Volatility of Volatility
CBOE Risk Management Conference

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Picton Mahoney Asset Management (PMAM) is a Canadian portfolio management boutique. We manage over $9 billion CAD in assets for investors through three lines of investment solutions:

- Authentic hedge strategies
- Sub-advisory services
- Institutional long-only mandates

**Our Founding Principles:**

- Authenticity
- Transparency
- Capacity
The diagram below shows the growth in assets under management per annum since inception from 2004 — December 31, 2014.

### Breakdown of PMAM Assets Under Management As at December 31, 2014 (Million CAD$)
- Retail Funds: $1,868.6 (20.3%)
- Endowments & Foundations: $489.3 (5.3%)
- Pension Fund: $1,394.3 (15.2%)
- Sub Advisory: $5,449.2 (59.2%)

### Geographical Composition of Portfolio Assets Under Management As at December 31, 2014 (Million CAD$)
- Canada: $5,042.9m (54.8%)
- US: $2,782.8m (30.2%)
- International: $1,375.8m (15.0%)
Volatility of volatility is not new in town

- Every option book has exposure to vol of vol (i.e. gamma of gamma or 4th moment)

- Vol of vol is the sensitivity of out-of-money options in relation to those at-the-money

- Why we increasingly hear about it:
  - Because vol of vol is directly related to “convexity”
  - Because vol of vol is directly related to “tails” (post-crisis everyone cares about “tails”)
  - Because VIX options are now being used by a wide range of market participants, and vol of vol matters in pricing and trading them
How to get exposure to vol of vol (pre-VIX options or other underlyings)

**Ratio back spreads: trade ATM options vs. multiple OTM options**

- Sell 1 ATM call Buy 2 x OTM call delta hedged
- Not as “clean” as trading vol of vol products (lower moments can take over)
Great news: Vol of vol is increasingly tradable (thank you CBOE!)

Open Interest of VIX options

Source: Bloomberg, Picton Mahoney Research, as at Feb 27, 2015.
Great news: Vol of vol is increasingly tradable (thank you CBOE!)

Source: Barclay’s Equity Derivatives Strategy Group, as at Feb 24, 2015.
Volatility of volatility in the context of VIX options

- Implied terminal PDF of VIX based on VIX options prices
- Realized distribution of VIX returns
- Implied distribution of VIX returns
- Characteristics of implied surface of volatility of VIX options
  - Term structure
  - The skew
Vol of vol distribution: lognormal?
Implied price distribution

Implied price distribution for Mar 2015 on Feb 26th, 2015

Source: Picton Mahoney Asset Management, Bloomberg
Vol of vol distribution: lognormal?
1 month constant maturity VIX daily returns

Source: Bloomberg
Vol of vol distribution: Lognormal?

Implied volatility by strike (as of Feb 27th)

Source: Picton Mahoney Asset Management, Bloomberg
Vol of vol term structure: Backwardation

Term structure of volatility of VIX and V2X on Feb 27 (ATM Options)

VIX

V2X

Source: Picton Mahoney Asset Management, Bloomberg
Vol of vol term structure: Backwardation

Rolling 3 months beta of VIX futures to VIX spot

Source: Picton Mahoney Asset Management, Bloomberg
Vol of vol term structure: Backwardation

Beta of VIX futures with VIX spot (3 mths rolling since June 2012)

Source: Picton Mahoney Asset Management, Bloomberg, as at Feb 27, 2015
Vol of vol in practice:
Similarities to commodities and fixed income

- **Each maturity represents a different underlying**
  - VIX futures are “forwards”: curve dynamics similar to forward rates

- **VIX and commodities exhibit higher uncertainty in the shorter maturities**
  - For commodities, the reason is supply/demand disruptions and implication of storage
  - VIX is similar: supply demand of gamma (the shorter expiry S&P option prices are – all else being equal – more sensitive to market movements, hence buying or selling gamma)

- **While the curves of the underlyings have many degrees of freedom, they are held by various relationships**
  - Fixed income: bootstrapping
  - Commodity: cost of carry
Volatility term structure for NatGas and Crude Oil futures

Source: Picton Mahoney Asset Management, Bloomberg
Vol of vol term structure:
Similarities with forward rates vol term structure

Implied volatility (bps annual)
of 1yr rate forward (1y in ... years) USD Feb 27th

Source: Picton Mahoney Asset Management, Bloomberg
Vol of vol in practice:
Similarities to commodities and fixed income

What kind of practical implications?

