Risk factor models: Five facts that enable smarter decisions

Risk factor models are the widely accepted standard method for measuring market risk, as they show how the return on any portfolio of assets is influenced by different economic factors such as changes in interest rates, FX rates, inflation, and oil prices. There are several types of factor models, but all are constructed using factor analysis techniques and can be divided into three basic categories: statistical, macroeconomic, and fundamental.

Different factor models include different factors – but which ones are the right ones to include?

The debate around fundamental factor models, which pre-specify factors, and statistical factor models, which use statistical processes to extract the factors from market prices, often draws on complicated mathematical arguments. In this article we discuss the five key points to consider when using risk factor models.

Overview: Factor models for market risk management

Statistical factor models

- Are economically motivated and consistent with asset pricing theory and the observed effects of arbitrage across markets

- The SunGard APT approach is to build a dataset of asset returns and a rich set of explanatory factors, including market and sector equity indices, FX rates, interest rates, credit spreads, commodity indices, inflation etc. This dataset allows cross-asset-class effects to be captured within the risk models

- The model does not pre-specify which factors are to be regarded as the sources of systematic risk within markets, and it does not assume that all the systematic risk can be captured with a named set of correlated factors

- Instead, statistical factor models rely on fewer assumptions, and use robust statistical processes to extract the factors from the whole universe of market prices and macro explanatory factors

- SunGard's APT uses a proprietary process similar to Principal Components Analysis (PCA), which is why the model is called a 'statistical model'

Fundamental factor models

- Start out by identifying micro-economic traits of assets, such as industry membership, financial ratios and exposure to technical indicators

- Then the impact certain events may have on individual stocks is determined based on publicly available information

- Next, a set of factors is pre-specified based on what the risk model provider deems logical, e.g. value, growth, sectors, interest rates, etc. Finally, statistical regression is applied to map historical stock prices onto factor values to infer the exposure of each stock to each factor

- Only after all these different assumptions are made can the fundamental factor model be used for risk analysis

- As every pre-specified factor model uses a different set of factors, it is recognized that this approach can introduce factor risk and lead to model mis-specification: Depending on the suppositions made, key factors may be missing and irrelevant factors may be included

Risk factor model facts

1. Why use factor models for market risk management?

○ Nearly all investors believe that there are systematic drivers of risk and return, therefore being able to create an attribution of the total or headline risk measure to the various risk factors, as well as to the positions in any portfolio, is very valuable for investment managers

○ Risk attribution can easily be performed when using a factor risk model such as the SunGard APT model. This helps answer the question "Which factor bets am I taking, and how well are they hedged or diversified?"

○ A factor model will be able to reveal style exposures (to value, growth and momentum) for an equities portfolio, and how much risk can be attributed to interest rate movements (shift, twist and butterfly yield curve factors) and how much to credit spread effects

○ The APT factor model provides insight into the risk factors that make up the systematic risk in the portfolio – it is vital to know the breakdown of total risk down to its systematic and specific parts

○ Using a factor model such as SunGard APT, it is also possible to calculate the portfolio beta to any market, industry or regional index

2. The risks of factor model

○ If we attempt to pre-specify (and likely mis-specify) factors when estimating a model from historical data, we cannot capture their effects as completely

○ There is a much higher likelihood of building a genuinely robust risk model when using a statistical methodology such as principal components modelling

3. Using factor models for multi-asset class risk management

○ The estimation of cross-asset-class correlations is quite natural within statistical models, whereas it is an ad-hoc process based on a separate methodology for pre-specified models. Thus the statistical factor modelling process generates a more coherent risk model than other approaches, and is less likely to create unreliable risk measures for portfolios containing assets across different classes

○ The problems of pre-specified factor models are multiplied when trying to create multi-asset-class (MAC) models. The lack of robustness associated with the judgmental approach to factor selection in each asset class becomes compounded when attempting to model the cross-assetclass correlations. A number of MAC risk modellers use only index-level correlation estimates between asset classes since their methods do not allow security-level estimation of these correlations. The estimation of factor correlations across asset classes is a judgmental exercise since there is no objective measure of how many factors are really required to explain cross-asset-class behaviour

