

It's Not All About the Economy: Climate Change and the U.K. and U.S. Mortgage Credit Risk



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Today's Speakers

Predictive Analytics



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Assistant Director



Petr Zemcik, PhD
Senior Director



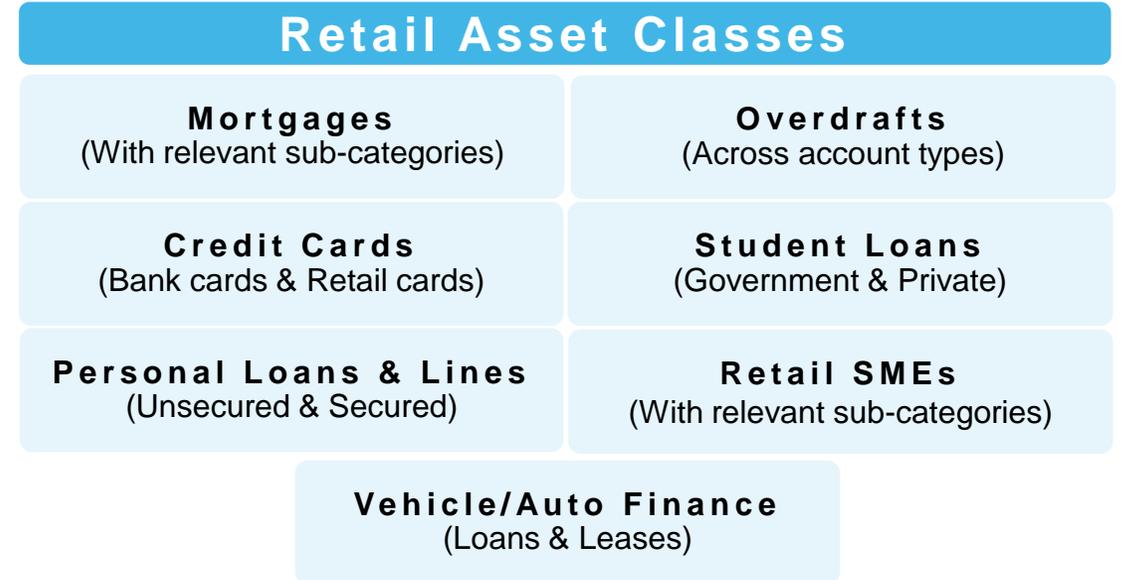
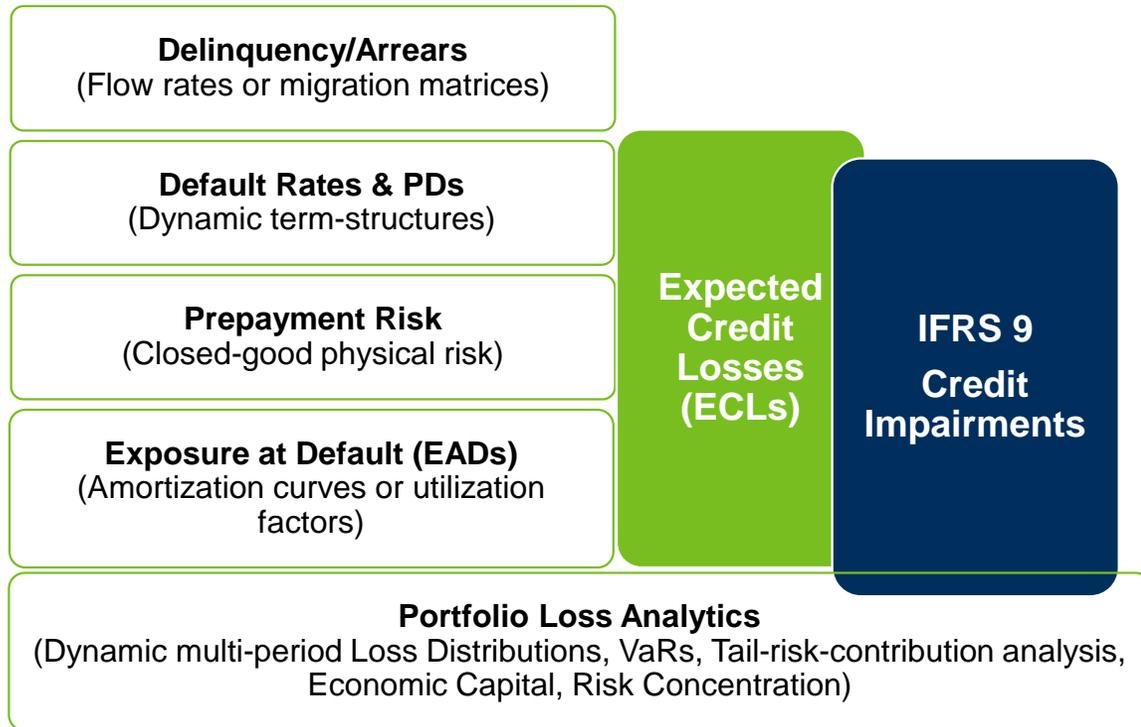
Pouyan Mashayekh, PhD
Senior Director



Cecilia Bocchio
Assistant Director

Portfolio Analyser (PA) Suite of Models

Retail loan-level econometric models for credit and impairment metrics



Agenda

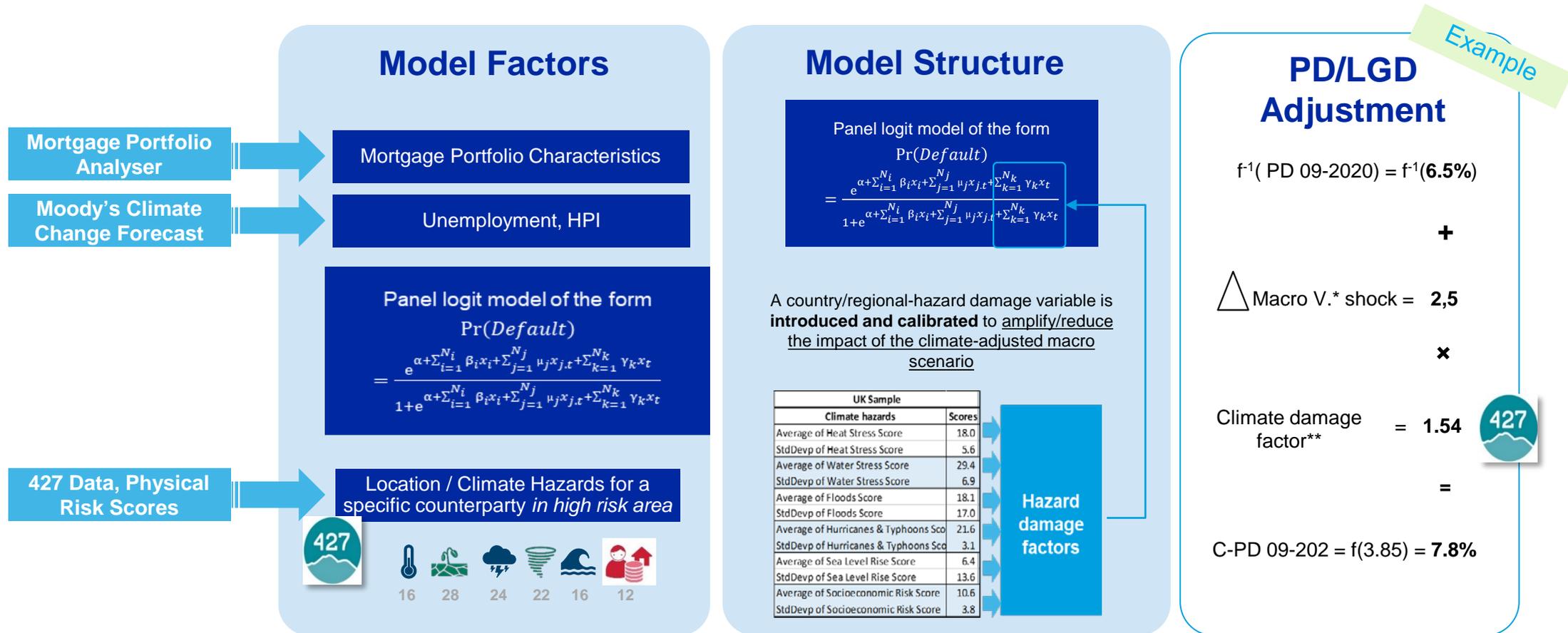
1. From climate to credit risk: Methodological Challenges
2. Impact of frequency and severity of natural disasters on the PD for U.S. mortgages
3. Simulations of natural disasters in credit models using the U.S. Mortgage Portfolio Analyzer
4. The effect of climate scenarios on the U.K. mortgages credit parameters
5. Usage of location-specific climate risk scores to forecast climate-adjusted credit risk metrics

1

From climate to credit risk:
Methodological challenges

Climate Risk Adjustment for PD/LGD

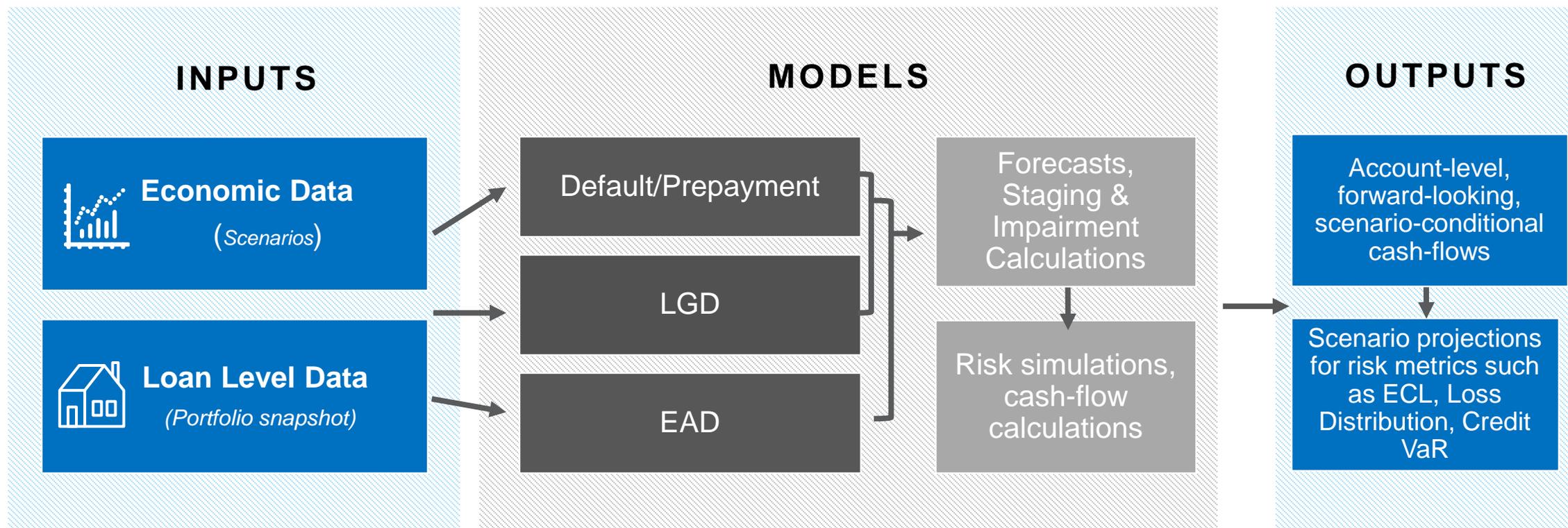
Mortgages



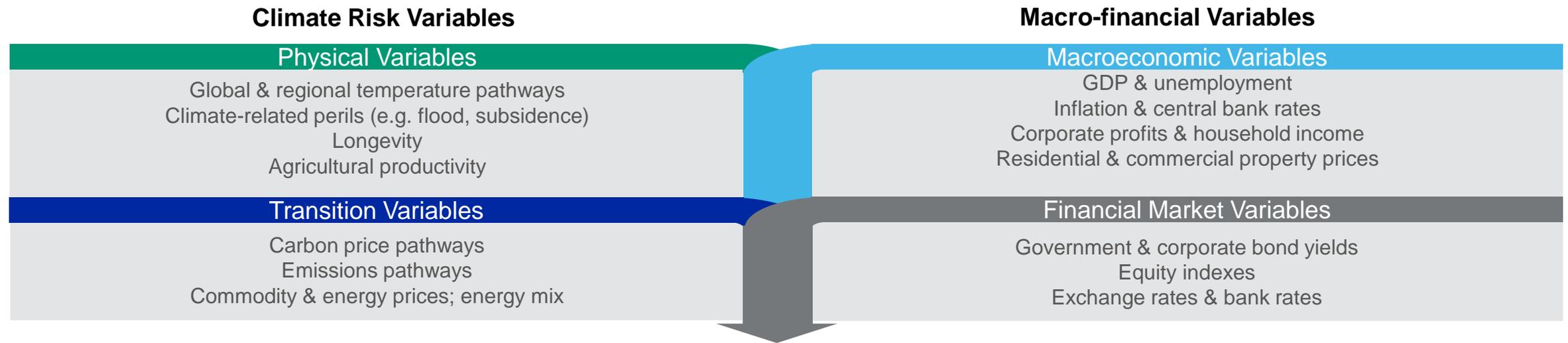
* Weighted average of the macroeconomic variables shocks by associated weights

** Weighted average of Hazard damage factors and 427 Climate Hazards scores – those factors have an indicative value as they will be estimated during the project over the relevant sample

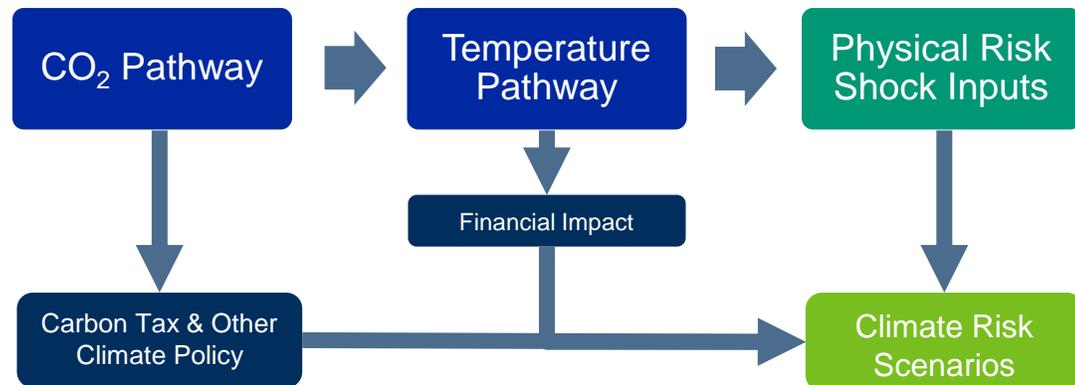
Mortgage Portfolio Analyzer



Moody's Analytics Climate Risk Scenarios



Start with parameters from regulators or clients and expand scenarios to populate additional variables using our Global Macro Model with climate risk components

