Return Dispersion and Statistical Arbitrage

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How does return dispersion affect statistical arbitrage returns?

- We often say casually that statistical arbitrage returns deteriorate when stock return volatility and dispersion are low, or when the level of correlations among stocks is high.

- To give empirical footing to this statement, we study the statistical properties of the returns of a representative basket of large cap stocks between 7/31/1995 and 7/30/2004 and their relationship to the returns of various hedge fund indices. The data for the indices are obtained from www.hedgeindex.com.

- The basket consists of 231 of the largest market capitalization stocks selected from the Russell 1000 Index as of 1/8/2004. All 231 stocks still exist on 7/30/2004 and 204 of them existed on 7/31/1995. There is some selection and survivor biases in the sample used for this study but we believe they do not alter the conclusions we will be drawing.

Definition of absolute dispersion

- We define the dispersion X_N^2 of the returns of a set of *N* stocks as the variance of the returns about the average return of the basket:

$$X_N^2 = \frac{1}{N}\sum_{i=1}^{N}\left(r_i - \frac{1}{N}\sum_{k=1}^{N} r_k\right)^2$$

  where r_i denote the return of stock i in the basket equal to the first difference of the logarithm of the price.

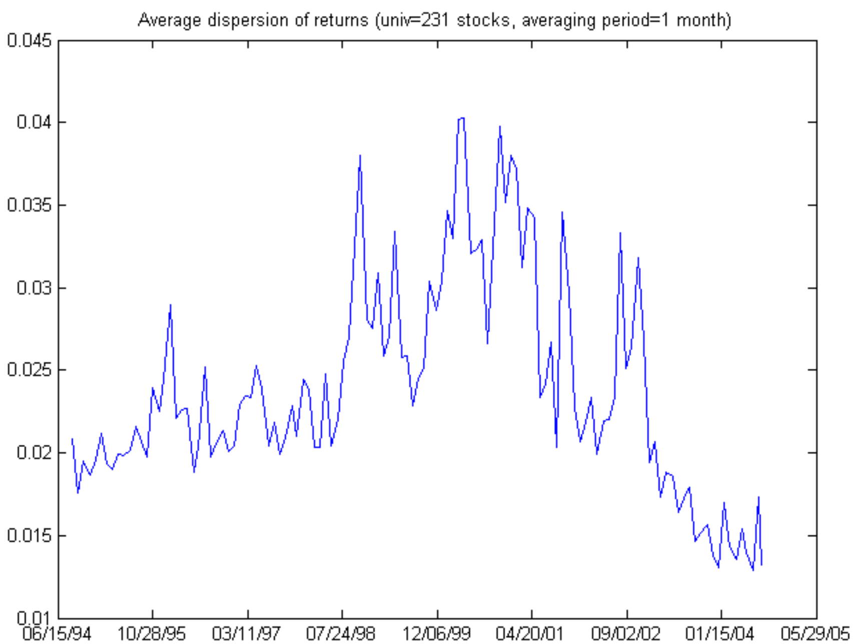
- Thus X_N^2 measures the amount of contemporaneous variation in the returns and can be calculated for each time period in the joint time series of the returns.

- For reasons to made clear later, we shall call X_N^2 the *absolute dispersion* of the basket of stocks.

Absolute dispersion in the stock market is declining

- The prevailing wisdom is that the dispersion of returns is on the decline due to the rising volume of program trading related to index products such as ETFs.

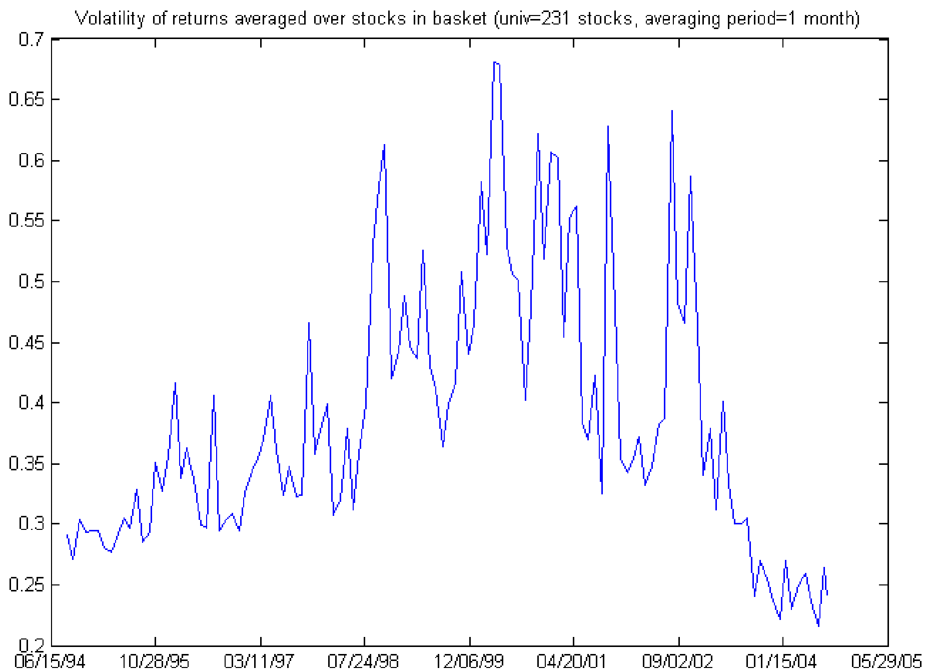
- Indeed the graph below shows an alarming downtrend in the absolute dispersion of large cap stocks, sounding a death knell for the type of statistical arbitrage known as “pairs trading”.



Each data point is the average over all days in a given calendar month of the absolute dispersion of the one-day returns of the 231 stocks in the our representative sample.

The average volatility of stock returns is also declining

- On the other hand the average volatility of the returns of the stocks in our sample is also declining as the graph below shows.
- How can we tell if the downtrend in the absolute dispersion is due merely to declining volatility and not to a genuine decrease in the "variety" of price moves occurring in individual stocks (which the concept of dispersion is supposed to capture)?



Each data point is the average of the return volatilities computed from prices in the given calendar month of all 231 stocks in our sample. The return volatility is the standard deviation of daily differences of the logarithm of the price.

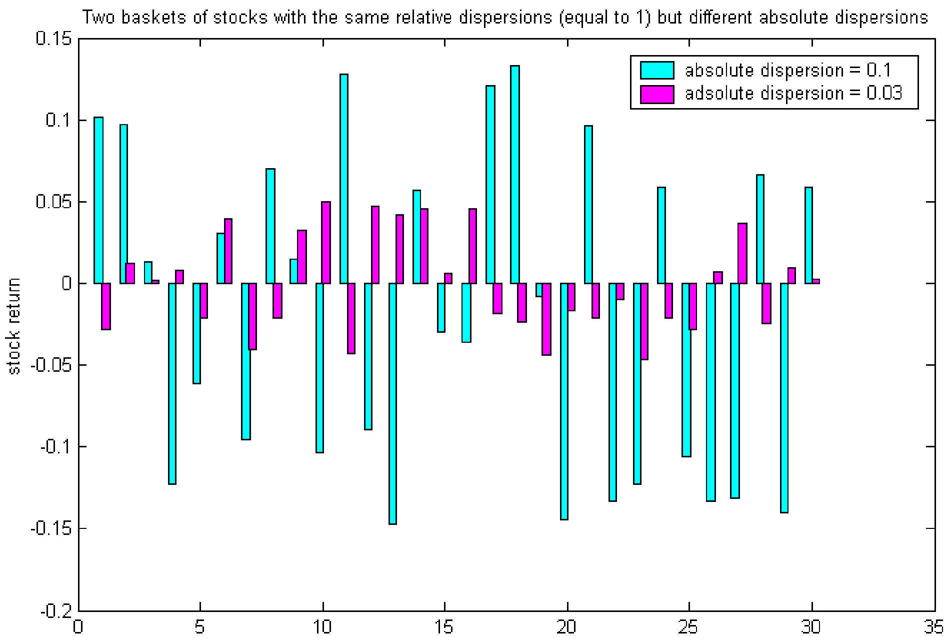
Absolute dispersion versus relative dispersion

- We define the *relative dispersion* D_N^2 of the returns of a basket of N stocks as:

$$D_N^2 = \frac{1}{N}\sum_{i=1}^{N}\left(\tilde{r}_i - \frac{1}{N}\sum_{k=1}^{N}\tilde{r}_k\right)^2$$

where $\tilde{r}_i \equiv \frac{r_i - \bar{r}_i}{\sigma_i}$ is the studentized return obtained by subtracting from each r_i its average $\bar{r}_i$ and dividing the result by its standard deviation σ_i.

