TA Review (Lecture #7)

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Agenda

- Forecasting
- Questions

Forecasting

Our Factor Models Are Relative Pricing Models

- CAPM tells us our **expected excess returns** as a function of our market risk *and* the market **risk premium**
  - FF3, FF5, and other factor models operate the same way (risks and risk premia ⇒ asset expected return)
- CAPM is a relative pricing model – what excess return do I expect *relative* to the market risk premium?
  - We are not asserting anything about the market risk premium, which can vary
  - We are asserting something about expected returns *relative* to the market risk premium

Why does this matter?

- We've found in our homework that risk premia appear to vary over time
- If I cannot assess what the risk premium for some factor will be, it may be difficult to assess whether I find this risk attractive to take
  - This is where forecasting becomes beneficial

Forecasting

- Forecasting is the process of using **time-t data** to predict **time-t+1 data**

$$\mathbb{E}_t\left[\tilde{r}^i_{t+1}\right] = f\left(x_t\right)$$

- Even if we believe CAPM holds, forecasting is still beneficial
- Forecasting is incredibly difficult

Industry Approach to Forecasting

- In reality, **absolute** excess returns are a *highly* complex and potentially nonlinear combination of random variables
  - News events, human behavior, movements in related markets, etc.
- We acknowledge we cannot possibly measure (let alone understand, or predict) all of the forces driving returns.
- Therefore, we try to ascertain the things that drive the variation in returns *the most*
  - This is not groundbreaking – this is simply feature selection in any model
- This is often a two step process:
  1) Decompose returns
  2) Forecast the components
- How does decomposition benefit forecasts?
  - Returns have lots of noise that will make direct return forecasting attempts difficult
  - We can do a good job of decomposition

Return Decomposition

- Reduces the dimensionality of our problem (going from many things that impact returns to just a few)
- Allows us to express returns in terms of things we understand (e.g. market beta)
- Allows us to express returns in forms we understand (e.g. linear)
- Understanding return components is highly beneficial for both risk management and forecasting
- How do we decompose returns?

Statistical Decomposition

- Using data, how can I express returns as some basic (typically linear) function of other things?
  - The more variance explained, the better
  - The more interpretable, the better
  - The more predictable, the better
- Examples:
  - Linear factor decomposition (LFD)
  - Machine learning
- The underlying components (factors) may or may not have economic significance

$$\tilde{r}_t^i = \alpha + \boldsymbol{\beta}^{i,x}\mathbf{x}_t + \epsilon_t$$

Direct Decomposition

- Directly expressing the return formula as a function of underlying things is also beneficial
  - This is the approach taken by GMO: decompose returns into components that they understand and believe they can forecast
- Directly understanding the big picture is hard, but maybe we can understand the components, and how the components compose the whole
- Taylor expansion
  - Greeks

First order Greeks

$$\delta P = \overset{\text{Theta } \Theta}{\boxed{\frac{\partial P}{\partial t}}} \cdot \delta t + \overset{\text{Delta } \Delta}{\boxed{\frac{\partial P}{\partial S}}} \cdot \delta S + \overset{\text{Vega } \nu}{\boxed{\frac{\partial P}{\partial \sigma}}} \cdot \delta \sigma + \overset{\text{Rho } \rho}{\boxed{\frac{\partial P}{\partial r}}} \cdot \delta r$$

$$+ \frac{1}{2} \underset{\text{Gamma } \Gamma}{\boxed{\frac{\partial^2 P}{\partial S^2}}} \cdot \delta S^2 + \underset{\text{Vanna}}{\boxed{\frac{\partial^2 P}{\partial S \partial \sigma}}} \cdot \delta S \cdot \delta \sigma + \frac{1}{2} \underset{\text{Volga}}{\boxed{\frac{\partial^2 P}{\partial \sigma^2}}} \cdot \delta \sigma^2 + \underset{\text{Charm}}{\boxed{\frac{\partial^2 P}{\partial S \partial t}}} \cdot \delta S \cdot \delta t + residual$$

Second order Greeks

Source: Quant Next (https://quant-next.com/option-greeks-and-pl-decomposition-part-1)

Returns and the dividend yield

By definition, stock returns are

$$R_{t+1} \equiv \frac{P_{t+1} + D_{t+1}}{P_t}$$

$$R_{t+1} \equiv \left(\frac{D_t}{P_t}\right) \frac{D_{t+1}}{D_t} + \frac{P_{t+1}}{P_t}$$

This identity holds for horizon, $t + k$, and in expectation:

$$\mathbb{E}_t \left[R_{t,t+k}\right] = \mathrm{DP}_t \; \mathbb{E}_t \left[\frac{D_{t+k}}{D_t}\right] + \mathbb{E}_t \left[\frac{P_{t+k}}{P_t}\right]$$

The GMO Approach

$$R_1 = \frac{D_1}{P_0} + \left(\frac{(P_1/E_1)}{(P_0/E_0)} \times \frac{(E_1/S_1)}{(E_0/S_0)} \times \frac{S_1}{S_0} - 1 \right) \approx \overbrace{\frac{D_1}{P_0}}^{\text{Dividend yield}} + \overbrace{\%\Delta(P/E)}^{\text{Multiple expansion/contraction}} + \overbrace{\%\Delta(E/S)}^{\text{Change in profit margin}} + \overbrace{\%\Delta(S)}^{\text{Growth in sales per share}}$$

Why?

- GMO believes they understand the dynamics of dividend yields, multiples, profit margins, and sales
- In the long-run, they believe dividend yields and sales growth drive returns
- In the short/medium term, they believe that mispricings can take hold and they can identify them by forecasting the underlying components

Questions?