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A Commentary by Harley Bassman:

The Convexity Maven

Value Concepts from the Credit Suisse Trading Desk
April 17, 2013

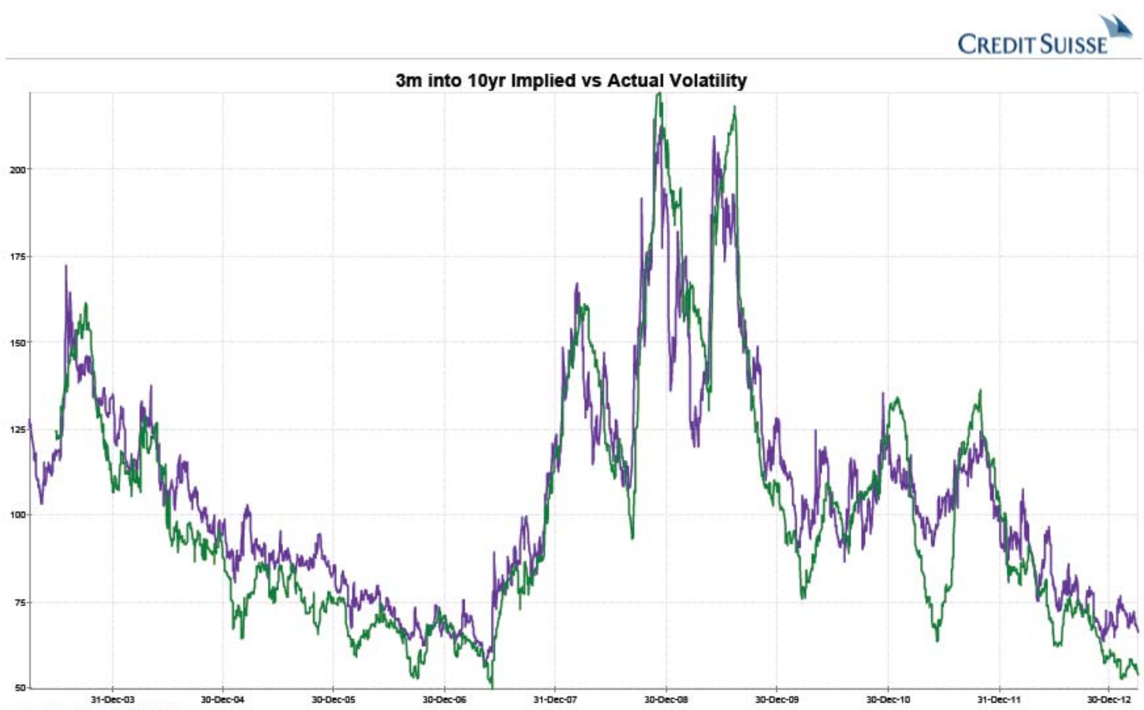
"Skewered by Skew"

Walking past the derivatives trading desk the other day, my ears perked up as I overheard snippets of a conversation focused upon the winning attributes of a "Fat-Tail". No, this was not a discussion about a Hollywood starlet, but rather an earnest debate about how to model and evaluate the "Skew" of a disparate package of options. In preview, this Commentary will detail the key drivers of Skew and identify various trading opportunities. If you have inadvertently picked up the wrong periodical, a quick click on TMZ.com should resolve this problem.

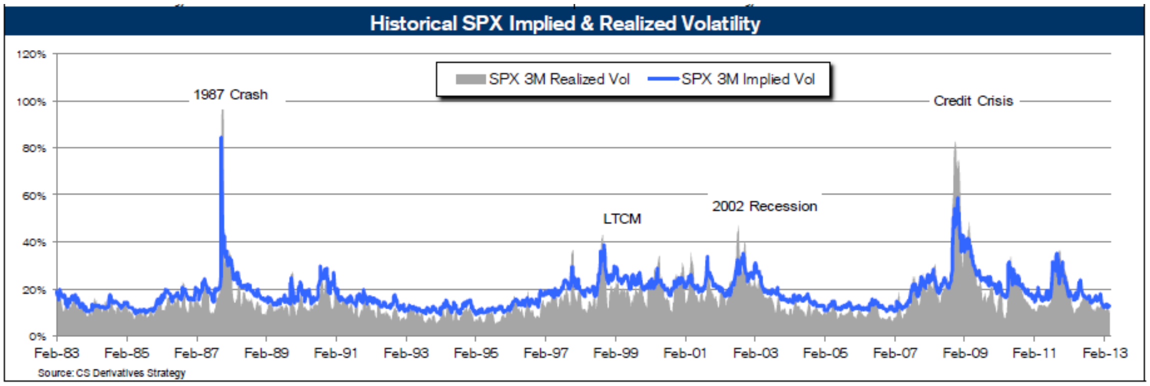
What is Skew ?