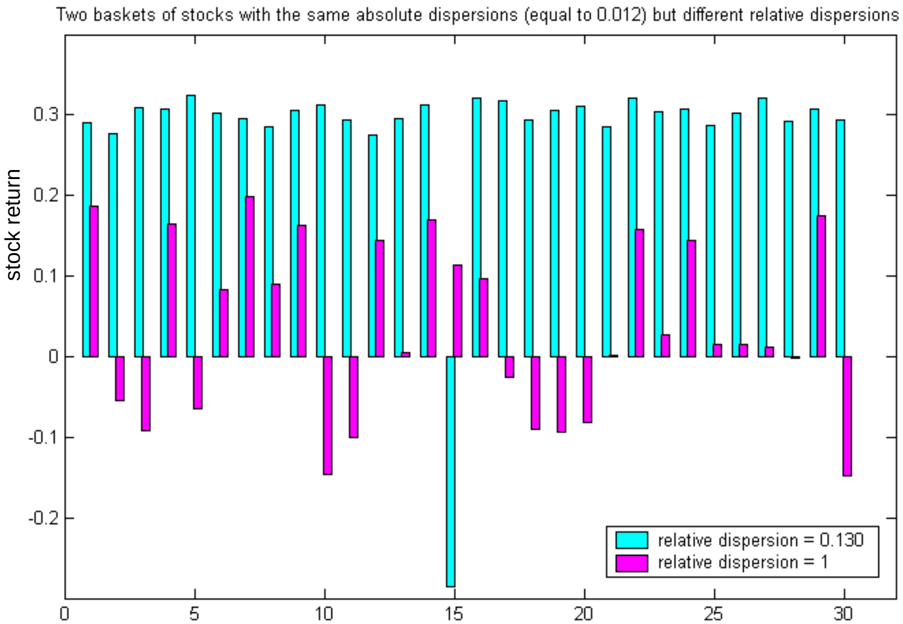
- Two baskets of stocks can have the same relative dispersion but different absolute dispersion if, for example, the returns in one basket were scaled by a constant factor relative to those in the other basket.



Two random sets of returns generated from statistical distributions that are identical except for scale.

Relative dispersion is a truer scale-free measure of variations in returns

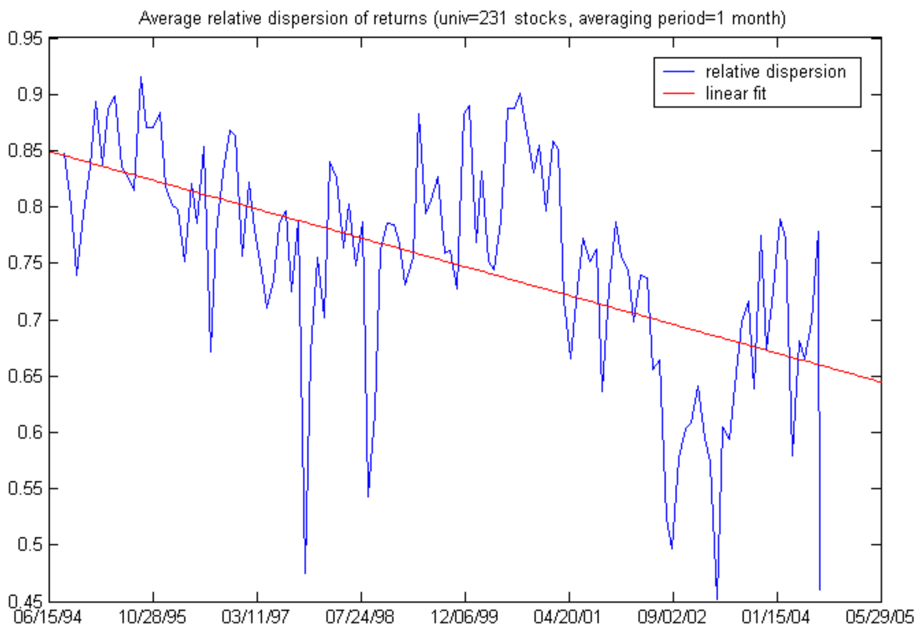
- Conversely two baskets of stocks can have the same absolute dispersion but different relative dispersion as the example below shows.
- The returns in the first set (shown in light blue in the graph) are volatile but highly correlated whereas those in the second set (shown in purple in the graph) are not volatile but completely uncorrelated. The two sets have the same absolute dispersion but very different relative dispersions.
- Relative dispersion captures the intuition that the second set of returns is more varied than the first set. It provides a measure of dispersion that is not distorted by volatility.
- When relative dispersion is equal to one, the returns are uncorrelated. When it is equal to zero, they are completely correlated.



The first set of returns consists of 29 returns all with means and standard deviations equal to 0.3 and correlation coefficient equal to 0.87, and one return with the same mean and standard deviation but uncorrelated with the first 29 returns. The second set consists of 30 uncorrelated returns all with means equal to 0.03 and standard deviations equal to 0.11.

Relative dispersion is also declining but with large swings

- The decline in the relative dispersion in the market is more insidious but nonetheless hard to dispute, as the graph below shows



Each data point is the average over all days in a given calendar month of the relative dispersion of the one-day returns of the 231 stocks in the our representative sample.

What is the connection between dispersion and correlation?

- Is there a mathematical connection between dispersion and correlation, or between dispersion and volatility?
- Yes, relative dispersion is mathematically equivalent to correlation and absolute dispersion is mathematically equivalent to covariance.
- Here is the derivation: The absolute dispersion X_N^2 can be written as:

$$\begin{aligned} X_N^2 &= \frac{1}{N}\sum_{i=1}^{N}\left(r_i - \frac{1}{N}\sum_{k=1}^{N} r_k\right)^2 \\ &= \frac{1}{N}\sum_{i=1}^{N} r_i^2 - \frac{1}{N^2}\sum_{j=1}^{N}\sum_{k=1}^{N} r_j r_k \\ &= \frac{1}{N}\left(1-\frac{1}{N}\right)\sum_{i=1}^{N} r_i^2 - \frac{1}{N^2}\sum_{k\neq l} r_k r_l \end{aligned}$$

This can in turn be written in quadratic form as $X_N^2 = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} a_{ij} r_i r_j$ where

$$a_{ij} = \begin{cases} 1-1/N & \text{if } i=j \\ -1/N & \text{if } i\neq j \end{cases}$$

(1) $$= \delta_{ij} - \frac{1}{N}$$

Taking expectations of X_N^2, and noting that the covariance matrix is $v_{ij} = \langle r_i r_j \rangle - \langle r_i \rangle \langle r_j \rangle$, we get

$$\langle X_N^2 \rangle = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} a_{ij}\langle r_i r_j \rangle = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} a_{ij}\left(v_{ij} + \langle r_i \rangle \langle r_j \rangle\right)$$

Or between dispersion and volatility?

