CORRELATION AND DISPERSION IN A PORTFOLIO CONTEXT

Why and how dispersion plays a fundamental role in portfolio, active and index returns.
WHAT DOES DISPERSION LOOK LIKE?

Dispersion measures the spread of performances among components of an index (or portfolio).

Source: S&P Dow Jones Indices. Past performance is no guarantee of future results.
KEY CONCEPT: “SPREAD” OF RETURNS

Source: S&P Dow Jones Indices. Past performance is no guarantee of future results.
HOW IS DISPERSION DEFINED?

Standard-deviation style calculation: “square-root of average of squared difference to mean”

Example: October 2001, DJIA

Source: S&P Dow Jones Indices. Past performance is no guarantee of future results.
DISPERSION - SUMMARY

Conceptually

The statistical “spread” of returns among securities

\[
\text{Dispersion} = \sqrt{\sum_{i=1}^{n} w_i (R_{i,t} - I_t)^2}
\]

Computationally

Practically

- The **outperformance potential** for active management
- The magnitude of **diversification benefit** achieved
- An **instantaneous** measure of **correlation**
- A component of the returns from **portfolio rebalancing**
- A **tradable** aspect of capital markets

Source: S&P Dow Jones Indices. Past performance is no guarantee of future results.
DISPERSION IS DIFFERENT - BUT CORRELATED - TO VOLATILITY

Source: S&P Dow Jones Indices. Past performance is no guarantee of future results.
A FEW OBSERVATIONS FROM HISTORY

Dispersion is similar to volatility in several respects:

- Both measures of standard deviation in price changes, capturing the degree of movement within a market over a specified time period or periods
- Volatile, and highly correlated to each other
- Historically persistent in the short term
- Historically mean-reverting in the long term

But with a few, potentially important differences

- High volatility and lower dispersion: for example in the macro-led markets of August 2011
- High dispersion and lower volatility: for example during the formation and collapse of the tech-bubble during 1998-2001
- Volatility requires a time series for measurement and speaks to a single security or portfolio, whereas dispersion is a cross-sectional measure, over a single period, for multiple securities
- (As we shall see) Dispersion is ultimately a particular combination of volatility and correlation
SECTION 2: APPLICATIONS OF DISPERSION

• Opportunity set for active management
• Measure of portfolio diversification
• Instantaneous approximation to correlation, completing an analytical ‘recipe’ for volatility
• Factor in determining the rebalancing ‘bonus’
THE OPPORTUNITY SET FOR ACTIVE RETURNS (1)

Dispersion is a measure of “idiosyncratic” risk that quantifies the impact of security selection.

The phrase “stock-picker’s market” is frequently heard, typically without precise definition.

- **Low correlation** is equated with the opportunities for active managers, but in our view incorrectly
  - e.g. 2013-2014 developed equities: no correlation, yet indifferent alpha opportunities.

- Return available from **security selection and weighting** is more naturally associated with **dispersion**

- When dispersion is high, decisions have a greater impact
  - **Measure of importance** e.g. country versus sector importance in international markets.

- When dispersion is low, the stakes at the table are lower (operational costs / fees may not be similarly reduced)

EXHIBIT: U.S. EQUITY MANAGERS & DISPERSION

“Good” managers performed better in relative terms when dispersion was high.

Annual Interquartile Range of U.S. Large-Cap Active Funds vs. S&P 500 Average Monthly Dispersion

Source: S&P Dow Jones Indices’ SPIVA scorecards (“S&P Index Versus Active”). Data for 2007 are to March end; all other years are full calendar years. Charts are provided for illustrative purposes. Past performance is no guarantee of future results.
High (or low) dispersion did not seem to influence the probability of the average manager outperforming the market versus S&P 500 Average Monthly Dispersion.

