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Fundamental Myths About Fundamental Models

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Introduction

- Many investment organizations have come to the belief that "fundamental" (endogenous) models of risk are somehow more useful as risk models for a variety of reasons.
- While some of these reasons are correct there are important aspects of fundamental models that are widely misunderstood. In particular, the assertion that fundamental models are *inherently more accurate* than other risk model structures is entirely false.
- Our purpose is to clarify the nuances as to what is and is not real about fundamental models in comparison to other risk model frameworks. It should be noted that our purpose is not to criticize fundamental models per se.
- The Northfield "US Fundamental" model is among our popular models, and our lineup of international fundamental models (the XRD range) is popular as well. We simply wish to make sure that users are educated as to the true benefits and disadvantages of this type of model.

Semantics

- We will consider a “fundamental” model as one where the factor exposures at the security level are observable at a moment in time. The analytical structure of the model then involves statistical estimation of factor returns for each time period, the estimation of the covariance matrix of these factor returns, *and possibly factor return forecasts.*
  - By way of example, we might think of the capitalization of a company, or the price/earnings ratio of the stock, or the membership of the firm in an industry group as “fundamental characteristics” *we observe at the security level*.
  - There is no need for statistical estimation of the information describing individual stocks or companies. Often, the “fundamental” aspect of such models arising from the use of data elements from the firm’s financial statements (i.e. book/price ratio) which is in some measure parallel to the way that fundamental investors might view a particular stock.
  - See diBartolomeo, Dan. 2012. “Equity Factor Models: Estimation and Extensions”, In: B. Scherer and K. Winston, Editors, The Oxford Handbook of Quantitative Asset Management, Oxford University Press.

The Arithmetic

- All factor models of security returns can be defined in the same fashion

$$R_{it} = \text{Sum}_{(j=1 \text{ to } n)}[\, B_{ijt-1} * F_{jt}] + e_{it}$$

R_{it} = return to security I in period t

B_{ijt-1} = the exposure of security I to factor j at time t-1

F_{jt} = return to unit exposure of factor j during period t

e_{it} = Idiosyncratic return of security I during period t

In fundamental (endogenous) risk models we observe the B values and estimate the F values statistically. If the F values are persistently of one sign, we refer to these returns as risk premia. If the F values are predictable (even if zero mean) we can think of these as returns as *factor alpha.*

A Flawed Motivation

- Our first point of consideration is the concept behind wanting to have a "fundamental" risk model in the first instance.
  - Many firms prefer fundamental models because they assert that the security characteristics involved are more familiar to portfolio managers. In turn, this makes the managers more willing to take the information from the risk model into consideration in their strategic and trading decisions.
  - While this preference may seem well founded there is an obvious counter argument to this logic. By framing the risk discussion around familiar concepts we are *intentionally avoiding focus on unfamiliar sources of risk*.
  - We might remember the words of a former US Secretary of Defense who famously said "in war there the known unknowns and the unknown unknowns". Obviously, sources of risk we choose to ignore are apt to be more damaging than those that we routinely give attention. In crossing a street you don't get hit by a car you see coming. *You get hit by the car you don't see coming.*
  - For the formalization of this issue, see Knight (1927).

To Whom Are Risks Fundamental?

- Another issue to think about is that many investors believe that the design of fundamental models implies that investment risks are actually fundamental in nature.
- If a manager predicates an active strategy on a fundamental variable (i.e. a value tilted portfolio defined by book/price ratio) the likelihood of such a strategy producing positive or negative benchmark relative returns can directly addressed in the model. To the manager who is hired and fired on benchmark relative performance, the *perceived risks* are about their active bets.
- The intended purpose of the model is often as much to provide a framework for the formulation and discussion of active strategies as it is to forecasting of future risk (as a the potential for economically undesirable outcomes).

