Research Paper

For

National Stock Exchange

On

Imbalances Created because of Structured Products in Indian Equity markets

By

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Abstract

This paper is study of effect of hedging of structured products on exchange traded equity products. We look at various aspects of the structured product markets including the motivation to buy, the risks of the products, the hedging behavior and the effect of hedging on exchange traded products. We conclude the hedging would be volatility supportive in a sell off and would be volatility suppressing in significant rally. We also suggest introduction of some new exchange products that would make the hedging process easy and also would help some retail investors express their view in a better fashion without the transaction costs involved in structured products.

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Introduction

Derivative trading is essential tool for the health of markets as they enhance price discovery and supplement liquidity. Although derivatives have been introduced very late in Indian equity markets they picked up prominence very quickly. In June 2000, index futures were introduced as the first exchange traded equity derivative product in the Indian markets. In a span of a year and a half after that index options, stock options and lastly stock futures were introduced. Since then, derivatives volumes have grown to multiples of cash market volumes and have been a mode of speculation and hedging for market participants, not possible otherwise through cash markets.

In 2007, Statistics from the NSE show that retail investors have been the largest participants in the derivatives markets in the past four-five years, accounting, on average, for around 60 per cent of all derivatives based activity.

Although derivatives are good instruments to expresses complex non linear views on markets, lack of sophistication and understanding has given rise to investments into structured products, which have derivative like payoffs but are bespoke and not exchange traded.

With the advent of structured products, many retail and HNI investors have been able to invest for more exotic payoffs compared to linear payoff they used to realize from their cash investments. In 2007, there were numerous institutions offering structured products to their clients and that has lead to growth of the institutional presence in derivatives segment. While the investor invests for a certain period, the issuer of the product constantly uses derivatives segment to hedge his positions to create the desired payoff for its clients.

Before the arrival of structured products the main avenues of investment for individual investors have been either investing directly in stocks or equity based mutual funds or in certain cases investing in fixed income securities like corporate and government bonds. Structured products have been created as an alternative to directly investing in underlying asset to give additional benefits to the investor.

The benefits of structured products include:

- principal protection
- diversification benefits (if the product is linked to an index or a basket of securities)
- tax-efficient access to fully taxable investments

- enhanced returns within an investment
- reduced volatility (or risk) within an investment
- express specific view of the investor

Unlike other exchange traded securities and derivatives, structured products are by nature not homogeneous - as the variety of underlying, payoff structure and maturities can vary significantly. The underlying instruments in structured products can however be broadly classified under the following categories

- Equity-linked Notes & Deposits
- Interest rate-linked Notes & Deposits
- FX and Commodity-linked Notes & Deposits
- Hybrid-linked Notes & Deposits
- Credit Linked Notes & Deposits
- Market Linked Notes & Deposits

Although structured products and OTC derivatives can be traded on a variety of asset classes the scope of this paper is to study the structured products linked to Equities. Now on when we say “Structured Products” it is to be assumed that we refer to the products linked to equity only.

Composition of the Structured Product Market

Prudential ICICI introduced India's first capital-protected constant proportion portfolio insurance (CPPI) product for Indian investors, dubbed the Principal Protected Portfolio (PPP). Developed with Deutsche Bank in London, the product was one of the biggest innovations to hit the Indian market

Prudential ICICI's CPPI has since been copied by a host of other issuers keen to tap the demand for principal protection. Typically, these products are issued within the portfolio management services (PMS) line offered by banks to their high-net-worth clients, although the growing appeal of capital protection has also seen the CPPI structure filtering into retail market. Subsequent to that another major development has been the issuance of structured products in note format, created using 'synthetic' options. The first of these was issued by Standard Chartered and structured by Merrill Lynch, offering investors an option-based payoff. The synthetic options are hedged by dealers with

international branches and issued in debenture format[1]. As demand for these products developed the market saw several issuers coming up with a range of products to suit the needs of the investors. Currently the suite of products available for investors is very rich in variety and innovation.

The existing structured products in the equity space can be broadly classified into the following categories:

- Equity linked notes (debentures) with capital protection
- CPPI and related structures
- Range accruals on Equity index/basket of stocks
- Autocallable notes and other exotic structures
- Structured on baskets of stocks

In this section we give a brief description of each of the products to enable the reader grasp the payoff of these structures. We also discuss the motivation behind investing in each of the products.

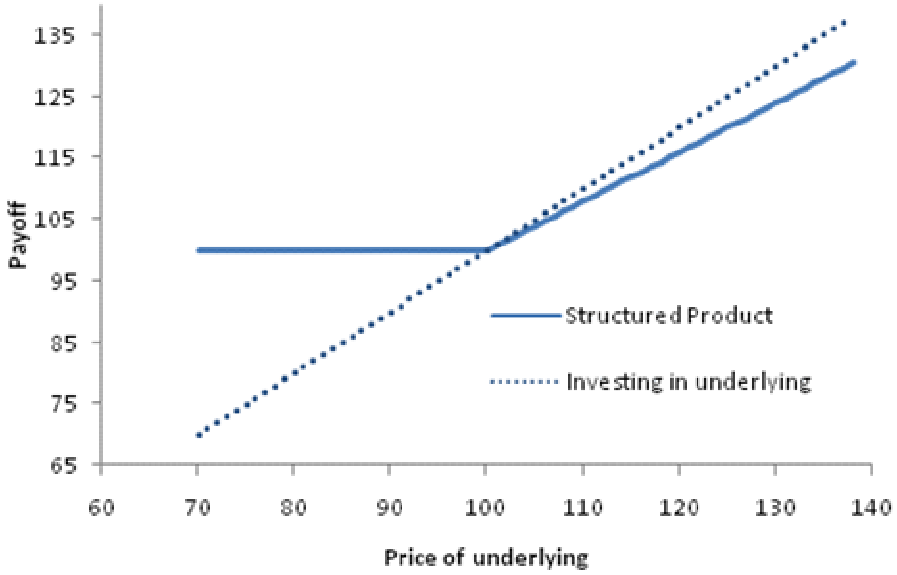
Equity Linked Debentures

An Equity-Linked Note (ELN) is an instrument that provides investors fixed income like principal protection together with equity market upside exposure. Capital protected equity linked notes are about the most prevalent of the structured products and constitute about 90% of the market in Indian equity linked structured products. Hence we devote significant part of this section and the future sections discussing various aspects of these notes.

The investment structure generally provides 100% principal protection, which means the capital of the investor is returned back at maturity. The coupon at maturity on the other hand is variable and is determined by the appreciation of the underlying equity. The payoff of a simple structured product with capital protection is juxtaposed with the payoff of investing in the underlying in the chart below.[2] By giving up part of upside (participation in upside is typically less than 100%) the investor gets a protection against downside. The instrument is appropriate for conservative equity investors or fixed income investors who desire equity exposure with controlled risk.

[1] Structured Products – A Positive Correction: http://www.structuredproductsonline.com/public/showPage.html?page=430482

[2] The charts displayed in this section are for the purpose of illustration alone and do not correspond to actually market prices.

