



GFSI: an index family of global financial stress

BofAML's Global Equity Derivatives Research Team introduced the BofA Merrill Lynch Global Financial Stress Index (BofAML GFSI™) in November 2010. The GFSI and its family of constituent indices are designed to be a comprehensive measure stress in financial markets.

GFSI measures risk, hedging demand & risk appetite

The GFSI encompasses three kinds of financial market stress. First, risk as indicated by cross-asset measures of volatility, solvency and liquidity (the Risk Index). Second, hedging demand implied by equity and currency option skew (the Skew Index). Third, investor risk appetite gauged by trading volumes and flows into equities and high yield bonds and out of money markets (the Flow Index). The GFSI and its 11 sub-indices can be followed daily on Bloomberg. Type GFSI <GO>.

An essential tool for managing assets today

Understanding diverse sources of global financial stress has become increasingly important. We believe the GFSI index family should be a key tool to assist investors in making investment and risk management decisions across asset classes. This report outlines the GFSI's structure, composition, calculation methodology as well as the major market timing tools we have developed and retroactively applied since the GFSI's launch.

Note: We recently changed tickers for the GFSI suite of indices across data vendors, as announced in [this](#) notification. Investors will find the new Bloomberg tickers on GFSI<go>, as shown in Chart 2. There have been no changes to the underlying dataset as a consequence of the ticker changes.

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Refer to important disclosures on page 23 to 24.

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GFSI: BofAML's Global Financial Stress Index

A comprehensive measure of global cross-asset risk

GFSI is a broad gauge of risk, hedging demand and investment flows across asset markets and geographies. It is designed to monitor and consolidate a wide range of market stresses, which can be caused by factors including poorly functioning financial systems, deteriorating micro and macro-economic fundamentals, expectations of greater asset volatility and risk-averse investor positioning.

Understanding financial stress: critical for managing assets

Since the start of the global financial crisis, systemic risks, including questions on financial markets' ability to function and the success of governmental remedies (and their side-effects), have been the primary drivers of investment risk and returns across asset classes. Importantly, we see this continuing for the foreseeable future.

Risks have emanated from areas outside of many investors' comfort zones, from other asset classes and regions, and market professionals have been forced to boost their market knowledge to understand what factors may dominate their base-case investment thesis.

In addition, as 2008 was the most volatile year in financial markets since the great depression, investors' perspective on risk has changed resulting in greater focus on risk management. Understanding which risks are important and how to hedge them without overpaying has been key to successful investing.

However, monitoring stress across asset classes and around the globe is not trivial, as many important markets for risk trade over the counter and are not easily observable by the public. In addition, comparing for example sovereign credit risk levels to implied equity volatility to the cost of FX tail hedges is not easy unless these measures can all be put on an equal footing and into a historical context. Not only must one know which markets are stressed but also by how much.

GFSI aims to monitor stress by incorporating 23¹ primary measures (which breakdown into 41 sub-components) of financial risk, hedging demand and investor risk-appetite across global credit, equity, rates, FX, and commodity markets. The GFSI and its components can be helpful to:

- Judge overall market stress relative to key historical periods
- Identify the beginnings of risk flares that have yet to show up in other asset classes or global markets, hence identifying cheaper hedges
- More successfully time market turning points by contrasting investment fund-flows and risk appetite with other risk measures to identify when investors are too bearish or too bullish relative to the market environment

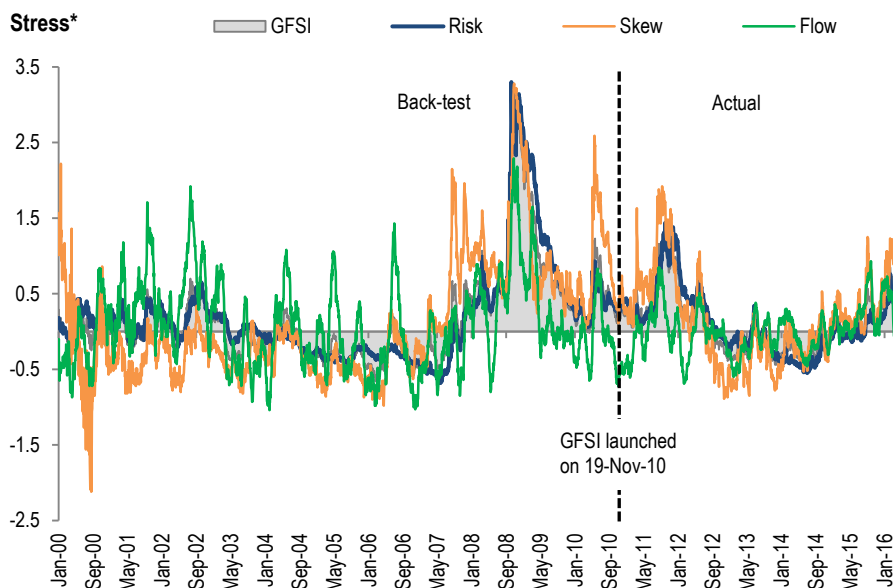
¹ See Chart 10 for a detailed diagram of GFSI's microstructure. There are 23 GFSI components as of the date of this report, which is unchanged since launch on 19-Nov-10. Note that the Global Equity Derivatives Research Team reserves the right to change the number and nature of these measures based on the procedures outlined in [Calculating GFSI: index mechanics & governance](#) (pg. 16)

GFSI integrates implied risks, hedging demand & investor flows

We have classified the risk factors that constitute the GFSI into three main categories, represented by the sub-indices **Risk**, **Skew** and **Flow** (see [GFSI's composition: Risk, Skew & Flow](#) for more detail). Briefly, GFSIRISK comprises measures of market, liquidity and solvency risk, GFSISKEW contains factors representing hedging demand against tail events and GFSIFLOW measures investor risk appetite via flows into and out of assets. We believe this classification captures the various risks and stresses faced by the financial system, linking market-implied risk measures with investor sentiment and risk appetite.

Chart 1 shows how these sub-indices and the GFSI would have evolved through time. GFSI's value and those of its sub-indices tell us how many standard deviations² the current readings are above or below equilibrium stress levels. **Positive values suggest greater stress in the financial system than average; negative values suggest a more benign environment than usual.** While we explore the sub-indices in detail later, we note how each would have peaked in Q3-Q4 2008, suggesting a perfect storm of stress metrics during what is recognized as one of the most extreme events in financial market history. Specifically, GFSI's peak stress level of 2.93 would have occurred on 27-Oct-08, six weeks following the collapse of Lehman Brothers.

Chart 1: Evolution of the GFSI and its sub-indices through time, backtested prior to 19-Nov-10 and live since



Source: BofA Merrill Lynch Global Research. Daily data from 3-Jan-00 to 18-Mar-16. *Stress = # of standard deviations from long term median – please see pg. 16 for details. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

² We compute deviations from a median stress level as opposed to an average, given the propensity of outsized moves in risk indicators (such as LIBOR-OIS spreads) to skew averages of historical distributions unfairly.

GFSI on Bloomberg

GFSI and its family of indices are available to track on Bloomberg. Chart 2-5 are screen shots that illustrate the different pages that can be used to view and monitor GFSI levels. For example, the GFSI <go> page should be a starting point from where one can drill down into the structure of the index to explore what is driving financial market stress.

