J.P.Morgan

GLOBAL FINANCE LIQUIDITY RISK REVISITED

Development of A Framework for Liquidity Assessment in Portfolio Construction Process

Presentations to the JP Morgan Global Head of Quant Research & Analytics & US Head of Portfolio Construction Teams

JP Morgan Alternative Assets Portfolio Liquidity Assessment Framework & Models: $500-600 Billion Fund of Funds
Teams Leader: Dr. Yogesh Malhotra

Being Published on SSRN for the first time given critical relevance to unfolding market events in June, 2022.
Original Weekly Presentations included here were developed & delivered over Spring and Summer of 2012.

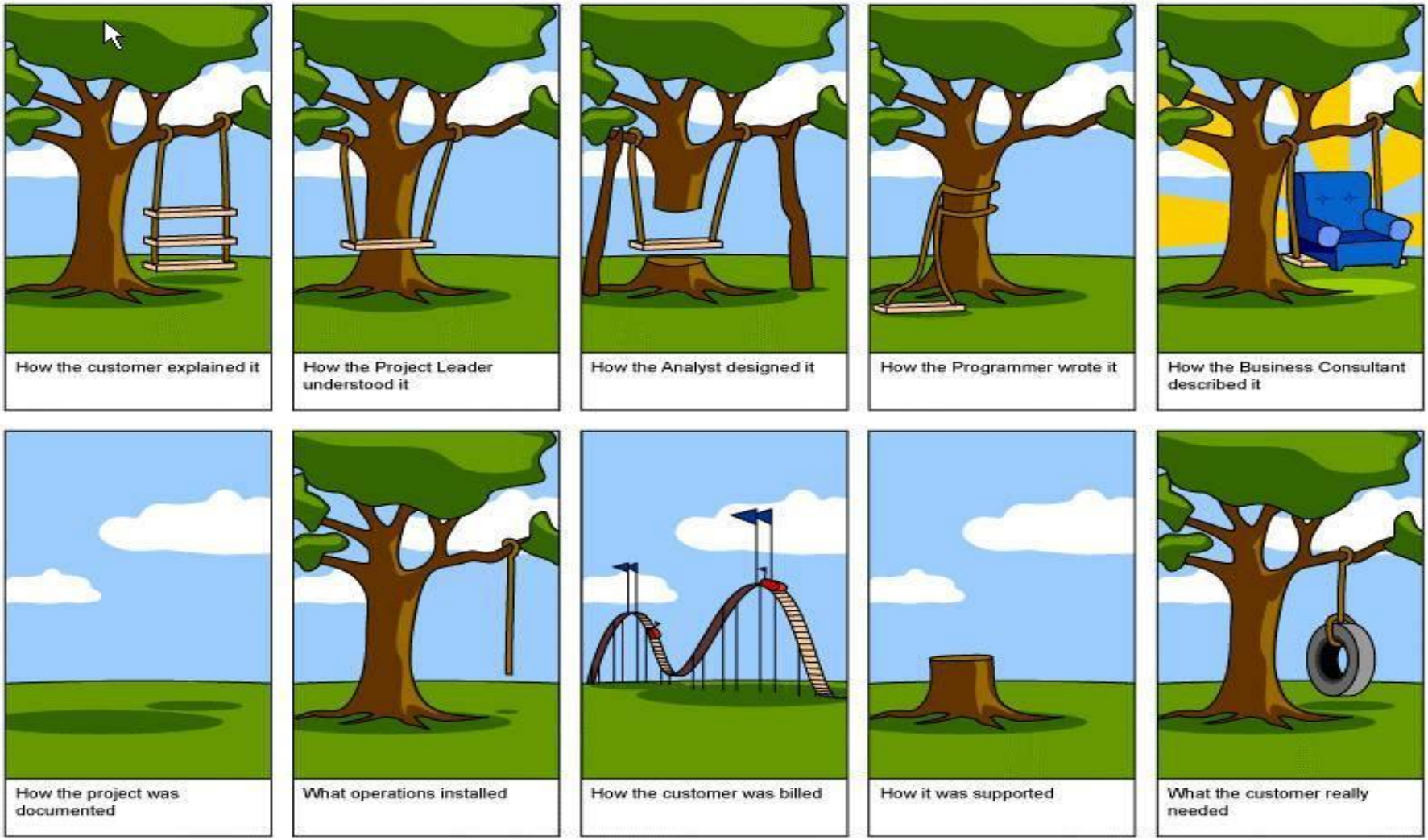
Development of A Framework for Liquidity Assessment in Portfolio Construction Process

- **Create a framework**
  - Liquidity Assessment
  - Portfolio Construction / Portfolio Optimization
  - Defined portfolio of asset classes & vehicles
- **LIQUIDITY will effect**
  - Time Horizon
  - Volatility (via Autocorrelation)
  - Returns
  - Stress Tests (via Price Discovery in Forced Liquidations)
- **In contrast to typical portfolio optimization**
  - Diverse risk and return measures
  - Liquidity as external constraint: “Simplistic”

Development of A Framework for Liquidity Assessment in Portfolio Construction Process

1) **Literature Review** (important & technical)
   - 2-4 approaches on definition of Liquidity
2) **Measure Definition**
   - Why Liquidity matters for PC? How?
   - Liquidity measures for asset classes/vehicles
     - Capture diversity of risk assets
     - Preserve core parameters for portfolios
   - Liquidity measures for portfolio level
     - Correlations: +ve, -ve, static, dynamic
3) **Portfolio Construction Framework**
   - Optimization: trade-off: risk/return (SR) vs. liquidity
4) **Implementation Models**

RATIONALE FOR SEQUENTIAL & PARALLEL GOAL ALIGNMENT



Literature & frameworks review

- Liquidity, Illiquidity, and Liquidity Risk
- Liquidity Risk, Funding Risk, Credit Risk: Linked
  - Liquidity crisis can cause a credit event.
  - Deterioration of credit quality can trigger a liquidity crisis.
- Lessons from Liquidity Risk Measurement Failures
- VaR, LaR, VLaR, EVT, Peaks over Thresholds: Limitations
  - Past data, Gaussian copula / linear correlations, normalcy, ignoring fat tails and black swans

LIQUIDITY & RISK METRICS

Liquidity:
Considerations of a Portfolio Manager

- 3 dimensions of liquidity: Price, Timing, and Quantity.
- Deviations in any of 3 dimensions impose shadow costs.
- Asset is perfectly liquid if a portfolio manager can trade:
  - PRICE: At Price no worse than uninformed E.
  - TIME: When she desires
  - SIZE: Quantity she desires
- 1-period, 3-agent model
- Liquidity provider, informed trader, uninformed investor

Hodrick & Moulton (2009), 'Liquidity: Considerations of a Portfolio Manager', Financial Management

Integrating LIQUIDITY IN Standard MVO FRAMEWORK

- Liquidity - at least 3 distinct attributes of trading process - price, time, size.
- A liquid security can be:
  - Traded quickly – Trading Volume
  - With little price impact – Cost of Transacting It
  - In large quantities.
- Define measures of liquidity of individual security
- Define liquidity of the portfolio as weighted average
- Construct liquidity-optimized portfolios

Lo et al. (2003) It's 11pm – Do You Know Where Your Liquidity Is?

Integrating LIQUIDITY IN Standard MVO FRAMEWORK

Amount of Trading

$$\text{Trading Volume} \equiv \text{Total Number of Shares Traded at Time } t$$

$$\text{Logarithm of Trading Volume} \equiv \log(\text{Trading Volume})$$

$$\text{Turnover} \equiv \frac{\text{Trading Volume}}{\text{Shares Outstanding}}$$

$$\text{Percentage Bid/Ask Spread} \equiv \frac{\text{Ask} - \text{Bid}}{(\text{Ask} + \text{Bid})/2}$$

$$\text{Loeb Price Impact Function} \equiv f(\text{Trade Size}, \text{Market Cap})$$

Lo et al. (2003) It's 11pm – Do You Know Where Your Liquidity Is?

Mean Variance Optimization (mvo) factor models

- Predicting Expected Returns: Forward Looking
- Risk Prediction: Also Cross-section Variability
- Expected Return Models: First Moment
- Risk Modelers: Second Moment
- Misalignment between Risk and Return Factors
- Constraint that limits exposure to Illiquid Assets
- Liquidity Risk Factor based on Daily Trading Volume
- Coefficients in Liquidity Constraint: f(Bid-Ask Spread)

Ceria et al. (2012). Factor Alignment Problems and Quantitative Portfolio Management. Journal of Portfolio Management, 28, 2.

LIMITATIONS OF MVO MODELS
DOWNSIDE RISK BECAUSE OF NON-NORMAILITY

- Two weaknesses of conventional MVO models
  - Asset returns are serially independent
  - Asset returns are normally distributed
- In many cases, returns are not independent
- In all cases, they are not normally distributed
  - Serial correlation from illiquidity, hard-to-price underlying
  - 'Fat' Left Tails (Negative Skewness and Leptokurtosis)
  - Correlations in extreme conditions not multivariate normal
- Standard Deviation ineffective as measure of risk
- CVaR95 a better quantifier as a risk measure

JPMorgan (2009), Non-normality of Market Returns: A framework for asset allocation decision-making.

Improving upon VaR & CVaR

- VaR, Expected Shorfall (ES) / CVaR, All have limitations

Scaling of short-horizon VaR to longer time horizon with common square-root-of-time scaling rule found inaccurate.

Time-varying volatility is a feature of many financial time series and can have important ramifications for VaR measurement.

VaR without time-varying volatility can ***dangerously under-estimate risk***, when true underlying risk factors exhibit time-varying volatility.

Extreme liquidity risk wherein ***collective liquidation*** of positions occurs is not accounted for in existing VaR Measures.

Basel Committee on Banking Supervision (January 2011). *Messages from the academic literature on risk measurement for the trading book*, Bank for International Settlements, Working Paper No. 19, 31.

Malhotra, Y. and Huang, P. Measuring & Managing Financial Risks with Improved Alternatives Beyond Value-At-Risk (VaR), Working Paper, 2012.

Improving upon VaR & CVaR

VaR ***lacks subadditivity*** i.e., its compartmentalised risk measurement based is not necessarily conservative.

The most prominent alternative to VaR is ***expected shortfall*****,** which is ***subadditive*** (Basel Committee 2011).

Spectral risk measures are a promising generalisation of expected shortfall.

VaR doesn't factor in ***stress testing*** and "***stressed VaR***" approach has not been adequately studied or analyzed.

Need to move to unified or ***integrated risk measurement*** that considers all risks jointly to factor in ***compounding effects***.

VaR capital requirements are of ***procylical nature*** and induce cyclical behaviors that exacerbate the economic cycle.

Basel Committee on Banking Supervision (January 2011). *Messages from the academic literature on risk measurement for the trading book*, Bank for International Settlements, Working Paper No. 19, 31.

Spectral Risk Measures

Marginal expected shortfall (MES): Measures loss in case returns go below certain %le of distribution (i.e. 1% or 5% on left side). How each group's risk taking adds to the financial institution's overall risk. Can also be calculated for financial institution as a whole: Contribution of each FI to risk of complete financial system.

Systemic expected shortfall (SES): An FI's propensity to be undercapitalized when the system as a whole is undercapitalized, which increases in its leverage, volatility, correlation, and tail-dependence (Acharya et al. 2010). Related to MES taking leverage and risk taking into account. Measures externalities when aggregate banking capital drops below a certain threshold: increases for high leverage & risks.

With use of SES and MES, banks have incentive to reduce tax (or insurance) payments and take into account externalities arising from their risks and default.

Source: Acharya, V., L. Pedersen, T. Philippon, and M. Richardson (March 2010). Measuring Systemic Risk. Federal Reserve Bank of Cleveland. Working Paper 10-02.

LIQUIDITY RISK MEASUREMENT AND MANAGEMENT: BASEL III AND BEYOND

Measuring liquidity risk

- Liquidity Risk: Possibility of running out of cash.
- Basel III: International Framework for Liquidity Risk Measurement, Standards, and Monitoring:
- Minimum standards for liquidity and funding:
- Liquidity Coverage Ratio, Net Stable Funding Ratio
- Liquidity consumed by:
  - Illiquid Assets and Volatile Liabilities
- Liquidity provided by:
  - Stable Funds and Liquid Assets

(Matz 2011)

Measuring liquidity risk

- Core piece of the methodology:
- Scenario engine for modeling
  - impact of various stress scenarios
  - on cash in—and outflows
  - of homogeneous product or business segments.
- Scenarios should allow for differentiating:
  - systemic, idiosyncratic, and combined stress situations.
- Withdrawal scenarios based on limited set of factors
  - Level of sophistication of counterparty, Absolute deposit size
  - Much quicker withdrawal: High net worth, Large corporates

(Matz 2011)

LESSONS FROM Liquidity Risk Measurement Failures

1. Embrace Forward-Looking Measures (Monte Carlo)
2. Perform “Worst-Case” Stress Tests
3. Not Misunderstand or Misapply VaR
4. Sufficient Data—Especially for New Products
5. No Confusion between “Risk” and “Uncertainty”
6. Don’t Prepare to Fight the Last War
7. Don’t Underestimate Potential Funding Requirements
8. Recognize Risk Linkages and Macro Factors

(Matz 2011)

OPTIMAL PORTFOLIOS

- Optimal portfolios are built by banks and institutional investors.
- Optimal in the sense that they provide the maximum reward for a given level of risk.
- Risk, in these models, is measured by volatility.
- Risk of each portfolio is less than the sum of the risk in each investment because of low correlations between the volatility of each piece.
- Rush to the Exits Scenario results from the fact that historical analyses of volatility and covariance have consistently proven to misstate risk from Black Swans.
- Black Swans are simply large disruptions that cannot be predicted from historical observations.

Stock and Flow view of LIQUIDITY

- “The coffers of the bank, so far as its dealings are confined to such customers, resemble a water pond, from which, though a stream is continually running out, yet another is continually running in, fully equal to that which runs out; so that, without any further care or attention, the pond keeps always equally, or very nearly equally full.”

(Adam Smith, in Matz, 2011)

Liquidity Gaps & INTEREST RATE GAPS

- Liquidity Gaps: Group assets and liabilities into time period segments based on when the cash flow is expected.
- Interest Rate Gaps: Group assets and liabilities into buckets based upon when they are expected to reprice.
- The Liquidity “Model” is likely to be something adapted from interest rate risk measurement.
- Issues and decisions to address when implementing liquidity gap analysis are very similar to those for repricing gaps.

(Matz 2011)

Stress testing: central pillar of liquidity risk management

- Scenario stress testing submits a scenario to large, adverse movements...
- …To determine whether the institution can survive adverse changes of that nature on that scale.
- Scenario is an integrated future view.
- Sensitivity test is a univariant test used to establish the extent to which an outcome depends upon a single variable or single assumption.
- Stress test is an integrated, multivariant test that shows degrees of severity for scenarios.
- “Integrated”: Assumptions for independent and dependent variables reflect interrelationships between them.

(Matz 2011)

Scenario stress testing

- Test to understand if we are holding enough liquidity to buy enough time to either outlast the event or implement remedial measures.
- Evaluate if we can liquidate assets and implement other remedial actions soon enough and in large enough amounts to survive.
- Stochastic Tools: Historical VaR, Extreme Value Analysis, Monte Carlo Simulation, Loss Distribution Approach (LDA), Square Root VaR Model.
- However, VaR is NOT appropriate for Liquidity Risk

(Matz 2011)

The Black swan problem

- Central problem with VaR and Extreme Value Analysis
- Tail in distribution of liquidity changes only reveals most severe changes in period covering observations.
- For most cases, historical data do not include the sorts of extreme events that comprise contingent liquidity risk.
- No matter what statistical tools one selects to peer into the tail, the events that concern can't be seen because they aren't there in the first place.
- Historical VaR and correlation/covariance VaR only work if the future looks like the past.
- Hence, VaR is a poor tool for quantifying liquidity risk.

(Matz 2011)

Stress Tests

- “Unlike VaR . . . stress tests simulate portfolio performance during abnormal market periods. Accordingly, they provide information about risks falling outside those typically captured by the VaR framework. Those [risks] associated with forward-looking scenarios that are not reflected in the recent history . . . used to compute VaR.” [BIS, 2005]

“Testing at Major Financial Institutions: Survey Results and Practice,” report by a working group established by the Committee on the Global Financial System, CGFS Publication 24, Bank for International Settlements, January 2005

Deterministic Scenario Stress Tests

- So the future does not look like the past—especially for extreme events.
- Data are hard to get.
- Relationships between variables are fragile and difficult to predict.
- Distributions are not normal.
- And the risk arises from structural changes not from scale.
- Deterministic, scenario-based stress tests are the *least-worst* solution.
- Key Point: Stress Testing Is NOT a Predictive Exercise

(Matz 2011)

Stress testing of liqudity

- Deterministic stress testing is simply an analysis of what can go wrong, when, how badly, and for how long.
- Stressed scenarios highlight potential problems.
- Stress testing also allows risk managers to identify opportunities for rapid and effective responses.
- Even if a crisis never occurs, evaluations of stressed scenarios can aid bank management.
- Regulators require stress testing.

(Matz 2011)

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APPENDIX

Improved Alternatives beyond VaR
Properties of a Coherent Risk Measure

A Risk Measure is “coherent” if it satisfies all of the following four axioms (Atzner et al. 1999):

Subadditivity (diversification) $R(L_1 + L_2) \leq R(L_1) + R(L_2)$

Positive homogeneity (scaling) $R(\lambda L) = \lambda R(L)$, for every $\lambda > 0$

Monotonicity $R(L_1) < R(L_2)$ if $L_1 < L_2$

Transition property $R(L + a) < R(L) - a$

Expected Shortfall (BIS, 2011)

To define ES, let L be a random loss with distribution function F_L and $\alpha \in (0,1)$ a confidence level (close to 1). Recall that the α-VaR is defined as the α-quantile of F_L. The ES at level α is defined by

$$ES_\alpha \equiv \frac{1}{1-\alpha}\int_\alpha^1 VaR_u(L)\,du$$

and can thus be understood as an average of all VaRs from level α up to 1. ES is a coherent risk measure – and so subadditive. It is continuous in α and thus avoids cliff effects that may appear when the distribution has discrete components.

If the loss distribution is continuous, there is an even more intuitive representation:

$$ES_\alpha = E\left(L \middle| L \geq VaR_\alpha\right)$$

i.e. ES is then the expected loss conditional on this loss belonging to the 100 $(1-\alpha)$ percent worst losses.

Spectral Risk Measures

Marginal expected shortfall (MES):

$$q_\alpha = sup\left\{z | Pr\left[R < r\right] \leq \alpha\right\} \qquad ES_\alpha = -E\left[R | R \leq q_\alpha\right]$$

$$ES_\alpha = -\sum_i y_i E\left[r_i | R \leq q_\alpha\right] \qquad \frac{\partial ES_\alpha}{\partial y_i} = -E\left[r_i | R \leq q_\alpha\right] \equiv MES_\alpha^i$$

- Measures how group i 's risk taking adds to the bank's overall risk.
- Can be measured by estimating group i 's losses when the firm as a whole is doing poorly.

Systemic expected shortfall (SES):

Default Expected Shortfall:

$$DES^i \equiv -E\left[I_i \cdot w_1^i\right]$$

Further, we define bank i's systemic expected shortfall (SES) as its the amount its equity w_1^i drops below its target level, which is a fraction z of assets a^i in case of a systemic crisis:

(Acharya et al. 2010)

$$SES^i \equiv E\left[\bar{I} \cdot (za^i - w_1^i)\right]$$

GOALS RECAP

- **Create a framework**
  - Liquidity Assessment
  - Portfolio Construction / Portfolio Optimization
  - Defined portfolio of asset classes & vehicles
- **LIQUIDITY will affect**
  - Time Horizon
  - Volatility (via Autocorrelation)
  - Returns
  - Stress Tests (via Price Discovery in Forced Liquidations)
- **In contrast to typical portfolio optimization**
  - Diverse risk and return measures
  - Liquidity as external constraint: “Simplistic”

Liquidity and Liquidity Risk: Definitions, Frameworks, Measures

- Liquidity: Finance ‘No Agreement’ vs. Accounting ‘Perfect Agreement’
- BASEL III Latest Updates on Liquidity and Liquidity Risk
- Liquidity: More Fundamental Definitions & Frameworks
- Liquidity Risk: More Fundamental Definitions & Frameworks
- Fund of Funds: Practitioner Definitions and Frameworks
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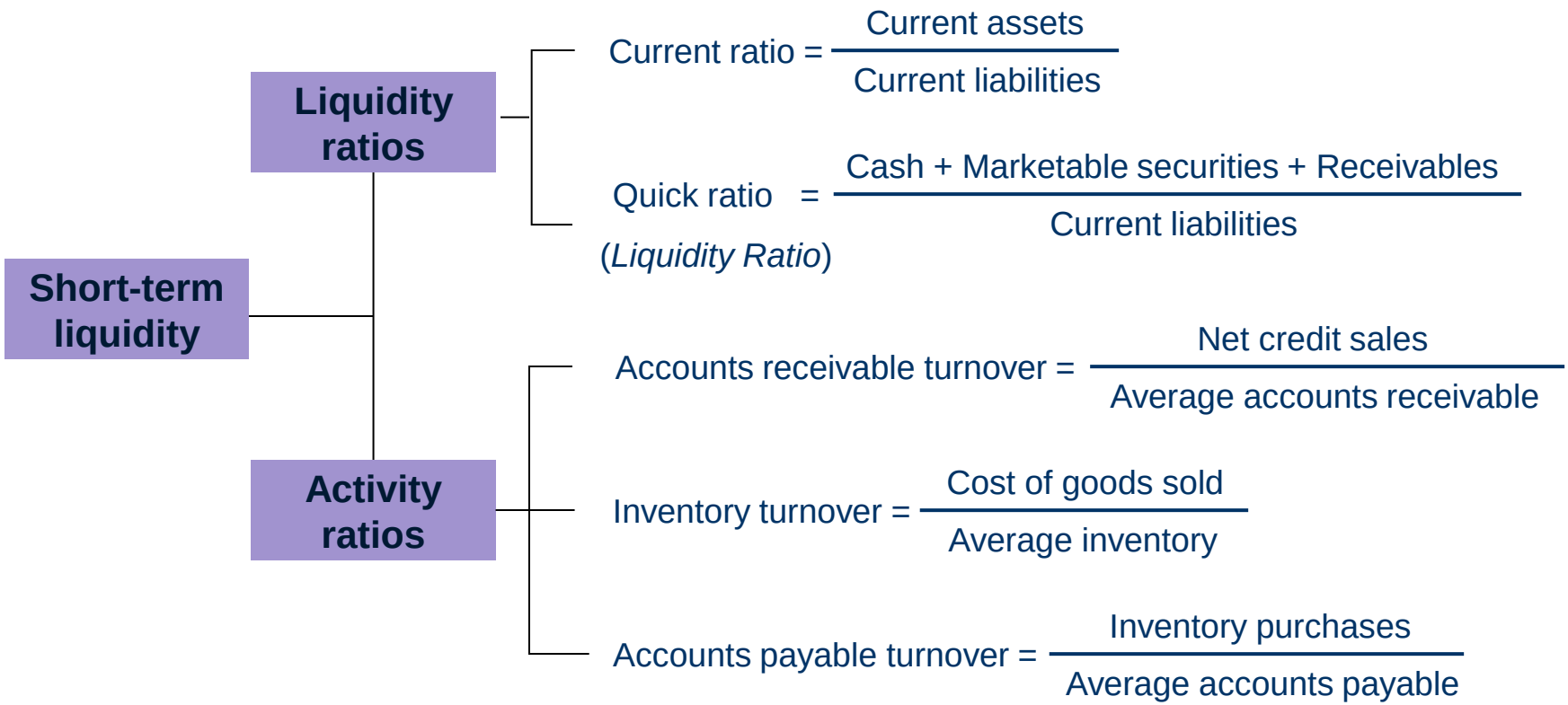
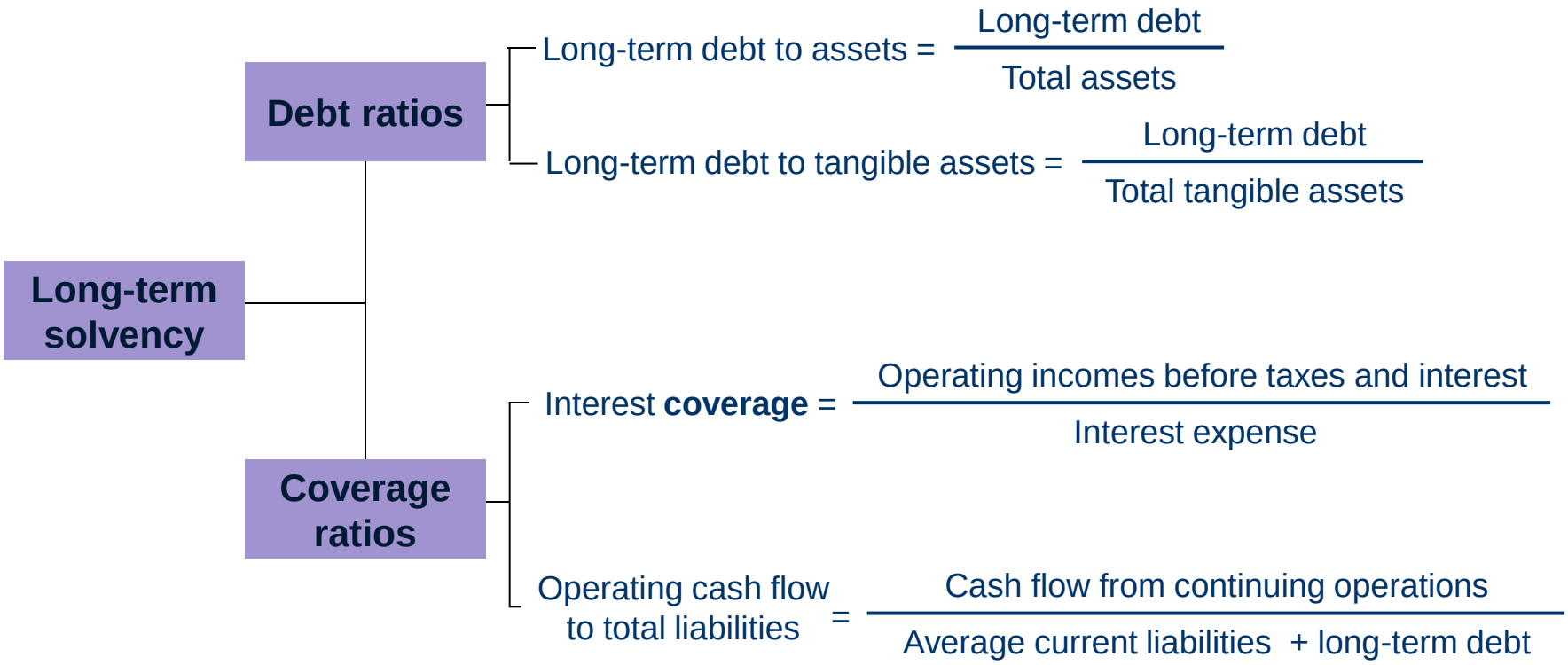
- EDHEC Risk Institute Perspective on Liquidity
- US OCC Perspective on Liquidity, PRMIA Presentation

Traditional liquidity ratios in Accounting



Revsine et al. (2012)

Traditional solvency in Accounting



Revsine et al. (2012)

Fundamentals of Liquidity & Solvency

- **Liquidity** refers to the ability of a company to meet its immediate obligations without any trouble or strain. Capability of covering current liabilities quickly with current assets.
- **Liquidity Risk**: Risk of not being able to meet immediate obligations. Risk of not being able to pay current liabilities with current assets, say if the assets are illiquid.
- **Solvency**: Ability of a business to have enough assets to cover all its liabilities or debts.
- **Solvency Risk**: Risk of payable debts exceeding the assets. Risk of being unable to pay debts even if all assets could be sold.

