

**Natixis**

## MEAN REVERSION TRADING ON VOLATILITY ASSETS





## 1. What is Mean Reversion?

- A simple definition
- Our intuition on Mean Reversion

## 2. Why consider Mean Reversion?

- For diversification purposes
- The main drivers are known

## 3. Implied volatility focus: How to trade Mean Reversion on VIX?

- How to illustrate mean reversion on VIX?
- A statistical approach to design a mean reversion strategy on VIX



## A simple definition

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Mean Reversion is a key property of financial assets

It characterizes the ability for an underlying asset to revert towards an average value after unusual moves away from that value:

- Extreme spikes are likely to be followed by drops
- Very sharp drops are likely to be followed by bullish runs

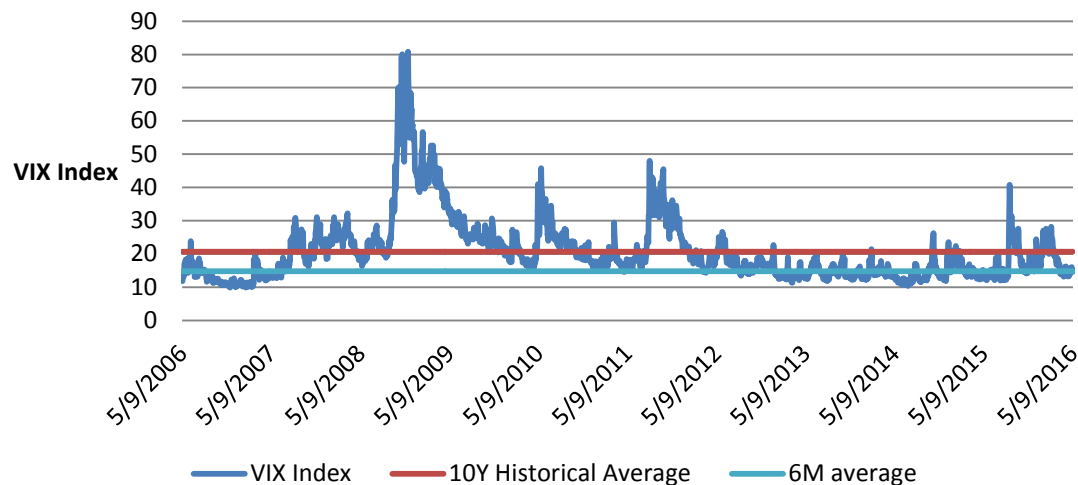
## Our intuition on Mean Reversion

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- 10Y VIX historical average value has been around 21 for the past 10 years
- VIX well above 21 could be viewed as 'expensive'
- VIX well below 21 could be viewed as 'cheap'
- The observation window matters

### VIX Index historical values



- Source: Natixis Financial Engineering, using Bloomberg Data

## US Equity Implied Volatility



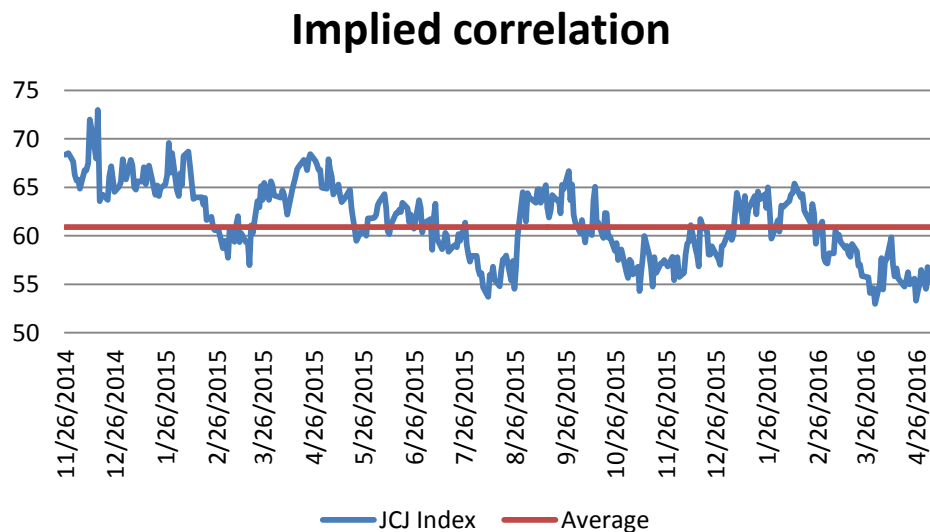


## Our intuition on Mean Reversion

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- The JCJ Index is a CBOE measure of the implied correlation of the S&P 500 components through S&P 500 option prices
- Average implied correlation has been around 61 for the past 2 years
- JCJ Index well above 61 could be viewed as 'expensive'
- JCJ Index well below 61 could be viewed as 'cheap'



- Source: Natixis Financial Engineering, using Bloomberg Data

## US Equity Implied Correlation

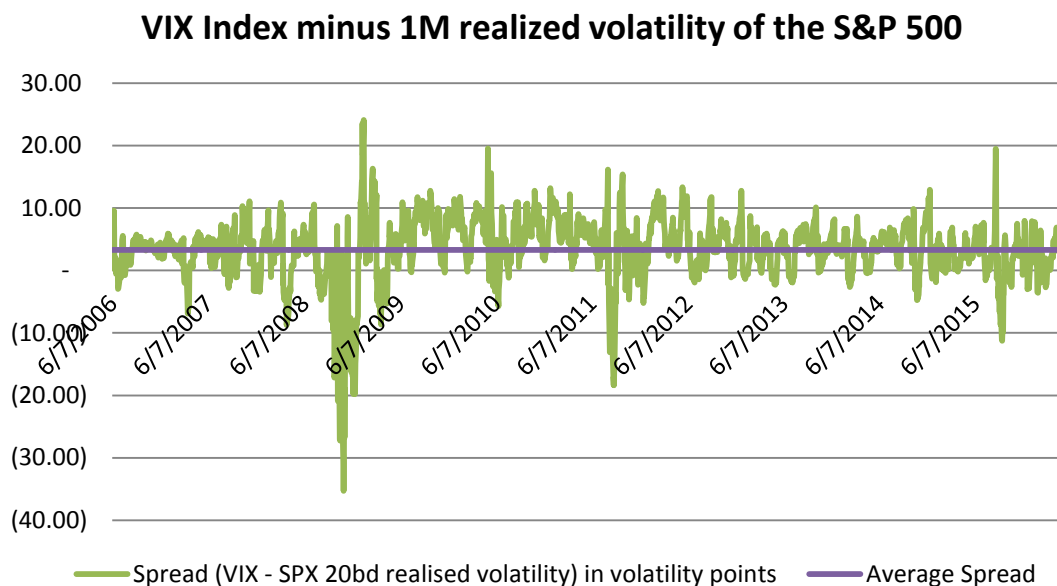


## Our intuition on Mean Reversion

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- The VIX Index can be viewed as a proxy of 1M Variance swap price
- Average carry has been positive, around +3.3 points for the past 10 years
- A carry well above 3.3 could be viewed as 'expensive'
- A carry well below 3.3 could be viewed as 'cheap'



- Source: Natixis Financial Engineering, using Bloomberg Data

## S&P 500 variance swap carry

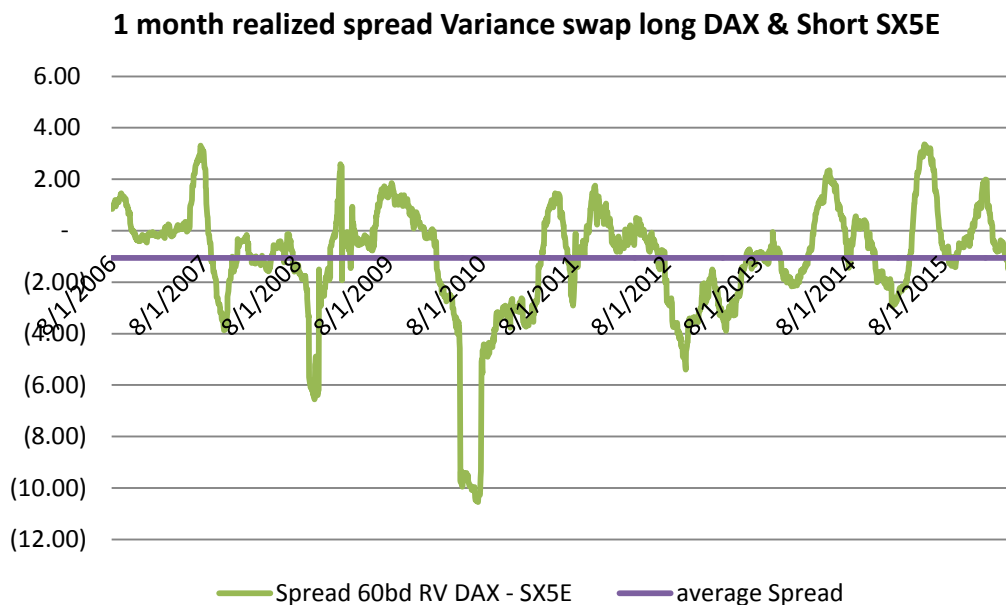


## Our intuition on Mean Reversion

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- The average realized variance swap spread between DAX Index and Eurostoxx 50 has been around -1 point for the past 10 years
- A spread well above -1 could be viewed as 'expensive'
- A carry well below -1 could be viewed as 'cheap'