Chart 2: GFSI <go>: The main GFSI family page, which can be used to navigate to any of the index pages and back again

DESCRIPTION	TICKER	VALUE	5 Day	1 Month	3 Month
1) BofA Merrill Lynch GFSI	GFSI	0.24	-0.11	-0.40	-0.12
2) BofA Merrill Lynch GFSI RISK	GFSIRISK	0.19	-0.05	-0.32	-0.09
3) BofA Merrill Lynch GFSI FLOW	GFSIFLOW	-0.25	-0.18	-0.78	-0.89
4) BofA Merrill Lynch GFSI SKEW	GFSISKEW	0.69	-0.16	-0.31	0.17
RISK, FLOW and SKEW constituents					
5) BofA Merrill Lynch GFSI Market Risk	GFSIRMK	-0.24	-0.12	-0.39	0.09
6) BofA Merrill Lynch GFSI Solvency Risk	GFSIRSOL	0.06	-0.01	-0.61	-0.21
7) BofA Merrill Lynch GFSI Liquidity Risk	GFSIRLIQ	0.53	-0.04	-0.14	0.03
8) BofA Merrill Lynch GFSI Fund Flow	GFSIFFND	0.18	-0.03	-0.56	-0.53
9) BofA Merrill Lynch GFSI Money Market Flow	GFSIMM	-0.39	-0.06	-0.14	0.02
10) BofA Merrill Lynch GFSI Volume Flow	GFSIFVOL	-0.97	-0.60	-1.85	-2.53
11) BofA Merrill Lynch GFSI Equity Skew	GFSISEQ	0.98	-0.18	-0.41	-0.06
12) BofA Merrill Lynch GFSI FX Skew	GFSISFX	0.40	-0.14	-0.21	0.40

Source: Bloomberg, BofA Merrill Lynch Global Research

Chart 3: A graphical component (created using Bloomberg's G graphing tool) that visualizes all the sub-indices on one screen



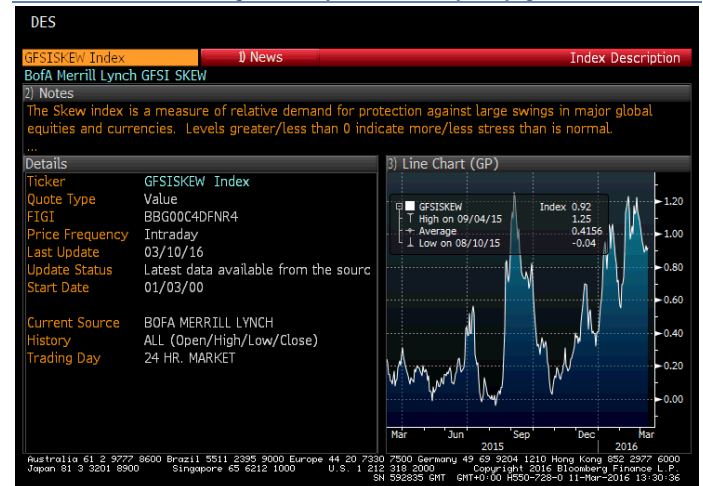
Source: Bloomberg, BofA Merrill Lynch Global Research

Chart 4: GFSIRISK Index DES <go>: A sample index description page



Source: Bloomberg, BofA Merrill Lynch Global Research

Chart 5: GFSISKEW Index <go>: A sample Index description page



Source: Bloomberg, BofA Merrill Lynch Global Research

GFSI's composition: Risk, Skew & Flow

The level of the GFSI, which is calculated on every weekday³, is an average of 23 components (see [GFSI's microstructure](#) for details of the components) that capture different aspects of stress in the global financial system. The value of each component is measured as of the close of every weekday (if a market is closed or data is unavailable, the most recent previous value is used). We group these components into three top level indices:

- **Risk (GFSIRISK <index>)** Includes market, solvency & liquidity risk. It uses the level of implied asset volatilities, credit default swaps and interest rate spreads and is similar in concept to risk measures used in other financial stress gauges
- **Skew (GFSISKEW <index>)** Linked to demand for protection against large losses, it is measured via the relative price of protection against outsized moves in global equities and currencies. We believe this is a novel and useful addition to measuring market-wide stress⁴
- **Flow (GFSIFLOW <index>)** Investor sentiment. Measured via appetite for equity, bond and money markets funds, and volume traded. While somewhat different from the first two categories in that this essentially tracks investor risk appetite rather than market implied perceptions, it is very useful in identifying contrarian investment signals.

As of the date of this report, GFSI is an average of 23 stress components

GFSIRISK has 13 components => ~57% weight

GFSISKEW has 6 components => ~26% weight

GFSIFLOW has 4 components => ~17% weight

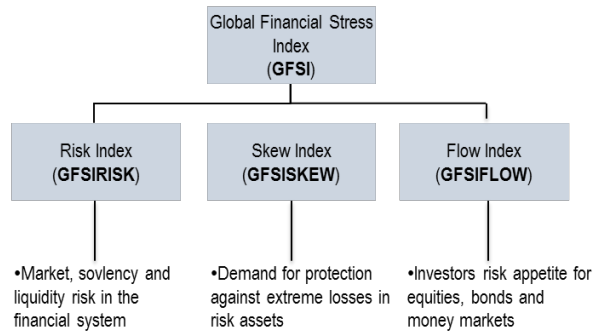
Consequently, GFSI can *also* be calculated as:

$$\begin{aligned} \text{GFSI} = & 13/23 * \text{GFSIRISK} \\ & + 6/23 * \text{GFSISKEW} \\ & + 4/23 * \text{GFSIFLOW} \end{aligned}$$

³ Here and in future references, weekdays refers to Monday-Friday

⁴ The value of information in the Skew index can be seen in early 2007, when the Skew index (driven primarily by equity skew) would have risen to stressed territory while more traditional indicators of financial stress (represented by the Risk index) signalled largely benign conditions. Even though relative demand for protection is not necessarily a predictor of future market direction, such divergences in outlook within markets are interesting for investors searching for potential leading indicators.

Chart 6: BofAML GFSI and sub-indices



Source: BofA Merrill Lynch Global Research

Each of the 23 components in GFSI has equal weight ($=1/23$). Since the Risk Index (GFSIRISK) has the most components (13), it accounts for the highest weight (~57%) in the GFSI. The Skew Index (GFSISKEW) has 6 components and makes up ~26% of GFSI, while the Flow Index (GFSIFLOW) with 4 components makes up the remainder. Note that the relative weights and constituents of these sub-indices are incidental rather than deliberate (when devising the index, more stresses that were deemed relevant fell into the Risk category) and are subject to change based on what is outlined in the [Process for making and communicating changes made to the GFSI](#) section.

Risk Index (GFSIRISK)

- **Measures:** Market, solvency and liquidity risk in the financial system
- **Why measure it:** This is the central pillar of the GFSI. Market-implied measures of asset volatilities, corporate & government credit quality as well as indicators of how smoothly banking systems & financial markets function should be the core constituents of any broad measure of financial stress
- **Components:** Market risk (asset price implied volatilities), Solvency risk (credit related metrics pertaining to corporate and sovereign credit quality) and Liquidity risk (spread metrics across asset classes, such as LIBOR/OIS, that gauge the liquidity and smooth functioning of financial markets)
- **Back-tested⁵ behaviour:** Secular trend downwards in cheap credit-fuelled risk compression period from late '02 through mid '07, it started rising thereon and spiked to a peak of 3.30 on 10-Oct-08.

Chart 7: The Risk index (GFSIRISK)



Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

⁵ Back-testing referred to here and from this point on refers to data prior to the GFSI's launch date of 19-Nov-10.

