Discussion of:

Understanding the Pricing of Carbon Emissions: New Evidence from the Stock Market

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NBER Capital Markets and the Economy

July 10, 2024

Columbia Business School

Outline

- Are a firm's emissions associated with its cost of capital/discount rate?
- Findings from the exisiting literature.
- emissions versus emissions intensity
- Null and alternative hypotheses; test size and power
- A new test using based on emissions shocks and cashflow duration.

What is our model of the proported emissions premium?

- *What could cause an emissions premium?*
  1. A risk premium, perhaps related to regulatory uncertainty.
  2. Investor dislike for hih emissions firms, leading to low prices/high $\mathbb{E}[R]$s for these firms (see, e.g., Hong and Kacperczyk, 2009)
  3. Investors incorrectly infer that higher emissions $\Rightarrow$ lower future CFs.
- Assuming there is a premium, understanding the mechanism that leads to this premium is an important area for future research.

Why do we care?

- Given political constraints, a global, uniform price on carbon emissions is perhaps impossible.
  - See however, the Bloomberg Net-Zero podcast with Catherine McKenna.
- From a policy perspective, perhaps financial market participants can drive up the cost of capital for high-emissions firms, incentivizing them to take into account the externalities associated with these emissions.
  - Note that a differential increase in the cost-of-capital of brown firms may lead to an overall increase in emissions (Hartzmark and Shue, 2022).
- While we are nowhere near fully understanding whether this mechanism would work, but this line of work is a crucial part of the research effort.

Emissions vs. Emissions Intensity

- Carbon Emissions are Priced
  - Bolton and Kacperczyk (2021, 2023)
- Carbon Intensity is not. Aswani, Raghunandan, and Rajgopal (2024a) argue that the BK papers are flawed because:
  - they use data-vendor estimated emissions rather than actual emissions.
  - they use unscaled emissions, and don't scale by firm revenues.
    - MM-like argument
- Which measure is right?
  - Bolton and Kacperczyk (2024); Aswani, Raghunandan, and Rajgopal (2024b).
- Gormsen, Huber, and Oh (2024) looks at perceived cost of capital as a function of emissions:
  - Like Bolton and Kacperczyk (2023), they find an relative cost-of-capital drop for green firms around the Paris accords.

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What this paper does

- This paper concerns itself with econometric issues associated with testing the hypothesis that emissions are priced:
  1. timing of information
  2. regressions rather than portfolios
  3. omitted variable bias
  4. a new test using additional information.

What are we testing?

- H_0: emissions intensity is not a priced characteristic.

$$\mathbb{E}[m_{t+1}R_{t+1}|\mathcal{F}_t] = 0$$

  for any excess return R_{t+1}.
- H_1: emissions intensity is a priced characteristic

$$\mathbb{E}[m_{t+1}R_{t+1}|\mathcal{F}_t] = \gamma e$$

How do we test this?

- Form a zero-investment portfolio uncorrelated with m which, under the alternative hypothesis, has maximum test power.
  - This is equivalent to forming a portfolio that has the highest expected Sharpe-ratio under the alternative hypothesis.
- However, the portfolio weights can *only* be based on information that is in the investors' information set as of the start of period $t + 1$.

Timing of Information

- This paper argues that a problem with both the HK and the ARR papers is that they are not careful about the timing of information.
- Thus, they run annual regressions based only on *ex-ante* emissions information (and controls)
- These regressions suggest that even emissions intensity is priced.

Regressions vs. Portfolios

- The authors advocate for the use of regressions rather than portfolios. They state

  > *. . . for tests for pricing based on the performance of high and low emissions portfolios, the portfolio comparison approach has important limitations that make it difficult to detect pricing. In particular, because the returns of the portfolios that are being compared are weighted average of the returns of firms in different industries, the portfolio approach cannot control for industry as a determinant of required returns. (p. 4)*

- I'm going to argue that this is wrong, and in fact that they are testing whether the mean returns of (zero-investment) portfolios are zero.
  - For the most part, this is what asset pricing tests do.