• If one has fundamental views on the underlying:
  • Calendar spread trades
  • Conditional curve trades
  • Roll down (carry) trades
  • Options on spread (i.e curve options in fixed income or CSO)
  • Midcurve options (ex: an option on June VIX expiring in April)
Vol of vol in practice:
Examples of carry and hedge

**Roll down (carry trade)**
- Put calendars
- Starts by having a view on the VIX term structure
- Takes into account concavity, vol of vol level to estimate positive carry

**Risk-off hedge**
- Call calendars
- Takes into account concavity, vol of vol level to estimate negative carry
Vol of vol in practice: Future developments?

Option on spreads

- A pure way of playing the steepening/flattening
- Trading vol of and vol and the correlation of VIX future curve

Mid-curves

- The possibility of trading the curve conditionally
- Price discovery of the term structure of a given maturity VIX future and gaining exposure to it
Volatility of VIX options is high enough for usual “intuition” and “common sense” to be misleading

- Delta of a month ATM call with a 120 vol and 2 month to expiry is 60%

Delta hedging (for those who want to pick up the risk premium)

- Can we (should we) use a different model than B&S?
  - CEV, local volatility, SABR, etc.
- If we use B&S to price, what approach should we have: “sticky delta” or “sticky strike”?
  - Let’s look at the real option prices and see how they have behaved to get a clue
The vol / vvol relationship:
Sticky delta? (Jan-08 to Feb-15)

\[ y = 0.7426x + 75.283 \]
\[ R^2 = 0.0886 \]

Source: Picton Mahoney Asset Management, Bloomberg
The vol / vvol relationship:
Sticky strike (Jan-14 to Feb-15)

VIX future vs. vol of 50 delta VIX option

Source: Picton Mahoney Asset Management, Bloomberg
We have witnessed tremendous evolution (increase) in VIX ETNs

- 1 Month constant maturity ETN launched in 2010
- Increase in levered ETNs AUM (and vega) since 2012
- Addition of dynamic ETNs
- And many OTC products offered by dealers (systematic and dynamic/rule based)

Has this proliferation of volatility products had any effect on the behavior of volatility?

- We have observed increased vol of vol in recent past
Vol of vol changing landscape: Volatility ETNs

ETN (unlevered + levered) vega

Source: Picton Mahoney Asset Management, Bloomberg
Vol of vol changing landscape: Volatility ETNs a driver?

**VIX ETN Vega** vs. Subsequent 1 Month Realized Volatility of 1st Month VIX future (Oct 11 to Feb 15)

* Includes the following Exchange traded notes: VXX, XIV, TVIX, SVXY, UVXY

Source: Picton Mahoney Asset Management, Bloomberg
Vol of vol changing landscape: Levered ETNs seem plausible cause of increased VIX future volatility

VIX ETN Vega * vs. Subsequent 1 Month Realized Volatility of 1st Month VIX future (Apr 14 to Feb 15)

\[ y = 4E-06x - 0.1814 \]
\[ R^2 = 0.138 \]

Increase in vega outstanding especially of levered volatility ETN seems to have a causal effect on the level of vol of vol

Source: Picton Mahoney Asset Management, Bloomberg
Volatility of volatility: Final thoughts

- A direct way to hedge or get exposure to “convexity”
- The advent of volatility products has made vol of vol accessible to many participants and is efficiently tradable
- The liquidity in the VIX complex has made many previously theoretical strategies a possibility
- Trading instruments with vol of vol exposure requires some preparation: understand pricing and sensitives
- More products will (hopefully) emerge and complete the market
  - Mid-curves, spread options, etc.
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