Introduction: Factor Models

A key challenge of successful portfolio management is the ability to forecast, or estimate the expected returns, and risk for a portfolio of securities. In order to tackle this challenge, most investors begin by recognizing that there are common factors affecting all stocks. For example, macroeconomic events, like sudden changes in interest rates, inflation, or unemployment, can affect all stocks to varying degrees, depending on the stock’s characteristics. The notion of common driving forces goes back to the seminal work of Barr Rosenberg¹ who developed the theory that the effects of macroeconomic events on individual securities could be captured through factors, such as industry membership, financial structure, or growth orientation. This insight into the linkage between macroeconomic events and microeconomic characteristics has been used for decades in the asset management industry to build powerful forecasting models known as multi-factor models.

Figure 1: Illustration of the common driving factors in stock returns. The chart shows cumulative returns to Merck, Pfizer, and Eli Lily, three of the large pharmaceutical companies in the US over a five-year period. The chart illustrates the similarity in the return behavior of these stocks, primarily because they are US large-cap equities within the same industry. We also see that Pfizer outperformed the other two companies over short periods, indicating that other firm-specific factors impacted its performance.
There is a strong parallel between factor models and traditional fundamental analysis. Fundamental analysis is the process of determining a security’s future value by analyzing a combination of both macro and micro economic events along with company-specific characteristics. In essence, fundamental analysts review a range of quantitative and qualitative information to help estimate future stock values. Similarly, the goal of a multi-factor model is to identify the driving forces and traits of the securities in a portfolio that are important in forecasting portfolio risk.

Multi-factor models of portfolio returns can be divided into three types: macroeconomic, fundamental, and statistical factor models. Macroeconomic factor models use observable economic time series such as consumption, inflation, and interest rates as measures of the pervasive shocks to security returns. Fundamental factor models use the returns to portfolios associated with attributes such as industry membership, dividend yield, cash flow, and company specific traits. Statistical factor models use factor analysis procedures such as principal components analysis to identify the pervasive factors in security returns. These different factor models are not theoretically inconsistent. For instance, the firm-specific attributes used in a fundamental factor model can be typically combined to produce the factor attributes from the macroeconomic factor model.

In this report, we discuss Motif Capital’s proprietary fundamental factor model and its applications in the construction of thematic indexes and tracking portfolios, and in portfolio risk and return attribution.

### The Motif Capital Fundamental Factor Model: Implementation

#### Factor Definition

The goal of a fundamental factor model is to identify traits that are important in forecasting security risk. These include characteristics from industry membership and financial ratios to technical indicators like price momentum and recent volatility that explain return variation across a relevant security universe. The complete list of security traits used in Motif Capital’s fundamental factor model is listed in Table 1.

<table>
<thead>
<tr>
<th>Valuation</th>
<th>Growth</th>
<th>Quality</th>
<th>Security</th>
<th>Liquidity</th>
<th>Financial Risk</th>
<th>Sector / Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Book-to-Price</td>
<td>Earnings Growth</td>
<td>Operating Cash Flow to Sales</td>
<td>Market Capitalization</td>
<td>Share Turnover</td>
<td>Debt-to-Equity</td>
<td>IBES Sector Membership</td>
</tr>
<tr>
<td>Free Cash Flow to Price</td>
<td>Sales Growth</td>
<td>Return on Equity</td>
<td>Short-term Price Momentum</td>
<td>Current Ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earnings to Price</td>
<td>Book Value Growth</td>
<td>Return on Assets</td>
<td>Long-term Price Momentum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sustainable Growth</td>
<td>Dividend Yield</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: The stock factors and their respective categories used in Motif Capital’s fundamental factor model.
The choice of factors used in Motif Capital’s fundamental factor model is based on extensive prior work by industry and academic researchers\(^3\). The factors used in the Motif Capital factor model can be grouped into seven subcategories:

i. **Valuation factors:** Attempt to measure whether stocks are relatively cheap or expensive

ii. **Growth factors:** Measure the company’s growth in accounting terms

iii. **Quality factors:** Measure how well the management is running the firm

iv. **Security factors:** Measure stock’s performance, yield, market value, etc.

