Le régime cat nat français, entre risque et solidarité

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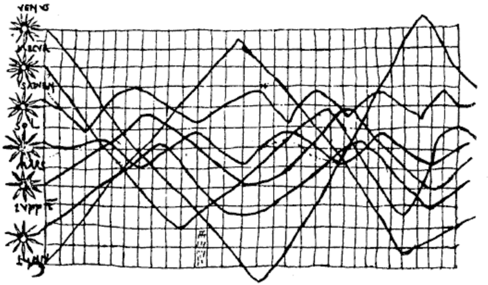
20 ans du Master Mathématiques et applications – Actuariat, Mai 2022

May 15, 2022

Back to the future...



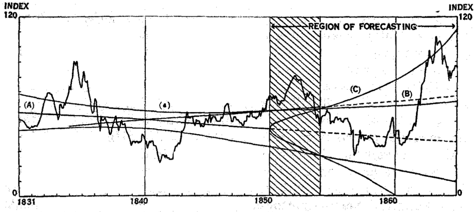


Figure 149.—Forecasting of Rail Stock Prices.
This chart shows the highly explosive character of trend extrapolations where the basic data are highly variable. The shaded region is the region of forecast corresponding to the standard error of the trend shown in the chart. (a) $y(t) + \sigma_f(t)$; (a') $y(t) - \sigma_f(t)$; (C) $y(t) \pm \sigma(m)$.

Cours de séries temporelles, partie 1 et partie 2

Published & on-going work on climate related risks

- Flood (Hurst / Gumbel, 2008)
  doi: 10.1002/env.909
- Windstorm dynamics (2006)
  doi: 10.1007/s00477-005-0029-y
- Insurability of climate risks (2008)
  doi: 10.1057/palgrave.gpp.2510155
- Public intervention ? (2014)
  doi: 10.1016/j.jpubeco.2014.03.004
- Earthquake dynamics (2015)
  doi: 10.1007/s10950-015-9489-9
- Heat wave and return period (2011)
  doi: 10.1007/s10584-010-9944-0
- Floods & fairness (2020)
  doi: 10.1057/s41288-021-00233-7
- Subsidence & heat waves (2021)
  doi: 10.5194/nhess-2021-214
- 'Le Livre Vert 2022' (2021)
  isbn: 9782746523616
- Wildfires (2021)
- Public intervention with RL (2021)

Dynamics of Climate Events [1]

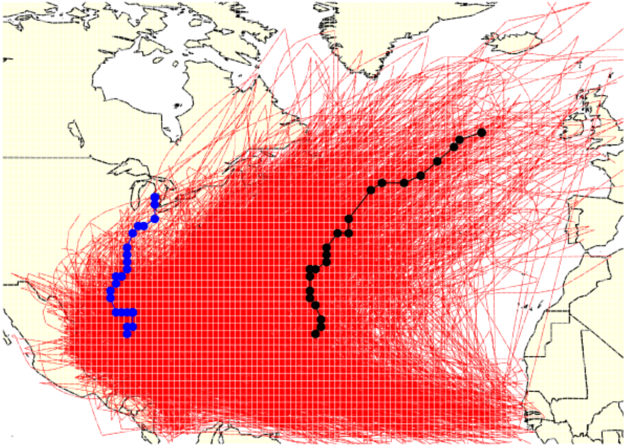
Joint work with David Sibaï (ENSAE) and several other (former) students.

- J.C. Bouette et al. "Wind in Ireland: long memory or seasonal effect?" In: *Stochastic environmental research and risk assessment* 20.3 (2006), pp. 141–151.
- A. Charpentier. "On the return period of the 2003 heat wave". In: *Climatic change* 109.3 (2011), pp. 245–260.
- A. Charpentier and M. Durand. "Modeling earthquake dynamics". In: *Journal of Seismology* 19.3 (2015), pp. 721–739.
- A. Charpentier and D. Sibaï. "Dynamic flood modeling: combining Hurst and Gumbel's approach". In: *Environmetrics* 20.1 (2009), pp. 32–52.