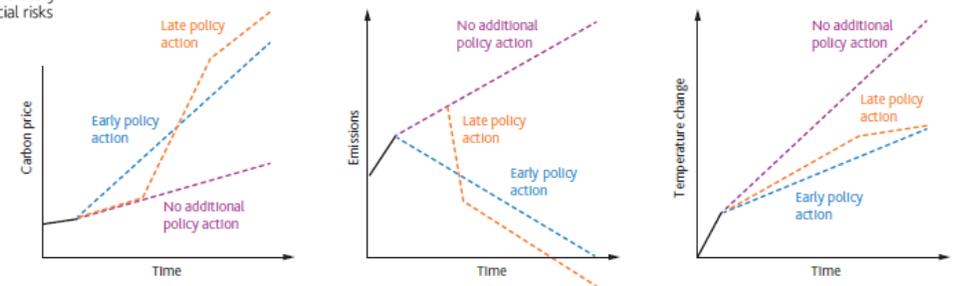


BANK OF ENGLAND

Financial Policy Committee
Financial Stability Committee

Discussion Paper
The 2021 biennial exploratory scenario on the financial risks from climate change
December 2019

Illustrative Variable Pathways in each Scenario



427 Data – Physical Risk Score

On-Demand Scoring

Key Features of 427 Data

-  Score single assets or large portfolios via an interactive, browser-based application or API
-  Analyze data and underlying climate indicators via multiple visualizations
-  Score thousands of properties in minutes
-  Identify hotspots and analyze the detailed drivers of exposure to six physical climate hazards

Use Cases

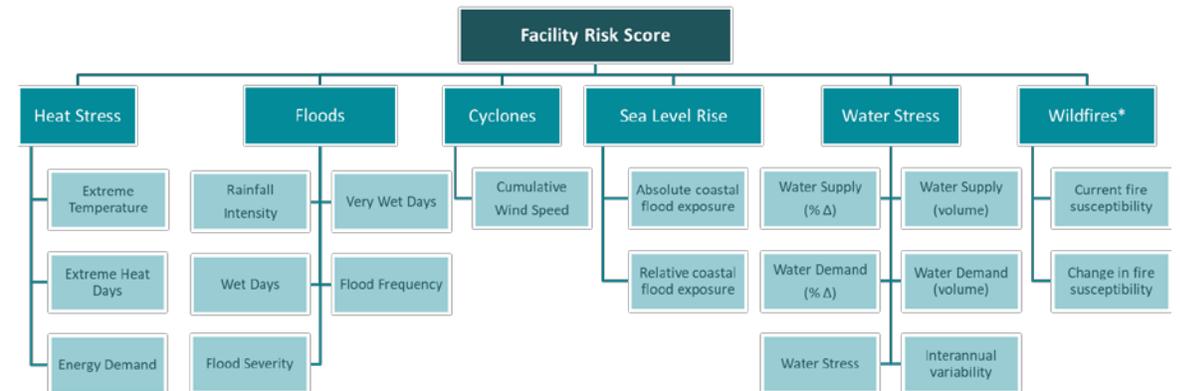


Asset Owners – evaluate the long-term risk exposure of your portfolio holdings and engage with asset operators to improve resilience and risk management

Portfolio Managers – enhance the analysis of your portfolio and monitor risk as portfolio holdings change over time. Screen assets for their exposure to climate hazards, pre-acquisition

Banks – identify the climate-related risks in commercial and residential mortgage portfolios. Incorporate climate risks into loan acquisition

Facility Risk Score



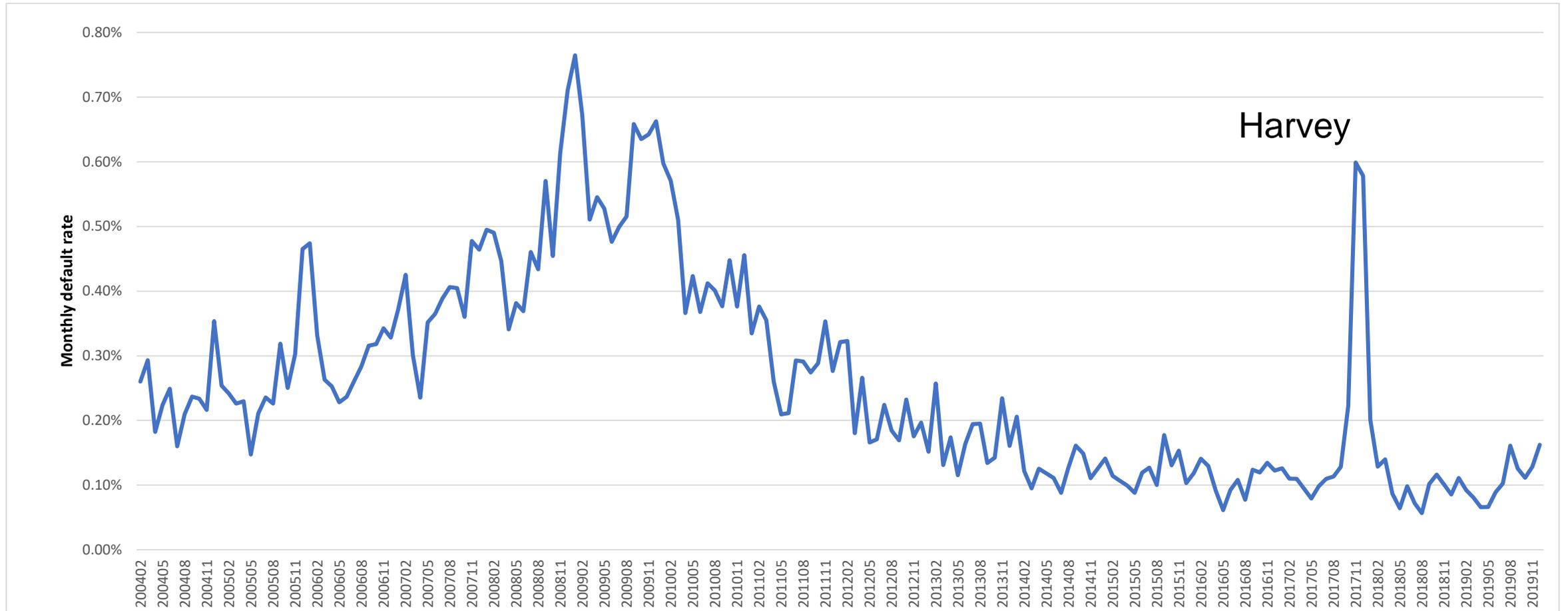
- » Best-in-class, peer-reviewed, publicly available climate models, supplemented by commercially available data.
- » Assessments on virtually **any property or corporate facility globally based on its exposure to key climate hazards**.
- » Ground-up climate risk scores for **real assets**, listed companies, REITs, U.S. municipalities and global sovereigns
- » Available through an API or online user interface for **real assets**.

2

Impact of frequency and severity of natural disasters on the PD for U.S. mortgages

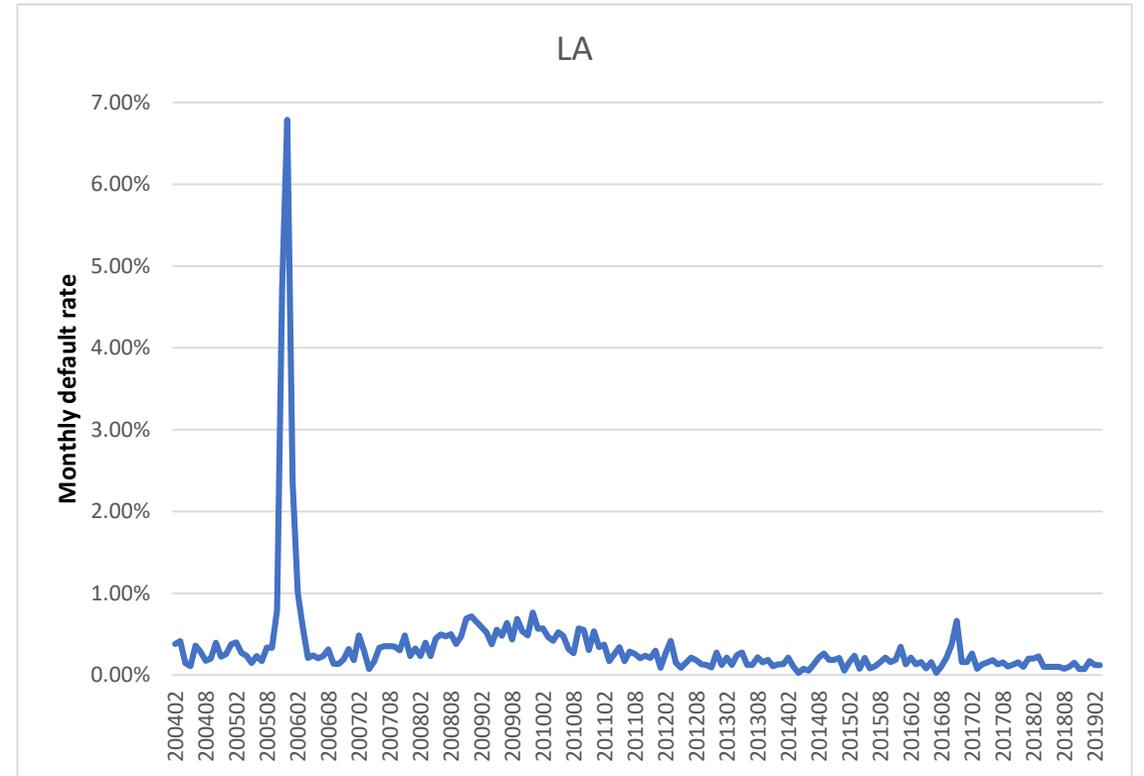
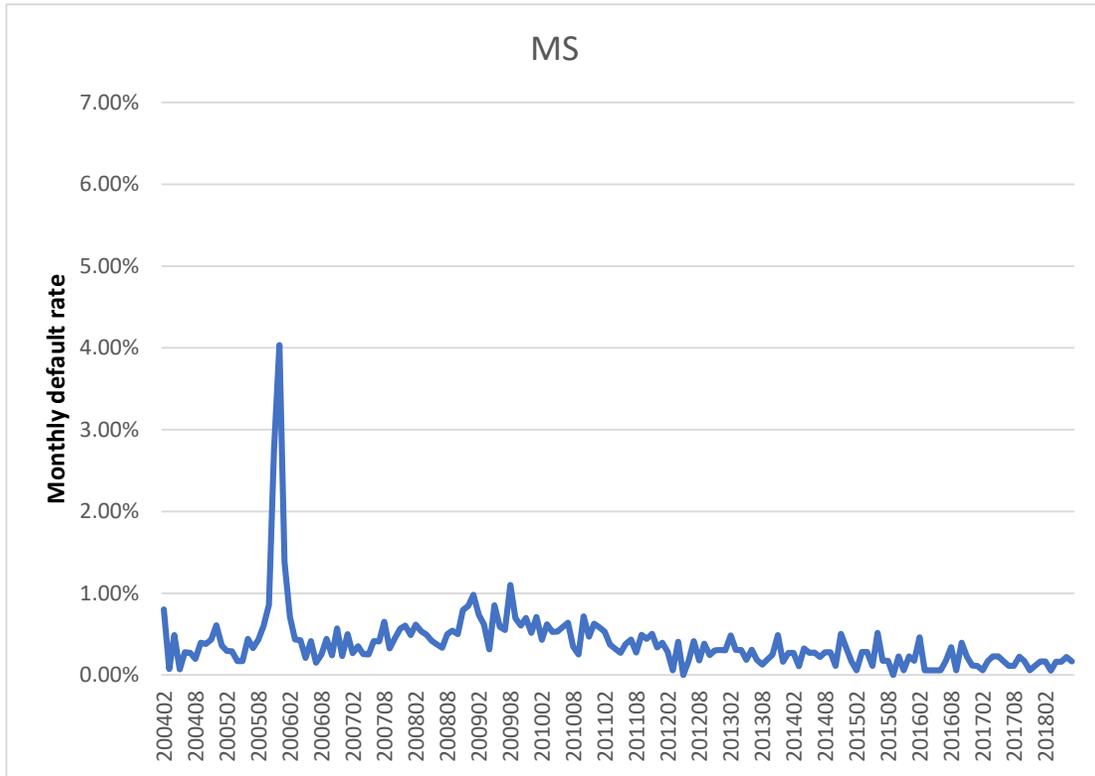
Hurricane Harvey

Mortgage default rate in Texas



Katrina

Mortgage default rate in MS and LA



Federal Emergency Management Agency (FEMA) data

Close to 13,000 events for 24 different event types: Year, month, State, number of deaths & the estimated amount of damage to property incurred by the weather event

Event Level	Event Type
1	flood
2	hurricane_typhoon
3	wildfire
4	tornado_waterspout
5	tsunami
6	blizzard
7	thunderstorm wind_heavy rain
8	high wind
9	hail
10	rip current
11	avalanche
12	landslide
13	lightning
14	fog
15	volcanic ash
16	heat
17	low tide
18	dense smoke
19	drought
20	dust storm
21	funnel cloud
22	northern lights
23	seiche
24	other