The Rosetta Stone of the options market is the famous Black-Scholes model, created in 1973 at the University of Chicago. Given a set of inputs, the most critical being the measure of Volatility, a “fair value” can be produced for an at-the-money option. Most important for option market makers is the fact that there exists an arbitrage free relationship between similar strike calls and puts; this is known as Put::Call Parity.

Of the five inputs required by the model, four are transparent (Spot price, Strike price, Interest Rate and Time) while the fifth, Implied Volatility, can be quite ephemeral. That said, “ball-parking” an at-the-money (ATM) option price is actually not that difficult (assuming you have a price history and an HP). Of all the many risk vectors that drive an asset’s price, the most closely correlated to its Implied Volatility is its recent Actual Volatility. The –shiraz line- below is the Implied Volatility for a three-month into ten year straddle while the –vine line- is the Actual Volatility for this rate over the trailing sixty business days. For this series, the Implied Volatility averages about 7% over its paired Realized Volatility and is generally within 10% of this spread. [See Commentary – *Wall Street Babylon*, November 28, 2011 for a fuller discussion]



In fact, you will find the Implied Volatility on short-dated "gamma" options for most tradable assets is usually about 10% above its matched Actual Volatility. For the supremely active US Equity options market, the –aqua line- that charts the Implied Volatility of three-month SPX options consistently traces slightly above the –graphite line- of similarly dated Actual Volatility.



With this insight, a seasoned derivatives professional can make a fairly good guess as to the price of an ATM option for most "liquid" assets; however, the same cannot be said for options that are out-of-the-money (OTM). Thus we introduce the concept of Skew. For our purposes, we will define Skew as the difference between the Implied Volatility for an ATM option and a similar expiry OTM option.

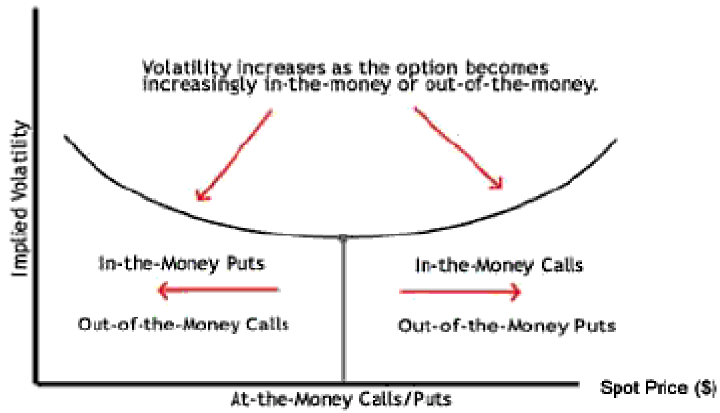
In general, there is no easy way to estimate what the Skew will be for a given asset; the OTM Implied Volatility can be positive, negative, or even flat to its ATM Implied Volatility. It must be understood that Put::Call Parity does not exist for equidistant OTM options. So for instance, if there is a 10% positive skew for a 25% OTM put option; this provides absolutely no information as to what Implied Volatility might be appropriate for a 25% OTM call option. *Put::Call Parity only holds for options with the same strike and expiry date.*

With this basic understanding under our belt, let's explore what drives Skew.

Risk Preference

Humans are social beings who for either genetic or environmental reasons are "risk averse". A simple example of this notion is that most people feel more emotional pain from losing $1,000 than they do pleasure from making a similar sum. I will state this as a fact supported by many social science studies and I shall not opine as to why this is the case. So let's skip the math and examine this concept heuristically.

Google is presently trading at $800 a share. Using exchange parameters, a three-month ATM straddle costs about $68. The Implied Volatility of this price is about 21.5%, which (not) coincidentally is nearly 10% above its three-month Actual Volatility of 19.5%. Using coincident exchange parameters, a three-month strangle with strikes of 700 and 900 would trade at $12; the Implied Volatility here is a blended 23.0%, about 7% above the ATM level.



