

## Some New Insights into Large Commercial Risks

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## AGENDA

- 1 Overview
- 2 Dataset
- 3 Estimation
- 4 Benchmarking
- 5 Conclusion

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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 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**



## DATASET

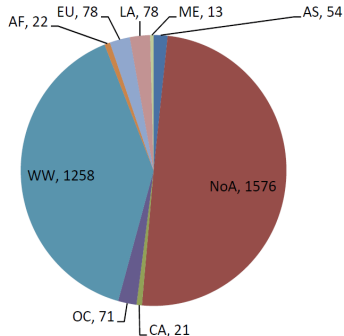
- Around **3,200 FGU claims** and **exposures** based on brokers' submissions
- Scope: **worldwide, 1999-2012**
- Granular classification of exposures by three **occupancy levels**
  - Definitions based on Lloyd's codes & individual syndicates' classification; can be related to ISO/PSOLD classification
- 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)	CO (commercial)	R (residential)	51 (Large Hotels)

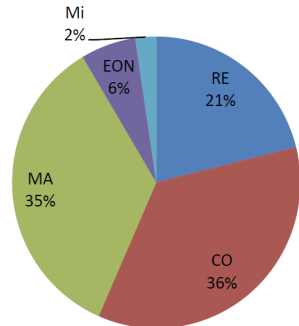
OCCUPANCY EXAMPLE - LEVEL 2 LIST

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 Manufacturers
O	Municipal Property	6	Warehouses
P	Energy (Oil Refineries/Petrochemicals)		

## GEOGRAPHICAL/OCCUPANCY SPLIT

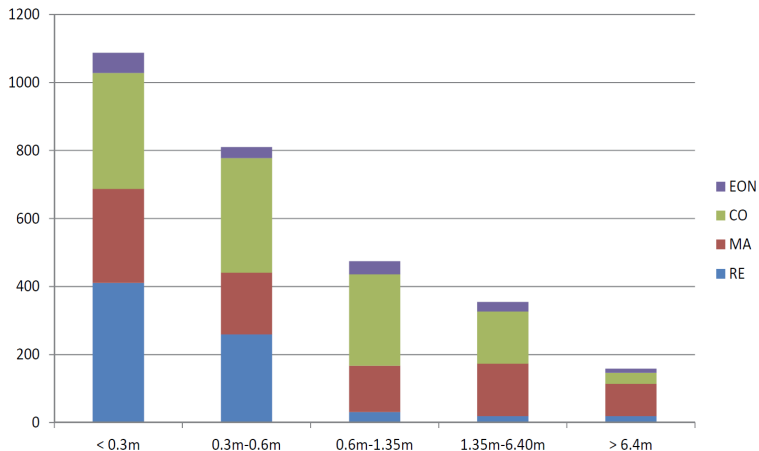


AF (Africa), CA (Central Asia), EU (Europe),  
LA (Latin America), ME (Middle East), AS  
(Asia-Pacific), NoA (North America), OC  
(Oceania), WW (Worldwide).

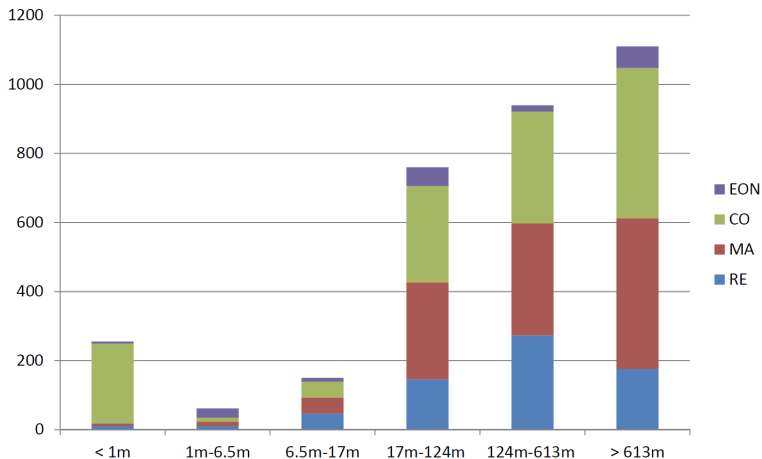


RE (Residential), CO (Commercial), MA  
(Manufacturing), EON (Energy on-shore), Mi  
(Miscellaneous).