Skew Index (GFSISKEW)

- **Measures:** Demand for protection against extreme losses in risk assets
- **Why measure it:** Given cyclical demand for tail protection, this measure can reflect market or investor fears and positioning by quantifying the relative demand for hedging against excessive moves in equities and currencies. It can thus be an indicator of stressed sentiment as expressed by the derivatives markets
- **Components:** Equity skew (3mth 90-110 implied volatility spreads for major global equity indices) and FX skew (3mth 25 delta risk reversals for major currency crosses involving the Yen)
- **Back-tested behaviour:** One of the earliest indicators to signal significant stress in mid-2007, rising to 2.15 in Aug-07 and peaking at 3.28 on 29-Oct-08, it would have spiked to near 2008 extremes in May-10 (driven by equity skew which eclipsed its 2008 peak) due to a combination of prior market positioning, severe tail risk perception given potential sovereign distress and widespread interest in tail hedging

Chart 8: The Skew index (GFSISKEW)

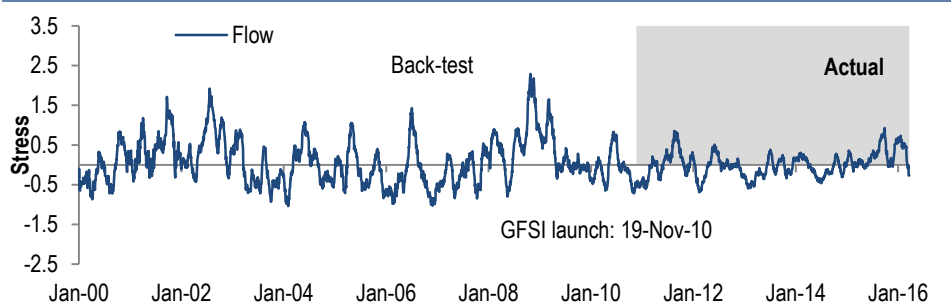


Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

Flow Index (GFSIFLOW)

- **Measures:** Investor flows for equities, bonds and money markets
- **Why measure it:** Inflows and redemptions from mutual funds enable us to quantify the appetite for certain asset classes. Big inflows into equity funds and redemptions from money market funds are often a sign of market 'euphoria', and vice versa. When combined with trading volume we can form a picture of the strength of conviction in market moves
- **Components:** Fund flow (net flows to developed and emerging market equity funds and global bond funds), Money market flow (assets in money market funds) and US equity trading volume
- **Back-tested behaviour:** Noisier than the other indices, the overall trend would have shown benign periods in the middle part of the 2000s, a notable spike in Jul-06 post the May-Jun '06 inflation scare driven by flows out of EM equities and HY bonds, peaking at 2.29 on 27-Oct-08. It also rose significantly in Mar-09 driven by flows into money market funds and out of risky assets

Chart 9: The Flow index (GFSIFLOW)



Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

GFSI's microstructure

Earlier, we showed how GFSI is constructed so as to capture three aspects of stress in the financial system: Risk, Skew and Flow, represented by the indices GFSIRISK, GFSISKEW and GFSIFLOW.

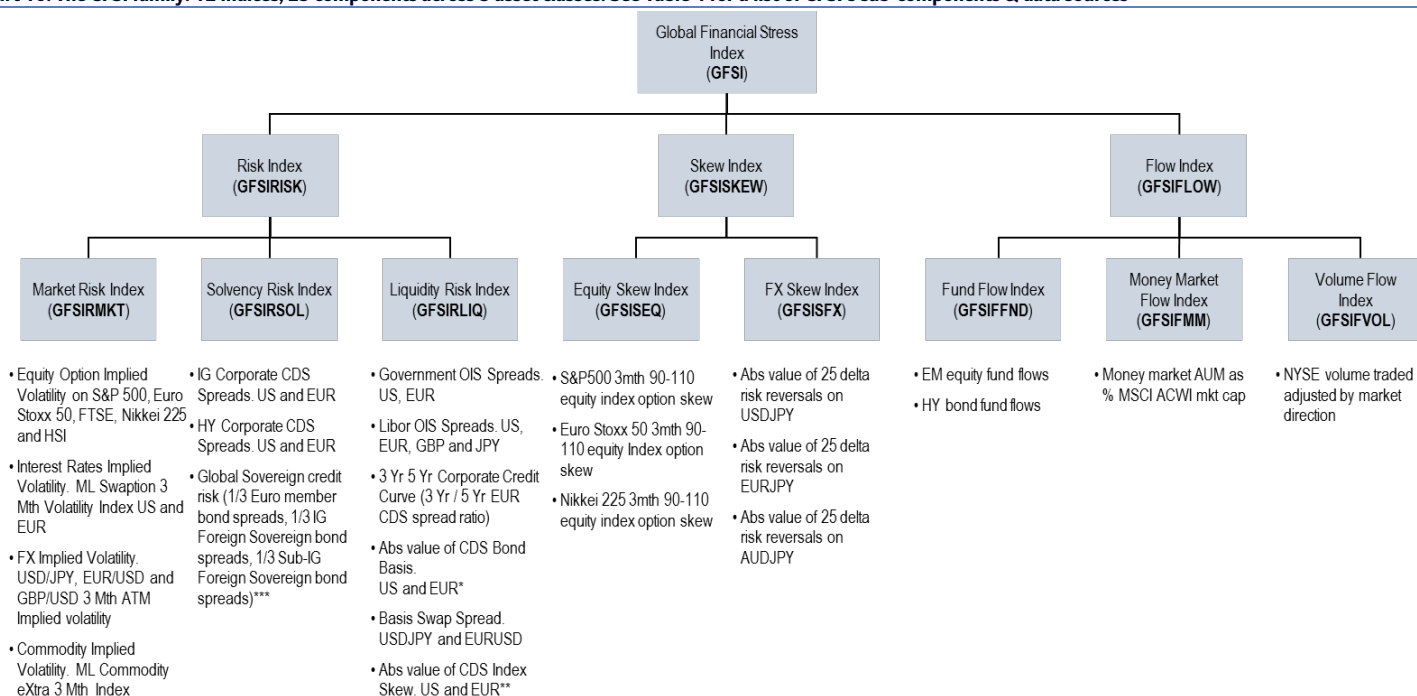
These indices themselves comprise sub-indices, each designed to capture a different aspect of risk, skew and flow respectively:

- GFSIRISK: Market (GFSIRMKT), Solvency (GFSIRSOL) and Liquidity risk (GFSIRLIQ)
- GFSISKEW: Equity (GFSISEQ), FX skew (GFSISFX)
- GFSIFLOW: Fund (GFSIFFND), Money Market (GFSIFMM) and Volume (GFSIFVOL)

This tree-like structure underscores one of the main benefits of GFSI, as it enables easy attribution of changes in stress to specific components. In total, the 8 low level sub-indices are made up of 23 distinct components that range from equity volatility to sovereign credit risk to high yield bond flows. The full breakdown of the GFSI including details of each sub-component (41 in total as of the date of this report) is shown in Chart 10.

What follows is a description of each of the lower level sub-indices, including their composition, what they measure, why they've been chosen and their historical behaviour.

Chart 10: The GFSI family: 12 indices, 23 components across 5 asset classes. See Table 4 for a list of GFSI's sub-components & data sources



Source: BofA Merrill Lynch Global Research.

*CDS bond basis = Difference between CDS spread and cash bond spread. From 8-Jan-13 onwards, we started using the Abs value of the CDS bond basis.

**CDS Index skew = difference between the index CDS spread and the fair value of the index CDS spread calculated from single name CDS spreads. From 12-Feb-13 onwards, we started using the Abs value of the CDS index skew.

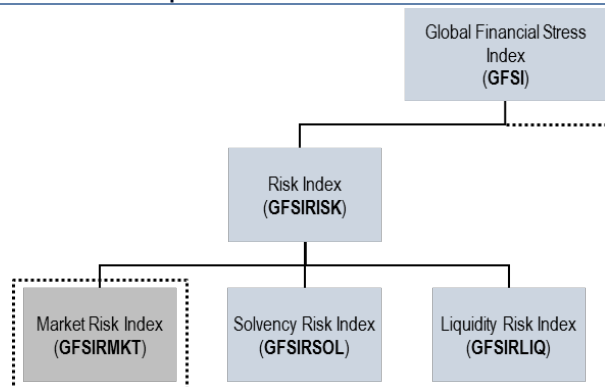
*** From 6-Mar-15 onwards, we started using 1/3 Euro member bond spreads, 1/3 IG Foreign Sovereign bonds spreads & 1/3 sub-IG Foreign Sovereign bond spreads. Prior to 6-Mar-15, we used 2/3 Global sovereign CDS & 1/3 USD denominated EM bond spreads

Risk's three sub-indices: Market, solvency and liquidity

1) Market Risk Index (GFSIRMKT)

- **Member of:** Risk Index (GFSIRISK)
- **Measures:** 3mth At-the-money option implied volatilities across asset classes, including equities, commodities, rates and currencies
- **Why measure it:** By assessing the extent of future price swings implied by option markets in different asset classes, we can gain a sense of future risk perception among market participants, an important component of financial market stress
- **Components:** 3mth At-the-money option implied volatilities on major global equity indices (S&P500, ESTX50, FTSE 100, Nikkei 225, HSI), yield curve weighted normalised implied volatility of 3mth swaptions on various maturity European and US interest rate swaps, 3mth At-the-money implied volatility for major currency crosses (EUR/USD, USD/JPY, GBP/USD), 3mth commodity implied volatility
- **Back-tested behaviour:** Would have shown increased levels of stress around 9-11 and again in the Internet bubble bursting of 2002. Would have shown benign levels of stress in the years leading up to the credit crisis in which it reached its most elevated levels yet.

