008
51. *Volatility Signals for Asset Allocation*, Ruy Ribeiro and Vadim di Pietro, November 2008
52. *Macro Credit-Equity Trading*, Tina Zhang, Saul Doctor, Abel Elizalde and Stephen Einchcomb, November 2008
53. *Combining directional and sector momentum*, Vadim di Pietro and Ruy Ribeiro, February 2009
54. *Profiting from slide in commodity curves*, Ruy Ribeiro, April 2009
55. *Trading and hedging long-term FX fundamentals with J.P.Morgan's Fair-Value model*, Gabriel de Kock, April 2009
56. *The EM vs Developed Markets equity allocation*, Grace Koo and Nikolaos Panigirtzoglou, April 2009
57. *Longevity risk and portfolio allocation*, Ruy Ribeiro and Vadim di Pietro, June 2009
58. *Trading cyclical vs defensive equity sectors*, Nikolaos Panigirtzoglou and Grace Koo, September 2009
59. *Economic and price signals for commodity allocation*, Ruy Ribeiro, October 2009
60. *Managing FX hedge ratios — A framework for strategic and tactical decisions*, John Normand et. al., May 2010
61. *Sector rotation in corporate bonds*, Grace Koo, Nov 2010
62. *Tail-risk hedging with FX options*, Matthias Bouquet, Jan 2011
63. *CDS Options Strategies - Strategies for every investor*, Danny White et. al., January 2011
64. *Evaluating bond markets in a world of rising debt*, Nikolaos Panigirtzoglou et. al., February 2011
65. *Trading on economic data releases: What works? What does not?*, Seamus Mac Gorain, March 2011
66. *Trading the US vs Europe*, Nikolaos Panigirtzoglou et. al., June 11
67. *Using unemployment to trade bonds*, Seamus Mac Gorain, November 2011
68. *Commodity equities or futures?*, Ruy Ribeiro, December 2011
69. *REVISITING: Using the Global PMI as trading signal*, Nikolaos Panigirtzoglou, January 2012
70. *Playing Away from Home in the Credit Markets*, Danny White et al, February 2012
71. *Trading Rich / Cheap Signals in EM Sovereigns & Corporates*, Ian Osband et al, February 2012
72. *Exploiting reversals in cross-market yield spreads*, Seamus Mac Gorain, March 2012
73. *Gold in asset allocation*, Matthew Lehmann, July 2012
74. *Simple rules to trade duration*, Seamus Mac Gorain, October 2012