Imperial College
London
Business School

Some New Insights into Large Commercial Risks

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CAS Seminar on Reinsurance

New York City
May 22, 2014

AGENDA

1. Overview
2. Dataset
3. Estimation
4. Benchmarking
5. Next Steps

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OVERVIEW

A new data source: **Imperial-IICI dataset**

- Insurance Intellectual Capital Initiative (IICI)
  - Bronek Masojada (Hiscox), James Slaughter (Liberty Mutual), Rob Caton (Hiscox)
  - Lloyd's of London
- Focus on Large Commercial Risks (LCR)
  - Commercial Property, On-shore Energy; non-natural hazards

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Implications for **reserving** and capital **modeling** (joint work with Davide Benedetti, Erik Chavez [Imperial]; with Andreas Milidonis [Nanyang] for Asia-Pacific region)

- Tail risk estimation
- Benchmarking exercise (market loss curves & scaling factors)

LCR

LCR largely **non-modelled** risks

- Heterogeneity of exposures by type and size
- Complex relation between hazard events and losses
- Paucity of data for model estimation/validation

Implications

- Considerable degree of judgment in pricing/reserving decisions
- Reported claims may not reflect true risk of business
- Pricing variability makes it difficult for corporates to budget for insurance

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DATASET

- Around **3,200 FGU claims** and **exposures** based on brokers' submissions
- Scope: **worldwide, 1999-2012**

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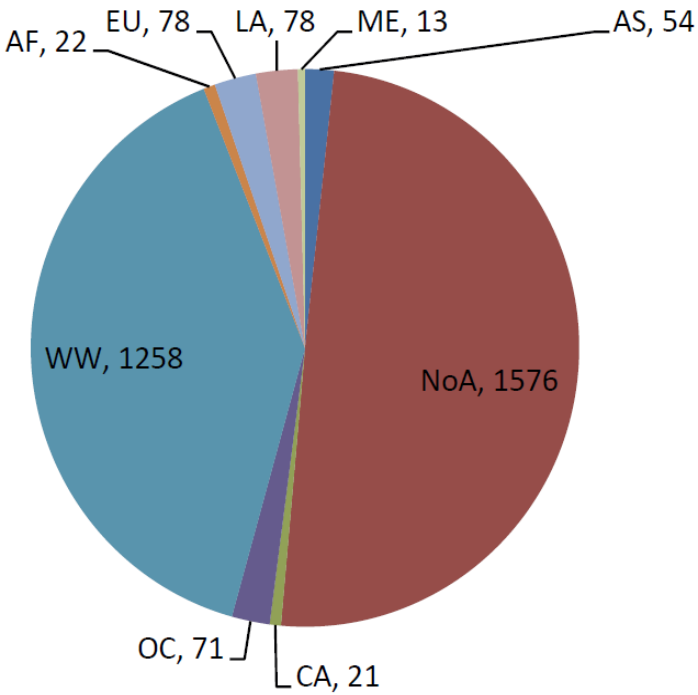
- Scope: **worldwide, 1999-2012**
- Granular classification of exposures by three **occupancy levels**
  - Definitions based on Lloyd's codes & individual syndicates' classification; can be related to ISO/PSOLD classification
- Anonymized **claim narratives** available
- Example:

Region	Country	Risk Code	Occupancy 1	Occupancy 2	Occupancy 3
NoA	US	P2 (Physical damage for primary layer property; USA; excluding binders)	RE (residential)	R (residential)	51 (Large Hotels)

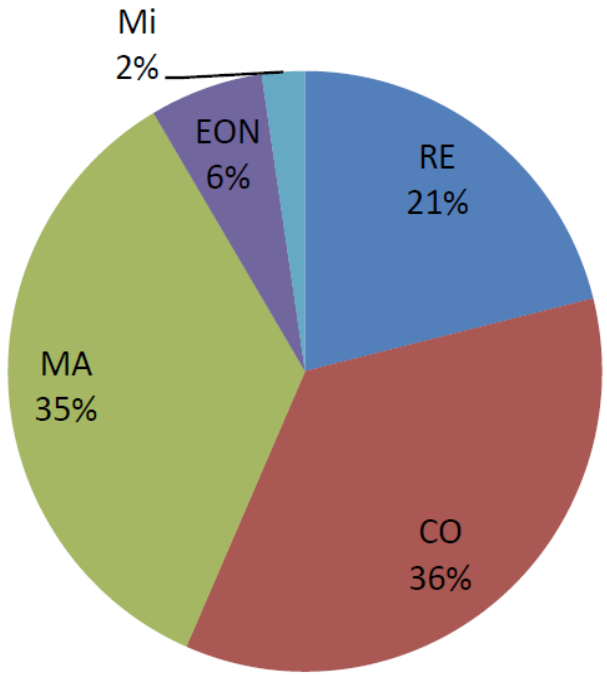
OCCUPANCY EXAMPLE - LEVEL 2 LIST

Code	Definition	Code	Definition
A	Miscellaneous	Q	Offices/Banks
B	Manufacturers/Processors	R	Residential
C	Chemicals/Pharmaceuticals	T	Transport
D	Bridges/Dams/Tunnels/Piers	U	Utilities
E	Conglomerates	V	Telecoms and Data Processing
F	Food	W	Woodworkers (Sawmills, Papermills)
G	Grain	X	Onshore Crude
H	General Mercantile/Shops	Y	Onshore GasPlants
J	Mines	Z	Onshore Construction
K	Crops	2	Hospital/Health care centres
L	Auto	4	Semiconductor/Fabs
M	Metals	5	Motor Manufaturers
O	Municipal Property	6	Warehouses
P	Energy (Oil Refineries/Petrochemicals)		

GEOGRAPHICAL/OCCUPANCY SPLIT

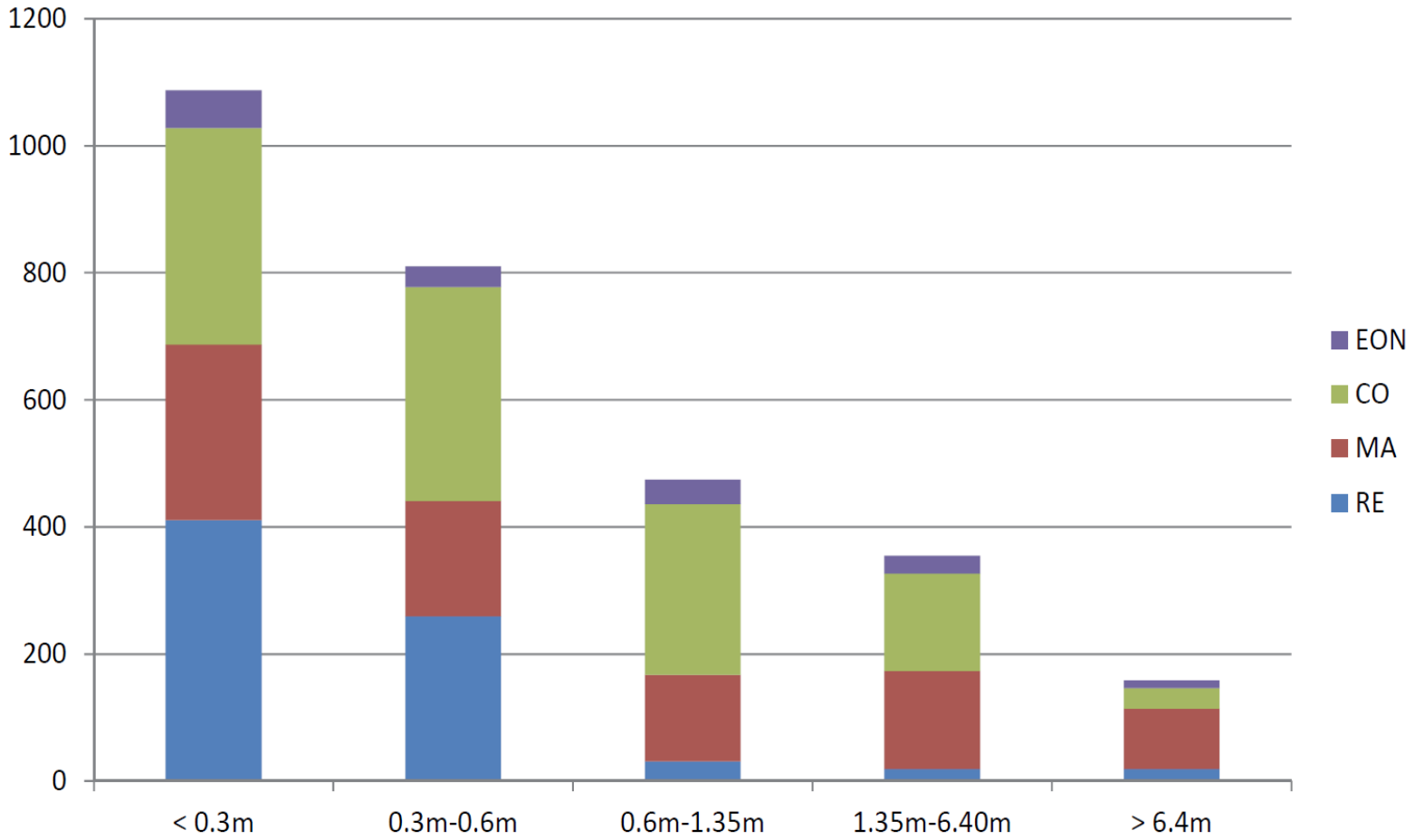


AF (Africa), CA (Central Asia), EU (Europe), LA (Latin America), ME (Middle East), AS (Asia-Pacific), NoA (North America), OC (Oceania), WW (Worldwide).