v. **Liquidity factors:** Indicate how easy or difficult it is to trade shares of the firm

vi. **Financial Risk factors:** Measure company’s ability to meet its obligations

vii. **Sector membership:** Represents the common risks associated with a specific sector such as technology or health care

These factors have not only been found to explain variations in stock returns over time but also exhibit relationships with stock returns that are stable and persistent, and can be explained by economic theory\(^4\).

### Factor Exposures

The next step is to determine the impact certain events may have on individual stocks, such as the sensitivity or weight of an individual security to a change in a given fundamental factor. One reasonably well-understood way of tackling the problem is the introduction of a linear model of security returns with a set of factors, or a linear factor model.

Motif Capital’s linear factor model is built in two steps. Step 1 calculates the factor exposures for all factors (also known as *style factors*) other than the sector membership factor. In this step, we pre-determine the factor exposures for all stocks based on fundamentals and pricing data for a specific period. The factor returns for each style factor in that period are then calculated using linear regression across the cross-section of stocks.

Step 2 is the computation of sector exposures. In this step, we start by defining the returns on the broad sector as the relevant factor return. A linear regression of each stock’s time series of residual returns (returns not explained by style factor exposure) against the relevant sector returns is then used to compute the sector exposure for the stock. For instance, for a company like Google that is engaged solely in technology-related activities—we start by defining its exposure to the style factors for each month using Google’s pricing and fundamentals data. Using the factor exposures and returns on the style factors computed in Step 1, we then compute the residual returns for Google for each month. Finally, the residual returns for Google are regressed against the returns for the US Technology sector to compute the Technology sector exposure for Google.

What does factor exposure mean in a linear factor model? In the same way that the classic Capital Asset Pricing Model (CAPM) beta measures how much a stock price moves with every percentage change in the market, a factor exposure measures how much a stock price moves with every percentage change in a factor. Thus, if the Value factor rises by 10%, a stock or portfolio with an exposure of 0.5 to the Value factor will see a return of 5%, all else equal.

Motif Capital’s fundamental factor model is a monthly model i.e., each stock’s exposure to the style factors and sector exposure is computed each month using contemporaneous fundamentals data and historical stock returns data going back to 1995. While the current model has been built and maintained for US-listed stocks, the framework may be easily extended to other markets. Using the linear fundamental factor model, a stock’s return is thus described by the returns of its sub-components: its size exposure times the return of the size factor plus its value exposure times the pure return of the value factor etc. Equation 1 summarizes the relationship for a representative stock (Google in this case) as shown in the equation below.

The remainder of the stock’s return (e.g., \(\alpha_{GOOG}\)) is deemed company specific and unique to each security as discussed in the next section.

\[ r_{GOOG} = \alpha_{GOOG} + \beta_{GOOG,Value} f_{Value} + \beta_{GOOG,Size} f_{Size} + \ldots + \beta_{GOOG,Technology} f_{Technology} \]
Company Specific Exposure

The final building block to our fundamental factor model is the modeling of company-specific returns. Predicting specific returns and risk is a challenging task that has been approached in a number of ways. A reasonable approach that avoids the many pitfalls of prophesizing about the future is to assume that specific returns and/or risk will be the same as they have been historically. Another approach is to use a structural model where the predicted specific risk of a company depends on its industry, size, and other fundamental characteristics.

In the Motif Capital fundamental factor model, we use both approaches—historical and modeled. The historical approach is used for firms that have traded for two years or more. The modeled approach is used for all issues that have traded for less than 2 years, since historical data on stock-specific variance is either unavailable or unreliable for newer securities.