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Basel Shift to Stress-Testing Models

Quant finance methodologies and internal risk modeling techniques based on normality assumption and historical statistical relationships have **failed** to capture extreme events in periods of systemic stress. Backward-looking assumptions about correlations, volatility and market liquidity embedded in risk models did **not hold** during **extreme stress**.

Historical relationships do **not** necessarily constitute a **good basis for forecasting development of future risks**. As shown by Mandelbrot and Taleb, there is need to distinguish between "**mild randomness**" (based on measures of uncertainty using Normal curve, which disregards possibility of sharp jumps or discontinuities) and "**wild randomness**." They advocate a methodology where **large deviation** and **stressful events dominate the analysis** instead of the other way around."

Hannoun (BIS, 2010)

Basel Principles of Liquidity Risk Management

- **Liquidity** is the ability of a bank to fund increases in assets and meet obligations as they come due, without incurring unacceptable losses.
- Fundamental role of banks in maturity transformation of **short-term deposits** into **long-term loans** makes banks inherently vulnerable to **liquidity risk**, both institution-specific and systemic.
- **Liquidity risk management** helps ensure bank's ability to meet cash flow obligations, which are uncertain as they are affected by external events and other agents' behaviour.
- **Funding liquidity risk**: not able to meet efficiently both expected and unexpected current and future cash flow and collateral.
- **Market liquidity risk**: not easily offset or eliminate a position at the market price because of inadequate market depth or market disruption.

Basel (BIS, 2008)

Basel Framework For Liquidity Risk Measurement

- Two *minimum* standards for funding liquidity
- **Liquidity Coverage Ratio (LCR)**: Promote short-term resilience of bank's liquidity risk profile by ensuring it has sufficient high-quality liquid assets to survive significant stress scenario lasting for a month.

$$\frac{\text{Stock of high-quality liquid assets}}{\text{Total net cash outflows over the next 30 calendar days}} \geq 100\%$$

- **Net Stable Funding Ratio (NSFR)**: Promote resilience over longer time horizon by creating additional incentives for banks to fund activities with more stable funding sources on ongoing basis

$$\frac{\text{Available amount of stable funding}}{\text{Required amount of stable funding}} > 100\%$$

Basel (BIS, 2010)

Disclosure Structure for Financial Market Infrastructure (FMI)

- *An FMI should effectively measure, monitor, and manage its liquidity risk.*
- *An FMI should maintain sufficient liquid resources in all relevant currencies to effect same-day and, where appropriate, intraday and multiday settlement of payment obligations with a high degree of confidence…*
- *…under a wide range of potential stress scenarios that should include, but not be limited to, the default of the participant and its affiliates that would generate the largest aggregate liquidity obligation for the FMI in extreme but plausible market conditions.*

Basel (BIS, 2012)

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Managing Liquidity in Fund Investing

- With hedge funds and funds of funds, two types of liquidity must be considered.
- **Position Liquidity**: How readily can the instruments used in the strategy be converted into cash at a known value.
- More Liquid Assets: Benefits and Costs
  - Lower trading and shorting costs,
  - Ease of fund-level cash management,
  - Smaller price movements for a given volume;
  - Price premium, i.e., a return discount.
- **Fund liquidity**: How quickly can investor exit fund investment, what can fund manager do to delay investor's exit, and, impact on market prices and **remaining** fund liquidity in event others exit?

Graboi (2011)

Good Fund Liquidity Management

- Position-level Transparency: Know assets underlying the fund.
- Know liquidity from trading volume or market depth at given time.
- Qualitative forward-looking scenarios to assess liquidity in stress.
  - How dependent is liquidity on intermediaries?
  - Who is marginal buyer in market?
  - How much leverage typically inherent in strategy?
- Know gates, suspensions or other liquidity-inhibiting measures.
- Ensure fund manager doesn't stray from liquidity profile / strategy.
- Ensure liquidity strategy appropriately transitioned toward redemption.
- Know manager's strengths and opportunity to align expectations.

Graboi (2011)

Liquidity Signals in the CDS Markets

- Manage counterparty credit risk use CDS market activity information.
- CMA market activity indicators supplement price to assess risk.
- Timely/accurate credit/counterparty risks assessment
  - Credit derivatives markets: close to real-time credit assessment
  - Backed by opinions of buyers and sellers risk in reference credit.
- Monitor sudden drops or rises in market interest in a given credit.
- Market activity levels as leading indicator of future price movements.
- Automated alert signals trigger assessment of counterparty or credit.
- Assess liquidity / market interest from frequency of price quotes.
- Combination of CDS price data and market activity
  - Develop more complete risk profile of reference entities.
  - Identify liquidity / market activity as leading indicator of price movement.

Koblas (2010)

Case for Shift from Asset Allocation to Stress VaR

- Liquidity risk is essentially a "hidden" market risk.
- Asset can potentially lose much more than observed from past record
- Extrapolation of past return variance misses 3 sources of hidden risk:
  - Risk factors which have been very quiet for some years.
  - Negative convexity vs. risk factor that becomes highly correlated in crisis.
  - If not ‘marked to market’, can’t anticipate potential loss based on its P&L.
- Hidden risks missed by traditional asset allocation and return-based risk methods making structural asset class risk premium an illusion.
- Steady excess performance does not equal true alpha.
- Correlation changes dramatically in crisis periods.
- High risk is no longer rewarded by higher return
- In Autumn 2008, 64% of fund of funds exhibited hidden risk:
- Losses exceeded twice past maximum drawdown in fund history
- 52% relative value, 42% event driven, 26% equity HFs, 9% macro.

Douady & Le Marois (2009)

HFT's "artificial liquidity" and "disappearing liquidity"

- Simplistic assumptions like HFT are "liquidity providers" or "dampen volatility" or "decrease bid-ask spreads" less credible.
- CAPM world of price discovery ignores liquidity, breadth/depth.
- HFT technique of market making, use of flickering quotes across multiple venues, and more passive aggressive forms of noise trading, led to "artificial liquidity" and "disappearing liquidity."
- HFT algos amplify cross stock correlation in face of rising volatility.
- HFT is positively correlated with stock price volatility.
- High volume stock trading significantly accentuates volatility.
- *Contemporary view*: Liquidity and Volume are **not** same
- "High trading volume is not necessarily a reliable indicator of market liquidity." (CFTC and SEC on Flash Crash of 6 May 2010)

Powell (2011)

Evolving Definition of Liquidity

- Disappearing liquidity: Marked imbalance between Executable Liquidity and Net Executed Volume.
- **Liquidity** could be defined as the ability to “trade in large size quickly, at low cost and when market participants want”: International Organisation of Securities Commissions.
- HFT does not facilitate the ability to trade in large size quickly:
- Higher trading costs: small quote size and disappearing liquidity.
- Attribution of recent volatility in financial markets –
- “HFT is indirectly to blame by removing vast swathes of liquidity from the market.”

Powell (2011)

Risk, Volatility, and Liquidity: Model Risks

- 2007-2008 crisis: Traditional ideas about correlation in a portfolio failed. Risk assessment difficult as volatility underlying entire portfolio exploded, correlation of diverse trades merged towards 1.
- Biggest concerns: confusion between **liquidity** vs. **volatility (risk)**.
- 2007-08 crisis was a **liquidity crisis** as access to credit collapsed when banks had to recognize losses due to bad loans.
- Search for better VaR model inevitably leads to measures of volatility both implied and actual and the spread between them.
- **Risk** is **not** the same as **volatility**. Treating two as same: inaccurate.
- Risk measure must factor in loss probability and potential magnitude.
- Expectation of loss – over a long period – meets this requirement.
- Quantitative models work best when used with macro risk indicators.

Savage (2010)

New macro risk indicators based on liquidity

- VIX and S&P 500 move in opposite direction on 76% trading days
- Issues surrounding the VIX as a proxy for global risk remain:
- Returns are not normally distributed in most portfolios.
- Returns across time may prove more chaotic than trending.
- Risk-free rates don't exist – as interest rates move towards zero other factors become larger impediments – such as inflation expectations, future volatility and credit concerns.
- Number of **indicators other than volatility used to model risk**:
- Credit Spreads: Credit and liquidity have a strong correlation.
- Bid-Ask Spread: Divided by portfolio volatility ~ Liquidation Risk.
- Trade Volumes: Market movements in high volumes matter more.
- Curves: How illiquid assets shift in value across duration.

Savage (2010)

Liquidity Concerns for Fund of Hedge Funds

- **Major lessons of current crisis**: Unsustainability of any substantial mismatch between the **liquidity terms** of funds of hedge funds (FoHFs) and those of underlying hedge funds.
- To improve portfolio liquidity, need to examine: Does investing in liquid hedge funds imply lower excess returns (e.g. lower alpha for investor)? Is liquidity concentrated in young and small hedge funds?
- Tradeoff between hedge funds' liquidity, maturity, size, performance?
- Any illiquidity premium observed in the data?
- Do liquid managers deliver inferior alphas than illiquid managers?
- Does illiquidity have to be related to the hedge fund life cycle?
- Is illiquidity the privilege of well established funds with large assets?

Guidotti (2009)

Liquidity Concerns for Fund of Hedge Funds

- Fund Characteristics Related to Liquidity and Alpha:
  - Redemption notice period
  - Redemption frequency
  - Lockup period
  - Age of the fund
  - Size of the fund, AuM
- 3 variables related to liquidity – redemption notice, redemption frequency and lockup period – positively/significantly correlated.
- Whether alpha, liquidity terms, age and size related?
  - Young funds tend to generate more alpha regardless of strategy.
  - Redemption notice period, lockup period: positive effect on alphas.
  - Market power of successful managers; Illiquidity premium exists.
- Investors pay the price of reduced alpha for higher liquidity.

Guidotti (2009)

FoHFs shift toward investor-level gates

- Use of ‘gates' to revise liquidity terms, improve liquidity profiles:
- Positive credit development that improves overall HF-ALM.
- Gate provisions limit withdrawals by specific redemption date.
- To prevent a run that could cause the fund to self-destruct as substantial withdrawals force a fire sale of assets.
- Promote orderly unwinding of positions and alleviate pressure of en masse investor redemptions during liquidity or stress events.
- Help reduce legal risks faced in balancing competing interests of redeeming investors and those remaining invested in a fund.
- Investor-level gates independently limit redemptions for each of a fund's underlying investors. Fund-level gates incentivize investors to submit "defensive redemptions" to get in line for liquidity.

HFJ Editors (2010)

Citi report focuses attention on liquidity crisis

- From Fund of Funds' perspective
  - Mismatch between terms they offered investors on their portfolios and liquidity they were able to realize on a fund's hedge fund investments during the crisis.
- How, in response, portfolio construction has evolved
  - Fund of Funds now aligning investment strategies across a "liquidity spectrum" and grouping strategies with similar liquidity profiles.
- Addition of liquidity as 3rd dimension besides style and leverage
  - Moving HF industry toward a set of "segments"
  - Strategies with similar styles, leverage and liquidity
  - Blurring distinctions: Long-only, Alternatives and Private Equity.

"The Liquidity Crisis & Its Impact on the Hedge Fund Industry" Citi, July 2010

Recent Liquidity Management Tools: StatPro

- **StatPro discovers solution to the liquidity risk paradox**
  - **Liquidity risk** refers to the risk of losing money when you suddenly liquidate one or more positions in your portfolio.
  - Loss comes from [**liquidation**] selling the positions at a lower price than the one at which those positions are marked-to-market.
- "In calibrating a **liquidity risk model** you need access to the bid, ask and volume information. Well, the problem is that this information is only available for liquid issues. Whatever model you invent, you will always lack the basic information to calibrate it for the instruments that present most of your liquidity risk. We call this the '**liquidity risk paradox**."
- **Innovative approach** to measuring market liquidity risk that **does not** rely only on observed bid, ask and volumes.
- Instead, factors such as market capitalization, the percentage of ownership of a stock and the size of an issue for a fixed income instrument are taken into account.

Cintioli (2010)

Recent Liquidity Management Tools: StatPro

- Facilitates selection of the appropriate liquidity risk scenario
- Computation of the expected loss for liquidity risk.
- View includes breakdown of liquidity risk loss across components.
- User can select one scenario and build a ‘tree’ of criteria
  - Break down the liquidity risk contribution at each hierarchy level
  - Down to composition of each single asset.
- Risk manager can drill down through every liquidity risk component
  - Discover how much is coming and from where…
  - …Without any previous knowledge of the portfolio.
- Enables risk manager to ‘X-ray’ liquidity risk of the portfolio
  - Spotting any challenging situations.

Cintioli (2010)

Recent Liquidity Management Tools

- **BNP Paribas**: integrated liquidity management solution for FoHFs.
  - Helps mitigate the complexities of liquidity forecasting.
  - Scalable committed financing and FX solution.
  - Integrates dedicated structuring, HF research, loan administration.
  - Transparency on credit scoring/monitoring of underlying HF holdings.
  - Trade order management, liquidity forecasting, accounting, investor and regulatory reports.
- **Fitch Solutions to offer liquidity scores for CDS**
- **BNY Mellon launches liquidity management tool**
- **Turquoise Liquidity Aggregation to launch in July**
- **SEI partners with Comada on liquidity management tool**

HFJ Editors (2009, 2010, 2011)

How market values are established

- FASB Accounting Standards Codification 820 (formerly FAS 157)
- Funds must base valuations on market value
- Must categorize each asset other than U.S. Treasury bonds
  - By three levels of valuation reliability.
- **Level 1**: Closing bid prices on listed, other actively-traded securities.
- **Level 2**: Liquid non-listed securities (e.g. bonds), less-active markets,
  - Prices based on assets similar to, but not same as, those actively traded.
  - If no less-active market, observable market data that sufficiently applies.
- **Level 3**: Assets difficult to price as no observable prices.
  - Value based on unobservable inputs based on little or no market activity.
  - E.g. comparable transaction multiples, comparable trading multiples, and DCF based on International Valuation Standards (IVS).

"Best Practices In Alternative Investing: Managing Complexity" Greenwich Roundtable, 2011

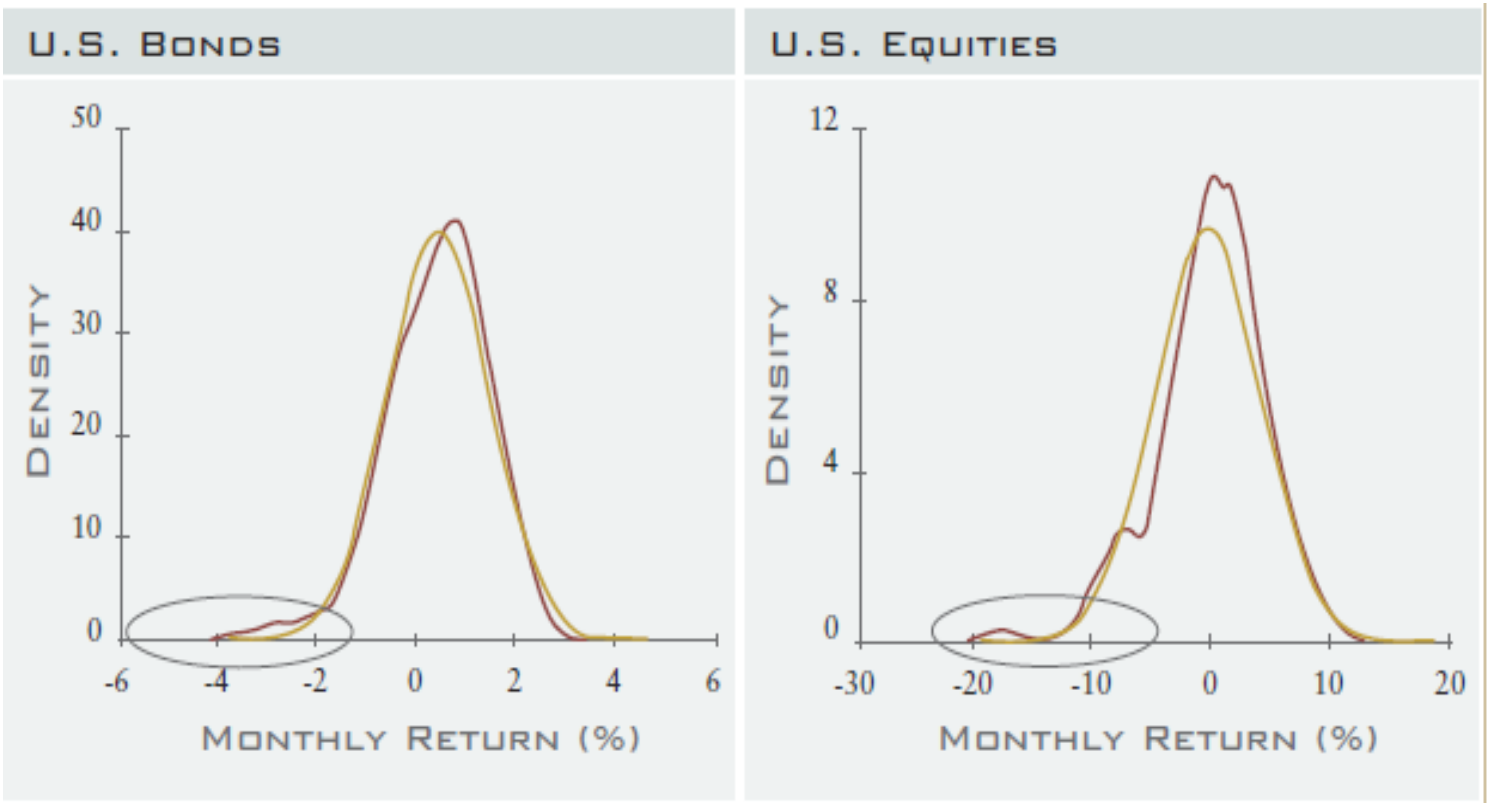
How market values are established

GAAP (generally accepted accounting principles) defines fair value as “price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date.” (What if there is no orderly market on that date?)

- **Private companies**: Earnings approach factoring financial condition and operating results, usually operating profits, cash flow, or profits before tax, and apply a relevant multiple, reduce this amount by the net debt.
  - Other: (a) forward-looking DCF,; (b) Net asset methodologies, derived from underlying value of tangible assets; (c) industry-specific benchmarks.
- **Private equity**: Returns are measured in IRR.
  - Annual volatility doesn’t mean much, given illiquidity, nature of valuations, and varying amount of assets over time in PE fund.
- **Hedge funds**: In addition to points covered on prior slides,
  - Manager’s valuation, NPV, valuations frequency, external inputs.

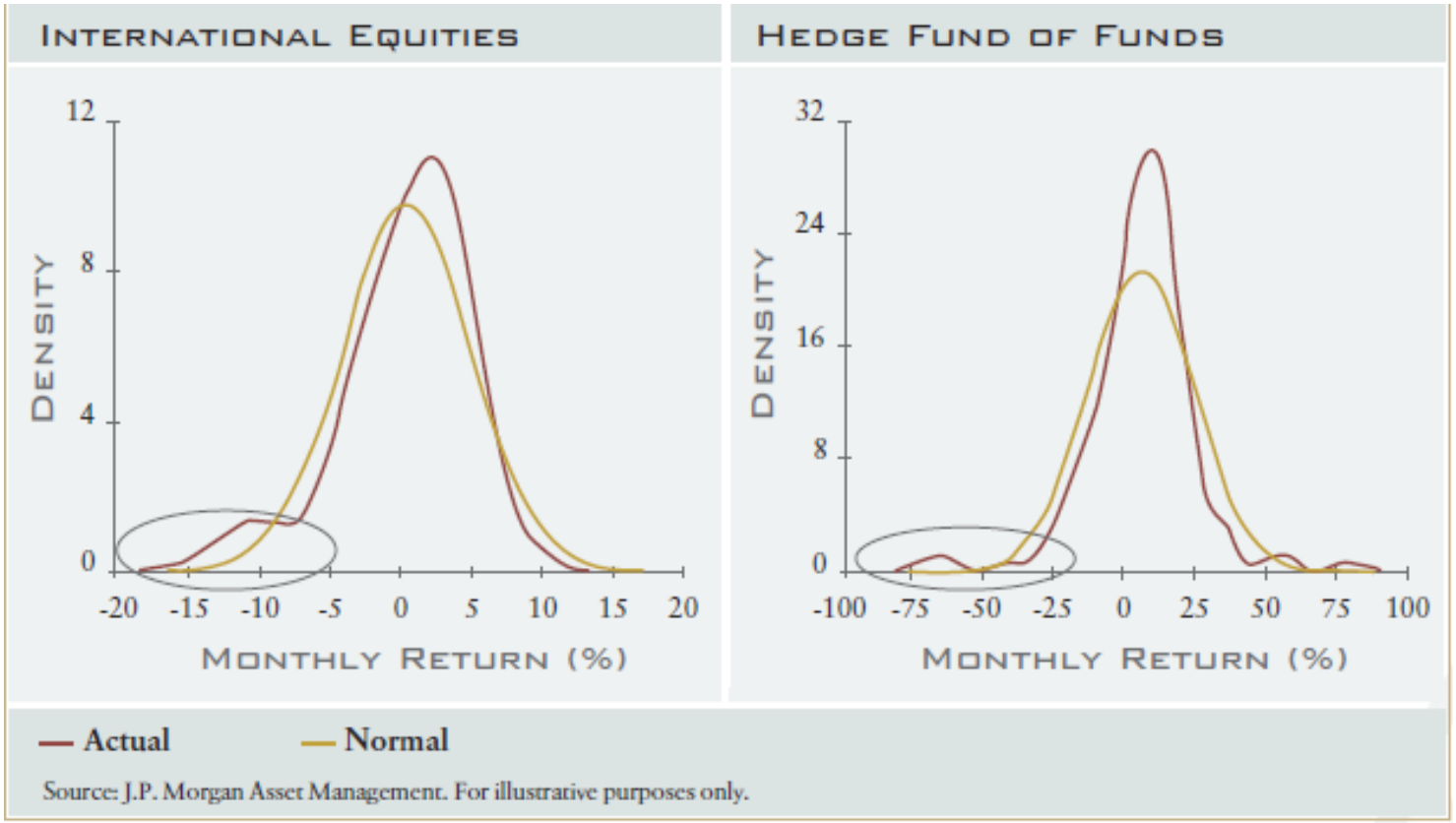
"Best Practices In Alternative Investing: Managing Complexity” Greenwich Roundtable, 2011

Actual Returns vs. Normal Curve



"Best Practices In Alternative Investing: Managing Complexity" Greenwich Roundtable, 2011

Actual Returns vs. Normal Curve



"Best Practices In Alternative Investing: Managing Complexity" Greenwich Roundtable, 2011

Correlations of Calendar Year Returns

	Stocks	Real Estate	Bonds	Commodities
1996–2000				
S&P 500 Index	1.00			
NAREIT Equity REIT Index	-.35	1.00		
Barclays Aggregate Bond Index	-.30	.20	1.00	
Dow Jones-UBS Commodity Index	-.74	.63	-.22	1.00
2001–2005				
S&P 500 Index	1.00			
NAREIT Equity REIT Index	.91	1.00		
Barclays Aggregate Bond Index	-.81	-.58	1.00	
Dow Jones-UBS Commodity Index	.12	-.04	-.56	1.00
2006–2010				
S&P 500 Index	1.00			
NAREIT Equity REIT Index	.89	1.00		
Barclays Aggregate Bond Index	.18	-.18	1.00	
Dow Jones-UBS Commodity Index	.63	.23	.52	1.00

*The correlations are based on five calendar-year returns in order to offset any compounding or mean-reversion of monthly returns. The result is that the correlations are based on only five data points, so they should be viewed as only rough approximations.