- Thus the absolute dispersion varies linearly with the covariance of returns. If the mean return $\langle r_i \rangle$ is zero or small relative to its standard deviation, then it can shown that

$$\left\langle X_N^2 \right\rangle = \left(1 - \frac{1}{N}\right)\left(\bar{v}_{\text{diag}} - \bar{v}_{\text{nondiag}}\right) \approx \left(\bar{v}_{\text{diag}} - \bar{v}_{\text{nondiag}}\right)$$

  where $\bar{v}_{\text{diag}}$ and $\bar{v}_{\text{nondiag}}$ are the averages of the diagonal and off-diagonal elements of the covariance matrix respectively; $\bar{v}_{\text{diag}}$ is just the average of the variances of the returns.

- Thus absolute dispersion is the contrast between the variances of individual stock returns and their covariances. It is highest when individual stock returns are highly volatile *and* negatively correlated to each other.

- If we replace r_i by its studentized version $\tilde{r}_i$, then X_N^2 becomes D_N^2 and

$$\left\langle D_N^2 \right\rangle = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} a_{ij}\left\langle \tilde{r}_i \tilde{r}_j \right\rangle = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} a_{ij} c_{ij}$$

  where $c_{ij} = \left\langle \tilde{r}_i \tilde{r}_j \right\rangle$ is the correlation matrix of the returns. If we let $\bar{c}_{\text{nondiag}}$ denote the average of the off-diagonal elements of the correlation matrix (the diagonal elements are unity), then from equation (1)

$$\begin{aligned}\left\langle D_N^2 \right\rangle &= \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N}\left(\delta_{ij} - \frac{1}{N}\right)c_{ij} \\ &= \left[\frac{1}{N}\left(1 - \frac{1}{N}\right)\sum_{i=1}^{N} c_{ii}\right] - \left[\frac{1}{N}\sum_{i \neq j} c_{ij}\right] \\ &= \left(1 - \frac{1}{N}\right)\left(1 - \bar{c}_{\text{nondiag}}\right)\end{aligned}$$

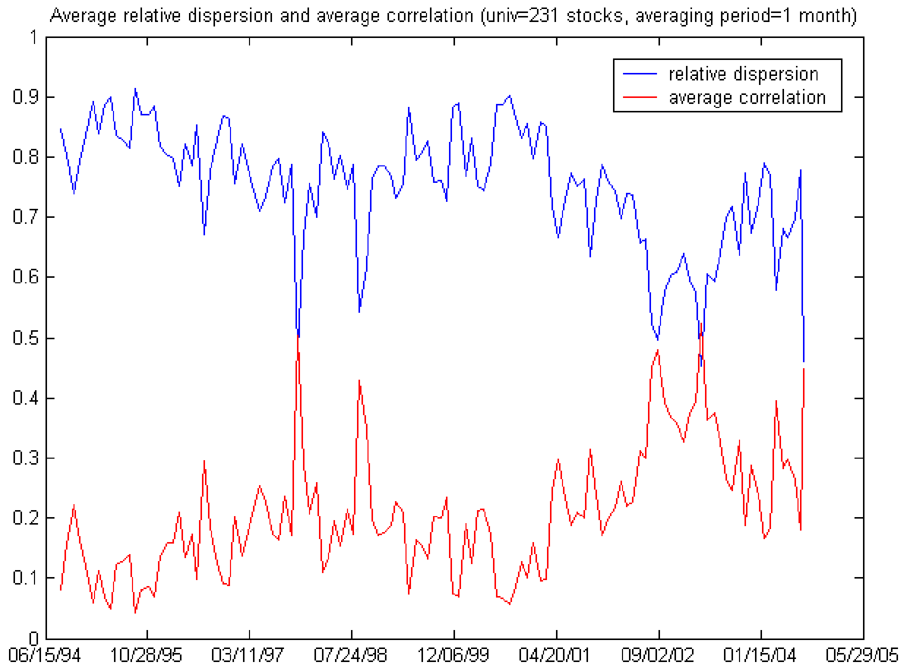
Relative dispersion contains the same information as average correlation

- Thus we have the simple relationship

$$\left\langle D_N^2 \right\rangle \approx 1 - \bar{c}_{\text{nondiag}}$$

- That is, the average relative dispersion varies inversely as average correlation. At any given instant, the amount of contemporaneous variation in returns is greater if the average correlation is lower and vice versa.

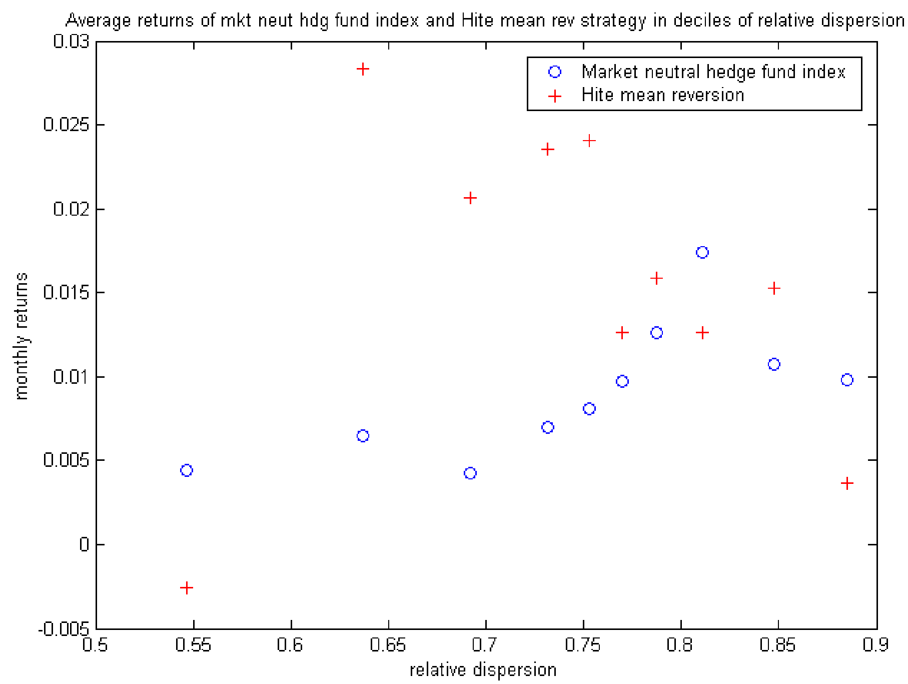
- This result is borne out by the following graph:



Average relative dispersion and average correlation are "mirror images" of each other. The average correlation is defined as the average of the off-diagonal upper triangular elements of the correlation matrix of the first differences of the log of the stock price.

How do dispersion and volatility correlate with statistical arbitrage returns?

- The information contained in the relative dispersion and in individual stock volatilities are mutually exclusive (i.e. one cannot know anything about individual stock volatilities by knowing only the relative dispersion and vice versa).
- But relative dispersion and individual stock volatilities contain all the information in the covariance matrix of returns.
- Therefore, to the extent that statistical arbitrage returns depend on covariance, we can attribute these returns by regressing them on relative dispersion and individual stocks volatilities as return-generating factors.



The returns of the market neutral hedge fund index increase with increasing relative dispersion whereas the those of the Hite mean reversion strategy decrease with increasing dispersion. The reason for the negative correlation between the latter strategy and dispersion is that the possibility for mean reversion is greatest when the market moves sharply. And individual stocks move in a highly correlated manner when the market moves sharply, leading to lower dispersion.

