

1 The Interplay Between Realized and Implied Volatilities: Implications for Structured Products

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- In the last ten years or so investors have engaged in an unabated search for higher nominal and real yields. This trend does not represent, in my opinion, a transitory phase; rather, it is an indicator of secular changes in savings and investment patterns whose most salient features I will try to sketch out below.
- Investors have often chased this yield enhancement by making use of structured products. In the global investment landscape structured products may constitute a relatively small fraction of the investment pie. I intend to argue that, despite their modest relative size, these instruments have changed (and, to some extent, are still changing) the trading landscape and certain important aspects of market dynamics to an extent disproportionate to the amount of money directly invested in them.

- The last few months seem to have witnessed an apparent reversal of the trend alluded to above. In particular, the sub-prime/CDO debacle has increased the risk aversion of investors towards certain classes of complex products. The investment community and the financial industry are therefore facing a number of related questions:
 - have recent events rung the death-toll for the search for yield enhancement?
 - How can this hunger for yield be reconciled with increasing risk aversion?
 - Will it be high leverage, 'opaqueness' or illiquidity that will fall out of favour? What will be the implications of these adjustments for financial intermediaries?

- To what extent will financial crises spill over from the financial sector to the real economy?
- What are the consequences of this state of affairs for the risk management profession?

- The answers the financial community will find to these questions above will have important effects on financial markets and the global economy. Indirectly, they will also shape the challenges faced in the short-to-medium term by the risk management community. As in the case of all complex phenomena, there is no simple explanation for this state of affairs. Rather, a confluence of contributing factors, both fundamental and 'optical', has brought this about. It is this confluence that I intend to explore in the first part of the present paper.

- We can start from the behaviour of **retail investors**, where the 'optical' factors alluded to above are probably more prevalent.
- We have been living in the last ten or so years in a world of **low inflation**. In absolute terms, real yields have fallen, but nominal yields have fallen even more. The US ten-year swap rate (a good proxy for the investment-grade yield an investor can achieve) has averaged around 7% in the 1990s, with highs of above 9%. In December 2007, however, the same swap rate was as low as 4.5%, and has averaged in the new century just above 5%.
- This matters, because investors tend to be very (perhaps 'irrationally') sensitive to nominal rates, and appear to have failed to adjust their investment decisions for the compensating effect of the fall in inflation of

recent years. **Italian retail investors**, for instance, could easily achieve (admittedly, in a higher-inflation environment) short-term yields of 12% just a few years before the Euro convergence. The same yields had plummeted, by late 1999 to about 2.5%. Similarly, for the **Japanese retail investors** the fact that inflation was zero or negative in the late 1990s to early 2000s was cause for little comfort with ten-year yields below 1%. They felt they 'had' to move into structured products to earn a 'decent' return: PRDCs, FX TARNs, knock-out equity puts and similar exotica were indeed created to cater for these requirements of Japanese investors. A similar story can be told for other investors across the globe.

- This focus on nominal yields may go some way towards explaining the appetite of retail investors for structured products. But the propensity to take on risk in order to boost nominal yields is but one of the many

converging factors I alluded to above. The behaviour of institutional investors and the global demand for savings is another, and probably far more important, piece of the puzzle.

- Let me start from the **demand for savings**. Despite the fact that in the West saving rates have been declining or have at best stagnated, **at a global level the emerging countries economies have provided a more-than-offsetting demand for savings products**. In the West, we often tend to forget that in ‘market-communist’ China, for instance, private individuals have to provide via personal savings for such basic services as health care, education and retirement . It is ironic that in the capitalist West we take for granted that these services should be, at least to some extent, provided by the state.
- At the same time, the trade surpluses (with the West) of these countries have produced excess reserves in Western currencies (mainly \$ and EUR). The global investment community in the emerging world has tended to find the risk-adjusted returns in marketable instruments denominated in \$ and EUR more attractive than by investing in locally-denominated instruments.