Chart 11: GFSIRMKT is part of the GFSIRISK index



Source: BofA Merrill Lynch Global Research

Chart 12: The Market Risk index (GFSIRMKT)



Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

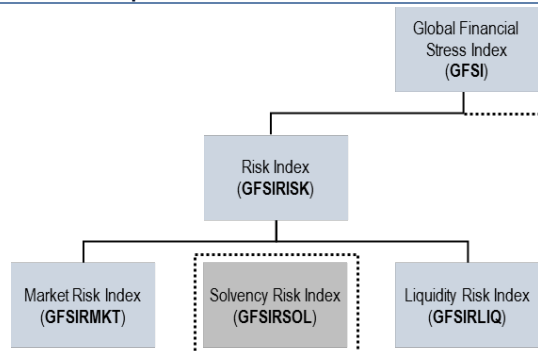
2) Solvency Risk Index (GFSIRSOL)

- **Member of:** Risk Index (GFSIRISK)
- **Measures:** Credit risk as priced by corporate and sovereign bond spreads
- **Why measure it:** The perception of credit worthiness or solvency is paramount for well-functioning banking and financial systems. Disruptions in these perceptions, whether it is for corporates or indeed governments, can lead to stress in markets and financial systems
- **Components:** 5yr CDS spreads for Investment grade and High yield corporates in the US and Europe, bond spreads vs relevant benchmarks of Euro member issued EUR-denominated bonds & Foreign sovereign (IG & sub-IG) bonds⁶

⁶ Euro member and foreign sovereign bond spreads used from 6-Mar-15 onwards. Prior to this, we used 5Y Global sovereign CDS spreads and EM USD denominated bond spreads

- **Back-tested behaviour:** Would have reacted strongly to the downgrades of GM and Ford in late 2002 and the following period of concern. Fuelled by cheap leverage, spread contraction led to the index dropping back to below normal levels in the years leading up to the credit crisis, when it peaked to its highest levels.

Chart 13: GFSIRSOL is part of the GFSIRISK index



Source: BofA Merrill Lynch Global Research.

Chart 14: The Solvency Risk index (GFSIRSOL)



Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

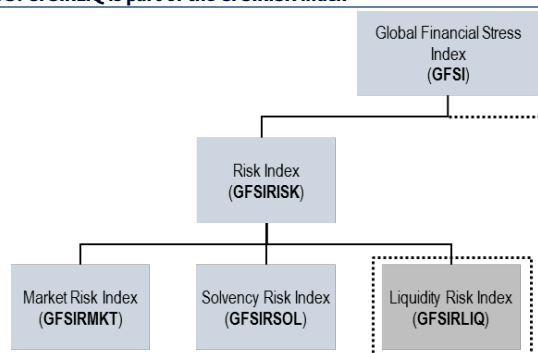
3) Liquidity Risk Index (GFSIRLIQ)

- **Member of:** Risk Index (GFSIRISK)
- **Measures:** Liquidity risk as measured by funding spreads, which tend to expand in times of financial turmoil (eg LIBOR-OIS spreads)
- **Why measure it:** Liquidity or lack thereof often measures the health or functioning of a financial system. While boundless liquidity is not necessarily a good thing given the potential for accelerating asset bubble formation, poorly functioning money markets and funding problems in general are often symptomatic with financial stress
- **Components:** Government bond – OIS spreads (US, Europe, UK), Libor – OIS spreads (US, Europe, UK, Japan), 3yr – 5yr Investment Grade credit curve (US and Europe), absolute value⁷ of 5yr CDS – Bond basis (US and Europe), USD and EUR 1yr Basis swaps, absolute value⁸ of 5yr CDS index skew (US and Europe)
- **Back-tested behaviour:** Would have shown signs of stress in 2000 after which it declined back to normal levels until the early parts of the credit crisis.

⁷ Absolute value used since 8-Jan-13; prior to this we used the actual (signed) value

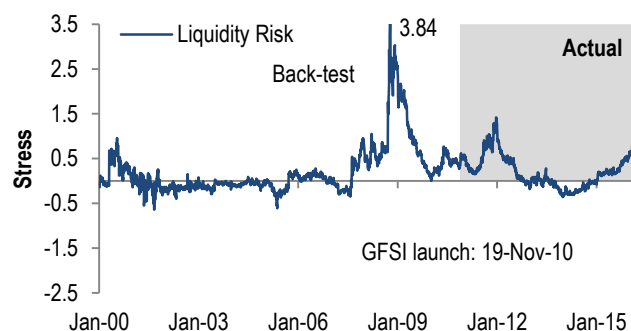
⁸ Absolute value used since 12-Feb-13; prior to this we used the actual (signed) value

Chart 15: GFSIRLIQ is part of the GFSIRISK index



Source: BofA Merrill Lynch Global Research

Chart 16: The Liquidity Risk Index (GFSIRLIQ)



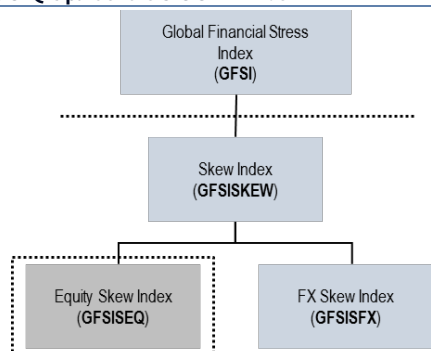
Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

Skew's two sub-indices: Equity and FX

1) Equity Skew Index (GFSISEQ)

- **Member of:** Skew Index (GFSISKEW)
- **Measures:** It is the relative demand for equity portfolio protection against large losses and often used as a gauge of equity market fear
- **Why measure it:** While a rise in equity skew does not consistently predict market turmoil, it is a useful quantity to observe and track as it can point towards derivatives market sentiment, an important indicator of stress
- **Components:** 3mth 90-110 implied volatility spread for the S&P500, Euro STOXX 50 and the Nikkei 225 equity indices
- **Back-tested behaviour:** Equity skew was one of the few stress sub-indices to rise to significantly stressed levels in Aug-07, and then again in May-10. It peaked at 3.49 on 21-May-10, becoming the only sub-index that signalled greater stress in the sovereign risk flare of Apr-May-10 than in 2008.