How do statistical arbitrage returns correlate with dispersion and volatility?

- The correlation matrix below shows the correlation among the returns of several statistical arbitrage strategies, relative dispersion and average variance of returns.

Correlation matrix (1995-2004)	Convertible Arbitrage	Dedicated Short	Emerging Markets	Equity Mkt Neutral	Event Driven	Distressed	Multi-Strategy	Risk Arbitrage	Fixed Income Arb	Global Macro	Long Short Equity	Managed Futures	Multi-Strategy	Hite mean reversion	S&P 500 Index	Relative Dispersion	Absolute Dispersion	Avg Variance of Returns
CSFB/Tremont Hedge Fund Index	0.38	-0.48	0.70	0.34	0.67	0.57	0.72	0.41	0.42	0.85	0.79	0.11	0.29	-0.10	0.48	0.42	-0.21	-0.32
Convertible Arbitrage		-0.22	0.32	0.24	0.58	0.49	0.61	0.44	0.56	0.27	0.22	-0.20	0.45	0.15	0.12	0.31	0.12	0.02
Dedicated Short			-0.62	-0.41	-0.64	-0.62	-0.58	-0.50	-0.04	-0.11	-0.72	0.19	-0.11	-0.10	-0.76	-0.14	0.08	0.12
Emerging Markets				0.40	0.74	0.64	0.77	0.51	0.30	0.45	0.65	-0.10	0.16	-0.06	0.55	0.32	-0.10	-0.20
Equity Mkt Neutral					0.41	0.36	0.39	0.39	0.06	0.18	0.37	0.15	0.03	0.12	0.45	0.30	0.26	0.20
Event Driven						0.94	0.95	0.71	0.37	0.38	0.64	-0.22	0.19	0.12	0.55	0.39	-0.17	-0.29
Distressed							0.79	0.59	0.29	0.30	0.55	-0.15	0.13	0.15	0.53	0.30	-0.21	-0.30
Multi-Strategy								0.71	0.43	0.45	0.66	-0.26	0.24	0.05	0.51	0.43	-0.13	-0.25
Risk Arbitrage									0.14	0.13	0.52	-0.21	0.11	0.20	0.46	0.47	0.00	-0.13
Fixed Income Arb										0.44	0.16	-0.03	0.39	-0.04	-0.02	0.26	-0.23	-0.30
Global Macro											0.42	0.25	0.22	-0.13	0.22	0.32	-0.16	-0.23
Long/Short Equity												-0.01	0.21	-0.02	0.58	0.35	-0.15	-0.24
Managed Futures													-0.09	0.02	-0.19	-0.09	0.05	0.08
Multi-Strategy														0.10	0.10	0.03	-0.16	-0.18
Hite mean reversion															0.15	-0.06	0.22	0.22
S&P 500 Index																0.23	-0.07	-0.12
Relative Dispersion																	0.18	-0.04
Absolute Dispersion																		0.97

- Most hedge fund categories, including equity market neutral and equity long/short but excluding dedicated short and global macro, are positively correlated to relative dispersion and to the S&P 500 Index.

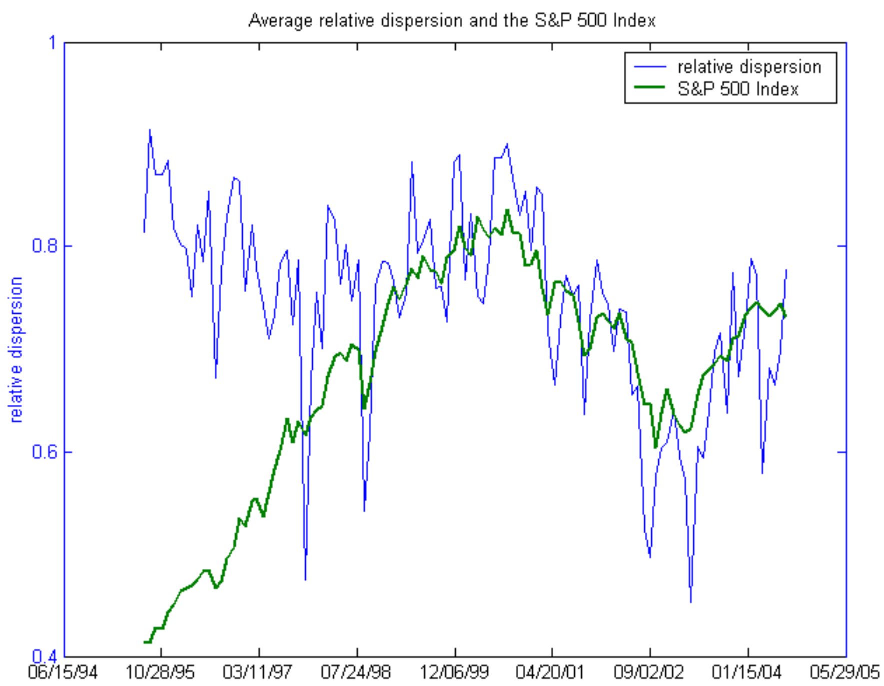
- It appears these strategies are all "long" dispersion (or equivalently "short" correlation) in the sense that they thrive when there are plenty of price divergences which are large enough to be exploited for profit.

- On the other hand, most strategies with the exception of dedicated short and equity market neutral are negatively correlated to absolute dispersion and average variance of returns. This is because these two measures increase when the market declines (note that they have a 0.97 correlation).

- The Hite mean reversion program enjoys the distinction of have a low correlation to the S&P 500 Index (0.15) *and* a slightly negative correlation (-0.06) to relative dispersion.

Stock rallies are tentative but sell-offs are concerted

- Observe that the S&P 500 Index is also positively correlated to relative dispersion.
- This lends credence to the notion that stocks usually go up separately but go down together. In other words, *rallies are tentative but sell-offs are concerted*.
- This observation has also been confirmed in other tests such as those measuring the entropy (amount of disorder) in stock returns during rallies and sell-offs.



Every major sell-off in the S&P 500 Index is accompanied by a sharp drop in the average relative dispersion.

Can we measure the amount of mean reversion in the market?

- We use the *efficiency ratio* and the *variance ratio* (explained in detail in *A Non-Random Walk Down Wall Street*, 1999, by Lo and MacKinlay) to measure the amount of mean reversion in stock returns.

- The efficiency ratio Y for the stock price S_t in a time interval during which M prices S_1, S_2, … S_M are observed is defined as

$$Y \equiv \frac{|S_M - S_1|}{\sum_{t=2}^{M} |S_t - S_{t-1}|}$$

- Thus if the price moves in a perfect trend in which successive price changes all have the same sign, then the efficiency ratio is 1. If the price flip-flops but returns to where it started, then the efficiency ratio is 0. In the former scenario, there is no mean reversion. In the latter scenario, there is complete mean reversion.