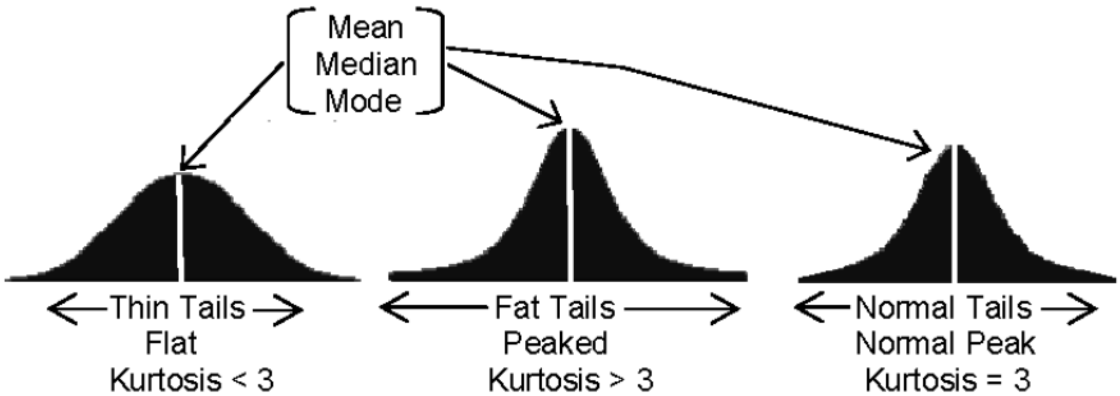
Source: Investopedia

So let's examine these two trades. In both cases, the buyer can only lose the premium paid with the potential for an unlimited gain. On the other hand, the seller's profit is limited to the fee received while he is exposed to a potentially huge loss. The model is supposed to produce prices that will have comparable, ex ante, Net Present Values, but the cold reality is that while the strangle does have 100 points of "cushion" over the straddle, they both ultimately have the possibility for "unlimited" loss. With due respect to the almighty, only an atheist could opine that Infinity plus one is greater than Infinity. As such, since the potential losses are similar (infinite) yet the strangle seller books a fee barely one sixth as large as the straddle seller, a risk averse strangle seller will demand a higher NPV, and thus its Implied Volatility is elevated above that of the straddle. While slightly convoluted, this is the best non-mathematical way I can describe the classic "smile" one sees for many option profiles. The diagram above is a textbook "smile".

Kurtosis

Option models tend to employ standard Normal or Lognormal distribution curves for ease and simplicity. The problem is that reality is not quite so tidy. As the CEOs of most integrated financial institutions bitterly discovered in 2008, markets tend to experience a "hundred year flood" about every seven years. Consequently, the far left and right sides of the distribution tend to be "fatter" in reality than expected under ideal theoretical circumstances. Kurtosis is the mathematical name for measuring the plumpness of the tails in a distribution.

The figures below were created by statisticians in an attempt to contort a standard distribution to better fit a sample. Ultimately, traders give up on the "implicit" solution of squishing the distribution via tweaking the Kurtosis setting to alter model option values. Instead, market convention is to employ an "explicit" method of arching the Skew profile to change the Implied Volatility input in such a manner that the model value more closely matches the market price.



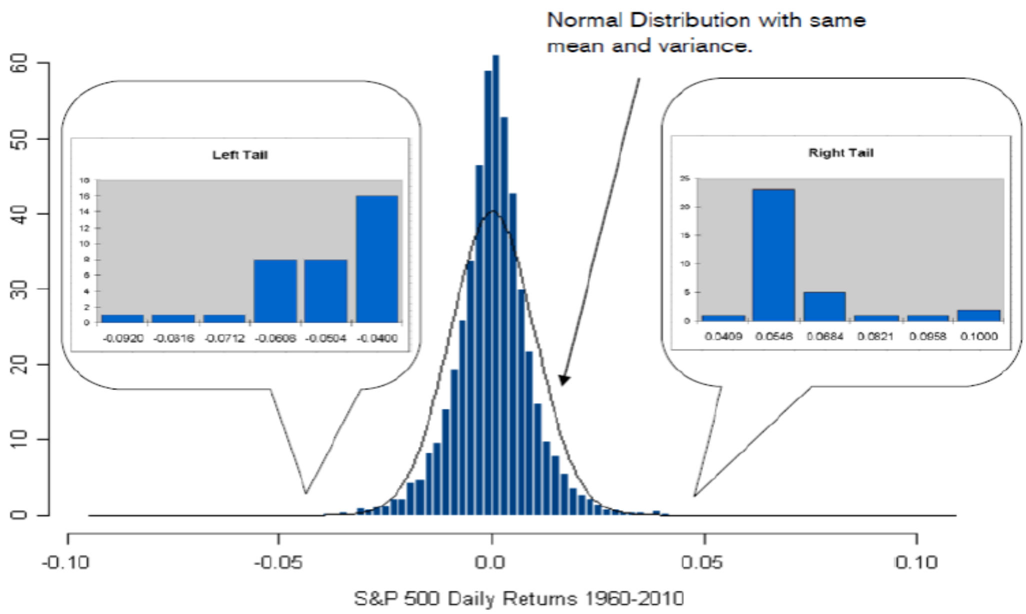
Source: Financial Planning – Body of Knowledge