"Best Practices In Alternative Investing: Managing Complexity" Greenwich Roundtable, 2011

Managing Liquidity of Alternative Investments

- Inclusion of hedge funds, PE, and less liquid segments of the bond market adds complexity to the liquidity of a portfolio.
- Liquidity of a security driven by numerous factors: trading volume, numbers of buyers/sellers, pricing availability, amount of information about that security, investor confidence, the integrity of counterparties, and investor psychology.
- Cash Requirements: Estimating amounts/timing of cash requirements or obligations, being prepared to meet unexpected calls for cash and cash for requirements within the portfolio.
- Sources of Cash: Contributions, CFs from private investments.
- Ensure to make all payments on time without fail
- % in each liquidity category: Overnight to > 15 months.

"Best Practices In Alternative Investing: Managing Complexity" Greenwich Roundtable, 2011

Managing Liquidity of Alternative Investments

- Scenario planning: normal, crisis, or black swan markets.
  - If not prepared for black swan markets, forced liquidation at artificially depressed prices.
  - Unless expect less liquid alternative to offer materially higher risk-adjusted return, opt for more liquid (and less complex) solution.
- Assessing Portfolio Liquidity of Hedge Funds:
  - Liquidity of the Fund's Strategy and Underlying Assets.
  - State of the Market and Potential Changes.
  - Leverage.
  - Financing Terms With Lenders.
- **Liquidity is dynamic**. It changes as markets change. Calls for ongoing due diligence and manager monitoring, including stress tests and use of projections with ample wiggle room.

"Best Practices In Alternative Investing: Managing Complexity" Greenwich Roundtable, 2011

Liquidity and Liquidity Risk: Definitions, Frameworks, Measures

- Liquidity: Finance ‘No Agreement’ vs. Accounting ‘Perfect Agreement’
- BASEL III Latest Updates on Liquidity and Liquidity Risk
- Liquidity: More Fundamental Definitions & Frameworks
- Liquidity Risk: More Fundamental Definitions & Frameworks
- Fund of Funds: Practitioner Definitions and Frameworks
- Multi-Asset Funds: Liquidity Definitions and Frameworks
- **EDHEC Risk Institute Perspective on Liquidity**
- **US OCC Perspective on Liquidity, PRMIA Presentation**

Liquidity: A View from EDHEC Risk Institute

- **Asset's Market Liquidity**: Ease with which it is traded.
- **Traders' Funding Liquidity**: Ease with which they obtain funding.
- **Liquidity Risk**:
  - **Market Liquidity Risk**: The risk that the market liquidity worsens when one needs to unwind a position.
  - **Funding Liquidity Risk**: The risk that a trader cannot fund his position and is forced to unwind.
- **Market Liquidity**: Low when it is difficult to raise money by selling an asset: when selling depresses the sale price.
- **Funding liquidity**: High when it is easy to borrow money to purchase assets. Margin lending is short term since margins can be adapted to market conditions on a daily basis.

Liquidity: A View from EDHEC Risk Institute

- **Market liquidity**: 3 forms:
  - **Bid-ask spread**: how much a trader can lose by selling an asset and buying it back right away.
  - **Market depth**: how many units traders can sell or buy at the current bid or ask price without moving the price
  - **Market resiliency**: how long it takes for prices that have fallen to bounce back.
- **Funding liquidity**: 3 forms:
  - **Margin funding risk**: risk that margins will change.
  - **Rollover risk**: risk that it will be more costly or impossible to roll over short-term borrowing.
  - **Redemption risk**: risk that demand depositors of banks or say equity holders of hedge funds withdraw funds.

Liquidity: A View from US OCC

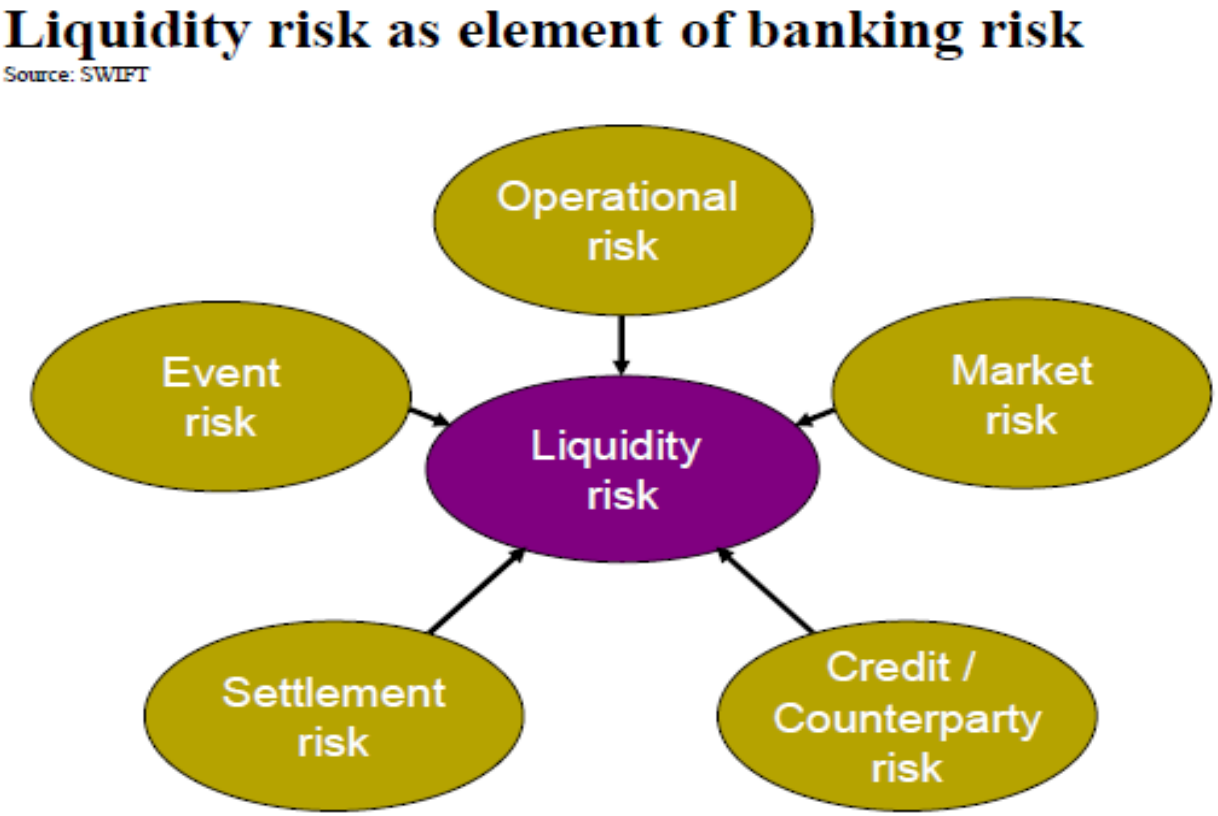
"Liquidity" or the related risk is not well-defined, but we try:

- *Liquidity* represents the capacity to fulfill all payment obligations as and when they come due, to the full extent and in the proper currency, on a purely cash basis
- *Liquidity risk* is the danger & accompanying potential undesirable effects of not being able to accomplish the above
- While liquidity events occur more frequently and with less severity than extreme stress events, they are sufficiently dangerous to disrupt business and alter the strategic direction of a bank.
- Liquidity must be available *all the time* (not just on average) – failure to perform, while a low probability event, implies potentially severe or even fatal consequences to the bank.

Liquidity: A View from US OCC

(Aadapted from Bartetzky, 2008, page 9)

Liquidity: A View from US OCC



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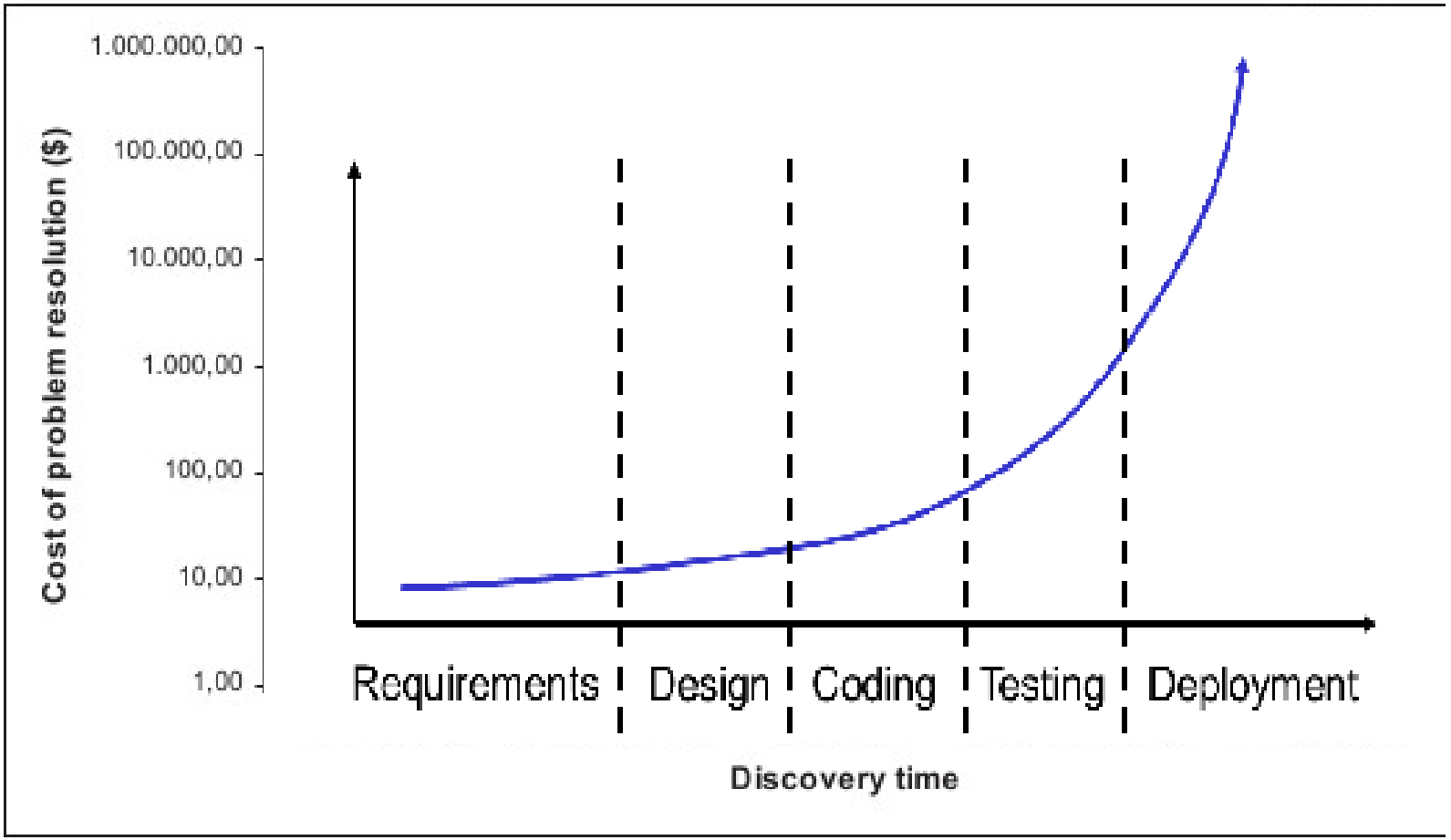
GOALS RECAP

- **Create a framework**
  - Liquidity Assessment
  - Portfolio Construction / Portfolio Optimization
  - Defined portfolio of asset classes & vehicles
- **LIQUIDITY will affect**
  - Time Horizon
  - Volatility (via Autocorrelation)
  - Returns
  - Stress Tests (via Price Discovery in Forced Liquidations)
- **In contrast to typical portfolio optimization**
  - Diverse risk and return measures
  - Liquidity as external constraint: “Simplistic”

Cost of 'problem' resolution increases exponentially with time to discovery



Hrgarek & Bowers (2009)

WEEK 3
Endogenous Liquidity and Liquidity Risk: Toward Unifying Models and Frameworks

- **Endogenous Liquidity as per Basel Committee**
- Improving Upon Already Proposed Measures
- Which Models Work Best?
- Framework for Liquidity Risk Across Asset Classes
- How to Account for Liquidity in Portfolio Choice
- Integrating Endogenous Liquidity in VaR
- References

Endogenous Liquidity as per Basel Committee

- Exogenous liquidity: Market-specific, average transaction costs
  - Can be captured by a “liquidity-adjusted VaR” approach
- Endogenous liquidity: Price impact of liquidation of specific positions.
  - Depends on trade size i.e. volume of block being traded
  - Relevant for orders large enough to move market prices
  - Represents elasticity of prices to volumes
  - Observed in situations of extreme liquidity risk
  - Characterized by collective liquidation of positions or,
  - All market participants reacting in the same way.
- Portfolios: Significant endogenous liquidity costs
  - Under all market conditions
  - Depends on trade size or other market participants’ positions.

Basel Committee (2011)

Endogenous Liquidity as per Basel Committee

- Practical Implication: Time to liquidate a position varies
  - Transaction costs
  - Size of position in market
  - Trade execution strategy
  - Market conditions
- Move beyond VaR risk measure, not subadditive: concentration risk
- Most prominent alternative is Expected Shortfall, is subadditive
- Financial Institutions coming to fully rely upon ES metrics.
  - Spectral Risk Measures are a promising generalization of ES.
- Integration of Stress Testing in Risk Modeling Frameworks
- Actively manage **IntraDay** Liquidity Positions and Risks.

Basel Committee (2008, 2011)

WEEK 3
Endogenous Liquidity and Liquidity Risk: Toward Unifying Models and Frameworks

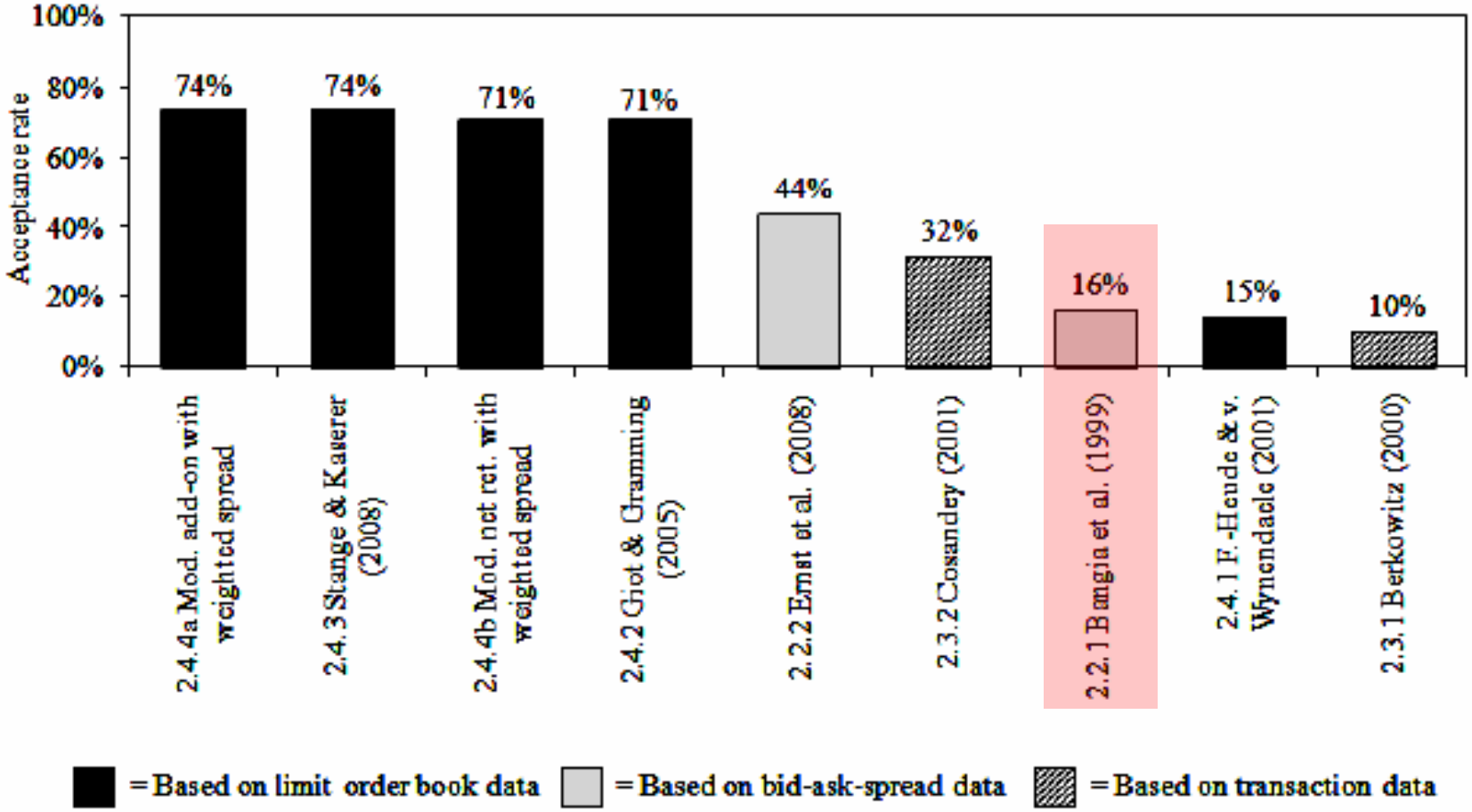
- Endogenous Liquidity as per Basel Committee
- **Improving Upon Already Proposed Measures**
- Which Models Work Best?
- Framework for Liquidity Risk Across Asset Classes
- How to Account for Liquidity in Portfolio Choice
- Integrating Endogenous Liquidity in VaR
- References

Improving Upon Already Proposed Measures
Bangia et al. (2001), BDSS Model

- Proposed Liquidity Metrics / Measures and their Known Limitations
  - Liquidity Incorporated VaR: Based on bid-ask spread data
  - Ranked **lowest** in back testing results: 16% on a 100% scale.
  - Characteristics of Bangia, et al. (2001) BDSS Model:
    - Simple and easy to implement as data available for many markets
    - LAVaR = Conventional VaR (mid-price) + Liquidity cost (bid-ask spread)
    - Acknowledges spreads can rise over time, especially in crises
    - Neglects: liquidity costs rise with order size beyond bid-ask-spread
    - Ignores endogenous liquidity risk: as focus on exogenous liquidity risk
    - Based on Normal distribution: not applicable to real markets
    - Assumes perfect liquidity-return correlation: not observed in real markets
    - Assumes perfect correlation between liquidity risk and VaR
      - Results in overestimation of LAVaR

Alexander & Sheedy (2008), Ernst et al. (2009), Qi & Ng (2009) , Stange & Kaserer (2009, 2010)

Improving Upon Already Proposed Measures
Bangia et al. Ranked Lowest In Back Testing Results



Ernst et al. (2009)

Improving Upon Already Proposed Measures
Bangia et al. (2001), BDSS Model

- Proposed Liquidity Metrics / Measures and their Known Limitations

$$Liqu._{Adj.}VaR_t = Mid_t \cdot \left[\left(1 - e^{[E(r) - \alpha\sigma]}\right) + \frac{1}{2} \cdot \left(\overline{S} + \alpha' \widetilde{\sigma}\right) \right]$$

with Mid_t : the 'Mid' price in t

r : the log return

$\overline{S}$: the average relative spread

α : the q percentile of the 'mid' log return distribution

α' : the q percentile of the relative spread distribution

σ : the standard deviation of the 'mid' log return distribution

$\widetilde{\sigma}$: the standard deviation of the relative spread distribution

Bangia et al. (2001), Francois-Heude & Van Wynendaele (2001)

Improving Upon Already Proposed Measures
Bangia et al. (2001), BDSS Model

- Proposed Liquidity Metrics / Measures and their Known Limitations
- Intuitive, simple way to quantify/integrate liquidity risk into VaR,
- Major Limitations:
- As distribution far from normal: can't precisely estimate alpha.
- Aggregation of two risk sources implies perfect correlation
  - Between extreme variations of prices and spreads
  - Hence, it overestimates risk
- Focus only on exogenous liquidity risk
  - Endogenous liquidity ignored
- Totally ignores dynamic aspect of liquidity inside trading session

- **Summary**: Incomplete and partial view of quantifying liquidity risks.

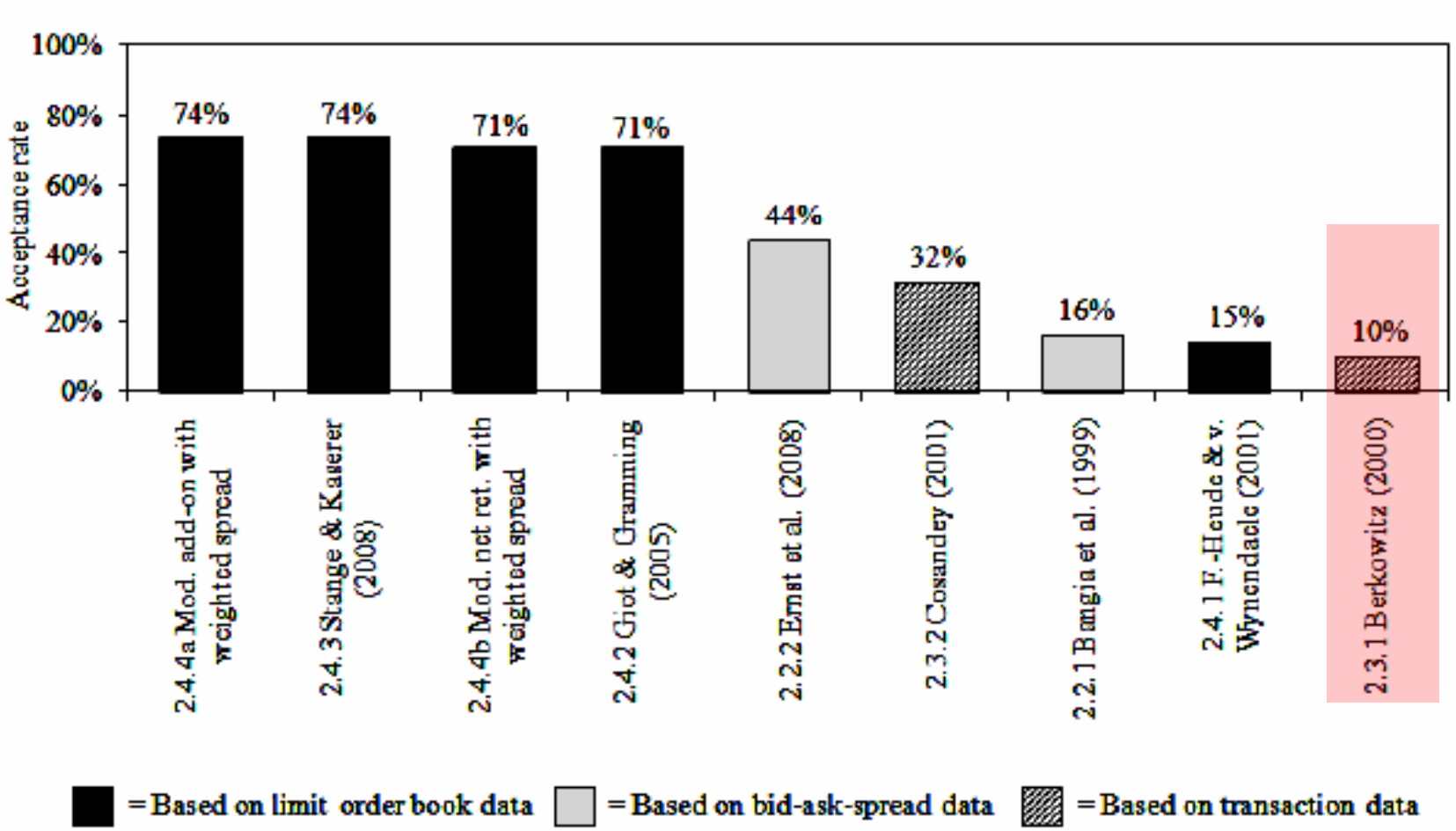
Francois-Heude & Van Wynendaele (2001)

Improving Upon Already Proposed Measures
Berkowitz (2000) Model

- Proposed Liquidity Metrics / Measures and their Known Limitations
  - Liquidity Incorporated VaR: Based on transactions or volume
  - Ranked **lowest** in back testing results: 10% on a 100% scale.
  - Characteristics of Berkowitz (2000) Model:
    - Focus on price impact of liquidating a position
    - Assumes company's own actions have negligible effect on market risk
    - LVaR by forecasting distribution of portfolio value
      - Assuming separate distribution of factor prices and distribution of trades.
    - Suggests use of normal or t-distribution
    - Conceptual weakness in assumption of linear demand curve
    - Liquidity coefficient is non-time-varying => Underestimates Risk in Crisis Time
    - Assumes zero correlation between market return and liquidity =>
      - Underestimation of risk
    - Requires hardly accessible transaction data for implementation

Ernst (2010), Ernst et al. (2009), Stange & Kaserer (2009, 2010)

Improving Upon Already Proposed Measures
Berkowitz (2000) Ranked Lowest In Back Testing Results



Ernst et al. (2009)

Improving Upon Already Proposed Measures
Berkowitz (2000) Model

- Proposed Liquidity Metrics / Measures and their Known Limitations

$$P_{mid,t+1} - P_{mid,t} = C + \theta N_t + x_{t+1} + \epsilon_t$$

effect of risk factor changes on the mid-price

$$\beta = Cov(r, r_M)/\sigma_{r_{market}}$$

$$x_{t+1} = \beta \times r_{M,t} \times P_{mid,t}$$

N_t number of shares
θ is the regression coefficient
absolute liquidity cost per share traded

liquidity-adjusted net return

$$rnet_t(q) = ln\left(1 + \left[\beta \times r_{M,t} - \hat{\theta} \times \frac{N_t + n}{P_{mid,t}}\right]\right)$$

daily risk forecasts
value-weighted market portfolio return r_M
estimates of the liquidity measure $\hat{\theta}$

liquidity-adjusted total risk

$$L - VaR(q) = 1 - exp\left(\mu_{rnet(q)} + \hat{z}\sigma_{rnet(q)}\right)$$

Ernst et al. (2009)

WEEK 3
Endogenous Liquidity and Liquidity Risk: Toward Unifying Models and Frameworks

- Endogenous Liquidity as per Basel Committee
- Improving Upon Already Proposed Measures
- **Which Models Work Best?**
- Framework for Liquidity Risk Across Asset Classes
- How to Account for Liquidity in Portfolio Choice
- Integrating Endogenous Liquidity in VaR
- References

Which Models Work Best?
Measuring market liquidity

- Models based on **bid-ask-spread data**
  - Add-on model with bid-ask-spread: Bangia et al. (1999)
  - Modified add-on model with bid-ask-spread: Ernst et al. (2008)
- Models based on **transactions or volume**
  - Transaction regression model: Berkowitz (2000)
  - Volume-based price impact: Cosandey (2001)
- Models based on **weighted spread data**
  - Limit order model: Francois-Heude and van Wynendaele (2001)
  - **T-dist. net return model w. weighted spread**: Giot & Gramming (2005)
  - **Empirical net-return model w. weighted spread**: Stange-Kaserer (2008)
- **Modified risk models with weighted spread**
  - **Modified add-on model with weighted spread**
  - **Modified net-return model with weighted spread**

Ernst et al. (2009)

Which Models Work Best?
Models based on weighted spread data

- Account for the fact: Liquidity Cost increases with order size
- Use Liquidity Cost measure 'weighted spread‘
  - calculates liquidity costs compared with fair price
  - when liquidating a position quantity q
  - against the limit order book.

$$WS_t(q) := \frac{a_t(v) - b_t(v)}{P_{mid,t}}$$

$a_t(v)$ is the volume-weighted ask price of trading v shares calculated as $a_t(v) = \sum_i a_{i,t} v_{i,t}/v$ with $a_{i,t}$ being the ask-price and $v_{i,t}$ the ask-volume of individual limit orders. An order of size q is executed against several limit orders until individual limit order sizes add-up to q, i.e. $q/P_{mid} = v = \sum_i v_i$. $b_t(v)$ is defined analogously. Weighted spread - similar to the bid-ask-spread - is the cost of a round-trip for position q.[12] In the following, weighted spread is used in liquidity risk models suggested in the literature.

