The importance of quantitative strategies in the current investment landscape

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Finance Concepts

Quant Invest, New York, December 8 2011
The case for quant strategies

• Since Q4 2007, markets have experienced unprecedented volatility and inter-asset correlation

• Traditional long-only strategies are lackluster

• Warren Buffet’s Berkshire Hathaway barely outperformed the S&P 500 over the last 5 years

• After making a killing in the subprime crisis, J. Paulson & Co. lost more than 46% in 2011

• Emerging markets strategies are being questioned given the macroeconomic outlook

• Deflation/inflation uncertainty and the European crisis make fixed-income unattractive as a buy and hold strategy. Same for credit.
Berkshire Hathaway vs. S&P 500

BRK information ratio=0.2, SPY information ratio=0.12
Paulson & Co. Hedge Funds in 2011

• Advantage funds (Advantage Plus and Advantage). Combined AUM= 11 billion USD. **Performance: -46% and -32% respectively**

• Gold Fund
  **Performance: +11%**

• Recovery Fund
  **Performance: -28%**

• Paulson Partners Enhanced Fund
  **Performance: -18%**

• Paulson Credit Opportunities
  **Performance: -18%**

Source: Bloomberg.com, Dec 5, 2011
Emerging Markets

High volatility and vulnerability to slow-down in China’s economy
Capitalizing on equity market volatility

- The dearth of opportunities on fundamental equity strategies led investors to reduce market exposure.

- Classical hedge fund strategies are less volatile than mutual funds but still carry significant Beta.

- Market-neutral Equity quant strategies that can earn money from realized volatility become an important alternative to cash.

- Systematic trading rules with new ideas.

- E.g.: arbitrage between "similar" equity products (and more products are similar due to volatility/correlation).
I. Examples of quant strategies that make use of algorithms & HFT

- Intraday index and ETF arbitrage
- Statistical arbitrage (``Stat Arb``)
- Liquidity providing (``Market making``)
- High frequency trading and price forecasting
Arbitrage of ETFs against the underlying basket

1. Buy/sell ETF against the underlying share holdings
2. Creation/redemption of ETFs to close the trade

This requires high-frequency algorithmic trading to lock-in arbitrage opportunities

Also, ETFs vs futures (E-mini vs. SPY)
LETF versus inverse LETF...
Intraday LETF arbitrage
UYG referenced to IYF between 11 and 12 AM
July 15, 2011

Sell the pops, buy the drops
HF Pairs trading  Intraday evolution of FAZ & FAZ (inverse leveraged ETFs)
Liquidity providing (high frequency)

Strategic placing of limit/cancel orders (liquidity) in the order book
Forecasting prices in HF?

• Based on models for the dynamics of order books

• Computing the probabilities of price changes (up or down) given liquidity on the bid side and ask-side
(Avellaneda, Stoikov, Reed, 2010: pre-published in SSRN, Oct-10)

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<th>Bid</th>
<th>Q(bid)=x</th>
<th>Ask</th>
<th>Q(ask)=y</th>
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<tbody>
<tr>
<td>100.01</td>
<td>527</td>
<td>100.03</td>
<td>31</td>
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• Modeling hidden liquidity in the market (not visible in the OB)
Level 1 Quotes: can imbalance predict price changes?

Quote size depletion may be a precursor for a price move.
Mathematical framework: Diffusion Approximation for Quote Sizes (Level I)

X = bid size
Y = ask size

\[ \begin{align*}
X_t &= \sigma W_t \\
Y_t &= \sigma Z_t \\
E(dW_t dZ_t) &= \rho dt
\end{align*} \]

A price change occurs when (i) one of the sizes vanishes and (ii) either there is a new bid or a new ask level

(See Rama Cont & collaborators for a full study of modeling quote dynamics)
Probability that the Ask queue depletes before the Bid queue

\[ u(x, y) = \frac{1}{2} \left( 1 - \frac{\tan^{-1} \left( \frac{\sqrt{1+\rho} \ y - x}{\sqrt{1-\rho} \ x + y} \right)}{\tan^{-1} \left( \sqrt{1+\rho} \right)} \right) \]

\[ \rho = 0 \quad \Rightarrow \quad u(x, y) = \frac{2}{\pi} \tan^{-1} \left( \frac{x}{y} \right) \]

\[ \rho = -1 \quad \Rightarrow \quad u(x, y) = \frac{x}{x + y} \]

\[ p \uparrow (x, y, H) = u(x + H, y + H) \]

Probability of an upward price change.