○ The statistical factor model methodology provides a coherent approach to MAC modelling, in which macroeconomic factors (whose influence extends across all asset classes) may be properly included within the estimation core. By including these macro factors, and carefully selecting the assets within the estimation core, we create a set of principal component factors which not only capture the systematic risks associated with equity/credit, rates, FX and commodity markets, but do so simultaneously all the cross-asset-class effects observed in the historical data

○ The most complete MAC model from APT contains 96 factors – 30 associated with rates, 20 associated with equity and credit, 26 associated with FX and 20 associated with commodities (to which all assets may be exposed). This is an economically sensible number of factors to represent the truly independent risk drivers of the global marketplace

4. Using factor models for equities market risk management

○ The first factor risk models were built for equities, and included industry factors only. It quickly became apparent that for these simple multi-variant regression models, adding style factors would improve the explanatory and forecast power of these models – but how many truly independent styles are there? When we build global equity models, is it better to include all country factors (say 40 factors or more) or to rely on regional factors? How many independent currency risk factors do we need? How much would the addition of commodity or macro-economic factors (such as oil, inflation, interest rates, credit spreads) improve a global equities model?

○ These are difficult questions for risk modellers to answer, because all the obvious explanatory factors are correlated with one another, and there may be other important risk factors which are not obvious. In addition, there are transitory factors which can affect equities markets strongly during some periods but are much less influential during other times

○ Building an equity risk model with pre-specified factors is always based on judgment rather than objective methods, and the results are often far from robust. It is this difficulty which has led some pre-specified risk modellers to include principal components factors alongside fundamental factors in their models, to capture the structure that pre-specified factors cannot. Whether the regression model for estimating betas is implemented on time-series or cross-sectionally, ultimately this approach provides little confidence that the systematic part of the risk is correctly estimated. Many 'surprises' in realised risk compared to forecasts from pre-specified models have been observed because of market risk factors which were only "identified" with the benefit of hindsight

5. Using factor models for bonds market risk management

○ Similar problems occur with other asset classes such as bonds. The risk factors associated with yield curves (e.g. shift, twist, butterfly factors) are very highly correlated across currencies (for example Euro and Swiss Franc) and the total number of factors to include in a global bond model is far from obvious

Conclusion

A robust market risk model must take into account the co-movement of asset returns, both in normal times and when markets are stressed. Statistical factor models make fewer assumptions about the systematic risk factors that drive markets and as a result there is a better chance of capturing these factors.

Effective risk management takes into consideration avoidance of mis-specification of the risk factors by beginning with a methodology that is both theory-based and objectively defined. This approach will also provide a robust measure of the systematic part of the risk on any portfolio.

Mis-specification of the risk factors can be avoided by starting with a methodology that is theory-based and objectively defined. This approach will also provide a robust measure of the systematic part of the risk on any portfolio.

The method of principal components, applied to the historical correlation matrix of a carefully selected "estimation core" of the assets within a single class such as equities, can provide a stable and robust set of systematic factors without the problems of co-linearity and arbitrary selection. By re-estimating the model factors every month, the problems associated with transitory factors are much reduced. It is then possible to overlay the explanatory factors of choice within the portfolio analysis to provide intuitive attribution and scenario analysis.

Creating long-term and short-term risk models can be easily achieved by applying an appropriate influence function to the historical data. The statistical factor methodology does not necessitate arbitrary judgements about which factors may or may not be most strongly affected when changing the effective time horizon of the risk model.

About APT

SunGard's APT provides award-winning investment technology for multi-asset class risk management, analytics and risk reporting, serving buy-side institutions globally. APT models market risk, liquidity risk, and counterparty risk across both liquid and illiquid asset classes, supporting regulatory reporting, portfolio optimization and performance analysis. The solution can be delivered as an installed or cloud-hosted offering, with a managed service component for clients who wish to outsource risk-based business processes. APT's customers include institutional asset managers, pension funds, hedge funds, private banks, wealth managers and sovereign wealth funds.

Enabling the adaptive enterprise

Sitting at the intersection of technology and finance, SunGard is focused on delivering fresh ideas and inventive solutions to help our customers adapt and thrive in an ever changing environment. With a blend of software solutions, cloud infrastructure, global service capabilities and deep domain expertise, SunGard is capable of supporting virtually every type of financial organization, including the largest and most complex institutions in the world. For more information, please visit **www.sungard.com**

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