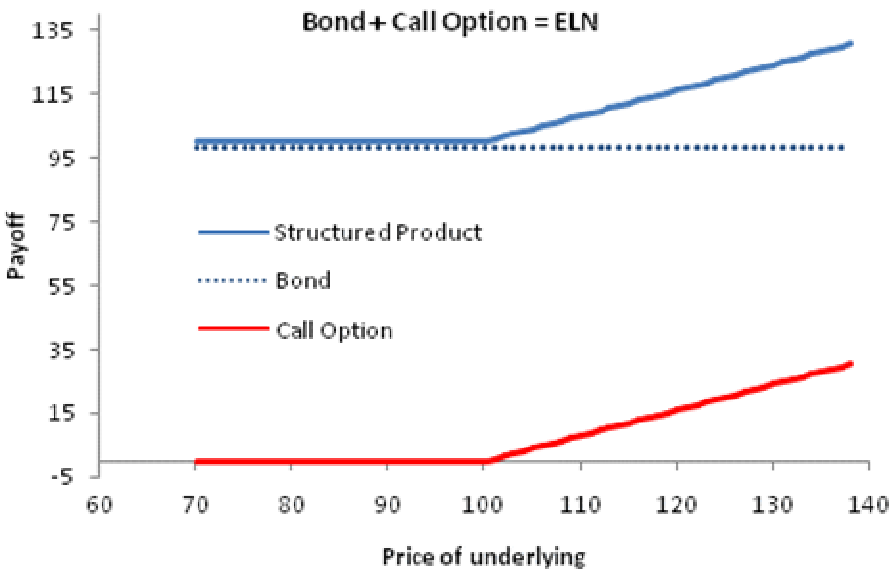


As an example of an ELN, assume an investor buys a hypothetical five-year 100% principal protected Equity-Linked Note with 80% participation in the upside of the S&P Nifty Index for Rs. 1,000. The starting index level is 4000. At maturity, if the S&P Nifty Index level is above 4000, then the payoff of the note will be Rs. 1,000 in principal plus an equity-linked coupon equivalent to any increase in the index. For example, if the index level in five years is 5000 (an appreciation of 25%), then the coupon would be Rs. 200 (80%*25%*1,000) and the total payoff would be Rs. 1,200 (1,000 + 200).

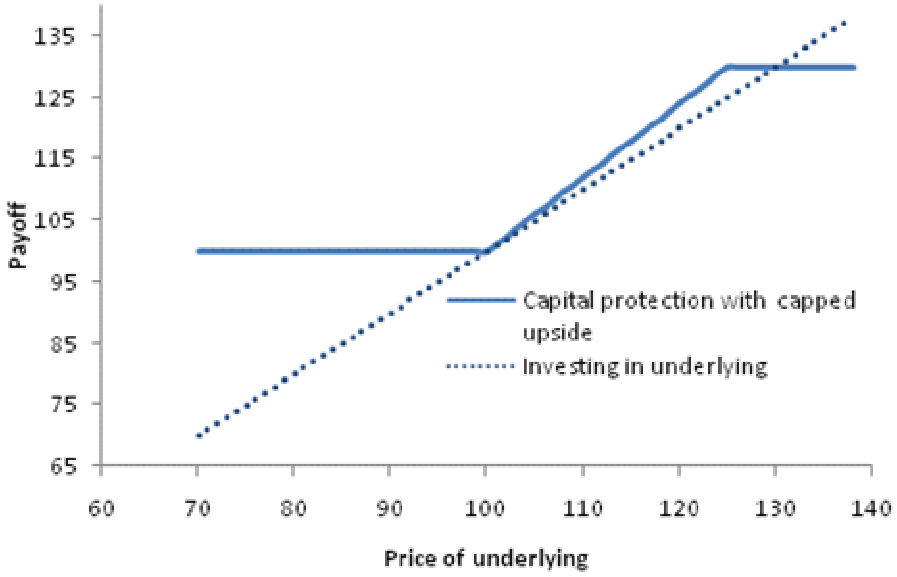
If the index level is below 4000 at maturity, i.e., the underlying equity performance is negative, the final payoff to the investor will be Rs. 1,000 in principal.

An ELN is structured by combining the economics of a long call option on equity with a long discount bond position.

Bond + Call Option => Equity Linked Note => Principal Protection + Equity Participation



Participations of more than 100% can be achieved by capping the upside beyond a certain level. In this case the payoff of the client linearly increases if at maturity the underlying is more than at the start of the product but after certain level the profits become flat. The chart below illustrates the payoff of such a product.



In this case the ELN is equivalent to a zero coupon bond plus a long ATM call and short position in high strike call.

Bond + Call Option – High strike call option => Principal Protection + Equity Participation with a cap

Opportunity Cost: Although ELN's repay an investor their principal at maturity, there is an opportunity cost even where an investor receives a return of principal in down markets; i.e., that investor has lost the use of his/her invested principal for the term of the ELN (in an investment in a risk-free asset like bank fixed deposit).

Call-trigger: The structures normally also have a call feature embedded within them which enables the issuer to call back the note if the underlying sells of by more than a trigger amount (typically 50%) from the start value. In this case the investor gets back only his principal at the end of maturity irrespective of how the underlying behaves once the trigger level is breached.

Factors affecting Price of an ELN

- Increase in Equity Price (+)
- Increase in Volatility (+)
- Increase in Interest rates (-)
- Increase in Time to Expiration (+/-)
- Increase in Dividend Yield (-)
- Issuer's Credit Rating (+)

CPPI/DPI

Equity linked debenture attains capital protection by replicating a call option pay off. The other way to achieve capital protection is by dynamically managing a portfolio so that the investor always has the money to buy a zero coupon bond, providing the money for capital payback at maturity. For example, say an investor has a portfolio of Rs. 100, a floor of Rs. 90 (price of the bond to guarantee his RS. 100 at maturity) and a multiplier of 5 (ensuring protection against a drop of at most 20% before rebalancing the portfolio). Then on day 1, the writer will allocate (5 * (100 - 90)) = Rs. 50 to the risky asset and the remaining Rs. 50 to the riskless asset (the bond). The exposure will be revised as the portfolio value

changes, i.e. when the risky asset performs or sells off. These rules are predefined and agreed once and for all during the life of the product.[3]

A variant to CPPI is DPI (Dynamic Portfolio Insurance) where the multiplier is not specified upfront but varies according to certain parameters like the volatility of the underlying.

The exposure to risky asset is completely unwound if the portfolio value falls below the bond floor. The bond floor is the value below which the CPPI value should never fall in order to be able to ensure national's guarantee at maturity. Bond floor is a function of time to maturity and interest rates. As interest rates fall, bond floor goes up because to ensure payment of principal at maturity one needs more cash upfront if interest rates are lower than if they are higher. Executing a CPPI would involve buying when the underlying rallies and selling when the underlying sells off. This process would further accentuate the market volatility as the hedging goes in the same direction as the market movement.