Path Dependency (1): Speed

Path Dependency is the key differentiator in valuing a "static claim" and a "contingent claim". (That is geek-speak for pricing a bond versus an option on a bond.) If a bond rises by 10% over a few weeks, you make a 10% profit no matter how that move occurs. In contrast, the path makes a big difference in option-land. An asset whose price rises by 1% a day for two weeks is a different animal from one where the 10% price change occurs on a single day; speed matters. Let's consider how option pricing reflects this reality.

Unlike the Futures market where all longs must fully offset every short, the cash markets do have a "net" position. Specifically, for listed Equities and liquid Bonds, investors are massively net long. This is because the "shorts" are the issuing corporations, US homeowners, or the US Government, who do not trade their positions. This is why the MBS market is "net short Convexity"; investors have sold the prepayment option to homeowners <u>who do not "delta hedge" their houses</u>. [See Commentary – *"The Convexity Vortex"*, March 6, 2013]

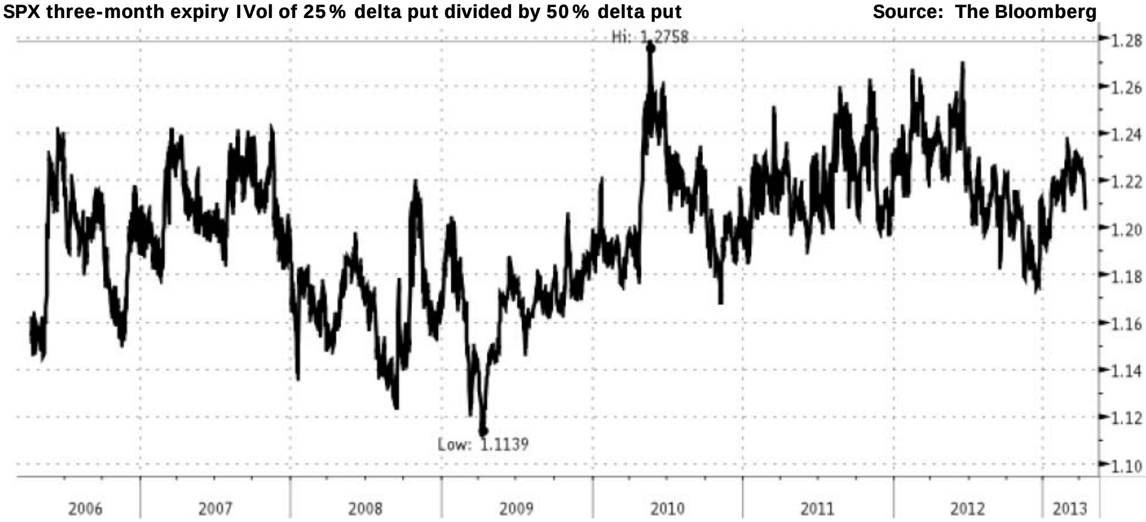
Since everybody is long (in aggregate), a seller can only sell to someone who is already long and is willing to become longer; this buyer often demands a discount when markets are volatile. This partially explains why prices tend to decline faster than they rise. The chart below details the fifty year history of daily Equity returns. As shown, the left tail (large price declines) is greater than the right tail (large price increases) as there are more extreme price drops than similarly large price jumps.



Source: Credit Suisse

Since short-dated "gamma" options are most impacted by the "speed" of a price change (recall that both gamma and acceleration are second order derivatives), investors who sell these types of options demand an extra risk premium. It is for this reason that short expiry OTM equity options always exhibit a significantly positive put skew. In the –chalkboard chart- below, the Implied Volatility of 25%-delta (OTM) puts has generally been about 21% above the Implied Volatility of 50%-delta (ATM) puts for three-month options on the SPX Index.