• Source: Natixis Financial Engineering, using Bloomberg Data

## Variance swap spreads



1. What is Mean Reversion?
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2. Why consider Mean Reversion?
  - For diversification purposes
  - The main drivers are known
3. Implied volatility focus: How to trade Mean Reversion on VIX ?
  - How to illustrate mean reversion on VIX?
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# Diversification benefits

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## North America

- S&P 500 Index – cap weighted index
- NASDAQ 100 Index – modified cap weighted index
- RUSSEL 2000 Index – cap weighted index



## Europe

- EUROSTOXX 50 Index – cap weighted index
- FTSE 100 Index – cap weighted index
- SMI index – cap weighted index



## Asia

- TOPIX Index – cap weighted index
- HANG SENG Index – cap weighted index
- HSCEI Index – cap weighted index



Most equity benchmarks are market cap weighted and thus follow a trend following behavior



## Diversification benefits

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- Market cap weighted indices can become overweight in some particular sector because of performance
- Exposure to financial bubbles can therefore be significant
- Mean Reversion may help to mitigate negative effects of speculative bubble bursts



- Source: Natixis Financial Engineering, using Bloomberg Data

## Potential diversification issues on market cap weighted indices



## The main drivers of mean reversion

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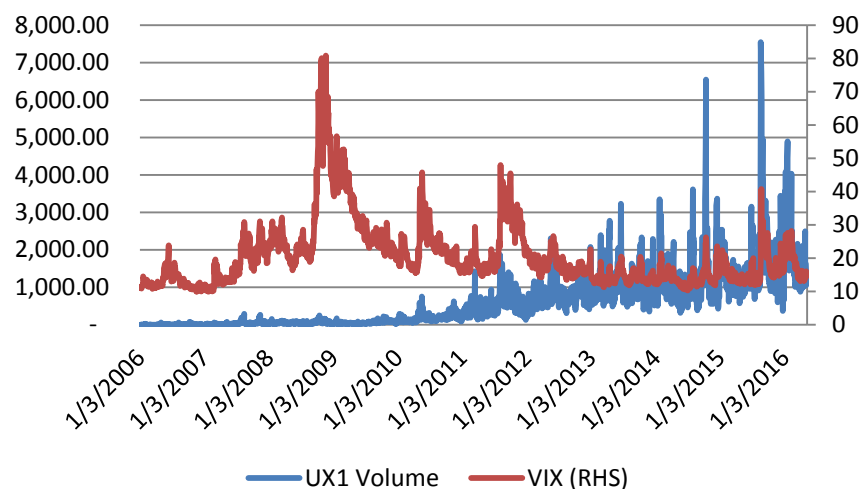
### Imbalance between offer and demand

- Liquidity drought can often link to under or over valuation levels
- Correlation is high between VIX major spikes and VIX futures liquidity
- Short-squeeze effects
- Over / under supply consequences (e.g. on commodities)

### General market participants behavior

- Herd / trend following behavior of market participants often link to an amplification of the movements (e.g. bubbles)

VIX Index and VIX volumes (M USD)



- Source: Natixis Financial Engineering, using Bloomberg Data

## Some drivers can be identified



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## The main drivers of mean reversion

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### Arbitrage

- Hedge funds, proprietary traders, and arbitrageurs
- Attractiveness of asymmetric trades (“easy money” to be made relatively quickly)
- Common beliefs often becomes self fulfilling

### Implied assets:

- Implied correlation trades range bound between -1 and +1
- Implied volatility, skew, term structure, and vol of vol are regarded as mean reverting

Some assets are ‘believed’ to be mean reverting





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## How to trade Mean Reversion on VIX ?

**The VIX Index reflects the short term implied volatility of the S&P 500:**

- The CBOE Volatility Index (VIX) is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices.

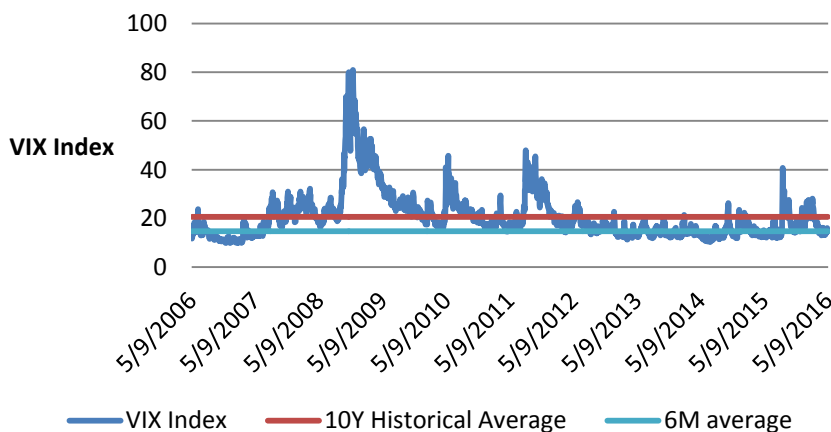
**The VIX Index spikes in bearish market environments:**

- VIX is known as the “fear gauge”
- Put option hedging flows on S&P 500 index increase in bearish markets
- The street increases its long implied volatility exposure

**The VIX Index has a relatively low level in quiet or bullish markets**

- Less hedging flows in quiet or bullish markets
- The street increases its short implied volatility exposure

### VIX Index historical values



- Source: Natixis Financial Engineering, using Bloomberg Data

## How to illustrate VIX Mean Reversion?



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# How to trade Mean Reversion on VIX ?

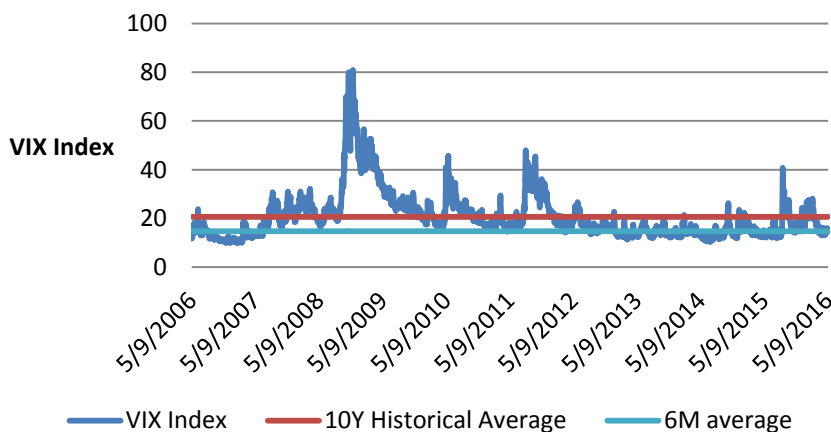
## Upside Mean Reversion:

- How often did the VIX Index close above its highest closing value of the month ?
- Once closing above its monthly highest value, how many consecutive days did the VIX continue to close above its previous value ?

## Downside Mean Reversion:

- How often did the VIX Index close below its lowest closing value of the month ?
- Once closing below its monthly lowest value, how many consecutive days did the VIX continue to close below its previous value ?