On the temporal occurrence of natural disasters...

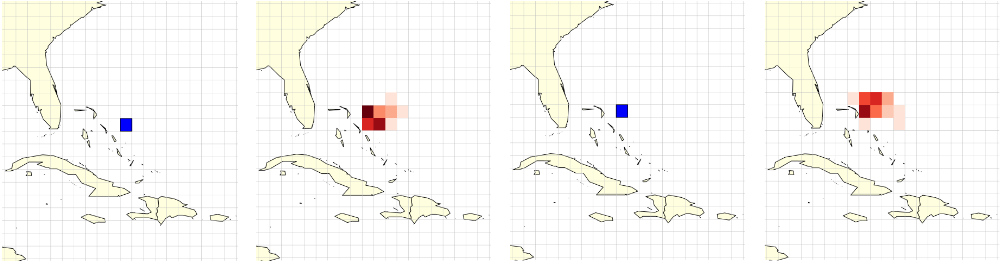
Dynamics of Climate Events [2]

Spatial models well documented in cat' software



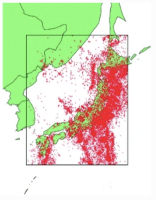
Dynamics of Climate Events [3]

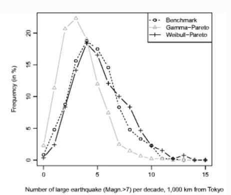
Spatial models well documented in cat' software

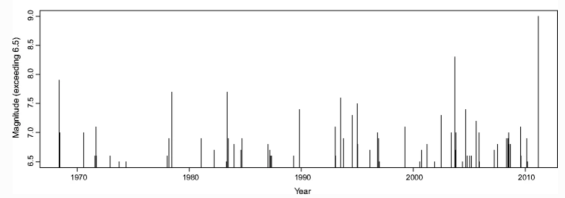


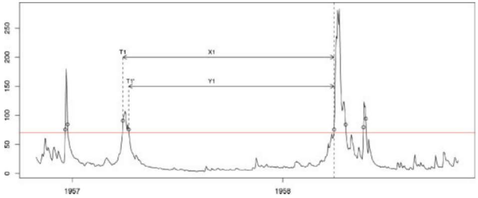
Dynamics of Climate Events [4]

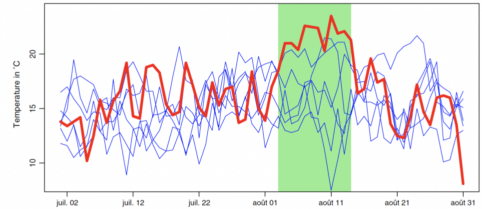
"*seismic gap hypothesis*" / dynamic of flood events / heat wave persistence











Flood Risk in France [1]

Joint work with Laurence Barry (PARI) and Molly James (EURIA / ACPR).

A. Charpentier, L. Barry, and M. James. "Insurance against Natural Catastrophes: Balancing Actuarial Fairness and Social Solidarity". In: *Geneva Papers on Risk & Insurance* (2021). DOI: 10.1057/s41288-021-00233-7.

On the fairness of the French "catastrophes naturelles" mechanism...

Actuarial fairness : a fair premium should be a function of the underlying risk
"*at the core of insurance business lies discrimination between risky and non-risky insureds*"
see also Maynard (1979), Boonekamp (1979), Landes (2015), Avraham (2017)

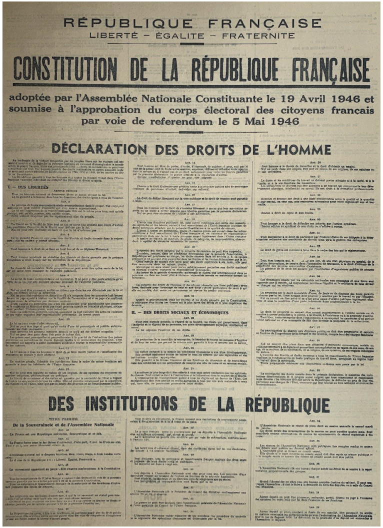
On fairness & solidarity

- French Constitution (1946)