Ernst et al. (2009)

Which Models Work Best?
Models based on weighted spread data

- Limit order model: Francois-Heude and van Wynendaele (2001)

$$L - VaR(q) = 1 - exp(-z\sigma_r)\left(1 - \frac{\mu(q)_{WS}}{2}\right) + \frac{1}{2}\left(WS_t(q) - \mu(q)_{WS}\right)$$

where z is the normal percentile and σ_r the standard deviation of the mid-price return distribution. $\mu(q)_{WS}$ is the average spread for a security for order quantity q, and $WS_t(q)$ is the spread at time t. In the second term, the average weighted spread is subtracted from worst mid-prices. However, as average spread might be different from the actual spread in time t, a correction term for the difference is added as a third term. The correction term is calculated on current not on worst mid-prices which can lead to misestimation.

Ernst et al. (2009)

Which Models Work Best?
Models based on weighted spread data

- T-distributed net return model: Giot and Gramming (2005)

Giot and Grammig (2005) define a net return based on the weighted spread as

$$rnet_t(q) = r_t \times \left(1 - \frac{WS_t(q)}{2}\right)$$

and then compute relative, liquidity-adjusted total risk as

$$L - VaR(q) = 1 - exp\left(\mu_{rnet(q)} + z_{ST}\sigma_{rnet(q)}\right)$$

z_{ST} is the chosen percentile of the student t-distribution.

Ernst et al. (2009)

Which Models Work Best?
Models based on weighted spread data

- Empirical net-return model: Stange and Kaserer (2008)

$$L - VaR(q) = 1 - exp\left(\mu_{rnet(q)} + \hat{z}(q) \times \sigma_{rnet(q)}\right)$$

where $\hat{z}$ denotes the empirical percentile of the net return distribution. This circumvents the assumption of t-distributed net returns.

Ernst et al. (2009)

Which Models Work Best?
Modified risk models with weighted spread

- Modified add-on model with weighted spread
- Analogous application to Ernst et al. (2011)
- Use Cornish-Fisher approximated percentiles of the return and spread distribution separately and calculate risk as

$$L - VaR(q) = 1 - exp(\mu_r + \tilde{z}_r \sigma_r) \times \left(1 - \frac{1}{2}\left(\mu_{WS(q)} + \tilde{z}_{WS(q)} \sigma_{WS(q)}\right)\right)$$

where $\tilde{z}$ denote the percentiles estimated with the Cornish-Fisher approximation (5) of the respective distribution. While assuming perfect correlation between mid-price returns and liquidity, this parametrization allows to account for liquidity risk as add-on. Also, forecasting of two parameters separately might prove to be more precise.

Ernst et al. (2009)

Which Models Work Best?
Modified risk models with weighted spread

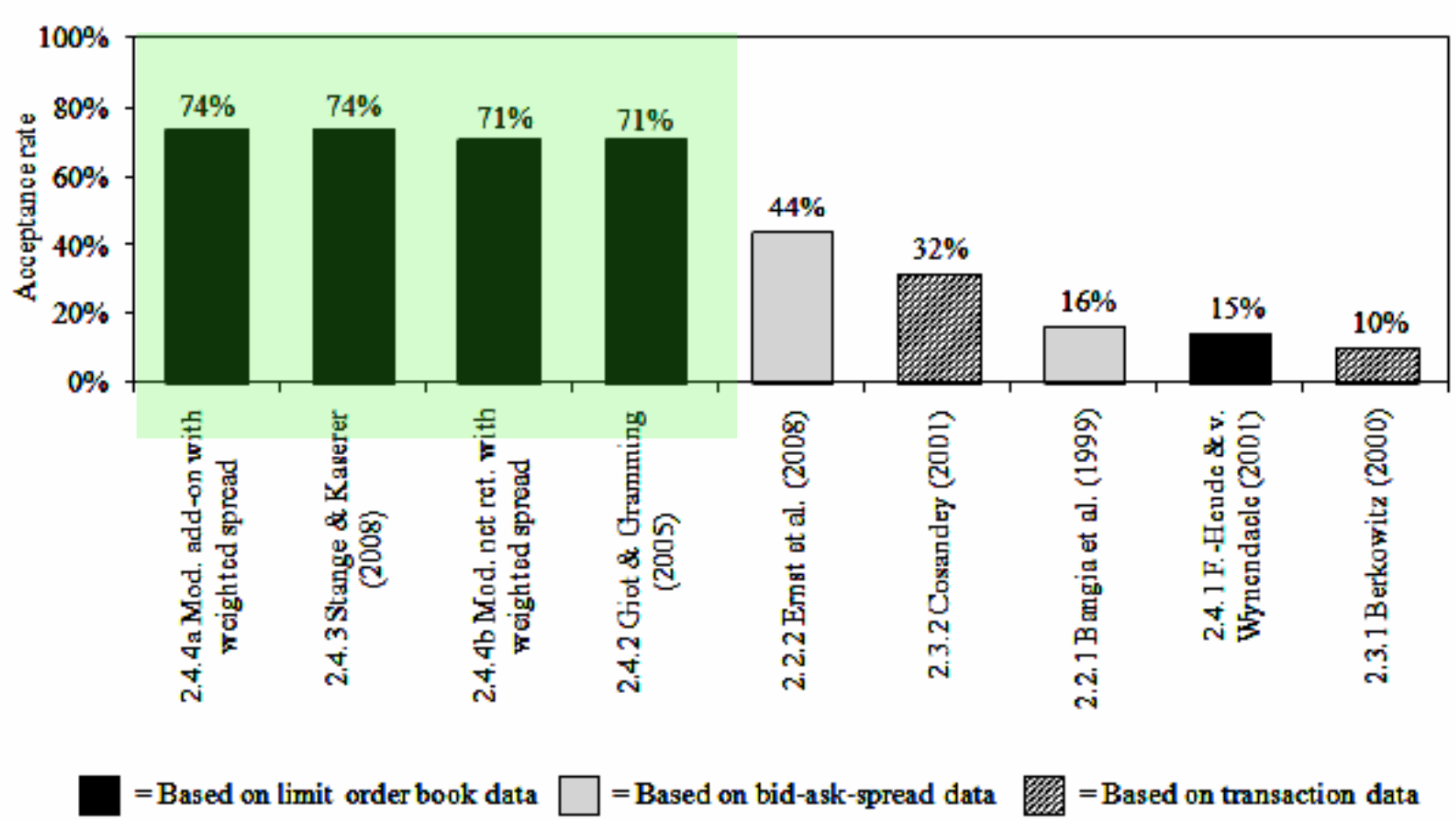
- Modified net-return model with weighted spread
- Analogous application to Ernst et al. (2011)
- Use Cornish-Fisher approximated percentiles of the return and spread distribution separately and calculate risk as

$$L - VaR(q) = 1 - exp\left(\mu_{rnet(q)} + \tilde{z}(q) \times \sigma_{rnet(q)}\right)$$

where $\tilde{z}$ is the percentile estimated with the Cornish-Fisher approximation (5). This alternative parametrization does not rely on the assumption of t-distributed net returns or perfect return-liquidity correlation.

Ernst et al. (2009)

Which Models Work Best?
Models Ranked Highest In Back Testing Results



Ernst et al. (2009)

WEEK 3
Endogenous Liquidity and Liquidity Risk: Toward Unifying Models and Frameworks

- Endogenous Liquidity as per Basel Committee
- Improving Upon Already Proposed Measures
- Which Models Work Best?
- **Framework for Liquidity Risk Across Asset Classes**
- How to Account for Liquidity in Portfolio Choice
- Integrating Endogenous Liquidity in VaR
- References

Framework for Liquidity Risk Across Asset Classes

- Liquidity risk arises from investing in an asset that
  - cannot be sold in a timely manner, or,
  - can only be sold at a large discount.
- Driven by uncertainty regarding investor's holding period
- Liquidity risk is the mismatch between
  - holding period for an asset compared to
  - time interval over which liquidity is needed
    - i.e., investment horizon of the investor
- Well-functioning market – above two time periods matched
- Dysfunctional market – above two time periods mis-calibrated
- T-ED spread is a measure of liquidity
  - Spread of 3-month LIBOR for ED over US T-bill yield.

Anson (2010)

Framework for Liquidity Risk Across Asset Classes

- Scale to measure relative liquidity of different asset classes
- Measure liquidity (& illiquidity) by serial correlation of asset prices
- Measurement of correlation of prices for same asset across time
- Correlation between R(i) at time t = 0 and at t+1.
- Greater influence of stale pricing, less liquid asset class
- Measure stale pricing via serial correlation: proxy for liquidity risk
- Serial correlation is relative (not absolute) scale of liquidity risk
- Can determine which asset class is *relatively* more or less liquid
- But, can't determine precise amount of the liquidity premium
- Lesser liquidity => Higher liquidity premium for that asset class

Anson (2010)

Framework for Liquidity Risk Across Asset Classes

Serial Correlation of Asset Returns for Different Asset Classes

Asset Class	Serial Corr T0, T+1	T Test	P Value	Serial Corr T0, T+2	T Test	P Value	Serial Corr T0, T+3	T Test	P Value	Serial Corr T0, T+4	T Test	P Value	Serial Corr T0, T+5	T Test	P Value
Currency	0.06	0.87	0.3875	-0.023	-0.32	0.751	0.074	1.01	0.313	-0.085	-1.16	0.248	0.05	0.72	0.47
S&P 500	0.13	1.77	0.0789	-0.016	-0.22	0.823	0.109	1.48	0.139	0.081	1.10	0.271	0.05	0.65	0.52
Emerging Stocks	0.22	3.32	0.0011	0.139	2.07	0.039	0.054	0.81	0.420	-0.028	-0.42	0.674	-0.03	-0.47	0.64
High Yield	0.31	4.20	0.0000	-0.062	-0.85	0.397	0.067	0.91	0.363	0.158	2.17	0.031	-0.02	-0.24	0.81
Converts	0.61	8.39	0.0000	0.309	4.23	0.000	0.157	2.15	0.033	0.113	1.54	0.125	0.02	0.27	0.78
Private Equity	0.42	5.45	0.0000	0.41	3.47	0.0009	0.22	1.88	0.064	0.20	1.71	0.091	0.03	0.26	0.80
Real Estate	0.80	6.77	0.0000	0.71	6.04	0.0000	0.53	4.51	0.0000	0.46	3.91	0.0002	0.24	2.06	0.04

- Currency markets: no serial correlation across any time period
- Large cap stocks: very low serial correlation
- Unlike markets not deep or liquid as above: high serial correlation
- Emerging Market Equities, High Yield Bonds
  - Convertible Bonds, Private Equity, Real Estate

Anson (2010)

Framework for Liquidity Risk Across Asset Classes

- To build a scale for liquidity risk
  - Plot serial correlations for each time period
  - Use exponential equation to determine decay value
  - Measure decay factor--how fast serial correlation dissipates
  - Results in a scale of illiquidity using following equation:
  - Y = a * [b.sup.X] (1)

    where

    (a) is a constant

    (b) is the exponential decay factor raised to the xth power

    (Y) is our dependent variable, e.g., serial correlation

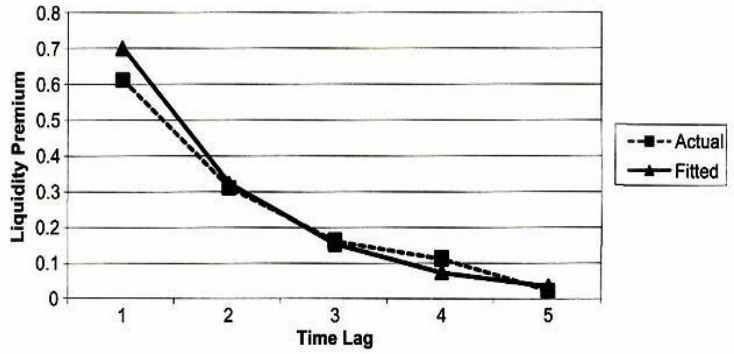
    (X) is the independent variable--the time lag (t + 1, t + 2, etc.)
  - b is a measure of liquidity coefficient for each asset class.

Anson (2010)

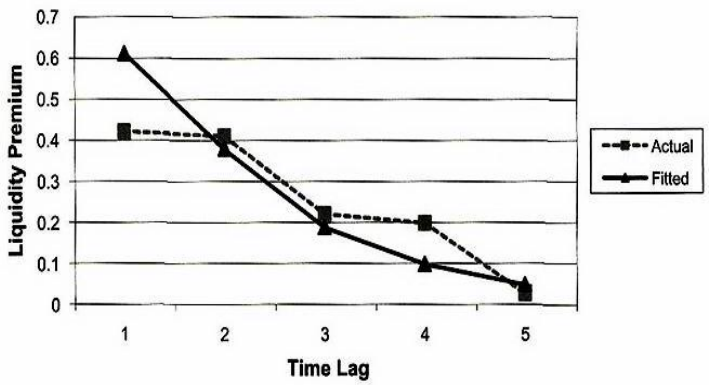
Framework for Liquidity Risk Across Asset Classes

- Y = a * [b.sup.X] (1)
- b is a measure of [il]liquidity coefficient for each asset class.

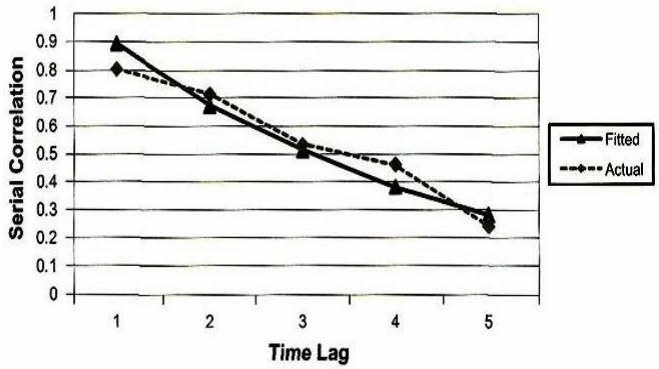
Decay of Liquidity Premium for Convertible Bonds Y = 1.55 * 0.455^x



Decay of Liquidity Premium for Private Equity Y = 1.12 * 0.55^x



Decay of Liquidity Premium for Real Estate Y = 1.12 * 0.753^x



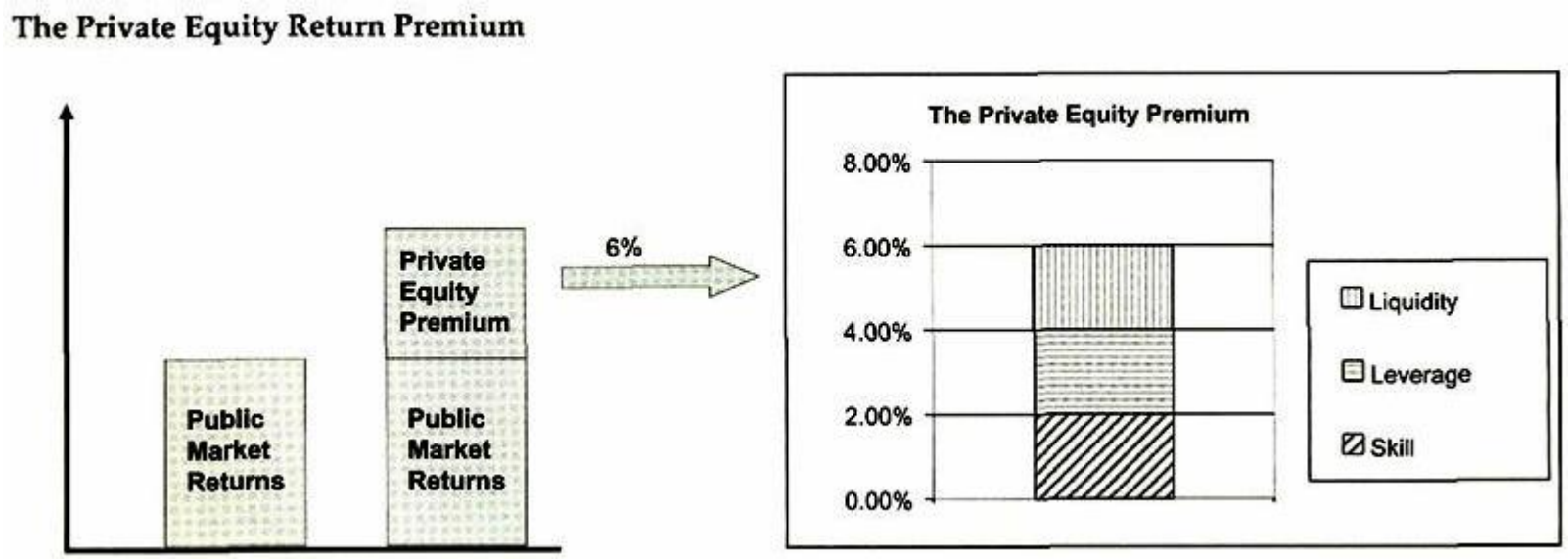
Anson (2010)

Framework for Liquidity Risk Across Asset Classes

- Y = a * [b.sup.X]
- Liquidity premium scale must be from 0 to 1.0 :
  - If b = 1.0, no decay: 1^x for all X values equals one
    - constant serial correlation with no decay over time
    - fully illiquid asset class with indefinite holding period
  - b > 1, illiquid asset class serial correlation increases over time
    - further out in time lesser liquid the asset – not real
  - b = 0, no serial correlation as 0^x for all X values equals 0.
  - b < 0, alternating serial correlation, not supported by economics
- Convert relative scale to absolute scale
  - Need a data point for liquidity premium size for an asset class
  - Unfortunately, limited research on above topic for illiquid assets
  - Use rule of thumb, Return Premium for PE = 6%
    - Return premium = Manager skill + Better B/S use + **Liquidity Premium**

Anson (2010)

Framework for Liquidity Risk Across Asset Classes



Measuring the Liquidity Premium $Y = a * b^x$

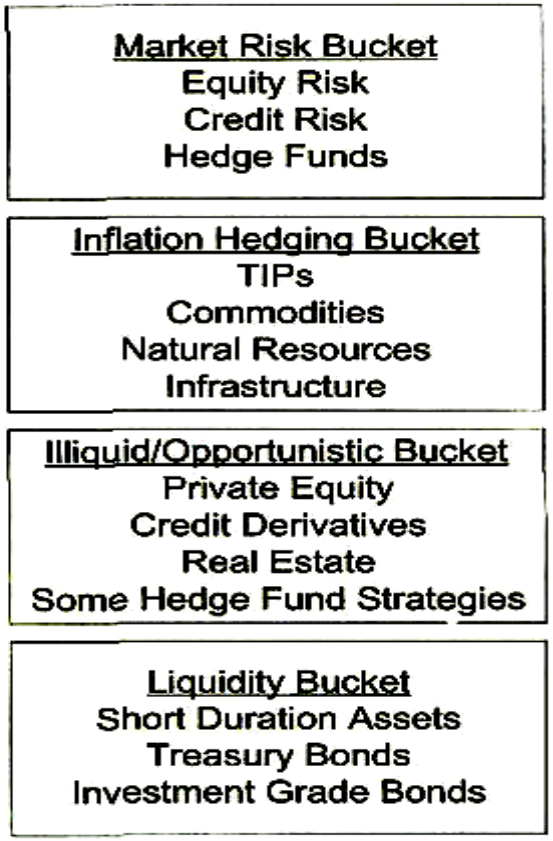
Asset Class	Constant	b value	Estimated Premium
Convertible Bonds	1.55	0.455	1.65%
Private Equity	1.12	0.55	2.00%
Direct Real Estate	1.12	0.753	2.74%

Anson (2010)

Framework for Liquidity Risk Across Asset Classes

- New development in management of liquidity risk:
  - Break portfolios into risk buckets instead of traditional asset classes.