Chart 17: GFSISEQ is part of the GFSISKEW index



Source: BofA Merrill Lynch Global Research

Chart 18: The Equity Skew Index (GFSISEQ)

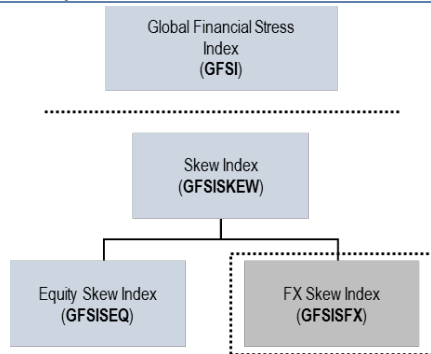


Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

2) FX Skew Index (GFSISFX)

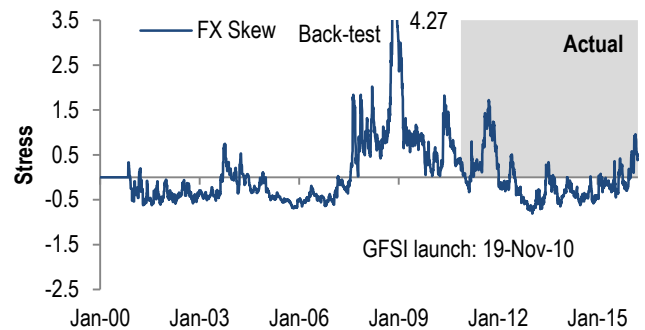
- **Member of:** Skew Index (GFSISKEW)
- **Measures:** The likelihood of extended appreciation or depreciation of a currency with respect to another (as priced into FX option markets); it is linked to investor demand for out-of-the-money options in one currency versus another
- **Why measure it:** Similar to equity skew, FX skew can point towards currency market sentiment, particularly in the case of 'risk-on' currency pairs or typical carry trade crosses like USD-JPY or AUD-JPY
- **Components:** 3mth 25 delta risk reversals (absolute value of) on the USD-JPY, EUR-JPY and AUD-JPY currency pairs, ie the absolute value of implied volatility of calls less that of puts of the same delta on the base currency volatility of calls less that of puts of the same delta on the base currency
- **Back-tested behaviour:** FX skew also rose to significant stress levels (>2) in mid-2007 and peaked at 4.27 on 21-Nov-08 led by USD-JPY skew as one of the most popular carry trades unravelled

Chart 19: GFSISFX is part of the GFSISKEW index



Source: BofA Merrill Lynch Global Research

Chart 20: The FX Skew Index (GFSISFX)



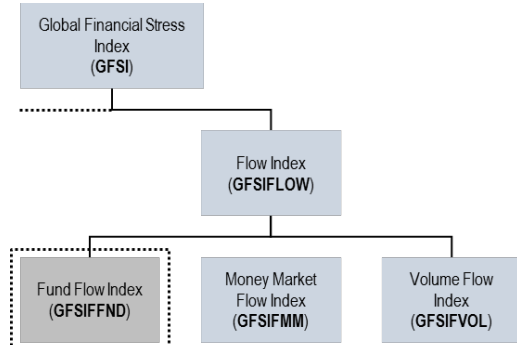
Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

Flow's three sub-indices: Fund, money market and volume

1) Fund Flow Index (GFSIFFND)

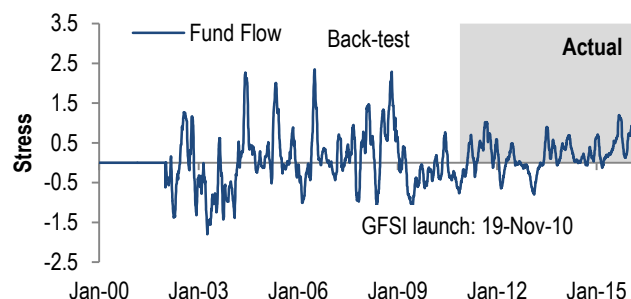
- **Member of:** Flow Index (GFSIFLOW)
- **Measures:** EPFR Global net flows into Emerging Market equity funds and high-yield bond funds, both controlled for size of total assets under management
- **Why measure it:** When risk appetite is falling investors withdraw funds from riskier assets like EM equities and HY bonds. EPFR Global tracks net daily flows into both of these assets. Higher readings of this index represent higher redemptions from funds focused on these asset classes
- **Components:** EM equity fund flows and HY bond fund flows
- **Back-tested behaviour:** The Fund Flow Index is one of the most volatile series with significant peaks in fund redemptions in Jun-04, May-05, Jul-06 and Oct-08.

Chart 21: GFSIFFND is part of the GFSIFLOW index



Source: BofA Merrill Lynch Global Research

Chart 22: The Fund Flow Index (GFSIFFND)

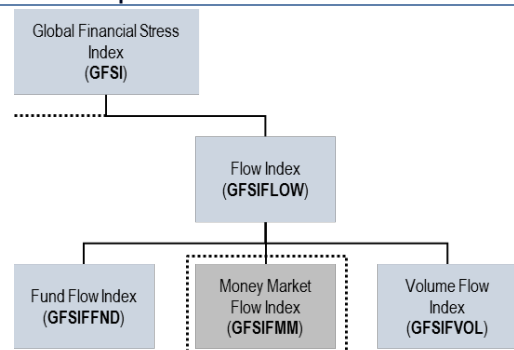


Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

2) Money Market Flow Index (GFSIFMM)

- **Member of:** Flow Index (GFSIFLOW)
- **Measures:** EPFR Global Money Market Funds AUM as a percent of total global equity market cap
- **Why measure it:** Increased demand for a 'safe haven' asset like money market funds reflects falling risk appetite. EPFR Global tracks daily AUM of global money market funds
- **Components:** Money market AUM controlled for size of MSCI ACWI market cap
- **Back-tested behaviour:** Money market fund assets increased up to 2003, coinciding with corporate accounting scandals at GM and Ford. This was followed by a secular run-down in AUM through the equity bull market to 2007. Interestingly, the index would have exhibited the first signs of stress as early as Jul-07, trending up until the Lehman bankruptcy of Sep-08 prompted a spike.

Chart 23: GFSIFMM is part of the GFSIFLOW index



Source: BofA Merrill Lynch Global Research

Chart 24: The Money Market Flow Index (GFSIFMM)



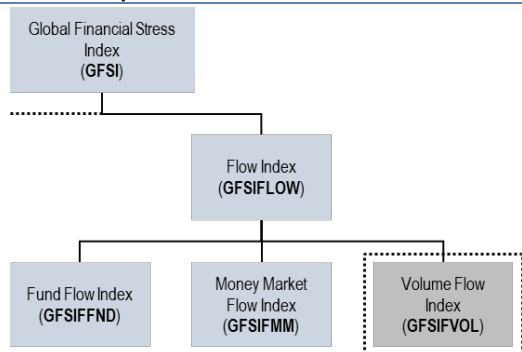
Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

3) Volume Flow Index (GFSIFVOL)

- **Member of:** Flow Index (GFSIFLOW)
- **Measures:** Volume traded on New York Stock Exchange, adjusted for daily direction of equity market
- **Why measure it:** Volume measures the level of conviction in daily equity market moves. By controlling for market direction, this measure can separate the strength of conviction in up-markets and down-markets

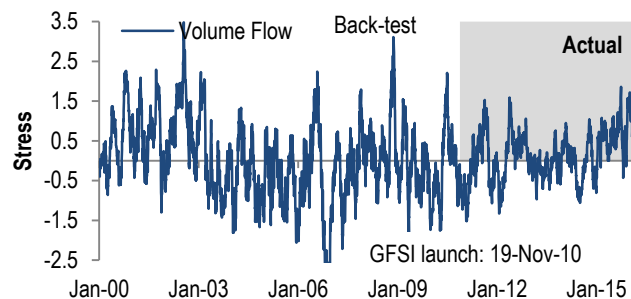
- **Components:** NYSE daily volume traded. Daily direction of S&P500
- **Back-tested behaviour:** Volume flow is the most volatile series in our family of indices. It would have picked up significant stress in the market during 9/11 and peaked in Jul-02 when WorldCom filed for bankruptcy. The index would have risen in Apr-10 on Eurozone sovereign debt concerns, before falling back.

Chart 25: GFSIFVOL is part of the GFSIFLOW index



Source: BofA Merrill Lynch Global Research

Chart 26: The Volume Flow Index (GFSIFVOL)



Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Backtesting is hypothetical in nature and reflects the application of the strategy prior to its introduction

Calculating GFSI: index mechanics & governance

Z-scores place stress metrics on an equal footing

Each of the 23 GFSI components (which further breakdown into 41-subcomponents) captures a different aspect of a 'stressful' or 'benign' market environment. But how do we ensure that the readings across different measures are comparable, particularly given that they can have very different historical distributions? We construct each component as a z-score, measuring how far away the current reading is from a historical 'norm'.