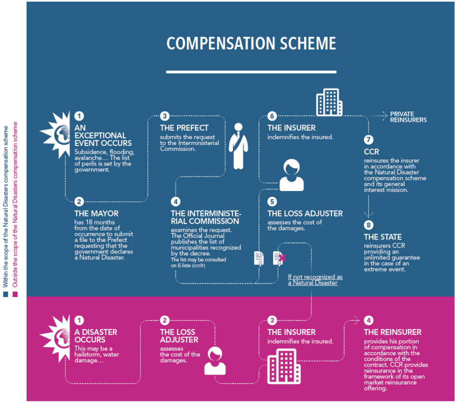
  12. *La Nation proclame la solidarité et l'égalité de tous les Français devant les charges qui résultent des calamités nationales.*

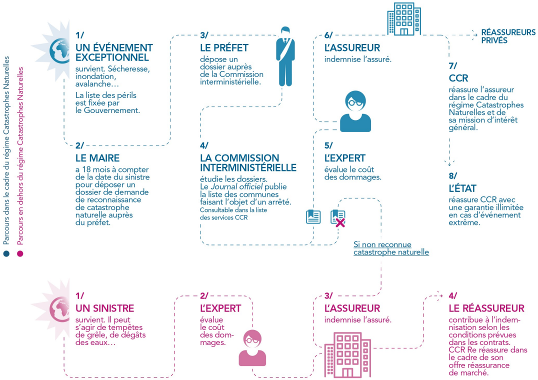
- 82-600 Law (1982)

  régime d'indemnisation des catastrophes naturelles


RÉPUBLIQUE FRANÇAISE
LIBERTÉ – ÉGALITÉ – FRATERNITÉ
CONSTITUTION DE LA RÉPUBLIQUE FRANÇAISE
adoptée par l'Assemblée Nationale Constituante le 19 Avril 1946 et soumise à l'approbation du corps électoral des citoyens français par voie de referendum le 5 Mai 1946
DÉCLARATION DES DROITS DE L'HOMME
DES INSTITUTIONS DE LA RÉPUBLIQUE

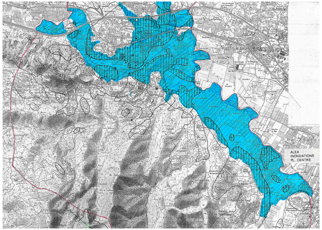
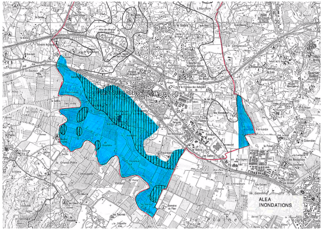
Flood Risk in France [3]

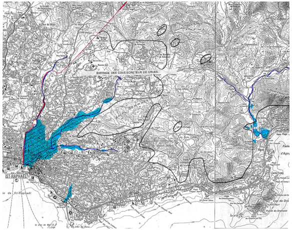




source: https://www.ccr.fr/en/-/indemnisation-des-catastrophes-naturelles-en-france

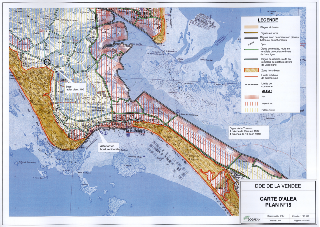
Two different flood perils : overflow vs. coastal
PPRIs (plan de prévention du risque inondation) in Roquebrune-sur-Argens, Puget and Saint-Raphaël. The plain area (in blue) is the risky area.