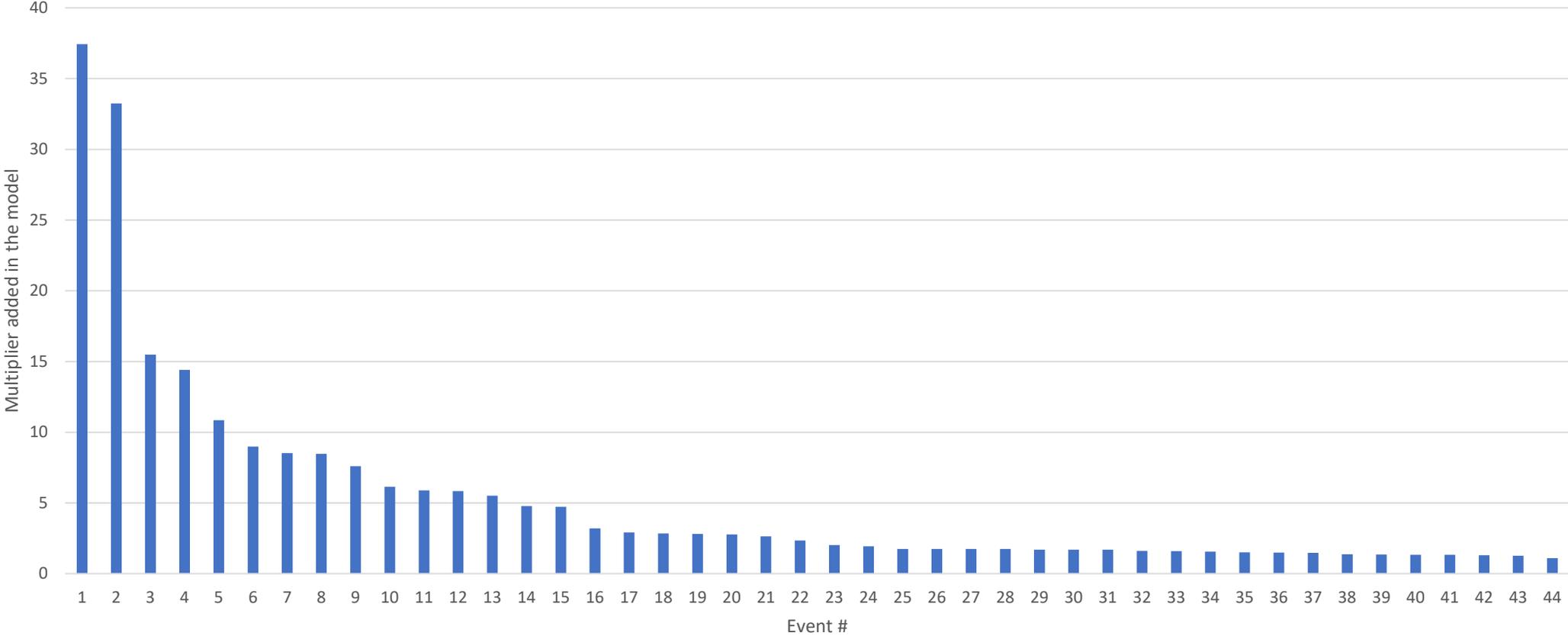
Top 9 natural disasters

56 natural disasters with more than \$500M estimated damage

state	ym	damage property	deaths	Disaster
TX	201708	\$ 43,704,268,000	67	Harvey
NJ	201210	\$ 20,950,000,000	2	Sandy
PR	201709	\$ 19,018,177,000	20	Irma
CA	201811	\$ 17,000,000,000	86	Wildfire
LA	200508	\$ 16,933,030,000	816	Katrina
MS	200508	\$ 13,482,120,000	181	Katrina
FL	200409	\$ 10,562,815,000	13	Stewart
FL	200510	\$ 10,215,603,000	1	Wilma
LA	201608	\$ 8,992,219,000	12	32 inches of rainfall

There are many events with significant impacts on PD

Multipliers in FRM pd model

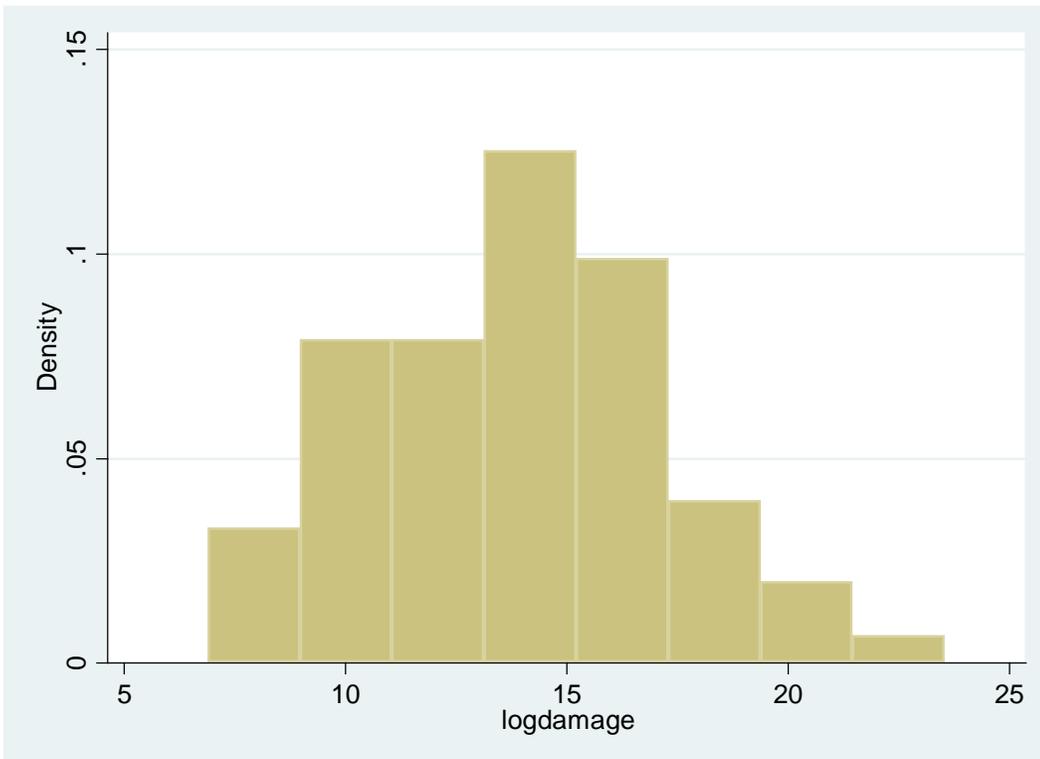


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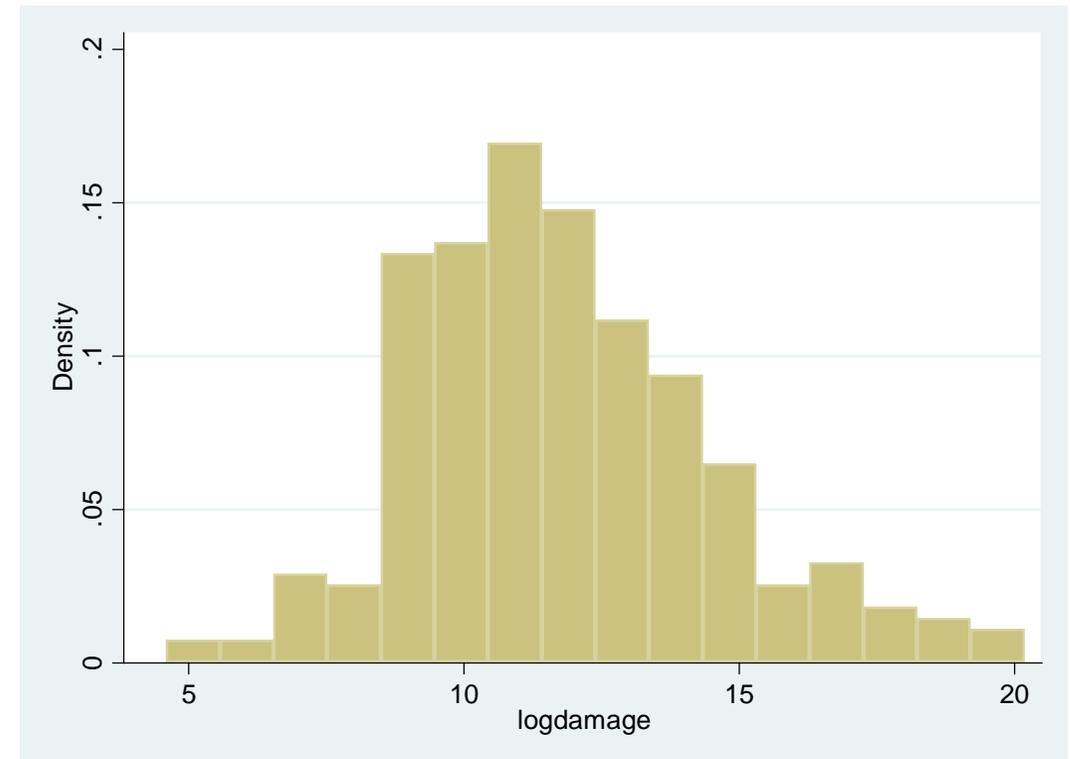
Simulations of natural disasters in credit models using the U.S. Mortgage Portfolio Analyzer