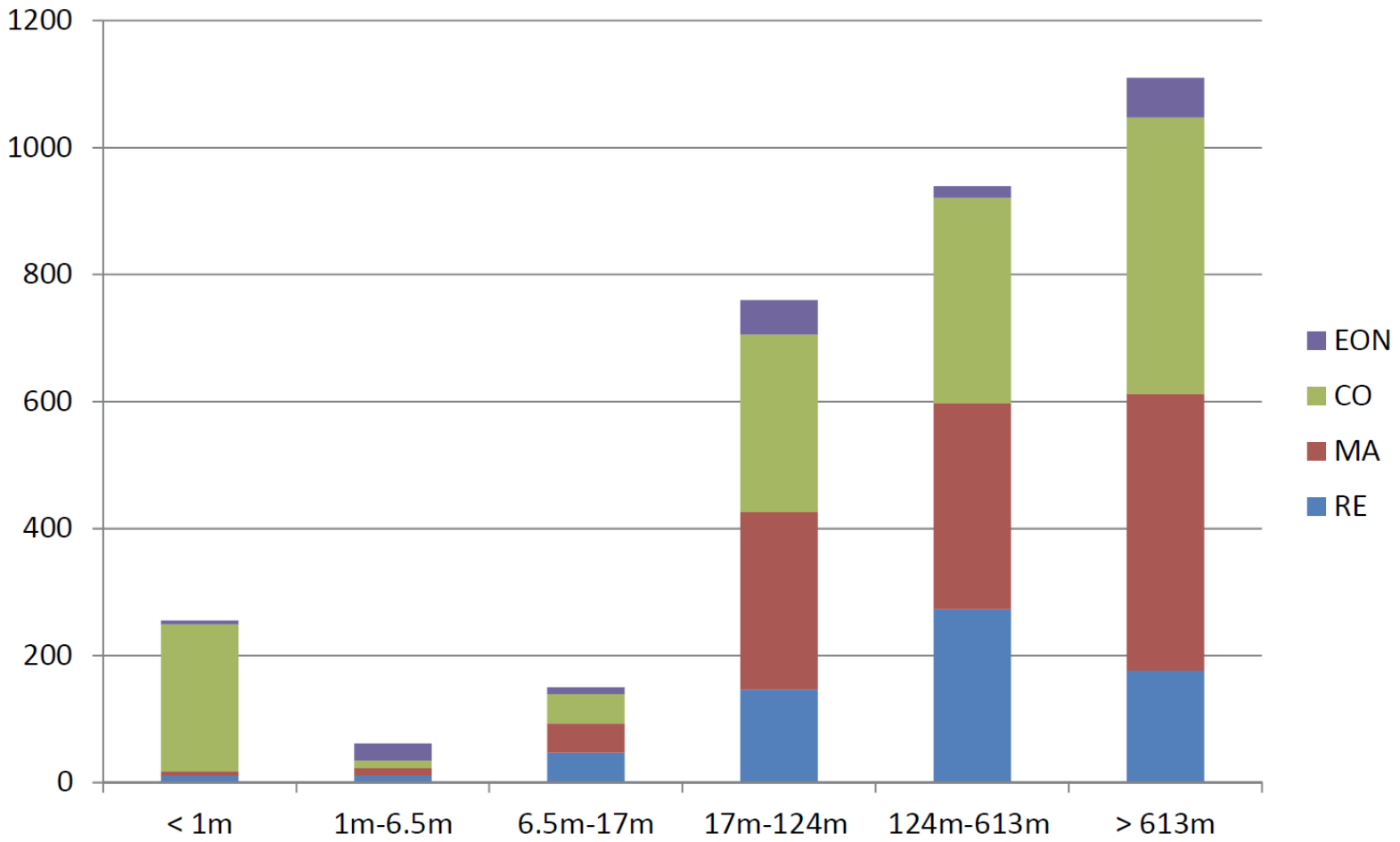


RE (Residential), CO (Commercial), MA (Manufacturing), EON (Energy on-shore), Mi (Miscellaneous).

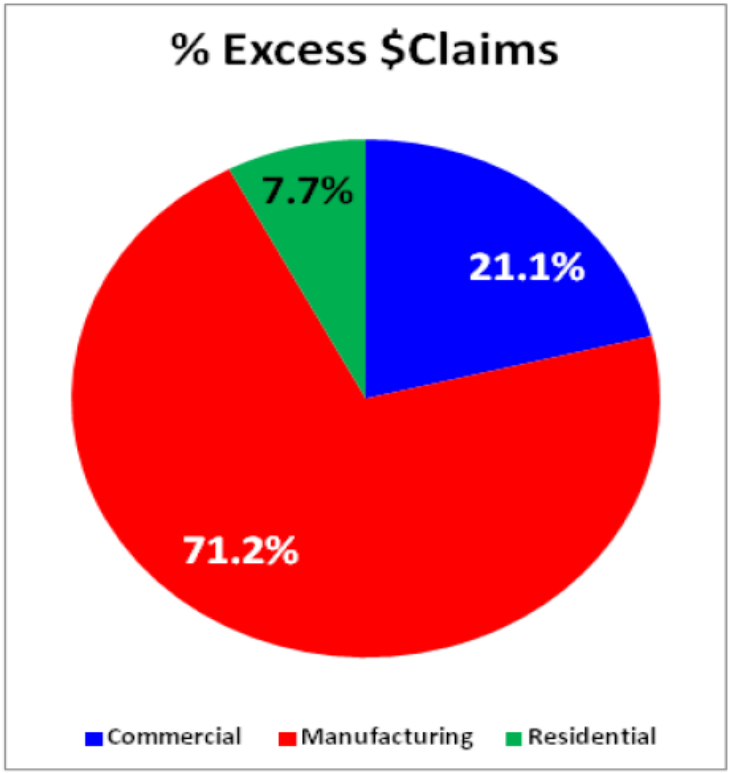
OCCUPANCY SPLIT BY CLAIM SIZE



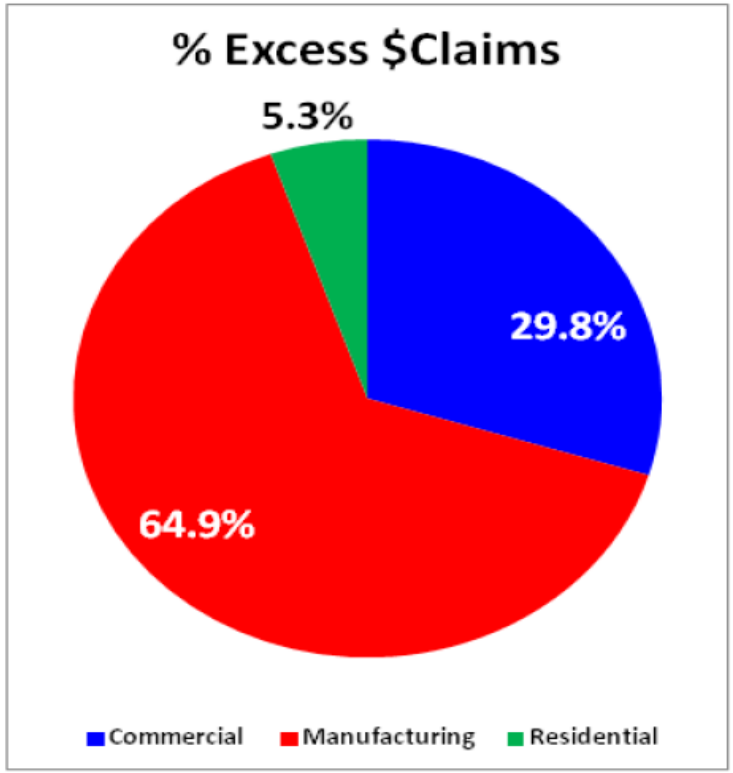
OCCUPANCY SPLIT BY TIV



OCCUPANCY SPLIT BY LOCATION



North America



Rest of the World

FGU claims $>$ USD 1m

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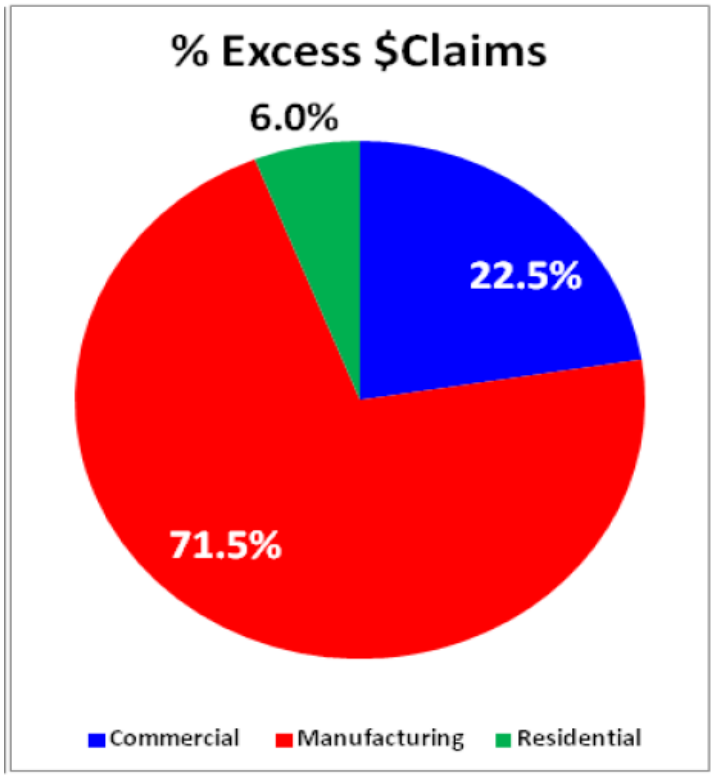

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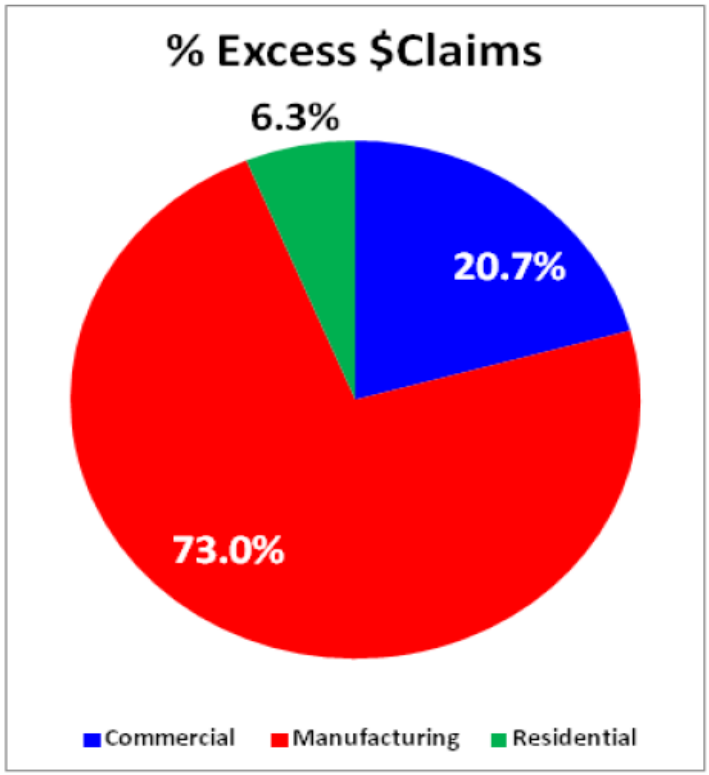
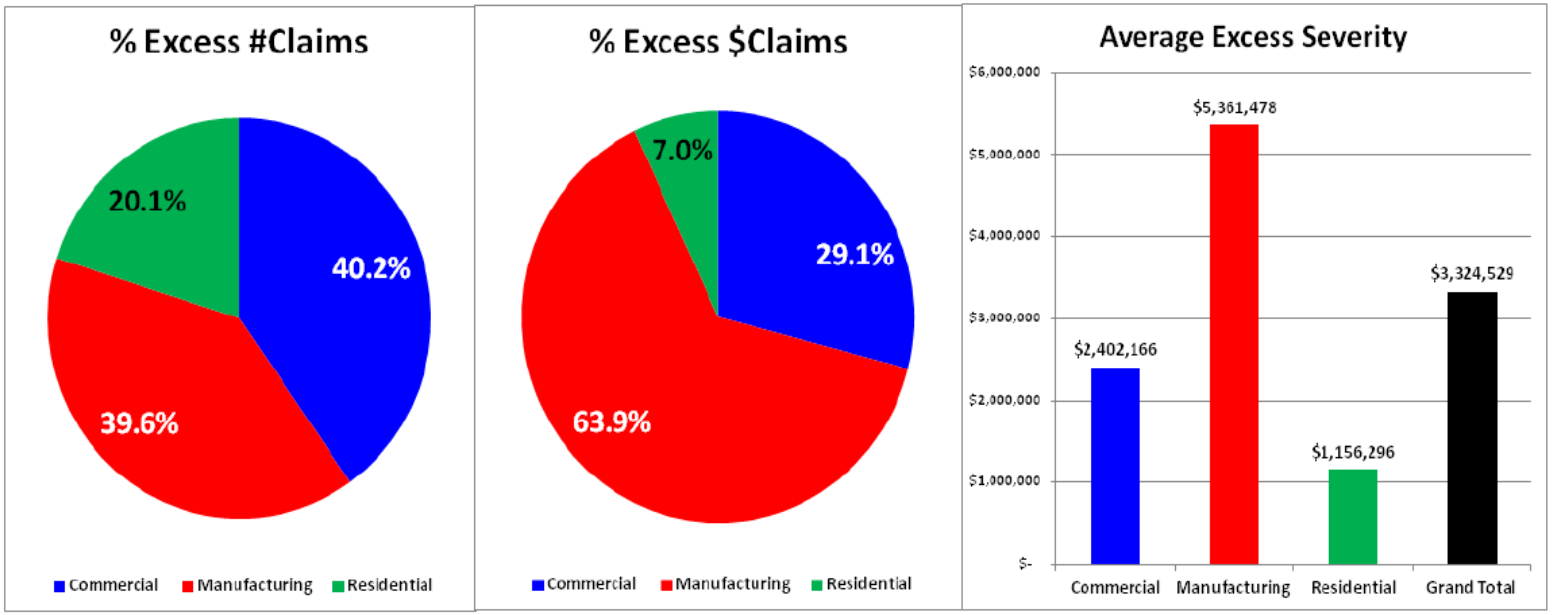