In our case, the z-score tells us how many standard deviations the current observation is above or below a long term median. A z-score of +1/-1 means the current reading is 1 standard deviation above/below this median.

Time window places GFSI in a historical context

For GFSI data up to and including 15-Aug-10, the median calculation for each component uses data from 3-Jan-00 through 15-Aug-10, a period of time that we believe captures a long enough history of risk factors to enable us to assess distributions across both benign and stressed markets. For readings after 15-Aug-2010, we expand our window of calculation of medians and standard deviations to include all new observations. This allows new readings to reflect all historical information available, thus building larger distributions as the index evolves.

However, this methodology does mean that a z-score reading on say 01-Jan-2003, is based on data that wasn't available at the time. Why do we allow this? Overall, we want any statistics measuring the variability of an indicator and its average level to be reflective of both normal and stressed market conditions. By doing so, we incorporate through-the-cycle information when reasoning about how stressed a particular measure is. Our decision to reflect this knowledge of the 'future' distribution from the start is simply to allow for a level playing field when we compare the severity of current and future market stresses to what was experienced in the past. So, GFSI's level prior to Aug-10 does not reflect what would have been the perceived level of stress then; rather it echoes what stress that period experienced in the light of what we know today.

GFSI's composition is flexible: outlining the scope of potential changes

We recognise that there may be sources of financial stress that we haven't yet identified or that may emerge/gain prominence in time, or indeed existing ones that become less relevant in future years. Moreover, data sources may prove to become unreliable, unavailable or perhaps new sources show greater promise/depth in measuring a risk factor. For these reasons, BofAML's Global Equity Derivatives Research Team reserves the right to modify GFSI's index composition in terms of its constituents (additions, deletions), choice of data series/sources to use and the z-score methodology used to calculate stress. This should help keep the GFSI framework dynamic enough to be useful across multiple market environments, in our view.

Process for making and communicating changes made to the GFSI

BofAML's Global Equity Derivatives Research Team reserves the right to make changes along the lines discussed above at any time, subject to approval by the Global Research Index Governance function. The team will publish a research note outlining the change prior to it being implemented. Importantly, no historical GFSI data will be restated in the event of an index change. Finally, if for some reason the GFSI and its family of indices are to be terminated, the team will issue a research note to this effect, generally, at least 3 calendar months prior to termination.

GFSI's market timing tools

Since the launch of the GFSI in Nov-10, the Global Equity Derivatives Research Team has created two **complementary** tools that leverage the wealth of information across regions and asset classes captured by the GFSI to help time risk markets. On [8-Jun-11](#), we introduced the GFSI's Critical Stress Signal, a binary (on/off) rule that warns of high risk of a large shock to risk assets. Then on [9-Sep-13](#), we introduced the Risk Allocator, a framework to help investors add or reduce exposure to risk assets on a more granular scale. Below we outline the details of both tools in detail.

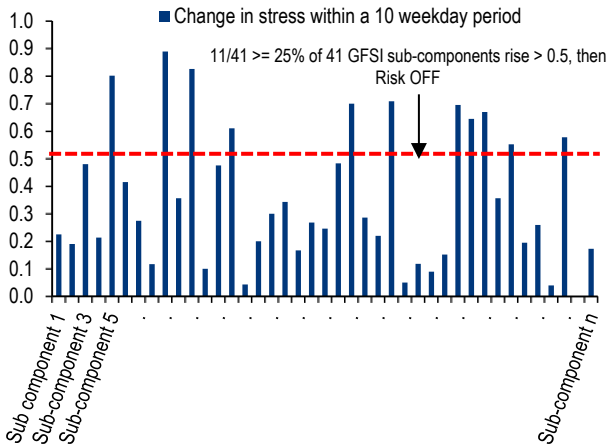
The Critical Stress Signal (CSS)

The Critical Stress signal has 2 states, Risk OFF and Not Risk OFF (it is in Not Risk OFF by default). It works as follows:

Risk OFF: The signal triggers Risk OFF if within a period of 2 weeks, at least 1/4th of the GFSI's constituent stress sub-components (41 in number as of Mar-2016) rise by greater than 0.5. The idea is if a sufficiently large number of stresses rise significantly in a short space of time, there is a good chance of stress cascading across the global financial system

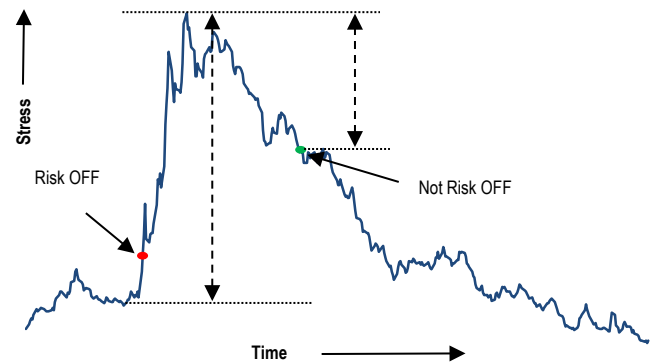
Not Risk OFF: If the above condition isn't satisfied, the signal is in this state. If the signal is in Risk OFF, then after a period of at least 2 weeks, it switches back to Not Risk OFF if the headline GFSI index retraces by more than 50% of the spike measured from the minimum GFSI level seen before the signal triggered Risk OFF

Chart 27: GFSI's Critical Stress Signal (CSS) 'Risk OFF' trigger



Source: BofA Merrill Lynch Global Research

Chart 28: GFSI's Critical Stress Signal (CSS) Not Risk OFF condition



Source: BofA Merrill Lynch Global Research

Formulaically, on any weekday t , we define

- CSS_t is the state of the Critical Stress Signal
- $NrGFSIsub_t$ is the number of GFSI sub-components
- $GFSIsub_{i,t}$ is the i th GFSI sub-component
- $\Delta GFSIsub_{i,t} = 1$
 - if $GFSIsub_{i,t} - \text{Min}(GFSIsub_{i,t}, GFSIsub_{i,t-1}, \dots, GFSIsub_{i,t-9}) > 0.5$
 - else $\Delta GFSIsub_{i,t} = 0$
- $GFSI_t$ is the level of the GFSI on weekday t

- Then, $CSS_t = Risk\ OFF$

- if
$$\frac{\sum_{n=1}^{NrGFSIsub_t} \Delta GFSIsub_{i,t}}{NrGFSIsub_t} \geq 0.25$$

and CSS_t remains Risk OFF so long as the number of weekdays between T & t (including both T & t) is no greater than 10, where T is the 2nd weekday after t* and t* is the weekday when the CSS last changed from Not Risk OFF to Risk OFF

When the number of weekdays between T & t (including T & t) is greater than 10, then

$$CSS_t = Not\ Risk\ OFF\ if\ GFSI_t < MaxGFSI_t - \frac{(MaxGFSI_t - MinGFSI_t)}{2}$$

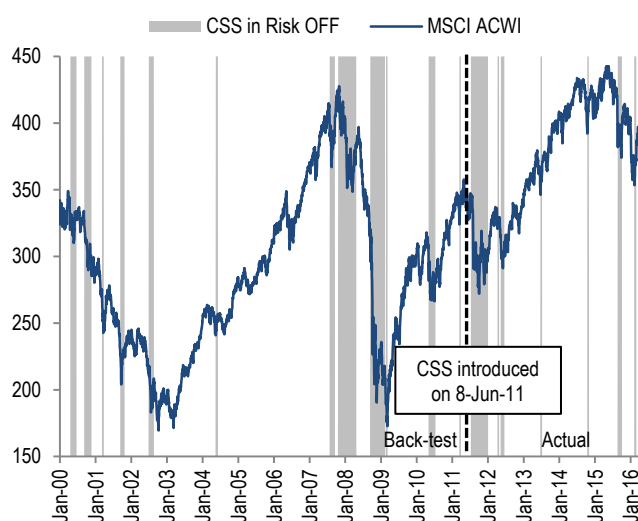
where $MaxGFSI_t$ is the highest GFSI level between T & t (including both T & t), and $MinGFSI_t$ is the lowest GFSI level in the 10 weekdays preceding (and including) T

Note: In the event of changes in GFSI composition since the GFSI's launch (19-Nov-10), data for new GFSI sub-components are used from when they enter the index. Also, consistent with the GFSI calculation, the most recent previous value of the sub-component is used to determine the state of the CSS in case a market is closed or data is unavailable.