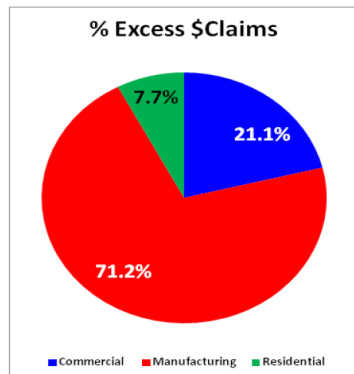
## OCCUPANCY SPLIT BY CLAIM SIZE



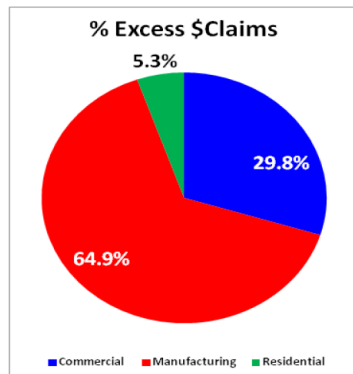
## OCCUPANCY SPLIT BY TIV



## OCCUPANCY SPLIT BY LOCATION



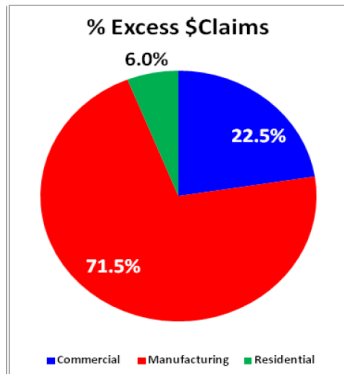
North America



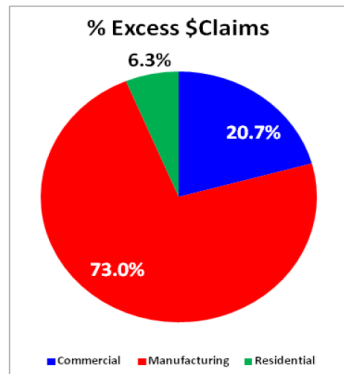
Rest of the World

FGU claims > USD 1m

## OCCUPANCY SPLIT BY LOCATION



North America

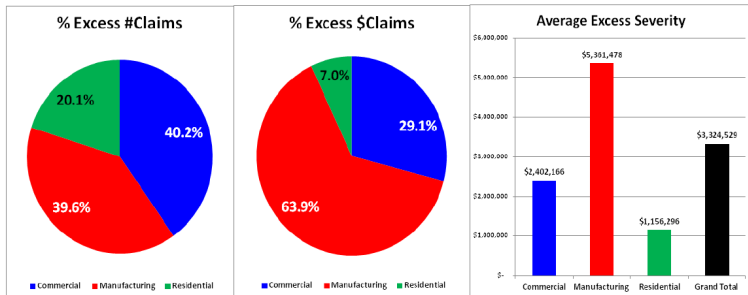


Rest of the World

FGU claims > USD 5m

VALIDATION

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

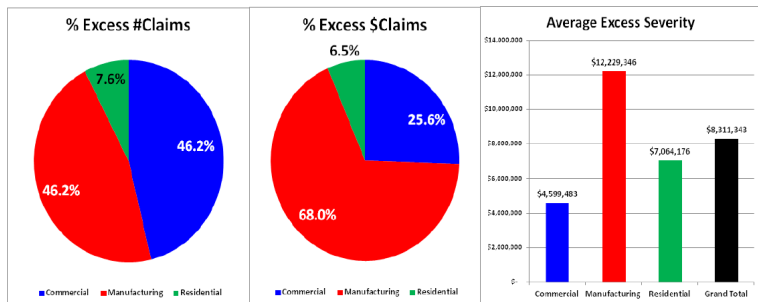


All FGU claims



## VALIDATION

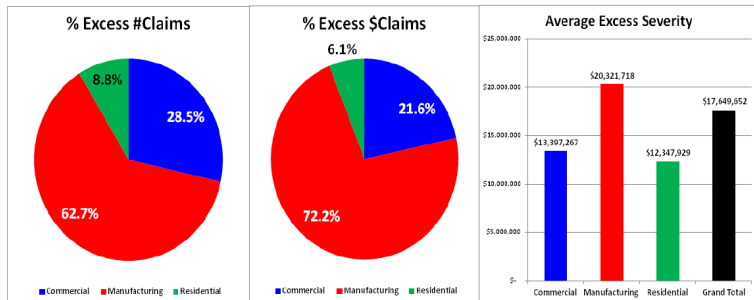
