Explaining Greenium in a Macro-finance Integrated Assessment Model

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1. Introduction

Research question

• How do climate disasters (e.g., hurricanes, floods, droughts, etc) affect equity returns and capital investments of green and brown firms?

What I do

• Provide novel empirical evidence that relates climate disaster shocks with equity returns and investments.

What I find

• Green stocks carry lower premium than brown stocks (a Greenium).
• A climate disaster shock depreciates stock market, but green stocks depreciate less than brown stocks.
• Green (Brown) firms increase (decrease) capital investment during a climate disaster.
• A simple analytical model qualitatively explain the empirical findings.

2. Data and Empirical Method

• Sort global firms using the E-score from Refinitiv Asset4.
• Aggregate economic losses (in U.S. dollars) due to climate disasters ⇒ a disaster index.
• Cross-sectional asset pricing tests on the greenium.
• Panel regressions & event studies to investigate how green and brown stock returns and investments respond to a disaster shock.

3. Empirical Results

• Green stocks have 3.8% lower return (annualized) than brown stock, i.e., a negative greenium.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Constant</th>
<th>CAPM</th>
<th>FF3</th>
<th>FF5</th>
<th>FF5&amp;MOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green minus Brown</td>
<td>α (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s.e. (%)</td>
<td>(1.39)</td>
<td>(1.18)</td>
<td>(0.98)</td>
<td>(1.22)</td>
<td>(1.25)</td>
</tr>
</tbody>
</table>

• A disaster shock depreciates green stocks less than brown stocks.
• Green (Brown) investment increases (decreases) during a climate disaster.

4. A Simple Analytical Model

Two periods

\[ t=0 \quad t=1 \quad t=2 \]

• A climate disaster shock \( e \) happens

\[ Y_2 = \left(1 - D(l_{B,t}, \epsilon)\right) \cdot f(l_{G,t}, l_{B,t}) \]

Production function with climate damage

• Key assumption: \( \frac{\partial D}{\partial e} > 0 \), a disaster shock increases belief about marginal cost of brown investment

• Implications:
  - A disaster shock decreases (increases) optimal brown (green) investment
  - Green stocks appreciate relative to brown stocks under investment friction

5. The Macro-finance IAM

Key ingredients:

• Recursive preference: prices news about (i) productivity shock and (ii) climate damage (i.e., disasters).
• Climate feedback + investment friction: heterogeneous disaster exposures of green and brown stocks.

Key Success:

• Model quantitatively explains equity premium & greenium.
• Model matches IRFs of stock returns & investments to a disaster.

Model implication:

• The Social Cost of Carbon is $40.4 per tonne of carbon.

6. Conclusion

Empirics:

• A negative greenium in the cross section of global stock market.
• A positive disaster shock (i) appreciates green stocks relative to brown stocks, (ii) increases capital investments of green firms.

Theory:

• A production model with climate feedback generates heterogeneous disaster exposures of green and brown firms.
• This model contributes by (i) explaining asset prices in IAM, and (ii) introducing climate risks in macrofinance.

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