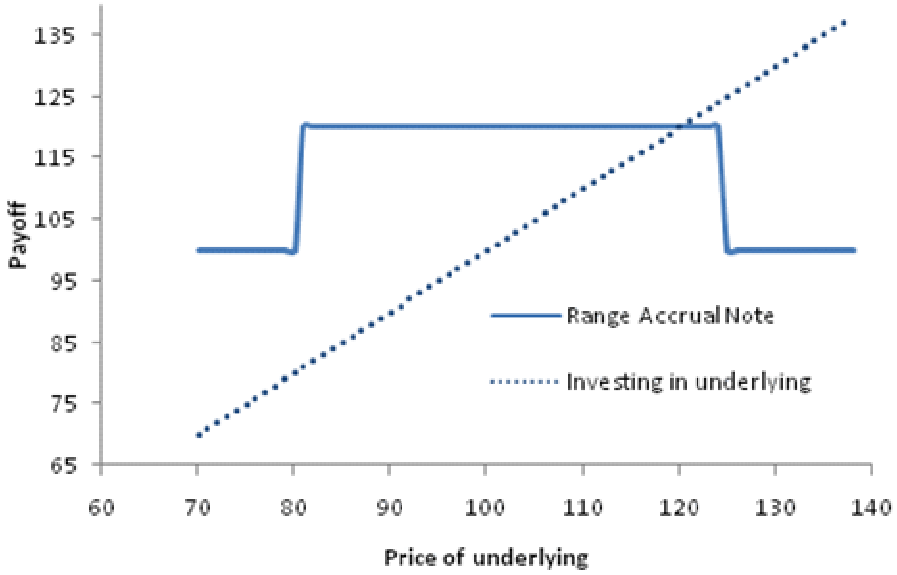
Range Accruals

Range accrual security is a kind of structured product where the interest is accrued only on days when the underlying equity/index is within a range. The capital is protected in most structures only the interest/coupon is variable. The coupon of the range accrual is paid according to a pre-agreed formula:

$$Coupon = Principal \times Fixed\ \%\ X \frac{Number\ of\ observation\ days\ in\ which\ the\ underlying\ is\ with\ in\ a\ range}{Total\ number\ of\ observation\ days}$$

The fixed % and the range are agreed at the start of the investment. The observation days could be daily, monthly, quarterly or even a single observation at the maturity of the product. Products with single observation at the maturity have been the most popular amongst range accrual notes. In this case the coupon is digital, as in if the underlying ends up within the range the investor gets a fixed coupon or else he just gets his principal back. The chart below shows the payoff of range accrual note for various values of underlying.

[3] Constant proportion portfolio insurance and the synthetic put option : a comparison, in Institutional Investor focus on Investment Management, Black, F., & Rouhani, R. (1989)



Auto-callable notes and other structures

The structures described above are aimed to get a capital protection plus some upside at the end of maturity depending on the value of underlying at maturity. More exotic structures offer payoffs linked to the path taken by underlying. Most typical of these are auto-callable notes. These notes are auto-called or redeemed by paying principal and a coupon if the underlying appreciates beyond a certain level anytime during the tenure of the note. If the underlying does not reach the auto-call level anytime before the maturity the principal is returned back. Auto-callable notes are equivalent to knock-out/knock-in barrier options in the OTC derivatives space. Once the note is called the payoff does not depend on future price of the underlying.

Auto-callable notes can be used for positioning for an appreciation or a sell-off in the underlying, although most of the structures prevalent in India position for a rally. Other exotic payoffs can also be structured like for example structures paying out coupon linked to maximum value of the underlying during the tenure. For more aggressive investors products have been offered where the investor takes downside risk if the underlying sells of beyond a certain level.

Although structured products are highly popular on indices some structures have been executed on baskets of stocks as well. These kinds of structures form about 1-2% of the total market of structured products. Although introducing baskets of stocks would add variety to the product suite offered by the issuer the hedging of such products becomes extremely cumbersome.

Though discussion on these products would be interesting and intellectually stimulating they do not matter much in terms of market share effect on Indian equity markets.

Evolution of Structured Notes in India

Although there are no concrete numbers available, the structured product industry is estimated to house products worth more than Rs 10,000 crore, with Citigroup, Merrill Lynch and Kotak accounting for a sizeable chunk of the market[4]

Prior to May 2005, issuers had been prohibited from explicitly marketing capital-protected products to investors. In August, however, partly as a result of the stock market falls SEBI relaxed these rules allowing issuers to offer funds with a rating agency seal of approval [5] The CPPI structures executed in India are mostly PMS based trading strategies without explicit guarantee of capital return. The capital is guaranteed through dynamically managing the portfolio and when the bond-floor (the minimum amount required to return capital at the maturity) is hit the strategy is liquidated and the proceeds are returned to the investor or invested in risk-free securities. As volatility in the markets increased in 2007 some of the CPPI products issued earlier got monetized in 2007. Most of the remaining structures got unwound in 2008 when markets fell significantly and bond prices went up (because of fall in interest rates).

Next wave of structured products came in the form of simple capital guaranteed structures with participation in the upside. These structures were very popular in the first half of 2007 when markets were exhibiting volatility. Initially the participation was around 90% with no cap on upside or very high cap. But as the markets sold off significantly in 2008 investors preferred more participation in the upside with a cap. Range accruals were also prevalent around that time as investors did not see much upside or downside in equity markets and as a result of high interest rates they preferred fixed coupon if the market remained in a range.

[4] http://economictimes.indiatimes.com/News/News_By_Industry/Banking_Finance_/Finance/Structured_products_face_heat_now/articleshow/3496022.cms

[5] Structured Products – A Positive Correction: http://www.structuredproductsonline.com/public/showPage.html?page=430482

The table below shows typical characteristics of the popular structured products based on a survey we conducted amongst the top issuers in this space[6]. Capital guaranteed participation notes and range accruals command about 93% of market share. Although CPPI structures constituted 5% of the total trades, as discussed earlier most of these structures have been unwound. More exotic structures are miniscule part of the total market. Hence we will focus on the first two classes of products for further discussions.

Type of Note	Typical Capital protection	Typical Characteristics	Index/ Underlying	Typical Tenure	% of Market Share	Time the product was prevalent
Capital guaranteed structures with upside participation	100%	1. 90% upside participation	Mostly Nifty	18 months - 3years	83%	Feb-May 2007
		2. 120% participation with cap at 30%				Jan-Jun 2008
Range Accruals	100%	Range of 80% to 125%		1.5-2 years	10%	Jan-Jun 2008
CPPI	100%	Multiplier of around 4Xgap		5years	5%	2006-2007
Auto-callable and others	100%	-		2years	2%	June-Dec 2007

Framework for Analysis

In this section we establish the framework required to understand the effect of structured products on equity markets. For the investor the payoff of a structured product is clear and he would be taking an outright view on the underlying and use the product to either express the view or to try to enhance his yields or to reduce his risks. An issuer of the product on the other hand does not desire to take outright view on the underlying. He would try to hedge away most of his exposure through various tradable instruments. This process of hedging transfers the risks he has to the broader equity market. We analyze this transfer mechanism to study the effect of the issuance of these products on Indian equity markets. For this purpose we use the following notations. These are the terminology that will help decipher the behavior of structured product issuers. These indicators of risk are also called Greeks as Greek letters are used to represent them.