The distribution of damages in California

Wildfire

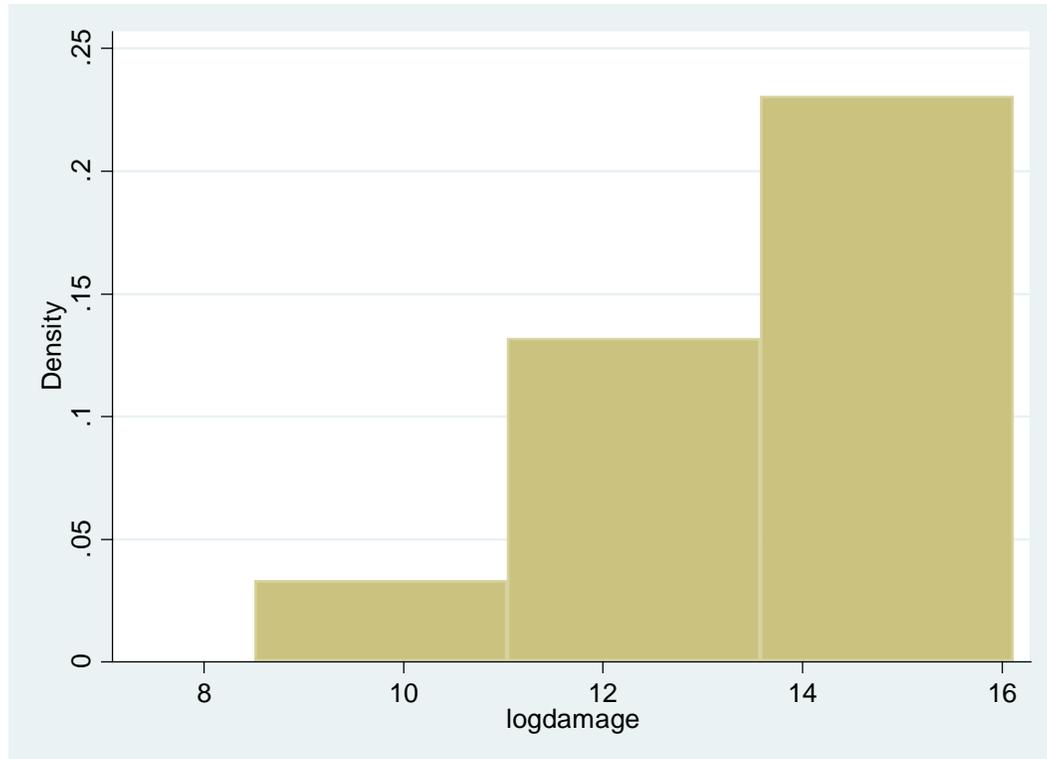


Flood, Hurricane, Tornado & Heavy Rain

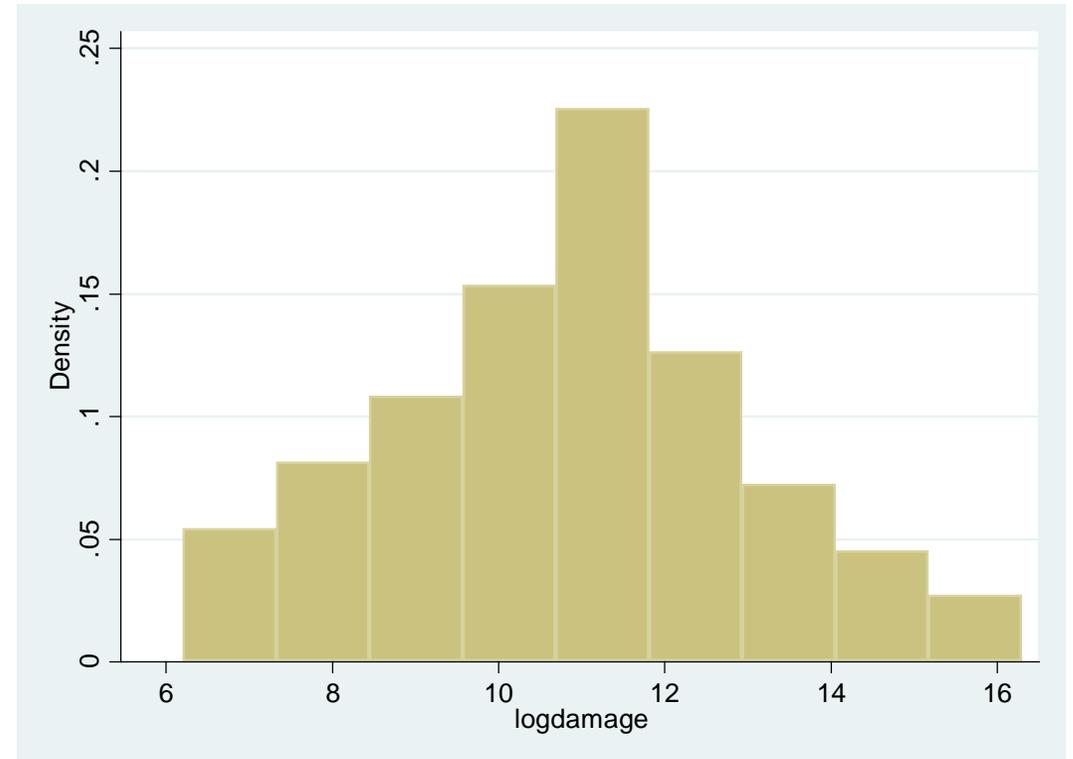


The distribution of damages in Wyoming

Wildfire



Flood, Hurricane, Tornado & Heavy Rain



Portfolio: 2688 loans, Total Balance = \$803M

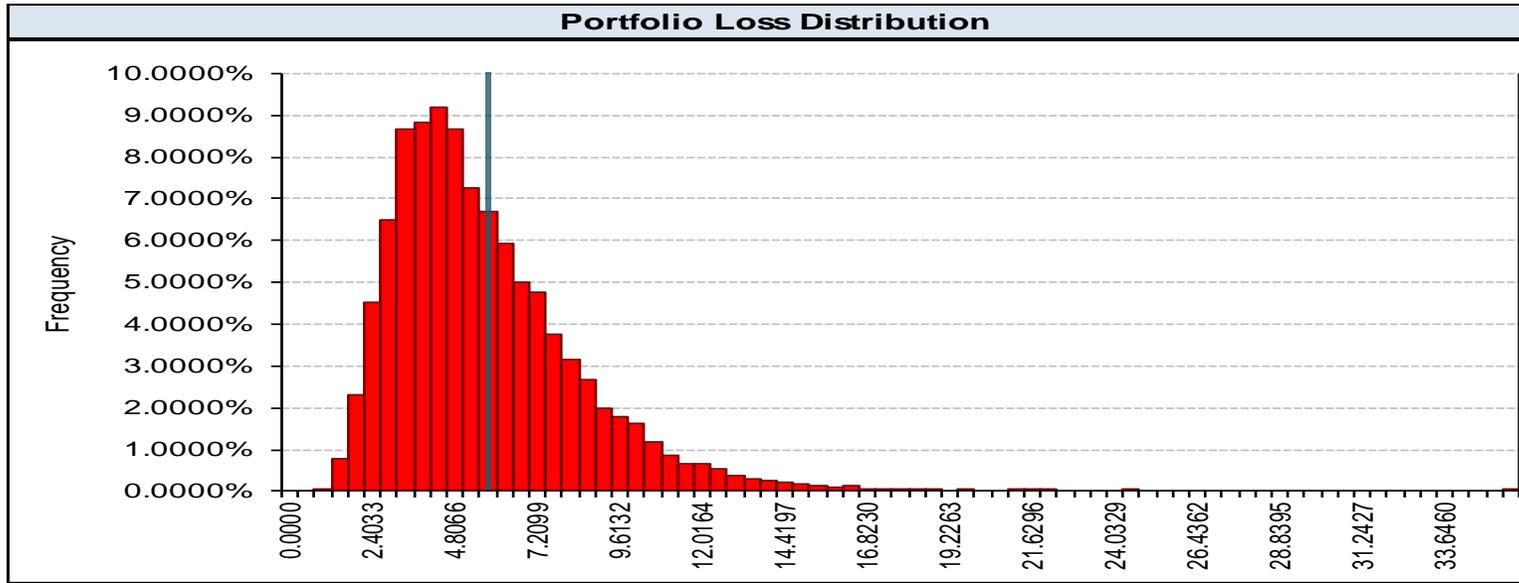
FICO	#	%	Exposure
>= 790	537	19.90	\$ 159,792,000
>= 750	331	12.53	\$ 100,668,000
>= 710	360	13.24	\$ 106,328,000
>= 670	356	13.31	\$ 106,868,000
>= 630	356	13.35	\$ 107,248,000
>= 590	356	13.06	\$ 104,916,000
>= 550	392	14.61	\$ 117,328,000
>= 510	0	0.00	\$ -
>= 470	0	0.00	\$ -
>= 430	0	0.00	\$ -

Loan Size	#	%	Exposure
>= 368,500	181	8.48	\$ 68,108,000
>= 352,000	327	14.66	\$ 117,744,000
>= 335,500	247	10.53	\$ 84,544,000
>= 319,000	244	9.89	\$ 79,444,000
>= 302,500	268	10.35	\$ 83,132,000
>= 286,000	282	10.31	\$ 82,836,000
>= 269,500	256	8.86	\$ 71,148,000
>= 253,000	298	9.73	\$ 78,128,000
>= 236,500	264	8.09	\$ 64,964,000
>= 220,000	321	9.10	\$ 73,100,000

LTV	#	%	Exposure
>= 100	0	0.00	\$ -
>= 95	65	3.08	\$ 24,700,000
>= 90	318	14.55	\$ 116,896,000
>= 85	322	13.95	\$ 112,000,000
>= 80	294	11.98	\$ 96,244,000
>= 75	326	12.52	\$ 100,532,000
>= 70	345	12.40	\$ 99,572,000
>= 65	356	11.88	\$ 95,428,000
>= 60	341	10.54	\$ 84,676,000
>= 55	321	9.10	\$ 73,100,000

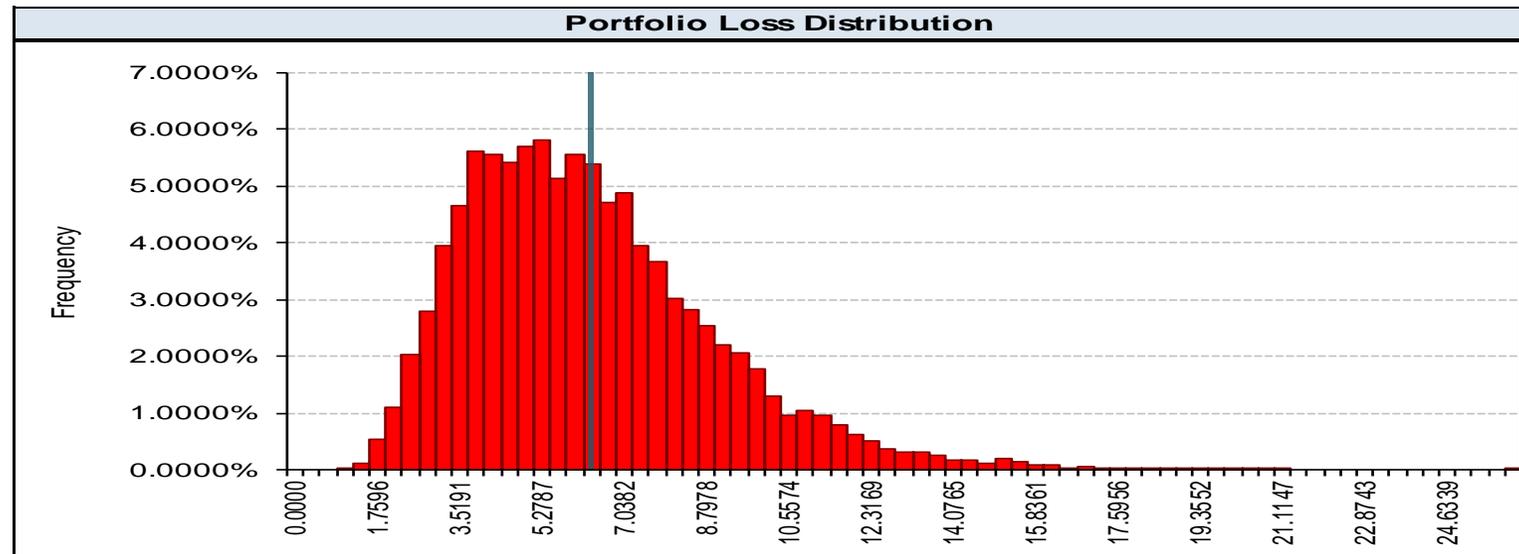
Seasoning (Months)	#	%	Exposure
>= 45	0	0.00	0.00
>= 40	0	0.00	0.00
>= 35	0	0.00	0.00
>= 30	0	0.00	0.00
>= 25	0	0.00	0.00
>= 20	0	0.00	0.00
>= 15	0	0.00	0.00
>= 10	0	0.00	0.00
>= 5	0	0.00	0.00
>= 0	2,688	100.00	803,148,000.00

Simulation results for loans in TX; Without natural disasters (above) and with natural disasters (below)



Aggregate Statistics	
Number of Simulations	10,000
Mean (Portfolio EL)	5.8959%
Standard Deviation	2.6908
Interquartile Range	3.3077
Skewness	1.4992
Kurtosis	5.3347
95th / 50th Percentile	2.0578

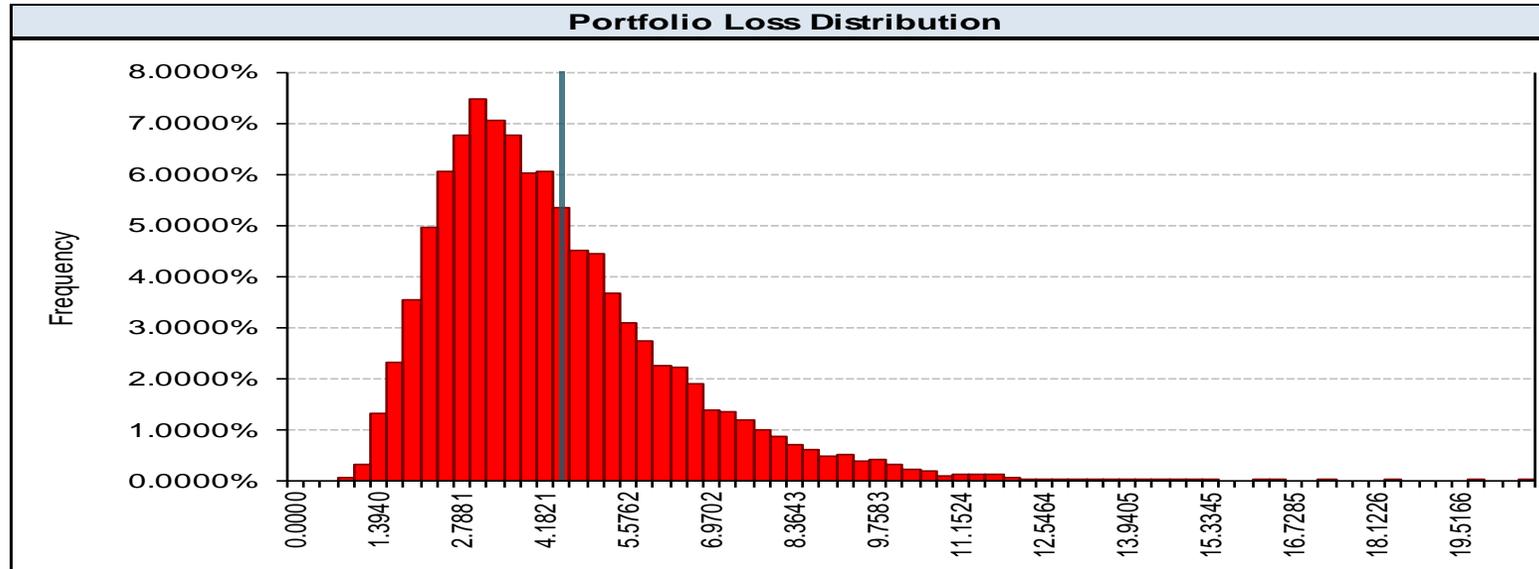
Percentiles	
5%	2.6345
10%	3.0726
25%	3.9670
50%	5.3252
75%	7.2746
90%	9.4209
95%	10.9580



Aggregate Statistics	
Number of Simulations	10,000
Mean (Portfolio EL)	6.4705%
Standard Deviation	2.6704
Interquartile Range	3.4410
Skewness	1.0242
Kurtosis	1.7184
95th / 50th Percentile	1.8817

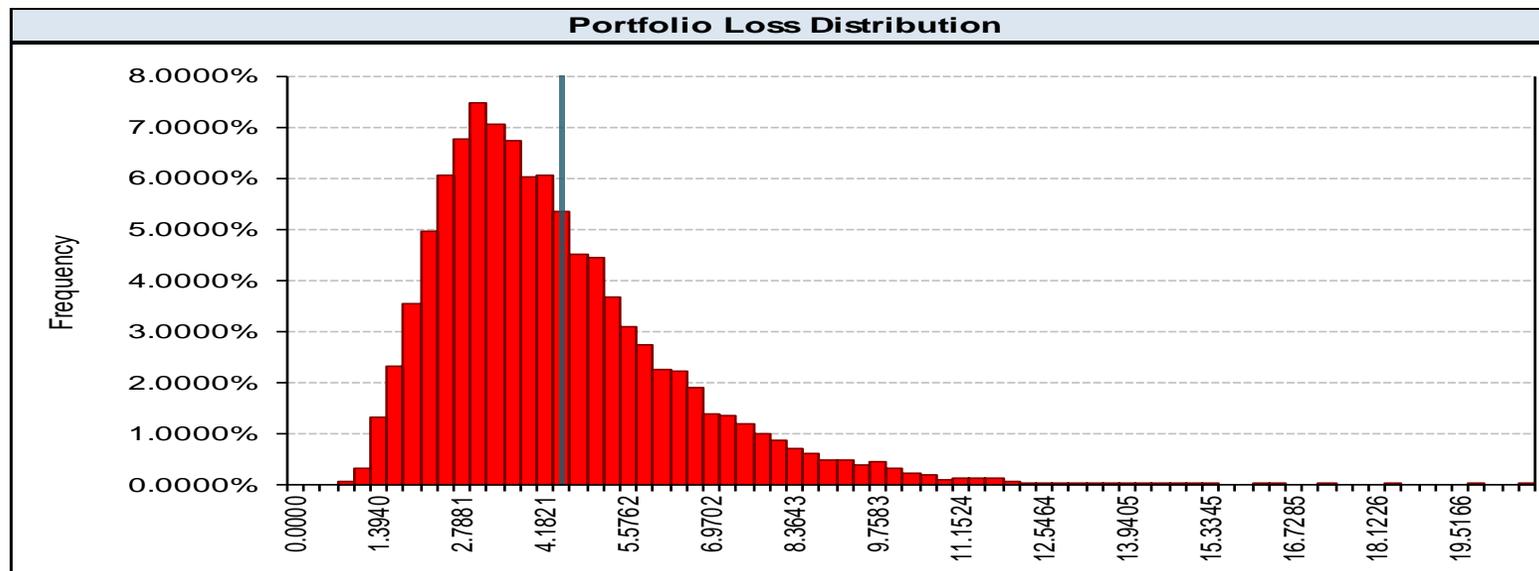
Percentiles	
5%	2.9795
10%	3.4734
25%	4.4881
50%	6.0788
75%	7.9291
90%	9.9837
95%	11.4384

Simulation results for loans in WY; Without natural disasters (above) and with natural disasters (below)



