The Beta and VIX:
Elementary Measures of Risk

This building on the left is in some way or another associated with risk ... you walk in, expose yourself to risk, and walk out a little richer or poorer. Financial markets are somewhat like that ...

The role played by uncertainty

The finance markets exist, and financial assets exist, and their prices exist, and their prices are variable and even sometimes volatile, because of uncertainty about the future value of financial assets, such as a company's profits, the value of a home, the future income stream from a bond, or in the case of esoteric derivatives, the future value of a price. Precise predictability is impossible. Even general fuzzy predictability (with a wide range and a wide time horizon) can be difficult and unreliable.

Solid financial theory is less about becoming a better predictor and more about making decisions that do not rely upon predictions. To "win" in a zero- or positive-sum game, you only need a slight edge.
Picking Turning Points (rebalancing)

Very, very hard to pick the turning points...

… where I bought (went 70/30)
… where I sold (went 30/70)

Beta: Our common risk estimator

$$B_x = \frac{COV_{xs}}{V_s}$$

The Beta of any stock ($x$) compares a stock to an index, like the S&P 500 ($s$), and using time-series data, is equal to the covariance of $x$ and $s$ divided by the variance of the index.

This is meant to be a measure of the relative volatility of the stock when compared to the index.

The data used here are growth rates (typically continuous annualized growth rates) of the two variables in question.
What is the covariance of two variables, such as a single stock and the S&P 500?

\[ COV_{xs} = CC_{xs} \times SD_x \times SD_s \]

where \( CC \) is the correlation coefficient between \( x \) and \( s \) as determined by correlation analysis, and \( SD \) represents standard deviation.

The correlation coefficient, which will be between -1 and 1, determines the degree to which two variables are correlated.

Again, observed values for the stock price and index are not used. Instead, continuous growth rates are used.

An example of a high risk, high gain / high loss (high beta) stock

Dendreon (DNDN), a biomedical research company

Look up the Beta for DNDN and a couple of your portfolio stocks and compare them to GE.
**Beta Rules of Thumb**

Below, (a) refers to Beta calculated in reference to an index, (b) refers to Beta calculated in reference to a portfolio.

- If Beta > 1, (a) the asset is more volatile than the index, (b) if the asset were added to the portfolio, the portfolio would become more volatile.
- If Beta > 0 and < 1, (a) the asset is less volatile than the index, (b) if the asset were added to the portfolio, the portfolio would become less volatile.
- If Beta is < 0, which implies negative correlation, the financial asset in question tends to move in the opposite direction of the (a) index or (b) portfolio.

---

**The Complicated VIX etc. Structure**

- The S&P 500 Index
- S&P 500 futures contracts
- CBOE Options on SPX (the S&P 500)
- The VIX index
  - Determined by the prices and premiums of these options, the higher the premiums the higher the index.
- CBOE VIX futures contracts
- VXX
  - the ETN that attempts to track the VIX through it’s NAV, using CBOE VIX futures contracts
- TVIX
  - the daily delta 2X VIX tracking ETN
CBOE SPX Options

- Relevant spot price is the actual value of the S&P500 index.
- Position value 100X (single contract size)
- Settlement impact: One SPX point move equals $1.
- Exercise: **European style** – options can be exercised only on expiration date.
- Deliverables: **None**. Contracts are automatically offset on last trading day if still in effect. Final settlement for open contracts takes place the Monday after expiration.
-Expiration date – Saturday following the 3rd Friday of the month
- Last trading day – the Thursday before that Saturday.