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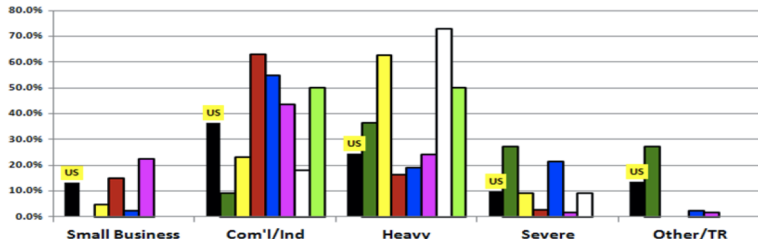
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## VALIDATION - Cross-occupancy comparison

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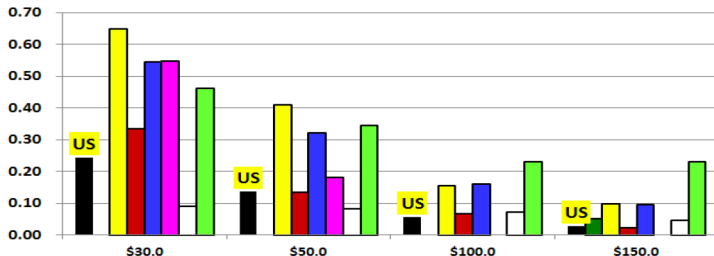


- Using US as the base, compare occupancy distribution of large losses using same definitions as underlying PSOLD-International
- On average, US has a larger proportion of large claims in the less severe occupancies, and less in the heavy and severe occupancies
- Occupancy mixes also account for a significant portion of the cross-country differences

