

Dynamic Portfolio Decisions with Climate risk and Model Uncertainty

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EXECUTIVE SUMMARY

Failure to act on climate change ranked No. 1 on the list of top ten global risks by severity over the next ten years according to the World Economic Forum's annual Global Risks Report. It has become well understood that the impact of climate change on financial markets is highly uncertain and that our society is only learning about it over time. Notwithstanding existing research, little is known about the time horizon effects of climate uncertainty on optimal portfolio decisions, where climate uncertainty is defined as uncertainty about probabilities of future climate trajectories. This paper fills the gap and studies the impact of climate uncertainty on stock–bond–cash portfolios with short to medium term investment horizons.

Scientific contribution

This paper contributes to the optimal asset allocation literature in three ways:

1. We examine the impact of climate uncertainty on stock market performance as well as to identify the differences between the responses of Environmental, Social, and Governance (ESG) stocks and traditional stocks to different future climate scenarios.
2. We estimate the welfare loss (in today's dollars) of an investor who ignores climate uncertainty when making investment decisions.
3. We study investment horizon effects on optimal portfolios and welfare losses under climate uncertainty.

Methodology

We develop a robust optimal asset allocation model for an investor who is uncertain about the underlying global temperature model. We adopt the robust control theory to deal with the fear of climate uncertainty. The stock risk premium is assumed to depend on the average global temperature and on an unobserved factor which is estimated via Bayesian learning. The optimal investment strategy, robust to the uncertainty about climate change, is derived in closed form.

Overall Findings

1. **ESG integrated stock market indices are less sensitive to climate uncertainty than traditional stock market indices.** We find the optimal allocation to the ESG-integrated stocks (S&P500 ESG index) is not changing dramatically under different temperature scenarios. For example, when investors select the S&P500 ESG index, the optimal stock position shrinks from 128% to 79% reflecting a 38% decrease in the stock holdings when the future climate scenarios deviate severely from the expectation, whereas for the S&P500 index the optimal stock position changes from 71% to 15% implying an almost 80% decrease in stock investments.
2. **The loss from ignoring climate uncertainty can be substantial.** If mis-specified climate scenario is applied in the investment decision process without a prudent treatment, investors will face a substantial welfare loss. Climate scenarios tend to underestimate the impact of the future climate dynamics on the expected stock returns, even if the investment is ESG-

factor integrated. For naïve long-term investors who ignore the extreme uncertain nature of climate risk may suffer a loss of up to 88% of their investment assets if invested in traditional (non-ESG) stocks. Even socially responsible investors who have included ESG-integrated stocks in their portfolio may still suffer a welfare loss of up to 40% under the worst climate scenario. Our analysis implicitly warns investors and policy makers that procrastinating the implementation of climate policies are detrimental to our future economy.

4. Climate uncertainty matters to short-term investors.

Our results indicate that the welfare loss of disregarding the climate model uncertainty could be very large even for short-term investors. The welfare loss can be as high as 53% for the non-ESG equity investors and 63% for the ESG-integrated equity investors.

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