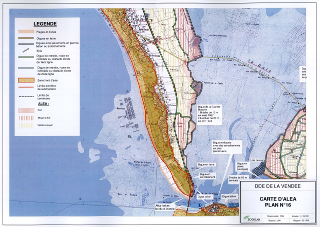



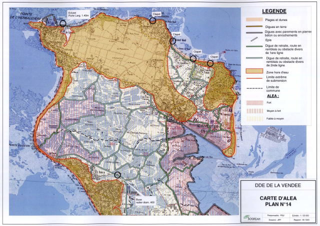


Areas clearly identified as risky, from documented (historical) floods.

PPRLs (plan de prévention des risques littoraux) in Vendée. The dashed area is the risky area. Areas with possible coastal risk.





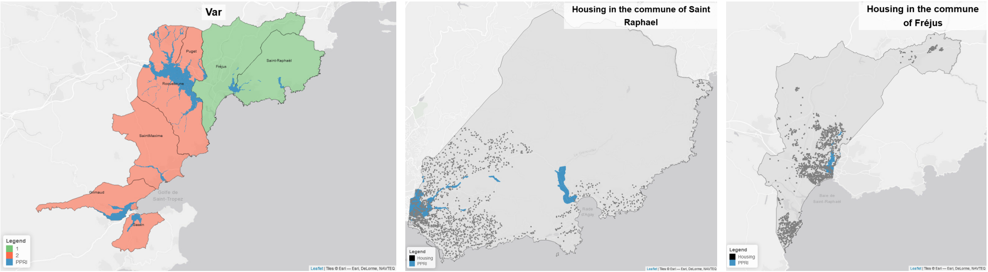


See https://github.com/freakonometrics/floods

Flood Risk in France [6]

10% of households represent 73.6% of the losses... who lives in those risky areas ?

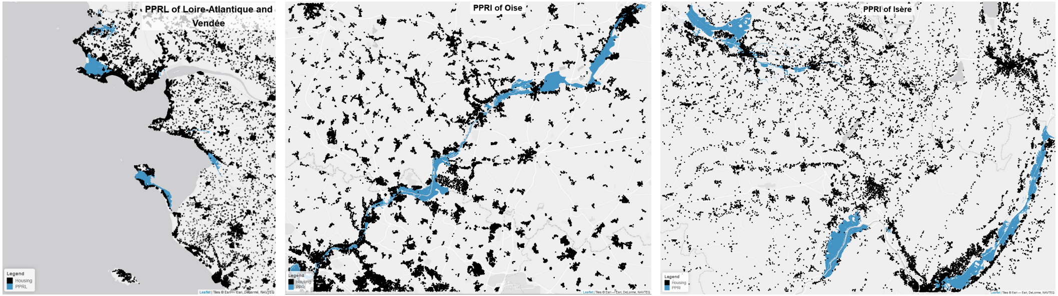
“ventes de biens fonciers” dataset, https://cadastre.data.gouv.fr/dvf, 2014-2018,



(possible bias on those 5-year notarial transactions...)

Flood Risk in France [7]

E.g. in 4 “departements” (Loire-Atlantique, Vendée, Oise, Isère)



- sold houses / apartments, ■ PPRI-PPRL areas

Flood Risk in France [8]

Table 1: coastal risk areas vs. Table 2: overflow / non-costal risk areas

			Average Price	Difference (%)	Maximum Price	Number	Proportion (%)	Welch t test
Vendée	Non risky	Apartments	4293		21840	329	9%	
		Houses	2928		65909	2795	74%	
	Risky	Apartments	3302	-23%	9773	39	1%	1.0
		Houses	10253	+250%	71483	637	17%	-60.1
Pays-Loire	Non risky	Apartments	4399		79913	8411	37%	
		Houses	3019		75472	12678	55%	
	Risky	Apartments	6784	+54%	68478	1001	4%	-8.6
		Houses	3245	+7%	22895	765	3%	-2.7

Table 1: Prices (€ per m^2) of houses sold (2014-2018) for Vendée - Western part of France, with PPRL (coastal risk). The *Difference* is the relative difference between average prices (per m^2) between the risky and the non-risky zones, either for apartments or houses.