Rest of the World

FGU claims $>$ USD 5m

VALIDATION

- Imperial-IICI data vs. Property Size-of-Loss Database (PSOLD) [John Buchanan (ISO-Verisk)]



All FGU claims

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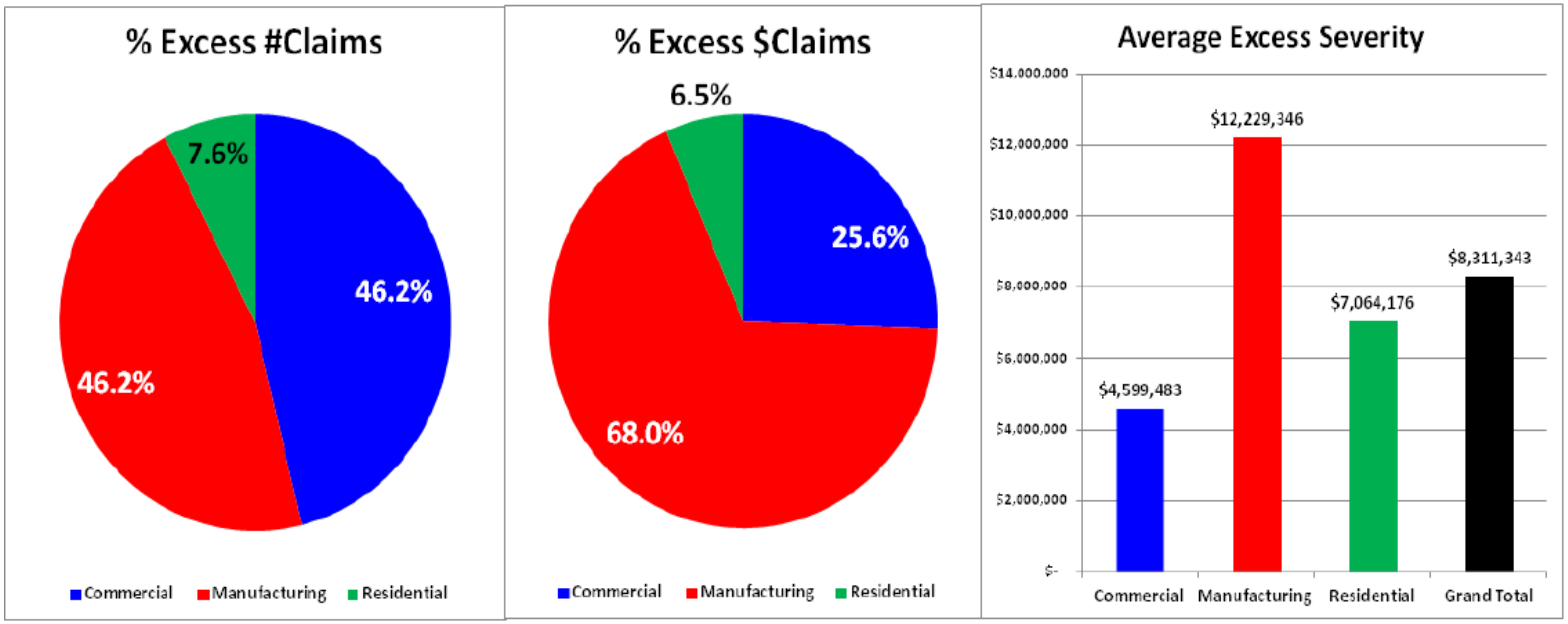

FGU claims > **USD 1m**

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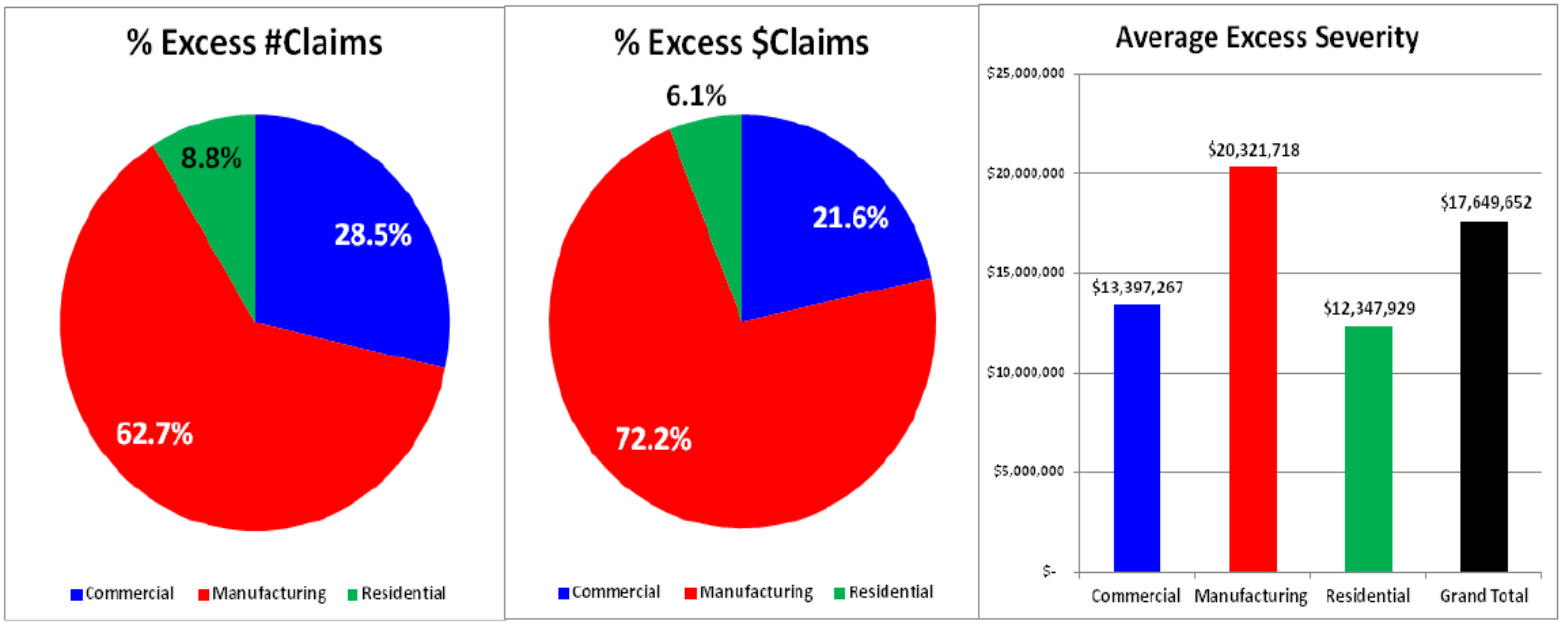


FGU claims $>$ **USD 5m**

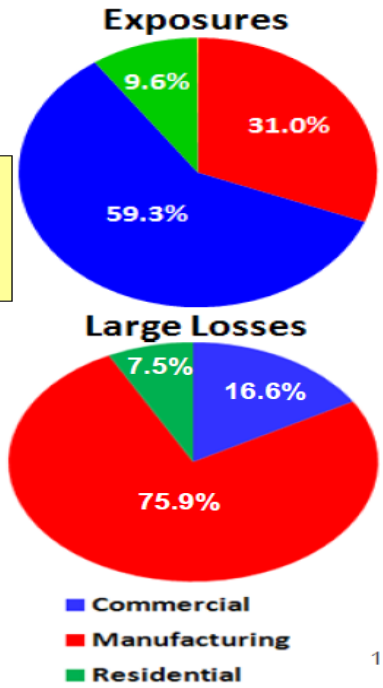
VALIDATION - **Cross-occupancy comparison**

- Imperial-IICI data vs. Property Size-of-Loss Database (PSOLD) [John Buchanan (ISO-Verisk)]

US Large Fire Loss Experience by Occupancy (NFPA 20 years: 1991-2010)

Row Labels	Sum of Estimated Loss (in $mm)	Count of Estimated Loss (in $mm)2	% Total Counts	US $XS Threshold 25mm	% XS Threshold
Commercial	2,727.6	33	16.6%	1,903	15.2%
Aircraft	489.9	9	4.5%	185	1.5%
Cafeteria	27.7	1	0.5%	3	0.0%
Casino	382.7	1	0.5%		
Casino/Hotel	46.7	1	0.5%		
College/University	69.1	2	1.0%		
Film/Movie Studio	44.1	1	0.5%		
Hangar	50.4	1	0.5%		
Hospital	71.6	1	0.5%		
Hotel	76.3	2	1.0%		
Hotel/Casino	115.9	1	0.5%		
Office	921.8	6	3.0%		
Office/Stores	231.4	1	0.5%		
Residential/Commercial	124.6	1	0.5%		
School	99.6	3	1.5%	25	0.2%
Store	55.8	2	1.0%	6	0.0%
Manufacturing	14,053.3	151	75.9%	10,278	82.3%
Chemical Waste	33.4	1	0.5%	8	0.1%
Electric Sub-station	26.9	1	0.5%	2	0.0%
Lumber Yard	38.7	1	0.5%	14	0.1%
Mall	263.7	3	1.5%	189	1.5%
Manufacturing	8,700.8	80	40.2%	6,701	53.6%
Meat Prep Plant	56.3	1	0.5%	31	0.3%
Mill	31.0	1	0.5%	6	0.0%
Packing Plant	119.4	1	0.5%	94	0.8%
Pipeline	146.7	2	1.0%	97	0.8%
Plant	534.1	11	5.5%	259	2.1%
Power Plant	102.4	2	1.0%	52	0.4%
Ship	90.3	1	0.5%	65	0.5%
Special Property	385.1	8	4.0%	185	1.5%
Tractor Trailor	49.5	1	0.5%	25	0.2%
Truck	119.4	1	0.5%	94	0.8%
Warehouse	3,355.6	36	18.1%	2,456	19.7%
Residential	689.0	15	7.5%	314	2.5%
Apartment	456.6	9	4.5%	232	1.9%
Condo	33.1	1	0.5%	8	0.1%
Residential	199.3	5	2.5%	74	0.6%
Grand Total	17,469.9	199	100.0%	12,495	100.0%

Very different Exposure and Large Loss distributions for Commercial & Manufacturing; Mfg with 31% of exposures, but 76% of the large losses (151 out of 199 >25M)



Source: National Fire Protection Association as compiled by ISO Verisk.