Aggregate Statistics	
Number of Simulations	10,000
Mean (Portfolio EL)	4.4758%
Standard Deviation	2.0276
Interquartile Range	2.3861
Skewness	1.4464
Kurtosis	3.6947
95th / 50th Percentile	2.0704

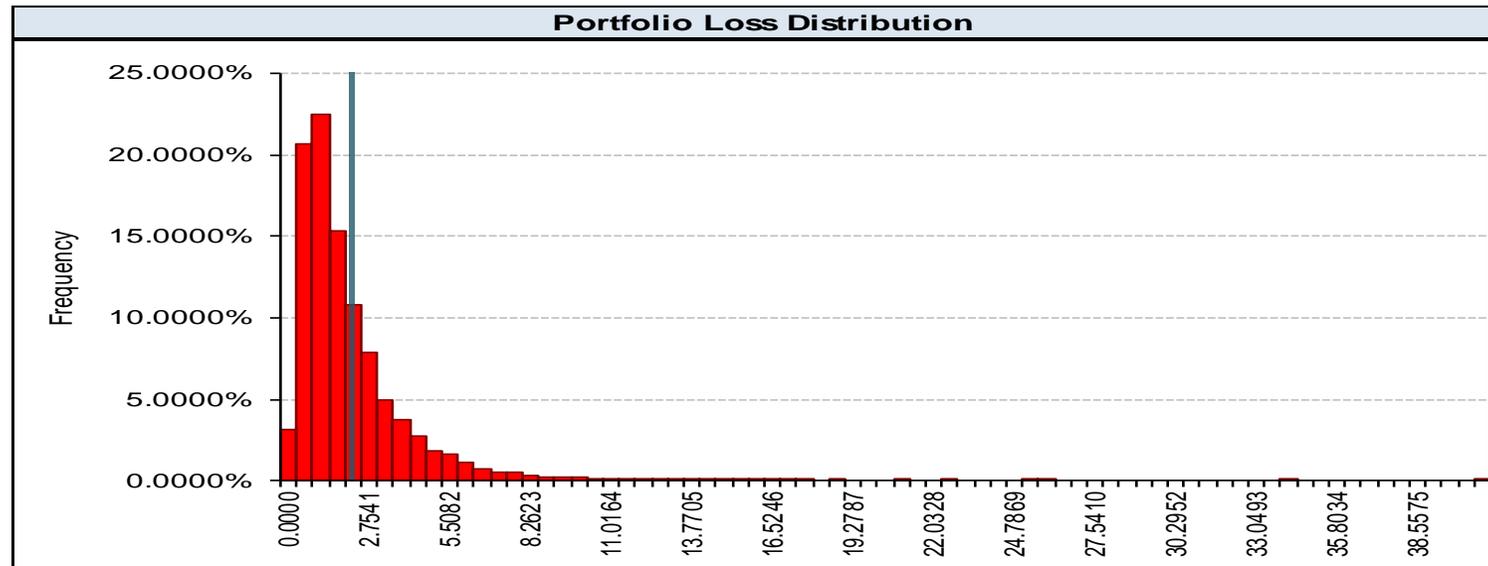
Percentiles	
5%	2.0342
10%	2.3689
25%	3.0490
50%	4.0534
75%	5.4351
90%	7.1330
95%	8.3922



Aggregate Statistics	
Number of Simulations	10,000
Mean (Portfolio EL)	4.4757%
Standard Deviation	2.0274
Interquartile Range	2.3868
Skewness	1.4468
Kurtosis	3.6980
95th / 50th Percentile	2.0699

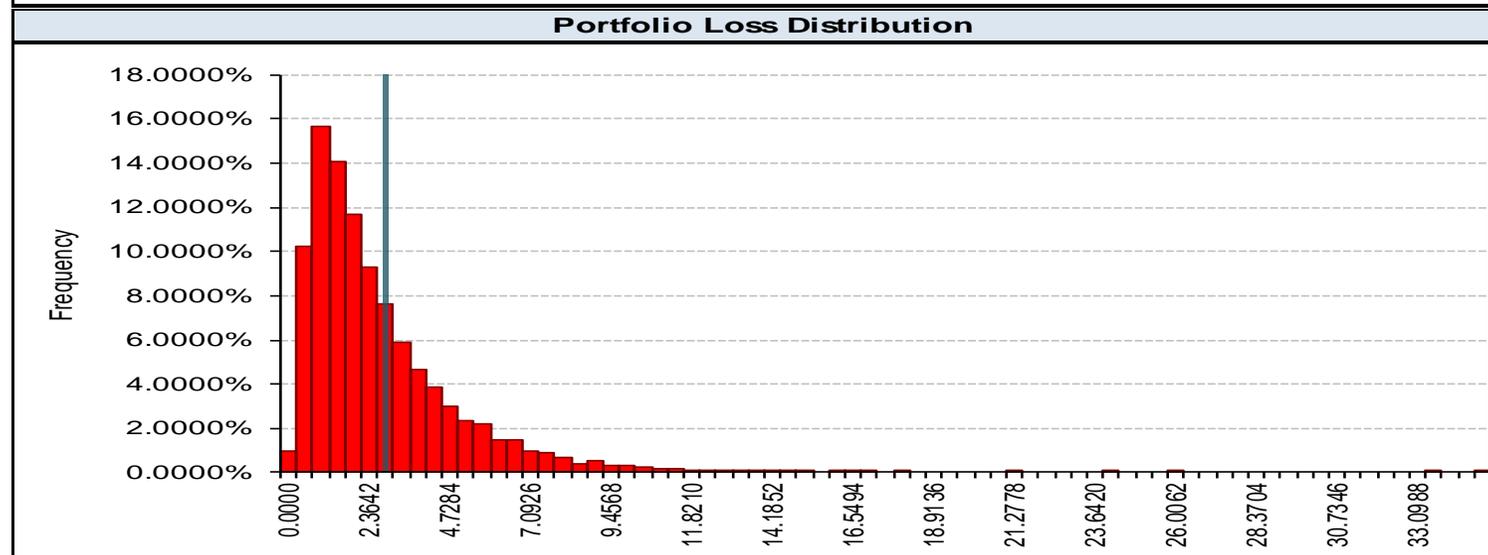
Percentiles	
5%	2.0342
10%	2.3689
25%	3.0490
50%	4.0544
75%	5.4358
90%	7.1301
95%	8.3922

Simulation results for loans in CA; Without natural disasters (above) and with natural disasters (below)



Aggregate Statistics	
Number of Simulations	10,000
Mean (Portfolio EL)	2.3528%
Standard Deviation	2.0021
Interquartile Range	1.7891
Skewness	3.8773
Kurtosis	35.5313
95th / 50th Percentile	3.3797

Percentiles	
5%	0.6207
10%	0.7803
25%	1.1276
50%	1.7676
75%	2.9166
90%	4.6195
95%	5.9740



Aggregate Statistics	
Number of Simulations	10,000
Mean (Portfolio EL)	2.9007%
Standard Deviation	2.2573
Interquartile Range	2.3703
Skewness	2.4709
Kurtosis	13.9273
95th / 50th Percentile	3.2391

Percentiles	
5%	0.7171
10%	0.9091
25%	1.3603
50%	2.2364
75%	3.7306
90%	5.7722
95%	7.2440

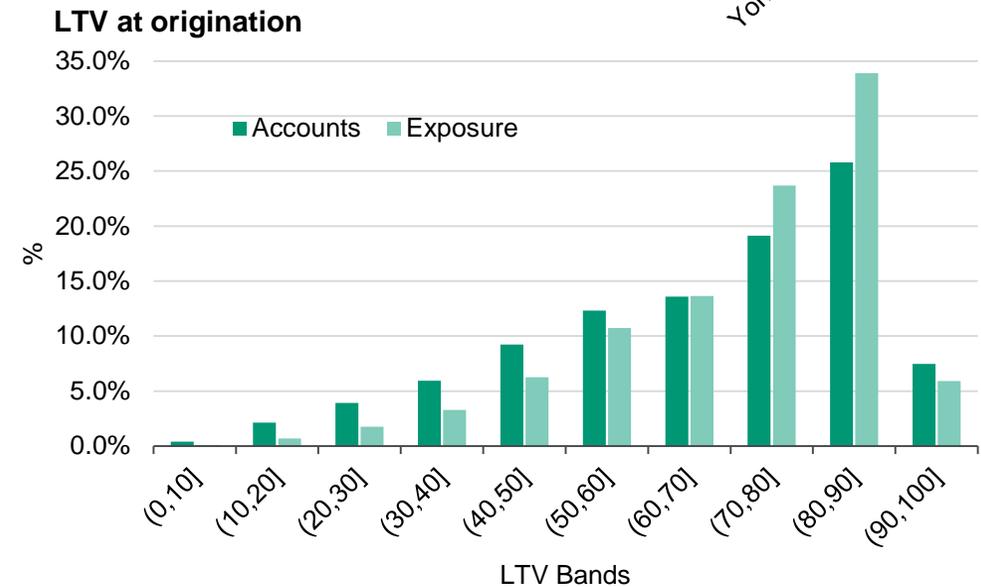
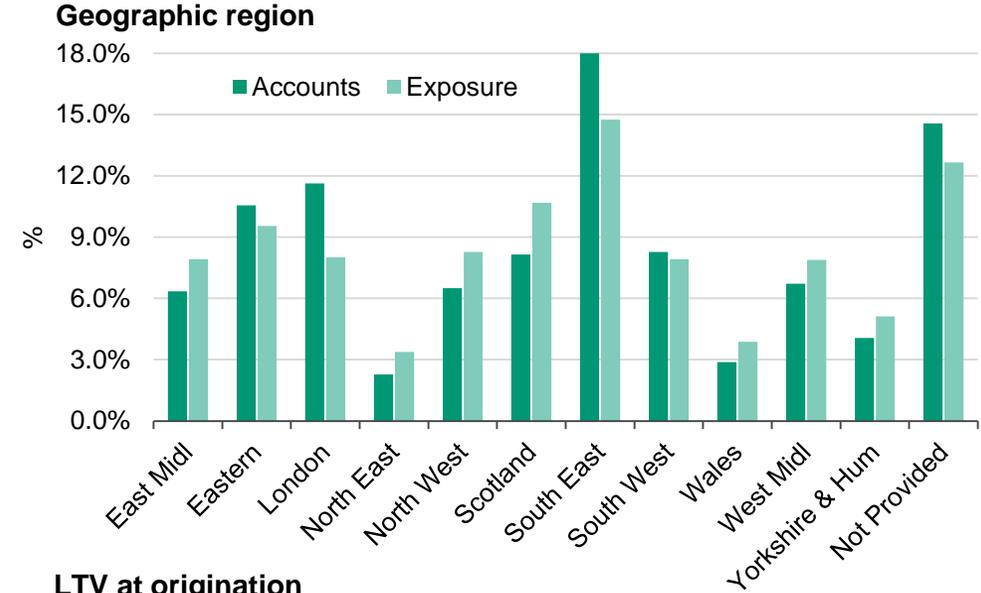
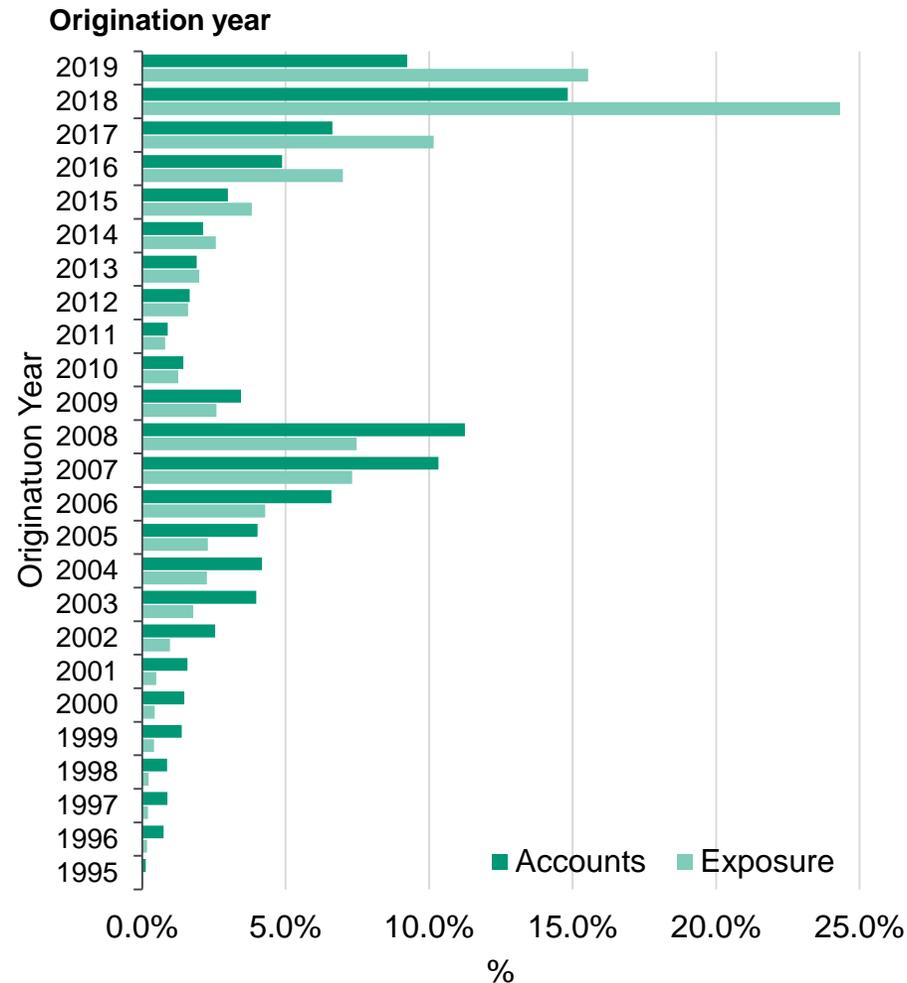
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The effect of climate scenarios on the U.K. mortgages credit parameters

Mortgage Characteristics

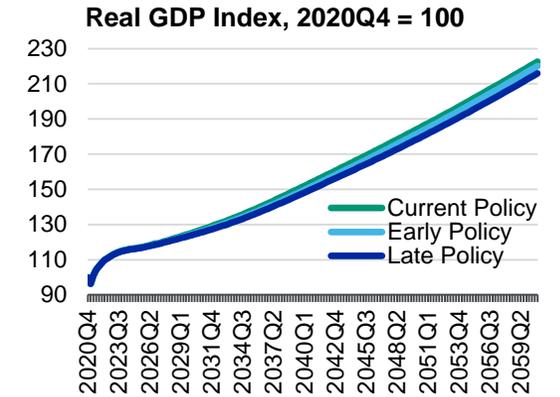
December 2020 snapshot

- » 126,396 mortgages totaling an outstanding balance of £12,149m.
- » There are 877 under-performing accounts, representing 0.55% of the total exposure.
- » Nearly 91% of customers are employed, whilst an additional 7.5% are self-employed.