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

## VALIDATION - Cross-country comparison

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



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

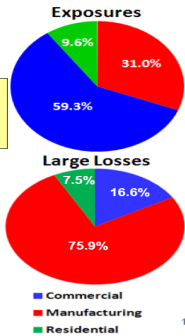
VALIDATION - NoA

- 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) <sup>2</sup>	% Total Counts	US \$Ks Threshold 25mm	% Ks Threshold
<b>Commercial</b>	<b>2,727.6</b>	<b>33</b>	<b>16.6%</b>	<b>1,903</b>	<b>15.2%</b>
Alcohol	499.9	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/Video Studio	44.1	1	0.5%		
Hangar	50.4	1	0.5%		
Hospital	71.6	1	0.5%		
Hotel	78.3	2	1.0%		
Hotel/Casino	115.9	1	0.5%		
Office	821.9	6	3.0%		
Office/Stores	231.4	1	0.5%		
Residential/Commercial	124.6	1	0.5%		
School	99.6	3	1.5%		
Store	95.8	2	1.0%	25	0.2%
				6	0.0%
<b>Manufacturing</b>	<b>14,053.3</b>	<b>151</b>	<b>75.9%</b>	<b>10,278</b>	<b>82.3%</b>
Chemical Waste	32.4	1	0.5%	8	0.3%
Electric Sub-station	26.9	1	0.5%	2	0.0%
Lumber Yard	38.7	1	0.5%	14	0.1%
Mail	263.7	3	1.5%	189	1.5%
Manufacturing	6,760.6	80	40.2%	4,701	50.0%
Meat Prep Plant	56.3	1	0.5%	31	0.3%
Milk	31.9	1	0.5%	6	0.0%
Packaging Plant	119.4	1	0.5%	94	0.8%
Pipeline	146.7	2	1.0%	97	0.9%
Plant	524.1	11	5.3%	259	2.5%
Power Plant	182.4	2	1.0%	52	0.4%
Ship	90.3	1	0.5%	65	0.5%
Special Property	289.1	8	4.0%	189	1.5%
Tractor Trailer	49.5	1	0.5%	25	0.2%
Truck	119.4	1	0.5%	94	0.8%
Warehouse	3,355.8	36	18.1%	2,450	19.7%
<b>Residential</b>	<b>689.0</b>	<b>15</b>	<b>7.5%</b>	<b>314</b>	<b>2.5%</b>
Apartment	456.6	9	4.5%	237	1.9%
Condo	33.1	1	0.5%	8	0.3%
Residential	199.3	5	2.5%	74	0.6%
<b>Grand Total</b>	<b>17,469.9</b>	<b>199</b>	<b>100.0%</b>	<b>12,495</b>	<b>100.0%</b>

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.

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## TAIL RISK

**Tail index** ( $\alpha$ ) 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  $w_1, \dots, w_n$  of risks  $X_1, \dots, X_n$
  - Resulting aggregate risk  $Z_{(w_1, \dots, w_n)} = \sum_i w_i X_i$
  - $VaR_p(Z_{(1,0, \dots, 0)}) < VaR_p(Z_{(\frac{1}{n}, \dots, \frac{1}{n})})$  for  $\alpha \in (0, 1)$ ,  $p \in (0, 1/2)$ , for stable distributions (e.g., Ibragimov, 2009)



## TAIL RISK

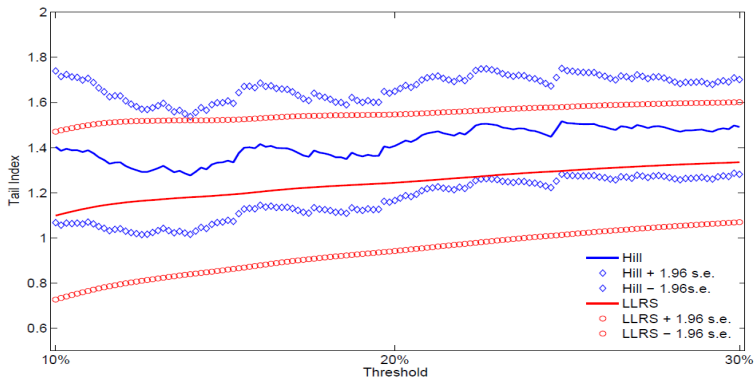
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What do we find for LCR?

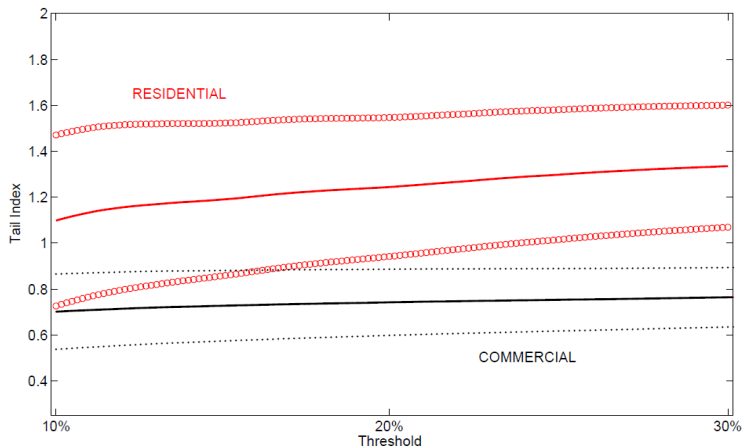
- Heavy tails & significant heterogeneity across occupancy type

