Total Plan Risk: Integrating Assets into a Consistent Risk Framework

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Do We Want to Measure Risk or Manage It?

- Measuring risk is an exercise in forecasting
- Managing risk requires decision making
- Managing risk well requires rational decision making based on an understanding of utility theory

What Risks are of Concern to Us?

- Asset/liability mismatch risks
- Asset class volatility
- Style and active management risks

How about Multiple Portfolios?

- The firm-wide (plan-wide) risk problem
  - Multiple portfolios with multiple benchmarks
  - Across countries, across asset classes
  - Mixture of liquid, and illiquid assets, derivatives
  - Need to integrate liabilities

Approach Number #1

- Build factor risk model for each portfolio separately and aggregate the risks
- Arises from the existing stock of models
- Advantage is that you are probably using the same models at the portfolio level so you have internal consistency
- Problems
  - Not intuitive, as you can't add exposures
  - Lots of factors may lead to covariance matrix which is not positive definite
  - Use high frequency data or an EM algorithm
  - Inclusion of liabilities or illiquid assets

Approach #2

- Proxy each asset class with indices and then use full covariance. Adapted from trading desk systems
- Advantage is simplicity. Works well for asset classes where instruments within the class are homogeneous
- Problems
  - Stocks are very heterogeneous, but covariance between individual stocks is very noisy and unstable
  - No index values for illiquid assets

Approach #3

- Build a single parsimonious factor model for all assets everywhere
- Chaumeton, Connor and Curds (1996)
- Advantage are parsimony, stability and transparency. Problematic assets can still be proxied with an index
- Disadvantage: risk assessment for a given portfolio may differ from that of an asset class specific model
- We favor approach #3

Decomposition of Securities is the Key to Parsimony

- Credit risk can be modeled using equity factors, so risky bonds can be decomposed into riskless debt and equity
- Convertible securities are combinations of risky debt and a warrant. Warrants are long term options, with delta-neutral underlying equivalents
- For a detailed example of decomposition see: http://www.northinfo.com/papers/pdf/EEConvertible.pdf
- "Proxy module" must have rules to decompose some securities and represent others with generic substitutes. It has to be *very clever*.

What Units of Risk do we Want?

- Volatility: Standard deviation and variance
  - Makes sense in utility theory
  - Parametric assumption
- VAR
  - May implicitly capture higher moments
  - Diversification properties are a problem

How Levered Are We?

- Are pension liabilities the same as debt financing of trading positions?
  - Not subject to immediate cash call
  - Actuarial smoothing
  - Option to change policies

- Trading desks have real bankruptcy risk so negative tail events matter a good deal
  - Higher moments are critical

Asset Liability Mismatch

- Monte Carlo simulations are often used. For more

  http://www.northinfo.com/papers/pdf/19960701_term_asset_liab.pdf

- Caveat
  - Most valuation models for fixed interest assets imply no arbitrage term structure
  - Actuarial studies often use single discount rate (flat term structure)
  - Even cash matched portfolios will show mismatch under term structure shifts

Traditional Utility Theory

- Bernoulli and the three stochastic dominants
- Log of wealth fits nicely
- U = E[R] – L * E[V] (Markowitz and Levy)
  - R is the arithmetic mean of returns
  - V is the variance of returns
- Higher order terms don't mean much because investor has no gearing

Relative and Absolute Risk

- Managers manage to benchmarks, but plan sponsors can't spend relative returns
- An explicit dual goal problem: the Harvard endowment
- How about U = E[R] – L1* E [Vr] – L2 * E[Va]?
- Three terms aren't needed. Absolute risk is just relative risk around the risk free asset
- Create a joint benchmark that includes benchmark for active management and cash
- Wilcox (1994), Chow (1995)
- Options approach, Kritzman and Rich (1997)

Active Risk

- Once we address the dual utility function, active risk becomes just another asset class
- Bad assumptions
  - Active risks are uncorrelated with systematic risks
  - Active risks are uncorrelated with each other
- Implicit market timing by hedge funds
  - Perform style analysis on HFR hedge funds
  - Estimated total volatilities of the style mixes are greater than the funds themselves