Source: S&P Dow Jones Indices’ SPIVA scorecards (“S&P Index Versus Active”). Data for 2007 are to March end; all other years are full calendar years. Charts are provided for illustrative purposes. Past performance is no guarantee of future results.
THE OPPORTUNITY SET FOR ACTIVE RETURNS (2)

Evidence suggests that opportunities might be presented subsequent to periods of high dispersion

- Intuitive expectation that high dispersion creates arbitrage opportunities:
  - In periods of large and widespread price dislocations (high dispersion), professional investors identify “mispricings”; and subsequently benefit at “return to normality” (lower dispersion).

- Various studies have identified that subsequent to periods of high dispersion, certain common strategies are more likely to outperform; similarly for certain hedge fund styles.

  - Value and contrarian strategies perform well subsequent to high dispersion periods, poorly subsequent to low dispersion periods.
  - Momentum and growth strategies conversely.

  Connors & Li; Market Dispersion and the Profitability of Hedge Funds (2009)
  - One of several studies identifying and positively correlating the excess performance achieved by hedge fund strategies coincident (and subsequent to) changes in dispersion regimes.
EXHIBIT: EQUAL-WEIGHT U.S. EQUITIES RELATIVE PERFORMANCE

Even equally-weighted indices showed an improved performance subsequent to periods extreme dispersion.


Source: S&P Dow Jones Indices. Index performance shown is relative total return in USD. Past performance is no guarantee of future results.
DISPERSION AND DIVERSIFICATION

Dispersion is naturally connected to the degree of “diversification” achieved by a portfolio

- The dispersion calculation aggregates and averages all the absolute movements in securities that are cancelled out in the portfolio return: suggestive of a diversification measure.

- In fact the relationship is empirically direct, once the single-period measure of dispersion is suitably averaged over time (to be compared to the multi-period measure of variance)

Source: S&P Dow Jones Indices. Past performance is no guarantee of future results.
DISPERSION, VOLATILITY AND CORRELATION

Pairwise they are related, as a triple they are strictly defined in combinations

\[ v = \text{portfolio volatility} \]
\[ F = (\text{weighted}) \text{ component volatility} \]
\[ c = (\text{weighted}) \text{ average correlation} \]
\[ d^2 = \text{average of period dispersion}^2 \]

Familiar concept: average correlation is the proportion of total risk accounted for by portfolio risk, or approximately:

\[ c \approx \frac{v^2}{F^2} \]

and since \( F^2 \approx v^2 + d^2 \), correlation is:

\[ c \approx \left( \frac{v^2}{v^2 + d^2} \right) \]

NOTE: \( v \) and \( d \) are simple to calculate with instantaneous interpretations in (e.g.) VIX and dispersion!

Source: S&P Dow Jones Indices. See Edwards & Lazzara; “At the Intersection of Diversification, Volatility and Correlation” (2014) for more details and additional references. Past performance is no guarantee of future results.
CONSEQUENCES OF THE DISPERSION RELATION

Nuanced perspectives on volatility are provided by the relationship to dispersion and correlation

- The equation can be also be re-arranged with (market) volatility as the subject:
  \[ v^2 \approx d^2 \times \left( \frac{c}{1-c} \right) \]

- Conceptually: **market volatility is driven by dispersion, amplified or diluted by correlations**

Source: S&P Dow Jones Indices. Formulae and charts represent models of securities behavior only, actual performance may differ significantly.
DISPERSION AND PORTFOLIO REBALANCING

The benefit (or detriment) to frequent portfolio balancing relates to long and short-term dispersion

- The effect on returns of portfolio rebalancing over multiple periods is a balance between:
  - The long-term benefit from diversification (recall the effect of volatility on geometric returns), which can be derived from the period dispersions.
  - The long-term cost of de-allocation from the most positive performer (in the long term, any un-rebalanced portfolio is dominated by the best-performing asset).

- Formally, the return from rebalancing can be expressed as:
  \[ \text{Return from rebalancing} \approx d^2 - \emptyset \]
  Where \( d^2 \) = average of period dispersion\(^2\) and \( \emptyset \) is a function of the spread of longer term returns.