SPX three-month expiry IVol of 25% delta put divided by 50% delta put **Source: The Bloomberg**



Path Dependency (2): Location

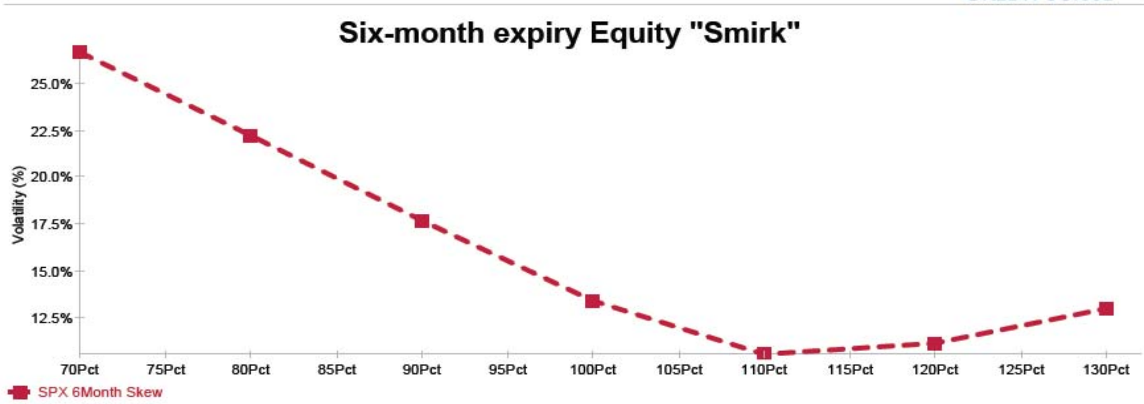
Path Dependency is a dual-pronged vector; now that we have examined the consequence of speed, we must now consider the implication of direction. It is for this reason that option modelers repeat a similar mantra to that of real estate brokers: Location, location, location.

When pricing an OTM option, the trader/investor must consider not only the probability of reaching the strike (before expiry), but also what will be the Implied Volatility for an ATM once one arrives there. Since option trades are frequently closed out before expiry (and almost always marked-to-market), this is not a trivial concept. If one buys a nine-month option whose strike price is 20% away, superior investors will have a reasonable notion as to what ATM Implied Volatility will be if that strike is reached in only three months.

In the equity markets, there is a logic that underpins the skew profile for short to mid-dated options. If the S&P rises by 100 points, about 7%, over the next few months, that would certainly imply happiness and goodness in the world; a world with less risk and fear. As such, one would expect ATM Implied Volatility (such as the VIX) to decline. It is for this reason that OTM calls usually exhibit a negative skew. Rare is the day that the stock market rises on an expectation of greater economic risk.

Alternatively, fear and loathing almost always accompany lower prices; stock prices pull back in anticipation of bad news. It is almost a given that lower prices are associated with risk and worry, the main ingredients for higher option prices.

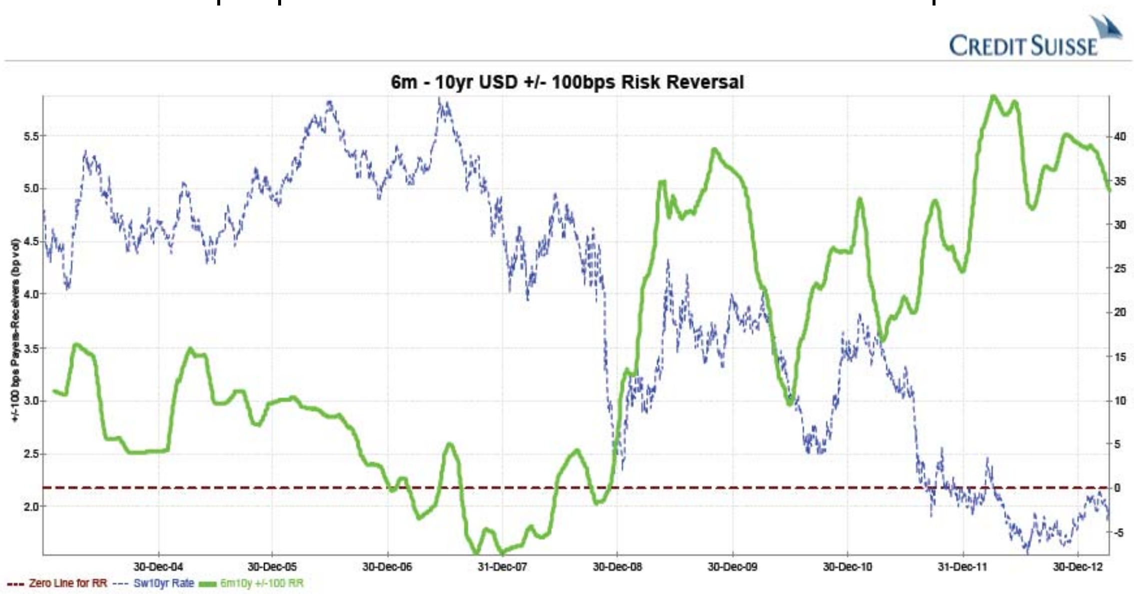
Instead of a "smile", the Skew profile for equity options tends to form a "smirk" where the left side of the -raspberry line- is tipped up and the right side is initially slanted down. The high correlation of Implied Volatility to location dominates the other factors.