- Of course, only an extremely small fraction of this wall of money has been directly invested in structured products. But **the excess demand for Treasuries**, highly-rated paper and similar instruments **has crowded the market for 'safe' instruments** in \$ and EUR and depressed their yields. This has pushed Western institutional and private investors, which would have otherwise possibly been happy with the yields provided by low-risk instruments, into riskier asset classes. This depression of yields for 'safe' securities is therefore a second important factor in the recent investment landscape.

- Here is another piece of the puzzle. A vast number of institutional investors across the world (such as state and private pension funds and life insurance companies) have made substantial nominal and real commitments in periods of higher yields and of different demographics. For instance, life insurers in many countries of the current Euro block made commitments in the high-yield pre-Euro days to provide annuities to their policy holders. These commitments were entered at rate levels that seemed then prudently low, but look now dangerously high. **Given the current low-yield environment, the only way out of the impasse is to achieve 'exceptional' returns.**
- In several countries the predicament of many private and state-run pension funds is no better. Broadly speaking, if in the aggregate the returns from the assets held by pension funds are insufficient to face the commitments

made to future retirees there are only three ways out: pay more into the fund, work longer or make the assets work harder. As the first two options appear to be the political equivalent of hara-kiri, we are back again to the 'exceptional-returns' solution. This source of demand for yield enhancement is therefore likely to remain with us for as long as this state of affairs prevails. For all intents and purposes, this is likely to mean for a long time.

- **Can financial engineering help?** One may be tempted to argue that, after all the alchemy of financial engineering has turned the relatively small muck of market frictions into the gold of market efficiency, the amount available for future consumption is simply related to how much the economy will produce in the future. As the UK minister of the 1980s who wanted every pupil to be above average was by necessity going to be disappointed, so the quest by every section of the investment community for exceptional returns therefore seems to be a case of wishful thinking – or of beggaring thy neighbour. Indeed, if the usual ceteris are indeed kept paribus (not an easy task with matters economic), this is in the aggregate broadly correct.

- This argument takes into no account, however, that sometimes the same consumption flows can be redirected over time in ways that increase the utility of all parties. Some investors, for instance, are ready to pay a premium for readiness of access to consumption. Others may display less impatience. So, if a class of investors (say, future retirees) do not ‘need’ immediate liquidity and are ready to wait for a considerable amount of time, a bargain can be struck between impatient and long-term investors, at the end of which both parties will see their utility enhanced – which is a fancy way to say that they will both feel better off. And, as recent events have shown with painful clarity, the compensation for liquidity can be very high indeed. So, not everyone can reap exceptional returns, but one of the most obvious ways for financial engineering to ‘create value’ is to devise ways to broker time patterns of future consumption: in other terms, to create a market in liquidity.

- There are, of course, many ways to 'sell liquidity'. Investing in structured products, well-known for having rather poor secondary-market liquidity characteristics, is one such way. And indeed structured products have been characterized by steadily increasing contractual maturities: some interest-rate/FX deals marketed to investors especially in Asia, if not 'called', could extend to thirty years.
- While these are the exception rather than the rule, the trend towards structured products with longer and longer maturities has been persistent. **Extracting more value from the liquidity premium, however, is not the main raison d'être for ever-longer structured products. Something else is at play.**

- In order to obtain the desired yield enhancement investors have had to give up something more than just liquidity: under one guise or another they have sold optionality to the traders' community – where the term 'optionality' should be understood in a generalized and non-technical sense to mean something like 'one-sided risk'. This one-sided risk (the price for risk enhancement) could be as simple as unleveraged, stand-alone default risk, or it could be as complex as the optionality embedded in a thirty-year callable range accrual on a CMS spread, but the concept does not change: **to obtain a higher yield, investors have to take on board the possibility of negative outcomes – the higher the yield enhancement, the more severe the possible negative outcomes.**

