Carbon Risk in Production Networks

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The puzzle: Where is carbon risk *really* borne?

The conventional view of carbon risk:

- The burden falls on high-emission ("brown") producers — utilities, refiners, airlines.
- Climate stress tests, disclosure metrics, portfolio-alignment scores all rely on this.
- This is where the literature usually starts: where carbon is *produced* (γ).

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The paper's view: in a networked economy, carbon risk does *not* stay where emissions occur.

- Firms are connected through input–output linkages.
- When carbon regulation tightens, **downstream customers** cut input demand $\rightarrow$ the shock propagates **upstream** to suppliers.
- A firm with modest direct emissions can still be heavily exposed — through its trading partners.
- This paper adds cash-flow exposure to carbon shocks through the production network.

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The central tension

Where carbon is *produced* (γ) need not be where carbon *risk is borne* ($\gamma + \chi$).

The mechanism: Utilities vs. Pipeline Transportation

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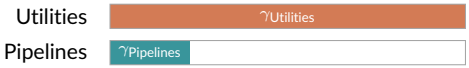
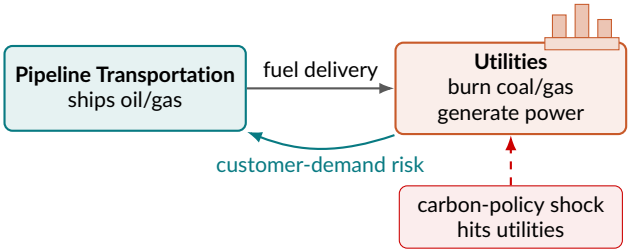
Direct emissions: γ



Utilities is the textbook "dirty" industry:

$\gamma_{Utilities} \approx \mathbf{4.5} \times \gamma_{Pipelines}$.

The mechanism: Utilities vs. Pipeline Transportation



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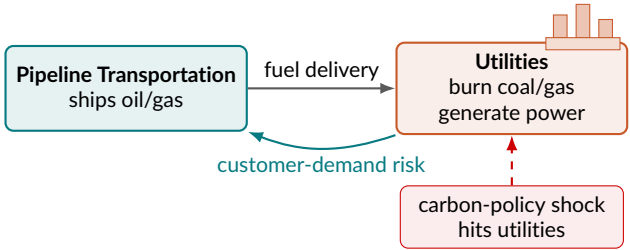

Ranking flip

by γ — Utilities dominate

by $\gamma + \chi$ — $\approx$ tied

Pipelines are roughly tied near the top because their network exposure is so large.

What the paper does

Model GE asset-pricing framework with input–output linkages and aggregate carbon-policy risk. Expected returns are ranked by $\gamma + \chi$, where χ captures network propagation.

Measure Industry-level χ from BEA I–O tables, mapped to firms using Compustat segment sales weights. Implied cost of capital (ICC) is the ex-ante return measure.

Headline High-χ firms have higher ICC. In the paper's decomposition, indirect exposure accounts for about 85% of the carbon-risk premium.

Mechanism A WSJ-based Carbon Regulatory Index. High-χ firms contract more in returns, investment, and earnings during regulatory-risk episodes.

$\Rightarrow$ **Carbon risk is not only direct emissions; it also moves through carbon-intensive demand.**

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  - Direct emissions can largely understate carbon exposure;
  - Scope 3 and future emissions can reshape the cross-section;
  - Carbon burden is priced in expected returns.

This paper's χ

- production-network cash-flow exposure;
- weights risk by network links;
- asks which firms lose when carbon-intensive demand falls.

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The comparison: cash-flow-weighted network exposure vs. social-cost-weighted future emissions.

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  - Baseline horse race: ICC on χ, Scope 3 intensity, total Scope 1+2+3 intensity, and Pastor et al. Carbon Burden.
    - ⋆ One column (Table 4, col. 6) showing the χ coefficient stable when Scope 3 is added.
    - ⋆ A 0.11 firm-level cross-sectional correlation with Scope 3 (and Scope 3 itself is noisy: provider correlations ≈ 0.58).
  - Repeat it in Fama–MacBeth, within/cross decomposition, factor tests, and CRI-response regressions.

$\Rightarrow$ Show that GE propagation in χ prices assets beyond standard value-chain carbon accounting.

Comment 2: Static theory, dynamic outcomes

- The model is a **short-run**, **fixed-network** environment:
  "...our focus is on short-run asset pricing implications using monthly or annual data. Over these horizons, it is reasonable to treat production technologies as fixed."
- Section 5 uses the same χ to predict revenue, investment, and net income:
  - $t+1$: plausible as a short-run accounting response.
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  - $t+2$: harder to interpret, because firms can substitute suppliers, renegotiate contracts, and reallocate inputs.
- The $t+2$ estimates may reflect firms' adjustment, not just mechanical network exposure.
  - A cleaner interpretation needs persistence evidence, slow-moving exposure, or a dynamic model.

Comment 3: CRI may mix policy news with energy news

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  - Several are fossil-fuel operations terms, not policy terms.
- Top-χ industries are energy-supply-chain industries: Pipeline Transportation, Oil and Gas Extraction, Mining, Utilities, and transport.

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  - Alternative: WSJ runs more bad news about oil & gas $\rightarrow$ energy-sector stocks fall $\rightarrow$ high-χ firms *are* energy-sector firms $\rightarrow$ returns drop. $\Rightarrow$ *"Energy news moves energy stocks."*

Comment 3: Clean up the CRI mechanism test

To separate network propagation from energy-sector exposure:

- Rebuild CRI from climate-policy keywords (“carbon tax,” “cap-and-trade,” “EPA rule,” “climate disclosure,” “transition”).
- Or orthogonalize CRI against energy-sector returns or a pollution-premium factor, then re-run Tables 8–9.

Conclusion

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- **To strengthen the empirical bridge, tighten three things:**
  1. **Horse race** χ against PST Carbon Burden as the frontier benchmark — and Scope 3 / Scope 1+2+3 as floors — across panel ICC, Fama–MacBeth, decomposition, and factor tests.
  2. **Reconcile** the static theory with the $t+2$ real-effects empirics — either restrict Section 5 to $t+1$, or extend the theory to allow input substitution.
  3. **Re-identify** the mechanism in Section 5 — rebuild CRI from climate-policy keywords, or orthogonalize CRI against energy-sector returns.
- I look forward to seeing the next version of this great paper!