Disaster risk and commercial real estate insurance cost in a portfolio

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All errors are our own.

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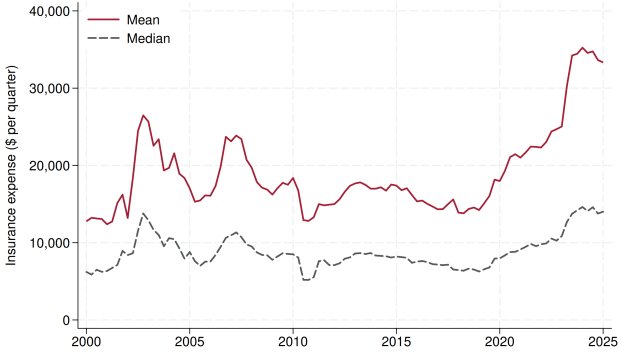
Agenda

- Motivation and research question
- Data, construction, and identification logic (own-out / fund-out)
- Empirical strategy
- Main evidence: nested specifications
- Fund type heterogeneity
- Takeaways

Motivation: Insurance costs rise sharply over time

- Commercial insurance costs have risen sharply in recent years, creating direct pressure on CRE operating expenses and NOI.
- In our sample, quarterly insurance expense per property rises substantially over time.
- This motivates the empirical setting, but our main question is **cross-sectional / within-time portfolio pricing**, not just aggregate time trends.



Motivation: Climate risk, insurance, and CRE valuation

- In practice, large CRE insurance programs are often negotiated at the **portfolio (account)** level, not purely property-by-property.
- Practitioner interviews suggest large CRE insurance programs are often negotiated using an overall account view (portfolio risk, pricing terms, market-power).
- In our interview with a large commercial real estate insurance company senior manager, she mentioned when "in insurance negotiations in CRE, policies are negotiated at the portfolio level, and that larger entities can receive discounts."

Related literature and the gap

Commercial property insurance costs are now an important climate-risk channel.

- Kim, Mahajan & Wang (2025) document large increases in commercial property insurance costs and show that owner characteristics matter for insurance costs even holding property risk fixed.
- Keys & Mulder (2024) document rapidly rising property-insurance premiums, a strengthening pass-through from disaster risk into premiums, and capitalization of higher premiums into lower property values.
- Buschbom, Eastman, Wang & Zhou (2025) show that climate risk and realized climate shocks are strongly related to commercial property insurance outcomes.
- Existing work does not directly test whether portfolio climate-risk characteristics enter recorded property-level insurance expense conditional on a property's own climate risk.

Kim–Mahajan–Wang (2025); Buschbom et al. (2025); Keys–Mulder (2024).

Why portfolio moments may matter in recorded property insurance

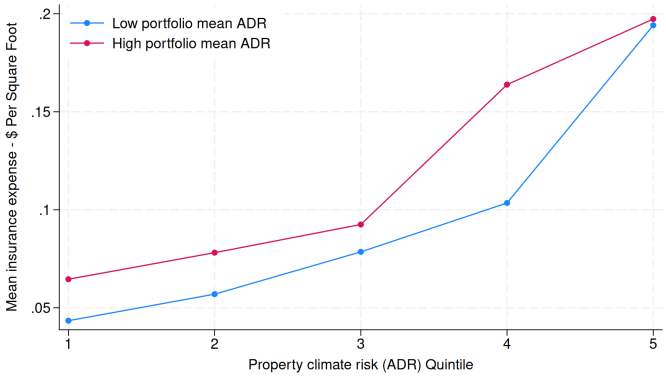
- If recorded property-level insurance costs reflect portfolio pricing and allocation rules, then measured property-level OpEx may depend on:
  - the property's own climate risk, *and*
  - the risk composition of the manager/fund portfolio.
- This matters for interpretation of property performance, valuation, and climate-risk pass-through.
- Empirically, since coverage terms and allocations can differ across locations/perils, the recorded property-level insurance costs may reflect **portfolio pricing + allocation**, not only local hazard.
- Therefore, we expect:
  - even holding a property's own risk fixed,
  - manager/fund portfolio risk **level**, **dispersion**, and **size**
  - may predict the property's recorded insurance expense.