- Whatever its precise form, it has been just this sustained selling of optionality that has caused the increase in leverage, maturity and complexity of structured products. Why has this been the case?
- Because the unrelenting selling of 'volatility' by investors to banks has depressed the compensation for a given 'unit of risk'. While the technicalities of these flows may be complex, the underlying principle is very simple: if the supply for something consistently outstrips demand, the bid from the reluctant buyers will be lower and lower as their inventories become more and more bloated. It matters little if the 'something' is raw materials, Treasuries or volatility.
- And indeed, under this 'wall of volatility selling', generalized implied volatilities (the going market bid for optionality risk) have been declining over the last decade in all asset classes.

- One-year \$/Yen implied volatility, as one example among many, fell from 18% at the end of 1999 to 6.5% in February 2007. The cataclysmic market events of August 2007 saw it spike back to 11.5%, but it only took a few weeks for the implied volatility to revert back to 7.5%. Figures 1 to 2 place the recent 'blip' in volatility in the broader context of its decade-long decline.

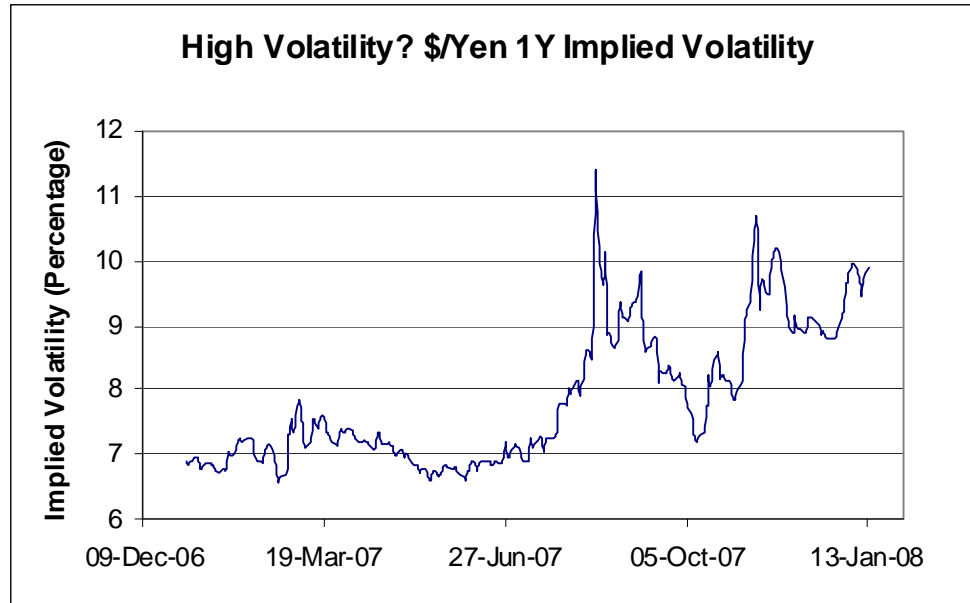


Figure 1:

Fig 1: The recent increase in \$/Yen 1-year implied volatility, reflecting the recent market turbulence.

Fig 2: The 1-year \$/Yen implied volatility again (with the recent 'blip') in the context of its decline since the LTCM crisis of 1998.