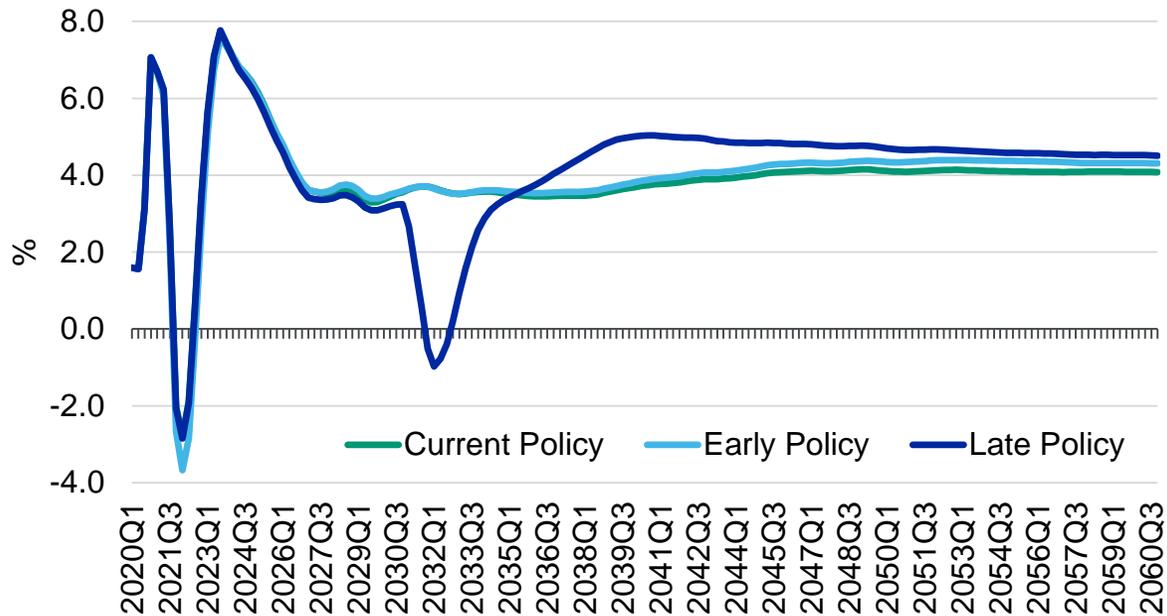


Climate Change Scenarios for the UK

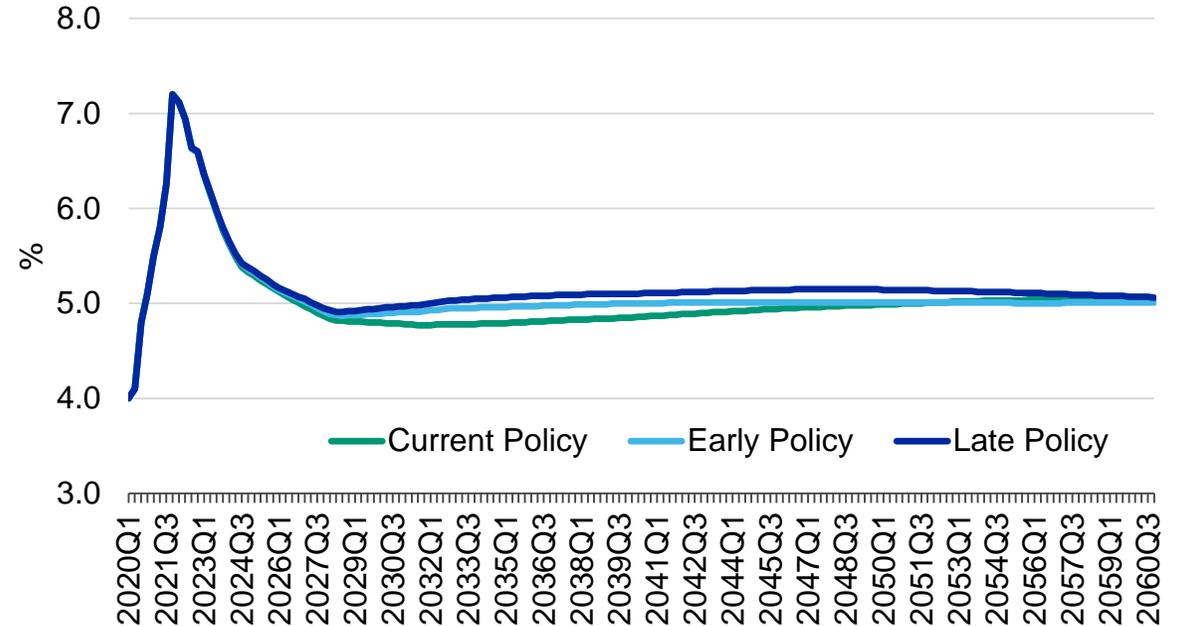
Projections for HPI and unemployment rate



HPI, % change yr ago

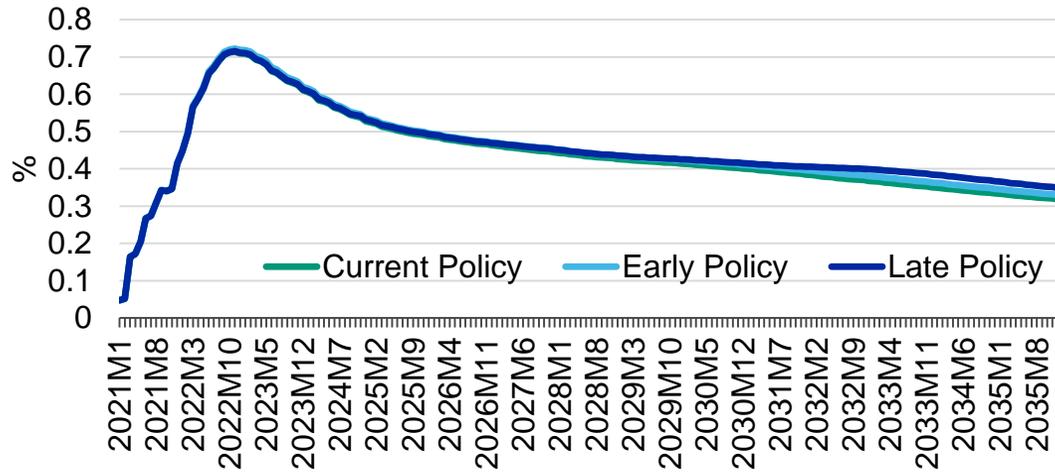


Unemployment Rate, %

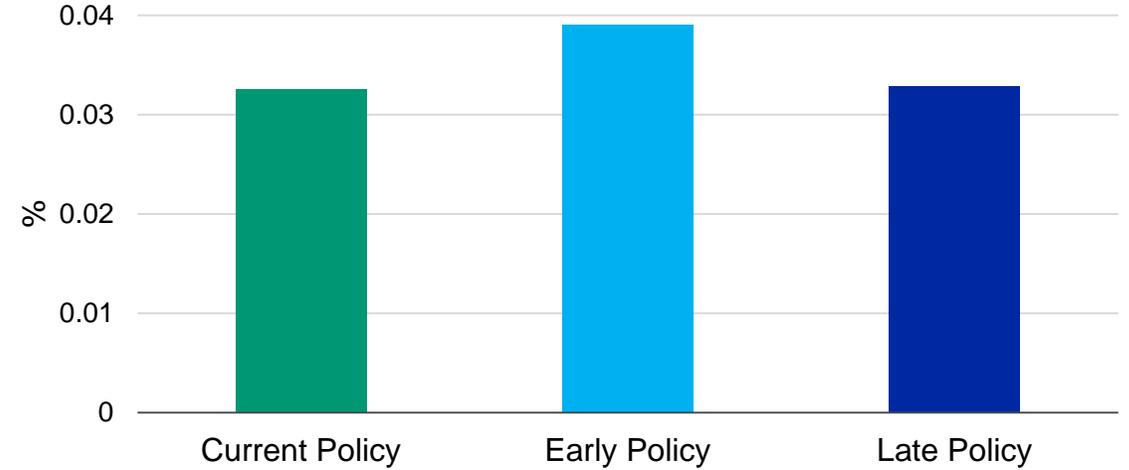


Impact of Climate Scenarios on Credit Risk

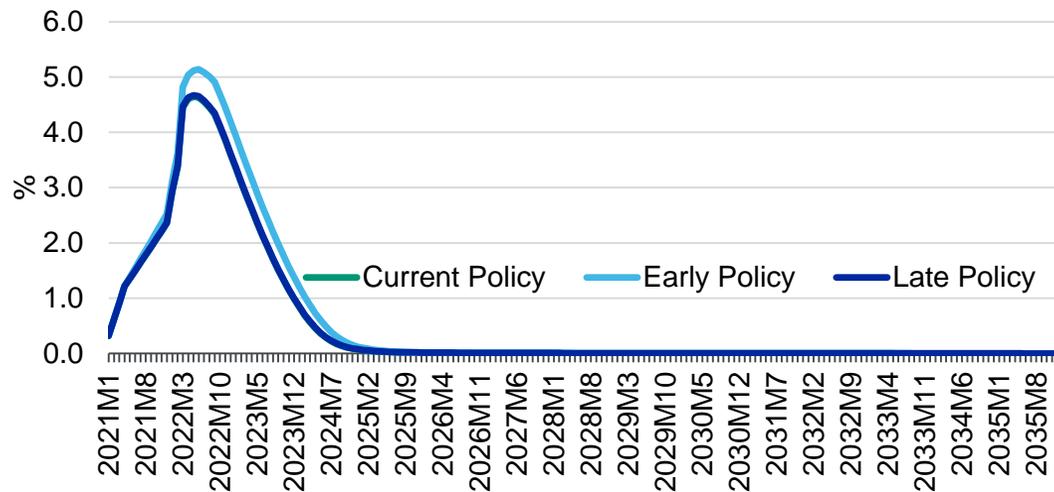
Annualised Conditional PD, %



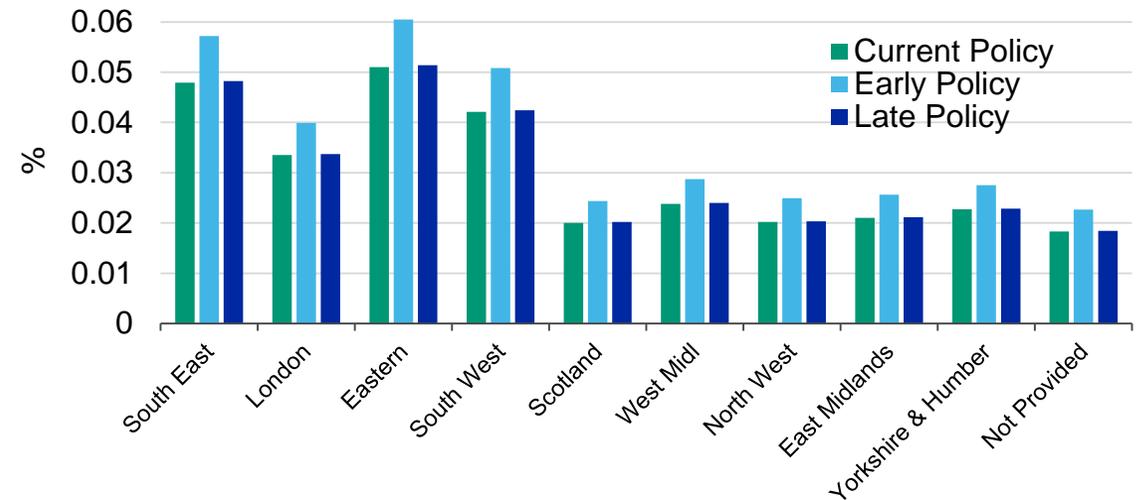
Expected Losses, %



LGD, %



Expected Losses by Geographic Region, %

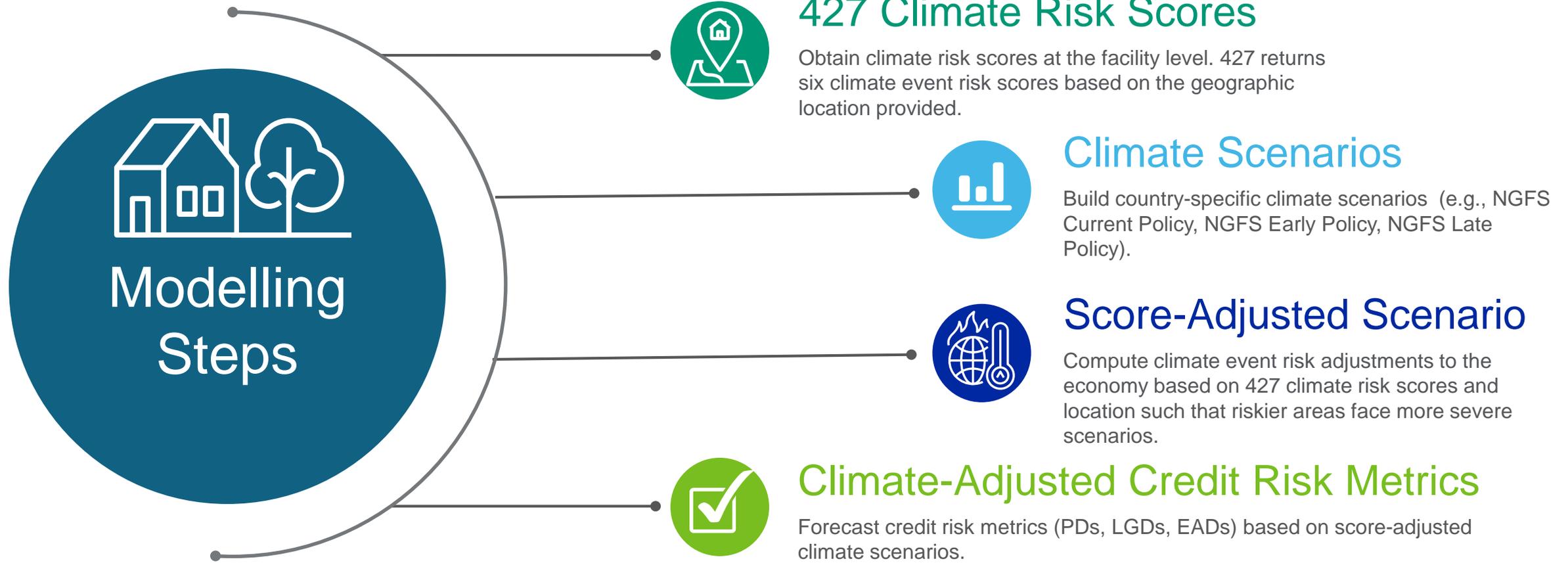


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Usage of location-specific climate risk scores to forecast climate-adjusted credit risk metrics