The Motif Capital Fundamental Factor Model: Applications

The key objectives of a factor model are the estimation of expected returns and portfolio risk. Motif Capital’s fundamental factor model is primarily used for the latter. As discussed in the previous section, the linear factor model decomposes the random return for each stock in a portfolio into factor-related and stock-specific return (Equation 1). The decomposition in Equation 1 lends itself to a factor-based definition of portfolio variance—the most common measure of portfolio risk used by practitioners. In matrix notation, the expected variance of the portfolio ($\sigma_p^2$) can be expressed as:

\[
\sigma_p^2 = w_p' \Sigma(r,r') w_p
\]

Where $w_p$ is the vector of portfolio weights and $\Sigma(r,r')$ is the covariance matrix of portfolio stock returns. The myriad challenges in estimating $\Sigma(r,r')$ from historical sample data have been detailed by previous researchers. An effective factor model helps address this challenge by decomposing the original securities covariance matrix into a much smaller factor covariance matrix and a set of factor exposures. Using the factor model, the stock covariance matrix can be expressed as:

\[
\Sigma(r,r') = \beta_p' \Omega(f,f') \beta_p + V(\epsilon)
\]

Where $\Omega(f,f')$ is the factor covariance matrix, $\beta_p$ represents the matrix of factor exposures for stocks in the portfolio and $V(\epsilon)$ is the diagonal matrix of stock-specific variances. The major advantage of using the factor model for estimating the covariance matrix is that it imposes structure and leads to significantly better out-of-sample estimates. The decomposition of portfolio in Equation 3 also represents the non-diversifiable $[\beta_p' \Omega(f,f') \beta_p]$ and diversifiable $[V(\epsilon)]$ components of portfolio risk.

The Motif Capital fundamental factor model allows us to define the estimated risk for any given portfolio of stocks using the form used in Equation 3. The model therefore serves as the lynchpin for the construction of our thematically weighted indexes allowing us to compute risk and define protocols for systematic risk reduction. The factor model also plays a pivotal role in constructing tracking portfolios for these broad thematic indexes. The calculation of weights for the tracking portfolios is set up as a constrained quadratic minimization problem where the objective is to minimize the tracking error of the portfolio with respect to the broader index. The Motif Capital factor model is used to define both the objective and constraints for this minimization problem.

Factor models also provide a convenient framework for portfolio returns and risk attribution. Since the Motif Capital factor model provides the factor returns and the factor exposures for each stock in a portfolio, we can use it to gauge how much of a thematic portfolio’s return is attributable to fundamental factors or sector exposure. The remaining component of the portfolio’s return can then be attributed to the theme or stock-specific returns. Similarly, the Motif Capital factor model can be used to understand the contribution of factors and individual stocks to portfolio risk, and compute tracking errors for portfolios relative to the relevant benchmark index.
Conclusion

In this report, we described the implementation of Motif Capital’s proprietary factor model and its applications in the index and tracking portfolio construction and maintenance process. The primary purpose of a fundamental factor model is to explain returns and estimate risk, just as fundamental analysis does. Ultimately, fundamental analysis focuses on in-depth company research, while the factor model focuses on common factors that tie securities together. The effect of these common factors on return and risk is critical at the portfolio level since common factors tend to dominate company-specific risk at the portfolio level. Understanding and managing these sources of return and risk is critical to the investment process.

References

Motif Capital Management is a next-generation global equity investment manager that specializes in the management of thematic investment strategies for financial institutions such as private wealth management, investment companies, endowments, and family offices. Our unique disciplined, scientific, and transparent approach to thematic investing relies on combining data-driven insights with objective fundamental research, algorithmic portfolio design and cutting-edge technology & analytics. Our goal is to work with our institutional partners to act on the economic, socio-political, and technological forces that are shaping the global economy for the benefit of their clients’ portfolios.

Learn more at [http://www.motifcapital.com](http://www.motifcapital.com).

About Motif Capital