Back-tested and live performance of the CSS

Chart 29 and Table 1 show the periods when the CSS would have been in Risk OFF in the past (back-tested signal history prior to 8-Jun-11 and live triggers since).

Chart 29: Global equities overlaid with periods that the Critical Stress Signal would have been (prior to 8-Jun-11) and was (since 8-Jun-11) in Risk OFF (the signal was introduced on 8-Jun-11)



Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Back-tested performance is based on criteria applied retroactively with the benefit of hindsight & knowledge of factors that may have positively affected performance, & cannot account for all risks that may affect performance of the strategy going forward. Back-testing is hypothetical in nature & reflects application of the strategy prior to its introduction. It is not actual performance & is not intended to be indicative of future performances.

Table 1: Dates between which the Critical Stress Signal was in Risk OFF (Signals 1 to 12 are back-tested)

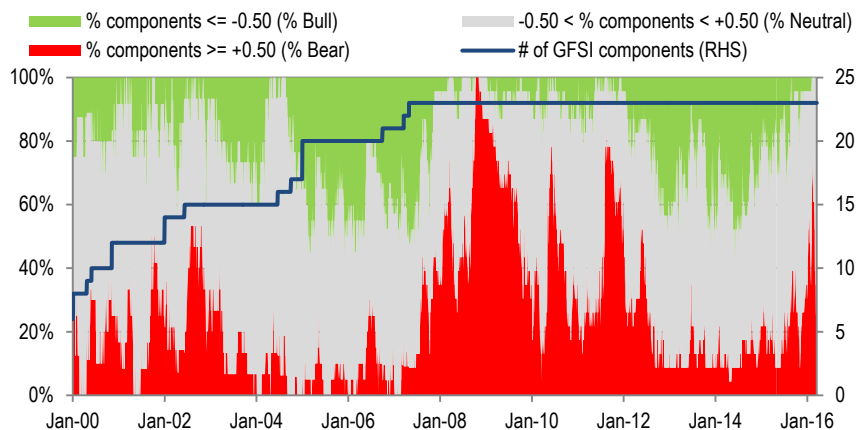
Signals	Risk off date	Not Risk off date	MSCI ACWI	MSCI ACWI max draw-down
1	19-Apr-00	21-Jun-00	2.3%	-4.7%
2	08-Sep-00	21-Nov-00	-10.1%	-10.5%
3	09-Mar-01	27-Mar-01	-4.4%	-10.4%
4	12-Sep-01	26-Oct-01	2.7%	-9.7%
5	01-Jul-02	22-Aug-02	-3.4%	-15.1%
6	17-May-04	08-Jun-04	6.7%	0.0%
7	27-Jul-07	19-Sep-07	3.7%	-5.9%
8	22-Oct-07	25-Apr-08	-5.9%	-14.7%
9	15-Sep-08	13-Feb-09	-32.4%	-38.2%
10	23-Feb-09	11-Mar-09	-3.1%	-8.6%
11	05-May-10	14-Jul-10	-3.5%	-10.1%
12	16-Mar-11	01-Apr-11	6.7%	0.0%
13	12-Jul-11	04-Jan-12	-9.1%	-18.9%
14	10-Apr-12	26-Apr-12	2.3%	0.0%
15	14-May-12	19-Jun-12	0.1%	-6.1%
16	24-Jun-13	10-Jul-13	5.0%	0.0%
17	16-Oct-14	03-Nov-14	6.4%	0.0%
18	24-Aug-15	06-Oct-15	3.6%	-2.2%
19	09-Feb-16	01-Mar-16	5.6%	-1.4%

Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 18-Mar-16. Signals 12 and prior are based on back-testing. Back-tested performance is based on criteria applied retroactively with the benefit of hindsight & knowledge of factors that may have positively affected performance, & cannot account for all risks that may affect performance of the strategy going forward. Back-testing is hypothetical in nature & reflects application of the strategy prior to its introduction. It is not actual performance & is not intended to be indicative of future performances.

The Risk Allocator (RA)

The GFSI's Risk Allocator can help investors add or reduce exposure to risk assets based on how GFSI stresses are distributed. Specifically, it uses the proportion of GFSI components (ie those that are averaged to calculate the GFSI) in Bullish, Bearish or Neutral territory to infer a level of conviction for investing in risk assets.

Chart 30: Visualising the historical distribution of financial stress. % Bull, % Neutral and % Bear are the fraction of GFSI components signaling benign, neutral & high risk, respectively



Source: BofA Merrill Lynch Global Research. Data from 3-Jan-00 to 18-Mar-16

Specifically, we define Exposure on any week day t as below

$$Exposure_t = Bull_{wgt} * \%Bull_t + Neutral_{wgt} * \%Neutral_t + Bear_{wgt} * \%Bear_t$$

where:

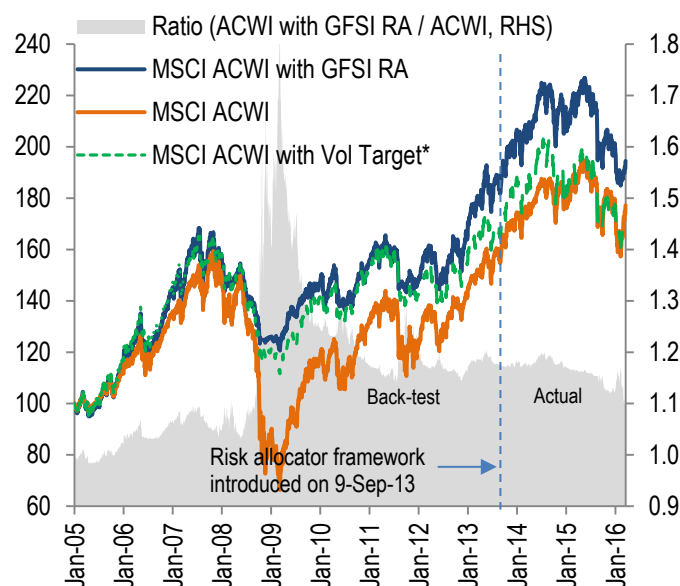
- $\%Bull_t = \% \text{ of GFSI components on weekday } t \text{ with values } \leq -0.5$
- $\%Neutral_t = \% \text{ of GFSI components on weekday } t \text{ with values in } (-0.5, 0.5)$
- $\%Bear_t = \% \text{ of GFSI components on weekday } t \text{ with values } \geq 0.5$
- $Bull_{wgt}, Neutral_{wgt} \text{ and } Bear_{wgt}$ can be chosen to suit investor risk tolerance

As an example, using Bull, Neutral and Bear weights of 2, 1 and 0 respectively, we find that Exposure can at most be 2 (ie twice levered), at least 0 (not invested) with Neutral exposure of 1 (fully invested).

