Climate Change Investment Risks: Exploring the Implications for Optimal Portfolio Construction
**The Challenge**

Climate change caused by man-made greenhouse gas emissions is rising rapidly up the agendas of decision-makers worldwide. Carbon pricing is already a feature of economic regulation in Europe and there are substantial pilot programs ongoing in China, India and the United States. As of today, about 20% of global economic activity is subject to some form of carbon tax. The 200% rise in European carbon allowance prices over the past 12 months has been wake-up call for investors in energy-intensive industries.

While many investors recognise that climate change poses financial risks, there are doubts about what actions can be taken consistent with fiduciary responsibilities. Institutional investors have increasing awareness of the problems, but they lack quantitative models to address their exposures. One proposed risk management strategy is for investors to underweight sectors with high carbon footprints, such as airlines, energy, and industrials. Such naïve actions don’t just misread energy transition risks, but could reduce long-term portfolio returns as well.

We present in this paper an alternative approach which can be used by institutional investors to assess and manage energy transition risks. This paper is co-authored with researchers at Impax Asset Management. A key benefit of the approach is that it uses standard tools of investment management.

The end result is the construction of “Smart Carbon Portfolios” that hedge carbon pricing states without altering the risk-return trade-off targeted by an investor. We find that investors could significantly reduce ex-post risk by lowering the weightings of some fossil fuel (E&P) stocks with correspondingly higher weightings towards companies active in energy efficiency (EE).

We employ Bayesian inference to integrate investors’ evolving views on carbon pricing into portfolio construction. Furthermore, forward-looking beliefs about asset returns are incorporated in a version of the Black-Litterman asset allocation model. These overlapping approaches allow for uncertain future carbon pricing scenarios to be reflected in the expectation of future financial returns.


**Asset Pricing Under (Carbon Price) Uncertainty**

We assessed the potential impact of carbon prices on companies’ future financial returns. Under assumed carbon price scenarios, the value of E&P stocks were calculated. The expected risk exposure for each stock represents a potential pricing anomaly in today’s asset prices. A portfolio construction methodology which captures these price anomalies and their associated probabilities was used to re-optimise the portfolios. The results were then tested for robustness.

While there is considerable uncertainty about the timing of transitions to future carbon pricing regimes, we anticipate that expectations will drive changes in asset valuation. Our work therefore focuses on creating carbon price sensitive portfolios to be implemented ex-ante. We estimate the probability of the timing and magnitude of the carbon price state occurring and assess any efficiency losses against potential gains.

**Reducing Risk Exposure for Institutional Investors**

The Smart Carbon Portfolios are constructed by incorporating probabilistic assumptions on carbon pricing to the universe of stocks in the MSCI World Index (n=1,649), of which 57 securities are classified as E&P and 56 are EE. In the full paper, we detail the strategies used to reduce exposure to E&P and rebalance the portfolio. Below, we present results from a graded divestment from E&P stocks with optimal rebalancing within the index (SCP-A), and the same divestment strategy with optimal reallocation towards EE stocks (SCP-B).

We determine optimal portfolio weights and associated efficient frontiers for a long-only mean-variance investor based on historical data.

The results show that the financial costs of reducing carbon risk are found to be statistically negligible. While there is much more work to be done, our work generates evidence that investors can substantially reduce their exposure to carbon pricing without sacrificing ex-ante financial gains.

### Smart Carbon Portfolio Compositions

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<thead>
<tr>
<th>SCP-A</th>
<th>SCP-B</th>
<th>Baseline Portfolio</th>
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<tbody>
<tr>
<td>16%</td>
<td>18%</td>
<td>52%</td>
</tr>
<tr>
<td>7%</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>77%</td>
<td>30%</td>
<td>41%</td>
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</tbody>
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**Energy Efficiency**  
**MSCI World Energy (rest)**  
**E&P**

### Carbon Pricing Scenarios – Probabilistic Input Assumptions

<table>
<thead>
<tr>
<th>Year</th>
<th>Price</th>
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<tbody>
<tr>
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<td>$20</td>
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<tr>
<td>2025</td>
<td>$60</td>
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Higher probability  
Lower probability
About the Centre

The Centre for Climate Finance & Investment undertakes cutting-edge research on how capital markets are responding to global climate change. Building on Imperial College London’s international reputation for multi-disciplinary analysis, the Centre is helping investors and policymakers overcome the lack of clarity about risk and return in clean energy, low-carbon technologies, and green infrastructure. Our mission is to help shape a global energy transformation through the fusion of business, technology and an entrepreneurial mindset.

The Centre receives generous support from: **Quinbrook Infrastructure Partners**

How will climate risks and opportunities affect your investments? Find out with the CCFI free online course ‘Climate Change: Financial Risks and Opportunities.’

For more information and to enrol visit [Imprl.biz/WhatIsClimateRisk](http://Imprl.biz/WhatIsClimateRisk)

#WhatIsClimateRisk

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