Main research question and data construction

Main question (existence): Do manager- and fund-level portfolio risk characteristics enter property-level recorded insurance costs?

- Unit of observation: **property** $\times$ **quarter** (NCREIF panel merged to Moody's RMS ADR).
- Property climate risk: **ADR** (annualized damage rate; all natural hazards). This measures the expected average (mean) yearly loss from natural hazard per dollar of value of the property. We use it as a proxy for the natural hazard "risk" of a property.
- Outcomes and controls use rolling (an average $\pm$ 4 quarters) property-quarter accounting variables (insurance expense, income, value).
- Portfolio moments (manager and fund):
  - value-weighted mean ADR,
  - value-weighted ADR standard deviation (SD),
  - portfolio size (property counts).

Stylized facts: portfolio climate risk shifts insurance



- Property climate risk (ADR) is strongly related to insurance costs.
- Within each property ADR Quintile, properties in higher Fund-portfolio ADR have higher insurance expense per sq ft.
- This motivates the core question: do portfolio-level climate-risk characteristics affect recorded property-level insurance costs *conditional on local risk*?

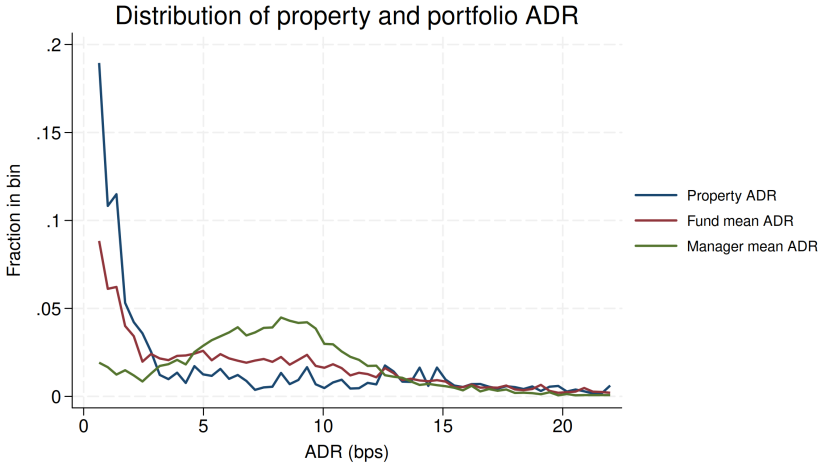
Notes. Mean insurance expense per sq ft is shown by property ADR quintile. Within each quintile, properties are split by Fund average ADR: high is above the median, low is below.

Summary statistics: key variables

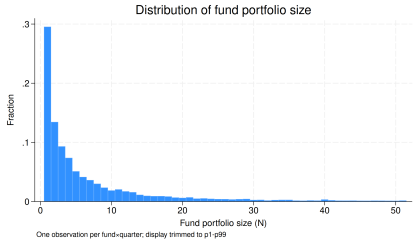
	p25	Median	p75	Mean	SD
Panel A: Property–quarter variables					
Property value ($M)	10.5	19.6	40.4	27.8	24.0
Square feet (k sqft)	68.8	150.0	294.3	229.6	286.0
ADR (bps; all hazards)	0.82	2.19	12.35	8.31	14.31
Insurance expense ($k per quarter)	2.3	7.7	20.6	19.5	46.9
Income ($k per quarter)	199.2	538.1	1,262.8	1,131.8	2,282.3
Panel B: Portfolio variables					
Manager portfolio size (# props; mgr×quarter)	10	24	64	62	105
Fund portfolio size (# props; fund×quarter)	1	4	10	12	33
Funds per manager×quarter	1	2	7	5	7
Manager mean ADR (bps; value-wtd)	4.89	7.93	10.38	8.55	7.18
Manager ADR dispersion (bps; value-wtd sd)	7.26	10.91	14.76	12.59	10.94
Fund mean ADR (bps; value-wtd)	2.59	6.57	11.22	8.50	8.93
Fund ADR dispersion (bps; value-wtd sd)	4.15	8.21	12.87	10.03	10.23

