The Impact of Carbon Risk on US Equity Retirement Investment Funds

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Abstract:

The study examines the impact of **Carbon Risk Scores** (CRS) on market risk measured by Value-at-Risk (VaR) of US Equity Retirement Investment Funds. The data of US Equity Retirement Investment Funds utilized in this study were downloaded from the Yahoo Finance. The logarithmic returns were calculated for each stock from January 2 to December 31, 2024, Carbon Risk Score (CRS) metrics were sourced from the Morningstar database as of January 17, 2025. This indicator was calculated according to the methodology developed by Sustainalytics. The CRS captures the degree to which a company's operations and products are aligned with the transition toward a low-carbon economy (Morningstar Rating Methodology, 2021).

The GARCH-type models were fitted to the daily rates of return of 1,182 funds out of 1,212 funds (for the other, the ARCH effect was not recognized, or the problem with the convergence of the optimization algorithm occurred). An automated parameter selection algorithm was utilized during the computational process. The model was selected automatically for each company based on the Akaike Information Criterion (AIC). AIC assesses the quality of a model, considering the fit to the data and the complexity of the model. The lower the AIC value, the better the model. In fact, there are 16 possibilities: the GARCH(1,1), GJR-GARCH(1,1),

EGARCH(1,1), and CGARCH(1,1) models with GED or t-Student innovations and its skewed generalisations,

Based on the GARCH-type models, we determined the Value-at-Risk (VaR) measure as a quantile of the return distribution

$$VaR_t^l(\alpha) = -\mu_t(1) - \sigma_t(1)z_\alpha,$$

where z_α is the α-quantile of innovation distribution, we consider $\alpha = 0.01$ and $\alpha = 0.05$.

In the next step, the relationship between the VaR and the funds' CRS. Considering that the relationship between VaR and funds' CRS may be non-linear, the analysis included not only the Pearson correlation coefficient, but also the Spearman rank correlation and the Kendall concordance coefficient. Furthermore, the relationship between VaR and funds' CRS was examined throughout the period analyzed for the funds grouping into nine-cell boxes according to Morningstar's Style Box classification. The Morningstar Style Box is a nine-cell matrix designed to classify publicly traded stocks and investment funds according to size and investment style. The vertical axis of the grid represents market capitalization, divided into three categories: small-cap, mid-cap, and large-cap. The horizontal axis represents investment style, segmented into value, growth, and blend (see Figure 1). The hybrid category (Blend) encompasses both value and growth characteristics.

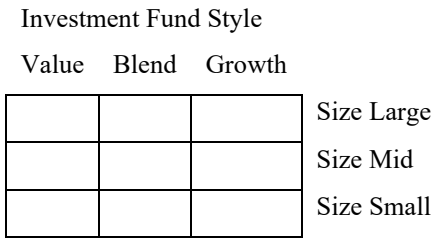

Figure 1. Morningstar Style Box
Source: Style Box Factsheet

The correlation analysis indicates a statistically significant relationship between market risk and CRS indicators. These relationships are not constant over time, becoming significantly weaker towards the end of the analyzed period.

Keywords:

Socially Responsible Investing, Carbon Risk, Carbon Risk Scores, Investment Funds, GARCH models.