Liquidity Asset Allocation Scheme



Anson (2010)

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How to Account for Liquidity in Portfolio Choice

- Analytical construct to incorporate liquidity in portfolio choice…
  - Treat liquidity as a **shadow asset**
    - Attached to assets that are easily tradable
    - Absent from those that are not
- …To estimate the liquidity premium required of an illiquid asset
- Can alternatively use the construct to determine
  - Optimal allocation to an illiquid asset, or,
  - Return required of shadow liquidity asset
- Solve for optimal allocation to liquid equity and liquid bonds
- Identify optimal weights by maximizing expected utility

$$E(U) = r_e w_e + r_b w_b - \lambda(\sigma_e^2 w_e^2 + \sigma_b^2 w_b^2 + 2\rho\sigma_e\sigma_b w_e w_b)$$

Kinlaw et al. (2012)

How to Account for Liquidity in Portfolio Choice

E(U) = expected utility
r_e = expected equity return
r_b = expected bond return
σ_e = equity standard deviation
σ_b = bond standard deviation
w_e = equity weight
w_b = bond weight
λ = coefficient of risk aversion
ρ = correlation of equity and bonds

- Optimal weights equate marginal utilities of equities and bonds

$$\frac{\partial U}{\partial w_e} = r_e - \lambda(2\sigma_e^2 w_e + 2\rho\sigma_e\sigma_b w_b)$$

$$\frac{\partial U}{\partial w_b} = r_b - \lambda(2\sigma_b^2 w_b + 2\rho\sigma_e\sigma_b w_e)$$

Kinlaw et al. (2012)

How to Account for Liquidity in Portfolio Choice

- Substitute illiquid asset for liquid equity
- Based on SD & correlation of observed illiquid asset
  - Solve for illiquid asset return
    - that yields same allocation as liquid equity.
  - Repeat this process
    - First correct downward bias in SD of illiquid asset from performance fees
- For single fund accounting for performance fees on annual basis
  - Convert returns of illiquid asset net of fees to returns gross of fees

$$r_n = r_g - b - \max\left(0, p * \left(r_g - b\right)\right)$$

$$r_g = \begin{cases} r_n + b \ \ for \ \ r_n < 0 \\ \frac{r_n}{1-p} + b \ \ for \ \ r_n \geq 0 \end{cases}$$

where

r_n = return net of fees
r_g = return gross of fees
b = base fee
p=performance fee

Kinlaw et al. (2012)

How to Account for Liquidity in Portfolio Choice

- De-smooth illiquid asset returns to offset reduction in SD from appraisals/fair value pricing.
- Estimate first order autoregressive model using least squares:

$$r_t = A_0 + A_1 * r_{t-1} + \varepsilon$$

- De-smooth the time series:

$$r_t' = \frac{r_t - A_1 * r_{t-1}}{1 - A_1}$$

where

r_t' = de-smoothed return observation at time t

r_t = return observation at time t

A_0 = intercept

A_1 = regression coefficient

ε = error term

Kinlaw et al. (2012)

How to Account for Liquidity in Portfolio Choice

Finally, introduce the shadow liquidity asset, assume:

- Expected return and risk of bonds are μ_b and σ_b
- SD of illiquid asset is σ_i
- Correlation between bonds and illiquid asset is $\rho_{b,l}$
- Re-state expected return, SD, correlation of bonds
  - Account for presence of the shadow asset:

$$\mu_{bl} = \mu_b + \mu_l$$

$$\sigma_{bl}^2 = \sigma_b^2 + \sigma_l^2$$

$$\rho_{bl,i} = \frac{\rho_{b,i} * \sigma_i}{\sigma_{bl}}$$

where

μ_{bl} = expected return of bonds with shadow liquidity asset

μ_l = expected return of shadow liquidity asset

σ_{bl} = standard deviation of bonds with shadow liquidity asset

σ_l = standard deviation of shadow liquidity asset

$\rho_{bl,i}$ = correlation of bonds (with shadow liquidity asset) and equity

Kinlaw et al. (2012)

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- References

Integrating Endogenous Liquidity in VaR

- Following Bangia et al. (1999) (BDSS),
- Approaches quantification of liquidity risk in quite different way
- Model providing a closed-form solution for
  - Simultaneously integrating exogenous and endogenous components of intraday liquidity risk
  - Original BDSS Model: $$Liqu._{Adj.}VaR_t = Mid_{BL_t} \cdot \left[\left(1 - e^{[-\alpha\sigma]}\right) + \frac{1}{2} \cdot \left(\overline{S} + \alpha' \widetilde{\sigma}\right) \right]$$
  - Market Risk = Pure Price Risk + Exogenous Liquidity Add-in
  - To avoid explicit modeling of distribution of spread and assumption of perfect correlation between the variations of prices and spreads
    - Model the joint impact in an single expression
  - VaR directly applied to a theoretical bid
    - Obtained from 'mid' adjusted by half average relative spread.

Francois-Heude & Van Wynendaele (2001)

Integrating Endogenous Liquidity in VaR

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Francois-Heude & Van Wynendaele (2001)

Integrating Endogenous Liquidity in VaR

- BDSS Model $Liqu._{Adj.}VaR_t = Mid_{BL_t} \cdot \left[\left(1 - e^{[-\alpha\sigma]}\right) + \frac{1}{2} \cdot \left(\overline{S} + \alpha' \widetilde{\sigma}\right) \right]$
- Proposed New Model: VaR adjusted to liquidity

$$L\_VaR_t = Mid_{BL_t} - \left(Mid_{BL_t} \cdot \left(1 - \frac{\overline{Sp}_{BL}}{2}\right) \cdot \left(e^{-\alpha\sigma}\right) \right)$$

- Liquidity adjustment made in 'normal' market conditions
- Introduce a dynamic component in order to:
  - measure tension on liquidity when inferring the VaR

$$L\_VaR_t = Mid_{BL_t} - \left(Mid_{BL_t} \cdot \left(1 - \frac{\overline{Sp}_{BL}}{2}\right) \cdot \left(e^{-\alpha\sigma}\right) \right) + Mid_{BL_t} \cdot \left(\frac{Mid_{BL_t} - B_{BL_t}}{Mid_{BL_t}} - \frac{\overline{Sp}_{BL}}{2} \right)$$

Francois-Heude & Van Wynendaele (2001)

Integrating Endogenous Liquidity in VaR

- Dynamic component allows to account for
  - Negative as well as positive liquidity effects.
- If relative quoted spread greater than average relative spread
  - Component will be positive, will come in addition to VaR number.
- If relative quoted spread lower than average relative spread
  - Component will be negative and will reduce the VaR number.
- Allows to position the immediate relative spread
  - In comparison with average spread in VaR framework.

$$L\_VaR_t = Mid_{BL_t} \cdot \left[\left(1 - \left(1 - \frac{\overline{Sp}_{BL}}{2} \right) \cdot \left(e^{-\alpha\sigma} \right) \right) + \frac{1}{2} \cdot \left(Sp_{BL,t} - \overline{Sp}_{BL} \right) \right]$$

Francois-Heude & Van Wynendaele (2001)

Integrating Endogenous Liquidity in VaR

- Integration of endogenous liquidity component
  - associated with price impact induced by liquidation
- Generalize above model in order to produce a VaR number valid
  - Not only for a single unit of asset, but for any quantity and position

$$L\_VaR_t = Mid_{BL_t} . \left[\left(1 - \left(1 - \frac{\overline{Sp}(Q)}{2} \right) . \left(e^{-\alpha\sigma} \right) \right) + \frac{1}{2} . \left(Sp_t(Q) - \overline{Sp}(Q) \right) \right]$$

with $Mid_t(Q)$: the 'mid' price adjusted to the quantity Q in t

Mid_{BL_t} : the 'mid' price in t

$\overline{Sp}(Q)$: the average spread adjusted to the quantity Q

$Sp_t(Q)$: the spread adjusted to the quantity Q in t

α : the q percentile of the 'mid' return distribution

σ : the standard deviation of the 'mid' return distribution

Francois-Heude & Van Wynendaele (2001)

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Feedback Integrated For Project Development

- Replicate Anson (2010) measures for given asset classes

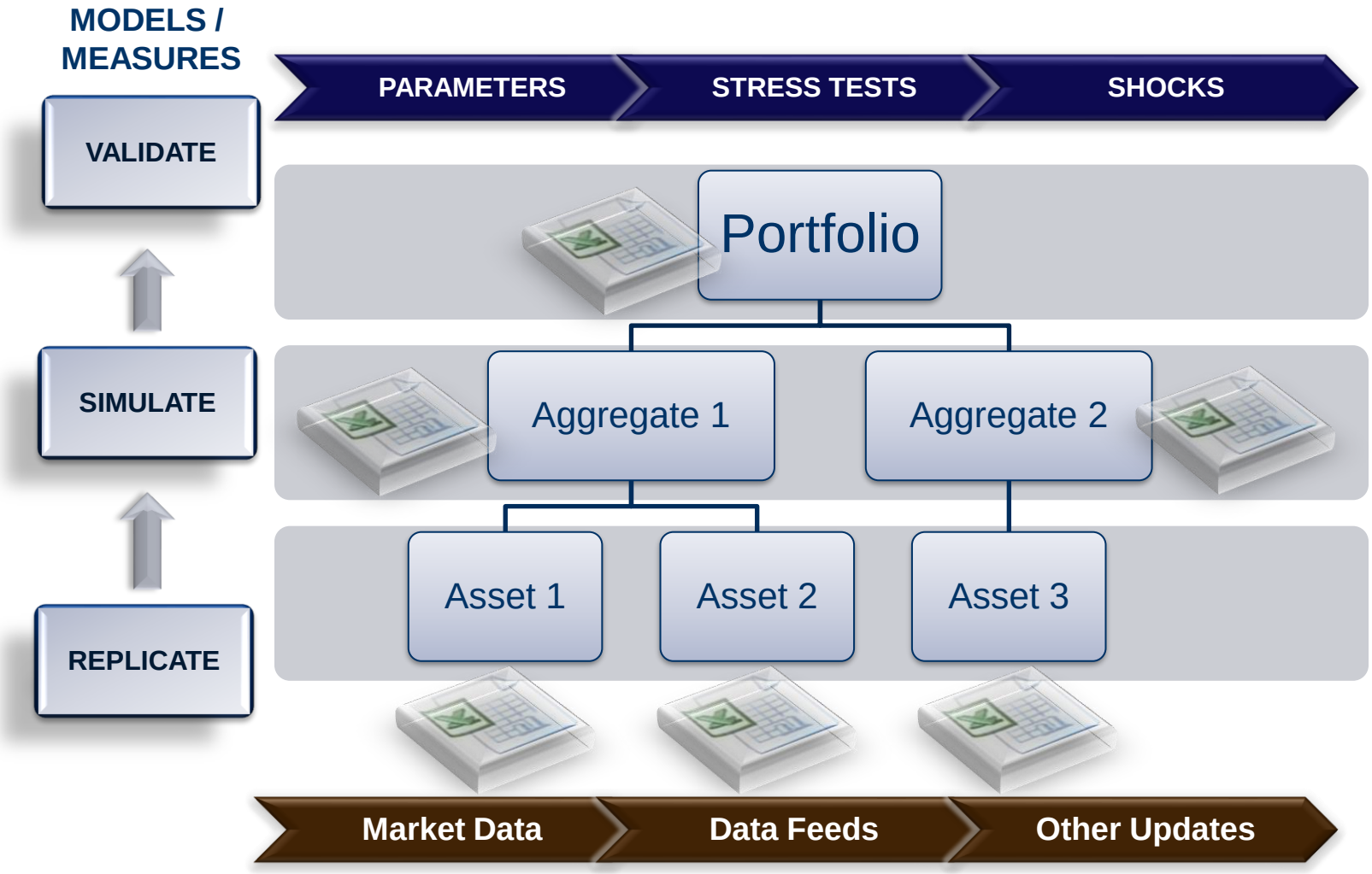
Developed Large EQ	Investment Grade Bonds	HFRI Statistical Arbitrage
Developed Small EQ	Inflation-Linked Bonds	HFRI Equity Hedge
Emerging Equity	High Yield Corporate Bonds	HFRI Merger Arbitrage
Unlisted Equity	Emerging Market Hard Currency Bonds	HFRI Macro
Various Commodities	Emerging Market Local Currency Bonds	HFRI Relative Value
Government Bonds	Major Currencies	

- Determine 'Valid' Return Proxy Measure for each Asset Class
  - Filter and / or account for Extreme Data Values / Extreme Events
  - Caution about 'Regime Changes'
- Determine Volatility, Correlations, Sharpe, Liquidity, Significance
- Develop Liquidity Measurement Model for 3 Levels
- Develop Liquidity Risk Buckets for JPM Fund of Funds
- Develop Heat Map to Depict Liquidity Status and Changes

Feedback Integrated For Project Development

- Assume 3-month Time Frame for Liquidation Risk Assessment
- Caution about Psychometrics: e.g. Integration of Nominal and Ordinal Measures, Discrete and Continuous Measures, etc.
- Administer Liquidity Shocks and Examine Results
  - Using LOGIT (e.g. Aït-Sahalia)
- Survey of New Global Risk and Macro Risk Measures for AI/HF
- Determine How to Detect 'Return Smoothing' (Madoff case)
  - Use Bias Ratio to benchmark: more sensitive than Sharpe Ratio
- Liquidity Score, Liquidity Loss, Gate Risk, Redemption Risk

Model Implementation: An Overview
Linked Worksheets and Workbooks with VBA



"I think you should be ambitious about your models, and push them as far as you can, but you need to be aware they will fail - and under what circumstances."

Big Picture View of Model Implementation

- Linked Spreadsheets: Portfolio – Aggregates & Asset Classes
  - Separate Worksheet for each Asset Class and Aggregate
    - Returns, Sigma, Volatility, Variance, Correlation, beta, Sharpe
  - Aggregate based upon Weighted integration of Asset Classes
  - Portfolio based upon Weighted Aggregates and Asset Classes
- Source Market Data contained in respective worksheet (sheet)
  - Parameters for Stress Test and Shocks linked from Portfolio sheet
  - [Shock] updates [Lower level sheets] update [Portfolio sheet]
- Heat Maps at each worksheet level: Portfolio and Lower levels

Illiquidity Exposure	Volatility
Potential Liquidation Loss	Sharpe Ratio / Others
Correlations	Cumulative / Overall

- Way to Monitor 'Expected' Relationships & their Breakdown
  - E.g. High correlations and Illiquidity move together in same direction

JPM Fund of Funds: Portfolio of AI and HFs

- Asset Class: Collection of investments: reasonably homogeneous set of characteristics: stable over time.
  - AI needs different measures from equity, FI, real estate, etc.
- Standard measures and methods of risk/return not apply to HFs
- Significant serial correlation in returns of HFs versus liquid assets
  - Illiquidity and smoothed returns in HFs
  - Biases in variances, betas, Sharpe ratios
  - Overestimation of Sharpe ratio by up to about 70%
  - Dynamic investment strategies => Dynamic Risk Exposures
    - Market beta: inadequate measure of risk
- HF Performance: Need Multiple Measures
  - Mean, SD, Sharpe Ratio, Market beta, Sortino Ratio, Maximum Drawdown, Worst Month.
- Increasing correlations (>80%) => No well-defined MVO solutions.

JPM Fund of Funds: Portfolio of AI and HFs

- HFs: Serial correlation: very useful proxy for liquidity risk.
- Comparative Performance Measures of HF Strategies
  - Average monthly return, Sharpe ratio, % Negative monthly returns
- AI and HFs: SD inadequate; Focus on Tail Risk: ES, ETL, EVT
- Correlation Matrix for Asset Classes and HF Strategies
  - Expected +ve or –ve relationships
  - Monitor when they break down and why
- Need Hedge Fund Indexes as proxy measures for HF Styles
- HF Styles have low, some –ve, correlation with market indexes
  - Correlations can change over time, e.g.:
  - AUM ↑ → Corr. ↑ → Illiquidity Exposure ↑
- Unstable Correlations may indicate 'regime shifts'
  - Rolling window of data excludes an 'extreme event' outlier, LTCM.

JPM Fund of Funds: Portfolio of AI and HFs

- Phase-locking behaviors: Sudden change from high to low Corr.
- Estimate risk model allowing such events explicitly

$$R_{it} = \alpha_i + \beta_i \Lambda_t + I_t Z_t + \varepsilon_{it} \qquad \Lambda_t,\ I_t,\ Z_t, \text{ and } \varepsilon_{it} \text{ (i.i.d.)}$$

phase-locking event indicator I_t

$$I_t = \begin{cases} 1 \text{ with probability } p \\ 0 \text{ with probability } 1-p \end{cases}$$

$$E(\Lambda_t) = \mu_\lambda,\ \mathrm{Var}(\Lambda_t) = \sigma_\lambda^2$$

$$E(Z_t) = 0,\ \mathrm{Var}(Z_t) = \sigma_z^2$$

$$E(\varepsilon_{it}) = 0,\ \mathrm{Var}(\varepsilon_{it}) = \sigma_{\varepsilon_t}^2$$

conditional correlation coefficient

$$\mathrm{Corr}(R_{it}, R_{jt} \mid I_t = 0) = \frac{\beta_i \beta_j \sigma_\lambda^2}{\sqrt{\beta_i^2 \sigma_\lambda^2 + \sigma_{\varepsilon_t}^2}\sqrt{\beta_j^2 \sigma_\lambda^2 + \sigma_{\varepsilon_j}^2}} \approx 0 \quad \text{for } \beta_i \approx \beta_j \approx 0$$

$$\mathrm{Corr}(R_{it}, R_{jt} \mid I_t = 1) = \frac{\beta_i \beta_j \sigma_\lambda^2 + \sigma_z^2}{\sqrt{\beta_i^2 \sigma_\lambda^2 + \sigma_z^2 + \sigma_{\varepsilon_t}^2}\sqrt{\beta_j^2 \sigma_\lambda^2 + \sigma_z^2 + \sigma_{\varepsilon_j}^2}}$$

$$\approx \frac{1}{\sqrt{1 + \sigma_{\varepsilon_t}^2/\sigma_z^2}\sqrt{1 + \sigma_{\varepsilon_j}^2/\sigma_z^2}} \text{ for } \beta_i \approx \beta_j \approx 0$$

JPM Fund of Funds: Portfolio of AI and HFs

unconditional correlation

$$\text{Corr}(R_{it}, R_{jt}) \equiv \frac{\text{Cov}(R_{it}, R_{jt})}{\sqrt{\text{Var}(R_{it})\text{Var}(R_{jt})}}$$

$$\text{Cov}(R_{it}, R_{jt}) = \beta_i\beta_j\sigma_\lambda^2 + \text{Var}(I_t Z_t) = \beta_i\beta_j\sigma_\lambda^2 + p\sigma_z^2$$

$$\text{Var}(R_{it}) = \beta_i^2\sigma_\lambda^2 + \text{Var}(I_t Z_t) + \sigma_{\varepsilon_t}^2 = \beta_i^2\sigma_\lambda^2 + p\sigma_z^2 + \sigma_{\varepsilon_t}^2$$

$$\text{Corr}(R_{it}, R_{jt}) = \frac{\beta_i\beta_j\sigma_\lambda^2 + p\sigma_z^2}{\sqrt{\beta_i^2\sigma_\lambda^2 + p\sigma_z^2 + \sigma_{\varepsilon_t}^2}\sqrt{\beta_j^2\sigma_\lambda^2 + p\sigma_z^2 + \sigma_{\varepsilon_j}^2}}$$

$$\approx \frac{p}{\sqrt{p + \sigma_{\varepsilon_t}^2/\sigma_z^2}\sqrt{p + \sigma_{\varepsilon_j}^2/\sigma_z^2}} \quad \text{for } \beta_i \approx \beta_j \approx 0$$

JPM Fund of Funds: Portfolio of AI and HFs

- Account for asymmetries in factor exposures, phase-locking behavior, jump risk, non-stationarities, and other nonlinearities endemic to high-performance active investment strategies
- HF risk model needs to include general group of factors:
  - Price factors, Sectors, Investment style, Volatilities, Credit, Liquidity, Macroeconomic factors, Sentiment, Nonlinear interactions
- HF returns: asymmetric sensitivity to the S&P 500

$$R_{it} = \alpha_i + \beta_i^+ \Lambda_t^+ + \beta_i^- \Lambda_t^- + \varepsilon_{it}$$

$$\Lambda_t^+ = \begin{cases} \Lambda_t & \text{if } \Lambda_t > 0 \\ 0 & \text{otherwise,} \end{cases} \qquad \Lambda_t^- = \begin{cases} \Lambda_t & \text{if } \Lambda_t \leq 0 \\ 0 & \text{otherwise} \end{cases}$$

Λ_t is the return on the S&P 500 index

JPM Fund of Funds: Portfolio of AI and HFs

- Above factors need to be customized for different HF styles
  - E.g. Long/Short equity HF

Investment style (value, growth, and so on)
Fundamental analysis (earnings, analyst forecasts, accounting data)
Factor exposures (S&P 500, industries, sectors, characteristics)
Portfolio optimization (mean-variance analysis, market neutrality)
Stock loan considerations (hard-to-borrow securities, short "squeezes")
Execution costs (price impact, commissions, borrowing rate, short rebate)
Benchmarks and tracking error (T-bill rate versus S&P 500)

  - vs. Fixed Income HF

Yield-curve models (equilibrium versus arbitrage models)
Prepayment models (for mortgage-backed securities)
Optionality (call, convertible, and put features)
Credit risk (defaults, rating changes, and so on)
Inflationary pressures, central bank activity
Other macroeconomic factors and events

Summary Statistics of Asset Classes & Aggregates: A Template

Variable	Sample size	Annual mean	Annual standard deviation	Correlation with S&P 500	Minimum	Median	Maximum	Skewness	Kurtosis	ρ_1	ρ_2	ρ_3	p-value of LB-Q
CSFB/Tremont indexes													
Hedge funds	128	10.51	8.25	45.9	–7.55	0.78	8.53	0.12	1.95	12.0	4.0	–0.5	54.8
Convertible arbitrage	128	9.55	4.72	11.0	–4.68	1.09	3.57	–1.47	3.78	55.8	41.1	14.4	0.0
Dedicated shortseller	128	–0.69	17.71	–75.6	–8.69	–0.39	22.71	0.90	2.16	9.2	–3.6	0.9	73.1
Emerging markets	128	8.25	17.28	47.2	–23.03	1.17	16.42	–0.58	4.01	30.5	1.6	–1.4	0.7
Equity-market neutral	128	10.01	3.05	39.6	–1.15	0.81	3.26	0.25	0.23	29.8	20.2	9.3	0.0
Event driven	128	10.86	5.87	54.3	–11.77	1.01	3.68	–3.49	23.95	35.0	15.3	4.0	0.0
Distressed	128	12.73	6.79	53.5	–12.45	1.18	4.10	–2.79	17.02	29.3	13.4	2.0	0.3
Event-driven multistrategy	128	9.87	6.19	46.6	–11.52	0.90	4.66	–2.70	17.63	35.3	16.7	7.8	0.0
Risk arbitrage	128	7.78	4.39	44.7	–6.15	0.62	3.81	–1.27	6.14	27.3	–1.9	–9.7	1.2
Fixed income arbitrage	128	6.69	3.86	–1.3	–6.96	0.77	2.02	–3.27	17.05	39.2	8.2	2.0	0.0
Global macro	128	13.85	11.75	20.9	–11.55	1.19	10.60	0.00	2.26	5.5	4.0	8.8	65.0
Long/short equity	128	11.51	10.72	57.2	–11.43	0.78	13.01	0.26	3.61	16.9	6.0	–4.6	21.3
Managed futures	128	6.48	12.21	–22.6	–9.35	0.18	9.95	0.07	0.49	5.8	–9.6	–0.7	64.5
Multistrategy	125	9.10	4.43	5.6	–4.76	0.83	3.61	–1.30	3.59	–0.9	7.6	18.0	17.2
S&P 500	120	11.90	15.84	100.0	–14.46	1.47	9.78	–0.61	0.30	–1.0	–2.2	7.3	86.4
Banks	128	21.19	13.03	55.8	–18.62	1.96	11.39	–1.16	5.91	26.8	6.5	5.4	1.6
LIBOR	128	–0.14	0.78	3.5	–0.94	–0.01	0.63	–0.61	4.11	50.3	32.9	27.3	0.0
USD	128	–0.52	7.51	7.3	–5.35	–0.11	5.58	0.00	0.08	7.2	–3.2	6.4	71.5
Oil	128	15.17	31.69	–1.6	–22.19	1.38	36.59	0.25	1.17	–8.1	–13.6	16.6	7.3
Gold	128	1.21	12.51	–7.2	–9.31	–0.17	16.85	0.98	3.07	–13.7	–17.4	8.0	6.2
Lehman bond	128	6.64	4.11	0.8	–2.71	0.50	3.50	–0.04	0.05	24.6	–6.3	5.2	3.2
Large minus small cap	128	–1.97	13.77	7.6	–20.82	0.02	12.82	–0.82	5.51	–13.5	4.7	6.1	36.6
Value minus growth	128	0.86	18.62	–48.9	–22.78	0.40	15.85	–0.44	3.01	8.6	10.2	0.4	50.3
Credit spread (not annual)	128	4.35	1.36	–30.6	2.68	3.98	8.23	0.82	–0.30	94.1	87.9	83.2	0.0
Term spread (not annual)	128	1.65	1.16	–11.6	–0.07	1.20	3.85	0.42	–1.25	97.2	94.0	91.3	0.0
VIX (not annual)	128	0.03	3.98	–67.3	–12.90	0.03	19.48	0.72	4.81	–8.2	–17.5	–13.9	5.8

Summary Statistics of Asset Classes & Aggregates: A Template

- Use a 60-month window of rolling serial autocorrelations
- Examine different asset classes for tail risk: skew, kurtosis
- Examine serial autocorrelation for different asset classes
- Examine *p*-value of the Ljung-Box *Q*-statistic
  - Degree of statistical significance for first 3 autocorrelations

$$Q = T(T+2)\sum_{j=1}^{k} \hat{\rho}_j^2/(T-j)$$

- Serial correlation: symptom of illiquidity risk exposure

Detect Extreme Shifts in Correlations
Monthly data from January 1994 to August 2004