Investor Risk

- On the other hand, the return variability added by a given active "bet" is generally very small compared to the absolute volatility of the portfolio.
  - This key issue was described in the seminal paper by Rosenberg and Guy (1976) where they argued that the benefit of fundamental models was not to analyze active risk but that it was a more efficient way to measure a stock's beta coefficient than the simple time series regressions that were standard at the time.
  - For investors the dominant risks remain measured in absolute terms. Investors do not pay their financial liabilities with "benchmark relative money". The agency conflict between managers who wish to focus solely on active risk while ignoring absolute risk has been thoroughly considered in papers such as Roll (1992) and Chow (1995).

The Big Real Reveal

- The real advantage of fundamental models is in the relationship between forecasting errors of the model and the number of securities in the portfolio.
  - In a fundamental model the factor exposures are observable at the individual security level, while factor returns are estimated by cross-sectional regressions *per time period* (large sample sizes are generally available). This is not a *panel data* regression (Fama MacBeth, 1973).
  - As financial market conditions change, The estimation errors show up in the factor covariance matrix. The estimation error relating to a "low P/E bet" is unrelated to the number of securities making up the low P/E portfolio. The possible errors in risk forecasts are largely independent of the degree of diversification of the subject portfolio.
  - Conversely, risk models estimated from security return time series observe information about the world (e.g. interest rates went up) but estimate the exposure of each security to these exogenous events. The estimation errors in time series models are likely to occur at the individual security level, which diversify away as the portfolio diversifies.

Unbalanced Design

- It should be noted that fundamental models can suffer from significant errors in factor returns if the sample sizes are uneven across factors.
  - For example, consider a fundamental model where one factor is “book/price” ratio and another is “membership in the railroad industry”.
  - If my universe consists of 1000 stocks, there are likely to be 1000 observations of the book/price ratio across companies. On the other hand, the number of firms that make up the railroad industry is apt to be less than ten even in large countries like the US.
  - In the absence of special estimation techniques, an extreme return event in the sample of railroads would have an unusually large influence over the factor returns not just to railroads but to all factors for that time observation.

When to Choose a Fundamental Risk Model

- The distinctions in the estimation error structure makes fundamental models a better choice in two circumstances.
  - The first is any portfolio that is concentrated rather than diversified. You need the model to be accurate as possible at the individual security level.
  - The second is portfolios where the set of securities from which the portfolio is drawn is biased with respect to risk. When I formulate a "minimum variance" portfolio the securities to be included will largely be from the low volatility tail of the universe of securities, rather than randomly from the full distribution.
  - In both cases, the diversification of errors in time series models is less effective, as evidenced in MacQueen and Mostovoy (2017, http://www.northinfo.com/Documents/737.pdf).

Concentration: Defining Breadth

- A simple way to quantify how concentrated a portfolio actually is.
  - Related to the concept of "breadth" as defined the Grinold and Kahn "Fundamental Law of Active Management" (1994), also see Buckle (2003).
  - We can consider a hypothetical portfolio where all securities are of the same risk, all securities are uncorrelated, and all active portfolio weights have the same magnitude. In this special case, the "effective number of equal, unrelated positions" is equal to the square of a ratio, where the numerator is average estimated volatility of the individual securities, and the denominator is the estimated volatility of the portfolio.
  - For example, if the average security level volatility in my portfolio is 40%, and I have a 4% tracking error relative to a 1000 stock benchmark, my active portfolio has the same degree of diversification as 100 unrelated securities, despite the fact that I may have more than a 1000 active positions.
  - The true degree of portfolio diversification can be observed in this fashion, and the question of the choice of fundamental versus exogenous model can be appropriately considered.

Back to Semantics: Precision

- The biggest conceptual problem for most investment professionals in dealing with fundamental models is the semantic distinction between *precision* and *accuracy*.
  - When we say that an estimate or measurement is *precise*, we mean that if we repeat the process over and over again with comparable inputs the results will be the same for each experiment. However, a precise result does not imply that we've actually gotten an accurate estimate or measure.
  - "Accuracy" implies that *we've actually gotten the right answer* which is a far stronger assertion than precision.
  - Given that factor exposures in fundamental models are calculated according to some formulaic structure, they are observable and precise. If I do the same calculations twenty times, I will get the same answer twenty times.