## VIX Index historical values



- Source: Natixis Financial Engineering, using Bloomberg Data

## How to illustrate VIX Mean Reversion?



## How to trade Mean Reversion on VIX ?

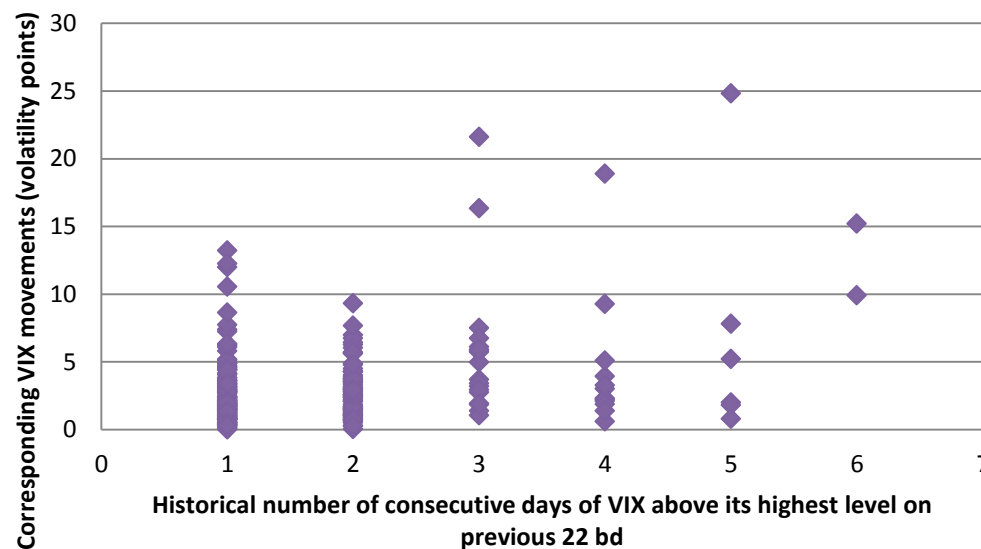
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Since January 1990:

- The VIX Index closed its 1m-high approximately 7% of the time
- Once above its 1m-high, the VIX Index closed above that value for an average period of 1.68 days before moving back down
- The VIX Index has never moved up by more than 25 points during those above periods

**Historical periods length (in consecutive bd) of VIX above its 1m-highs and corresponding VIX move**



◆ VIX move over the period

- Source: Natixis Financial Engineering, using Bloomberg Data

An illustration of upside mean reversion behavior



# How to trade Mean Reversion on VIX ?

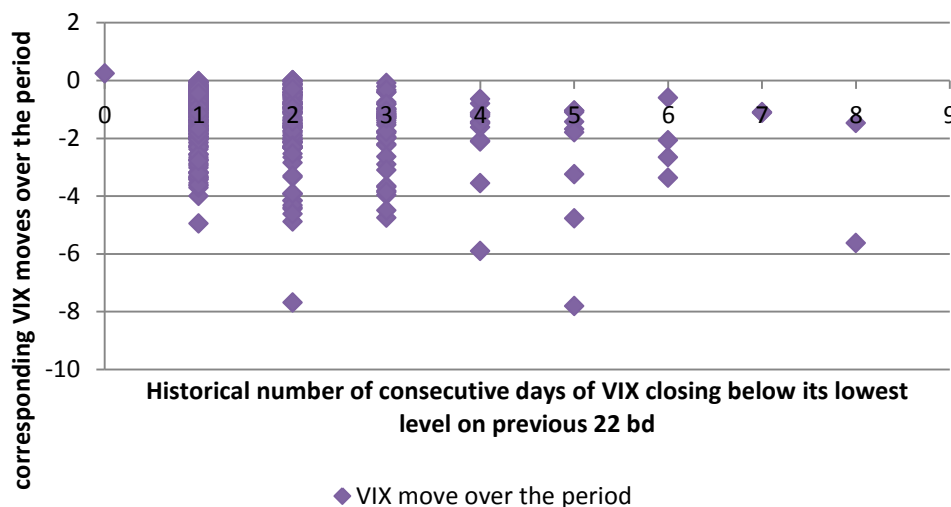
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Since January 1990:

- The VIX Index closed below its 1m-low approximately 11% of the time
- Once below its 1m-low, the VIX Index closed below that value for an average period of 1.76 days before moving back up
- The VIX Index has never moved down by more than 8 points during those above periods

**Historical periods length (in consecutive bd) of VIX below its 1m-lows and corresponding VIX move**



- Source: Natixis Financial Engineering, using Bloomberg Data

An illustration of downside mean reversion behavior



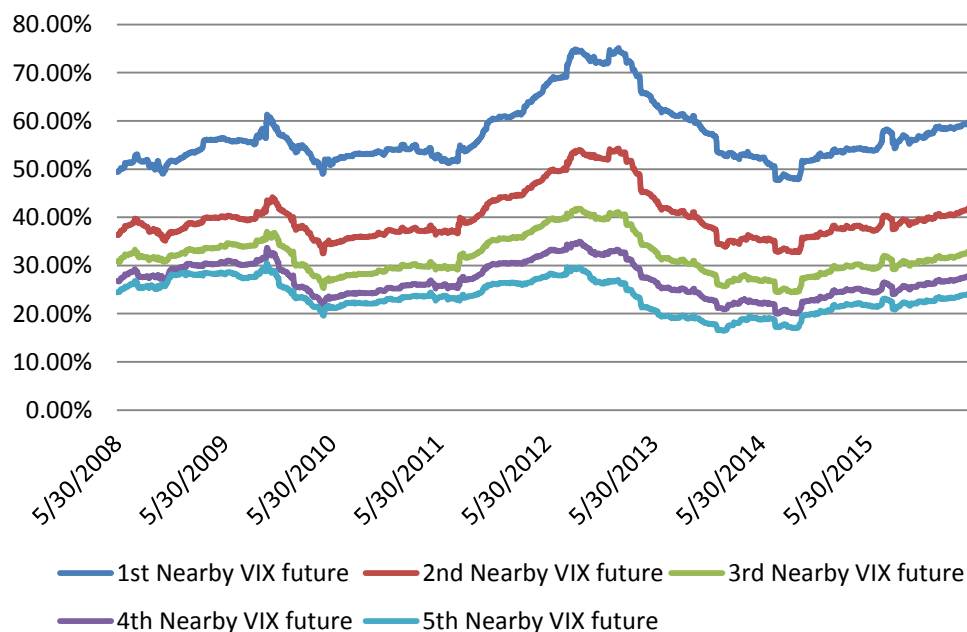
## How to trade Mean Reversion on VIX?

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- ✓ **The VIX is not an investable index**
- ✓ **Selection of the best proxy of the VIX**
- VIX Future contracts are the best proxy of VIX Index
- The first nearby contract exhibits the highest sensitivity to the VIX index

### Rolling 1Y beta with VIX Index



• Source: Natixis Financial Engineering, using Bloomberg Data

The first VIX future contract may be the best VIX proxy

# How to trade Mean Reversion on VIX?

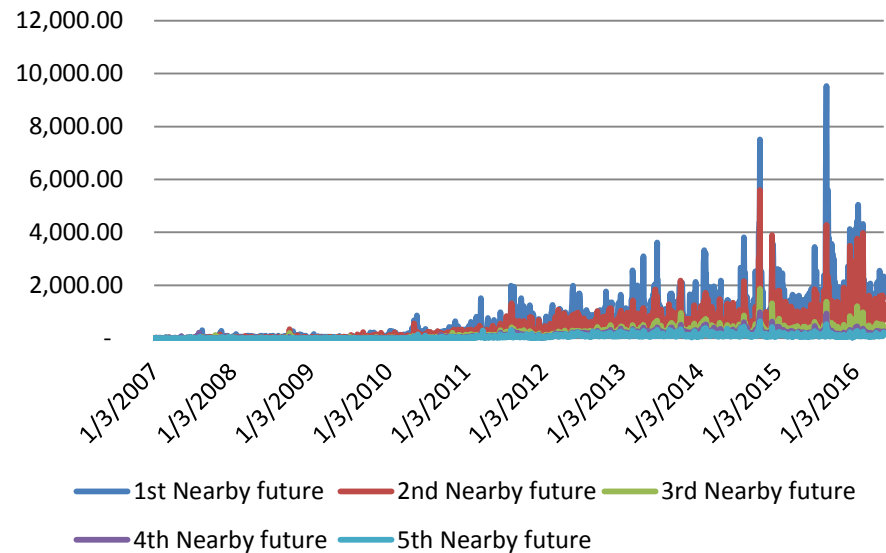
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## Selection of the most liquid underlying

- VIX Future contracts are the best proxy of VIX Index
- The first nearby contract is much more liquid than following contracts

VIX futures daily volume (Million USD)