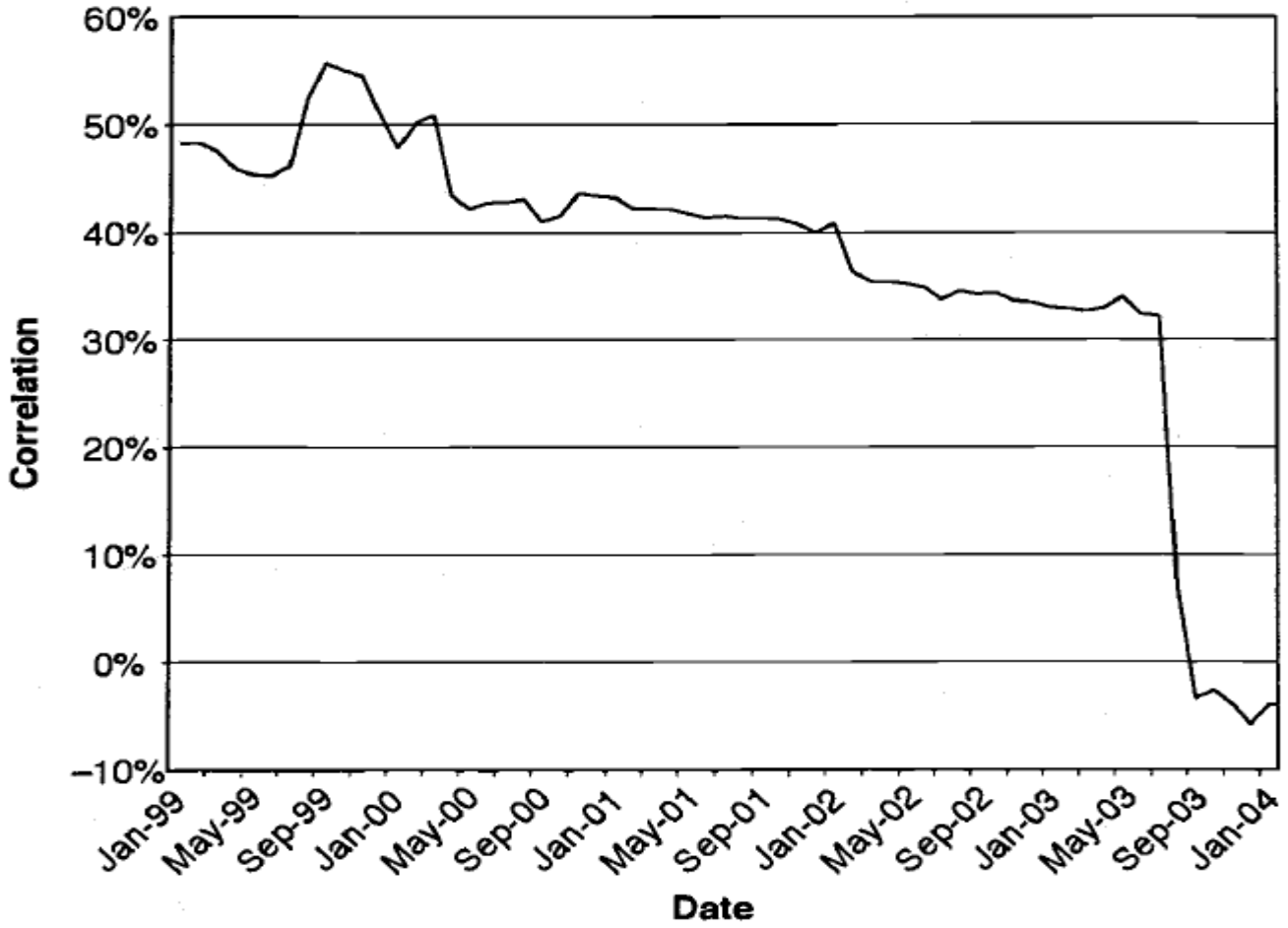
Correlation matrix	Hedge funds	Convertible arbitrage	Dedicated shortseller	Emerging markets	Equity-market neutral	Event driven	Distressed	Event-driven multi-strategy	Risk arbitrage	Fixed income arbitrage	Global macro	Long/Short equity	Managed futures	Multi-strategy
Hedge funds	100.0													
Convertible arbitrage	39.1	100.0												
Dedicated shortseller	–46.7	–22.3	100.0											
Emerging markets	65.7	32.0	–56.8	100.0										
Equity-market neutral	32.0	30.0	–34.6	24.8	100.0									
Event driven	66.1	59.0	–62.9	66.5	39.3	100.0								
Distressed	56.5	50.7	–62.3	57.7	35.7	93.6	100.0							
Event-driven multistrategy	69.0	60.1	–54.0	67.1	37.3	93.0	74.9	100.0						
Risk arbitrage	39.6	41.8	–50.6	44.1	32.1	69.7	58.0	66.6	100.0					
Fixed income arbitrage	40.7	53.0	–4.6	27.1	5.7	37.3	28.3	43.3	13.2	100.0				
Global macro	85.4	27.5	–11.0	41.5	18.6	36.9	29.5	42.7	12.9	41.5	100.0			
Long/short equity	77.6	25.0	–71.9	58.9	34.2	65.2	57.0	63.9	51.7	17.0	40.6	100.0		
Managed futures	12.4	–18.1	21.1	–10.9	15.3	–21.2	–14.6	–24.4	–21.1	–6.7	26.8	–3.6	100.0	
Multistrategy	16.0	35.0	–5.8	–3.2	20.6	15.9	10.9	19.7	5.9	27.3	11.3	14.5	–2.4	100.0

Detect Extreme Shifts in Correlations Monthly data from January 1994 to December 2003

	Dedicated short	Emerging markets	Equity-market neutral	Event driven	Distressed
		January 1994 to December 2003			
Convertible arbitrage	–23.0	31.8	31.2	58.7	50.8
Dedicated short		–57.1	–35.3	–63.4	–63.2
Emerging markets			22.0	67.8	59.2
Equity-market neutral				37.9	34.9
Event-driven					93.8
		January 1994 to December 1998			
Convertible arbitrage	–25.2	48.2	32.1	68.4	61.6
Dedicated short		–52.6	–43.5	–66.2	–69.1
Emerging markets			22.1	70.8	65.4
Equity-market neutral				43.4	44.9
Event-driven					94.9
		January 1999 to December 2003			
Convertible arbitrage	–19.7	–5.8	32.3	41.8	33.5
Dedicated short		–67.3	–22.9	–63.0	–56.8
Emerging markets			22.1	60.6	45.2
Equity-market neutral				20.8	6.4
Event-driven					91.4

Source: AlphaSimplex Group.

Detect for Extreme Shifts in Correlations



Note: The sharp decline in September 2003 is due to the fact that this is the first month in which the August 1998 observation is dropped from the sixty-month rolling window.

Summary Statistics of Asset Classes & Aggregates: A Template

Category	Sample size	Annualized mean (%)		Annualized SD (%)		ρ_1 (%)		Annualized Sharpe ratio		Annualized adjusted Sharpe ratio		Ljung-Box *p*-value (%)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Live funds													
Convertible arbitrage	127	9.92	5.89	5.51	4.15	33.6	19.2	2.57	4.20	1.95	2.86	19.5	27.1
Dedicated shortseller	14	0.33	11.11	25.10	10.92	3.5	10.9	–0.11	0.70	0.12	0.46	48.0	25.7
Emerging markets	130	17.74	13.77	21.69	14.42	18.8	13.8	1.36	2.01	1.22	1.40	35.5	31.5
Equity-market neutral	173	6.60	5.89	7.25	5.05	4.4	22.7	1.20	1.18	1.30	1.28	41.6	32.6
Event driven	250	12.52	8.99	8.00	7.15	19.4	20.9	1.98	1.47	1.68	1.47	31.3	34.1
Fixed income arbitrage	104	9.30	5.61	6.27	5.10	16.4	23.6	3.61	11.71	3.12	7.27	36.6	35.2
Global macro	118	10.51	11.55	13.57	10.41	1.3	17.1	0.86	0.68	0.99	0.79	46.8	30.6
Long/short equity	883	13.05	10.56	14.98	9.30	11.3	17.9	1.03	1.01	1.01	0.95	38.1	31.8
Managed futures	195	8.59	18.55	19.14	12.52	3.4	13.9	0.48	1.10	0.73	0.63	52.3	30.8
Multistrategy	98	12.65	17.93	9.31	10.94	18.5	21.3	1.91	2.34	1.46	2.06	31.1	31.7
Fund of funds	679	6.89	5.45	6.14	4.87	22.9	18.5	1.53	1.33	1.48	1.16	33.7	31.6
Graveyard funds													
Convertible arbitrage	49	10.02	6.61	8.14	6.08	25.5	19.3	1.89	1.43	1.58	1.46	27.9	34.2
Dedicated shortseller	15	1.77	9.41	27.54	18.79	8.1	13.2	0.20	0.44	0.25	0.48	55.4	25.2
Emerging markets	133	2.74	27.74	27.18	18.96	14.3	17.9	0.37	0.91	0.47	1.11	48.5	34.6
Equity-market neutral	87	7.61	26.37	12.35	13.68	6.4	20.4	0.52	1.23	0.60	1.85	46.6	31.5
Event driven	134	9.07	15.04	12.35	12.10	16.6	21.1	1.22	1.38	1.13	1.43	39.3	34.2
Fixed income arbitrage	71	5.51	12.93	10.78	9.97	15.9	22.0	1.10	1.77	1.03	1.99	46.0	35.7
Global macro	114	3.74	28.83	21.02	18.94	3.2	21.5	0.33	1.05	0.37	0.90	46.2	31.0

continued

Summary Statistics of Asset Classes & Aggregates: A Template

Category	Sample size	Annualized mean (%)		Annualized SD (%)		ρ_1 (%)		Annualized Sharpe ratio		Annualized adjusted Sharpe ratio		Ljung-Box *p*-value (%)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Long/short equity	532	9.69	22.75	23.08	16.82	6.4	19.8	0.48	1.06	0.48	1.17	47.8	31.3
Managed futures	316	4.78	23.17	20.88	19.35	–2.9	18.7	0.26	0.77	0.37	0.97	48.4	30.9
Multistrategy	41	5.32	23.46	17.55	20.90	6.1	17.4	1.10	1.55	1.58	2.06	49.4	32.2
Fund of funds	273	4.53	10.07	13.56	10.56	11.3	21.2	0.62	1.26	0.57	1.11	40.9	31.9
Combined funds													
Convertible arbitrage	176	9.94	6.08	6.24	4.89	31.4	19.5	2.38	3.66	1.85	2.55	21.8	29.3
Dedicated shortseller	29	1.08	10.11	26.36	15.28	5.9	12.2	0.05	0.59	0.19	0.46	52.0	25.2
Emerging markets	263	10.16	23.18	24.48	17.07	16.5	16.2	0.86	1.63	0.84	1.31	42.2	33.7
Equity-market neutral	260	6.94	15.94	8.96	9.21	5.1	21.9	0.97	1.24	1.06	1.53	43.3	32.3
Event driven	384	11.31	11.57	9.52	9.40	18.4	21.0	1.71	1.48	1.49	1.48	34.1	34.3
Fixed income arbitrage	175	7.76	9.45	8.10	7.76	16.2	22.9	2.59	9.16	2.29	5.86	40.4	35.6
Global macro	232	7.18	22.04	17.21	15.61	2.3	19.3	0.60	0.92	0.70	0.90	46.5	30.8
Long/short equity	1415	11.79	16.33	18.02	13.25	9.5	18.8	0.82	1.06	0.81	1.07	41.7	31.9
Managed futures	511	6.23	21.59	20.22	17.07	–0.6	17.4	0.34	0.91	0.50	0.88	49.8	30.9
Multistrategy	139	10.49	19.92	11.74	15.00	14.7	20.9	1.67	2.16	1.49	2.05	36.7	32.9
Fund of funds	952	6.22	7.17	8.26	7.75	19.6	20.0	1.27	1.37	1.21	1.22	35.8	31.8

Note: The columns "*p*-value (*Q*)" contain means and standard deviations of *p*-values for the Ljung-Box *Q*-statistic for each fund, using the first eleven autocorrelations of returns. SD = standard deviation.

Measuring Illiquidity Risk

- Common theme for all HFs: credit risk and liquidity risk
- Serial Correlation and Illiquidity: autocorrelation coefficients of HFs or asset class' monthly returns ρ_k

$$\rho_k \equiv \mathrm{Cov}(R_t, R_{t-k})/\mathrm{Var}(R_t)$$

  - *k*-th order autocorrelation of (*Rt*)
  - Degree of correlation between:
  - month *t*'s return and month *t* – *k*'s return

The *k*-th order autocorrelation of a time series (R_t) is defined as the correlation coefficient between R_t and R_{t-k}, which is simply the covariance between R_t and R_{t-k} divided by the square root of the product of the variances of R_t and R_{t-k}. But since the variances of R_t and R_{t-k} are the same under the assumption of stationarity, the denominator of the autocorrelation is simply the variance of R_t.

Serial Autocorrelations of Asset Classes & HFs: A Template

Fund	Start date	T	$\hat{\mu}$ (%)	$\hat{\sigma}$ (%)	$\hat{\rho}_1$ (%)	$\hat{\rho}_2$ (%)	$\hat{\rho}_3$ (%)	ρ_4 (%)	$\hat{\rho}_5$ (%)	$\hat{\rho}_6$ (%)	p-value of Q_6 (percent)
Mutual funds											
Vanguard 500 Index	76.10	286	1.30	4.27	–3.99	–6.60	–4.94	–6.38	10.14	–3.63	31.85
Fidelity Magellan	67.01	402	1.73	6.23	12.37	–2.31	–0.35	0.65	7.13	3.14	17.81
Investment Company of America	63.01	450	1.17	4.01	1.84	–3.23	–4.48	–1.61	6.25	–5.60	55.88
Janus	70.03	364	1.52	4.75	10.49	–0.04	–3.74	–8.16	2.12	–0.60	30.32
Fidelity Contrafund	67.05	397	1.29	4.97	7.37	–2.46	–6.81	–3.88	2.73	–4.47	42.32
Washington Mutual Investors	63.01	450	1.13	4.09	–0.10	–7.22	–2.64	0.65	11.55	–2.61	16.73
Janus Worldwide	92.01	102	1.81	4.36	11.37	3.43	–3.82	–15.42	–21.36	–10.33	10.95
Fidelity Growth and Income	86.01	174	1.54	4.13	5.09	–1.60	–8.20	–15.58	2.10	–7.29	30.91
American Century Ultra	81.12	223	1.72	7.11	2.32	3.35	1.36	–3.65	–7.92	–5.98	80.96
Growth Fund of America	64.07	431	1.18	5.35	8.52	–2.65	–4.11	–3.17	3.43	0.34	52.45
Hedge funds											
Convertible/Option Arbitrage	92.05	104	1.63	0.97	42.59	28.97	21.35	2.91	–5.89	–9.72	0.00
Relative Value	92.12	97	0.66	0.21	25.90	19.23	–2.13	–16.39	–6.24	1.36	3.32
Mortgage-Backed Securities	93.01	96	1.33	0.79	42.04	22.11	16.73	22.58	6.58	–1.96	0.00
High Yield Debt	94.06	79	1.30	0.87	33.73	21.84	13.13	–0.84	13.84	4.00	1.11
Risk Arbitrage A	93.07	90	1.06	0.69	–4.85	–10.80	6.92	–8.52	9.92	3.06	74.10
Long/Short Equities	89.07	138	1.18	0.83	–20.17	24.62	8.74	11.23	13.53	16.94	0.05
Multistrategy A	95.01	72	1.08	0.75	48.88	23.38	3.35	0.79	–2.31	–12.82	0.06
Risk Arbitrage B	94.11	74	0.90	0.77	–4.87	2.45	–8.29	–5.70	0.60	9.81	93.42
Convertible Arbitrage A	92.09	100	1.38	1.60	33.75	30.76	7.88	–9.40	3.64	–4.36	0.06
Convertible Arbitrage B	94.07	78	0.78	0.62	32.36	9.73	–4.46	6.50	–6.33	–10.55	8.56
Multistrategy B	89.06	139	1.34	1.63	49.01	24.60	10.60	8.85	7.81	7.45	0.00
Fund of Funds	94.10	75	1.68	2.29	29.67	21.15	0.89	–0.90	–12.38	3.01	6.75

Source: AlphaSimplex Group.

Notes: Means, standard deviations, and autocorrelation coefficients for monthly total returns of mutual funds and hedge funds from various start dates through June 2000 for the mutual fund sample and various start dates through December 2000 for the hedge fund sample. "$\hat{\rho}_k$" denotes the k-th autocorrelation coefficient, and "p-value of Q_6" denotes the significance level of the Ljung-Box (1978) Q-statistic $T(T+2)\sum_{k=1}^{6}\rho_k^2/(T-k)$, which is asymptotically χ^2_6 under the null hypothesis of no serial correlation.

Autocorrelations and Betas of Asset Classes & HFs: A Template

								Market model			Contemporaneous and lagged market model						
Series	Period	T	Mean (%)	SD (%)	$\hat{\rho}_1$ (%)	$\hat{\rho}_2$(%)	$\hat{\rho}_3$ (%)	$\hat{\beta}$	SE($\hat{\beta}$)	R^2 (%)	$\hat{\beta}_0$	SE($\hat{\beta}_0$)	$\hat{\beta}_1$	SE($\hat{\beta}_1$)	$\hat{\beta}_2$	SE($\hat{\beta}_2$)	R^2 (%)
Ibbotson Small Company	192601–200112	912	1.35	8.63	15.6	1.7	–10.6	1.27	0.03	66.9	1.25	0.03	0.16	0.03	0.03	0.03	68.0
Ibbotson Long-Term Government Bonds	192601–200112	912	0.46	2.22	6.7	0.3	–8.3	0.07	0.01	2.8	0.07	0.01	–0.03	0.01	–0.02	0.01	3.6
Ibbotson Long-Term Corporate Bonds	192601–200112	912	0.49	1.96	15.6	0.3	–6.0	0.08	0.01	5.2	0.08	0.01	–0.01	0.01	–0.01	0.01	5.3
Ibbotson Large Company	192601–200112	912	1.03	5.57	9.8	–3.2	–10.7	1.00	0.00	100.0	1.00	0.00	0.00	0.00	0.00	0.00	100.0
Merrill Lynch Convertibles Index	199401–200210	168	0.99	3.43	6.4	12.0	5.1	0.59	0.05	48.6	0.60	0.05	0.15	0.05	0.07	0.04	52.2
AXP Extra Income Fund (INEAX)	198401–200112	216	0.67	2.04	35.4	13.1	2.5	0.21	0.03	20.7	0.21	0.03	0.12	0.03	0.04	0.03	28.7
Vanguard 500 Index Trust (VFINX)	197609–200112	304	1.16	4.36	–2.3	–6.8	–3.2	1.00	0.00	100.0	1.00	0.00	0.00	0.00	0.00	0.00	100.0
CSFB/Tremont Indexes																	
Aggregate hedge fund index	199401–200210	106	0.87	2.58	11.2	4.1	–0.4	0.31	0.05	24.9	0.32	0.05	0.06	0.05	0.16	0.05	32.1
Convertible arbitrage	199401–200210	106	0.81	1.40	56.6	42.6	15.6	0.03	0.03	1.1	0.04	0.03	0.09	0.03	0.06	0.03	12.0
Dedicated short bias	199401–200210	106	0.22	5.29	7.8	–6.3	–5.0	–0.94	0.08	58.6	–0.93	0.08	–0.06	0.08	0.08	0.08	59.3
Emerging markets	199401–200210	106	0.54	5.38	29.4	1.2	–2.1	0.62	0.11	24.0	0.63	0.11	0.19	0.11	0.03	0.12	26.2
Equity-market neutral	199401–200210	106	0.89	0.92	29.4	18.1	8.4	0.10	0.02	21.1	0.10	0.02	0.02	0.02	0.00	0.02	22.1
Event driven	199401–200210	106	0.83	1.81	34.8	14.7	3.8	0.23	0.04	30.2	0.23	0.03	0.11	0.03	0.04	0.03	38.2
Fixed income arbitrage	199401–200210	106	0.55	1.18	39.6	10.8	5.4	0.02	0.03	0.7	0.03	0.03	0.05	0.03	0.09	0.03	12.9
Global macro	199401–200210	106	1.17	3.69	5.6	4.6	8.3	0.24	0.09	7.5	0.26	0.09	–0.01	0.09	0.23	0.09	14.1
Long/Short	199401–200210	106	0.98	3.34	15.9	5.9	–4.6	0.48	0.06	36.7	0.49	0.06	0.06	0.06	0.15	0.06	40.7
Managed futures	199401–200210	106	0.55	3.44	3.2	–6.3	0.7	–0.12	0.08	2.5	–0.13	0.08	–0.17	0.08	0.02	0.08	7.8

Notes: Autocorrelations and contemporaneous and lagged market betas for the returns of various indexes and two mutual funds, the Vanguard 500 Index Trust (which tracks the S&P 500 index), and the AXP Extra Income Fund (which focuses on high current income and invests in long-term, high-yielding, lower-rated corporate bonds). Total returns of the S&P 500 index are used for both market models. SD = standard deviation; SE = standard error.

Aggregate Measure of Illiquidity

First-order autocorrelation coefficient in month *t* for fund *i* using a rolling window of past returns: $\rho_{1t,i}$

Aggregate measure of illiquidity ρ_t^*

Cross-sectional weighted average of rolling autocorrelations:

$$\rho_t^* \equiv \sum_{i=1}^{N_t} \omega_{it} \rho_{1t,i}$$

ω_{it} proportion of assets under fund i management

$$\omega_{it} \equiv \frac{\text{AUM}_{it}}{\sum_{j=1}^{N_t} \text{AUM}_{jt}}$$

References

Lo, A.W. *Hedge Funds: An Analytic Perspective*. Princeton University Press. 2010. (including research papers cited therein).

E-mail Status Update of July 01, 2012

- File 1: Framework/Templates for Ms-Excel Model Implementation:

Develops overall framework for model implementation and related guidelines, templates, methods, and measures to ensure: (a) valid measures and methods are selected for given set of asset classes; (b) industry standard, rigorous, and robust measures, methods, and procedures are used.

- File 2: MS-Excel Data Experiments with Returns, Correlations, Heat Map:

Various data feeds for specific asset prices retrieved from Bloomberg and other data sources are aggregated and preliminary tests done for specific examples of assets such as equities, bonds, currency pair(s), funds, etc.

- File 3: Data Experiments to fit Anson Illiquidity Exposure Autocorrelation Model:

As obvious – these tests like the ones in File 2 – are experimental and very preliminary in nature and will next lead to focus on specified asset classes and choice of most appropriate corresponding measures.

Next Step Mentioned in E-Mail Update: Check?

- Next step is to find and select most appropriate measures for each asset class specified as project inputs.
- Based upon review of published research and industry practices:

Asset Class	Selected Proxy Measure
Developed Large EQ	Russell Developed Large Cap Index
Developed Small EQ	Russell Developed Small Cap Index
Emerging Equity	Vanguard Emerging Markets ETF (Yahoo)
Unlisted Equity	LPX50 Listed Private Equity Index (TR)
Various Commodities	MSCI ACWI Commodity Producers
Government Bonds	SSgA World Government Bond Index Fund
Investment Grade Bonds	Robeco Capital Growth - Robeco Investment Grade Corporate Bonds
Inflation-Linked Bonds	Credit Suisse Institutional Master Fund - Inflation Linked Bonds CHF
High Yield Corporate Bonds	FINRA - BLP Active High Yield US Corporate Bond Index
Emerging Market Hard Currency Bonds	Emerging Market Hard Currency Bonds
Emerging Market Local Currency Bonds	Stone Harbor Investment Funds plc - Emerging Markets Local Currency Debt Fund
Major Currencies	Trade Weighted U.S. Dollar Index: Major Currencies (TWEXMMTH)
HFRI Statistical Arbitrage	Merged in HFRI EH: Equity Market Neutral Index
HFRI Equity Hedge	HFRI Equity Hedge (Total) Index
HFRI Merger Arbitrage	HFRI ED: Merger Arbitrage Index
HFRI Macro	HFRI Macro (Total) Index
HFRI Relative Value	HFRI Relative Value (Total) Index

Developed Large EQ
Russell Developed Large Cap Index

http://www.russell.com/indexes/data/fact_sheets/global/russell_developed_large_cap_index.asp

Facts and characteristics

Facts

Bloomberg ticker symbol	RDEVL
Weighted average market cap ($B)	72.603
Median market cap ($B)	5.020
Largest stock by market cap	534.259

Market capitalization ranges as of latest reconstitution

Characteristics

Price/Book	1.63
Dividend Yield	2.93
P/E Ex-Neg Earnings	13.0
Long-Term Growth Forecast - IBES	10.25
EPS Growth - 5 Years	6.4

Developed Small EQ
Russell Developed Small Cap Index

http://www.russell.com/indexes/data/fact_sheets/global/russell_developed_small_cap_index.asp

Facts and characteristics

Facts

Bloomberg ticker symbol	RDEVS
Weighted average market cap ($B)	1.200
Median market cap ($B)	0.497
Largest stock by market cap	4.064

Market capitalization ranges as of latest reconstitution

Characteristics

Price/Book	1.31
Dividend Yield	2.27
P/E Ex-Neg Earnings	13.8
Long-Term Growth Forecast - IBES	12.34
EPS Growth - 5 Years	3.8

Emerging Equity
Vanguard MSCI Emerging Markets ETF

https://personal.vanguard.com/us/FundsSnapshot?FundId=0964&FundIntExt=INT

Vanguard MSCI Emerging Markets ETF (VWO)

Also available as Admiral™ Shares and Investor Shares mutual funds.

Buy Compare

Overview | Price & Performance | Portfolio & Management | Fees | Distributions | News & Reviews

Product summary

- Invests in stocks of companies located in emerging markets around the world, such as Brazil, Russia, China, Korea, and Taiwan.
- Goal is to closely track the return of the MSCI Emerging Markets Index over the long term.
- Has high potential for growth, but also high risk; share value may swing up and down more than that of stock funds that invest in developed countries, including the United States.
- Only appropriate for long-term goals.
- ETF formerly known as Vanguard Emerging Markets ETF.