VALIDATION - **Cross-country comparison**

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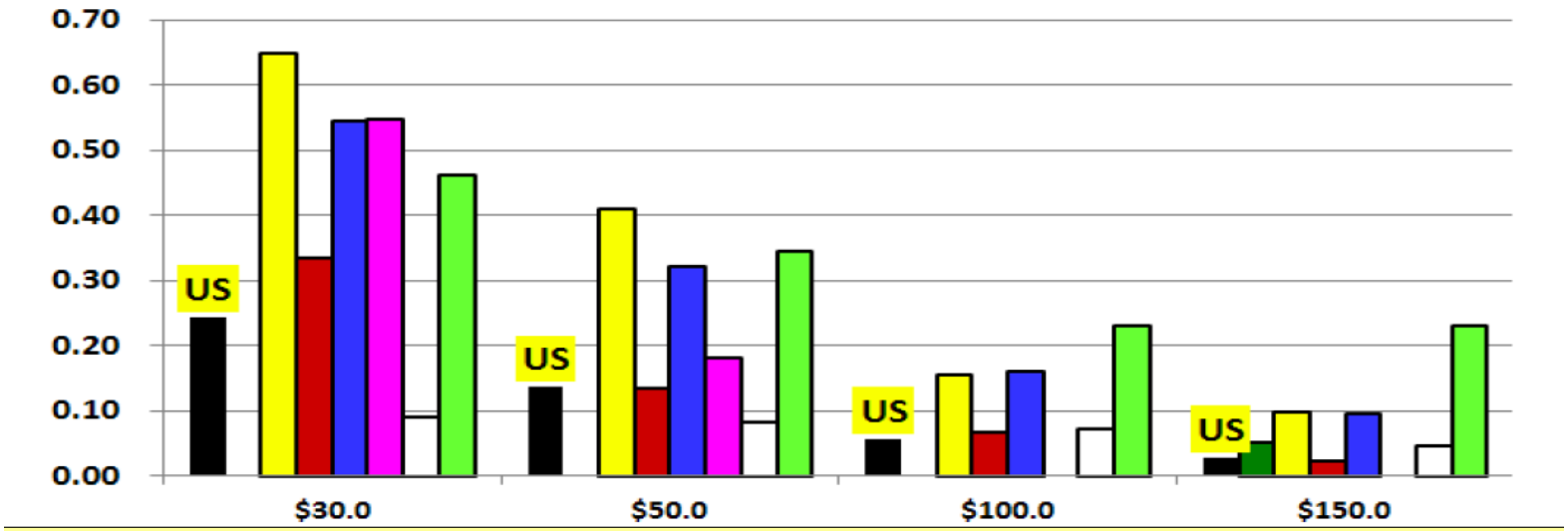
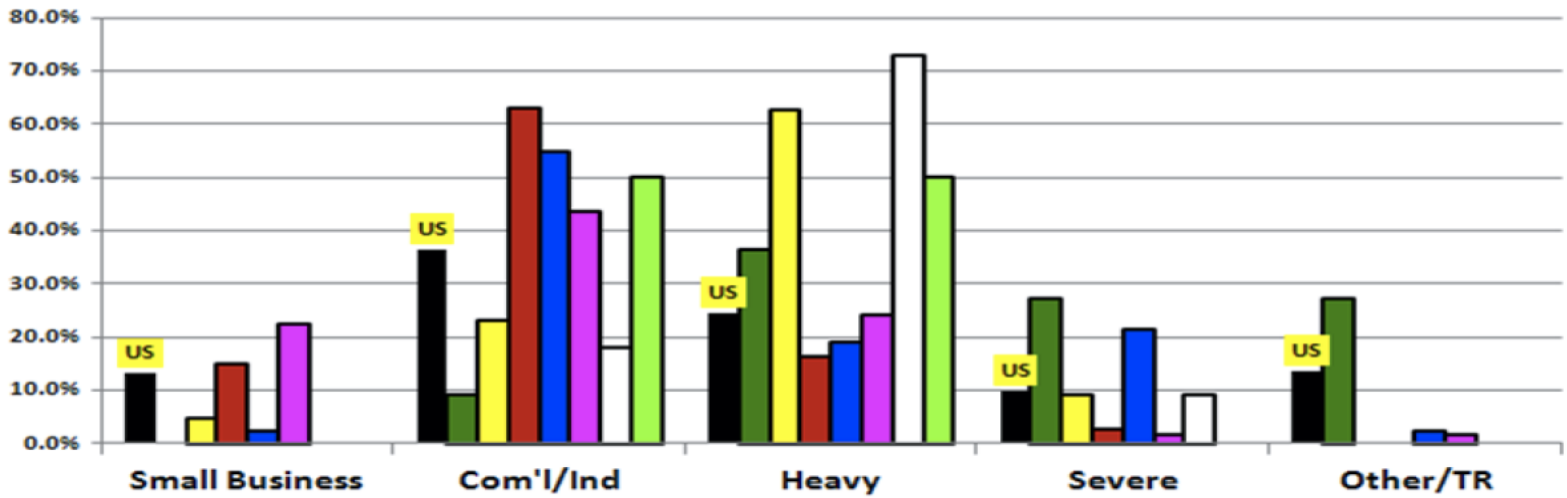


• Using US as the base, compare # of large claims per $B of total commercial property premium in excess of various thresholds. Shown are thresholds ranging from $30M to $150M
•Although varies significantly by country, the number of large claims on average is 40-50% higher than the US for these largest claims
•Protection/ sprinkler differences may account for a significant portion of the US vs. non-US experience

Source: ISO Verisk.

VALIDATION - **NoA**

- Imperial-IICI data vs. Property Size-of-Loss Database (PSOLD) [John Buchanan (ISO-Verisk)]



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Tail index (α) estimation: $\mathbb{P}(Z > z) \sim Cz^{-\alpha}$

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- Existence of **centered moments** (mean, variance, etc.)
  - Mean/Variance finite if and only if $\alpha > 1$ ($\alpha > 2$)
- Extent of **diversification** benefits for quantile-based risk measures
  - Retain fractions $w_1, \ldots, w_n$ of risks $X_1, \ldots, X_n$
  - Resulting aggregate risk $Z_{(w_1,\ldots,w_n)} = \sum_i w_i X_i$
  - $VaR_p(Z_{(1,0,\ldots,0)}) < VaR_p(Z_{(\frac{1}{n},\ldots,\frac{1}{n})})$ for $\alpha \in (0,1), p \in (0, 1/2)$, for stable distributions (e.g., Ibragimov, 2009)

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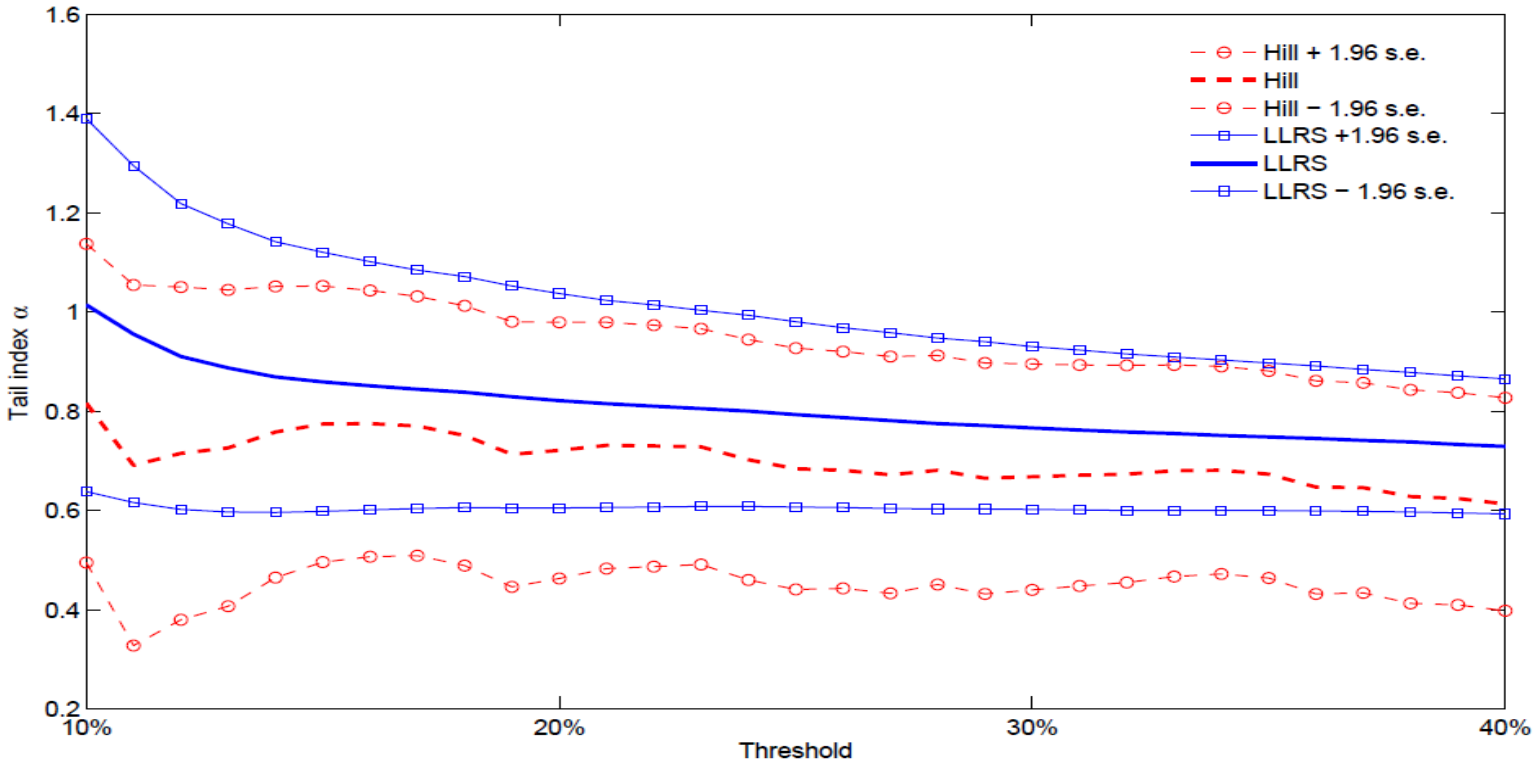
What do we find for LCR?