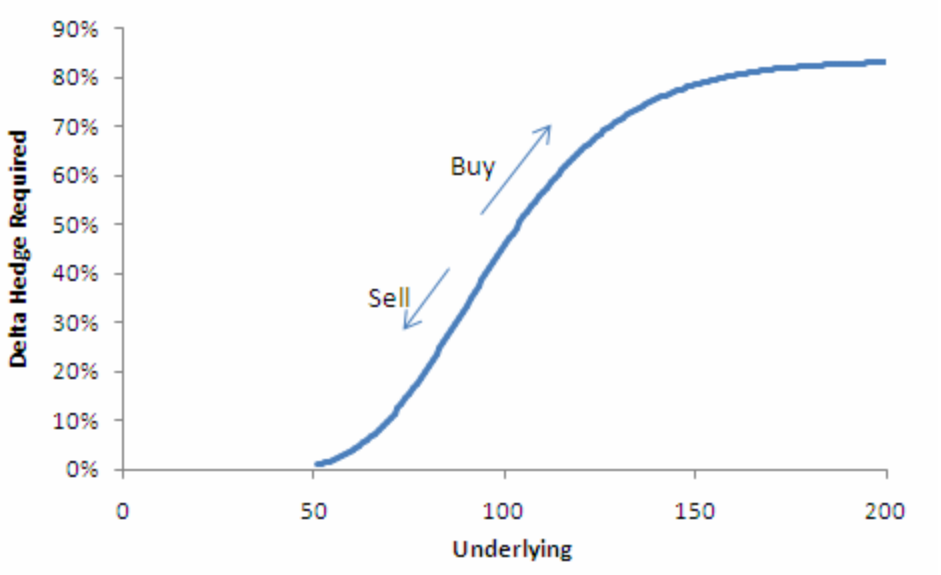
Delta: Delta is the rate of change in the price of structured product with respect to change in the underlying. We further classify delta into initial delta and subsequent delta.

[6] The participants request anonymity

Initial Delta: Every product when issued creates an exposure to the underlying for the investor. For example when a capital protected participation note is issued the issuer has a short exposure in the underlying. Thus to hedge the position the issuer needs to create a long position in the underlying security (though not to the same extent as the notional of the note) either through cash market or derivatives market (futures/calls). This would create a demand for the underlying.

Dynamic Delta: Even after putting in place the initial hedge the issuer is not completely hedged from the movements of underlying because of the non-linear nature of structured products. The delta of the structured product changes as the underlying moves. These changes have to be constantly hedged using derivatives. Once we model the structured note using a theoretical model we can come up with the exposure as the underlying moves. For example the chart below shows the delta of capital guaranteed note for different underlying movements. Change in delta would mean the dealer has to rehedge his exposure by buying/selling the underlying.

Delta for different underlying moves for principal protected note[7]

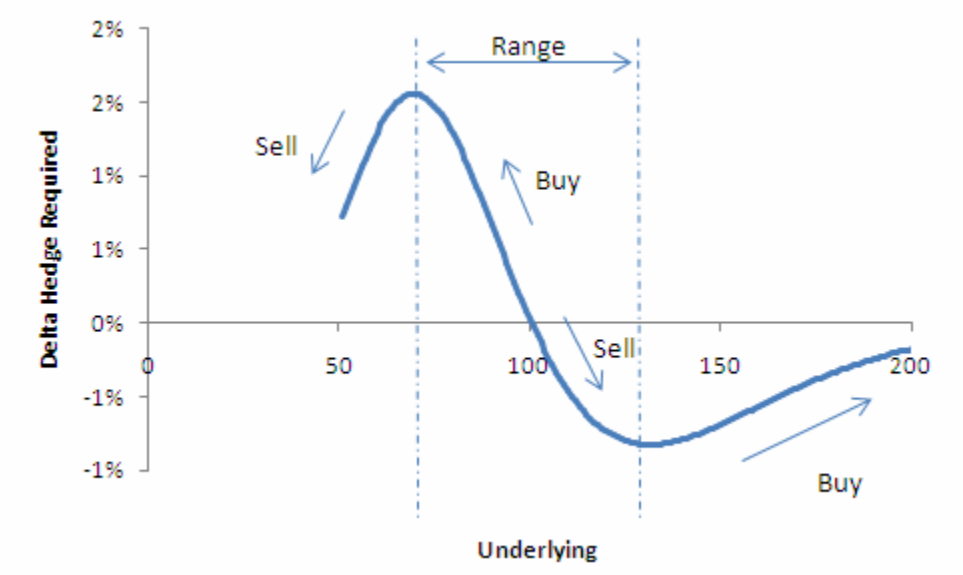


It is worthwhile to note that as market rallies the dealer is forced to buy more of the underlying to hedge his exposure and as market sells off the dealer would sell some of his hedge. Thus hedging of principal protected note would accentuate the market volatility as the dealer buys in a rally and sells in a

[7] The graphs in this section are for illustration for more accurate graphs refer to subsequent sections.

selloff. The profile of hedging would be different for range accruals. The graph below shows the delta for a range accrual with a range of 80% - 125%.

Delta for different underlying moves for range accrual note



In the case of range accrual the dealer is forced to sell the hedge either in a huge rally or sell off, he would hold to his initial hedge only if the underlying remained in the range. Thus hedging of a range accrual would dampen volatility if the underlying is trading within the range and the hedging will accentuate volatility if the underlying is trading outside the range.

Gamma: Gamma is the rate of change of delta with respect to change in underlying. Gamma of a product can be hedged by taking opposite positions in options. Once the gamma is hedged frequent delta hedges are not required as the changes in delta in structured products and the hedges cancel out each other. But gamma hedging comes with a cost hence most players prefer dynamic delta hedging to gamma hedging. Gamma of a capital protected structure is positive and is negative for a range accrual (within range).

Gamma of the structured product is very relevant to understand the effect of delta hedging. If the gamma of a product is positive then the gamma of the dealer/issuer who has the opposite exposure of the structured product is negative and vice versa. Thus positive gamma of the product implies that the hedging of the product would accentuate the volatility of the underlying and negative gamma means that the hedging would dampen the volatility of the market. Gamma of a simple capital protected

structure is the gamma of the call option embedded in the structure. This gamma can be theoretically calculated using Black-Scholes formula. The gamma of the structured product under this assumption would be –

$$\gamma = \frac{\phi(d_1)}{S\sigma\sqrt{t}}$$

Where

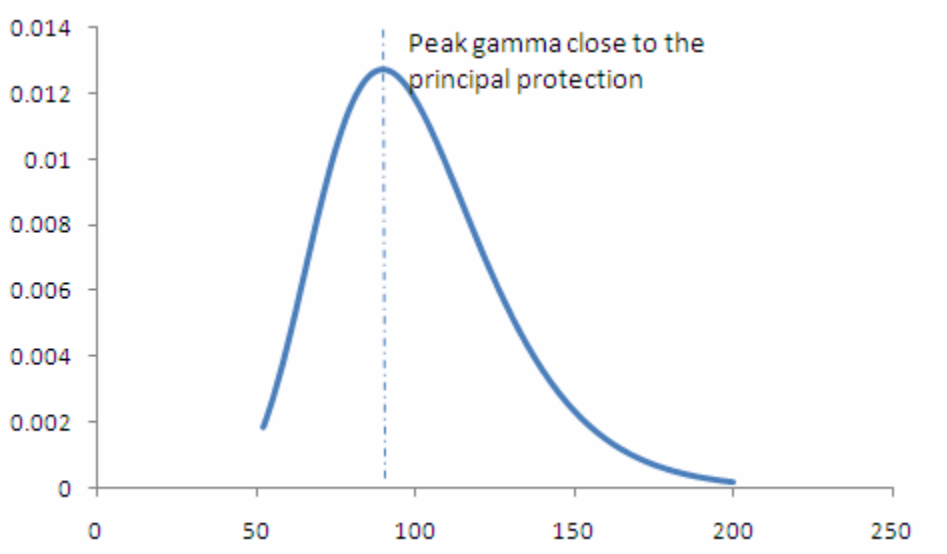
$$d_1 = \frac{ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