- Source: Natixis Financial Engineering, using Bloomberg Data

The first VIX future contract may be the best VIX proxy



# How to trade Mean Reversion on VIX?

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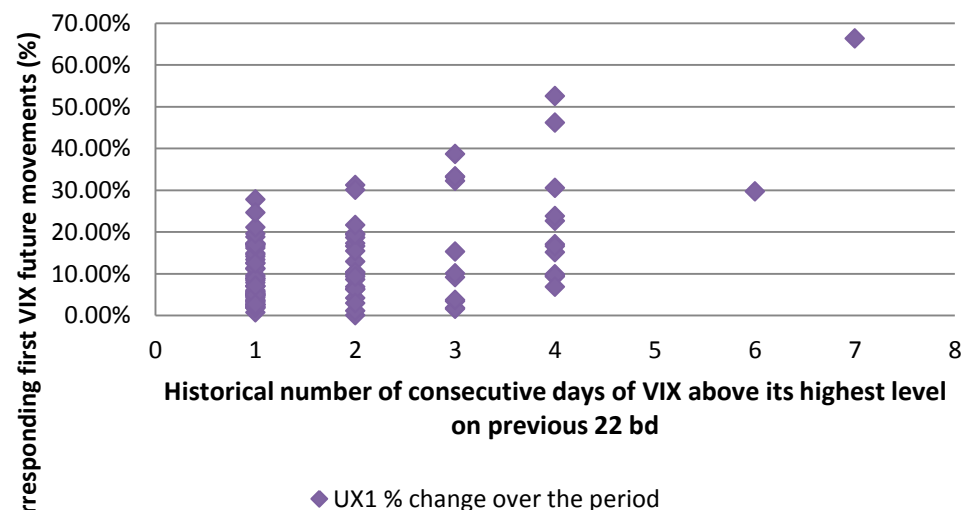
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## An Illustration of the Mean Reversion of the first rolled VIX future contracts

Since January 1990:

- The first VIX future rolled contract quoted (at the close of VIX index) above 1m-high approximately 7% of the time
- Once above 1m-high, the first VIX future rolled contract stayed (at the close of VIX index) above that value for an average period of 1.93 days before moving back down
- The first VIX future rolled contract Index has never moved up by more than 70% during those above periods

## Historical periods length (in consecutive bd) of first VIX future above 1m-high and corresponding first VIX future move (%)



- Source: Natixis Financial Engineering, using Bloomberg Data

## Illustration of upside mean reversion of the first rolled VIX future contract



# How to trade Mean Reversion on VIX?

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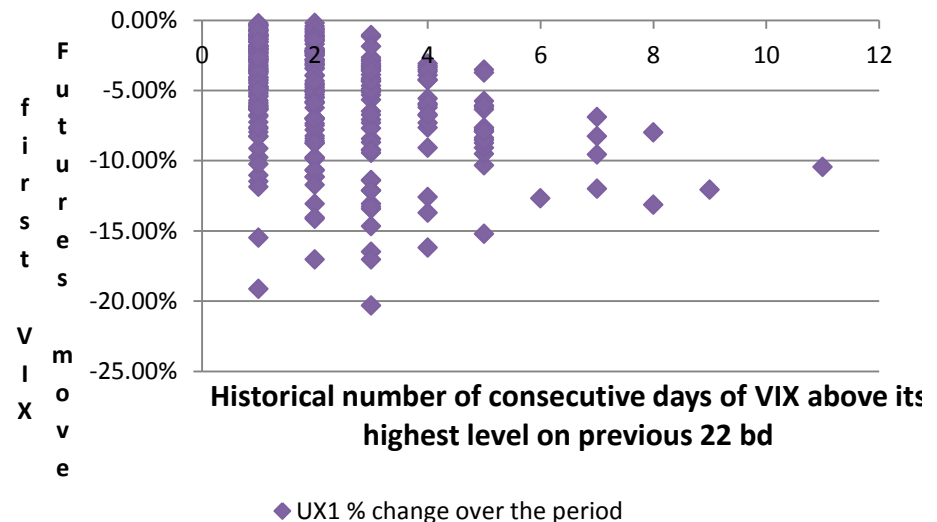
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## An Illustration of the Mean Reversion of the first rolled VIX future contracts ("UX1")

Since January 1990:

- The first VIX future rolled contract quoted (at the close of VIX index) below its 1m-low approximately 22 % of the time
- Once below its 1m-low, the first VIX future rolled contract stayed (at the close of VIX index) below that value for an average period of 2.25 days before moving back up
- The first VIX future rolled contract Index has never moved down by more than 21% during those above periods

Historical periods length (in consecutive bd) of first VIX future closing below its 1m-low and corresponding first VIX future move (%)



- Source: Natixis Financial Engineering, using Bloomberg Data

## Illustration of downside mean reversion of the first rolled VIX future contract



# How to trade Mean Reversion on VIX?

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## Basic mean reversion strategy:

- We have identified the first rolled VIX future contracts as a good proxy of the VIX index
- We have identified the first rolled VIX future contracts as a mean reverting underlying
- Basic systematic investment strategy:
  - Buy weekly variance swap against daily variance swaps on first rolled VIX future contract
  - In theory: product is worth 0 but it pays in case of effective mean reversion of the underlying
  - Daily cap of the delta exposure at 100% in absolute terms
- For liquidity issues, replicate the above strategy using delta component only

## Step 1: construction of a basic systematic Mean Reversion Strategy



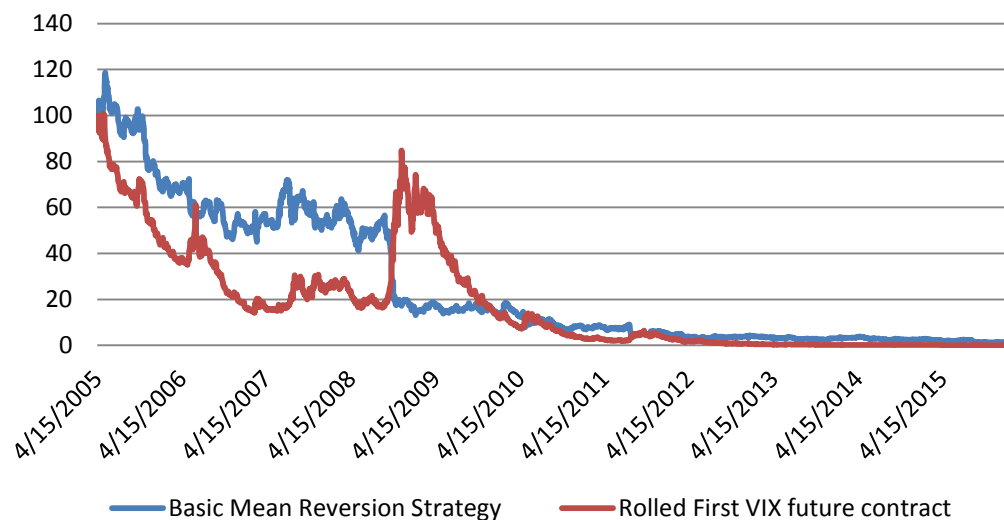
# How to trade Mean Reversion on VIX?

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- The historical performance of the basic mean reversion strategy is not attractive
- The contango has a significant impact on the strategy
- Need for timing in order to capture more value

## Historical simulation



• Source: Natixis Financial Engineering, using Bloomberg Data

## Step 1: construction of a basic systematic Mean Reversion Strategy



# How to trade Mean Reversion on VIX?

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## Statistical approach of when mean reversion is relevant on the first VIX future contract:

- Simulation of 10 systematic sub-strategies per observation window
- Each sub-strategy :
  - ✓ Systematically implements the basic mean reversion strategy on a daily basis if the rolled first VIX future falls between one predefined percentile at the close of the VIX index
  - ✓ 10 sub-strategies corresponding to 10 percentiles ( $\leq 10\%$ ,  $]10\%-20\%$ ],
  - ✓ 4 Observation windows considered: 1 month, 3 months, 6 months and 12 month
- Total number of strategy is 40 (10 sub-strategies for a given observation window)

## Step 2: A systematic approach based on statistics





# How to trade Mean Reversion on VIX?

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## SUMMARY OF RESULTS OF THE 10 SUB-STRATEGIES WITHIN A 1 MONTH WINDOW

- ✓ On a 1 month window the sub systematic strategy invested only on the [40%-50%] percentile would historically limit more the contango effect
- ✓ Mean Reversion would have been hurt more in the <10% percentile sub-strategy
- ✓ One month window is not historically an attractive one

Percentile	Internal rate of return (IRR)	Realised Volatility (Vol)	IRR/vol	Maximum Drawdown	Beta	Trade Proportion
<= 10%	-24.86%	25.31%	(0.98)	-96.47%	(0.31)	40%
[10%-20%]	-7.27%	13.96%	(0.52)	-57.21%	(0.09)	10%
[20%-30%]	-9.44%	10.98%	(0.86)	-67.00%	(0.02)	6%
[30%-40%]	-4.70%	9.48%	(0.50)	-48.70%	0.02	6%
[40%-50%]	-0.23%	7.11%	(0.03)	-26.61%	(0.01)	5%
[50%-60%]	-4.42%	8.72%	(0.51)	-43.59%	0.01	4%
[60%-70%]	-3.52%	11.10%	(0.32)	-37.41%	0.03	5%
[70%-80%]	-0.87%	10.14%	(0.09)	-19.85%	0.06	4%
[80%-90%]	-2.29%	12.33%	(0.19)	-38.37%	0.11	5%
> 90%	-9.55%	34.63%	(0.28)	-78.50%	0.65	14%

