Chapter 15
Global Equity Risk Modeling

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15.1 Introduction

The pioneering work of Markowitz (1952) formally established the intrinsic tradeoff between risk and return. This paradigm provided the foundation upon which the modern theory of finance was built and has proven so resilient that it has survived essentially intact for over 50 years. Almost as remarkable is the vigor with which the theory has been embraced by academics and practitioners alike.

The specific problem addressed by Markowitz was how to construct an efficient portfolio from a collection of risky assets. Markowitz defined an efficient portfolio as one that had the highest expected return for given level of risk, which he measured as standard deviation of portfolio returns. Markowitz showed that the relevant risk of an asset is not its stand-alone volatility, but rather its contribution to portfolio risk. Henceforth, the concepts of risk and correlation became inseparable.

A plot of expected return versus volatility for the set of all efficient portfolios maps out a curve known as the efficient frontier. In order to construct the efficient frontier using the Markowitz prescription, an investor must provide expected returns and covariances for the universe of all investable assets. The Markowitz procedure identifies the optimal portfolio corresponding to the risk tolerance of any given investor.

Tobin (1958) took the Markowitz methodology and extended it in a very simple way that nonetheless had profound implications for portfolio management. By including cash in the universe of investable assets, Tobin showed that there existed a single portfolio on the efficient frontier that, when combined with cash, dominated all other portfolios. For any investor, therefore, the optimal portfolio would always consist of a combination of cash and the “super-efficient” portfolio. For instance, risk-averse investors may combine the super-efficient portfolio with a large cash position, whereas risk seekers would borrow cash to purchase more of the super-efficient portfolio. Therefore, according to Tobin, the optimal investment strategy...
consists of two separate steps. The first is to determine the super-efficient portfolio. The second step is to determine the appropriate level of cash that matches the overall risk tolerance of the investor. This two-step investment process came to be known as the Tobin separation theorem.

The next major step in the development of Capital Market Theory was due to Sharpe (1964). By making certain assumptions, such as that all investors followed mean-variance preferences and agreed on the expected returns and covariances of all assets, he was able to show that the super-efficient portfolio was the market portfolio itself. Sharpe’s theory, known as the Capital Asset Pricing Model, predicts that the expected return of an asset depends only on the expected return of the market and the beta of the asset relative to the market. In other words, within CAPM, the only “priced” factor is the market factor.

Using the CAPM framework, the return of any asset can be decomposed into a systematic component that is perfectly correlated with the market, and a residual component that is uncorrelated with the market. The CAPM predicts that the expected value of the residual return is zero. This does not preclude the possibility, however, of correlations among the residual returns. That is, even under the CAPM, there may be multiple sources of equity return co-movement, even if there is only one source of expected return.

Rosenberg (1974) was the first to develop multi-factor risk models to estimate the asset covariance matrix. This work was later extended by Rosenberg and Marathe (1975), who conducted a sweeping econometric analysis of multi-factor models. The intuition behind these models is that there exists a relatively parsimonious set of pervasive factors that drive asset returns. For instance, equity returns may be explained by country and industry membership, as well as by the exposure to style factors such as Size or Momentum. Returns that cannot be explained by the factors are deemed “stock specific” and are assumed to be uncorrelated. Rosenberg founded a firm, Barra, which made widespread the use of multi-factor risk models and dedicated itself to helping practitioners implement the theoretical insights of Markowitz, Tobin, Sharp, and others. The first multi-factor risk model for the US market, dubbed USE1, was released in 1975.

The availability of rigorous multi-factor risk models such as USE1 enabled practitioners for the first time to apply the Markowitz procedure under realistic covariance assumptions. Even then, in the early days of portfolio optimization, practitioners were hampered by limitations in computational power. Consequently, much of the early research focused on the development of clever algorithms designed to overcome these obstacles, as described, for example, by Rudd and Rosenberg (1979).

Another major milestone on the path to practical implementation of modern portfolio theory came in 1989 with the development of the first Barra global equity risk model, dubbed GEM. This model was estimated via monthly cross-sectional regressions using countries, industries, and styles as explanatory factors, as described by Grinold et al. (1989).

In this paper, we present the latest Barra global equity risk model, GEM2. This model incorporates several advances and innovations over previous Barra global equity risk models. For instance, GEM2 employs an updated industry fac-