And Φ is the standard normal function

$$\phi(x) = \frac{e^{\frac{-x^2}{2}}}{\sqrt{2\pi}}$$

Because of the symmetry and the bell-like shape of $\phi(x)$ the Gamma of a simple capital protected note with equity participation would also be of the bell shape and the peak gamma is attained when the underlying is close to the initial value as evident in the chart below:

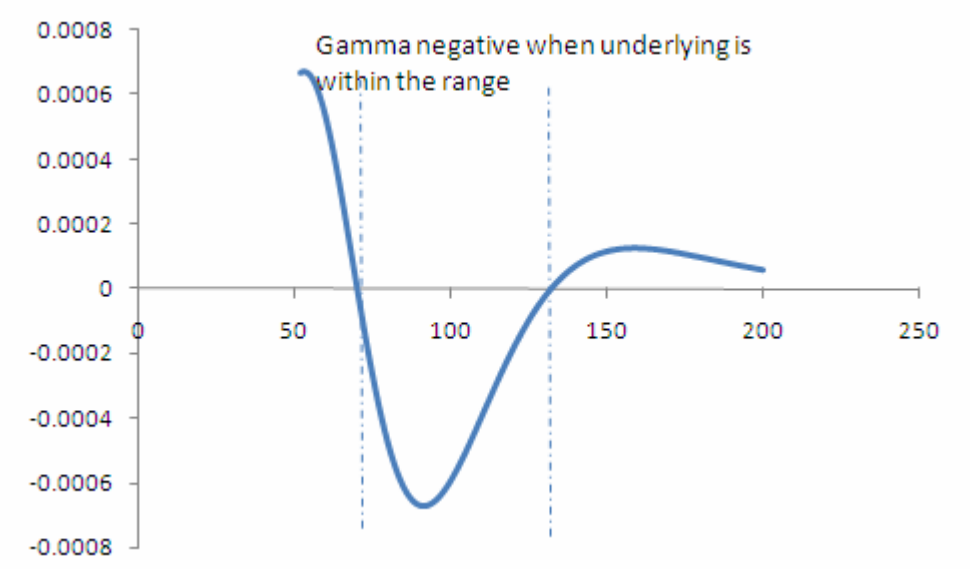
Gamma for different underlying moves for a simple principal protected note[8]



[8] All the charts in this paper are for the notes held by the investor the risks of the issuer will be exactly opposite of this

The range accrual note on the other hand behaves differently compared to a capital protected note. The gamma of the note is negative when the underlying is within the range. Maximum negative gamma is attained when underlying is close to the middle of the range. As we move out of the range the gamma switches sign from –ve to +ve. Thus hedging of range accruals dampens volatility when underlying is within the range and accentuates volatility when the underlying is outside the range.

Gamma for different underlying moves for range accrual note



Vega: Price of a non-linear structure not only changes with the underlying but also with the volatility of the underlying. This exposure is called Vega. Vega can be hedged by taking opposite position in long dated options. Long dated options are typically used to hedge the capital guarantee part of the structures.

As we have seen in this section a simple analysis also gives insights into the effect of structured products on market volatility. Until now we have used Black-Scholes framework, going forward we develop more sophisticated pricing framework and use stylized market data to get more accurate analysis.

Pricing and Modeling

Given the knowledge of risks of the dealer and how they change with underlying movement we can come up with educated guess on hedging behavior of the aggregated dealer community. Even though this may not be extremely accurate (because of difference in modeling across dealers and presence of

OTC market) we think this analysis would give more insights into the supply demand dynamics of the derivatives market. For understanding the risks first step would be to model the securities and to set up a pricing engine.

Although Black-Scholes formula is good enough for pricing simple derivatives advanced methods are necessary for pricing structured products given the call-trigger embedded in most of the notes. For this reason we developed Monet-Carlo simulation engine to price some of the typical structured notes for various underlying and volatility assumptions. The engine prices the securities by assuming a geometric-Brownian motion for the underlying. More complex models are used for pricing some exotic products but for the purpose of understanding risks geometric-Brownian motion is an accurate assumption. [9]

Under the assumption of Brownian motion the underlying security is modeled as a random process:

$$dS = \mu S dt + S\sigma dW$$

Where W is a Wiener process or Brownian motion and μ ('the percentage drift') and σ ('the percentage volatility') are constants. For small time steps one can generate a sequence of prices for the underlying from the following equation:

$$S_{t+\Delta t} = S_{t+\Delta t} e^{(\mu - 0.5\sigma^2)\Delta t + \sigma\sqrt{\Delta t} N_{0,1}}$$

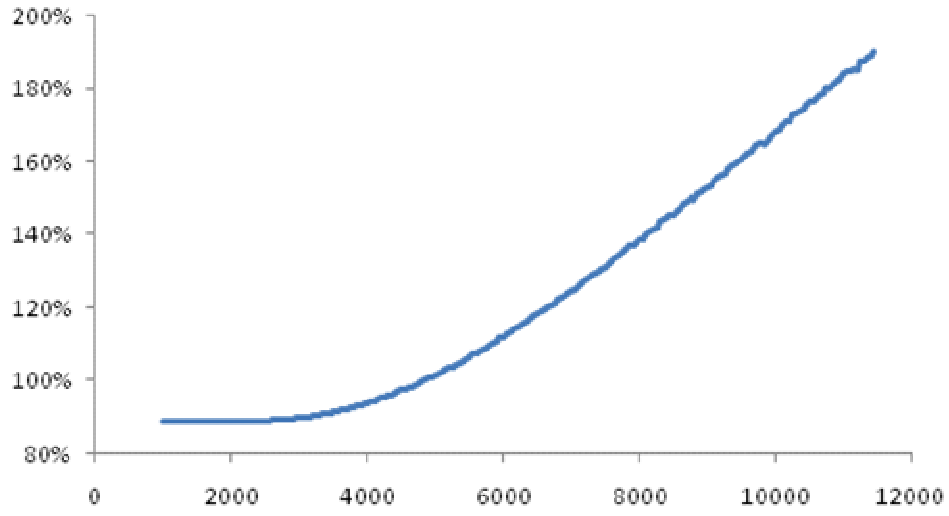
Where $N_{0,1}$ is a normal variable with 0 mean and standard deviation 1. For different values of *N* one can obtain different paths for the underlying. We use simulate 30,000 such paths and get the payoff of the security in each path. The average of the discounted payoffs over all the 30,000 paths gives the model price of the security. The price is dependent on S (price of underlying), time to maturity and σ. Then we repeat the process for various values of S to obtain the risk profile viz. delta and gamma for different scenarios. For an example let us take a capital protected structure with the following characteristics:

