Risk factors driving risk measures

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Recap

- Focus of risk measurement on
  1. "loss" measurement,
  2. for portfolios of one given set of asset class,
  3. for portfolios including multiple types of asset classes.
- Need a focus on "coherent risk measures" to implement the above.
- Traditional measures typically work when assuming an underlying distribution. Difficult to know.
- Out of the recent measures:
  1. *VaR* is a good candidate with known flaws.
  2. *CVaR* or *ETL* is more applicable.
  3. *Stress test results* are the best of the above.
- In all cases, it is important to identify *forecasts* of risk.

Risk measured as sensitivity to factors

Risk measures vs. Risk factors

- Some risk measures focus on loss arising out of the risk of the portfolio.
  These ignore that the factors driving that risk are themselves prone to change.
  E.g., *VaR* for a portfolio using the past returns on the portfolio.
- Some risk measures capture the sensitivity of the portfolio to the risk of the underlying risk *factor*.
  E.g., *VaR* of a portfolio calculated as a function of the β of the portfolio wrt market index.
- Most stark demonstration of this: equity vs. bond portfolio VaR.
  Equity is infinitely lived; bonds have finite maturity.
  Risk measures of these two are apparently fundamentally different.

Loss on a bond: recap from last course

- A ZC bond which pays Rs.100 at T has price as $f(r_T)$, ZC rate at T:

$$B_t = \frac{100}{(1+r_t)^t}$$

- Then, $r_t = \log(B_t/B_{t-1})$ is tracked as:

$$\log\left(\frac{100}{(1+r_t)^T}\frac{(1+r_{t-1})^T}{100}\right)$$

  which comes to:

$$-T(\log(1+r_t) - \log(1+r_{t-1}))$$

  the change in the interest rate r_T from $t-1$ to t.

- Thus, the VaR of a ZC bond today can be calculated as a function of σ_{r_T}, which is change in the underlying factor.

Loss on a coupon bond

- A coupon bond contains a series of rates.
- Traditional measure: collapse it into changes at one rate y_D, where D is the duration of the bond.
- Then the "return" on the bond becomes $\log(dB)$ where

$$dB = -(D * B) \times dy_D$$

- Here, the risk measure as a historical *sigma* of the same bond *cannot* apply.
- *Problems*:
  - Duration is a summary measure of a set of rates which also changes – needs to be recalculated for each bond.
  - How does it apply in a multi-instrument setting – how do durations of different bonds correlated with each other?
- *Alternative*: treat all coupon bonds as a portfolio of ZC bonds. VaR is then a multivariate problem on distribution of interest rates at different maturities.

Factors in equity portfolio

- Search for factors in equity portfolios were driven by learnings from portfolio optimisation.
  1. Diversification means all risk is not important.
  2. Operationalising the Markowitz optimisation for large N components in equity portfolio is difficult enough to render the exercise futile.
- Identify factors driving risk.
  Portfolio risk becomes a function of the factor risk.
- **Problem:** No consensus from theory on what are the expected optimal risk factors.
- Two well-known alternatives:

Selection of risk measures

Alternative approaches in comparing risk measures

- Comparison frameworks are entrenched in the application domain of the risk measure.
- Two main approaches in comparing risk measures:
  - Traders/securities markets regulators – banks, trading firms.
    Objective? Minimising the impact of an "unexpected loss" over a very short horizon.
  - Portfolio fund managers – mutual funds, pension funds, insurance companies.
    Objective? Maximise future portfolio performance over long time horizons.
- Securities markets: VaR, ETL.
- Fund managers: "Sharpe's Ratio" of the portfolio, tracking error, Treynor's alpha.