- The variance ratio F is the ratio of variances of returns of a stock computed using different aggregation time periods:

$$F(q) \equiv \frac{\sigma^2(q)}{q\sigma^2(1)}$$

$$\sigma^2(q) \equiv \mathrm{var}\left(\log\left(\frac{S_t}{S_{t-q}}\right)\right) = \left\langle \left[\log\left(\frac{S_t}{S_{t-q}}\right) - \left\langle \log\left(\frac{S_t}{S_{t-q}}\right)\right\rangle\right]^2 \right\rangle$$

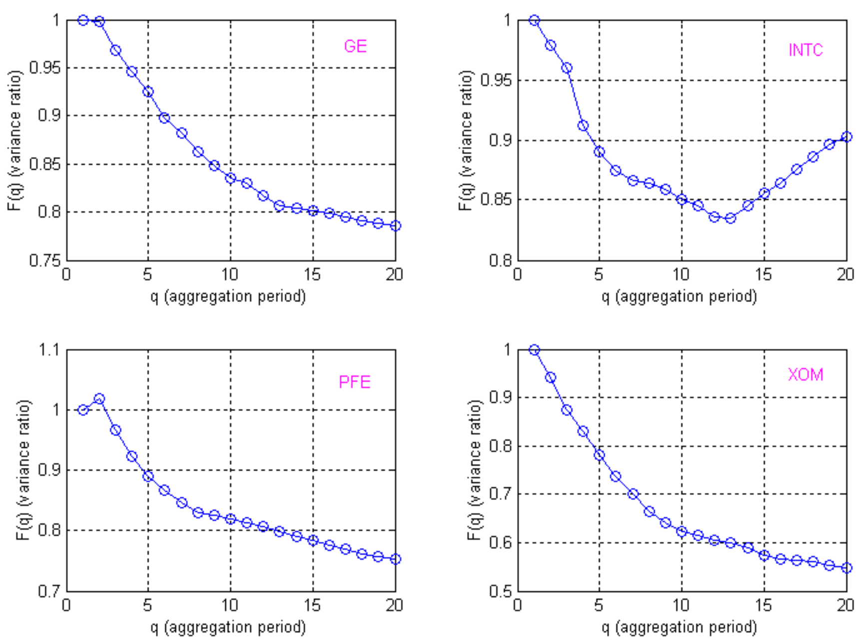
- For example, If $q = 5$, then $F(q)$ is the ratio of the variance of 5-day returns divided by 5 times the variance of 1-day returns.

Variance ratio is a scale-free measure of mean reversion in returns

- If prices follow a geometric random walk, then variances are additive. The variance of 2-day returns will be twice the variance of 1-day returns, and the variance of 9-day returns will be 3 times the variance of 3-day returns, etc.

- If prices are mean reverting over a time frame of, say, 5 days, then the variance ratio with aggregation period $q = 5$ will be less than one. The price is closer to where it started after five days than after one day (it “came back” after five days). Therefore the volatility of 5-day returns is lower than what it would be if prices were following a pure random walk.

- The variance ratios of several famous stocks are shown below:

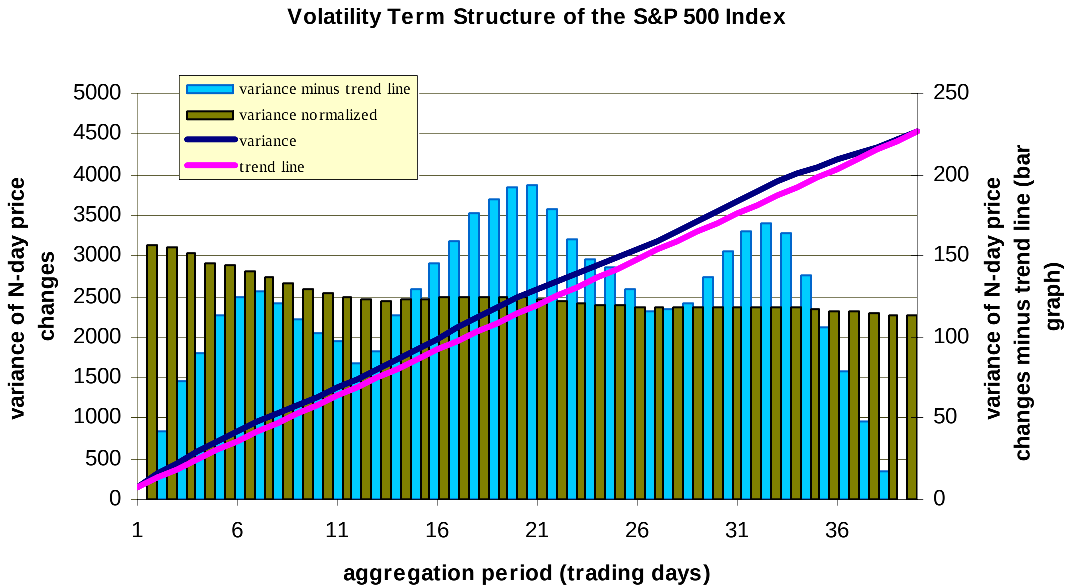


The variance ratio as a function of aggregation period (in days) has the same structure for all large cap stocks, viz. near or slightly greater than 1 for aggregation periods of 2 days or less, followed by a steep decline for aggregation periods from 2 to 5 days, and a slower decline for aggregation periods greater than 5 days. Thus prices would trend on a time scale of 2 days or less but would mean revert after that. Most of the mean reversion occur on a time scale of 2 to 10 days.

The variance ratios are computed from returns between 7/31/1995 and 7/30/2004.

The mean reverting volatility term structure of the S&P 500 Index

- The variance ratio is a depiction of volatility "term structure" since it shows the relationship between long-term and short-term volatilities.



- In the above graph, the volatility term structure of S&P 500 Index price changes is depicted as (1) variance of returns as a function of the aggregation period used to calculate the returns; and (2) variance ratio (normalized variance) of the returns over different aggregation periods.

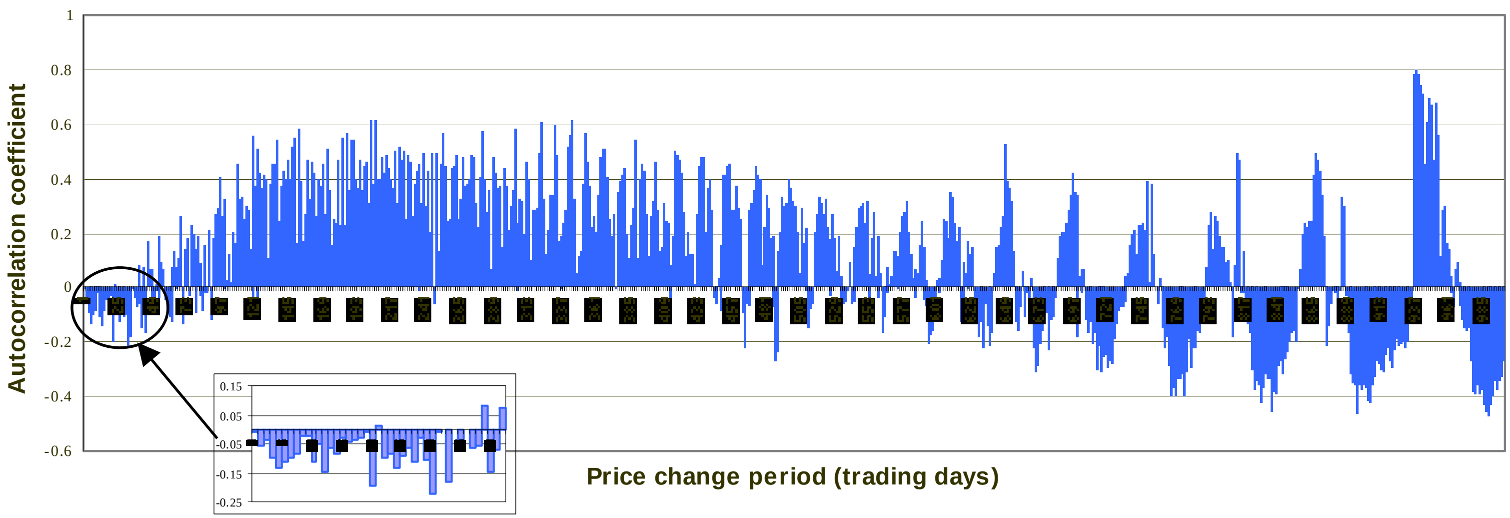
- Let the variance of returns $v(h)$ with aggregation period h be defined as $v(h) = \mathrm{var}(S(t) - S(t-h))$ where $S(t)$ is the price (or cumulated return) at time t. It can be shown that if $v(h)$ is a concave function of h, i.e. if the dark blue curve in the graph is always above the pink trend line that connects the two ends of the curve, then the correlations of successive price changes over N periods, where N lies in the range in which $v(h)$ is concave, will be always be negative. In other words, if $v(h)$ is concave in some range of values of h, then mean reversion will be present on a time scale of h.