- In equal weight portfolios, the additional return from rebalancing is well approximated by full-period dispersion:
  \[ \text{EQW Return from rebalancing} \approx d^2 - \frac{(N - 1)}{2} e^2 \]
  Where \( e \) is the dispersion of average annual returns among components and \( N \) is the number of periods.

CURRENT DISPERSION ENVIRONMENT (JULY 2014)

Currently in an environment of relatively low dispersion; higher (as usual) in EM and small caps

Can periods of high dispersion support the identification of bubbles?

- (With acknowledgements to Paul Cox of NEST) S&P 500 monthly dispersion strongly in excess of implied volatility (VIX) has historically pre-empted severe market stresses

**Monthly Dispersion Relative to VIX: Jan 1991 - Jan 2014**

- tech 'bubble' end Aug 2000
- Market peak end Oct 2007
- Market low end Sep 2002
- Market low end Feb 2009

PERFORMANCE DISCLOSURE

The S&P 500 Equal Weight Index (the “Index”) was launched on Jan. 9, 2003. All information presented prior to the launch date is back-tested. Back-tested performance is not actual performance, but is hypothetical. The back-test calculations are based on the same methodology that was in effect when the index was officially launched. Complete index methodology details are available at www.spdji.com. It is not possible to invest directly in an index.

S&P Dow Jones Indices defines various dates to assist our clients in providing transparency on their products. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the Index is set at a fixed value for calculation purposes. The Launch Date designates the date upon which the values of an index are first considered live: index values provided for any date or time period prior to the index’s Launch Date are considered back-tested. S&P Dow Jones Indices defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company’s public website or its datafeed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed “Date of introduction”) is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index’s public release date.

Past performance of the Index is not an indication of future results. Prospective application of the methodology used to construct the Index may not result in performance commensurate with the back-test returns shown. The back-test period does not necessarily correspond to the entire available history of the Index. Please refer to the methodology paper for the Index, available at www.spdji.com for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Another limitation of using back-tested information is that the back-tested calculation is generally prepared with the benefit of hindsight. Back-tested information reflects the application of the index methodology and selection of index constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the equities, fixed income, or commodities markets in general which cannot be, and have not been accounted for in the preparation of the index information set forth, all of which can affect actual performance.

The Index returns shown do not represent the results of actual trading of investable assets/securities. S&P Dow Jones Indices LLC maintains the Index and calculates the Index levels and performance shown or discussed, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the Index or investment funds that are intended to track the performance of the Index. The imposition of these fees and charges would cause actual and back-tested performance of the securities/fund to be lower than the Index performance shown. As a simple example, if an index returned 10% on a US $100,000 investment for a 12-month period (or US $10,000) and an actual asset-based fee of 1.5% was imposed at the end of the period on the investment plus accrued interest (or US $1,650), the net return would be 8.35% (or US $8,350) for the year. Over a three year period, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US $5,375, and a cumulative net return of 27.2% (or US $27,200).
GENERAL DISCLAIMER

Copyright © 2014 by S&P Dow Jones Indices LLC, a part of McGraw Hill Financial. All rights reserved. S&P, S&P 500, S&P MidCap 400, S&P SmallCap 600, S&P GSCI, S&P Europe 350, S&P Composite1500 and STANDARD & POOR'S are registered trademarks of Standard & Poor's Financial Services LLC ("S&P"), a subsidiary of McGraw Hill Financial, Inc. Dow Jones is a registered trademark of Dow Jones Trademark Holdings LLC ("Dow Jones"). Trademarks have been licensed to S&P Dow Jones Indices LLC. Redistribution, reproduction and/or photocopying in whole or in part are prohibited without written permission. This document does not constitute an offer of services in jurisdictions where S&P Dow Jones Indices LLC, Dow Jones, S&P or their respective affiliates (collectively "S&P Dow Jones Indices") do not have the necessary licenses. All information provided by S&P Dow Jones Indices is impersonal and not tailored to the needs of any person, entity or group of persons. S&P Dow Jones Indices receives compensation in connection with licensing its indices to third parties. Past performance of an index is not a guarantee of future results.