Location-Specific Climate Risk

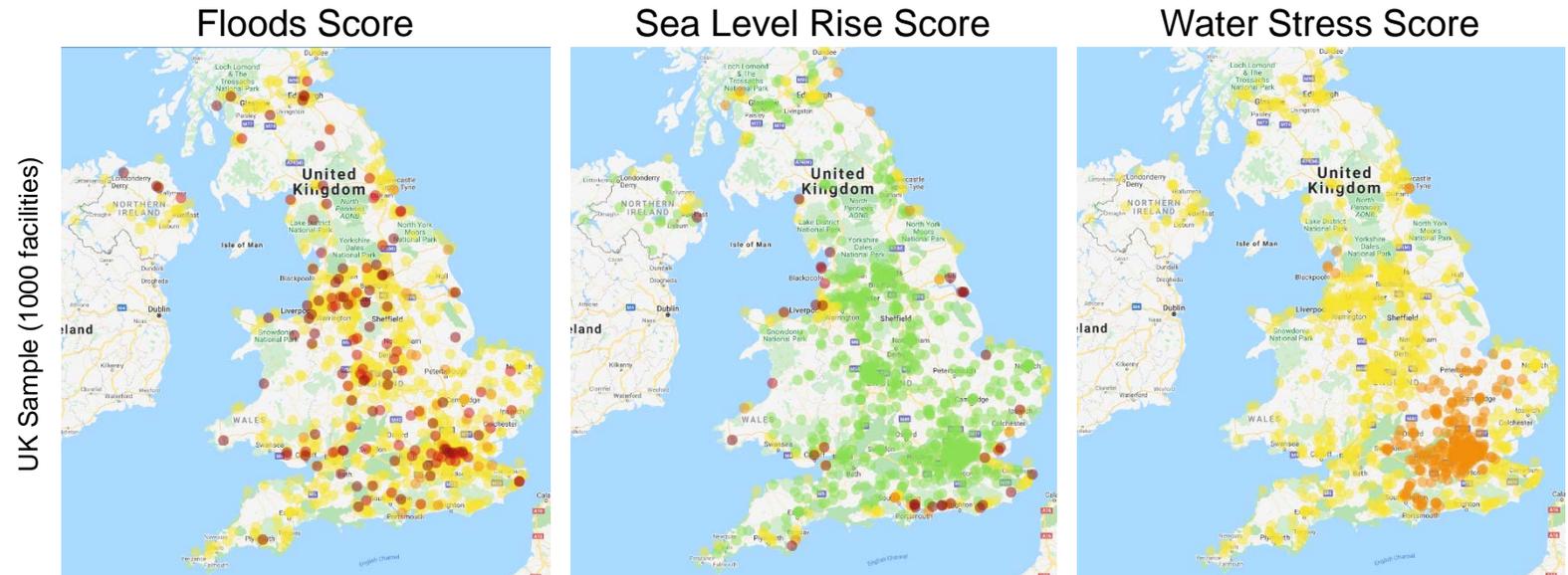
Modelling Methodology



Physical Climate Risk Score

427 Data

- » 1,000 random names of the portfolio and ran the physical risk climate scores within the on-demand scoring application
- » **Six climate hazards** assessed at the facility-level: floods, sea level rise, water stress, heat stress, wildfire, and hurricanes & typhons
- » Majority of the portfolio is low risk but some material hotspots across specific climate hazards
- » While few UK facilities may lead to Red Flags, **UK Floods and Sea Level Risk** scores can easily double or triple, amplifying damages for local economies and assets
- » Flood risk followed by Water Stress appears to be the prominent climate hazards affecting the portfolio analysed

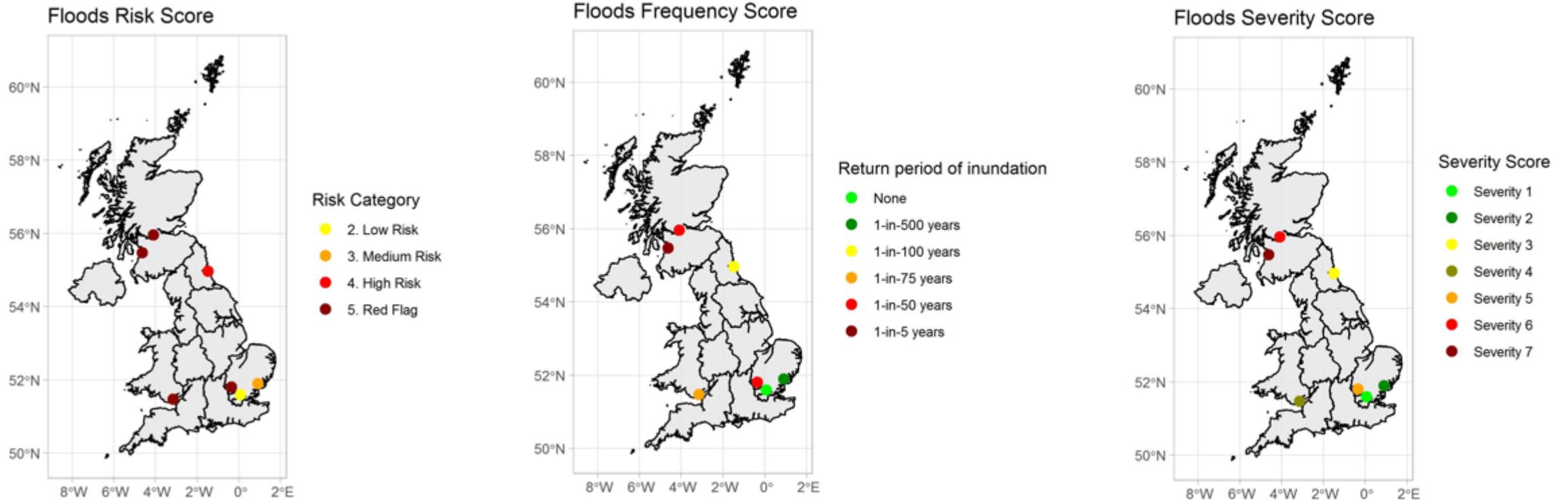


Credit Risk Impact of Flooding Exposure

A Worked Example on a UK Residential Mortgage

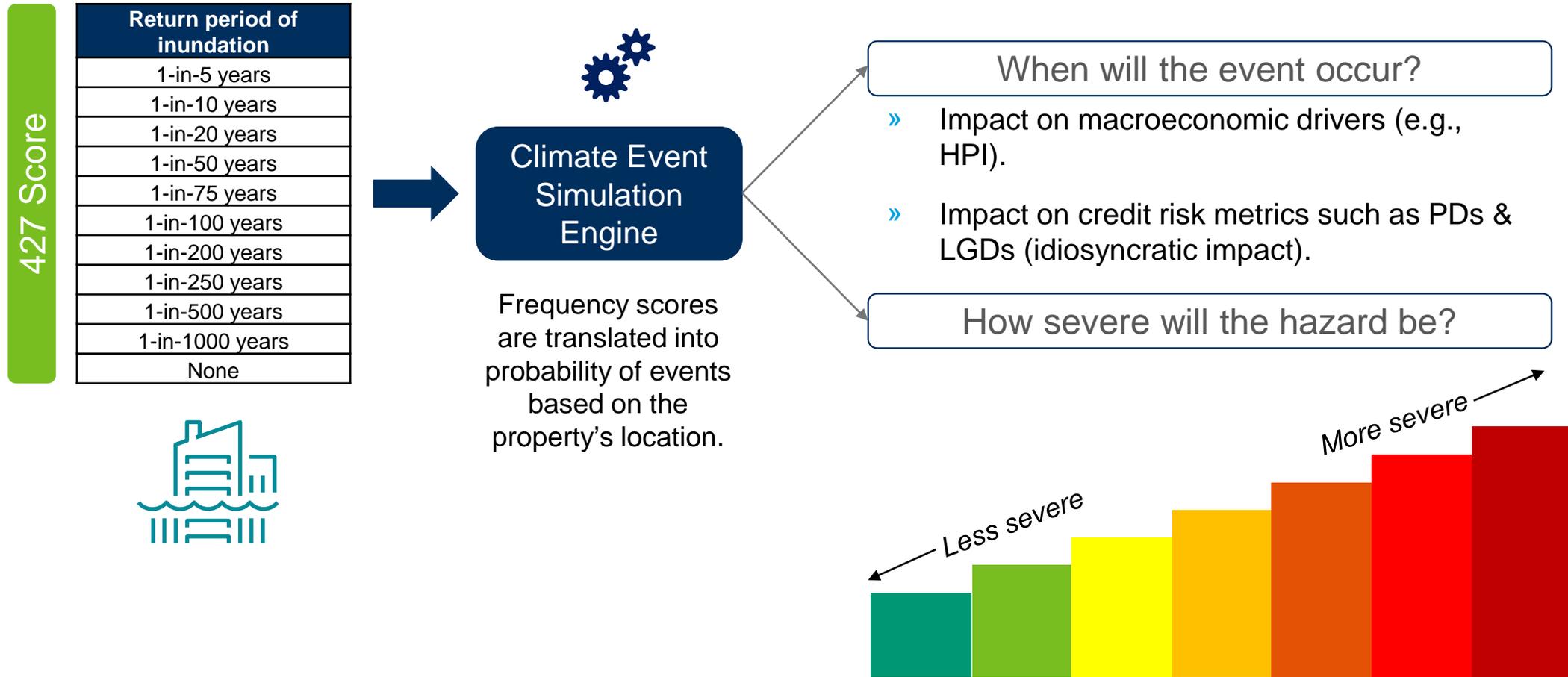


Assume 7 loans with the same characteristics (exposure, LTV, interest rate, DPD status, etc.) but located in different areas of the UK.



Linking Probability of Climate Events to Credit Risk

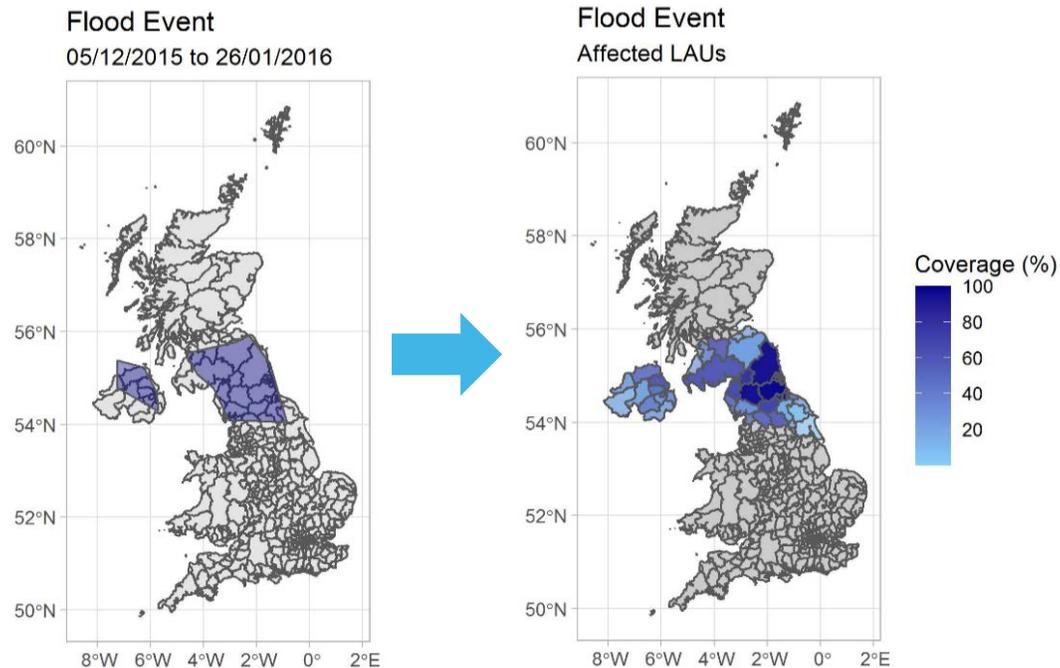
Example for flood events



Linking Severity of Climate Events to Credit Risk

Impact of flooding in HPI

1. Analyse 70+ flooding events in the UK.
2. Classify the events based on severity.
3. Analyse the impact on HPI after the event is observed by severity buckets.