The consistently “smirked” skew for equities is not replicated in the debt markets. Like most urban cities in the US, where central downtown has cycled between au courant and slum as the demographic cycle flows, relative strike locations swing between chic and shabby.

At the dawn of liquid option trading on Fixed Income securities, higher interest rates were “bad” and lower rates were “good”. Higher rates (lower prices) meant either Inflation or Liquidation, both negative for Total Rate of Return. With Rates averaging 7% throughout the 1990s, a 5% rate would imply a stable economy and higher stock prices while a 9% rate would mean a return of the dreaded scourge of inflation. As such, OTM puts traded at a higher Implied Volatility than equidistant OTM calls. [For quants, they traded fully Lognormal. See Commentary – “Wall Street Babylon”]

Fast forward to early 2007, the eve of the Financial Crisis; Interest Rates were circling around 5%. In this case, higher rates would confirm that the FED’s tighter policy was indeed supported by a strong economy and that the housing market would experience only a shallow retracement; higher rates would imply less risk and lower Implied Volatility. However, much lower rates could only occur if the most dire predictions of a housing bubble were true. Since the last time national housing prices declined was during the Great Depression; fear surrounded the prospect of lower rates which was reflected in the price of Skew.



In the chart above, the –kiwi line- is the Implied Normal Volatility for a six-month into ten year 100bps OTM payer (put) minus the Implied Volatility for a 100bps OTM receiver (call). The –huckleberry line- is the Sw10yr Rate. Notice how the OTM call option became much dearer as the housing collapse gained steam in late 2007. The market recognized that lower rates could only occur in a more desperate environment; a world of much higher Implied Volatility.

Presently, lower yields would be concurrent with the endless boredom, and low Volatility, of QE~ (infinity). On the flip side, consensus seems to be that a 3%-handle on the Sw10yr Rate could only occur if the FED strongly hinted at the prospect that they may soon scale back their buying program. Ipso, facto, a 3% ten-year could only occur in a more uncertain environment as market forces would be released from the FED's repressive grip and would once again independently manage the risk transfer process. Consequently, it should be no surprise that put versus call skew is near its steepest level ever.

Supply versus Demand

No discussion of asset prices can ignore consideration of Supply versus Demand dynamics. So briefly:

1) The Equity market almost always exhibits a "smirk". Fundamental considerations aside, there are large and well established option overlay programs that employ "collars" and "covered calls". As such, market makers are almost always overly long OTM calls versus short OTM puts.
2) At one time, the Debt markets had a similar "smirk" profile. This was reduced when the S&L crisis essentially ended "covered call" selling by financial institutions. Regulatory changes, specifically in the form of FASB 122, converted MBS Servicing Rights from an off-balance sheet intangible to an on-balance sheet asset. In tandem, these two "accounting" changes have balanced out the supply::demand structure for Rates products.
3) Commodities and FX have relatively balanced flows, as such, the Skew profile of these markets tend to most often exhibit the classic "smile".

Trading Opportunities

<u>Respect the MBS market</u>

The largest participant in the USD options market is the Mortgage Servicing Rights (MSR) business. And while the FED's policy of Financial Repression has temporarily dampened their hedging activity, the underlying of gross risk of MSR has only increased in the past few years. Current option prices do not fully indicate an appreciation of how the MBS market will react to higher interest rates.

Buy	100mm	5 year into 5 year	payer	K = 3.65%	98nv
Sell	100mm	5 year into 5 year	payer	K = 4.50%	106nv
Sell	100mm	5 year into 5 year	payer	K = 5.50%	116nv

Enter trade for Zero cost; flat delta, flat gamma, positive carry.