Underlying Index	Nifty
Index value at the time of Issuance	5500

[9] Applications of Monte Carlo Methods in Finance: Option Pricing, Y. Lai and J. Spanier: http://www.smartquant.com/references/MonteCarlo/mc6.pdf

Time to maturity (current)	18months
Capital Protected	100%
Participation	85%
Cap	No Cap

For the purpose of this analysis we are assuming 32% annual volatility, which is the current implied volatility of exchange traded options. Implied volatility is appropriate for this analysis as market participants hedge based on implied volatilities. Although some numbers might change when implied volatilities change but broad conclusions of this paper should be unchanged. The drift μ is assumed as 8%, the risk free interest rate. The current modeled price of the security as a percentage of initial value for various assumptions of the index level is shown in the chart below:

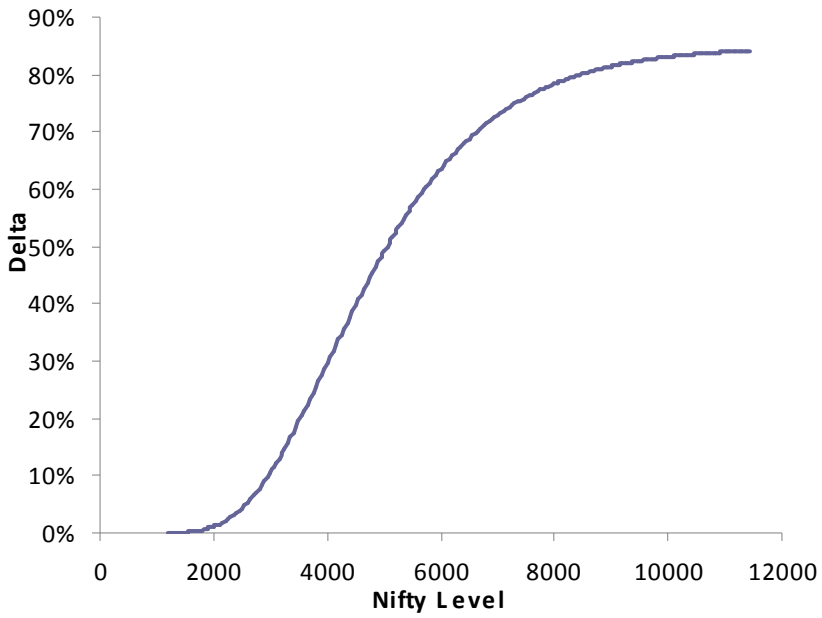


Risks of Each Product

Once the pricing mechanism is set we proceed towards calculating delta as the slope of the graph at each Nifty level. For the product described above we get a delta profile as expected from the discussions in the previous sections. The delta profile is upward sloping and flattens out as we go out of the money and plateaus at 85% (the upside participation parameter). The delta is expressed as a percentage of original notional.

Delta profile of Cap-guaranteed structure: Participation 85%, no cap

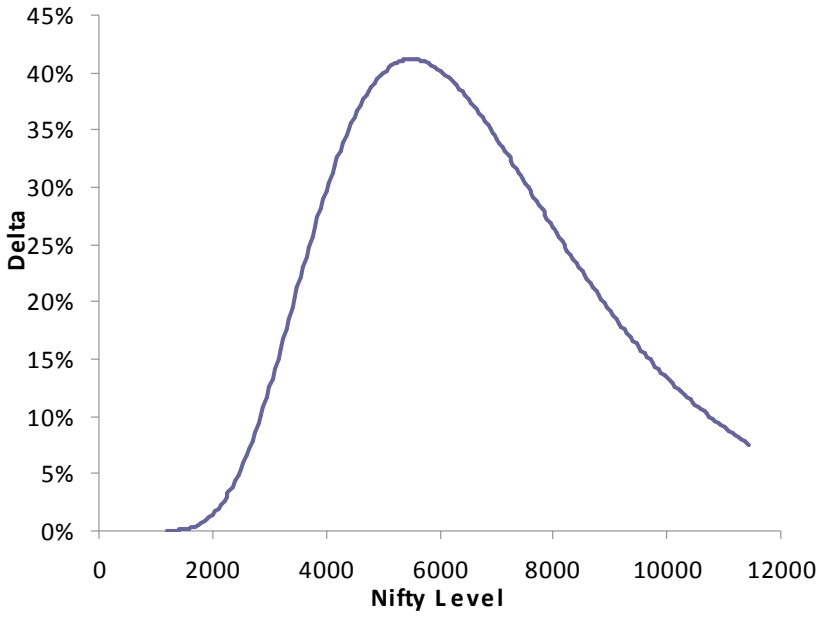
Underlying	Nifty
Index value	5500
Time to	18months
Capital	100%
Participation	85%
Cap	No Cap



If we change the structure slightly by introducing a cap on the returns we get a delta profile different from the above. The delta is still upward sloping when Nifty is close to initial value, but as we go closer to the cap on participation it drops very fast and tends to zero on further rally. Thus in a rally, hedging of this product would dampen volatility as opposed to accentuating.

Delta profile of a Cap-guaranteed structure: Participation 120%, 150% cap

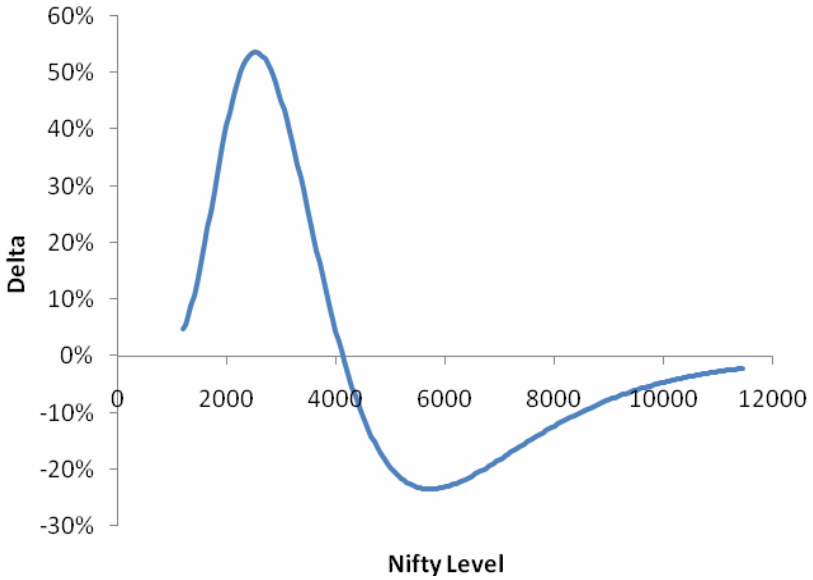
Underlying	Nifty
Index value	4500
Time to	2years
Capital	100%
Participation	120%
Cap	150%



The delta profile of a range accrual also comes out similar to the Black-Scholes approximation. The delta increases as Nifty falls from initial levels up until the lower barrier of the range. Once the Nifty breaches the lower barrier delta starts dropping. The behavior of delta in a rally is the mirror image of this. Delta keeps falling as nifty rallies until the upper barrier is crossed; beyond that delta starts increasing and approaches 0. Hedging of the following product would dampen volatility if Nifty is in the range of 3000-5000. For Nifty levels below 3000 and above 5000 the hedging would accentuate the volatility.

