Volatility Dispersion
Presentation for the CBOE Risk Management Conference

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Volatility Dispersion

This is a term that’s been bandied about

Typically means:

“I have volatility exposure in one or more instrument, can I get rid of it using other instruments”
Volatility tracking

- Market makers used to sell options on the US dollar / Swiss franc and hedge using the US dollar / German mark.
- As long as both currencies moved in tandem, this worked rather well.
- But – there were periods where the currencies diverged and the hedge fell apart.
Past correlation

In the previous example, there was a relationship between the currencies that has been observed in the past.

It does *not* mean that it will be sustainable in the future.
Types of Equity Indexes

Focus of Index
- Broad Index (S&P 500, Nasdaq)
- Narrow (industry group) index (e.g. Semiconductor index, Health Care index)

Weighting
- Market Cap weighted (e.g. S&P 500, Nasdaq)
- Equally weighted price (Dow Jones)
- Equally weighted return index (e.g. the Value-Line index)
Index to component arbitrage

Many try to arbitrage between the index (e.g. DJIA) and its components stocks

Others also include futures (DJIA index futures)

This relationship has been “arb-ed to death”
Relationship scale

- Simple relationship (e.g. index to components – easy to do so there is not much profit potential)

- Historical relationship (very dangerous - high possible profits but also high potential risks)

- In the middle: relationship between the implied volatility of the index and the implied volatility of its components
Index options

- Some index options are only traded at a single exchange as compared with equity options which may be traded at up to five exchanges.
- Index options have high bid-ask spreads as compared to single stock options.
- Have high implied volatilities as compared with the historical volatility of the index.
Implied vs. Historical – NDX

Avg Hist 41.43%, Imp 44.28%

NDX : Imp & Hist Vols

[Graph showing Implied and Historical Volatility from Dec-01 to May-03]
Implied vs. Historical – GE

Avg Hist 40.03%, Imp 40.13%

GE : Imp & Hist Vols

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Hedge Fund Strategy - I

- Some hedge funds just sell options on the index:
  - Sell at the money near term (1-2 months) S&P options
  - Buy far from the money 1-2 months S&P options
- As the hedge fund says…
  - Natural suppliers of index options do not exist
  - Buyers must pay a premium
  - Benefit from overpricing on index options
Rationale

Because the implied is higher than the actual volatility
So they collect more premium than they risk to their capital

Example: Acorn Derivatives
Hedge Fund Strategy - II

- Sell index options – close to ATM straddles or strangles

- Buy component options
Why not the reverse?

- Short index options
- Long component options
- ... not the reverse

- Index options are expensive
- You can be surprised with a single stock (e.g. bankruptcy, takeover, earnings surprise) but not with the entire index
Delta hedging

- Each are Delta hedged with its own underlying
- As this is a hedged position...
- They get a better treatment from the clearing firm

- It is really a “volatility” play – or more precisely a “correlation” play
Examples

- The Barracuda fund of Artradis in Singapore
- Balanced Asset Management of Hungary
- Our fund (Keren Asset Management) in the USA may also employ this strategy

- The Buy-Write index takes advantage of the same phenomena
Market Makers

- Are attracted by the high bid ask spreads in index options
- They sell these index options…
- …and benefit from high implied volatilities
- …as well as the large bid-ask spreads
- Market makers may find it difficult to buy them (as natural sellers may be hard to come by)
- So – they need to hedge their volatility exposure (vega)
Reducing vega

- By purchasing component options which are relatively cheap
- ... and have low bid – ask spreads
High Volatility

- Typically, volatility rises when markets tumble
- Stock drop across the board
- Correlation is high

- Sell straddles in high volatility environments
- … but worry: “can volatility increase even more”?
- Volatility dispersion is a way to reduce the risk
- …Since correlation is bounded $\leq 1$
The Portfolio Equation

\[ Var_p = \sum_{i=1}^{n} \sigma_i^2 w_i^2 + \sum_{i=1}^{n} \sum_{j=1, i \neq j}^{n} \rho_{i,j} \sigma_i \sigma_j w_i w_j \]

\[ \sigma_p = \sqrt{Var_p} \]
Portfolio Equation - II

\[ \sigma = \text{standard deviations of returns} \]
\[ \rho = \text{correlation of returns} \]
\[ w_i = \text{weights for each security} \]
Currency Options

The portfolio equation is used by foreign currency (forex) option participants.