To read more, go to http://www.cboe.com/products/indexopts/spx_spec.aspx

---

SPX Nov 2012 Options Chain

SPX at 1381.03 11:00 AM Nov 20, 2012

<table>
<thead>
<tr>
<th>Calls</th>
<th>Strike Price</th>
<th>Contract Name</th>
<th>Last Trade</th>
<th>Change</th>
<th>Bid</th>
<th>Ask</th>
<th>Volume Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPW12K301365.0</td>
<td>20.60</td>
<td>-3.95</td>
<td>21.70</td>
<td>23.10</td>
<td>15</td>
<td>351</td>
<td>1,365.00</td>
</tr>
<tr>
<td>SPW12K301370.0</td>
<td>11.40</td>
<td>-6.95</td>
<td>12.20</td>
<td>13.50</td>
<td>271</td>
<td>1.110</td>
<td>1,370.00</td>
</tr>
<tr>
<td>SPW12K301375.0</td>
<td>16.90</td>
<td>-5.00</td>
<td>18.90</td>
<td>19.40</td>
<td>62</td>
<td>347</td>
<td>1,375.00</td>
</tr>
<tr>
<td>SPW12K301380.0</td>
<td>8.76</td>
<td>-4.24</td>
<td>9.20</td>
<td>9.90</td>
<td>114</td>
<td>2.682</td>
<td>1,375.00</td>
</tr>
<tr>
<td>SPW12K301385.0</td>
<td>14.30</td>
<td>-6.26</td>
<td>15.80</td>
<td>16.20</td>
<td>231</td>
<td>4.068</td>
<td>1,375.00</td>
</tr>
<tr>
<td>SPW12K301390.0</td>
<td>6.60</td>
<td>-4.46</td>
<td>6.50</td>
<td>6.70</td>
<td>552</td>
<td>1.678</td>
<td>1,380.00</td>
</tr>
<tr>
<td>SPW12K301395.0</td>
<td>11.30</td>
<td>-6.00</td>
<td>12.60</td>
<td>13.20</td>
<td>247</td>
<td>1.913</td>
<td>1,380.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Puts</th>
<th>Strike Price</th>
<th>Contract Name</th>
<th>Last Trade</th>
<th>Change</th>
<th>Bid</th>
<th>Ask</th>
<th>Volume Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPW12K301405.0</td>
<td>11.48</td>
<td>-2.76</td>
<td>8.30</td>
<td>9.10</td>
<td>442</td>
<td>1.204</td>
<td>1,385.00</td>
</tr>
<tr>
<td>SPW12K301410.0</td>
<td>5.60</td>
<td>-4.00</td>
<td>10.30</td>
<td>10.70</td>
<td>362</td>
<td>783</td>
<td>1,385.00</td>
</tr>
<tr>
<td>SPW12K301415.0</td>
<td>2.55</td>
<td>-2.65</td>
<td>2.45</td>
<td>2.60</td>
<td>1,861</td>
<td>2.164</td>
<td>1,390.00</td>
</tr>
<tr>
<td>SPW12K301420.0</td>
<td>8.30</td>
<td>-2.95</td>
<td>8.20</td>
<td>8.59</td>
<td>378</td>
<td>3.448</td>
<td>1,390.00</td>
</tr>
<tr>
<td>SPW12K301425.0</td>
<td>1.15</td>
<td>-1.10</td>
<td>1.15</td>
<td>1.55</td>
<td>446</td>
<td>4.283</td>
<td>1,395.00</td>
</tr>
<tr>
<td>SPW12K301430.0</td>
<td>6.50</td>
<td>-2.50</td>
<td>6.50</td>
<td>6.60</td>
<td>55</td>
<td>381</td>
<td>1,395.00</td>
</tr>
<tr>
<td>SPW12K301440.0</td>
<td>0.75</td>
<td>-1.30</td>
<td>0.75</td>
<td>0.80</td>
<td>4,762</td>
<td>8,737</td>
<td>1,400.00</td>
</tr>
</tbody>
</table>

Source: CBOE
The VIX formula

\[ \sigma^2 = \frac{2}{T} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T} \left[ \frac{F}{K_0} - 1 \right]^2 \]

Better yet – read the CBOE whitepaper:

The formula on the previous page, which you are not required to know, essentially weighs, discounts, and sums the size of the premiums on all OTM put and call options going out two contract months (next term and the term after). Generally, the bigger the premiums the higher the VIX. The spikes shown here are associated with times of extreme crisis.

Source: finance.yahoo.com
iPath S&P 500 VIX Short-term Futures ETN (VXX)

The S&P 500 VIX Short-Term Futures™ Index TR is designed to provide access to equity market volatility through CBOE Volatility Index® (the “VIX Index”) futures. Specifically, the S&P 500 VIX Short-Term Futures™ Index TR offers exposure to a daily rolling long position in the first and second month VIX futures contracts and reflects the implied volatility of the S&P 500® Index at various points along the volatility forward curve. The index futures roll continuously throughout each month from the first month VIX futures contract into the second month VIX futures contract.

(On November 21, 2012) 40,004,468 shares outstanding, market cap of $1,246,139,178. All data and quote above are from the online fact sheet.

VIX Futures in Contango

November 20, 2012

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Last</th>
<th>Chg</th>
<th>Symbol</th>
<th>Last</th>
<th>Chg</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIX</td>
<td>15.20</td>
<td>-0.04</td>
<td>VX H3-CF</td>
<td>20.22</td>
<td>-0.23</td>
</tr>
<tr>
<td>VX X2-CF</td>
<td>15.18</td>
<td>-0.07</td>
<td>VX J3-CF</td>
<td>21.20</td>
<td>-0.30</td>
</tr>
<tr>
<td>VX Z2-CF</td>
<td>16.45</td>
<td>-0.15</td>
<td>VX K3-CF</td>
<td>21.85</td>
<td>-0.40</td>
</tr>
<tr>
<td>VX F3-CF</td>
<td>18.22</td>
<td>-0.43</td>
<td>VX M3-CF</td>
<td>22.43</td>
<td>-0.27</td>
</tr>
<tr>
<td>VX G3-CF</td>
<td>19.35</td>
<td>-0.30</td>
<td>VX N3-CF</td>
<td>23.15</td>
<td>-0.20</td>
</tr>
</tbody>
</table>
VXX does not track the VIX (in 2012)

This is meant to be an example of the poor tracking performance, of ETPs and especially ETNs that are futures-backed, especially in contango or backwardation.

The VIX by itself ...

The VIX tracking against VXX, underperforming