## RESIDENTIAL EXAMPLE: HILL vs. LLRS-1/2

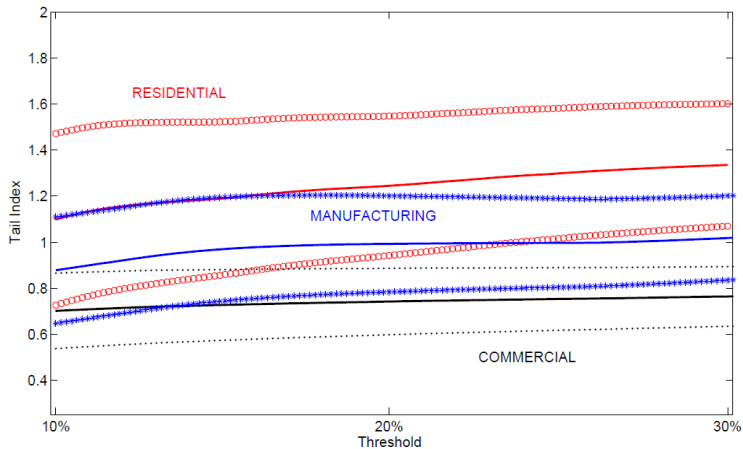


Hill (1975) vs. Gabaix-Ibragimov (2011)'s log-log rank-size regression method with optimal ranks shift  $-1/2$  and correct standard errors.