The S&P 500 Index is mean reverting up to a time scale of 40 trading days

- The variance ratio for the S&P 500 Index is a declining function of the aggregation period up to about 40 trading days, implying that within this time scale long-term volatility is lower than short-term volatility.

- That the S&P 500 Index is mean reverting on this time scale is borne out by the following graph of the correlations of successive *N*-day changes in the Index with *N* going from 1 to 1000 trading days:

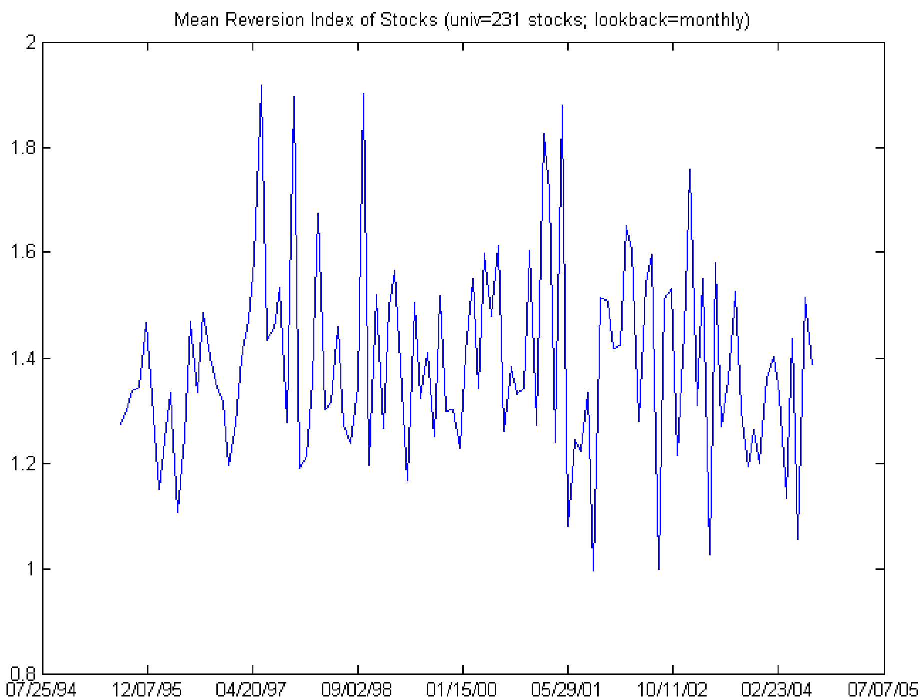
Autocorrelations of consecutive N-day price changes of S&P 500 Index (1/4/1960 - 9/3/2004)



- The inset shows that the autocorrelations of consecutive one-day to 40-day changes are almost always negative. This is the time scale of interest for most strategies that exploit mean reversion.

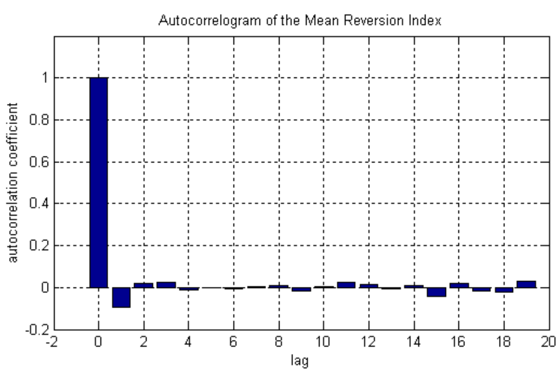
The Mean Reversion Index

- If we average the reciprocals of the variance ratios of all stocks in our sample, then we create a *mean reversion index* that measures the amount of mean reversion in the market.
- We use the reciprocal, i.e. q times variance of 1-day returns divided by variance of q-day returns, because the resulting index would be easier to interpret. It would increase with increasing mean reversion and would be greater than one if mean reversion is present.
- As shown below, the index values are almost always greater than one, indicating that mean reversion is always present in the market.



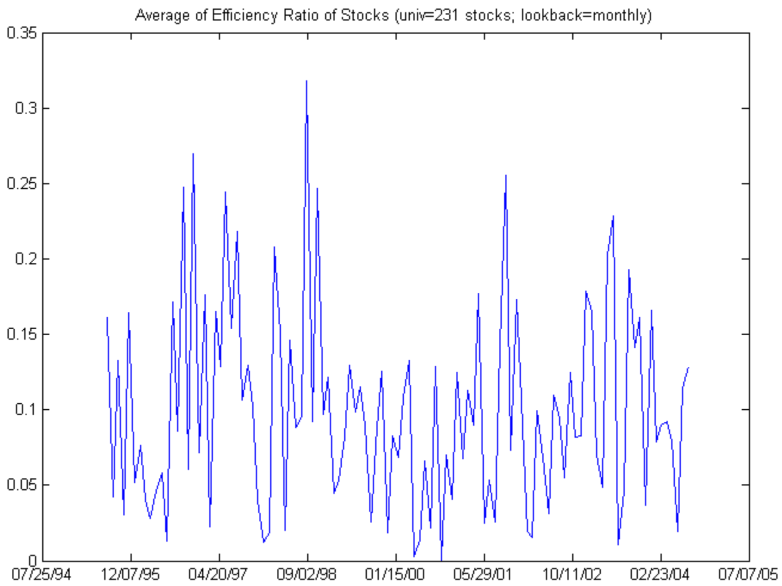
The mean reversion index is computed by averaging the reciprocals of the variance ratios with a 5-day aggregation period of all 231 stocks in our sample. One index value is computed each calendar month using the variance ratios calculated from the stock returns in that month.

The autocorrelation coefficients of the mean reversion index shown in the graph below indicate that the time series has no memory.

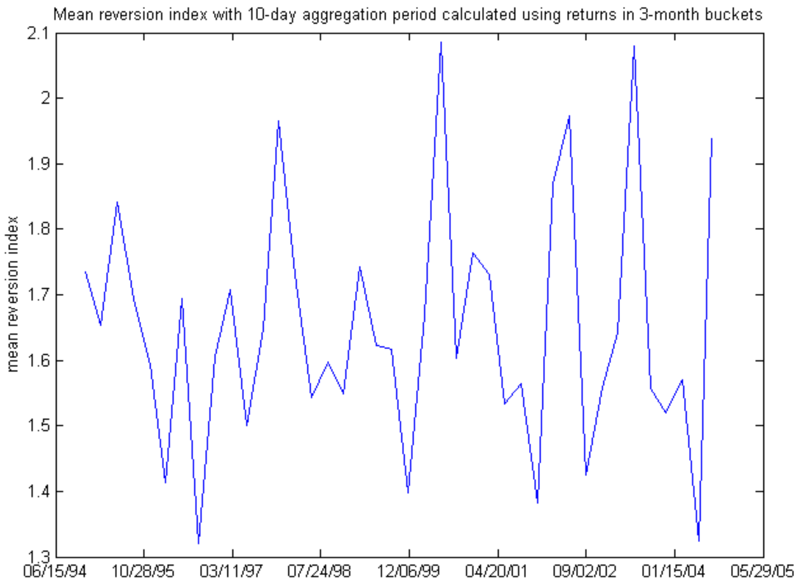


Mean reversion is a more persistent effect than dispersion

- Dispersion and mean reversion are different phenomena. The market can have a lot of dispersion but no mean reversion, or it can have a lot of mean reversion but no dispersion.
- The graphs below show that the amount of mean reversion in the market appears to be staying at historical levels.



