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Performance Attribution Inclusive of Derivatives

Dan diBartolomeo

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Introduction

- The use of derivative instruments has become pervasive across a broad range of portfolio management strategies from retail mutual funds to complex hedge fund strategies.
- Once derivatives have been included in a portfolio the common methods of performance attribution become more cumbersome, but the process is quite tractable once a few key choices have been made.
- Many derivatives such as index futures are based on "baskets" of underlying securities rather than individual underlying assets. We will illustrate when derivative positions should be evaluated on a "stand-alone" basis, and when a "look through" to the underlying constituents is more appropriate.
- A new aspect of the attribution process is to separate profits/losses on derivative positions into two parts, the impact of price changes in the underlying asset and the realization of any mispricing of the derivative.

A Bit of Lit

- Feibel (*Journal of Derivatives*, 2022) is an excellent overview of fitting derivatives into standard attribution frameworks.
- Cooper and Li (*Journal of Performance Measurement*, 2015) provides a method to include options in attribution of *absolute returns*.
- The issue of separating derivative returns into "underlying driven" and "mispricing driven" requires forming expectations of returns for derivatives conditional on the returns of the underlying assets
  - Rubinstein (*Journal of Finance*, 1984)
  - Carr and Wu (*Journal of Finance*, 2020).
- You can also infer the return distribution for the underlying asset from multiple derivative prices (e.g. different option strikes) and then calculate "mispricing" of individual contracts relative to the consensus.
  - Jackwerth, Rubinstein, et. al. (*Journal of Finance*, 1996)

Challenges and Choices

- The basic equation for return on a portfolio is just the dot product (vector multiplication) of the asset arithmetic returns times the *initial* weights of the assets in the portfolio.
  - Linear derivatives such as futures and swaps often have a *zero initial weight* making the traditional calculation problematic.
- Even when initial weights are non-zero (e.g. options), the notional value of the position (economic value subject to price change) and market value are different, creating *implicit leverage*.
  - The notional value of a conventional asset is equal to the market value
- Depending on the desired analysis leverage may need to be tracked at the aggregate portfolio level or at the individual instrument level.
  - To make this choice clear we can represent each derivative as a portfolio.
  - For example, an option can be a portfolio of the "delta-neutral" weight in the underlying asset and the remainder as risk-free cash.

A Sometime Useful Short Cut

- Portfolio return can be defined as the summation of *return contributions* that are each a position return times the initial *market value weight.*
  - Another way to think about the problem is that portfolio return is equal to the total portfolio profit/loss divided by the initial portfolio market value.
  - We can therefore calculate *return contributions* by position as the profit/loss of that position divided by the total portfolio profit/loss times the return on the portfolio.
  - This representation of return contributions does not require that each position have an initial market value weight (i.e. computationally tractable for swaps and futures).
- To avoid distortion, we can also calculate *conventional return contributions* for positions that have initial market values, sum and subtract from the total return.
  - The residual return can be apportioned based on the respective profits/losses if multiple futures or swap positions are present.

What Types of Analysis Do We Need?

- There are several different types of performance attribution available at Northfield for which we would like to facilitate inclusion of derivatives.
- CFA style Brinson-Fachler (or the similar Brinson, Hood, and Beebower)
- Factor driven attribution as provided by Northfield, MSCI, Quontigo
- Effective Information Coefficient,
  - see diBartolomeo (*Journal of Performance Measurement*, 2008)
- Portfolio Dynamics
  - Focuses on interaction of signal quality, constraints, and turnover costs
  - Sneddon (*Journal of Investing*, 2008) and Sneddon (*Journal of Performance Measurement*, 2022)

Example Case 1: No Fireworks

- We are a US dollar-based investor holding a $100M investor holding fifty equally weighted (2% each) Japanese stocks with an EAFE benchmark.
  - We believe that the Japanese Yen will fall in value relative to the US$ so we enter into an US $80M currency swap (short JPY/long US$) to hedge which has zero initial market value.
  - The total notional value of the portfolio is $180M (holding US$ is riskless to a US investor) so our 2% equity positions are now each 1.11% of the "notional" exposure, *which distorts our interpretation of any attribution.*
  - We could calculate returns contributions based on notional weights.
  - A better representation of the swap is a negative US$ 80M position in JPY and an offset of a positive US $80M, which can be combined with existing US cash.
- With this representation, the weights of the equity positions are still 2% and will work correctly in both absolute and benchmark relative analyses.
  - The short position in the JPY shows up as a separate asset with a non-zero market value so it fits into Brinson as well as other methods