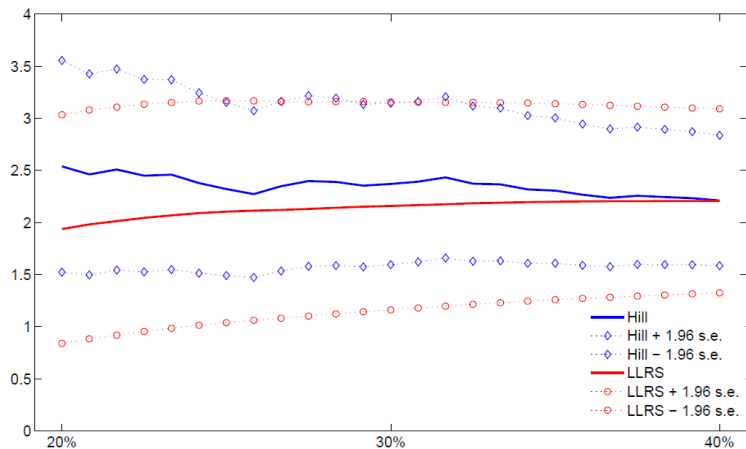
## OCCUPANCY TYPE



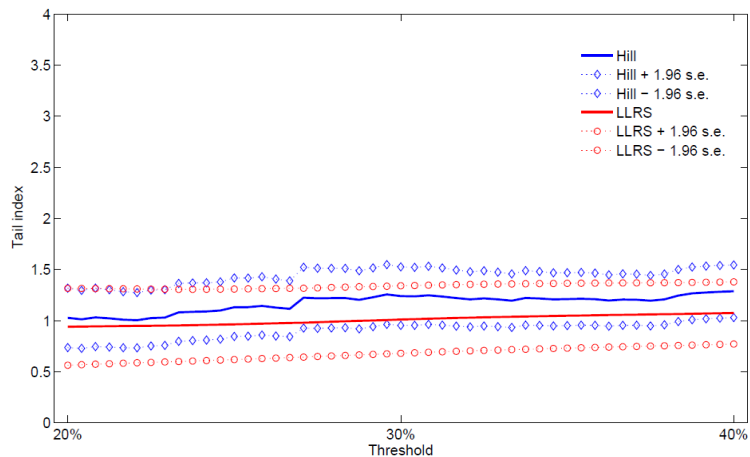
## OCCUPANCY TYPE



## OCCUPANCY LEVEL 3 - Hotels



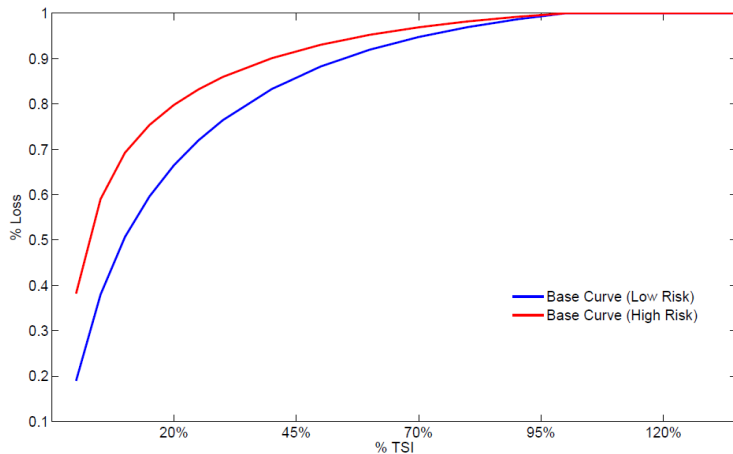
## OCCUPANCY LEVEL 3 - Condos & Housing Associations



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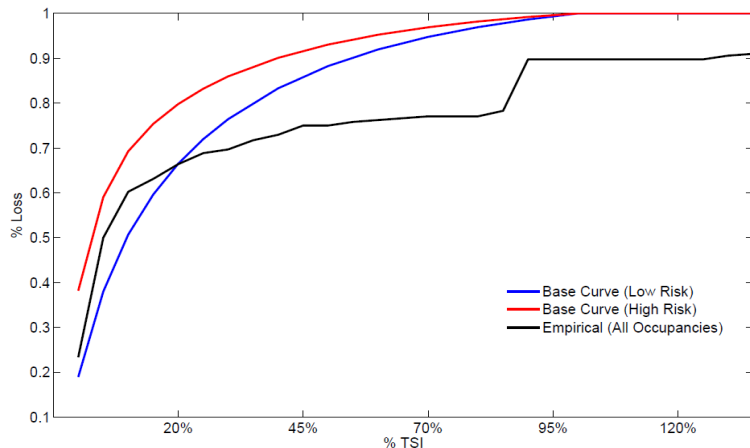
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## BENCHMARKING EXERCISE - A SPECIFIC TIV BAND