View prospectus and reports

ETF facts

Asset class	International/Global Stock	
Category	Diversified Emerging Markets	
IOV ticker symbol	VWO.IV	
Expense ratio as of 02/28/2012	0.20%	This is **88% lower** than the average expense ratio of funds with similar holdings.*
ETF advisor	Vanguard Equity Investment Group	

Unlisted Equity?
LPX50 Listed Private Equity Index (TR)

http://shop.lpx.ch/product_info.php?info=p17_LPX50

July 2012 up to July 2012 Currency: EUR Separator: comma

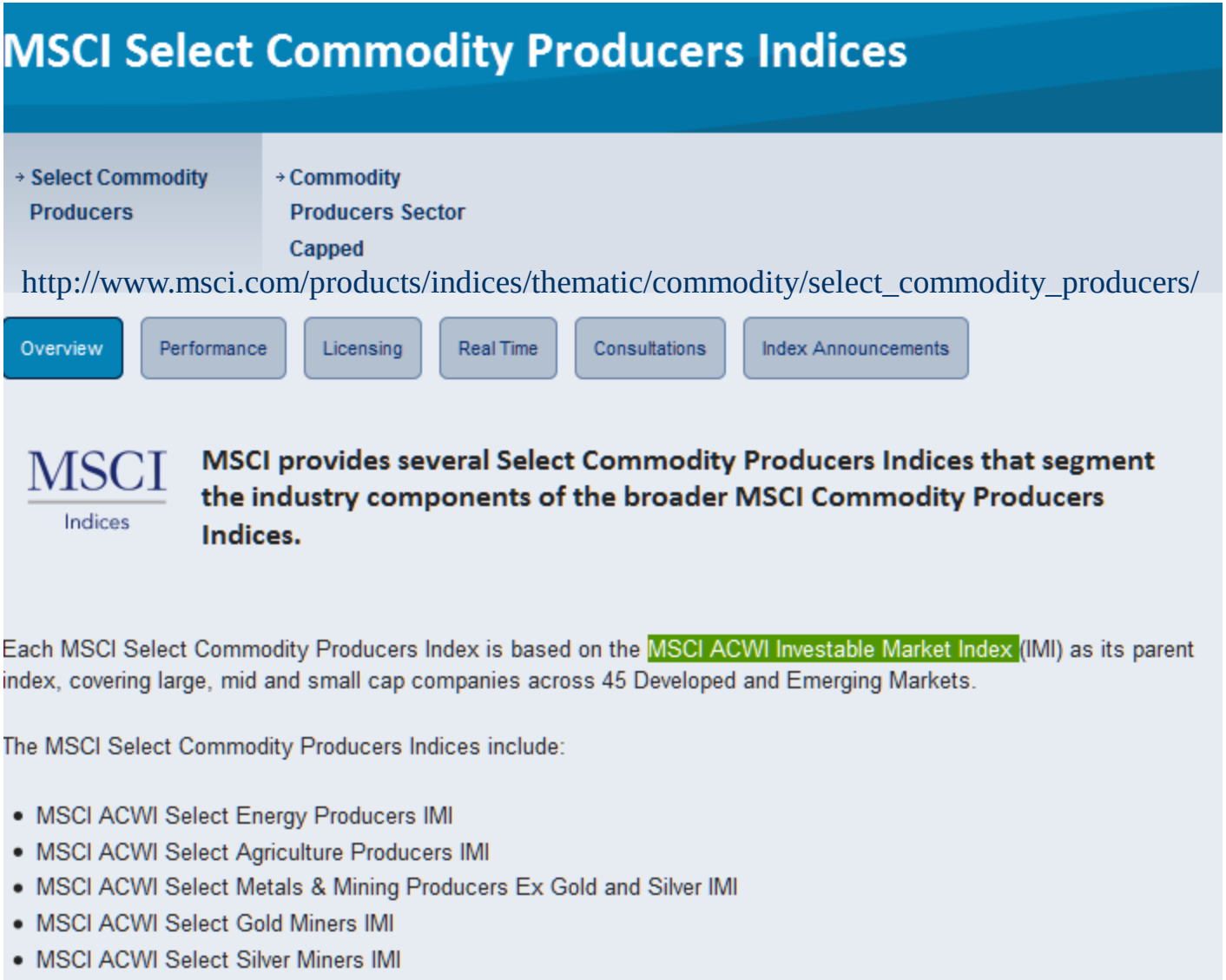
LPX50® TR: 07/05/2012

3 months | 6 months | 1 year | 3 years

Name:	LPX50® Total Return (TR)
Reference date:	December 31, 1985
Currency:	EUR
Value:	EUR 963,34 (+0,37%)
ISIN:	CH0022737545
Bloomberg:	LPX50TR Index
Reuters:	.LPX50TR
Financial Products:	SGAM Index Liquid Private Equity (LPX50) Swisscanto (LU) Equity Fund LPE

Noted in academic and applied research as proxy for Unlisted Equity.
Basel uses LPX50; some recommend Thomson-Reuters / NVCA's PE Index.

Various Commodities?
MSCI ACWI Commodity Producers

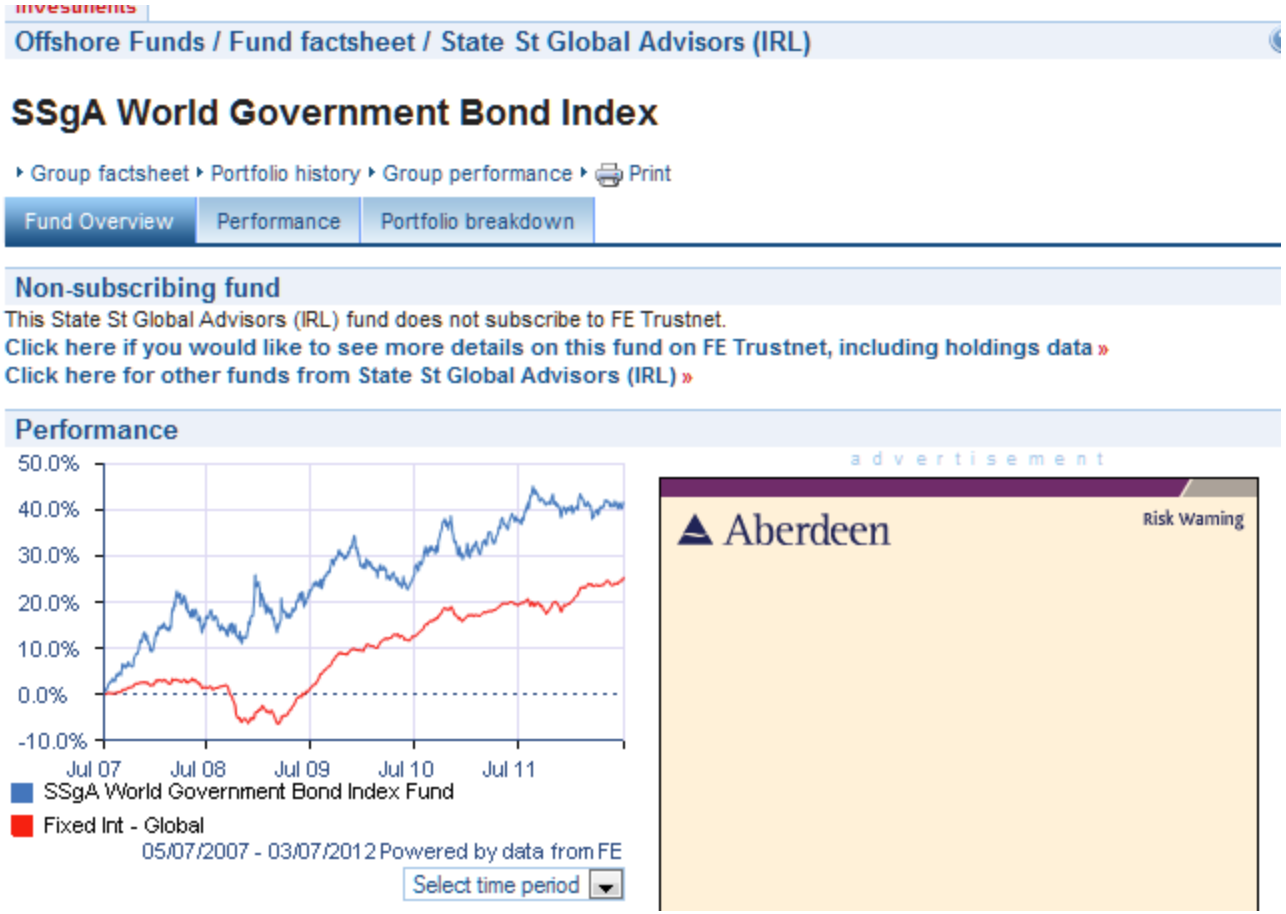


Various Commodities
MSCI ACWI Commodity Producers

http://origin-www.bloomberg.com/quote/MXWDCOMP:IND

Government Bonds
SSgA World Government Bond Index Fund

http://www.trustnet.com/Factsheets/Factsheet.aspx?fundCode=TKF38&univ=B



Investment Grade Bonds?
Robeco Investment Grade Corporate Bonds

http://www.robeco.nl/dut/particulieren/robeco_investment_grade_corporate_bonds.jsp

ROBECO

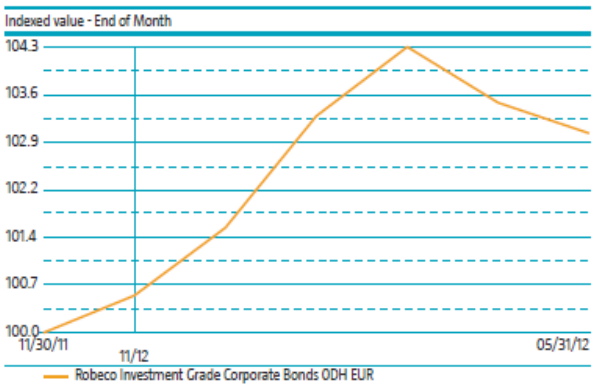
Robeco Investment Grade Corporate Bonds ODH EUR

Figures as of 31/05/2012

Tracks Citigroup World Government Bond Index. Alternative is DBSGUSHL Global Developed Country Fixed Coupon Government bond.

Performance

	Fund	Rel.
3 m	-0.25%	-2.10%
Ytd	2.43%	-3.08%



General facts

Type of fund	Bonds
Currency	EUR
Total Size of fund	EUR 1,465,023,155
Size of sub fund	EUR 50,500
Outstanding shares	5
1st quotation date	02/11/2011
Close financial year	30/06
Daily tradable	Yes
Dividend paid	No
Management Company	Robeco Luxembourg S.A.
Ex-ante tracking error limit	-

Fund Manager

Peter Kwaak

Fund Manager since 27/03/09

We argue that investing in credits offers attractive diversification opportunities within the fixed income asset class. Robeco's Investment Grade Corporate Bonds aims to achieve outperformance predominantly through superior issuer selection based on extensive qualitative and quantitative analyses. This combined with a low interest rate senstivity makes this fund very interesting for investors just wanting to have investment grade corporate bond exposure (excluding financials).

Expectation of Fund Manager

We continue to have a modest overweight on investment-grade credit. We like the non-financial corporate part of the market. It is well positioned to deal with lower growth globally and the recession in parts of Europe. While we remain concerned about the European debt crisis, this mainly affects the financial sector. Corporates continue to offer attractive spreads over government bonds. The IGCB Index spread (ex-financials) stood at 205 basis points at the end of May.

Credit Suisse Institutional Master Fund Inflation Linked Bonds CHF?

http://www.bloomberg.com/quote/CSIMILD:SW

Multiple versions with different issue dates just like prior Robeco Funds.

High Yield Corporate Bonds
FINRA - BLP Active High Yield US Corporate Bond Index

http://www.bloomberg.com/quote/IEMDIHC:LX

FINRA - BLP Active High Yield US Corporate Bond Index Price + Add to Portfolio

NBBHPR:IND 131.23790 ↑ 0.16740 0.13%

As of 07/05/2012.

More on NBBHPR

Snapshot

Chart

Snapshot for FINRA - BLP Active High Yield US Corporate Bond Index Price (NBBHPR)

Open: - High: -

Rate Chart for NBBHPR »

Interactive NBBHPR Chart »

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3 Asian Stoc Disappoint

4 Amazon S Apple

5 Buffett, Zu Event

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Emerging Market Hard Currency Bonds

http://www.bloomberg.com/quote/IEMDIHC:LX

ING L Renta Fund - Emerging Markets Debt Hard Currency

+ Add to Portfolio

IEMDIHC:LX 4,351.99 EUR ↑ 45.68 1.06%

As of 00:59:30 ET on 07/05/2012. Mutual Fund NAVs include dividends.

More on IEMDIHC

- Snapshot
- Chart
- Browse All Funds

Snapshot for ING L Renta Fund - Emerging Markets Debt Hard Currency (IEMDIHC)

Year To Date:	+9.15%	3-Month:	+2.30%	3-Year:	+16.30%
1-Month:	+4.85%	1-Year:	+10.74%	5-Year:	+7.73%

Mutual Fund Chart for IEMDIHC »

Interactive IEMDIHC Chart »

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4. Amazon Apple
5. Buffett, Z Event

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Emerging Market Local Currency Bonds

Stone Harbor Investment Funds plc - Emerging Markets Local Currency Debt Fund

http://www.bloomberg.com/quote/SEMLCIA:ID

Stone Harbor Investment Funds plc - Emerging Markets Local Currency Debt Fund + Add to Portfolio

SEMLCIA:ID 189.23 GBP ↑ 0.29 0.15%

As of 00:59:30 ET on 07/04/2012. Mutual Fund NAVs include dividends.

More on SEMLCIA

- Snapshot
- Chart
- Browse All Funds

Snapshot for Stone Harbor Investment Funds plc - Emerging Markets Local Curre

Year To Date:	+6.53%	3-Month:	+1.20%	3-Year:	+13.74%
1-Month:	+4.44%	1-Year:	+1.98%	5-Year:	-

Mutual Fund Chart for SEMLCIA »

Most Po

1. Eur Job
2. Asi Dis
3. Sar Est
4. Am App
5. Buf Eve

Mor

Advertise

Major Currencies

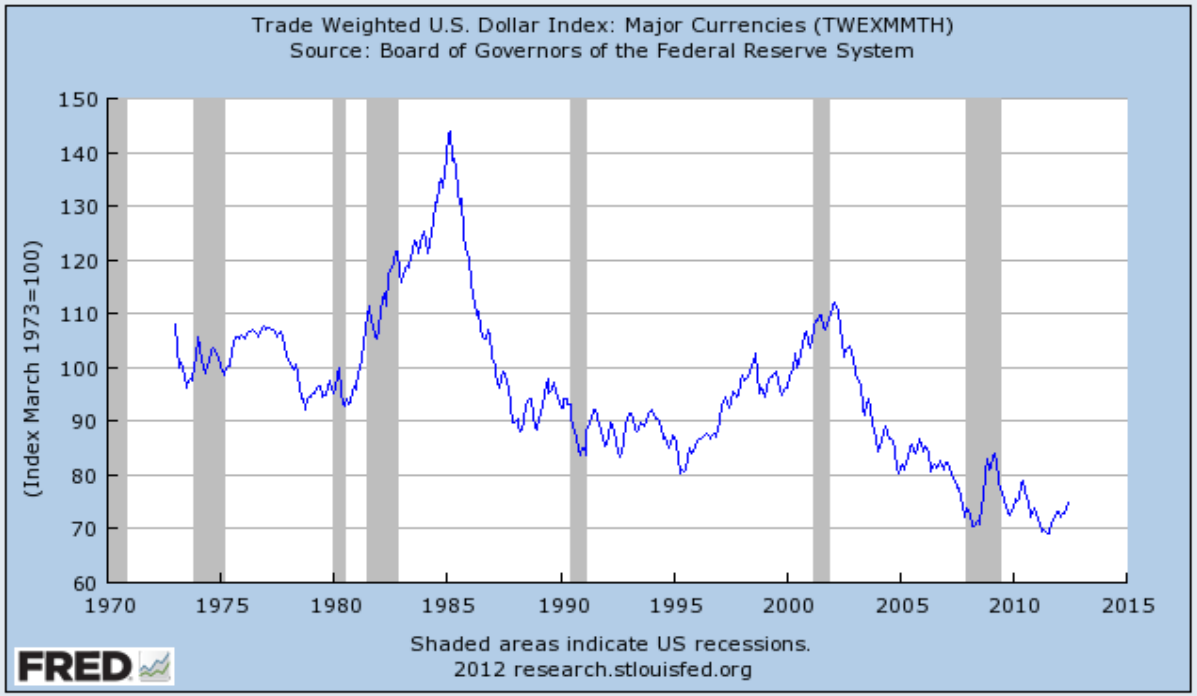
Trade Weighted U.S. Dollar Index: Major Currencies (TWEXMMTH)

http://research.stlouisfed.org/fred2/series/TWEXMMTH

Home > FRED® Economic Data > Categories > Money, Banking, & Finance > Exchange Rates > Monthly Rates

Trade Weighted U.S. Dollar Index: Major Currencies (TWEXMMTH)

2012-06: **75.0265** Index March 1973=100 Last 5 Observations
Monthly, Not Seasonally Adjusted, Updated: 2012-07-02 9:31 AM CDT



HFRI Statistical Arbitrage?
Merged in HFRI EH: Equity Market Neutral Index

https://www.hedgefundresearch.com/monthly/index.php?fuse=showFund&fid=194426048&

HFRI Monthly Indices

HFRI EH: Equity Market Neutral Index

Ticker	Strategy	Substrategy	Regional Investment Focus	Currency	Reporting Interv
HFRIEMNI	Equity Hedge	Equity Market Neutral	Global	USD	Monthly

PERFORMANCE

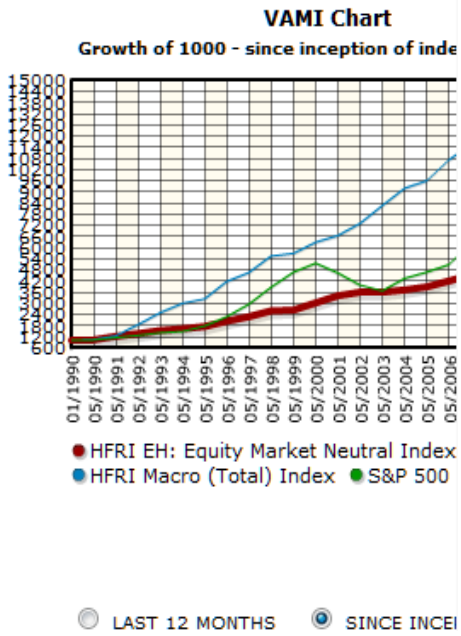
Total Return	One Year	Three Year	Five Year	Ten Year
As of 05/2012	-2.88%	2.82%	-2.07%	23.20%

Annualized Return	Three Year	Five Year	Ten Year
As of 05/2012	0.93%	-0.42%	2.11%

HFRI EH: Equity Market Neutral Index

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD
2012	1.23%	0.48%	-0.06%	-0.20%	-0.67%								0.78%
2011	0.73%	0.47%	0.40%	0.35%	-0.40%	-0.12%	-0.26%	-2.45%	-2.76%	1.85%	-0.18%	0.32%	-2.13%
2010	-0.20%	0.44%	0.59%	-0.07%	-0.68%	-0.65%	0.89%	-0.70%	1.17%	0.87%	0.26%	0.93%	2.85%
2009	0.15%	-0.89%	0.07%	-0.37%	1.12%	0.16%	0.27%	0.51%	0.31%	-0.10%	-0.34%	0.55%	1.43%
2008	-1.04%	1.45%	-0.57%	0.16%	1.12%	1.37%	-1.13%	-1.38%	-2.87%	-0.50%	-0.02%	-2.56%	-5.92%
2007	0.84%	0.23%	0.92%	0.77%	1.26%	0.71%	-0.05%	-1.26%	0.72%	0.90%	-0.30%	0.45%	5.29%
2006	1.45%	0.27%	0.91%	1.29%	-0.07%	0.63%	0.36%	0.06%	0.21%	0.67%	0.49%	0.83%	7.32%
2005	0.64%	1.16%	0.10%	-0.38%	0.58%	0.84%	0.82%	0.56%	0.95%	-0.30%	0.56%	0.54%	6.22%
2004	1.07%	0.57%	0.41%	-1.15%	0.35%	0.38%	0.18%	-0.23%	0.79%	-0.01%	1.31%	0.43%	4.15%
2003	0.30%	-0.18%	-0.05%	0.36%	0.35%	0.40%	-0.44%	0.13%	0.60%	1.06%	0.20%	-0.29%	2.44%
2002	0.76%	-0.22%	0.06%	0.99%	0.03%	0.05%	-0.27%	0.53%	-0.25%	-0.29%	-0.91%	0.51%	0.98%
2001	-1.57%	2.07%	1.77%	0.06%	0.28%	0.36%	0.45%	1.73%	1.31%	0.01%	-0.36%	0.46%	6.71%
2000	-1.19%	2.26%	0.48%	2.64%	0.27%	1.50%	-0.04%	3.06%	0.94%	0.23%	1.03%	2.58%	14.56%
1999	0.15%	-1.33%	-0.76%	-0.65%	0.17%	2.02%	1.81%	0.70%	0.85%	0.44%	1.05%	2.39%	7.08%

CHARTING



HFRI Equity Hedge
HFRI Equity Hedge (Total) Index

https://www.hedgefundresearch.com/monthly/index.php?fuse=showFund&fid=218484032&

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HFRI Equity Hedge (Total) Index

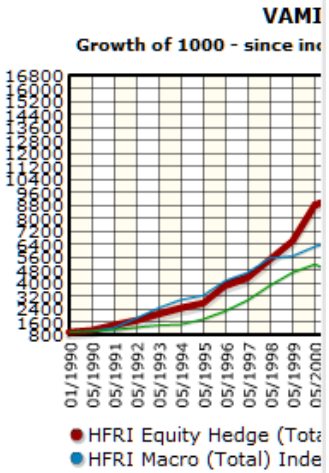
Ticker	Strategy	Substrategy	Regional Investment Focus	Currency	Reporting
HFRIEHI	Equity Hedge	Composite	Global	USD	Monthly

PERFORMANCE

Total Return	One Year	Three Year	Five Year	Ten Year
As of 05/2012	-9.39%	13.97%	-3.50%	55.53%

Annualized Return	Three Year	Five Year	Ten Year
As of 05/2012	4.45%	-0.71%	4.52%

CHARTING



HFRI Equity Hedge (Total) Index

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD
2012	3.88%	2.89%	0.01%	-0.78%	-4.63%								1.15%
2011	0.42%	1.30%	0.50%	1.34%	-1.28%	-1.26%	-0.33%	-4.89%	-6.04%	4.91%	-2.02%	-0.91%	-8.38%
2010	-1.27%	0.92%	3.15%	1.19%	-4.05%	-1.85%	2.36%	-1.37%	4.74%	2.37%	0.64%	3.52%	10.45%
2009	-0.88%	-2.20%	2.90%	5.44%	6.37%	0.18%	3.20%	1.37%	3.22%	-0.72%	1.57%	2.07%	24.57%
2008	-4.47%	1.31%	-2.84%	2.45%	2.38%	-2.44%	-2.84%	-2.17%	-8.14%	-9.46%	-3.77%	0.22%	-26.65%
2007	1.16%	0.63%	1.01%	1.86%	2.24%	0.89%	0.17%	-1.67%	3.18%	3.09%	-2.89%	0.53%	10.48%
2006	3.95%	0.02%	2.55%	1.76%	-2.32%	-0.54%	-0.54%	1.03%	0.16%	1.86%	2.00%	1.35%	11.71%
2005	-0.58%	2.13%	-1.05%	-2.23%	1.55%	1.96%	2.95%	0.74%	2.25%	-1.87%	2.14%	2.32%	10.60%
2004	1.95%	1.11%	0.36%	-2.08%	-0.19%	1.07%	-1.88%	-0.37%	1.99%	0.48%	3.37%	1.76%	7.68%
2003	-0.01%	-0.78%	-0.07%	2.43%	4.08%	1.52%	2.41%	2.38%	0.78%	3.12%	1.14%	1.93%	20.54%

HFRI Merger Arbitrage
HFRI ED: Merger Arbitrage Index

HFRI Monthly Indices Two week free trial of HFRDatabase.com

https://www.hedgefundresearch.com/monthly/index.php?fuse=showFund&fid=246381056&

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HFRI ED: Merger Arbitrage Index

Ticker	Strategy	Substrategy	Regional Investment Focus	Currency	Reporting Interval
HFRIMAI	Event-Driven	Merger Arbitrage	Global	USD	Monthly

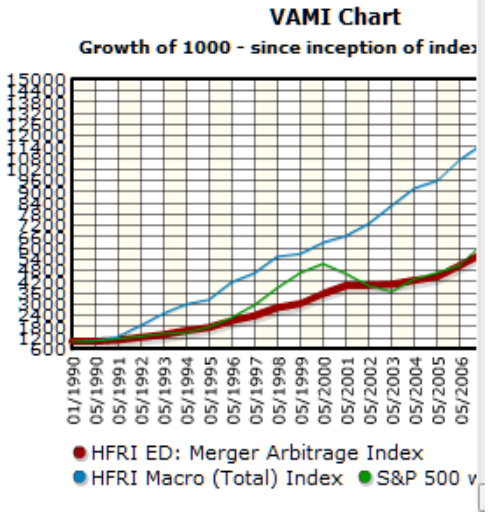
PERFORMANCE

Total Return	One Year	Three Year	Five Year	Ten Year	Annualized Return	Three Year	Five Year	Ten Year
As of 05/2012	0.23%	13.93%	13.80%	62.04%	As of 05/2012	4.44%	2.62%	4.95%