Alternative Asset Classes

- Hedge funds
  - Beware the short volatility trap
  - Crucial violation of Markowitz assumptions
- Illiquid Asset Classes
  - Direct property, Private equity, Hedge Funds
  - The Timberland fiction
  - Property indices, appraisal smoothing (NCREIF)
  - Reporting delays reduce apparent volatility
- Weisman (2000)

A Closer Look at Risk Aversion

- But wealth creation over long horizons arises from compound returns

  C ~ R – V/2 + …….. (Messmore)

- So compound return and utility are comparable if L = .5

So Why Doesn't L = .5 for Everybody

- Time Horizons
  - Traditional Markowitz is a Single Period Model. The future is one long period.
- Estimation Errors
  - Problem Parameters are not known
  - Problem Parameters are transient
- Relative Returns may matter

Implying Risk Aversion From Benchmarks – A Caveat

- Active managers measure risk relative to benchmark indices
- Indices are presumed to be mean-variance efficient
- But if the index is efficient, active management can't work. If active management works, the index cannot be efficient.
- Roll (1992), Wilcox (2000)
- Tracking error is an inadmissible estimator of risk for active managers

Implying Risk Aversion From Benchmarks

- Despite the foregoing, we march forward on an FTSE example
- Assume: Risk free rate 5%, expected return 10%, variance 400%^{2}
- Portfolio of 99% FTSE, 1% Cash has expected return 9.95%, variance of 392 %^{2}
- Portfolio of 101% FTSE, -1% Cash has expected return 10.05%, variance of 408%^{2}
- Look at finite differences. We're willing to trade 16 %^{2} units of variance for .1% return
- Really an upper limit since we've left out estimation risks

An Alternative Approach – Wilcox (2000)

- If we are trying to maximize wealth in the long run, we know the answer L = .5
- But to have a long-run, we have to survive. Introduce a floor but NOT like portfolio insurance
- Lets assume we can lose 20% of our wealth before we declare catastrophe
- If we're fully invested, we're leveraged 5 to 1 compared to our "risk capital", so L = .5 time 5 = 2.5
- If we lose 10% of our wealth, we're now leveraged 10 to 1, so L = .5 * 10 = 5
- Do higher moments matter now?

Considering The Costs of Risk Limits

- The expected values of risk are not true parameters, only estimates. Estimation risks are large. We have to consider the extent to which we are indifferent to small changes in risk. Michaud (1998)
- Transactions costs are known imprecisely but with probably greater precision that risks or returns
- Avoidance of risk accrues economic value over time. Transaction costs occur at a moment in time, so costs must be amortized over a reasonable time horizon, so $U = E[R] – L1 * E[V] – C * A$
- Tax costs are more complex. After-tax risk levels are smaller and are dependent upon the nature of applicable taxes

Time Horizon

- We always quote conventional risk values in annual terms. We usually quote VAR in daily terms.
- We model some data frequency (daily, monthly,etc.) and present “annualized values”
- If volatility is not time varying, high frequency data is not needed. If volatility is time varying, “annualizing” is not a simple process.
- diBartolomeo (2000), Brooks, et al (2000)

Higher Moments

- Skewness and Kurtosis
  - Arises mostly with high frequency returns
  - Derivatives and leveraged positions
  - For traditional plan sponsor portfolios, it probably is not worth worrying about
    - Hlawitscka and Stern (1995)
    - Wilcox (2000)

Liquidity and Other Non-Observable Risks

- Infrequent marks-to-market for illiquid assets mask volatility
- Short volatility strategies (often using derivatives) can trade income today for volatility tomorrow
- Liquidation costs can vary widely on market conditions
- Consider LTCM. Due to high leverage they had to unwind some positions that moved the markets against themselves
- Special risks of long/short portfolios. When a short position goes bad, it becomes a bigger part of your portfolio

Conclusions

- Total risk exposures of a firm across all asset classes and geographic exposures can be measured efficiently using a parsimonious model
- Efficient risk measurement requires decomposition of complex securities such as derivatives and convertible bonds
- Efficient management (as opposed to measurement) of firm-wide risk requires explicit specification of risk tolerance and trading practices