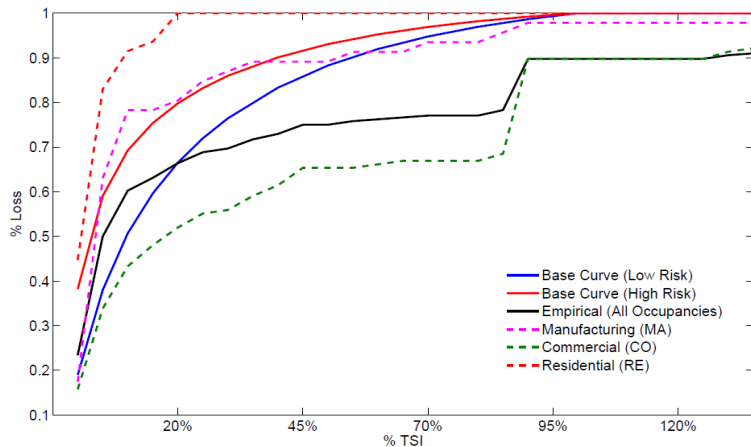




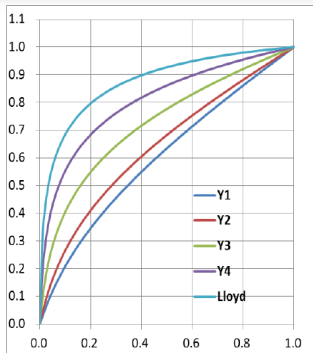
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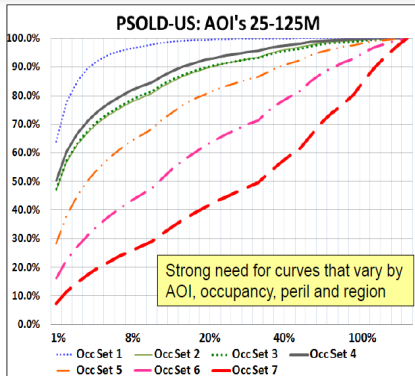
## BENCHMARKING EXERCISE - A SPECIFIC TIV BAND



## LOSS CURVES HETEROGENEITY



Source: China Re CPRC 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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## CONCLUSION

### New data source for LCR

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

## CONCLUSION

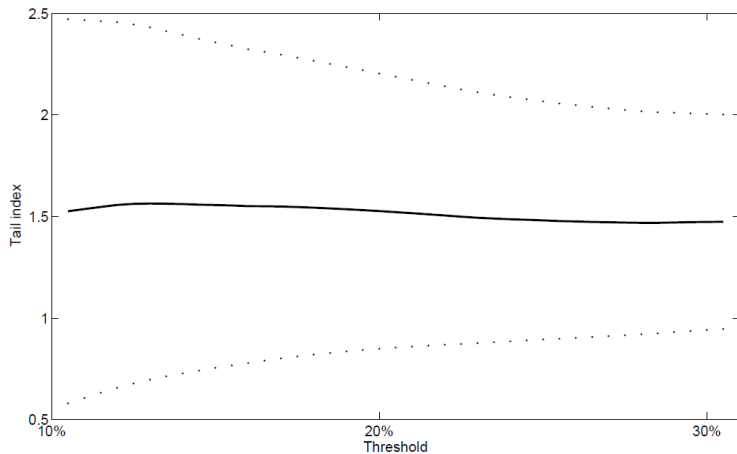
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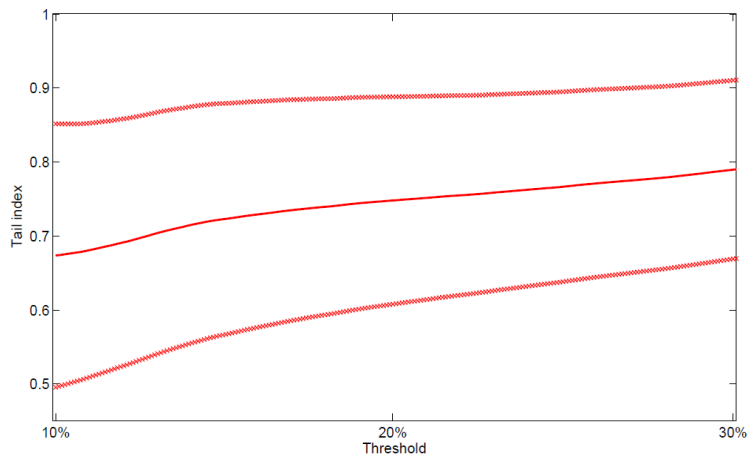
### Lessons from Imperial-IICI data collection, validation, and analysis

- 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': AN INSURER



## OCCUPANCY LEVEL 1 'CO': MULTIPLE DATA SOURCES





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



Insurance Risk & Finance Research Centre  
at Nanyang Business School Singapore

[www.irfrc.com](http://www.irfrc.com)

SCOR



verisk  
Analytics

THANK YOU

Contact: [E.Biffis@imperial.ac.uk](mailto:E.Biffis@imperial.ac.uk)