H=‘hidden liquidity’.
Estimating hidden liquidity in different exchanges (ability to forecast price moves)

Sample data

<table>
<thead>
<tr>
<th>symbol</th>
<th>date</th>
<th>time</th>
<th>bid</th>
<th>ask</th>
<th>bsize</th>
<th>asize</th>
<th>exchange</th>
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<td>161</td>
<td>271</td>
<td>P</td>
</tr>
</tbody>
</table>

Estimated H across markets

<table>
<thead>
<tr>
<th>Ticker</th>
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<th>NYSE</th>
<th>BATS</th>
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<tbody>
<tr>
<td>XLF</td>
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<td>0.17</td>
<td>0.17</td>
</tr>
<tr>
<td>QQQQ</td>
<td>0.21</td>
<td>0.04</td>
<td>0.18</td>
</tr>
<tr>
<td>JPM</td>
<td>0.17</td>
<td>0.17</td>
<td>0.11</td>
</tr>
<tr>
<td>AAPL (s=1)</td>
<td>0.16</td>
<td>0.9</td>
<td>0.65</td>
</tr>
<tr>
<td>AAPL (s=2)</td>
<td>0.31</td>
<td>0.6</td>
<td>0.64</td>
</tr>
<tr>
<td>AAPL (s=3)</td>
<td>0.31</td>
<td>0.69</td>
<td>0.63</td>
</tr>
</tbody>
</table>
Empirical Probabilities for upward price move conditional on the quote (XLF)
Fitted model (XLF)
USD-BRL Futures (DOLc1)
Low H: imbalance is predictive
Bovespa Index Futures (INDc1)
High H: imbalance is not predictive
II. Statistical Arbitrage

Stock return is compared to the return on the corresponding sector ETF (regression, co-integration)

Residuals: modeled as a mean-reverting process

\[
\frac{dS_i(t)}{S_i(t)} = \beta_i \frac{dI(t)}{I(t)} + \varepsilon_i(t)
\]

\[
\varepsilon_i(t) = \alpha_i dt + dX_i(t)
\]

\[
dX_i(t) = \kappa_i (m_i - X_i(t)) dt + \sigma_i dW_i(t)
\]

Example of sampling window = 3 months (~ 60 business days)
Medium frequency rebalancing/ fully systematic

systematic component

idiosyncratic component

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Building a portfolio from ETF-based signals: the `PLATA’’ strategy

-- Large, diversified trading universe of equities (~ 500 names)

-- Select those stocks within the trading universe that have a trading signal via co-integration and open trades

-- All trades consist of stocks paired with ETFs

-- Monitor for closing trades through co-integration

-- Monitor for degradation of statistical parameters, stop-losses, etc.

-- Investment per stock ~ 25 bps (~250K per 100MM notional capital)

-- Typical profile 30 to 50 % long / 30 to 50 % short, dollar-neutral.

-- Portfolio-level risk management used to ‘’vet’’ trades.
Difference between managed risk and unmanaged risk in the Fall of 2008

(Back-testing simulation)
SPY+PLATA: a synthetic 130/30 fund

Based on a notional amount of 100 MM:

-- go long 100 MM SPY and

-- implement a PLATA strategy based on 100MM notional amount
  (30 to 50 mm long/ 30 to 50 mm short)

(parameters for PLATA: big universe, 25bps per stock,
  target daily stdev of portfolio=40bps)

Due to market-neutrality of PLATA, this portfolio looks essentially like
a 130/30 to a 150/50 depending on the volatility in the market and the
turnover.
Comparing SPY+PLATA with SPY

An overlay of beta with a long-short stat arb portfolio will work better in a recovery with high volatility
III. Quantitative Low-Frequency ETF strategies

- **Contango/backwardation** in commodity- and volatility-based ETFs

- **Path-dependence and volatility exposure** in Leveraged ETFs
Contango implies futures drop towards spot

\[ F_t^{(i)} = S_t e^{(r_i - d_i)(T_i - t)} \quad \text{contango} \Rightarrow r_i - d_i > 0 \]

\[ S_t = \text{spot price} \]
\[ r_i = \text{rate for expiration } T_i \]
\[ d_i = \text{convenience yield} - \text{storage cost for mat. } T_i \]

\[ \frac{dF_t^{(i)}}{F_t^{(i)}} = \frac{dS_t}{S_t} - (r_i - d_i)dt, \]

Negative drift
Futures-based ETFs: the rolling conundrum

ETF mandate (prospectus):