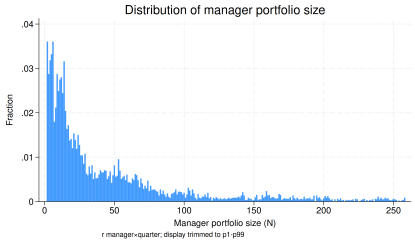
Notes. Full sample after RMS match/processing ($N = 542{,}150$ property–quarter observations). Property value in $ millions; square feet in thousands; insurance expense and income in $ thousands per quarter. ADR reported in basis points (ADR $\times 10{,}000$). Portfolio sizes are computed over manager×quarter and fund×quarter groups.

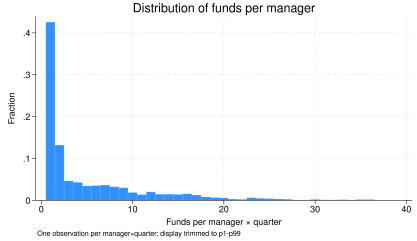
Distribution of property and portfolio ADR



Distribution of portfolio size







Notes. The median fund has 4 properties, the median manager has 24 properties, and the median manager has 2 funds

Identification logic: avoiding mechanical correlation

- If we include the focal property in portfolio moments, coefficients can be mechanically inflated (the property helps define the regressor).
- We therefore construct portfolio moments excluding the focal observation.
- For manager moments, we use a stronger exclusion in the main specification: **fund-out** (exclude all properties in the focal fund).

	Manager mean ADR	Manager SD ADR	Fund mean ADR	Fund SD ADR
Main specification	Exclude focal fund	Exclude focal fund	Exclude focal property	Exclude focal property
Why this helps	Reduces mechanical overlap between the dependent variable's property and the portfolio regressors; makes the manager-side result harder to attribute to within-fund composition of the same property.			

Empirical strategy: what counts as evidence of "existence"

- Baseline outcome: $\log(\text{quarterly insurance expense}_{i,t})$.
- Key regressors:
  - property risk: $\log(\text{ADR}_{i,t})$
  - manager portfolio moments (fund-out)
  - fund portfolio moments (own-out)
- Controls: $\log(\text{sqft}), \log(\text{value}), \log(\text{income})$, plus funds-per-manager on the manager side.
- Fixed effects (baseline): quarter, state, property subtype, fund type.
- Standard errors clustered by manager$\times$quarter.

Existence test in practice:

- Add portfolio moments to a property-risk + controls specification.
- Ask whether portfolio moments load in the expected direction and improve fit.
- Then test whether the result survives **property FE**.

Empirical specification (full notation)

$$\log(\text{Ins}_{i,t}) = \alpha + \beta \log(\text{ADR}_{i,t}) + \gamma M_{m,t,i} + \delta F_{f,t,i} + \theta Z_{i,t} + \mu_t + \mu_s + \mu_\kappa + \mu_\tau + \varepsilon_{i,t}.$$

Indices: i = property, t = quarter, m = manager of property i, f = fund of property i, s = state, κ = property subtype, τ = fund type.

- $Z_{i,t}$: property controls (log square feet, log property value, log income)
- $M_{m,t,i}$: manager-level portfolio moments for manager m in quarter t, constructed **excluding the focal fund** of property i (fund-out)
- $F_{f,t,i}$: fund-level portfolio moments for fund f in quarter t, constructed **excluding the focal property** i (own-out)
- Fixed effects: quarter (μ_t), state (μ_s), property subtype (μ_κ), fund type (μ_τ)
- Standard errors clustered by manager×quarter

Main evidence: nested specifications

	(1) Risk only	(2) +Fund moments	(3) +Mgr moments	(4) +Fund+Mgr
Property risk (log ADR)	0.1207***	0.1217***	0.1211***	0.1214***
Fund mean risk (own-out, log)		0.0433***		0.0469***
Fund risk dispersion (own-out, log SD)		-0.0889***		-0.0876***
Fund portfolio size (own-out, log N)		-0.0536***		-0.0555***
Manager mean risk (fund-out, log)			0.0519	0.0727**
Manager risk dispersion (fund-out, log SD)			0.0662***	0.0366*
Manager portfolio size (fund-out, log N)			-0.0060	0.0079
Property controls (log sqft, value, income)	Yes	Yes	Yes	Yes
Quarter + state + subtype + fund type FE	Yes	Yes	Yes	Yes
Observations	220,337	220,329	220,323	220,315
Adj. R^2	0.812	0.814	0.813	0.815

Interpretation for this talk. The existence result is the combination of (i) stable positive property-risk loading and (ii) incremental predictive power of fund and manager portfolio moments in the full specification.