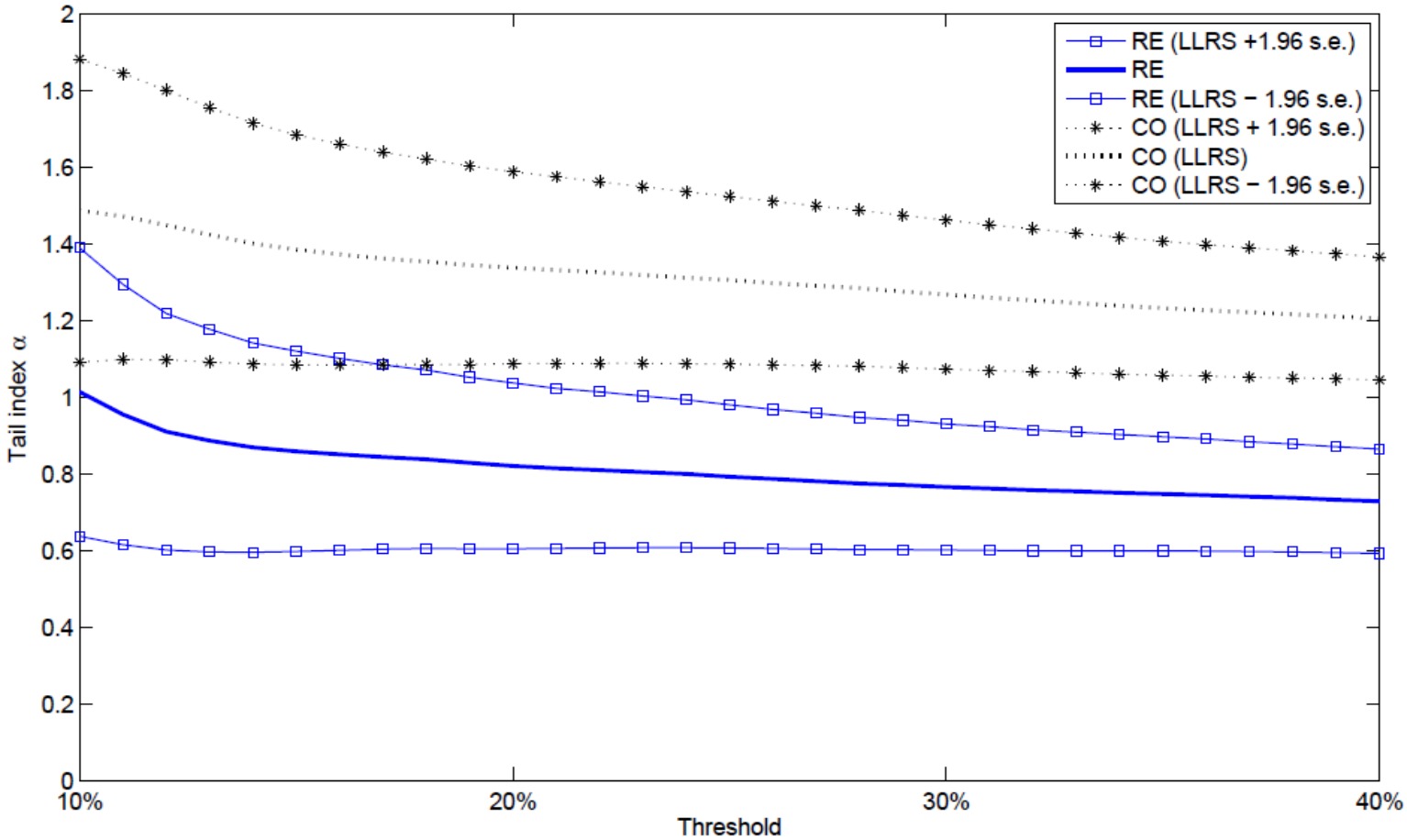
- Heavy tails & significant heterogeneity across occupancy type

RESIDENTIAL EXAMPLE (ALL TIVs)



Hill (1975) vs. Gabaix-Ibragimov (2011)'s log-log rank-size regression method with optimal ranks shift -1/2 and correct standard errors.

OCCUPANCY LEVEL 1 (ALL TIVs)



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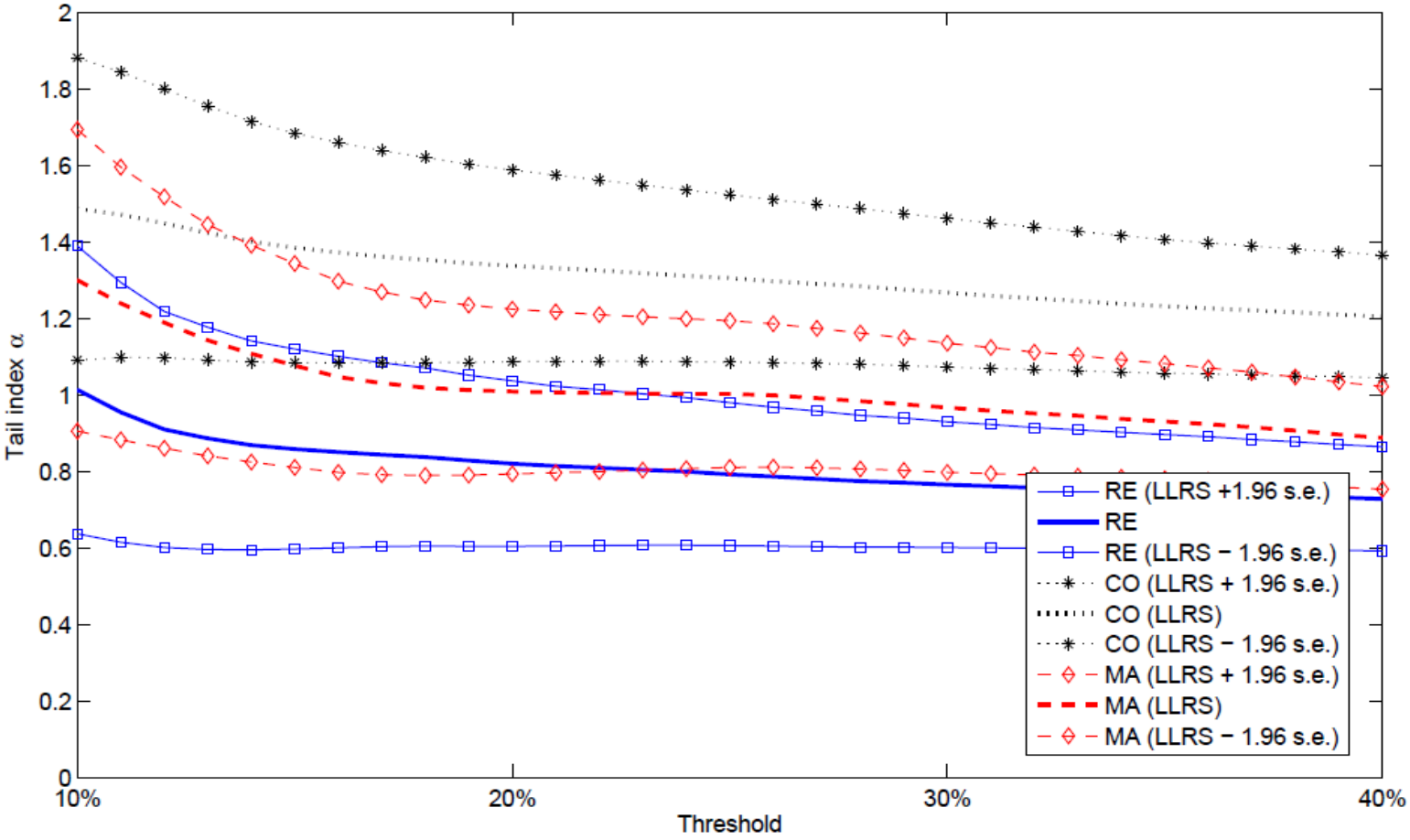
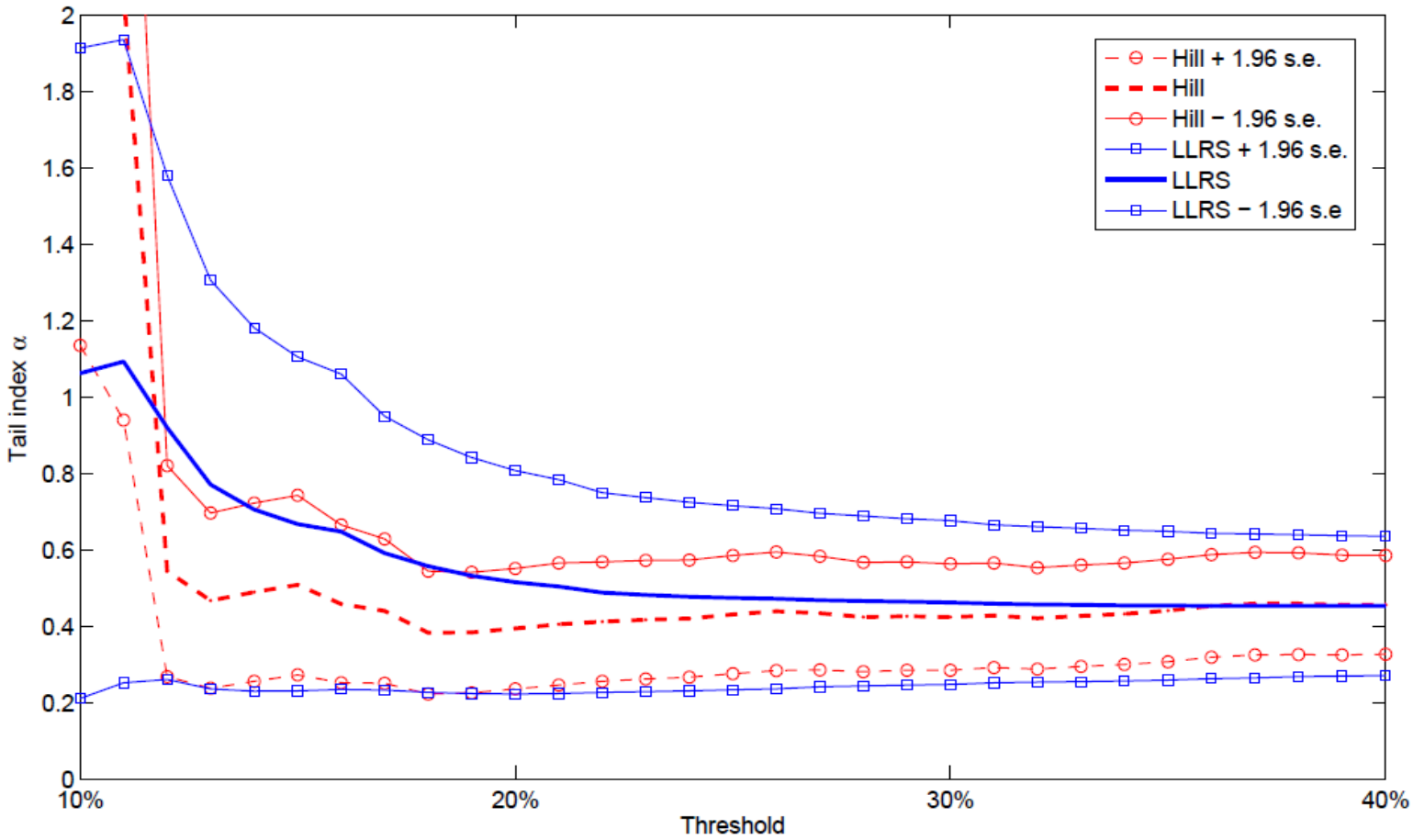
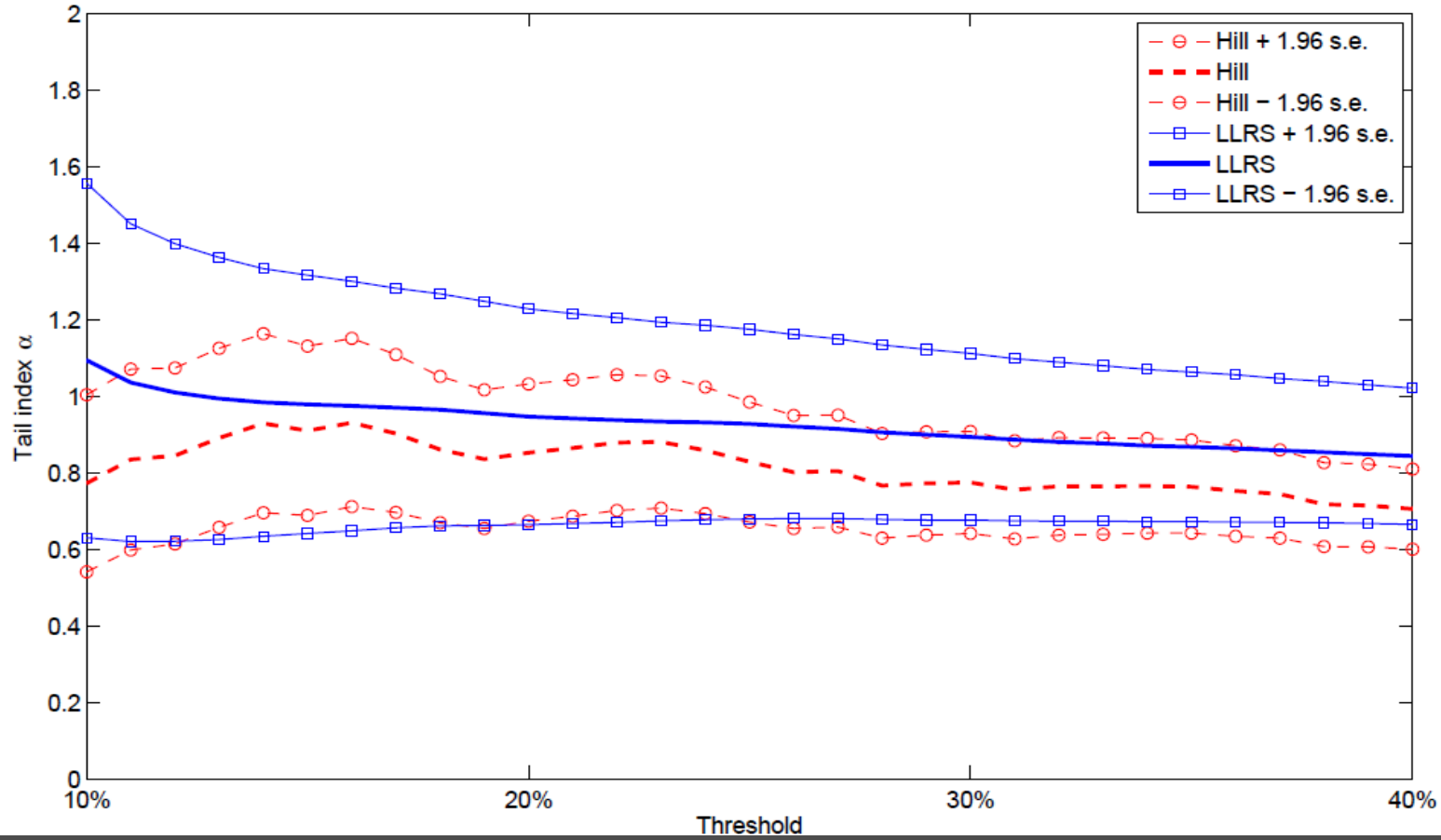