Fixed effect model

$$y_{it} = \alpha + \lambda_t + c_i + \tau_t D_{it} + \mu_{it}$$

where

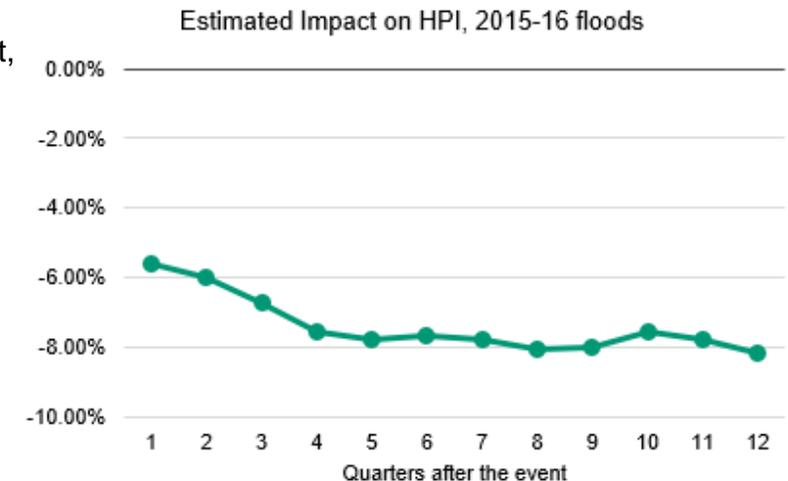
y_{it} : HPI for LAU i at time t ,

λ_t : Time effect (year-quarter dummy),

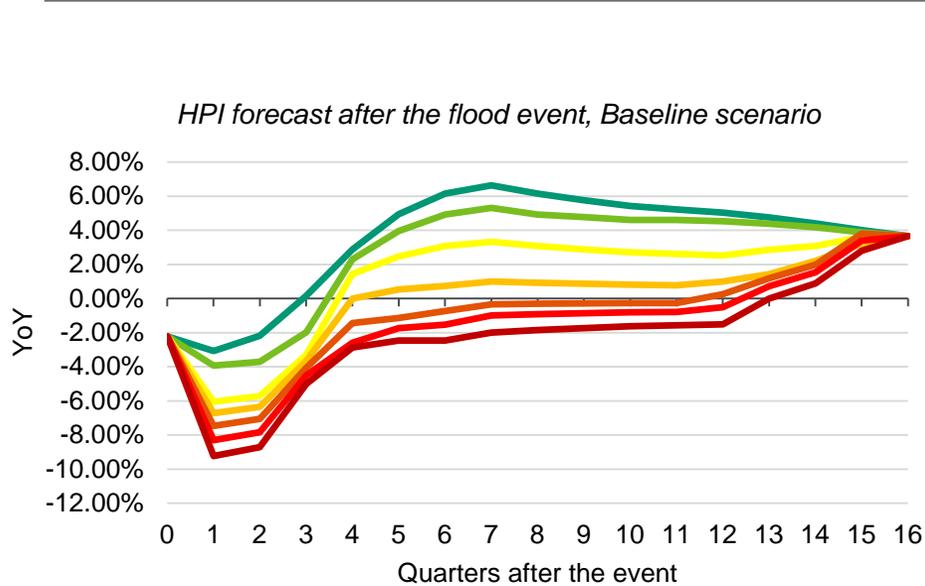
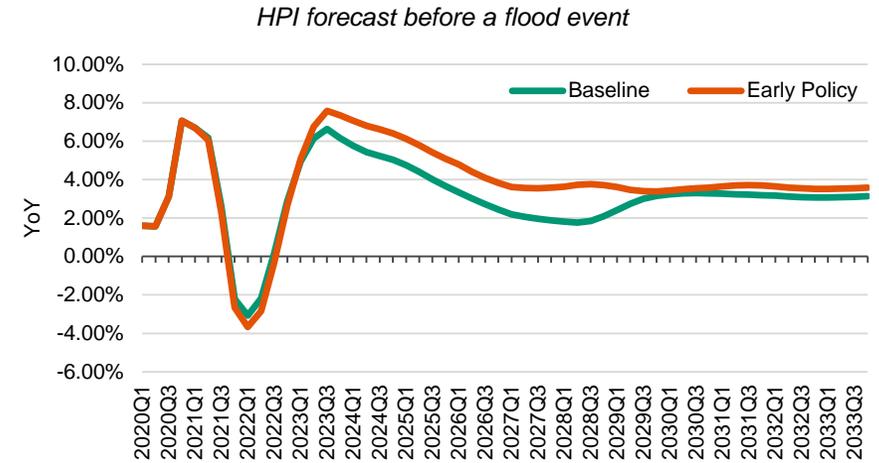
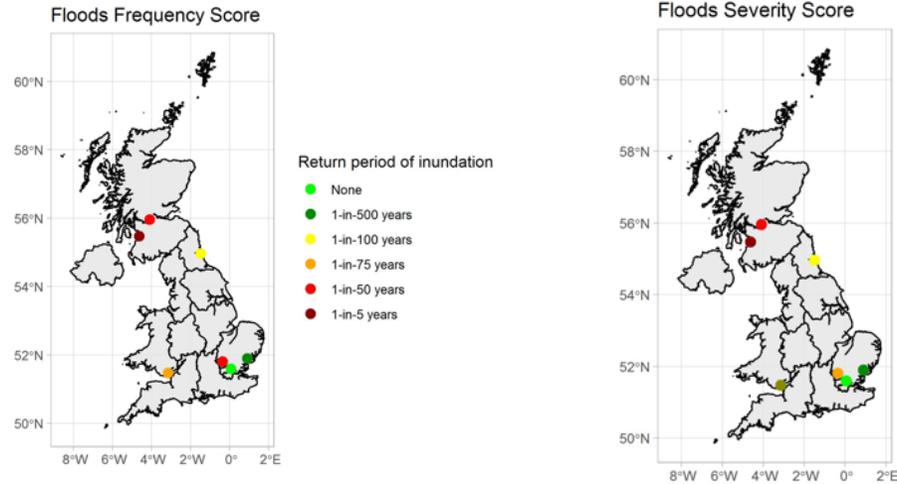
c_i : Region fixed effect,

τ_t : Time-varying flood event effect,

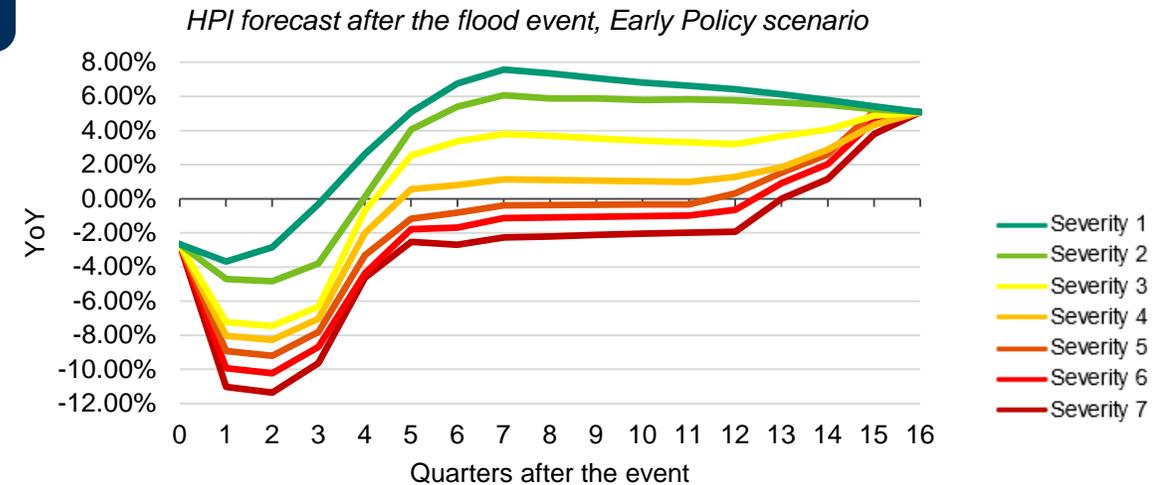
D_{it} : flooded LAU (dummy)



Impact of Flooding in Location-specific HPI



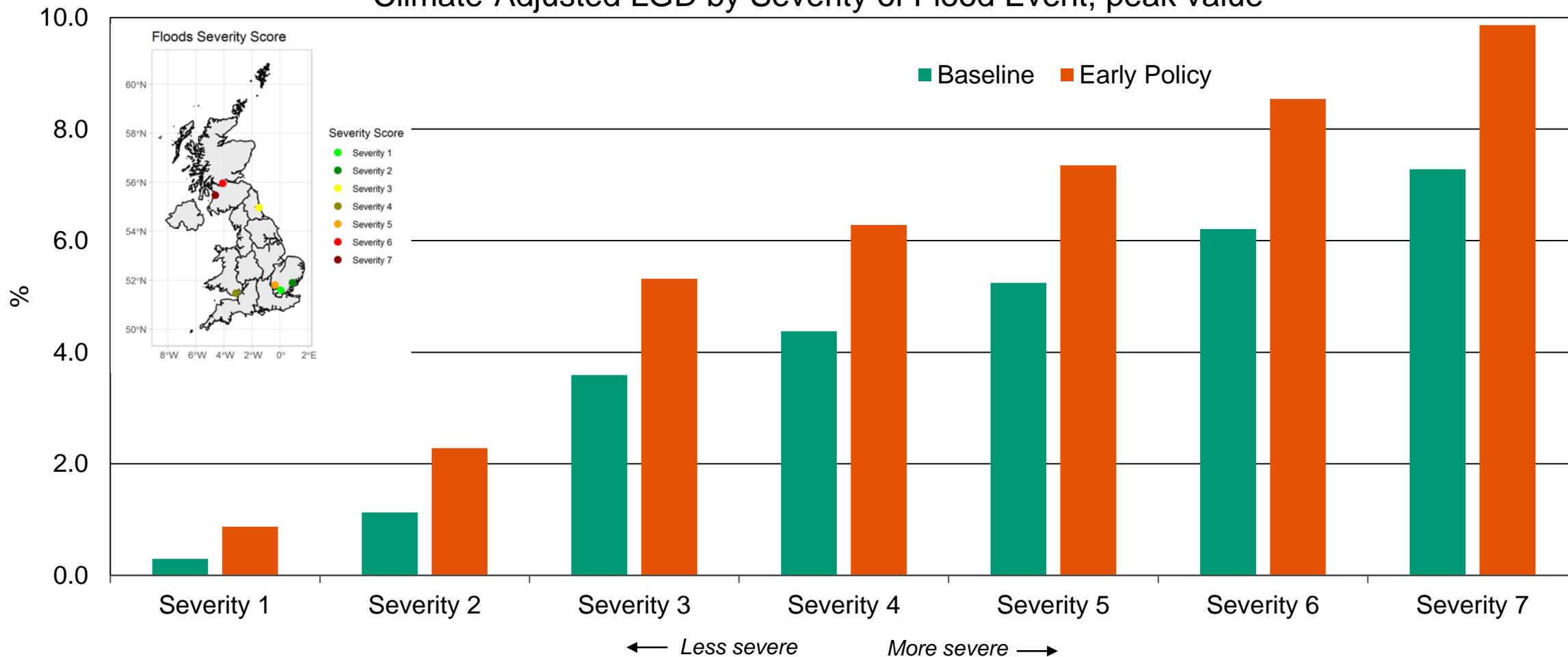
If a flood event is predicted to occur in 2021Q4



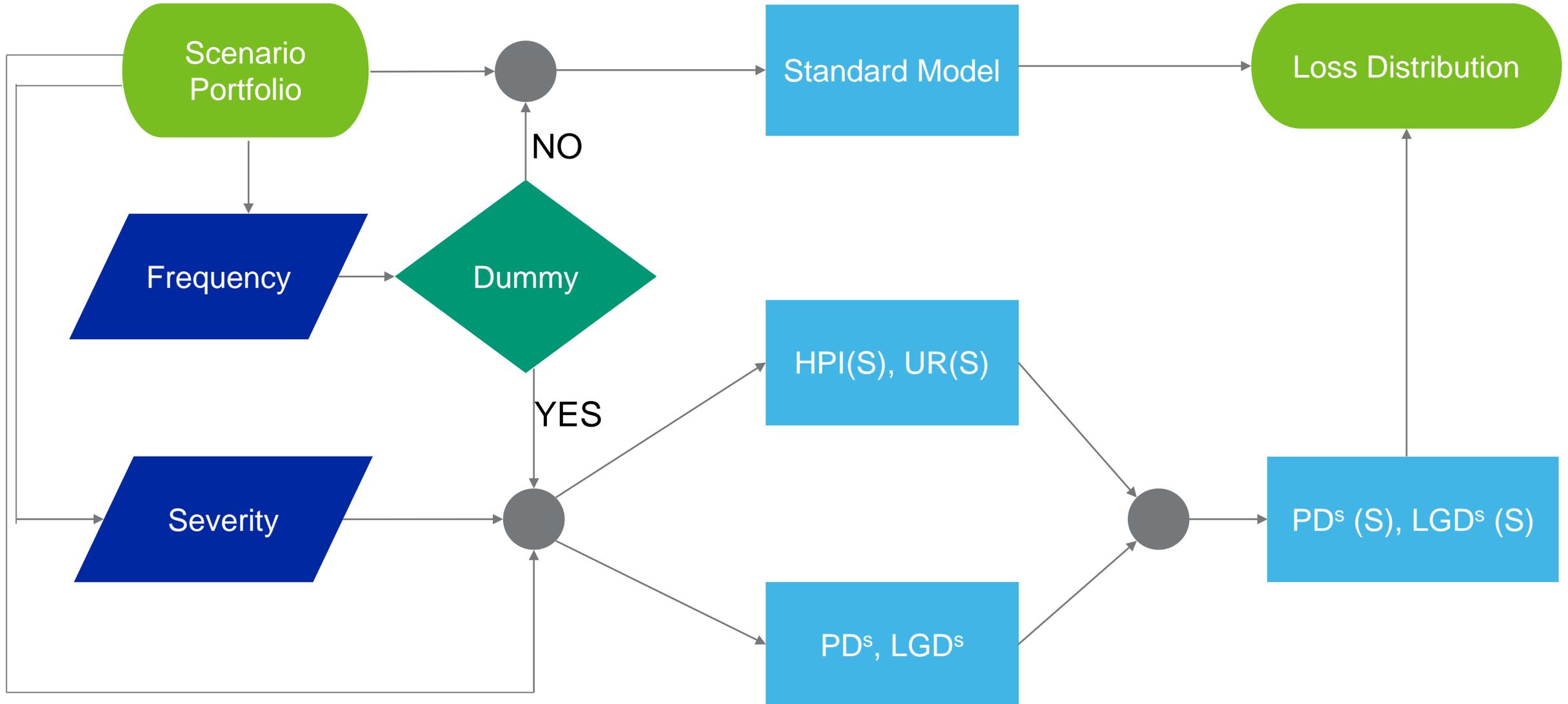
Impact of Flooding Events in LGD

Location-specific LGD

Climate-Adjusted LGD by Severity of Flood Event, peak value



Climate-Adjusted Credit Risk Approach: Summary



Q&A

Additional questions? Email us at help@economy.com

Additional Analysis, Whitepapers, Case Studies and Solution Information:
www.economy.com/products/consumer-credit-analytics/portfolio-analyzer

Contact Us: Content Solutions - Economics & Business Analytics Offices

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