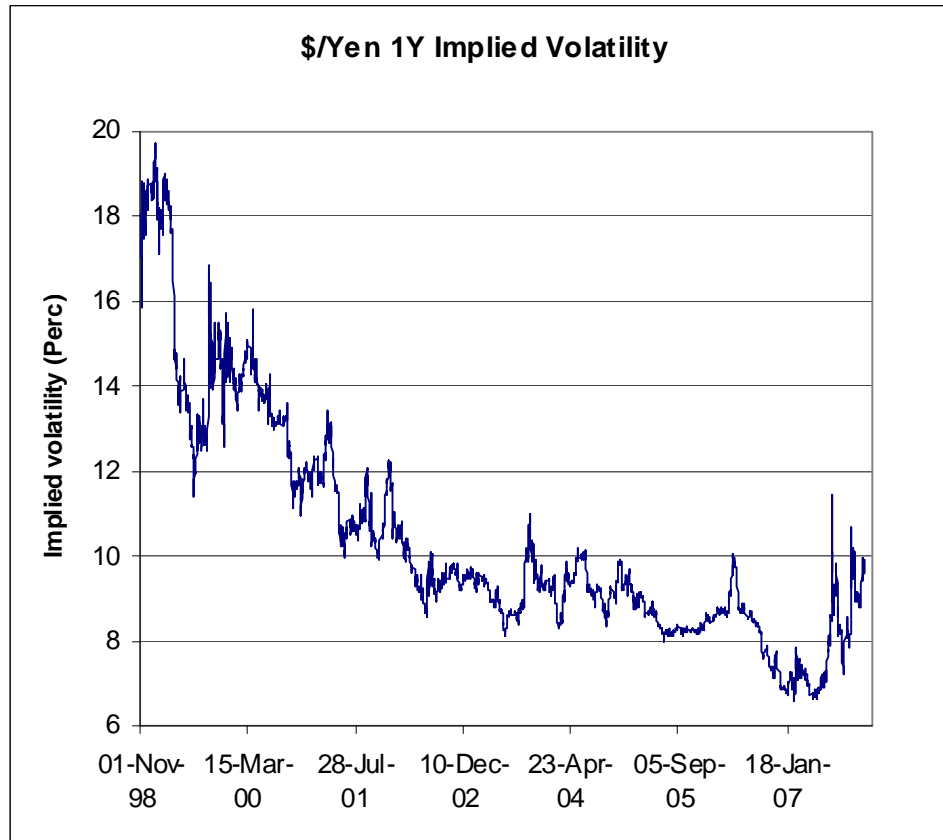


Figure 2:

- But, in an efficient market, shouldn't depressed implied volatilities entice arbitrageurs to buy optionality (ie, to buy the oversold 'cheap' options) and restore prices towards their fundamentals? Matters are not quite as simple because this argument neglects the subtle **interplay between realized and implied volatilities**.
- Until recently (until, that is, the recent market mayhem), the received wisdom was that implied volatilities were low because realized volatilities were also low (until July 2007, for instance, the average daily basis point move in EUR rates had almost halved over the last five years). The causal link flowed from the low realized volatilities to the low implied volatilities. The sky, in other words, was blue, and both realized and implied volatilities were conveying a similarly benign picture of a goldilocks economic world. Markets were simply efficiently translating this benign outlook into the prices of traded options.

- I had expressed my doubts about this panglossian view a few weeks before the recent market turmoil, and the subsequent events proved that the news of the robust health of the financial markets had indeed been greatly exaggerated. In my opinion, what has been at play is rather subtle, but it will have profound implications for market dynamics in general and for the job of the risk manager in particular. This, in my view, is how these complex dynamics are unfolding.
- For the global reasons outlined above, the trading community has been at the receiving end of an unprecedented amount of volatility selling. Traders who end up being 'long volatility' as a result of these yield-enhancing trades also find themselves structurally 'long gamma'.
- This means that **if market prices and rates do not move, they steadily lose the time value of the optionality they have bought.** In order

to crystallize their profits, these traders have to 'trade the gamma', ie, sell when prices increase and buy as they decrease.

- The more prices ‘vibrate’, the more the long-gamma trader will profit. *Per se*, this is hardly a novel observation. What is novel is that the size of this market activity has become so large that, collectively, **these long-gamma traders have ceased to be pure price-takers**. There are clear signs that the size of this gamma trading activity is having a direct effect on the prices themselves. **The distinction between ‘underlying’ and ‘derivative’ product is becoming increasingly blurred.**
- As long-gamma traders buy when prices fall and sell as they rise, the continuous (and furious) buying and selling against the market moves has a stabilizing effect on prices (known, in the equity world, as ‘pinning’). But this apparently benign outcome sets in motion a complex chain reaction:
- if the long-gamma trader sells as soon as the price increases and buys as it falls, the realized volatility (ie, the life and blood of the selfsame long-gamma trader) will be depressed.

