Impact of Variable Annuity Hedging

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Vega embedded in Variable Annuity Riders

- Total assets under management : $ 1.7 trillion
- Policies with living benefits : $ 700 billion
- Equity exposure of living benefits : $ 500 billion
- Total equity vega of living benefits : $ 1.25 billion

Source : BNP Paribas, LIMRA

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Insurance companies vega hedging

- Insurance companies are the largest buyers of long term SPX volatility.
- The standard hedging instrument is a SPX vanilla put. The average delta is around 25%.
- Hedging activity has increased since 2009. Since 2010, insurance companies are buying every year around $ 75 mln vega of long term SPX puts (maturity from 5 to 10 years).
- Trading activity has significantly decreased over the last 2 quarters.

Insurance companies current position in SPX and SPTR options

Maturity	<=6m	6m – 18m	18m – 5y	> 5y
Notional ($mln)	**20,025**	**30,303**	**22,706**	**22,171**
Vega ($mln)	**21**	**44**	**94**	**203**

Insurance companies vega traded in SPX and SPTR options over the last quarters

Vega ($000)					
	<=6M	6M – 18M	18M – 66M	>66M	Total
Q4 2012	3,398	5,227	9,308	22,401	**40,333**
Q1 2013	18,867	16,724	21,598	10,061	**67,251**
Q2 2013	19,402	12,463	10,289	1,745	**43,899**

Source : BNP Paribas, NAIC Schedule DB

Hedging Impact on SPX Long Term Volatility (1/2)

Variable annuity hedging has created a significant risk premium in SPX long term volatility.

S&P500 implied volatility since Oct 2003

Implied Volatility

50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%

Oct-03 Apr-04 Oct-04 Apr-05 Oct-05 Apr-06 Oct-06 Apr-07 Oct-07 Apr-08 Oct-08 Apr-09 Oct-09 Apr-10 Oct-10 Apr-11 Oct-11 Apr-12 Oct-12 Apr-13

10 years
2 years

Source : BNP Paribas as of 30 Sep 2013. Past performance is not indicative of future performance

Hedging Impact on SPX Long Term Volatility (2/2)

Long term volatility risk premium is higher on S&P500 than Eurostoxx50. The difference has increased since 2009.

Difference between 10y and 2y implied volatility

Volatility pts

10
8
6
4
2
0
-2
-4
-6
-8
-10

SPX
SX5E

Oct-05 Apr-06 Oct-06 Apr-07 Oct-07 Apr-08 Oct-08 Apr-09 Oct-09 Apr-10 Oct-10 Apr-11 Oct-11 Apr-12 Oct-12 Apr-13

Source : BNP Paribas as of 30 Sep 2013. Past performance is not indicative of future performance

Hedging impact on implied dividends

Insurance companies are mainly buyers of SPX puts.
Dealers are short long term SPX implied dividends.

Implied dividend term structure

160%
150%
140%
130%
120%
110%
100%
90%
80%
70%
60%

SPX
SX5E

1y 2y 3y 4y 5y 7y 10y

Source : BNP Paribas as of 30 Sep 2013. Past performance is not indicative of future performance

Long term volatility supply

- Supply was initially provided by dealers
  - Hedging started in 2005
  - Short term to long term vega transformation

- Berkshire sold vanilla and worst of put options in 2006
  - average maturity 15 years
  - Premium $ 5 billion   Vega $250 million

- Pension Funds & Hedge Funds
  - Before credit crisis sold mainly through 10 years SPX variance swaps
    - around $ 150 million vega
  - Some liquidated their positions during the crisis.

- Since 2010 supply has moved towards fixed strike downside puts or strangles
  - Skew and dividend exposure
  - Less convexity than variance swaps

Source : BNP Paribas, public reports

Disclaimer

Call or Put Purchasing: The risk of purchasing a call/put is that you will lose the entire premium paid.
Call or Put Vertical Spread Purchasing (same expiration month for both options): The basic risk of effecting a long spread transaction is limited to the premium paid when the position is established.
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