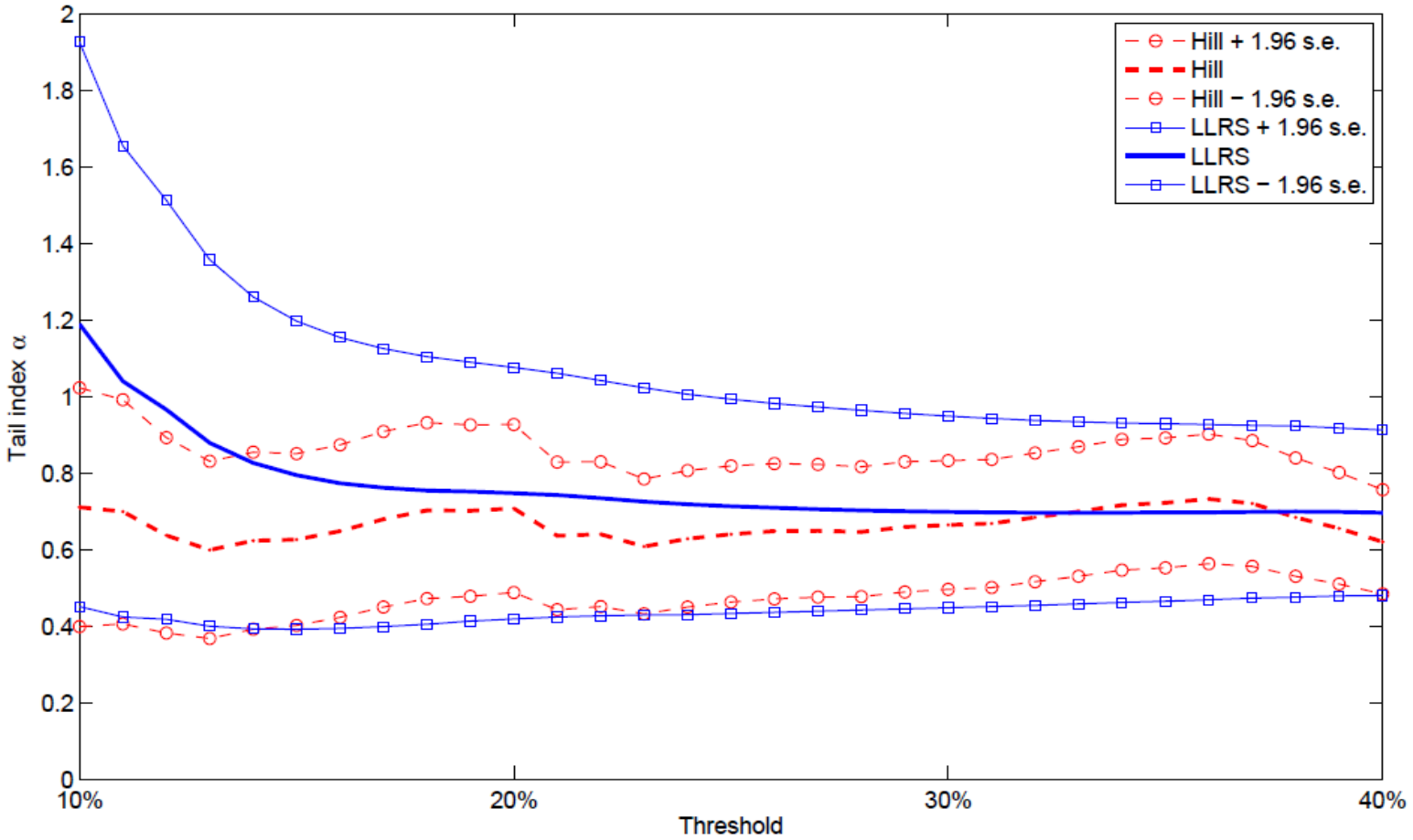
OCCUPANCY LEVEL 3 - Large Hotels



OCCUPANCY LEVEL 3 - Institutional Housing, Condos, Housing Associations



OCCUPANCY LEVEL 2 - Chemicals, Metals, Mines



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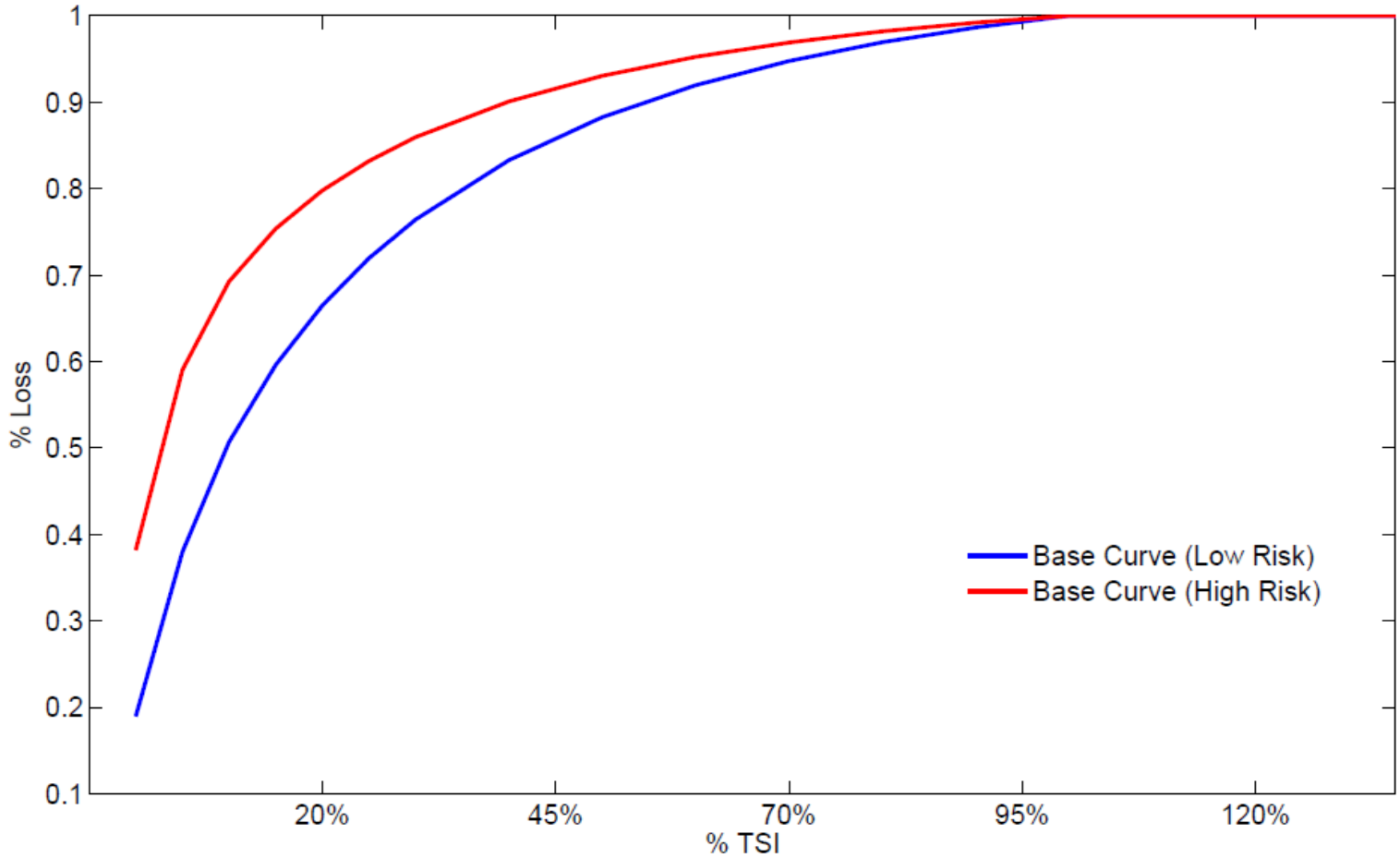
BENCHMARKING EXERCISE - A SPECIFIC TIV BAND