• Source: Natixis Financial Engineering, using Bloomberg Data

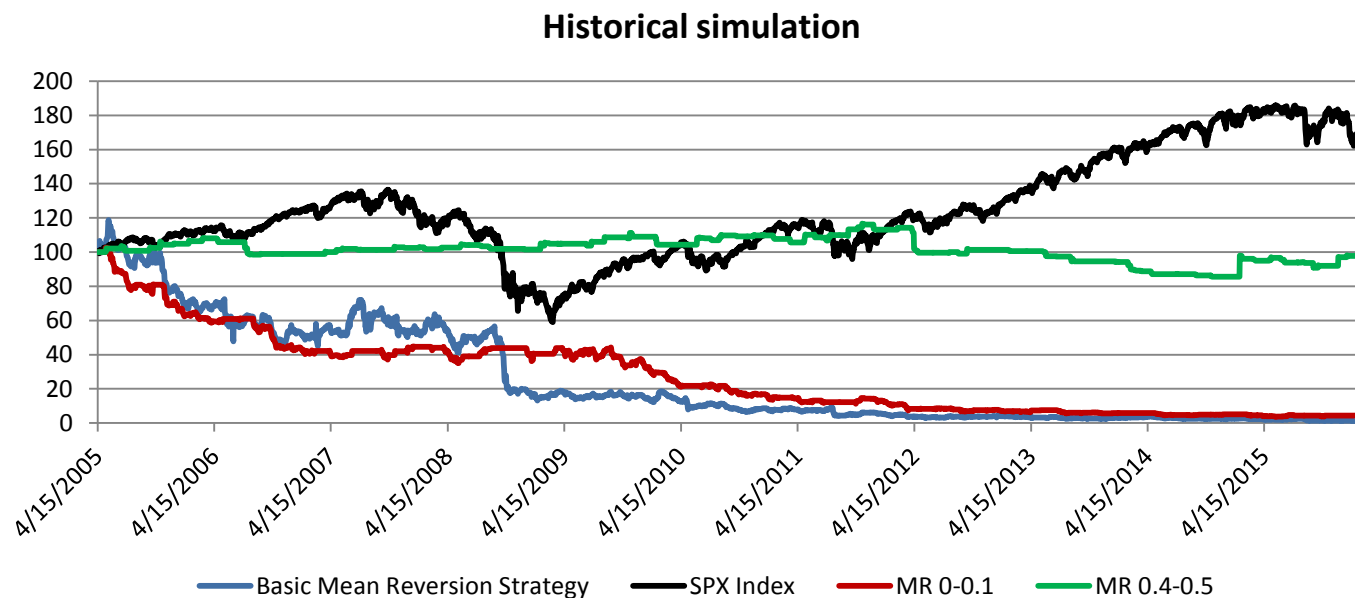
## Step 2: A systematic approach based on statistics – 1 month window

# How to trade Mean Reversion on VIX?

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## HISTORICAL SIMULATION OF THE BEST AND WORST SUB-STRATEGIES WITHIN A 1 MONTH WINDOW



• Source: Natixis Financial Engineering, using Bloomberg Data

## Step 2: A systematic approach based on statistics – 1 month window



# How to trade Mean Reversion on VIX?

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## SUMMARY OF RESULTS OF THE 10 SUB-STRATEGIES WITHIN A 3 MONTHS WINDOW

- ✓ On a 3 months window the sub systematic strategy invested only on the [20%-30%] percentile would historically perform better on a risk return basis
- ✓ Mean Reversion would have been hurt more on the <10% percentile sub-strategy

Percentile	Internal rate of return (IRR)	Realised Volatility (Vol)	IRR/vol	Maximum Drawdown	Beta	Trade Proportion
<= 10%	-24.58%	27.50%	(0.89)	-95.77%	(0.33)	46%
[10%-20%]	-4.81%	12.01%	(0.40)	-54.85%	0.01	10%
[20%-30%]	5.97%	11.50%	0.52	-17.15%	0.01	6%
[30%-40%]	-6.20%	11.14%	(0.56)	-53.28%	(0.01)	5%
[40%-50%]	-4.29%	11.67%	(0.37)	-45.01%	0.02	5%
[50%-60%]	-14.53%	15.46%	(0.94)	-82.05%	0.08	4%
[60%-70%]	-3.83%	9.17%	(0.42)	-42.22%	0.02	4%
[70%-80%]	2.91%	10.37%	0.28	-18.55%	0.03	5%
[80%-90%]	0.43%	10.95%	0.04	-30.31%	0.03	5%
> 90%	-9.56%	30.43%	(0.31)	-79.88%	0.57	10%

- Source: Natixis Financial Engineering, using Bloomberg Data

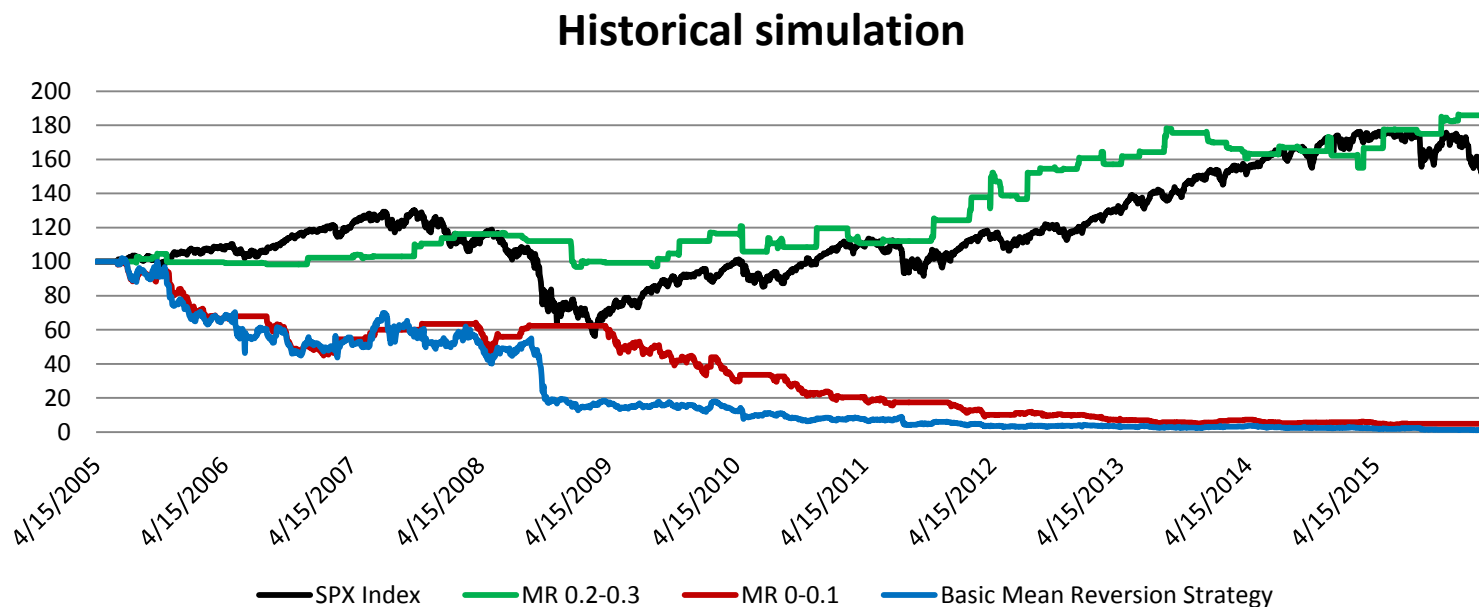
## Step 2: A systematic approach based on statistics – 3 months window

# How to trade Mean Reversion on VIX?

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## HISTORICAL SIMULATION OF THE BEST AND WORST SUB-STRATEGIES WITHIN A 3 MONTHS WINDOW



• Source: Natixis Financial Engineering, using Bloomberg Data

Step 2: A systematic approach based on statistics – 3 months window





# How to trade Mean Reversion on VIX?

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## SUMMARY OF RESULTS OF THE 10 SUB-STRATEGIES WITHIN A 6 MONTHS WINDOW

- ✓ On a 6 month window the sub systematic strategy invested only on the [10%-20%] percentile would have historically performed better on a risk return basis and offered a good diversification
- ✓ Mean Reversion would have been hurt more in the <10% percentile sub-strategy