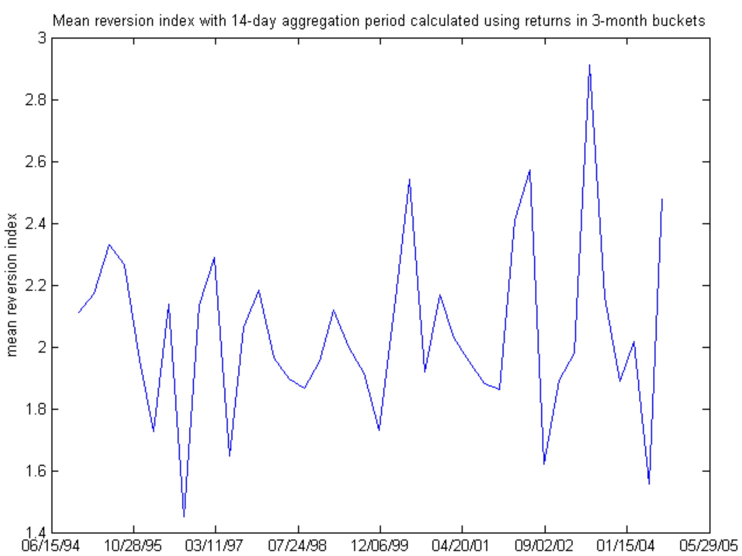
Shown here is the average efficiency ratio for each calendar month computed by averaging the efficiency ratio for each stock in our sample calculated using only prices in the given month.



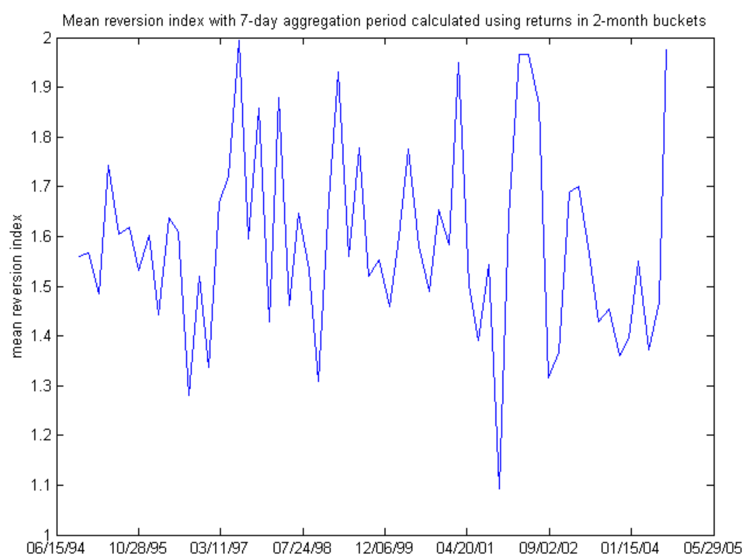
The mean reversion index shown here is slightly different from the one shown on the previous page. It is computed using a 10-day aggregation period (instead of a 5-day period), and individual stock variance ratios are computed from returns in non-overlapping 3-month periods.

Mean reversion is persistent, ubiquitous and present on many time scales

- There are many reasons why mean reversion should be present in the market – the psychology of investors causing behaviorial flaws and cognitive errors, the fact that intrinsic valuation is never certain or precise leading to large price fluctuations around it, short-term liquidity needs of traders, etc.
- The graphs below show that mean reversion is present on different time frames – particularly that up to a period of several weeks the effect is more pronounced as the time frame lengthens.
- **Prices vary *much less* over increasing time intervals than they would if they were purely random.**



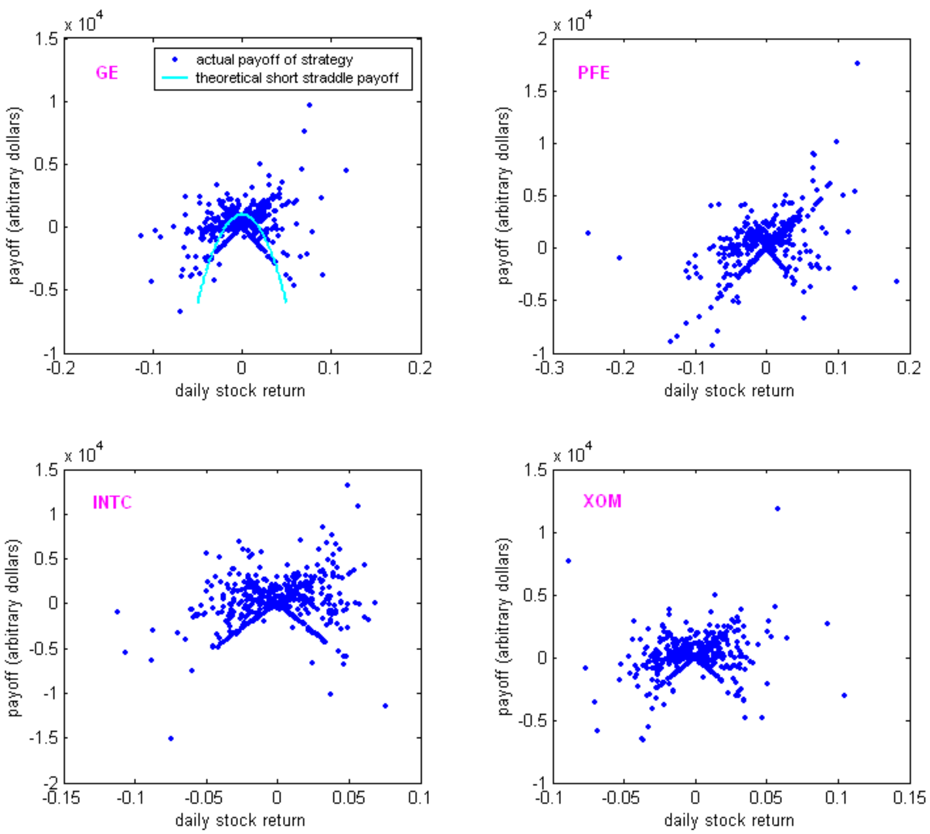
Mean reversion index calculated using a 14-day aggregation period. The average value of the index is about 2, indicating that in 14 days prices only move about 70% of the distance they would move in the same time if they were purely random.



Mean reversion index calculated using a 7-day aggregation period. The average value of the index is about 1.6, indicating that in 7 days prices only move about 80% of the distance they would move in the same time if they were purely random.

Short straddle-like payoff of the Hite Mean Reversion Equity Program

- The unhedged mean reversion equity program offered by Hite has a 0.48 correlation coefficient to the mean reversion index calculated using a 5-day aggregation period.
- Thus, the program is designed to capture the type of mean reversion in stock prices indicated by the mean reversion index.
- Conceptually, the program does this by creating, via a mechanical trading strategy, short straddle-like pay-offs on individual stocks (albeit with much less convexity than a real option straddle).