Forex option triangle:

Participants know the volatility on:
- USD/Euro options
- USD/JPY options
- Euro/Joy options

From here, we can get at the correlation numbers.
Two stock index

Given the two implied volatility numbers and the index implied volatility, we can deduce the correlation number – this is the “implied correlation.” If it is much higher than the historical correlation number – it may be a good trade.
## Hypothetical Example

<table>
<thead>
<tr>
<th></th>
<th>Weight in Index</th>
<th>Implied Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock A</td>
<td>70%</td>
<td>30%</td>
</tr>
<tr>
<td>Stock B</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Correlation</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Volatility of index</td>
<td></td>
<td>30.62%</td>
</tr>
</tbody>
</table>
Question

- Sold 100 index ATM straddles
  - How many straddles in each component?

- Sold 100 index slightly out-of-the-money call options
  - How many call options in each component?
  - Which strikes should you use?
Equating “Greeks”

- Delta’s are hedged in each instrument separately

- If the trader sold 5000 Gamma (or Vega) units on the index option

- … they would like to have an equivalent amount in the component options
Profit

- If the implied correlation comes back in line with normal levels
  - by index implied volatility dropping
  - by component implied volatility increasing
- Then the trade makes money

- Windfall win – when one stock jumps up and the other down
  - The index is unchanged
  - The component options made money
Danger

- As the stocks & index move these options may no longer be close to ATM
- So even if the implied volatility numbers came in line
- ...you may not have made any money

- Do you readjust the option position?
Correlation “explosion”

- The trade is a “bet” that correlation will return to normal levels.
- If correlation continues to increase (e.g. due to all stocks moving in the same direction) the trade may, in fact, lose money.
Broad vs. Narrow indexes

- Broad index has many constituents so must buy many component options and manage them
- Narrow index has few component options so it is an easier trade
- Sector index has high levels of correlation to start out with – when it is really high – there is not too much correlation risk (the most it can go to is 1)
Index weights

- As the stocks move up and down, their relative weightings in the index change.
- This impacts on the index implied volatility.

- If a stock moves down dramatically, then its weight in the index drops. On the other hand, its implied volatility increases.
- These effects tend to partially cancel each other.
Many stocks

<table>
<thead>
<tr>
<th>Weight in Index</th>
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<tbody>
<tr>
<td>A</td>
<td>10%</td>
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<tr>
<td>B</td>
<td>15%</td>
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<tr>
<td>C</td>
<td>20%</td>
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<tr>
<td>D</td>
<td>25%</td>
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<tr>
<td>E</td>
<td>30%</td>
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<table>
<thead>
<tr>
<th>Correlation matrix</th>
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<tbody>
<tr>
<td>A</td>
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<tr>
<td>B</td>
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<td>C</td>
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<th>C</th>
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<tbody>
<tr>
<td>A</td>
<td>100%</td>
<td>70%</td>
<td>30%</td>
<td>60%</td>
<td>70%</td>
</tr>
<tr>
<td>B</td>
<td>70%</td>
<td>100%</td>
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Index Volatility: 33.918%
Difficulty

- With many stocks, we cannot uniquely determine an implied correlation matrix.
- One method...
  - Use the historical correlation and the implied volatility.
  - Compare the resulting volatility with the actual implied volatility of the index.
How to compare?

If the implied volatility of the index is 35% but the result of the computation is 33% - is that enough to be a seller?

Need some way to assess the relative implied volatility differential (e.g. on a historical basis)
More difficulties

- We do not hedge with the entire index
- But with a select group of stocks
- These are
  - the heavily weighted stocks – large market cap
  - the ones with large liquidity
  - the ones with large implied volatility numbers
- How many stocks should you choose?
Lag Risk

- It is often impossible to place all the legs of this trade simultaneously

- .. so the trade is exposed to lag risk
Volatility dispersion models

- Ivolatility.com
- Brisk systems
- ... and others
Profit attribution

- Why did we make money on a particular trade?
- Was it a result of implied correlation coming in?
- Or perhaps the trader accumulating Deltas?
Science & Art

- We have developed volatility dispersion tools for consulting clients.
- These models are quite mathematical.
- But volatility dispersion trading is also an art.
- Beware of a “black box” model.