Standard errors clustered by manager×quarter.

How to read the main table

- The property-risk coefficient is stable across all columns (≈ 0.12), so adding portfolio moments is not simply replacing local hazard risk.
- **Fund-side moments** load strongly in the expected direction in both column (2) and column (4):
  - higher fund mean risk $\rightarrow$ higher recorded insurance
  - greater fund dispersion / larger fund portfolio size $\rightarrow$ lower recorded insurance
- **Manager-side moments** also matter in the full specification:
  - manager mean risk (fund-out) becomes positive and statistically meaningful in column (4)
  - manager dispersion remains positive but attenuates versus the manager-only column
- **Existence**: Portfolio characteristics enter property-level recorded insurance costs, even after controlling for property risk and standard fixed effects.

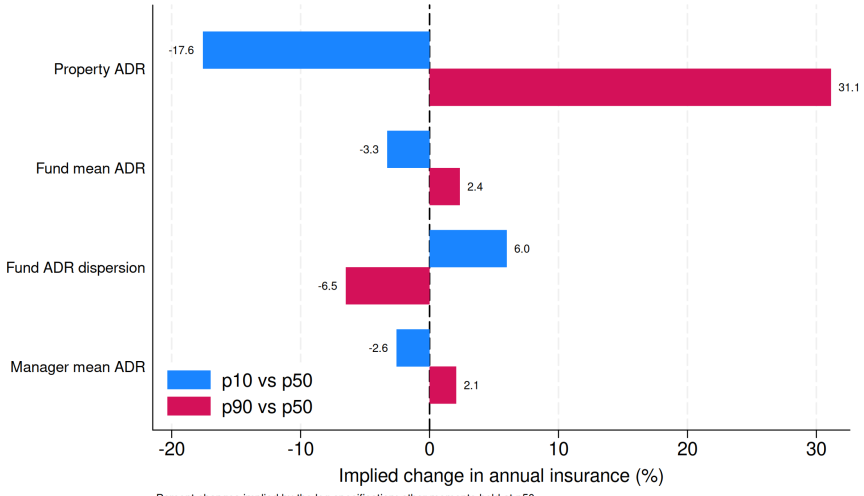
Interpreting magnitudes: portfolio position and implied insurance differences

- Lets take a look at a typical median property; 150K Sqft with a value of $\sim \$19M$, and the median insurance cost $\approx \$7.5$k per quarter; $\approx \$30.0$k per year.
- Each row shifts **one** portfolio attribute from p50 to p10 or p90 (others held at p50).

Portfolio attribute shifted (p50→p10/p90)	**p50 to p10**	**p50 vs p90**
Property ADR	-17.6% ($-\$5.3$k)	$+31.1\%$ ($+\$9.3$k)
Fund mean ADR	-3.3% ($-\$1.0$k)	$+2.4\%$ ($+\$0.7$k)
Fund ADR dispersion	$+6.0\%$ ($+\$1.8$k)	-6.5% ($-\$1.9$k)
Fund portfolio size (N)	$+7.4\%$ ($+\$2.2$k)	-7.9% ($-\$2.4$k)
Manager mean ADR	-2.6% ($-\$0.8$k)	$+2.1\%$ ($+\$0.6$k)

Notes. Dollar changes are annualized relative to the baseline median annual insurance expense ($\approx \$30.0$k/year).

Magnitudes: implied portfolio-risk shifts



Percent changes implied by the log specification; other moments held at p50.