Percentile	Internal rate of return (IRR)	Realised Volatility (Vol)	IRR/vol	Maximum Drawdown	Beta	Trade Proportion
<= 10%	-22.76%	28.93%	(0.79)	-94.68%	(0.26)	49%
[10%-20%]	1.34%	13.84%	0.10	-20.20%	0.02	9%
[20%-30%]	-10.45%	16.44%	(0.64)	(0.70)	0.06	7%
[30%-40%]	-4.01%	10.68%	(0.38)	-41.48%	0.00	5%
[40%-50%]	-3.81%	15.46%	(0.25)	-39.00%	0.07	5%
[50%-60%]	0.41%	15.50%	0.03	-30.14%	0.05	4%
[60%-70%]	-0.65%	10.61%	(0.06)	-31.02%	(0.01)	5%
[70%-80%]	-5.55%	10.86%	(0.51)	-52.94%	0.06	4%
[80%-90%]	-4.32%	10.79%	(0.40)	-43.71%	0.05	4%
> 90%	-5.30%	24.36%	(0.22)	-69.57%	0.40	8%

- Source: Natixis Financial Engineering, using Bloomberg Data

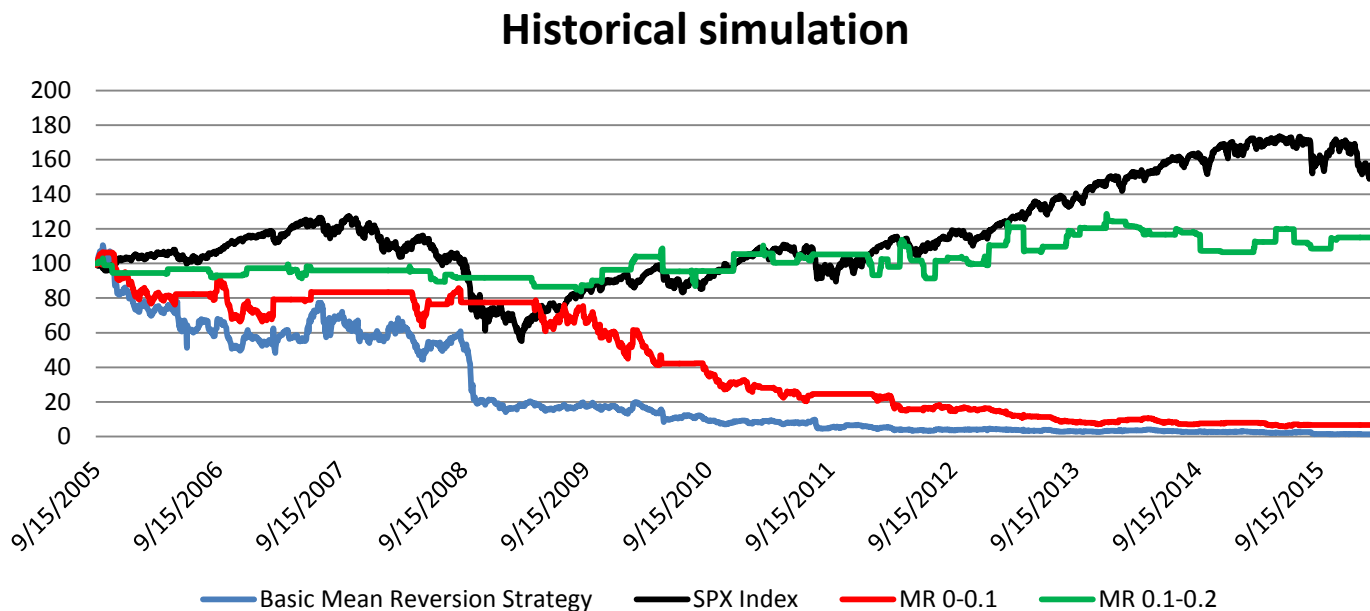
## Step 2: A systematic approach based on statistics – 6 months window

# How to trade Mean Reversion on VIX?

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## HISTORICAL SIMULATION OF THE BEST AND WORST SUB-STRATEGIES WITHIN A 6 MONTHS WINDOW



• Source: Natixis Financial Engineering, using Bloomberg Data

## Step 2: A systematic approach based on statistics – 6 months window



# How to trade Mean Reversion on VIX?

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## SUMMARY OF RESULTS OF THE 10 SUB-STRATEGIES WITHIN A 12 Months WINDOW

- ✓ On a 12 months window the sub systematic strategy invested only on the [30%-40%] percentile would have historically performed better on a risk return basis and offered a good diversification
- ✓ Mean Reversion would have been hurt more from a risk return perspective on the [40%-50%] percentile sub-strategy

Percentile	Internal rate of return (IRR)	Realised Volatility (Vol)	IRR/vol	Maximum Drawdown	Beta	Trade Proportion
<= 10%	-14.37%	30.25%	(0.47)	-85.42%	(0.16)	48%
[10%-20%]	-11.93%	19.63%	(0.61)	-73.71%	0.05	13%
[20%-30%]	-9.24%	21.16%	(0.44)	(0.62)	0.13	9%
[30%-40%]	6.93%	12.31%	0.56	-27.51%	0.03	6%
[40%-50%]	-11.00%	13.01%	(0.85)	(0.69)	0.04	4%
[50%-60%]	-7.05%	15.12%	(0.47)	-61.06%	0.08	2%
[60%-70%]	4.53%	12.61%	0.36	-15.09%	0.03	3%
[70%-80%]	3.55%	10.87%	0.33	-23.80%	(0.02)	5%
[80%-90%]	-9.20%	12.10%	(0.76)	-63.12%	0.05	6%
> 90%	-2.75%	15.41%	(0.18)	-56.82%	0.23	5%

- Source: Natixis Financial Engineering, using Bloomberg Data

## Step 2: A systematic approach based on statistics – 12 months window



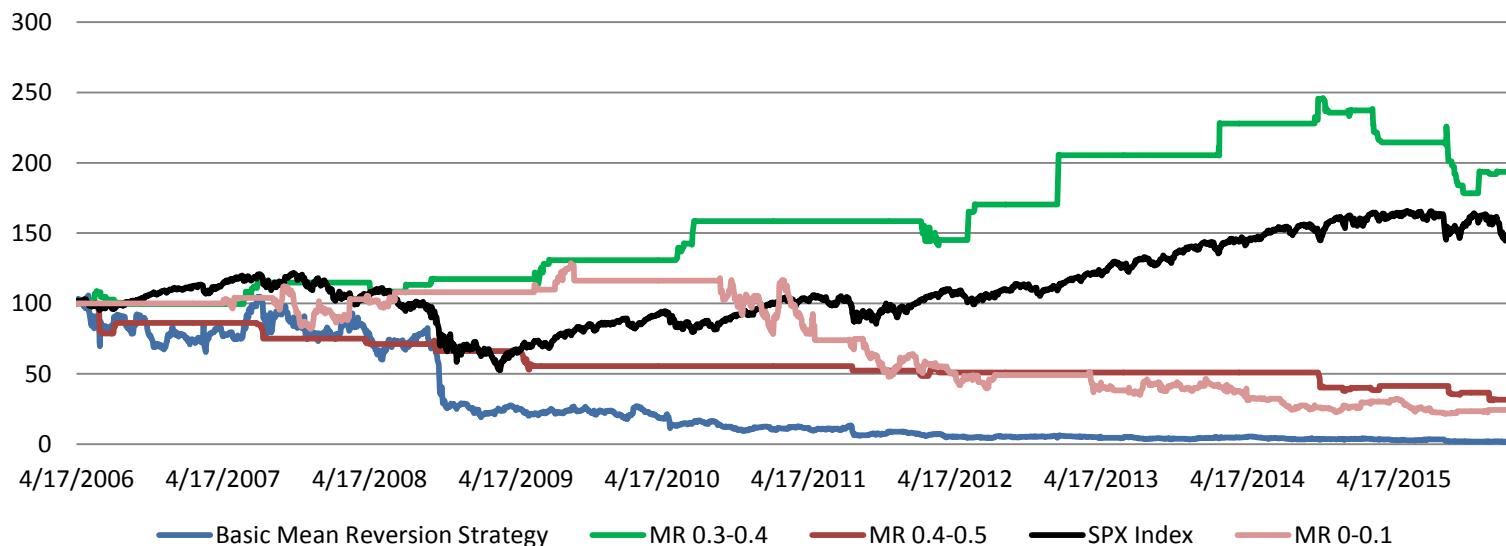
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## HISTORICAL SIMULATION OF THE BEST AND WORST SUB-STRATEGIES WITHIN A 12 MONTHS WINDOW