Delta profile of a Range Accrual: 80% to 125% range

Underlying Index	Nifty
Index value at the time of	4000
Time to maturity(curr)	18months
Range	80%-125%
Coupon	45%



In this section we looked at the risks of individual products. In the next section we will focus on the aggregated risks across all the products.

Aggregation of Risks

The table below shows delta values for structures issued in the past three years. The values are for typical products on the basis of a survey done amongst primary issuers. Initially when the products were issued the total delta would have been around 50% of the market size of structured products. This would have amounted to buying demand from issuers to the amount of 5000crore notional in Nifty. Currently almost all the products are trading at close to 0 delta. Thus as we sold off from the peak the issuers are forced to unwind their hedge thus a supply of close to 5000crore notional in Nifty came from the dynamic hedging of these products. This could have further accentuated the fall in the market. The gamma of capital protected notes is positive (unless in the case of a huge rally). Thus hedging of these products would have been one of the causes of market volatility. Also the gamma of range accruals at the time of issuance would have been negative but as we sell off and nifty crosses the lower barrier (which is around 20% lower than the level at the time of issuance) the gamma of the product flips sign and becomes positive. Thus in a sell off the hedging of range accruals is also supportive of volatility.

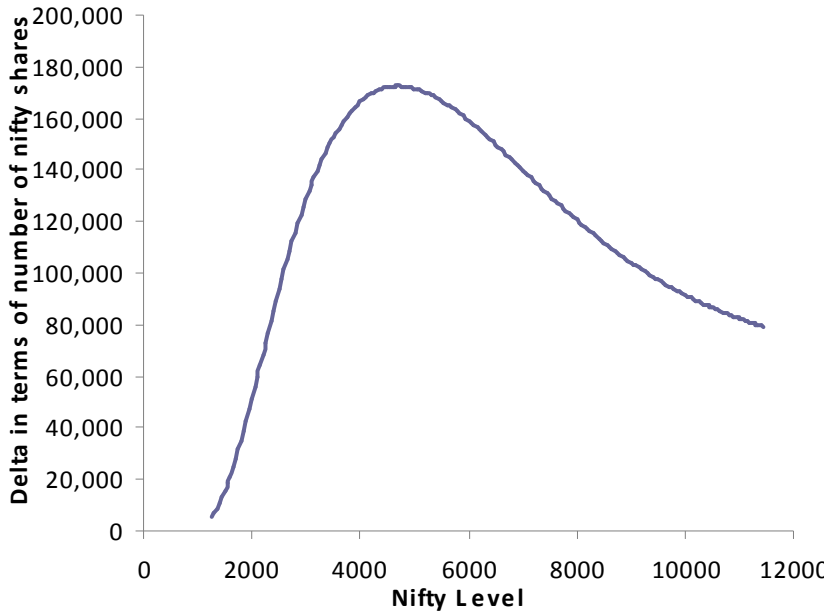
Table Summarizing Basic Risks of Each Product[10]

Product	Initial Delta	Current Delta	Gamma/Dynamic delta hedging	Vega
Capital guaranteed structures with upside participation	50%	close to 0	+ve for the note -ve for dealer	same as gamma
Capital guarantee and cap	60%	close to 0	+ve for the note -ve for dealer	
Range Accruals	close to 0	positive	initially +ve for dealer now -ve for dealer	
CPPI	110%	unwound	none, although execution implies buying high and selling low	none
Auto-callable and others	varies	close to 0	close to zero	close to zero

Although risks for individual products can be calculated but what affects the market is the combined effect of hedging all the products. Hence for the purpose of analysis we look the aggregated risks of the structured product universe. The first step to look at aggregated risks is to get aggregated delta of the structured product universe. This we obtain by replicating the structured product universe with 5 typical products. Of these 4 products are capital guaranteed structures with various tenures and characteristics. These are assumed to make up upto 80% of the 10,000 crore market. We assume 13% to be consisting of a typical range accrual. The rest of the 7% is assumed be consisting of CPPI kind of structures and autocallable notes, most of which have been called back or monetized/unwound. Of all the risks the risk hedged out first is delta risk. And this has the highest impact on the equity markets. The delta of each product is calculated using monte-carlo simulation as described in the previous section. The aggregated net delta is obtained by multiplying each delta with the assumed notional and adding up. This aggregated delta profile of the structured product universe is a representative of the delta hedging behavior of the issuers. The profile is shown below. The delta profile peaks around the nifty level of 4700 and falls on both sides (sell off and rally). In a sell off, the net effect of hedging puts further selling pressure.

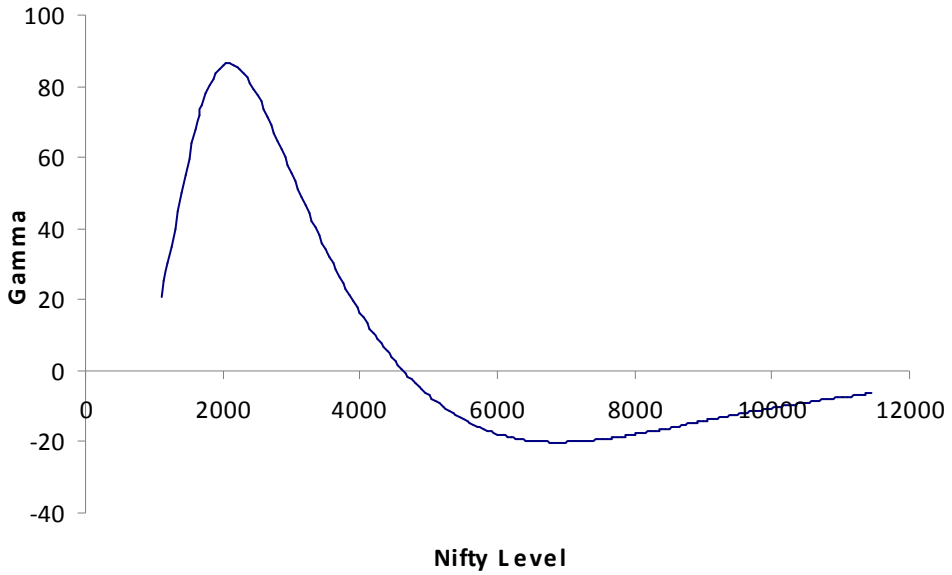
[10] The estimates are as of May 2010

Aggregated Delta of All Structured Products Put Together



To understand the nature of delta we have to delve into gamma profile of the structured product universe. Gamma profile can be obtained by taking the slope of the above curve. Gamma profile shows the effect of hedging on volatility. The gamma of the structured product universe is positive for Nifty levels below 4700 and flips sign for higher nifty levels. This indicates hedging of these products would be a cause of increase in volatility if the level of Nifty is below 4700 and it would be a volatility suppressing factor if the Nifty levels are above 4700. Peak gamma is attained around a Nifty level of 2200 and gamma falls as nifty rallies/sells off from there. **Thus is a rally hedging of structured products would have a dampening effect on volatility of Nifty and in a sell off below 4700 the effect would be to accentuate the volatilities.**

Aggregated Gamma of All Structured Products Put Together



In the survey we performed with the issuers we found out that most issuer do only delta hedging of their exposures. Some issuers use long dated options to take off some of the volatility (gamma and vega) exposure. But because of lack of liquid markets in this sector this strategy is not widely popular. Shorter dated options are also not much used because of mismatch of maturities and negative carry involved in using shorter dated options as typically long-term volatility is lower than the implied volatility of shorter dated options.