Back-tested and live performance of the RA

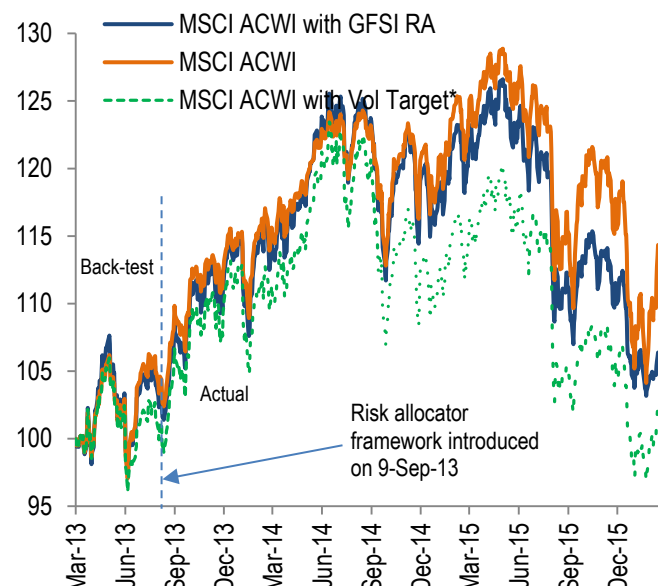
In Chart 31 and Chart 32 we show the historically back-tested performance of managing global equity exposure through time as recommended by the Risk Allocator framework. We use the above example of Bull, Neutral and Bear weights and establish a 5% exposure threshold for adjusting exposure to reduce trading intensity. The charts and Table 2 show that the Risk Allocator would have helped to outperform global equities in the past 10 years on a return and a risk-adjusted return basis. Please see the publications [Smarten up your beta](#) (27-Feb-14) and [Enhancing portfolios across asset classes with the GFSI](#), 6-Jan-15 for more potential applications and results using the Risk Allocator framework.

Chart 31: Historical performance of managing global equity beta by varying exposure (from 0 to 200%) using the GFSI's Risk Allocator framework (Bull, Neutral, Bear weights = 2, 1, 0)



Source: BofA Merrill Lynch Global Research. Data from 3-Jan-05 to 18-Mar-16. *Using an 11% daily vol target (to match the realised vol of the Risk Allocator overlay) helps compare the performance of the framework vs traditional methods of risk control. Back-tested performance is based on criteria applied retroactively with the benefit of hindsight & knowledge of factors that may have positively affected performance, & cannot account for all risks that may affect performance of the strategy going forward. Back-testing is hypothetical in nature & reflects application of the strategy prior to its introduction. It is not actual performance & is not intended to be indicative of future performance.

Chart 32: The benefits of using the GFSI RA to manage beta risk are not restricted to 2008-style tail events; in the last 3Y, our (2, 1, 0) GFSI RA overlay would have proved superior to backward looking volatility targeting



Source: BofA Merrill Lynch Global Research. Data from 18-Mar-13 to 18-Mar-16. *Using an 11% daily vol target (to match the realised vol of the Risk Allocator overlay) helps compare the performance of the framework vs traditional methods of risk control. Back-tested performance is based on criteria applied retroactively with the benefit of hindsight & knowledge of factors that may have positively affected performance, & cannot account for all risks that may affect performance of the strategy going forward. Back-testing is hypothetical in nature & reflects application of the strategy prior to its introduction. It is not actual performance & is not intended to be indicative of future performance.

Table 2: Historical performance statistics of the Risk Allocator (2, 1, 0) overlay suggests outperformance in long term

	2005 to 2016			Last 3Y		
	MSCI ACWI with GFSI RA	MSCI ACWI with Vol target	MSCI ACWI	MSCI ACWI with GFSI RA	MSCI ACWI with Vol target	MSCI ACWI
Return	6.1%	5.0%	5.2%	2.8%	1.4%	5.5%
Risk	11.0%	10.9%	16.8%	11.0%	11.2%	11.3%
Max DD	-28.3%	-32.8%	-58.4%	-18.5%	-21.6%	-19.2%
Info Ratio	0.56	0.46	0.31	0.25	0.13	0.49

Source: BofA Merrill Lynch Global Research. Data from 3-Jan-05 to 18-Mar-16

Table 3: Range of exposure recommended by the GFSI Risk Allocator (2, 1, 0) in the past 10 and 3 years

Exposure	2005 to 2016		Last 3Y	
	GFSI RA overlay	Vol target overlay	GFSI RA overlay	Vol target overlay
Min	0%	17%	22%	52%
Avg	92%	90%	107%	107%
Max	155%	184%	143%	184%

Source: BofA Merrill Lynch Global Research. Data from 18-Mar-13 to 18-Mar-16.

Table 4: GFSI sub-components and their data sources

S.No.	GFSI sub-component	Classification	Data Source
1	Equity Vol UKX	Market Risk	BofAML Global Markets
2	Equity Vol NKY	Market Risk	BofAML Global Markets
3	Equity Vol HSI	Market Risk	BofAML Global Markets
4	Equity Vol SPX	Market Risk	BofAML Global Markets
5	Equity Vol SX5E	Market Risk	BofAML Global Markets
6	Rate Vol USD	Market Risk	BofAML Global Markets
7	Rate Vol EUR	Market Risk	BofAML Global Markets
8	FX Vol USDJPY	Market Risk	BofAML Global Markets
9	FX Vol EURUSD	Market Risk	BofAML Global Markets
10	FX Vol GBPUSD	Market Risk	BofAML Global Markets
11	Comm Vol MLCXV3M	Market Risk	BofAML Global Markets
12	HY corp CDS EUR	Solvency Risk	BofAML Global Markets
13	IG corp CDS EUR	Solvency Risk	BofAML Global Markets
14	IG corp CDS USD	Solvency Risk	BofAML Global Markets
15	HY corp CDS USD	Solvency Risk	BofAML Global Markets
16	Sub IG Foreign Sovrn Bond Spread	Solvency Risk	BofAML Global Research
17	Euro member Bond Spread	Solvency Risk	BofAML Global Research
18	IG Foreign Sovrn Bond Spread	Solvency Risk	BofAML Global Research
19	Cross Currency Basis Swap EURUSD	Liquidity Risk	Bloomberg

Table 4: GFSI sub-components and their data sources

S.No.	GFSI sub-component	Classification	Data Source
20	Cross Currency Basis Swap USDJPY	Liquidity Risk	Bloomberg
21	CDS Index Skew EUR	Liquidity Risk	BofAML Global Markets
22	CDS Index Skew USD	Liquidity Risk	BofAML Global Markets
23	CDS Bond Basis EUR	Liquidity Risk	BofAML Global Research
24	CDS Bond Basis USD	Liquidity Risk	BofAML Global Research
25	3Y/5Y credit curve EUR	Liquidity Risk	BofAML Global Markets
26	Gov OIS spreads USD	Liquidity Risk	Bloomberg
27	Gov OIS spreads GBP	Liquidity Risk	Bloomberg
28	Libor OIS spreads USD	Liquidity Risk	Bloomberg
29	Libor OIS spreads EUR	Liquidity Risk	Bloomberg
30	Libor OIS spreads GBP	Liquidity Risk	Bloomberg
31	Libor OIS spreads JPY	Liquidity Risk	Bloomberg
32	Equity Skew NKY	Equity Skew	BofAML Global Markets
33	Equity Skew SPX	Equity Skew	BofAML Global Markets
34	Equity Skew SX5E	Equity Skew	BofAML Global Markets
35	FX Skew USDJPY	FX Skew	BofAML Global Markets
36	FX Skew AUDJPY	FX Skew	BofAML Global Markets
37	FX Skew EURJPY	FX Skew	BofAML Global Markets
38	Equity Fund Flow Risk EM	Fund Flow	EPFR
39	HY Bond Flow Risk EM	Fund Flow	EPFR
40	Money Market Flow MSCI	Money Market Flow	MSCI & Bloomberg
41	Volume Flow Risk NYSE	Volume Flow	Bloomberg

Source: BofA Merrill Lynch Global Research. As of 21-Mar-16

Disclosures

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Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster*
Buy	≥ 10%	≤ 70%
Neutral	≥ 0%	≤ 30%
Underperform	N/A	≥ 20%

* Ratings dispersions may vary from time to time where BofA Merrill Lynch Research believes it better reflects the investment prospects of stocks in a Coverage Cluster.

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