More Semantics: Accuracy

- There are many reasons why a fundamental model can be *precise without being accurate.*
  - The most common sort of fundamental factor is a standardized financial statement ratio (e.g. book/price). To implement this kind of factor, we calculate the desired ratio at a moment in time for all securities of interest and then transform the ratio for a given security into a Z-score relative to the distribution of that ratio for a representative set of securities in the universe.
  - While there are numerous nuances of this process, *one key feature stands out.* It is not possible to know the value of a financial statement item (e.g. earnings, debt/equity, book value) *as of the present time*.

Data Reporting Limitations

- We can only know financial statement information as of the last time the financial statements were issued.
  - Of the more than 45,000 publicly traded companies in the world only the fraction report these items more frequently than once a year so fundamental ratio values are often completely out of date.
  - While US firms and some large global firms report financials on a quarterly basis, even in these cases there is no synchronization of fiscal years. Obviously, if our factor is P/E, we can update the "P" on the daily basis, but not the "E".
  - *This reality nullifies the usefulness of daily updating of fundamental factor exposures.* In terms of the changes from one day to the next more than 90% of variation in fundamental factor exposures often arise solely from price movements. You can update models much less frequently as long as the model has some kind of momentum factor to account for price changes.
  - It should be noted that the US regulator, SEC, has recently been requested by the US president to consider reducing reporting frequency from quarterly to semi-annually

The Impact of Accounting Standards

- There are also numerous sets of accounting standards that are likely to make their way into financial statements of a global portfolio (US GAAP, IFRS, and whatever is the local standard in a given country).
  - Taken together with slow and non-synchronous financial data, these two considerations mean that financial statement items are never exactly comparable across firms.
  - The idea that a cross-sectional Z-score of a "fundamental variable" is an *accurate* representation of the actual economic circumstances of a given firm at a moment in time is deeply flawed.
- If we think of this issue in grammatical terms we are dealing with a false syllogism. Consider a comparison between "apple" and "fruit".
- While it is true that all apples are fruit, it is not true that all fruit are apples. *Similarly, accurate models are precise but it is not true that precise models are necessarily accurate.*

Explanatory Power

- Another misconception is that since fundamental models typically have many more factors than exogenous models they must have greater "in sample" explanatory power.
  - Northfield pioneered the concept of hybrid models in 2003. This process has been identified as superior in Scrowcroft and Sefton (2006), Miller (2006) and Menchero and Mitra (2008).
  - There is no evidence that Northfield's own fundamental models have greater explanatory power in sample. A direct comparison was provided in this presentation from our 2014 client conference (see slides 19-22), http://www.northinfo.com/Documents/620.pdf. In this sample period (which included the Global Financial Crisis) the hybrid exogenous model had higher explanatory power in sample.
  - However, it should be noted that *all risk is in the future not the past* so the evaluation of risk models on their "in sample" explanatory power is a *very weak test* (and should be avoided).

Factor Return Estimation

- The factor returns in a fundamental model must still be statistically estimated and are therefore subject to error.
  - An important subtlety of this process is how to weight the cross-sectional regressions. Equal weighting the observations puts model emphasis on the far more numerous small firms, while capitalization weighting puts emphasis on the much smaller (but more economically important) sample of very large firms.
  - Many models are estimate factor returns with "square root" of capitalization weighting. This method represents a practical compromise and has some desirable statistical properties (see Grinold and Kahn, Active Portfolio Management, [first edition 1995, pg. 59],
  - To the extent that weights of the securities vary over time in the estimation of factor returns, the factor returns themselves are not consistently defined over time as they would be with an exogenous variable (e.g. 10 Year Treasury Year Bond Yield).

Conclusions

- Fundamental models certainly have an important role in the investment process for both risk and alpha purposes.
- Our models of this type have been demonstrated to provide excellent results in a variety of active strategies, as shown in http://www.northinfo.com/documents/716.pdf.
- However, it should be recognized that fundamental models are not an inherently superior construct as has been widely asserted by some organizations in the industry.