While this trade looks like a "classic option ladder" with a maximum payoff between 4.50% and 5.50% and a lower bound breakeven of 6.35%, the plan here is be out of the trade well before expiry with a rather tidy profit.

The 5yr-5yr rate is presently at 3.00% while the Par MBS rate is near 2.50%. A 125bps rise in rates, a notion that is not totally insane since that would only push the cash ten-year to 2.95%, would also make FN 3s a discount bond and FN 3.5s a current coupon security. The FED's policy of Financial Repression has "re-couponed the stack" such that the point of Maximum Convexity (the Convexity Vortex) has been repositioned.

Assuming a parallel shift, the –redwood line- 5yr-5yr would be at 4.25% and the 3.65% strike payer option you are long would be 60bps in-the-money. As per Put::Call Parity, this option is similar in Volatility to a 60bp OTM call option.

So here is the magic: (1) Since rates would now be on the other side of the Convexity Vortex, MSR hedgers will need to buy OTM calls, not puts. As such, the 3.65% strike will not be negatively skewed by 8nv to the 4.50% strike you are short. (2) Additionally, since the 5yr-5yr has historically rotated around the –leaf line- of 5.00%, speculators will not be willing to pay a 10nv premium between the 4.50% strike and the 5.50% strike. Ultimately, there will NOT be an 18nv Skew across this ladder. The big profits will not be earned from delta or theta, they will be booked as vega profits when the Skew profile compresses and ultimately inverts.

It is never different this time

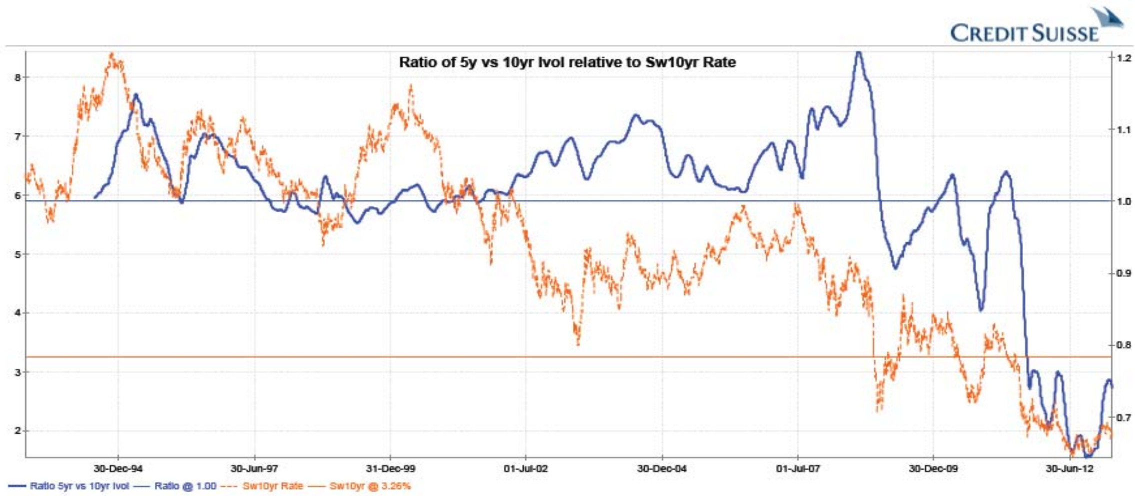
Until the FED implemented ZIRP and yanked the Fed Funds rate to zero, the ratio of the Implied Volatility of 6m-5yr versus 6m-10yr averaged 105% and rarely breached the parity barrier. This is a long way from the current ratio of 70%. While it is unclear when rates will rise, what we can almost guarantee is that on that distant date when rates move significantly higher, this ratio will once again return to a premium.

Buy 100mm 18 month into 5yr Payer K = 2.25% 79nv
Sell 53mm 18 month into 10yr Payer K = 3.26% 88nv

Enter trade for Zero cost with a 90% Volatility Ratio

Below, the –azure line- is he Implied Volatility ratio of 6m-5yr versus 6m-10yr while the –clementine line- is the Sw10yr rate. Critical concepts:

1) The ratio was almost always above 1.00 until ZIRP;
2) Even during ZIRP, the ratio expanded when rates jumped;
3) A Sw10yr rate above 3.26% was associated with a ratio above 1.00



While this trade might look like your standard "conditional bear flattener", the magic here is that you can enter the trade at a 90% ratio at a strike level where the ratio should be above parity. The plan here is to book at least a 10nv vega profit as the Implied Volatility ratio expands with rising rates. Any curve profits will be gravy.