### Historical simulation



• Source: Natixis Financial Engineering, using Bloomberg Data

## Step 2: A systematic approach based on statistics – 12 months window





# How to trade Mean Reversion on VIX?

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## SUMMARY: SOME DIVERSIFICATION AMONG THE 4 SUB-STRATEGIES SHORT LISTED

- 1 month window: mean reversion applied to the [40%-50%] percentile
- 3 months window: mean reversion applied to the [20%-30%] percentile
- 6 months window: mean reversion applied to the [10%-20%] percentile
- 12 months window: mean reversion applied to the [30%-40%] percentile
- Mean reversion on implied volatility have been a very risky strategy in very high or very low volatility environment
- 3 months and 12 months windows have historically been the best windows

### -Historical correlation matrix

	MR 0.3-0.4 12m Window	MR 0.1-0.2 6m Window	MR 0.2-0.3 3m Window	MR 0.4-0.5 1m Window
MR 0.3-0.4 12m Window	100.00%	-0.07%	1.53%	3.05%
MR 0.1-0.2 6m Window	-0.07%	100.00%	53.60%	0.67%
MR 0.2-0.3 3m Window	1.53%	53.60%	100.00%	1.86%
MR 0.4-0.5 1m Window	3.05%	0.67%	1.86%	100.00%

- Source: Natixis Financial Engineering, using Bloomberg Data

## Step 3: taking advantage of the intra diversification

# How to trade Mean Reversion on VIX?

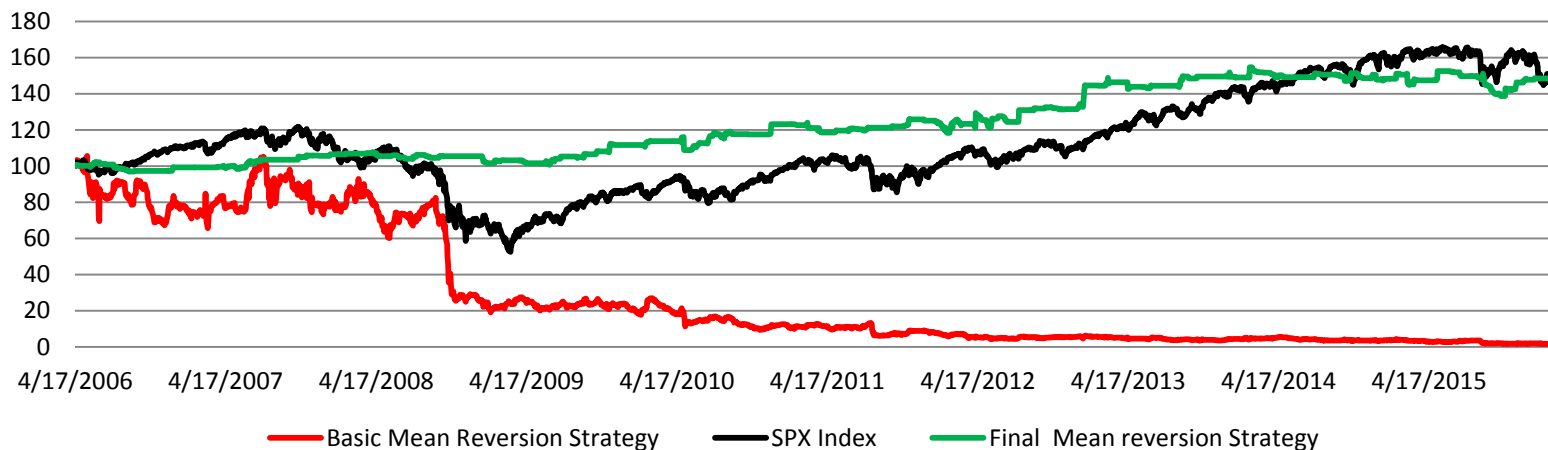
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FINAL SYSTEMATIC MEAN REVERSION STRATEGY: EQUALLY WEIGHTED AMONG THE 4 SUB-STRATEGIES

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- 1 month window: mean reversion applied to the [40%-50%] percentile
- 3 months window: mean reversion applied to the [20%-30%] percentile
- 6 months window: mean reversion applied to the [10%-20%] percentile
- 12 months window: mean reversion applied to the [30%-40%] percentile

## Historical simulation



• Source: Natixis Financial Engineering, using Bloomberg Data

## Step 3: building the final mean reversion strategy on VIX



# How to trade Mean Reversion on VIX?

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## FINAL SYSTEMATIC MEAN REVERSION STRATEGY: EQUALLY WEIGHTED AMONG THE 4 SUB-STRATEGIES

- 1 month window: mean reversion applied to the [40%-50%] percentile
- 3 months window: mean reversion applied to the [20%-30%] percentile
- 6 months window: mean reversion applied to the [10%-20%] percentile
- 12 months window: mean reversion applied to the [30%-40%] percentile

## ➤ AN ILLUSTRATIVE EXAMPLE OF SYSTEMATIC MEAN REVERSION STRATEGY ON IMPLIED VOLATILITY BASED ON A STATISTICAL APPROACH

Indicative Statistics	Basic Mean Reversion Strategy	S&P 500 Index Index	Final Mean reversion Strategy
Internan Rate of Return (IRR)	-33.4%	4.2%	4.1%
Standart deviation (Stdev)	54.3%	21.0%	7.0%
IRR/Stdev	(0.61)	0.20	0.58
Beta	0.46	1.00	0.02
MDD	-98.4%	-56.8%	-10.3%
Correlation	17.9%	100.0%	5.0%

- Source: Natixis Financial Engineering, using Bloomberg Data

## Step 3: building the final mean reversion strategy on VIX



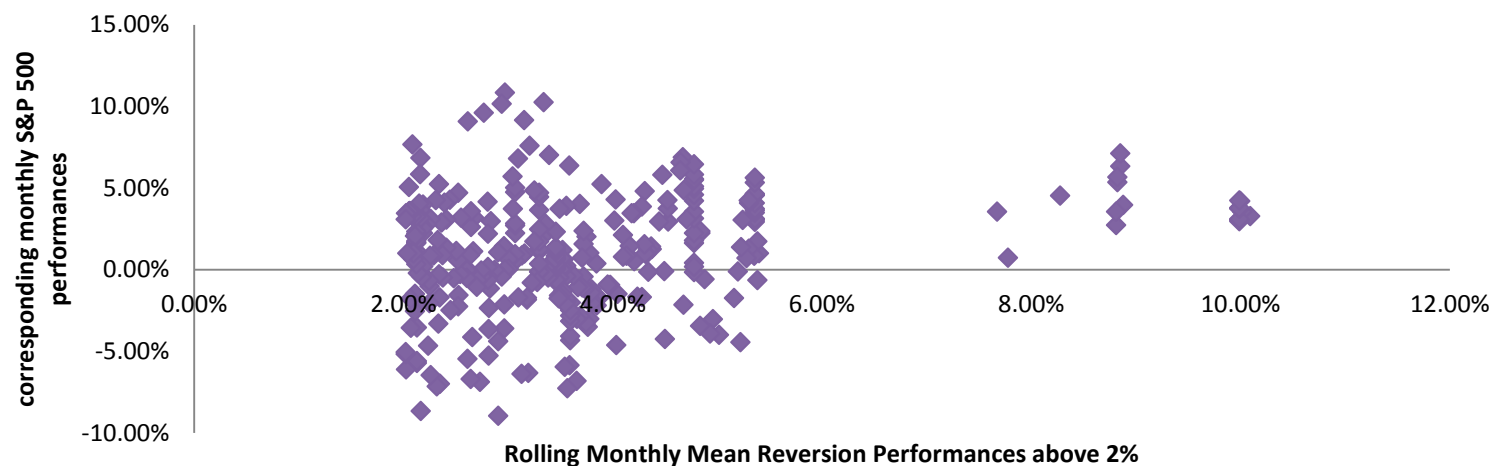
## How to trade Mean Reversion on VIX?