Fund structure subsamples

	Open	Closed	Separate
Property risk (log ADR)	—	—	—
Fund mean risk (own-out, log)	0.0312	0.0478**	0.0907***
Fund risk dispersion (own-out, log SD)	-0.0005	-0.0177*	-0.0299
Fund N (own-out, log)	-0.0085	0.0242	-0.0446***
Manager level controls	Yes	Yes	Yes
Observations	52,222	24,901	65,295
Adj. R^2	0.962	0.982	0.961

Notes. Dependent variable is log insurance expense. Fixed effects: quarter, state, property subtype, and **property (prop)**. Standard errors clustered by manager × quarter.

Fund-side takeaway

- **Separate accounts:** strongest fund-side signal.
- **Closed-end:** weaker positive loading on fund mean ADR.
- **Open-end:** little fund-side variation.

Takeaways

- **Property climate risk matters:** higher own-property ADR is strongly associated with higher recorded insurance expense.
- **Portfolio climate risk also matters:** fund- and manager-level portfolio risk moments add explanatory power conditional on the property's own risk.
- **The fund-side signal is especially robust:** higher fund mean ADR predicts higher recorded insurance, while some fund size / dispersion measures load negatively.
- **Interpretation:** recorded property-level insurance expense reflects not only local hazard, but also portfolio-level pricing and allocation.

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Appendix: replacing ADR dispersion with geographic concentration (HHI)

	(1) Baseline	(2) HHI Both
Property risk (log ADR)	0.1214***	0.1185***
Fund mean risk (own-out, log)	0.0469***	-0.0481***
Fund risk dispersion (own-out, log SD)	-0.0876***	-
Fund county HHI (value-based)	-	-0.2336***
Fund N (own-out, log)	-0.0554***	-0.0770***
Manager mean risk (fund-out, log)	0.0714**	0.1034***
Manager risk dispersion (fund-out, log SD)	0.0375*	-
Mgr county HHI (value-based)		-1.7873***
Manager N (fund-out, log)	0.0078	-0.0117
Observations	220,329	220,333
Adj. R^2	0.815	0.815

Notes. DV: log insurance expense. Controls included in all columns. FE: quarter, subtype, state, and fund type; cols. (3)–(4) add property FE. SEs clustered by manager×quarter. Higher HHI = more geographic concentration.

Appendix: replacing ADR dispersion with expected loss weighted geographic concentration (HHI)

	(1) Baseline	(2) HHI Both
Property risk (log ADR)	0.1214***	0.1217***
Fund mean risk (own-out, log)	0.0469***	-0.0336***
Fund risk dispersion (own-out, log SD)	-0.0876***	-
Fund county HHI (value-based)	-	-0.1784***
Fund N (own-out, log)	-0.0554***	-0.0781***
Manager mean risk (fund-out, log)	0.0714**	0.1223***
Manager risk dispersion (fund-out, log SD)	0.0375*	-
Mgr county HHI (value-based)	-	-0.6938***
Manager N (fund-out, log)	0.0078	-0.0123*
Observations	220,329	220,333
Adj. R^2	0.815	0.815

Notes. DV: log insurance expense. Controls included in all columns. FE: quarter, subtype, state, and fund type; cols. (3)–(4) add property FE. SEs clustered by manager×quarter. Here, county HHI is based on county shares of portfolio value × ADR, so higher HHI indicates greater concentration of risk-weighted portfolio exposure..

Appendix: Robustness - does the portfolio signal survive tighter fixed effects?

	(1) Baseline	(2) +Property FE
Property risk (log ADR)	0.1214***	-
Fund mean risk (own-out, log)	0.0469***	0.0488***
Fund risk dispersion (own-out, log SD)	-0.0876***	-0.0175*
Fund portfolio size (own-out, log N)	-0.0554***	-0.0347***
Manager mean risk (fund-out, log)	0.0714**	-0.0051
Manager risk dispersion (fund-out, log SD)	0.0375*	0.1028***
Manager portfolio size (fund-out, log N)	0.0078	-0.0489***
Property controls (log sqft, value, income)	Yes	Yes
Quarter FE	Yes	Yes
State + subtype + fund type FE	Yes	Yes
Property FE	No	Yes
Observations	220,329	220,130
Adj. R^2	0.815	0.963