Example Case 2: Explode or Not Explode

- We are a Japanese investor holding the same $100 M equal weighted 50 stock portfolio with a benchmark of the Nikkei 225.
  - We believe the market is generally going to decline so we hedge some equity exposure by buying put option on the Nikkei 225 that has delta -.3 for the $100M of exposure.
  - We have a notional value of negative $30M but the long option position does have a positive market value, so we can calculate a return for the separate option position.
- For some analyses, we want to keep the option as a separate position, while for others we "look through" to the underlying securities
  - Brinson (individual security level), EIC as separate
  - For Brinson "stratification" (e.g. sectors, weights by capitalization range), Factor analytics we look through.
  - For Portfolio Dynamics analysis it depends on the structure of the input trading "signals".

Tracking Leverage by Position

- For the same of simplicity most investment organizations track the implicit leverage created by derivatives *only at the portfolio level.*
- In many situations it is useful to understand how profits or losses on individual positions contribute to changes in portfolio level leverage.
  - Consider a portfolio consisting of $100M in US stocks and a long position in futures contracts for the FTSE 200 index with notional value US $50 Million and a long future position in the Nikkei 225 for US $50 Million.
  - We have 2 to 1 leverage ($200M notional, $100M market value)
- While the US and UK markets are closed, the Japanese market declines 20%, so our $50M notional equity exposure in Japan is now $40M.
  - A "to date" loss of US $10M, return of -20% on notional value
  - Our aggregate leverage is higher at 2.11 ($190M notional, $90M market value) *because of the losses in Japan and nothing else.*
  - Representing derivatives via composite assets allows tracking this as the Nikkei composite would take on a negative market value.

Analyzing Derivative Performance

- Everything we've discussed so far has been about fitting derivatives into one or more existing frameworks for performance attribution.
- We can also attribute profit/loss on derivative positions into two categories.
  - The first category is the profit/loss associated with the derivative position because of changes in the price of the underlying asset.
  - The second category is the profit/loss associated with the derivative position being mispriced when the position was opened.
- It is often difficult to tell *why* a derivative position was established.
  - US Treasury bond futures use by mutual funds has greatly increased recently.
  - Positions could also be taken as a "basis trade" where fund managers believe futures contracts are mispriced relative to the underlying bonds.
  - Positions could be taken because the fund wants to micro-manage interest rate risk, as transaction costs in futures are often less than for cash bonds.

Attributing Derivative Performance

- While there are several different computational approaches to allocating derivative profits into "cause and effect" parts, the simplest is from Rubinstein (Journal of Finance, 1984).
- For simple derivatives like futures, swaps, and vanilla options we can estimate what the value of the derivative will be at the end of the return observation period (e.g. month) *to compute an expected return on the derivative conditional on our return expectation for the underlying asset.*
- At the end of the return observation period, we will have realized returns for the underlying asset and the derivative, as well as the respective expected returns.
- Once we have the end of period price of the underlying, we can calculate the end of period of fair value of the derivative, allowing us to separate the realized derivative return into arising from unexpected return in the underlying or initial mispricing of the derivative.

It's About Time

- Like bonds, derivative contracts have finite lives with known expiration dates.
- For options, the value will converge to intrinsic value as the time to expiration declines.
  - We can therefore define part of the return to option positions as representing a "passage of time" effect known as time decay.
- *Since we already know the value of the derivative at the start of the measurement period, and we've estimated its value at the end of the measurement period, we can estimate value for any intermediate date holding all inputs constant except the passage of time.*
- See our webinar on option alpha for more information Expressing Alpha on Non-Linear Derivatives (northinfo.com)

Conclusions

- The use of derivative contracts has become pervasive in all levels of investment portfolios. In order than performance attribution fulfill its purpose in helping to isolate how investment strategies can be improved in the future, the sensible incorporation of derivatives is necessary.
- *With a few basic choices of representation methods, the presence of derivative positions in portfolios can be tractably handled within Northfield's multiple attribution frameworks.*
- Depending on the analytical use case, "basket" derivatives may or may not be appropriately "exploded" into the underlying constituents.
- While most attribution frameworks don't address the issue, it is possible to decompose derivative profit/loss to illustrate the separate influence of behavior of the underlying, passage of time, and mispricing the derivative position.