Regressions vs. Portfolios

- Consider a regression of individual firm returns $R_{i,t}$ on a set of predictive variables and controls $\mathbf{X}_{i,t-1}$:

$$\mathbf{R}_t = \mathbf{X}_{t-1}\boldsymbol{\beta}_t + \boldsymbol{\epsilon}_t$$

- The OLS regresion coefficient is (eliminating time subscripts):

$$\hat{\boldsymbol{\beta}}_t = \underbrace{\left(\mathbf{X}'\mathbf{X}\right)^{-1}\mathbf{X}'}_{=\mathbf{w}'_{t-1}}\mathbf{R}_t$$

  so each element of $\hat{\boldsymbol{\beta}}_t$ is the return on a portfolio.
- *What can we say about the portfolio weights?*. Since

$$\left(\mathbf{X}'\mathbf{X}\right)^{-1}\mathbf{X}'\mathbf{X} = \mathbf{I}, \text{ or } \quad \mathbf{w}'\mathbf{X} = \mathbf{I},$$

  which means that each x-sectional regression coefficient is the return to a zero-investment portfolio which has unit exposure to that stock characteristic, and zero exposure to every other characteristic.

Omitted Variable Bias

- The authors state:

  In the regressions where investors are assumed to know too much, at the beginning of the year, the residual will be correlated with the emissions intensity regressor. Given that the regressor is correlated with the residual, we will refer to the resulting bias as omitted variables bias, and we will show below that adding an additional regressor can eliminate this bias (p. 19)

- That is, if the independent/forecasting variable is in the investors' information set, then there is no bias.
- I'm not sure it makes sense to fix any "bias" introduced by including future emissions information in this way, but let's look at this test.

A new test—motvation

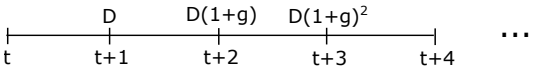
- Emissions intensity follows a random walk

$$\mathbb{E}_{t-1}[e_{i,t}] = e_{i,t-1}$$

- Expected returns are a linear function of emissions intensity

$$\mathbb{E}_{t-1}[r_{i,t} - r_{f,t}] = \gamma \mathbb{E}_{t-1}\left[e_{i,t}\right] = \gamma e_{i,t-1}$$

- Firm is dividends grow at a constant rate g_i



- Shocks to emissions intensity are uncorrelated with future dividends.
- In this setting, the firm value is:

$$P = \frac{D}{r-g} = \frac{D}{\gamma e - g}$$

A new test—motvation(2)

- Differentiating w.r.t. emissions intensity gives

$$\frac{\partial P}{\partial e} = -\gamma \frac{D}{(\gamma e - g)^2}$$

- Or, since $P/D = \frac{1}{(\gamma e - g)}$,

$$\frac{\delta P}{P} \approx -\gamma \frac{P}{D} \delta e$$

- So, over a period where there is an innovation in emissions equal to $\delta e = e_{i,t} - e_{i,t-1}$, the realized return will be:

$$r_{i,t} - r_{f,t} \approx \gamma e_{i,t-1} - \gamma \left(\frac{P_{i,t-1}}{D_{i,t-1}} \right) (e_{i,t} - e_{i,t-1})$$

  - That is, the expected return, *plus the unexpected return due to the innovation in the long-term discount rate.*

Why don't we typically run tests like this?

- As the authors note, this is a unique estimation procedure. Why don't we typically run regressions like this?
- The problem is that this relies on the assumption that the contemporaneous negative correlation between emissions innovations and returns is driven only by news about discount rates.
  - *Are we that confident that emissions intensity spikes are unrelated to future cashflows?*
  - If you are going to go down this road, you need to estabish that Δe really is a shock *only* to discount rate, and not to cashflows, in the context of a Campbell and Shiller (1988) decomposition.

Are emissions innovations correlated with future cashflow?

- The authors argue that there is no evidence that emissions innovations are correlated with future cashflows.
  - Thus, they argue, we really can view Δe as a pure change in expected returns.
- Measuring the correlation between the PV of all future cashflows and any shock is really hard.
  - This is like asking whether market returns forecast future dividends or future expected returns (see, e.g., Cochrane, 2008).
  - Measuring near term correlations of emission shocks and profits won't capture everything.

Conclusions and Suggestions

- This paper and this research agenda are really interesting and important.
- The literature needs to think more carefully about optimal, theoretically-motivated tests of the relation between emissions and future returns.
  - Determining the source of the premium is key.
- This paper makes a nice contribution in cleaning up some of the econometric problems (ie., using instruments that are not *ex-ante*)
- The test using emissions innovations is interesting, but is also potentially really problematic.

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