-- roll position in one or more contracts, aiming to carry a fixed-maturity

-- change contracts systematically as expiration arrives

\[
\frac{dI_t}{I_t} = a(t) \frac{dF_t^{(1)}}{F_t^{(1)}} + (1 - a(t)) \frac{dF_t^{(2)}}{F_t^{(2)}} + r dt
\]

\[
I_t = \text{value of the index at date } t
\]

\[
F_t^{(i)} = \text{futures with settlement date } T_i
\]
Consequence for futures-based ETFs

\[
\frac{dI_t}{I_t} = a(t) \frac{dF_t^{(1)}}{F_t^{(1)}} + (1 - a(t)) \frac{dF_t^{(2)}}{F_t^{(2)}} + rdt
\]

\[
= \frac{dS_t}{S_t} - [a(t)(r_1 - d_1) + (1 - a(t))(r_2 - d_2)]dt + rdt
\]

\[
= \frac{dS_t}{S_t} + [a(t)d_1 + (1 - a(t))d_2]dt
\]

Negative drift if convenience yields are negative
VIX Futures

Contracts with monthly expirations settling on spot VIX.

VIX is generally in contango (like index option volatility)

• Intuitively, in a `bull market’, option implied volatility is higher for longer maturities unless the market is very stressed.

• Slope is less steep for longer maturities, although this has changed in the past year (Black Swan funds buying long-dated volatility?)
The VXX and VXZ ETNs

VXX: iShares ETN which tracks short term VIX futures (months 1 and 2);
target maturity 30 days; continuous roll

VXZ: iShares ETN, tracks mid-term VIX futures (months 4 through 7);
target maturity 120 days; continuous roll

Both securities have negative drift and are correlated to the same
underlying asset.

This gives rise to the possibility of arbitrage by building a long-short position
Connecting the volatilities of both products empirically

20-day regression coeff of daily returns: VXZ/VXX
Short the front-month ETN, long the back-month × 2 (since inception)

short 100% of VXX, long 200% of VXZ

Very profitable until October 2010
Arbitrage Strategies with Leveraged ETFs

- Leveraged ETFs must rebalance daily their position in the underlying asset to maintain fixed market exposure (2X, 3X)

- Even though this is done via total return swaps, the hedging of the swaps will induce a market impact unfavorable to the fund

- **Volatility** plays against LETFs

- **Borrow costs** of LETFs diminish, but not eliminate, arbitrage opportunities

- **A structural arbitrage**: short LETFs and hedge market exposure
Another example: FAS/FAZ

*Direxion 3X and -3X Financial ETF*
Relation between LETF and underlying index

\[
\frac{L_t}{L_0} = \left(\frac{S_t}{S_0}\right)^\beta \exp\left[(1-\beta)rt - ft - \frac{1}{2}(\beta^2 - \beta)\int_0^t \sigma_s^2 ds\right]
\]

Leveraged funds have *negative exposure to volatility*.

Avellaneda & Zhang (2009), Cheng and Madhavan (2009)
Analysis of Borrow costs

• In the current market, LETFs trade at a negative borrow rate.

• However, LETFs typically underperform their benchmark over a single trading date due to market impact (slippage).

• The rate of return of this trade excluding shorting costs can exceed 10% per year (4 bps per day).

• Except for the case of EEM, a study based on data from June 2009 until now suggests that the borrowing costs charged by one major brokerage (Interactive Brokers) typically offset the gains from slippage in the LETFs.
Short UYG/Short SKF, daily rebalancing

Ann return before costs = 9% or 2.4 bps per day
Short EDC/Short EDZ, daily rebalancing

Ann return before costs = 25% or 10 bps per day, after costs = 10% or 4 bps per day.
UYG/SKF short-short, managed exposure
Pro-forma performance of a portfolio of LETF trades (June 26, 2009 to Aug 7, 2011)

Return

Initial Value=$100
Final Value= $141.96
Leverage = 3 (1.5/1.5)
Cumulative 2-year return= 41.96%

Daily Risk Stats

99% VaR=-150 bps
99.5% VaR=-240 bps
Sharpe Ratio=2
Conclusions

• Present market conditions favor quant strategies which are market neutral and/or positioned to capitalize on excess realized volatility

A few promising themes:

• Intraday index/etf/letf/futures arbitrage -- they require HFT technology (Market making also)

• Price-forecasting based on order book imbalance

• Intermediate-frequency trading based on mean-reversion

• Contango/backwardation trades in commodities and VIX

• Leveraged-etf trades to capitalize on high realized volatility