The Hite mean reversion strategy is a mechanical trading system that creates a short straddle-like payoff on individual stocks. The system is designed to dynamically compensate for the movement of the mean price (detrending) and changes in volatility. It also pyramid positions conservatively to avoid taking too much risk. Therefore it has a payoff convexity that is much less than that of a real option straddle.

As the graphs show, the strategy tends to make money whenever the stock return stays within about ±5% on a time scale of several days. It tends to lose money whenever the stock makes a large move in either direction over the same time scale.

The payoffs statistics are collected by applying the trading system to GE, INTC, PFE and XOM between 7/31/1995 and 7/30/2004.

How do statistical arbitrage returns correlate to mean reversion?

- We present again the correlation matrix of statistical arbitrage returns and the various statistical properties of stock returns – this time including the mean reversion index.

Correlation matrix (1995-2004)	Convertible Arbitrage	Dedicated Short	Emerging Markets	Equity Mkt Neutral	Event Driven	Distressed	Multi-Strategy	Risk Arbitrage	Fixed Income Arb	Global Macro	Long Short Equity	Managed Futures	Multi-Strategy	Hite mean reversion	S&P 500 Index	Relative Dispersion	Absolute Dispersion	Avg Variance of Returns	Mean Reversion Index
CSFB/Tremont Hedge Fund Index	0.38	-0.48	0.70	0.34	0.67	0.57	0.72	0.41	0.42	0.85	0.79	0.11	0.29	-0.10	0.48	0.42	-0.21	-0.32	-0.14
Convertible Arbitrage		-0.22	0.32	0.24	0.58	0.49	0.61	0.44	0.56	0.27	0.22	-0.20	0.45	0.15	0.12	0.31	0.12	0.02	0.09
Dedicated Short			-0.62	-0.41	-0.64	-0.62	-0.58	-0.50	-0.04	-0.11	-0.72	0.19	-0.11	-0.10	-0.76	-0.14	0.08	0.12	-0.01
Emerging Markets				0.40	0.74	0.64	0.77	0.51	0.30	0.45	0.65	-0.10	0.16	-0.06	0.55	0.32	-0.10	-0.20	-0.14
Equity Mkt Neutral					0.41	0.36	0.39	0.39	0.06	0.18	0.37	0.15	0.03	0.12	0.45	0.30	0.26	0.20	0.08
Event Driven						0.94	0.95	0.71	0.37	0.38	0.64	-0.22	0.19	0.12	0.55	0.39	-0.17	-0.29	-0.02
Distressed							0.79	0.59	0.29	0.30	0.55	-0.15	0.13	0.15	0.53	0.30	-0.21	-0.30	0.00
Multi-Strategy								0.71	0.43	0.45	0.66	-0.26	0.24	0.05	0.51	0.43	-0.13	-0.25	-0.05
Risk Arbitrage									0.14	0.13	0.52	-0.21	0.11	0.20	0.46	0.47	0.00	-0.13	0.01
Fixed Income Arb										0.44	0.16	-0.03	0.39	-0.04	-0.02	0.26	-0.23	-0.30	-0.01
Global Macro											0.42	0.25	0.22	-0.13	0.22	0.32	-0.16	-0.23	-0.18
Long Short Equity												-0.01	0.21	-0.02	0.58	0.35	-0.15	-0.24	-0.05
Managed Futures													-0.09	0.02	-0.19	-0.09	0.05	0.08	-0.05
Multi-Strategy														0.10	0.10	0.03	-0.16	-0.18	0.19
Hite mean reversion															0.15	-0.06	0.22	0.22	0.48
S&P 500 Index																0.23	-0.07	-0.12	0.01
Relative Dispersion																	0.18	-0.04	-0.03
Absolute Dispersion																		0.97	0.10
Returns																			0.10

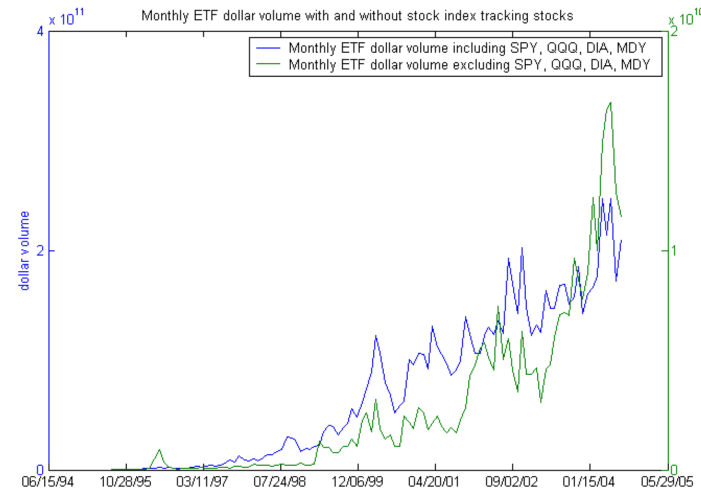
- Of the hedge fund categories, only convertible arbitrage, equity market neutral, and multi-strategy are positively correlated to the mean reversion index.

- The returns of the Hite mean reversion program has a correlation of 0.48 to the mean reversion index. **Thus these returns depend on a factor that appears to be stationary.**

What is the effect of rising ETF volumes?

- There is a *very* negative correlation between rising ETF dollar volumes and relative dispersion, as the table below shows. Most hedge fund categories also have a slight negative correlation to ETF volume.

Correlation matrix (1995-2004)	ETF Doll Vol (excluding SPY, QQQ, DIA, MDY)	ETF Doll Vol (including SPY, etc)
CSFB/Tremont Hedge Fund Index	-0.12	-0.20
Convertible Arbitrage	-0.19	-0.14
Dedicated Short	-0.02	-0.02
Emerging Markets	0.04	0.00
Equity Mkt Neutral	-0.27	-0.26
Event Driven	-0.07	-0.15
Distressed	-0.06	-0.13
Multi-Strategy	-0.07	-0.14
Risk Arbitrage	-0.16	-0.21
Fixed Income Arb	0.00	-0.09
Global Macro	-0.06	-0.09
Long Short Equity	-0.13	-0.21
Managed Futures	-0.08	-0.01
Multi-Strategy	-0.10	-0.14
Hite mean reversion	-0.09	0.00
S&P 500 Index	-0.08	-0.16
Relative Dispersion	-0.38	-0.50
Absolute Dispersion	-0.34	-0.07
Avg Variance of Returns	-0.27	0.02
Mean Reversion Index	-0.11	-0.06



Monthly dollar volume (sum over daily volumes times daily closing prices for given month) for 60 ETFs encompassing the MSCI country, sector and specialty funds, SPDR sector funds, and Lehman Bond Index funds.

Summary

- We analyzed the statistical properties in connection with dispersion, volatility and mean reversion of the returns of a representative basket of 231 large cap stocks between 7/1995 and 7/2004.
- The concepts of absolute and relative dispersion and their connection to the covariance and correlation matrices are explained mathematically. Absolute dispersion is shown to correspond to the contrast between the magnitudes of return variance (squared volatility) and return covariance. Relative dispersion is just one minus the average correlation among stocks.
- Absolute and relative dispersions are declining in the stock market.
- The returns of many hedge fund strategies, including equity market neutral and equity long/short, have a positive correlation to dispersion.
- Mean reversion is a persistent and ubiquitous effect that is present on many time scales in stock returns. The most basic observation is that prices vary much less over increasing time intervals than they would if they were purely random.
- A mean reversion index is constructed by averaging the variance ratios of stock returns. The values of this index indicate that mean reversion is present in the market at historical levels. The index has no serial correlation and appears to be stationary.
- The Hite unhedged mean reversion program has a correlation coefficient of 0.48 to the mean reversion index.