It is not possible to invest directly in an index. Exposure to an asset class represented by an index is available through investable instruments based on that index. S&P Dow Jones Indices does not sponsor, endorse, sell, promote or manage any investment fund or other investment vehicle that is offered by third parties and that seeks to provide an investment return based on the performance of any index. S&P Dow Jones Indices makes no assurance that investment products based on the index will accurately track index performance or provide positive investment returns. S&P Dow Jones Indices LLC is not an investment advisor, and S&P Dow Jones Indices makes no representation regarding the advisability of investing in any such investment fund or other investment vehicle. A decision to invest in any such investment fund or other investment vehicle should not be made in reliance on any of the statements set forth in this document. Prospective investors are advised to make an investment in any such fund or other vehicle only after carefully considering the risks associated with investing in such funds, as detailed in an offering memorandum or similar document that is prepared by or on behalf of the issuer of the investment fund or other vehicle. Inclusion of a security within an index is not a recommendation by S&P Dow Jones Indices to buy, sell, or hold such security, nor is it considered to be investment advice. Closing prices for S&P US benchmark indices and Dow Jones US benchmark indices are calculated by S&P Dow Jones Indices based on the closing price of the individual constituents of the index as set by their primary exchange. Closing prices are received by S&P Dow Jones Indices from one of its third party vendors and verified by comparing them with prices from an alternative vendor. The vendors receive the closing price from the primary exchanges.

These materials have been prepared solely for informational purposes based upon information generally available to the public and from sources believed to be reliable. No content contained in these materials (including index data, ratings, credit-related analyses and data, research, valuations, model, software or other application or output therefrom) or any part thereof (Content) may be modified, reverse-engineered, reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of S&P Dow Jones Indices. The Content shall not be used for any unlawful or unauthorized purposes. S&P Dow Jones Indices and its third-party data providers and licensors (collectively "S&P Dow Jones Indices Parties") do not guarantee the accuracy, completeness, timeliness or availability of the Content. S&P Dow Jones Indices Parties are not responsible for any errors or omissions, regardless of the cause, for the results obtained from the use of the Content. THE CONTENT IS PROVIDED ON AN "AS IS" BASIS. S&P DOW JONES INDICES PARTIES DISCLAIM ANY AND ALL EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, FREEDOM FROM BUGS, SOFTWARE ERRORS OR DEFECTS, THAT THE CONTENT'S FUNCTIONING WILL BE UNINTERRUPTED OR THAT THE CONTENT WILL OPERATE WITH ANY SOFTWARE OR HARDWARE CONFIGURATION. In no event shall S&P Dow Jones Indices Parties be liable to any party for any direct, indirect, incidental, exemplary, compensatory, punitive, special or consequential damages, costs, expenses, legal fees, or losses (including, without limitation, lost income or lost profits and opportunity costs) in connection with any use of the Content even if advised of the possibility of such damages.

S&P Dow Jones Indices keeps certain activities of its business units separate from any other in order to preserve the independence and objectivity of their respective activities. As a result, certain business units of S&P Dow Jones Indices may have information that is not available to other business units. S&P Dow Jones Indices has established policies and procedures to maintain the confidentiality of certain non-public information received in connection with each analytical process.

In addition, S&P Dow Jones Indices provides a wide range of services to, or relating to, many organizations, including issuers of securities, investment advisers, broker-dealers, investment banks, other financial institutions and financial intermediaries, and accordingly may receive fees or other economic benefits from those organizations, including organizations whose securities or services they may recommend, rate, include in model portfolios, evaluate or otherwise address.

CBOE, CBOE Volatility Index and VIX are registered trademarks of Chicago Board Options Exchange, Incorporated (CBOE). CBOE has granted S&P Dow Jones Indices a license to use the VIX methodology to create a variety of volatility indices.
THANK YOU

Tim Edwards
timothy.edwards@spdji.com