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### ILLUSTRATIVE FINAL SYSTEMATIC MEAN REVERSION STRATEGY: EQUALLY WEIGHTED AMONG THE 4 SUB-STRATEGIES

- Good performance can occur in both bullish and bearish market environments on Mean Reversion strategy



◆ S&P Index monthly performance for Mean reversion monthly performance  $\geq 2\%$

- Source: Natixis Financial Engineering, using Bloomberg Data

### Step 3: building the final mean reversion strategy on VIX





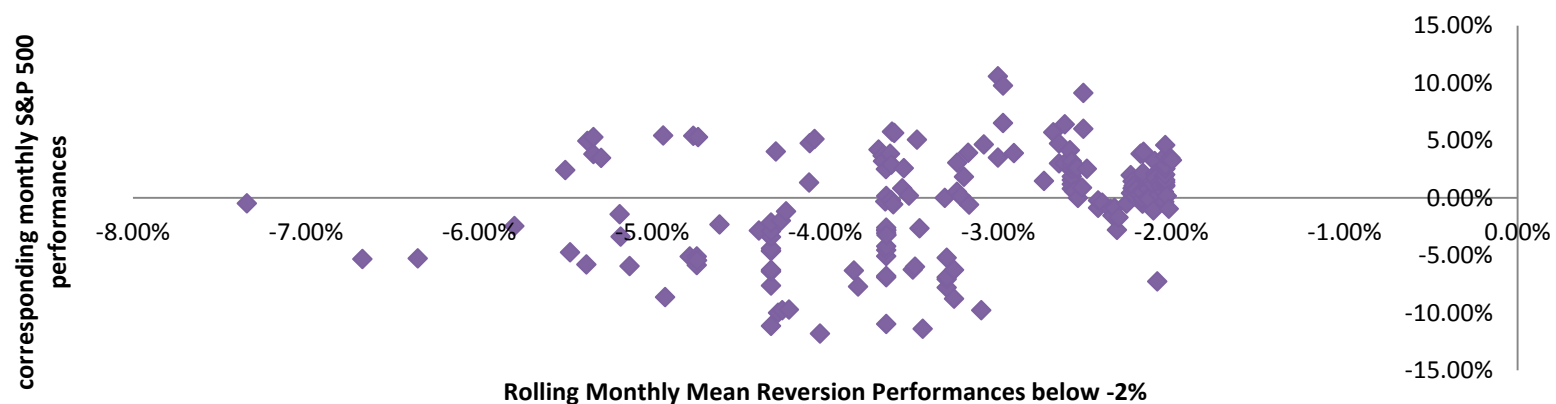
## How to trade Mean Reversion on VIX?

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### ILLUSTRATIVE FINAL SYSTEMATIC MEAN REVERSION STRATEGY: EQUALLY WEIGHTED AMONG THE 4 SUB-STRATEGIES

- Poor performance can occur in both bullish and bearish market environments on Mean Reversion strategy



◆ S&P Index monthly performance for Mean reversion monthly performance  $\leq -2\%$

- Source: Natixis Financial Engineering, using Bloomberg Data

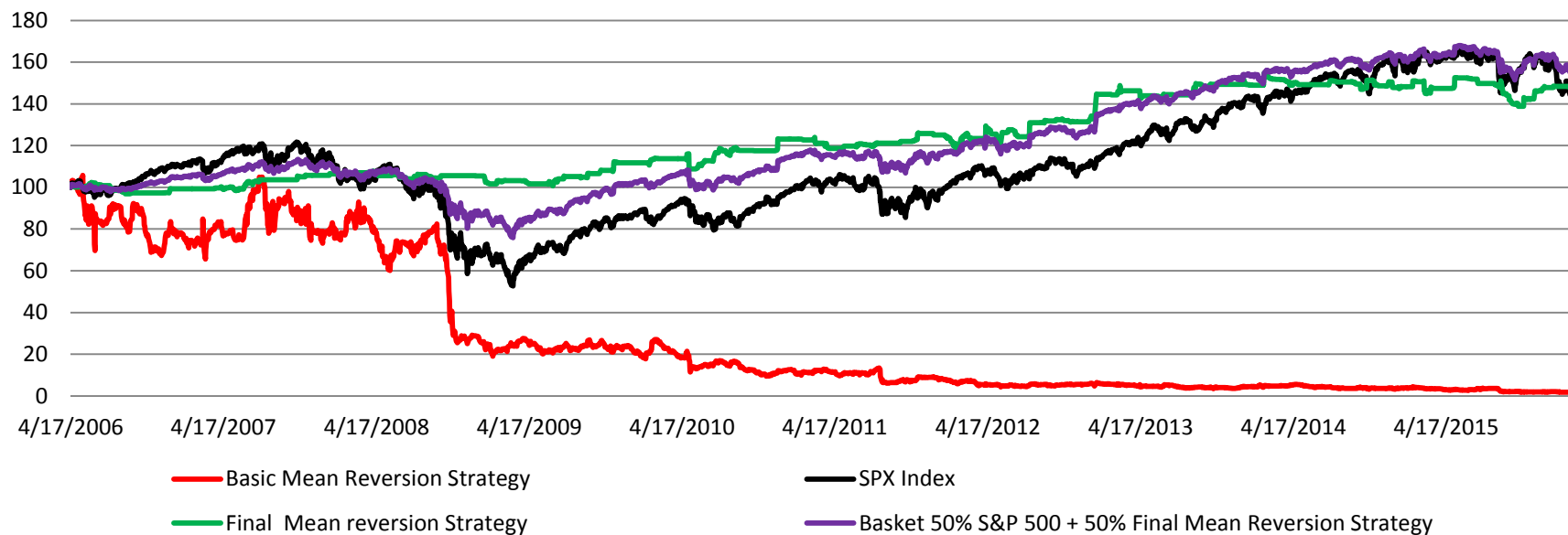
### Step 3: building the final mean reversion strategy on VIX

# How to trade Mean Reversion on VIX?

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## Historical simulation



• Source: Natixis Financial Engineering, using Bloomberg Data

Equal weight basket between the S&P 500 and the final mean reversion strategy



# Customizable Volatility Screener

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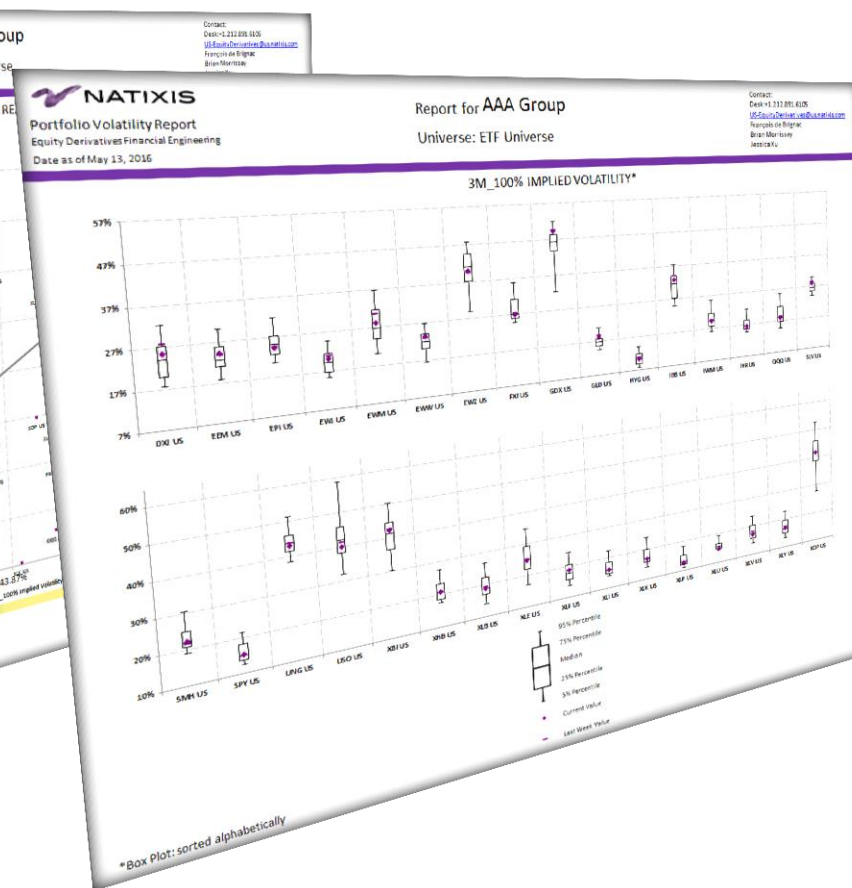
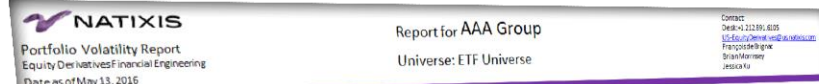
## Adding value for our clients

- We have a customizable volatility screener that helps clients visualize trends in volatility
- When a client shares their portfolio holdings with us (after signing an NDA), we can run internal reports to determine where vol is 'cheap' and where vol is 'expensive' relative to its sector and its single stock/ETF history
- This can aid in mean reversion strategies and other volatility plays

# Customizable Volatility Screener

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# Conclusion

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- Questions?





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