- Knowing that he will have little realized volatility to play with, **the trader will therefore bid lower and lower for the next 'bit' of implied volatility offered to him.**
- This will reduce the 'yield enhancement' provided by a given structured product.

- To counteract the fall in implied volatility (the price for yield enhancement) the ingenuity of financial engineering will have to produce longer-maturity, more leveraged (and, as a result, more complex) products, by means of which more volatility can be sold to the traders community. *Au refrain.*
- If this analysis is correct, **lower realized and implied volatilities are therefore not independent and ‘objective’ indicators of an exogenous market condition, but interact with each other via a positive feedback mechanism.**
- The ultimate result of this trading pattern has been to alter the market dynamics for the underlying used for hedging and, as a result, the distributional features of asset returns.

- Because of gamma trading during normal times the price moves will be very limited, fattening the centre of the distribution – witness, for instance, the fall in size of the daily move in interest rates or FX rates alluded to above.
- ‘Medium-size’ moves become rarer, as they are counteracted by the against-the-tide buying and selling actions of the long-gamma traders.
- But when really cataclysmic events occur, technical factors like gamma trading cannot stand in the way of a major repricing: prices ‘dislocate’, the market enters a new phase and the tails of the return distributions become populated by more and more ‘impossible events’.

- **What are the consequences of this state of affairs?** If I am correct, there are serious implications for the risk management profession, for market dynamics and for the economy as a whole.
- Starting from the former and, admittedly, more parochial concerns, **this is the stuff risk managers' nightmares are made of.** The analytical and statistical tools at their disposal are of little or no use when these market dislocations occur – ie, when it really matters. When they are used for prediction before the crisis, these tools are calibrated to artificially low price moves. They therefore provide a completely distorted picture of the tail risk that could be just around the corner. In particular, these are just the conditions that make a mockery of the statistical tools designed to tell us something about the remotest events : witness the sub-prime-backed 'supersenior' tranches trading in the last months of 2007 at 20 cents in the dollar.

- To give an idea of the scale of the scale of this failure in prediction, at the beginning of October **2007 Moody's Interactive Website contained 4,303 downgraded bonds going back to 1990. On a single day, 11th October, 2007, Moody was forced to downgrade 2,507 issues:** more than half as many bonds, in other terms, were downgraded in one day than over the preceding 17 years!

- There is far more at play, however. To begin with, in many areas, **the derivatives tail has begun to wag the dog of the ‘underlying’ more and more vigorously** – and invariably, when this has happened, this has been linked to yield-enhancement structured products.
- Extremely long-dated plain-vanilla FX options, for instance, have seen the light as a response to the hedging needs of the banks who found themselves at the receiving end of this type of optionality from their trading in PRDCs and TARNs.
- Or, in a different asset class, the volume of credit default swaps (a bona-fide 21st century ‘underlying instrument’) has soared after the introduction of tranching credit derivatives and CDOS (Collateralized Debt Obligations) because these require credit default swaps for hedging.

- This has important **consequences for market liquidity**. One of the ways to look at **bid-offer spreads is the market maker's compensation for bearing inventory risk**. *Ceteris paribus*, this compensation will therefore in general decline in periods of low volatility.
- But, as we have seen, during normal periods the gamma activity of traders has a pinning effect on prices, and realized volatility becomes muted.
- This explains the amazingly low, but fair-weather, bid-offer spreads of many hedging instruments (such as credit default swaps) in normal market conditions.
- When market dislocations occur, however, the same links between bid-offer spreads, inventory risk and volatility make liquidity work in reverse: pinning

no longer works, a 'fat-tail' event occurs, volatility increases suddenly and massively, and liquidity all but disappears.