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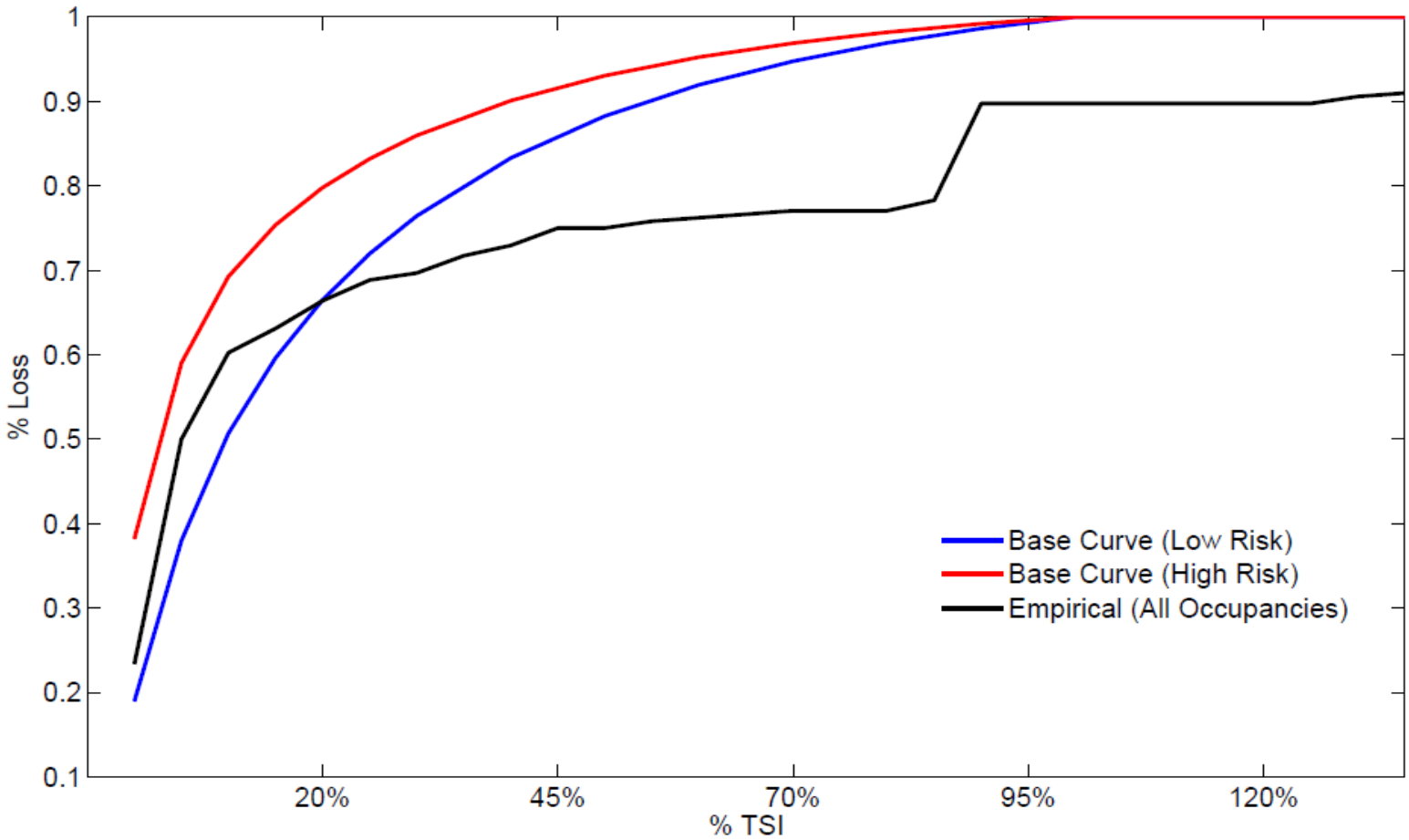

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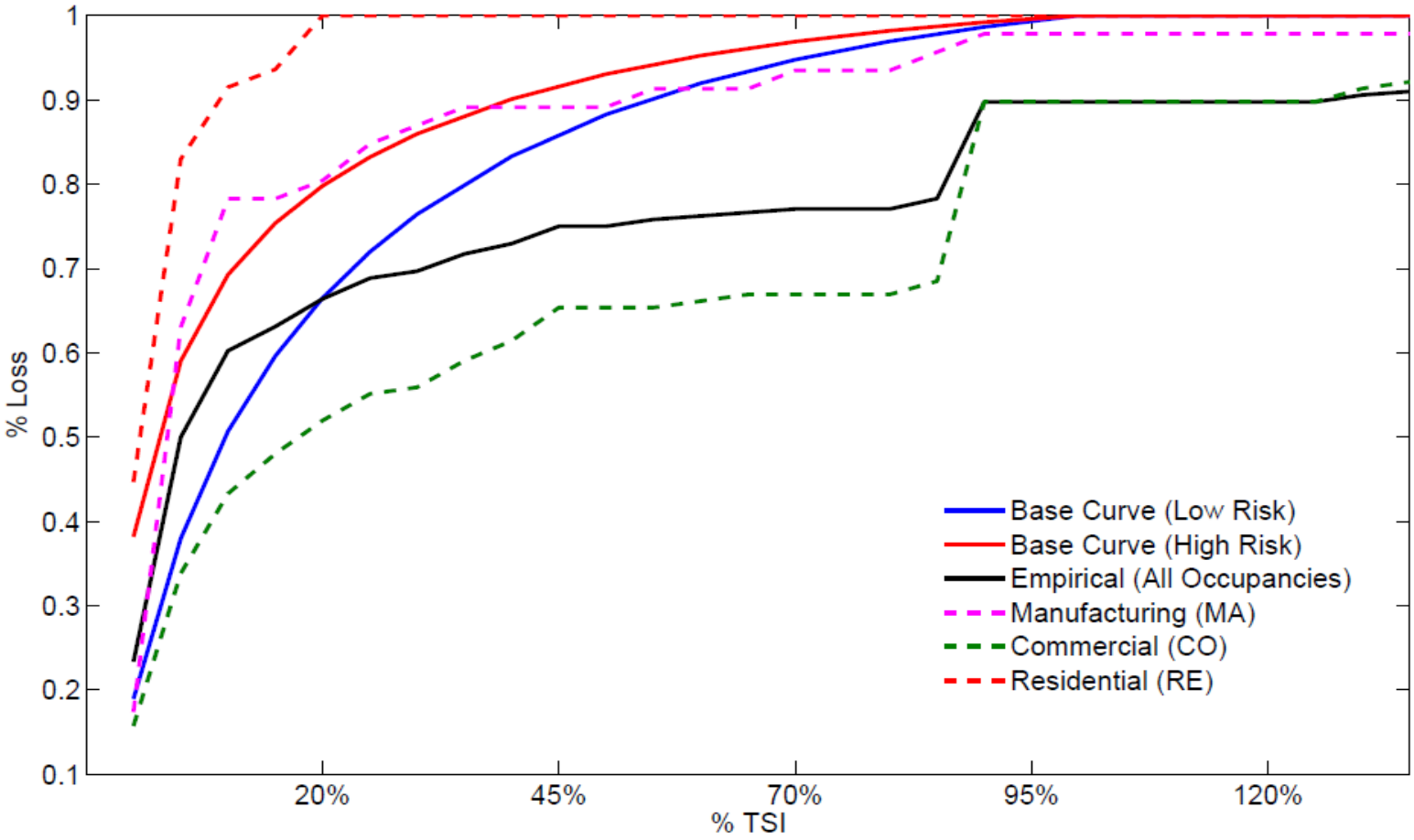
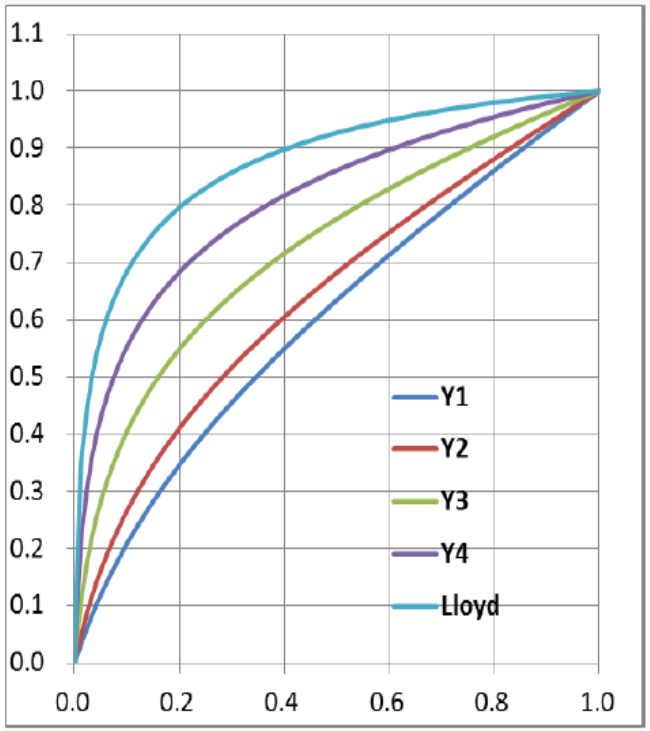
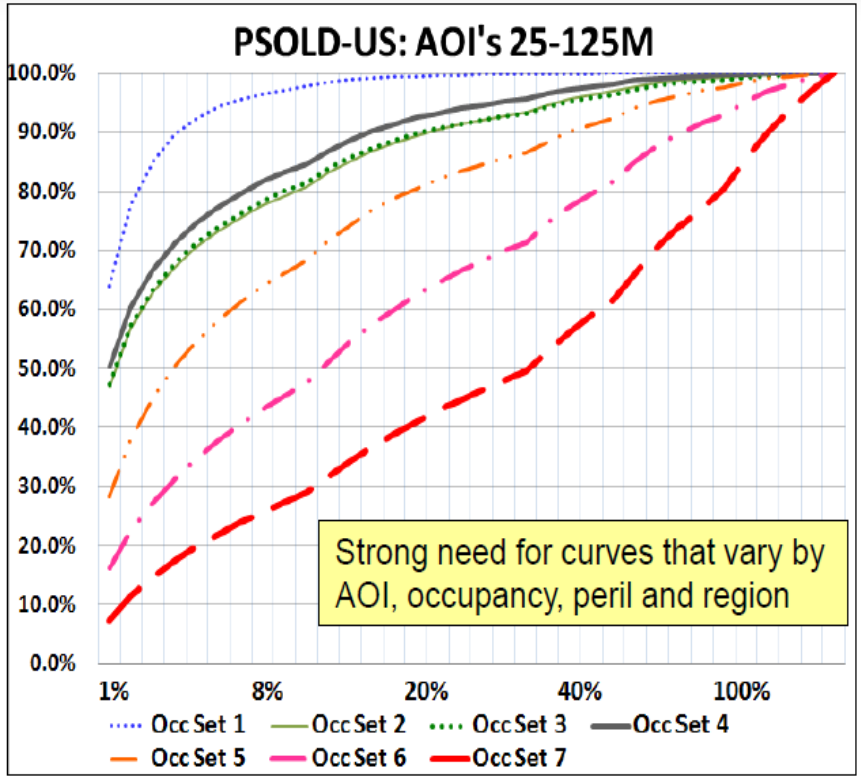