Effect on Exchange Traded Products

In this section we summarize our findings on the effect of the hedging on some of the exchange traded products.

Volatility of Nifty: Hedging has been supportive of volatility on nifty. In a huge rally this support might wane and hedging could become volatility suppressing beyond 4700 Nifty level.

Nifty cash/futures basis: As futures are the preferred way of hedging, the volatility caused by hedging is transferred more to the futures market than the cash market. Hence the futures could trade more volatile than the cash market. This implies the futures could trade at huge discount in sell off and at a premium in a rally.

Short dated options: Although shorter dated options are not directly used by most of the issuers to hedge their books, the higher realized volatility might translate into higher option prices/implied volatility.

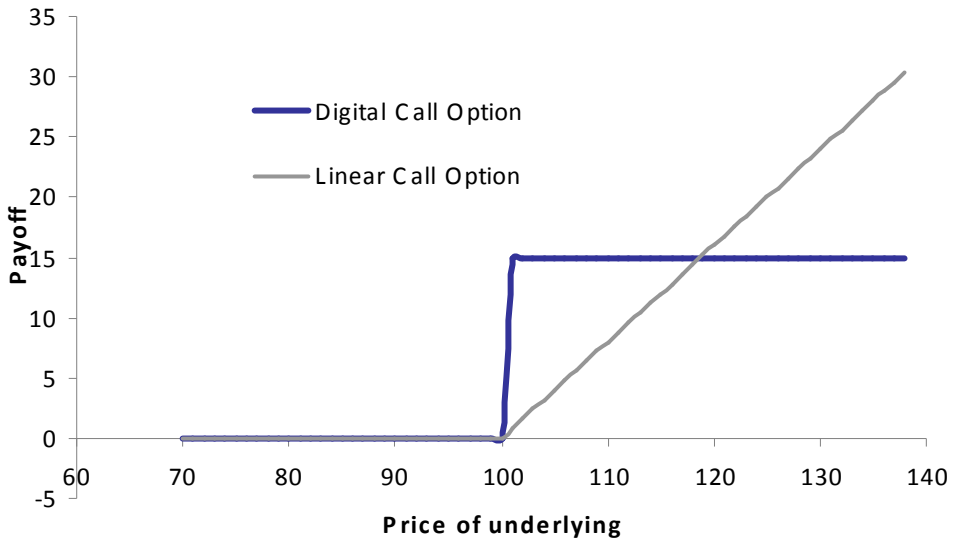
Long dated options: Longer dated options are used by some issuers to hedge their exposure, especially for getting capital protection. This would cause a bid in longer expiry options (beyond one year expiry)

VIX: Having a long position in VIX can be used to hedge the short volatility exposure of the issuers although the hedge is not that straight forward.

New Products

In this section we discuss some new products that could be introduced as exchange traded instruments to ease the hedging needs of issuers of structured products. These products are not only useful for the hedging needs of issuers but they can also be used by retail clients to express their views on equity markets, avoiding transaction costs involved in structured products.

Digital Options: Unlike linear Puts/Calls which pay a linear pay off if the option is exercised, digital options pay a fixed coupon if the strike condition is met. These options are a straightforward hedge to the range accruals. Also these options are extremely useful expressing certain views on the underlying (like a range bound view or a mild rally/sell off view etc). The payoffs of a linear and a digital call option are juxtaposed in the chart below.



Variance Swaps/futures: Variance swap/future is an instrument to hedge/take exposure to the realized volatility of the underlying. In this instrument one of the counterparties receives the floating leg which is the variance of the underlying and pays a predetermined fixed price. The other counterparty pays the variance and receives the fixed leg. Variance swaps are useful instruments to hedge Gamma exposure without trading short-dated options.

Variance is a measure of how spread out a distribution of daily returns is. It is computed as the average squared deviation of each day's returns from its mean. An example of such a product in the developed markets is the "CBOE S&P 500 Three-Month Variance Futures". These are cash-settled, exchange-traded futures contracts based on the realized variance of the S&P 500 Composite Stock Price Index[11]. The CBOE S&P 500 Three-Month Variance futures contract is quoted in terms of variance points. Variance points are defined as realized variance multiplied by 10,000. For example, a variance calculation of 0.06335 would have a corresponding price quotation in variance points of 633.50.

A "continuously compounded" daily return (Ri) is calculated from two reference values, an initial value (Pi) and a final value (Pi+1), using the following formula: Ri = ln(Pi+l/Pi). Daily returns are accumulated over a three-month period, and then used in a standardized formula to calculate three-month variance. This three-month value is then annualized assuming 252 business days per year:

$$V = 252 * \sum_{i=1}^{N-1} \frac{R_i^{\,2}}{N-1}$$

Where N is the actual number of Nifty values used to calculate daily returns during the three-month period.

Futures on VIX: Future contracts on Volatility Indices are extremely useful to hedge the volatility exposure of structured products. These instruments are especially useful to hedge the Vega exposure as VIX is directly linked to the implied volatility. An example of futures on volatility indices is the set of CBOE DJIA Volatility Index (VXD) Futures.[12]

GAP risk swaps: The gap options are a class of exotic equity derivatives offering protection against rapid downside market moves (gaps). The floating leg of these swaps is paid out if there is a huge move in the underlying beyond a certain trigger/strike (lets say 10% downward move in a day). These options have

[11] CBOE S&P 500 3-month Variance Futures, Product Specifications: http://cfe.cboe.com/Products/Spec_VT.aspx
[12] Futures on the CBOE DJIA Volatility Index, A Quick Guide: http://www.cboe.com/micro/vxd/vxdqrg.pdf

close to zero delta, allowing to make bets on large downside moves of the underlying without introducing additional sensitivity to small fluctuations, just as volatility derivatives allow to make bets on volatility without going short or long delta. The market for gap options is relatively new, and they are known under many different names: gap options, crash notes, gap notes, daily cliquets, gap risk swaps etc. The gap risk often arises in the context of constant proportion portfolio insurance (CPPI).[13] The CCPI market in India is in nascent stages and might see an increased interest from retail players if there is an instrument available to hedge the Gap risk.

[13] Pricing and hedging gap risk, Peter Tankov: http://people.math.jussieu.fr/~tankov/gap_risk.pdf