- What this state of affairs produces is the occurrence of '**bipolar liquidity**': wafer-thin spreads in normal market conditions, and yawning bid-offer spreads at the first signs of market turbulence.

- There are farther-reaching effects of the state of affairs described above.
- It may well be true, in fact, that structured products constitute, in the big picture, a relatively small portion of the global investment portfolio.
- It may also be true that financial intermediaries provide the oil of intermediation that keeps the engine of the economy running smoothly, but not its fuel.
- However, the **nexus between the financial sector and the real economy is strengthened by the fact that often the same financial institutions that provide the engineering for the much-sought-after yield enhancement are also the providers of credit for the private and corporate sectors.**

- Via the leverage embedded in structured products, the effects of the global demand for exceptional returns can become magnified out of proportion to the apparent notionals at stake. In situations of market distress, the hang-over from the risk concentration generated by the supply of structured products can therefore feed into the real economy via the restriction of the supply of credit: when this happens the 'real' economy may no longer remain fundamentally unaffected by the shenanigans of the financial wizards.

- Financial institutions have been trying **to avoid this risk concentration, at least in the credit area, via distribution**. Recent events have raised a question mark as to the resilience of this exit route when most needed. But even during the good times, the distribution of risk away from the banking sector has only been effective on a large scale in the credit area.
- In other asset classes, such as interest rates or equities, the banks' ability to dispose of the risks associated with the provision of yield enhancement has always been limited. Recent events have done nothing to improve this situation. In all likelihood, the distribution solution will, if anything, be more difficult to achieve in the near-to-medium-term future. The link between the provision of structured products and the ability to provide credit to the real economy will therefore, if anything, become stronger in the future.

- Investors have understandably been scalded by the recent CDO debacle. As a result, many commentators have predicted that 'structured products are over'.
- If the analysis I have presented above is correct, these predictions are wide of the mark. Investors may have become more selective (rationally or irrationally so) about the type of risk they are ready to buy. It may be curtains time for CDOs (and CDOs squared) backed by NINJA mortgages. 'Sub-prime' may remain a by-word for financial nuclear waste for years to come.
- But the long-term trends that have pushed the investor community towards structured products have not fundamentally changed.

- Risk aversion may well have increased – and perhaps irrationally so – for certain types of products. But this is emphatically not true for all asset classes. Consider the following recent quote for instance from the specialized financial press:

“[Issuance of] callable range accruals has picked up in recent days and traders say that some of the activity is likely to be related to re-allocation of cash into structured notes...” .

The quote would be hardly worth noticing, were it not for the fact that it was printed the week after the equity melt-down of 21st January, and the largest-ever recorded loss from derivatives in banking history (the SocGen equity debacle). So much for increased risk aversion...

- In sum: **there is widespread consensus that subdued inflationary pressures and global savings patterns will keep nominal and real rates low for many years to come** . As a consequence, in the aggregate the **hunger for yield and the tolerance for risk have not come down.**
- And, despite recent events, the overall compensation for risk in asset classes other than those in the middle of the recent storm has barely budged from the recent lows.
- As a recent IMF report points out “[a]lthough recent turbulence has been associated with an increased market volatility and an unwinding of positions predicated on a low volatility environment, some broad global indicators still signal a willingness to establish or extend positions in risky assets.”

- If my analysis is correct, the banking community will still find itself at the receiving end of '**volatility selling**' (albeit, possibly, in different forms.)
- Because of the accompanying need to '**trade the gamma**', there are still going to be coiled springs aplenty in the financial landscape.
- '**Bipolar liquidity**' will become a persistent market feature. It is well-nigh impossible to predict exactly where the pressure of this 'price pinning' will be released. But I believe that we are in for more 'impossible events' in the relatively near future.