HFRI ED: Merger Arbitrage Index

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD
2012	0.68%	0.89%	0.11%	-0.19%	-0.46%								1.03%
2011	0.63%	0.72%	0.25%	0.73%	-0.04%	-0.12%	-0.39%	-1.11%	-0.66%	1.22%	0.17%	0.10%	1.50%
2010	0.31%	0.61%	0.63%	0.26%	-1.25%	0.08%	1.38%	0.46%	1.19%	0.33%	-0.35%	0.87%	4.60%
2009	0.21%	0.20%	2.07%	1.11%	1.44%	0.97%	0.71%	1.14%	1.16%	0.39%	0.77%	0.91%	11.65%
2008	-1.78%	0.88%	-0.86%	1.40%	0.93%	-1.43%	-0.39%	0.32%	-2.90%	-2.47%	-0.25%	1.15%	-5.37%
2007	1.86%	1.12%	0.33%	1.27%	1.87%	-0.29%	-0.76%	0.37%	0.98%	1.89%	-1.46%	-0.28%	7.05%
2006	3.12%	1.16%	1.97%	1.41%	-0.07%	0.82%	0.76%	0.68%	-0.30%	1.49%	0.92%	1.47%	14.24%
2005	-0.03%	0.72%	0.12%	-1.42%	1.62%	1.14%	1.12%	0.71%	0.63%	-1.57%	1.29%	1.82%	6.25%
2004	1.02%	0.59%	0.07%	-0.85%	-0.14%	0.32%	-1.02%	0.20%	0.59%	0.54%	1.62%	1.10%	4.08%
2003	0.15%	-0.01%	-0.10%	1.29%	1.76%	0.43%	0.71%	0.69%	0.63%	0.72%	0.29%	0.69%	7.47%

CHARTING



HFRI Macro
HFRI Macro (Total) Index

https://www.hedgefundresearch.com/monthly/index.php?fuse=showFund&fid=246210432&

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HFRI Macro (Total) Index

Ticker	Strategy	Substrategy	Regional Investment Focus	Currency	Reporting Ir
HFRIMI	Macro	Composite	Global	USD	Monthly

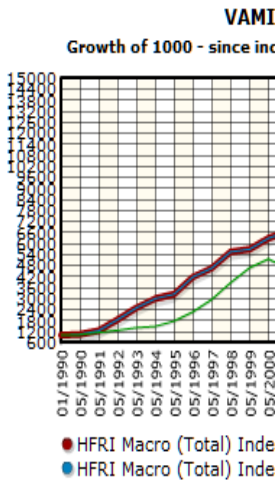
PERFORMANCE

Total Return	One Year	Three Year	Five Year	Ten Year	Annualized Return	Three Year	Five Year	Ten Year
As of 05/2012	-2.67%	6.40%	22.25%	93.46%	As of 05/2012	2.09%	4.10%	6.82%

CHARTING

HFRI Macro (Total) Index

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD
2012	1.27%	0.79%	-1.32%	-0.54%	0.83%								1.01%
2011	-0.72%	1.28%	-1.09%	2.37%	-2.30%	-1.74%	1.66%	-0.51%	-1.24%	-0.92%	-0.65%	-0.25%	-4.16%
2010	-1.95%	0.16%	1.59%	0.82%	-1.58%	-0.12%	-0.06%	1.69%	2.74%	2.23%	-0.92%	3.34%	8.06%
2009	-0.10%	-0.12%	-0.61%	-0.09%	3.54%	-1.17%	0.49%	0.37%	1.71%	-0.52%	2.17%	-1.30%	4.34%
2008	1.08%	4.22%	-1.22%	-0.03%	1.20%	1.19%	-2.62%	-1.18%	-1.21%	1.63%	0.73%	1.11%	4.83%
2007	0.37%	0.22%	-0.09%	1.63%	1.81%	1.51%	0.79%	-2.11%	3.23%	3.26%	-0.89%	0.98%	11.11%
2006	2.40%	-0.47%	1.15%	2.76%	-1.36%	-0.48%	-0.26%	0.23%	-0.76%	1.14%	2.36%	1.27%	8.15%
2005	-0.58%	1.81%	-0.60%	-1.06%	0.35%	1.06%	0.74%	0.73%	2.11%	-0.63%	1.46%	1.28%	6.79%
2004	0.65%	2.00%	1.12%	-2.84%	-0.70%	-0.11%	-0.33%	-0.23%	0.84%	0.84%	2.81%	0.61%	4.63%
2003	2.52%	1.91%	-2.23%	1.23%	5.67%	0.53%	0.73%	1.86%	2.26%	1.73%	0.19%	3.38%	21.42%



HFRI Relative Value
HFRI Relative Value (Total) Index

https://www.hedgefundresearch.com/monthly/index.php?fuse=showFund&fid=246466368&

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HFRI Relative Value (Total) Index

Ticker	Strategy	Substrategy	Regional Investment Focus	Currency	Reporting Interval
HFRIRVA	Relative Value	Composite	Global	USD	Monthly

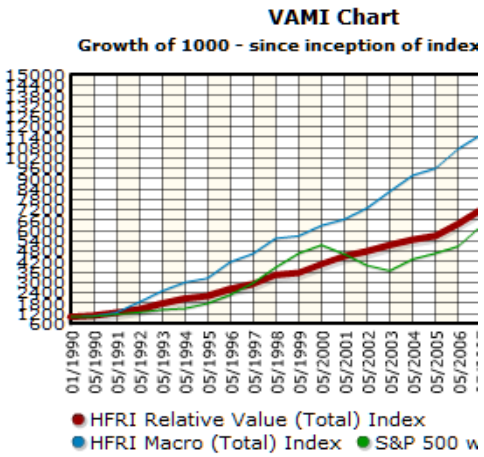
PERFORMANCE

Total Return	One Year	Three Year	Five Year	Ten Year	Annualized Return	Three Year	Five Year	Ten Year
As of 05/2012	0.06%	30.52%	22.16%	83.65%	As of 05/2012	9.28%	4.08%	6.27%

HFRI Relative Value (Total) Index

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD
2012	1.97%	1.58%	0.56%	0.21%	-1.12%								3.21%
2011	1.15%	0.91%	0.29%	0.83%	0.10%	-0.25%	0.00%	-2.17%	-1.68%	1.27%	-0.59%	0.38%	0.15%
2010	1.53%	0.56%	1.62%	1.39%	-1.79%	0.37%	1.70%	0.82%	1.63%	1.56%	0.46%	1.07%	11.43%
2009	2.05%	0.52%	1.00%	3.10%	3.93%	1.55%	2.97%	1.75%	2.45%	1.26%	0.61%	2.05%	25.81%
2008	-1.29%	-0.09%	-1.99%	1.39%	1.27%	-0.63%	-0.82%	-0.14%	-5.90%	-8.03%	-2.80%	-0.24%	-18.04%
2007	1.37%	0.76%	0.75%	1.42%	1.49%	0.56%	-0.58%	-0.69%	1.35%	2.10%	-0.53%	0.64%	8.94%
2006	2.20%	0.62%	1.33%	1.12%	0.20%	0.55%	0.42%	0.71%	0.37%	1.23%	1.37%	1.61%	12.37%
2005	0.30%	0.78%	-0.35%	-0.84%	-0.10%	0.96%	1.34%	0.69%	1.18%	-0.36%	0.82%	1.48%	6.02%
2004	1.21%	0.55%	0.43%	-0.51%	-0.35%	0.16%	0.65%	0.83%	0.36%	0.31%	1.07%	0.75%	5.58%
2003	1.03%	0.70%	0.71%	1.39%	0.98%	0.48%	0.04%	0.37%	0.86%	1.06%	0.48%	1.23%	9.72%

CHARTING



Asset Classes: Ticker Codes & More Information

http://www.bloomberg.com/quote/RDEVL:IND
http://www.bloomberg.com/quote/RDEVS:IND
http://www.bloomberg.com/quote/VWO:US
http://www.bloomberg.com/quote/LPX50TR:IND
http://origin-www.bloomberg.com/quote/MXWDCOMP:IND
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Spreadsheet Template: Asset Class
Emerging Equity

A1 | fx | Date

	A	B	C	D	E	F	G	H	I	J	K
1	Date	Open	High	Low	Close	Volume	Adj Close	%RET	WMA	EWV	VAMI ($)
2	1/3/2007	78.27	79.1	77.4	77.9	1176000	34.42	-0.00474	-0.01%	1.19%	100
3	1/4/2007	77.4	77.45	76.54	77.05	1115600	34.05	-0.00453	-0.01%	1.17%	100.00
4	1/5/2007	76.03	76.25	74.65	74.9	1145800	33.1	-0.01497	-0.01%	1.20%	99.98
5	1/8/2007	75.32	75.77	74.88	75.72	496200	33.46	0.005297	-0.01%	1.14%	99.99
6	1/9/2007	75.3	75.3	73.23	73.91	934600	32.66	-0.01863	-0.01%	1.15%	99.97
7	1/10/2007	73	73.85	72.25	73.7	839200	32.57	0.009543	-0.01%	1.16%	99.98
8	1/11/2007	73.89	75.32	73.6	74.68	1155600	33	0.010635	-0.01%	1.17%	99.99
9	1/12/2007	75.11	75.77	74.75	75.77	403200	33.48	0.008749	-0.01%	1.19%	100.00
10	1/16/2007	76.4	76.4	75.53	75.8	1024000	33.5	-0.00788	-0.01%	1.23%	99.99
11	1/17/2007	75.75	76	75.35	75.6	1346400	33.41	-0.00198	-0.01%	1.19%	99.99
12	1/18/2007	76.5	76.5	75.1	75.2	724800	33.23	-0.01714	-0.01%	1.19%	99.97
13	1/19/2007	75.76	76.65	75.5	76.65	998000	33.87	0.011679	-0.01%	1.22%	99.98
14	1/22/2007	76.97	77	76.17	76.58	616800	33.84	-0.00508	-0.01%	1.20%	99.98
15	1/23/2007	76.74	77.9	76.52	77.9	847600	34.42	0.015003	-0.01%	1.23%	99.99
16	1/24/2007	78.09	78.61	77.64	78.61	652000	34.74	0.006637	-0.01%	1.11%	100.00
17	1/25/2007	78.09	78.2	75.96	76.21	1030000	33.68	-0.02437	-0.01%	1.14%	99.97
18	1/26/2007	77	77	75.7	76.67	520000	33.88	-0.00429	-0.01%	1.17%	99.97
19	1/29/2007	76.44	76.6	75.78	76.05	380200	33.61	-0.00512	-0.01%	1.15%	99.96
20	1/30/2007	75.79	76.87	75.79	76.87	1012600	33.97	0.014149	-0.01%	1.10%	99.98
21	1/31/2007	76.12	77.46	75.83	77.45	2860200	34.22	0.017322	-0.01%	1.13%	99.99
22	2/1/2007	77.92	78.37	77.65	78.23	1995600	34.57	0.003971	-0.01%	1.17%	100.00
23	2/2/2007	78.4	78.4	77.79	78.2	650800	34.56	-0.00255	-0.01%	1.20%	100.00
24	2/5/2007	78.4	78.4	77.77	78.2	1338200	34.56	-0.00255	-0.01%	1.24%	99.99

Spreadsheet Template: Asset Class
Emerging Equity

Descriptive Statistics	
AVERAGE:	-0.00051
STD DEV:	0.017298
SKEW:	-0.10
EXCESS-KURTOSIS:	6.94
MEDIAN:	0.000204
MIN:	-0.10703
MAX:	0.107158
Q 1:	-0.00783
Q 3:	0.007526

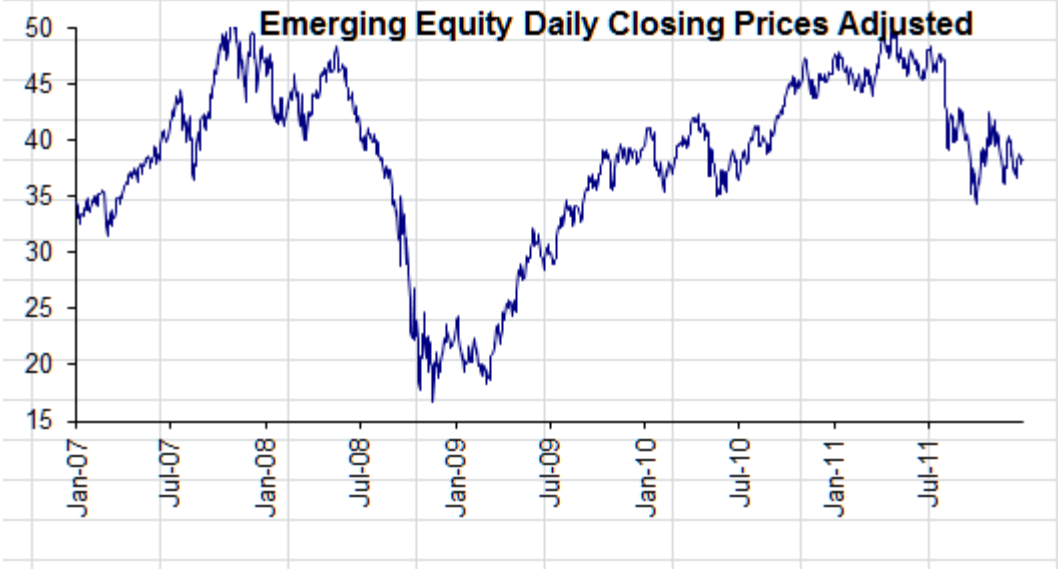
Significance Test			5.00%
Target	P-Value	SIG?	
0.000	14.84%	FALSE	
0.000	7.57%	FALSE	
0.000	0.00%	TRUE	

Test	p-value	SIG?
White-noise	6.99%	TRUE
Normal Distributed?	0.00%	FALSE
ARCH Effect?	0.00%	TRUE

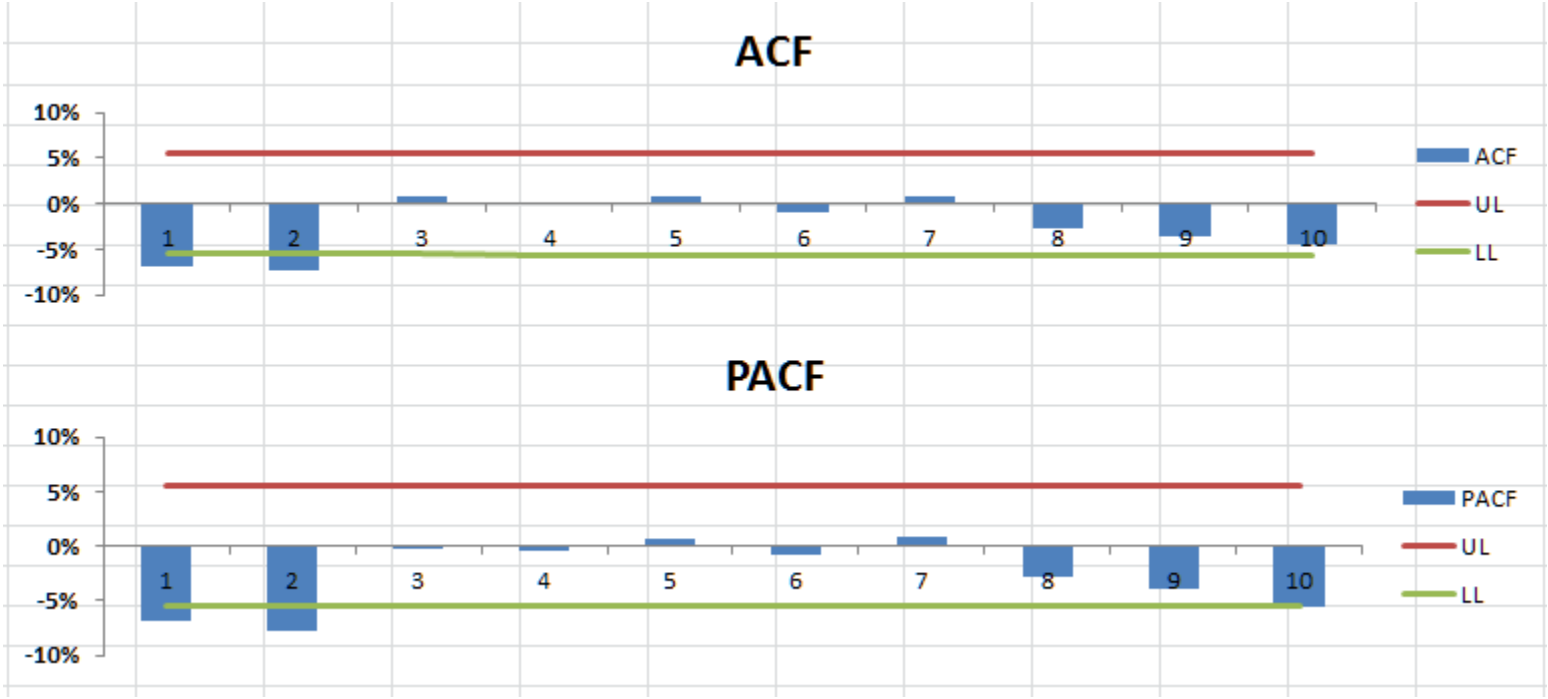
Spreadsheet Template: Asset Class
Emerging Equity

Correlogram Analysis

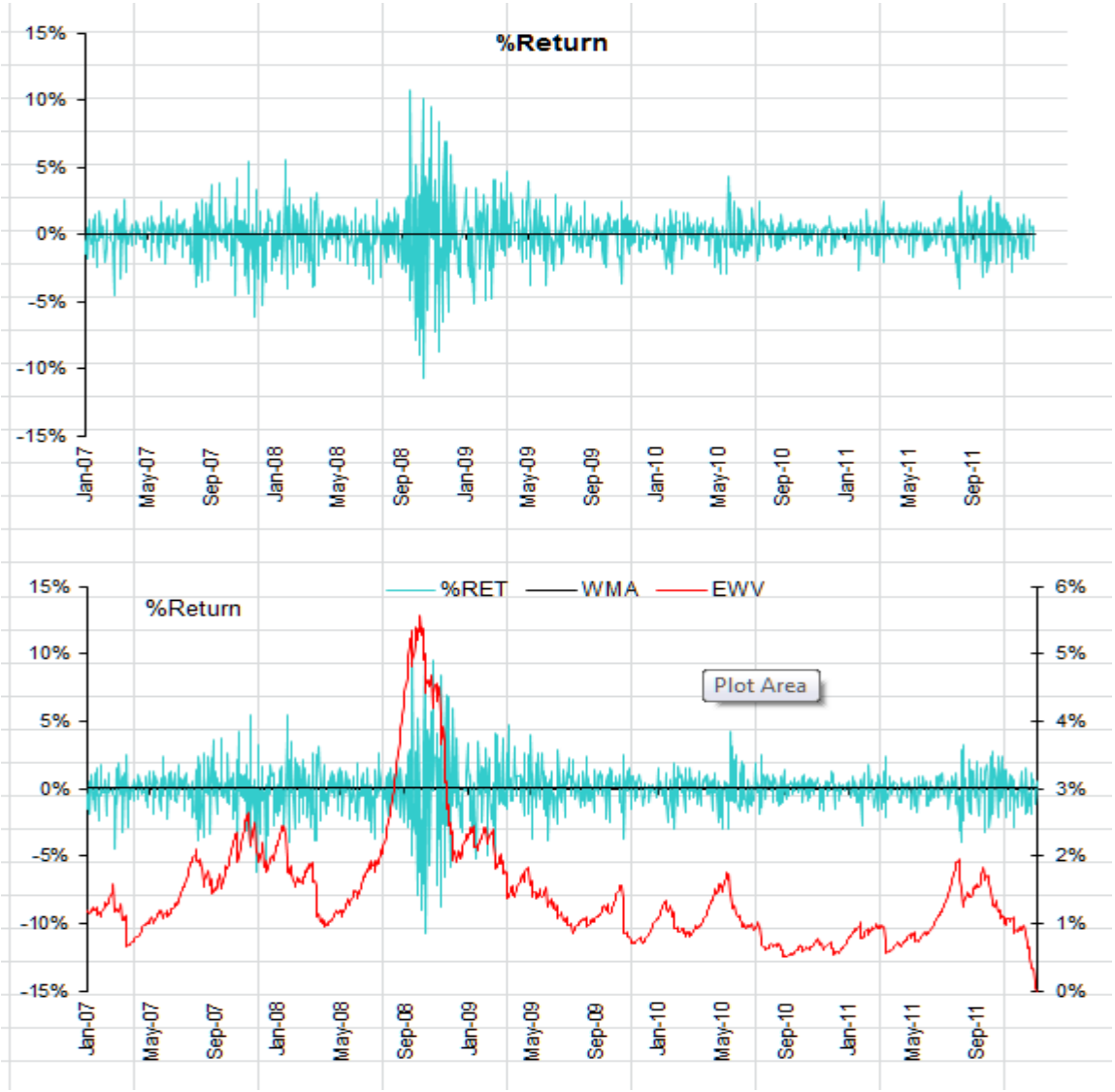
Lag	ACF	UL	LL	PACF	UL	LL
1	-6.86%	5.52%	-5.52%	-6.86%	5.52%	-5.52%
2	-7.35%	5.52%	-5.52%	-7.86%	5.52%	-5.52%
3	0.90%	5.55%	-5.55%	-0.19%	5.52%	-5.52%
4	0.12%	5.58%	-5.58%	-0.41%	5.52%	-5.52%
5	0.70%	5.58%	-5.58%	0.74%	5.52%	-5.52%
6	-0.87%	5.58%	-5.58%	-0.80%	5.52%	-5.52%
7	0.76%	5.58%	-5.58%	0.76%	5.52%	-5.52%
8	-2.79%	5.58%	-5.58%	-2.85%	5.52%	-5.52%
9	-3.54%	5.58%	-5.58%	-3.88%	5.52%	-5.52%
10	-4.55%	5.58%	-5.58%	-5.62%	5.52%	-5.52%



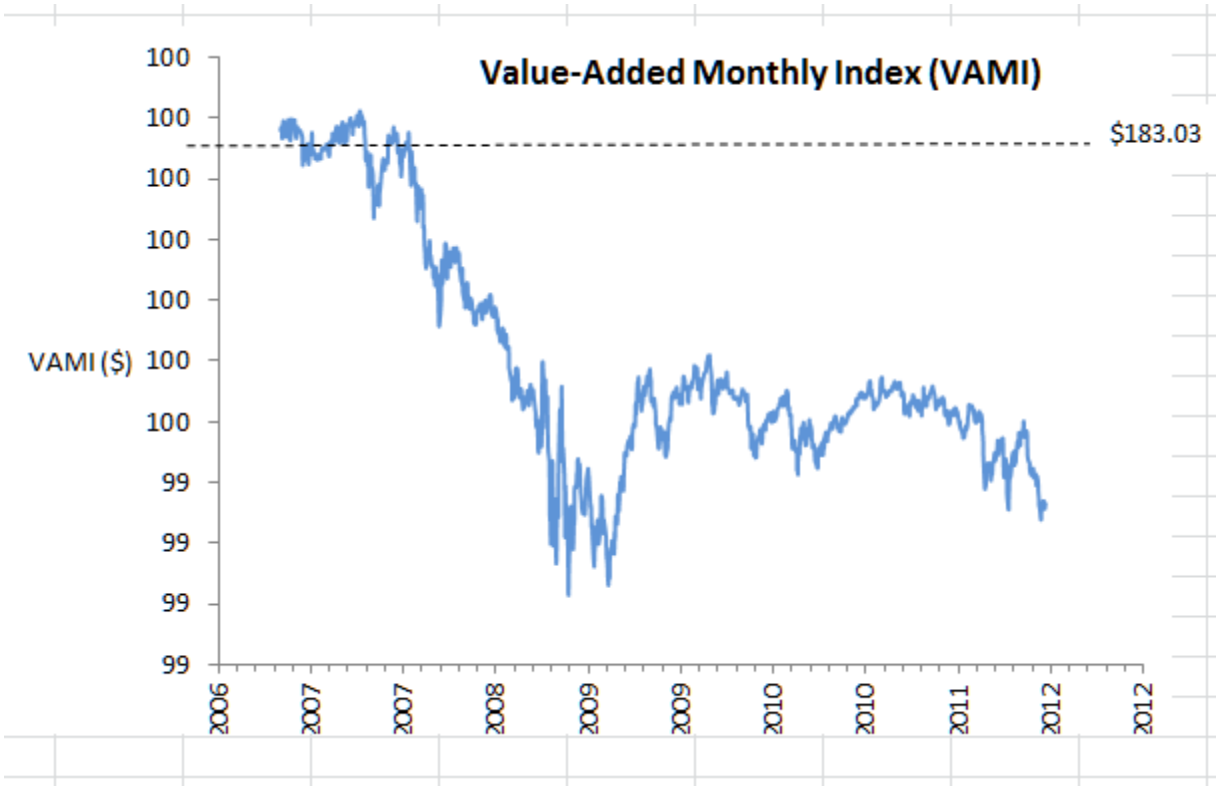
Spreadsheet Template: Asset Class
Emerging Equity: Autocorrelation, and Partial AC



Spreadsheet Template: Asset Class
Emerging Equity



Spreadsheet Template: Asset Class
Emerging Equity



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