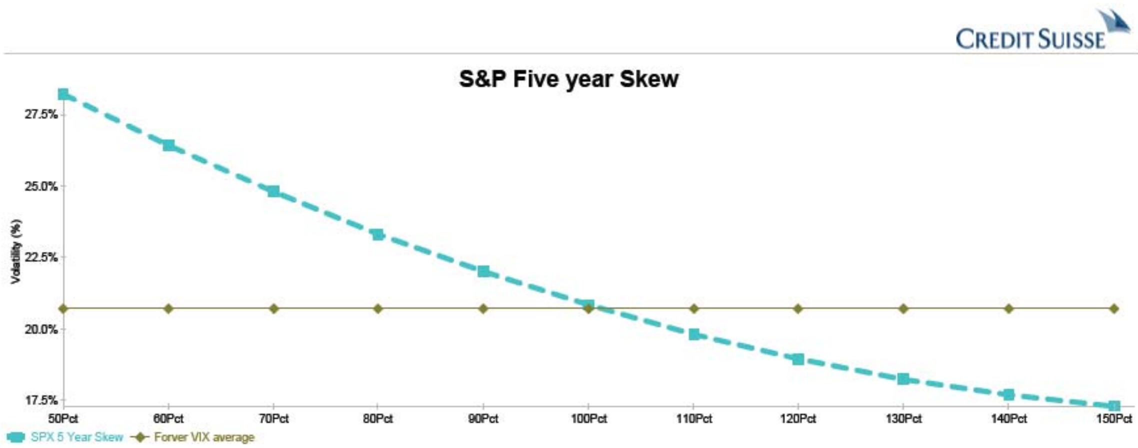
Still the BEST trade for 2013

If I pound the table any harder on this trade, I will fracture my wrist.

If you have actually read the preceding ten pages, then you hopefully appreciate the fact that unlimited loss is feared and that unlimited loss with only the hope for a small gain tends to increase Skew. So why is it that the Skew for long-dated equity options seems to completely reverse this logic ?

Let's conduct a thought exercise. If one buys $100mm of the S&P, the most one can lose is $100mm. This scenario may be a bit servere, nonetheless, the loss is limited. Now consider the potential outcome of shorting $100mm of the S&P. The loss potential over a long period of time is substantially larger. I will not say infinite, but two times to five times over a decade is not out of bounds.

So riddle me this: How is it that a five-year expiry 40% OTM put on the S&P, an option on the limited loss side of the distribution, trades with a +25% Skew premium to the ATM while an equidistant 40% OTM call, an option on the UNLIMITED loss side of the distribution, trades at a -15% Skew discount ?



Buy 100mm five-year expiry call option, K = 2000
Sell 100mm five-year expiry put option, K = 1000
Enter the trade at Zero cost, Spot S&P ~~ 1575

Reality Check #1: How is possible that the dollar cost to own 28% of the payoff distribution (the delta of the call) is the same as the dollar cost of 15.8% of the distribution (the delta on the put) ?

Reality Check #2: For the same dollar price, you can be long an unlimited gain option struck 425 points away versus being short a limited loss option struck 575 points away.

Reality Check #3: The -robin's egg line- above is the Skew profile of five-year expiry S&P options while the –over-ripe avocado line- is the "forever" average of the VIX Index. Implicit in this trade, one is buying an unlimited gain "tail option" for a 10% lower Implied Volatility than the lifetime average. This is almost silly.

Since outright execution of this trade may be problematic, we suggest you consider executing this trade as an "asset substitution" for your "beta exposure" to the equity market. Let us detail the superior characteristics of this strategy.

Conclusion

While trading duration (or any asset with a linear return) is not easy, at least you only have to manage one risk vector. The added complication of trading options is that the risk profile now has more than a single dimension.

The key message here is not that everyone should become an option trader, but that there is significant information embedded in the skew profile of an asset. Often is the time that Skew will rotate in advance of a large market move.

Both our CS Rates and Equity strategy teams employ various Skew constructions as key indicators to linear risk. Even Barron's quotes Skew on the VIX in their weekly options column. As such, Skew can be used either directly in trading or indirectly in risk construction to increase portfolio returns.

We welcome your questions on this topic. Please call your CS representative.

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April 17, 2013

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