LOSS CURVES HETEROGENEITY



Source: China Re CPCR curve comparison
MBBEFD (Y1-Y4) parametric approximation;
Lloyd's empirical from unknown data source



PSOLD has over 1 million individual curves for 60 AOI bands, 38 occupancies, 4 sets of perils, 50 states, etc.; some collapse to between 500 and 1,000 curves

Source: John Buchanan (ISO-Verisk).

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New data source for LCR

- Robust estimation of **tail risk**
- **Comparing** claim costs across occupancy/TIV bands/location

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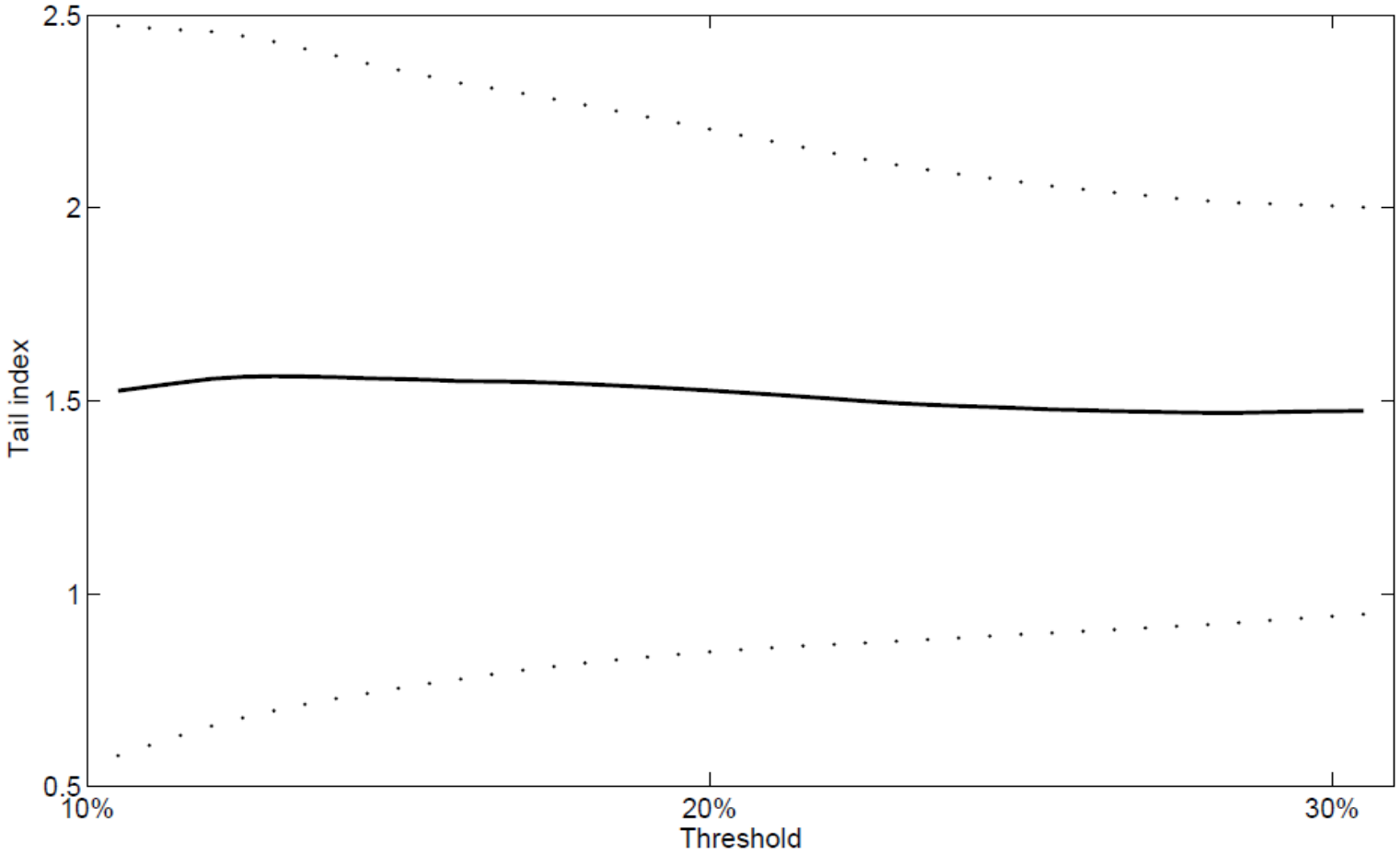
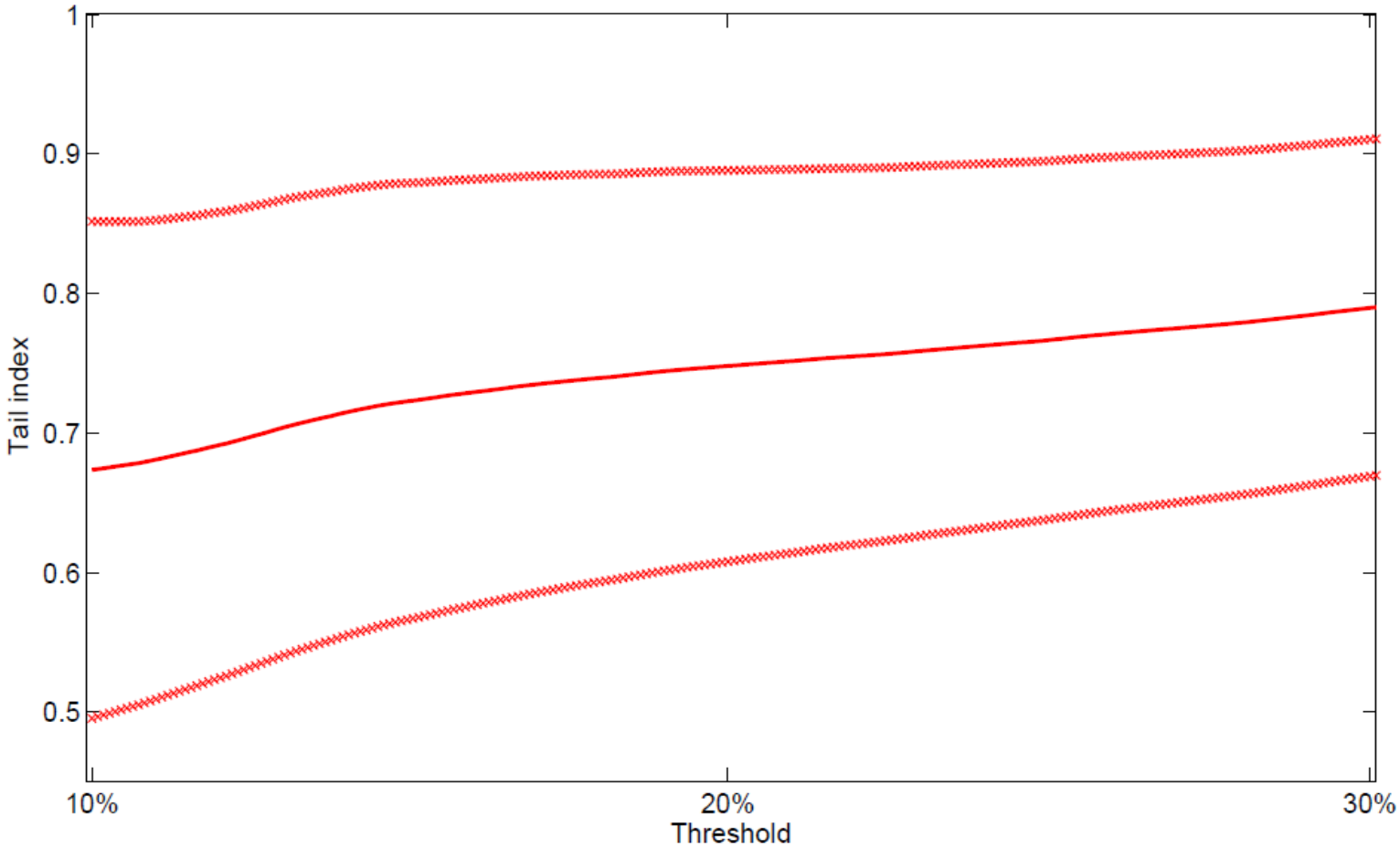
Lessons from Imperial-IICI data collection, validation, and analysis

- Link between claims and exposures crucial: Systematic storage of claims & exposures information (policy schedules & claims narratives in digital, compatible format) should be a priority
- Macro-validation (e.g., Fire Protection Agencies) & micro-validation (e.g., syndicate level) of data important for *structural* understanding of risk
- Gains from data aggregation HUGE - **please contribute!**

OCCUPANCY LEVEL 1 'CO', α^{-1}: AN INSURER



OCCUPANCY LEVEL 1 'CO', α^{-1}: MULTIPLE DATA SOURCES



WORK IN PROGRESS (ASIA-PACIFIC REGION) & NEXT STEPS

Insurance Risk & Finance Research Centre
at Nanyang Business School Singapore

www.irfrc.com

THANK YOU

Contact: E.Biffis@imperial.ac.uk