Flood Risk in France [9]

			Average Price	Difference (%)	Maximum Price	Number	Proportion (%)	Welch t value
Var	Non risky	Apartments	5392			9874	53%	
		Houses	5957			6913	37%	
	Risky	Apartments	4190	-22%		1471	8%	6.4
		Houses	4172	-30%		226	1%	5.2
Haute Loire	Non risky	Apartments	2399		38333	3403	27%	
		Houses	1314		20625	8857	69%	
	Risky	Apartments	2163	-11%	28125	319	2%	1.6
		Houses	1247	-5%	7432	272	2%	0.9
Seine et Marne	Non risky	Apartments	6260		79710	82133	44%	
		Houses	3356		79167	98824	53%	
	Risky	Apartments	4333	-30%	40000	2177	1%	8.0
		Houses	2693	-20%	54096	1784	1%	7.5

Flood Risk in France [10]

			Average Price	Difference (%)	Maximum Price	Number	Proportion (%)	Welch t value
Isère	Non risky	Apartments	4960		79800	27982	52%	
		Houses	2429		69375	24600	45%	
	Risky	Apartments	3252	-3%	35714	885	2%	6.1
		Houses	2543	+5%	14067	435	1%	-1.2
Oise	Non risky	Apartments	6170		79963	24613	34%	
		Houses	3126		78214	44737	62%	
	Risky	Apartments	5725	-7%	50000	1385	2%	2.1
		Houses	2866	-8%	62184	1640	2%	4.6

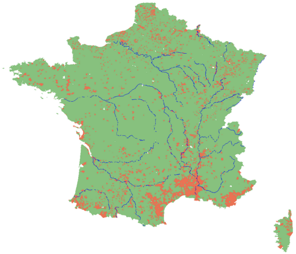
Table 2: Prices (€ per m^2) of houses sold (2000-2020) for several départements in France, with PPRI (overflow risk, or non-costal).

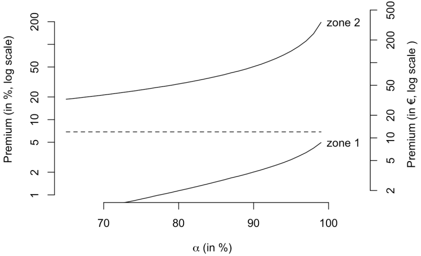
Flood Risk in France [11]

2 zone model, $\alpha \in [0\%, 100\%]$,

- zone 1, proportion α, less risky
- zone 2, proportion $1-\alpha$, more risky

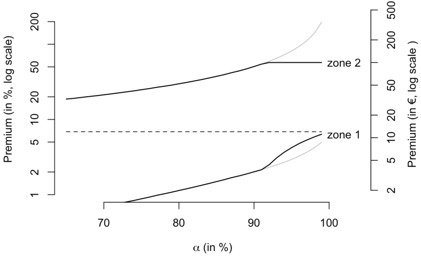
so called "*Will Rogers phenomenon*",
When the Okies left Oklahoma and moved to California, they raised the average intelligence level in both states.





$\alpha = 90\%$, less risky,
26.4% of losses, 3.5€

$1-\alpha = 10\%$, more risky,
73.6% of losses, 88.5€



Flood Risk in France [12]

		Uniform			Two-Zone Model		
		Country	Region	Municipality	$\alpha = 95\%$	$\alpha = 90\%$	$\alpha = 80\%$
Var	Frejus	12.0€	30.6€	15.7€	5.1€	3.5€	52.1€
	Grimaud	12.0€	30.6€	84.3€	142.3€	88.5€	52.1€
	Puget	12.0€	30.6€	133.0€	142.3€	88.5€	52.1€
Pays Loire	Assérac	12.0€	3.6€	6.7€	5.1€	3.5€	2.0€
	Mesquer	12.0€	3.6€	10.2€	5.1€	3.5€	2.0€
	Le Croisic	12.0€	3.6€	25.9€	5.1€	88.5€	52.1€
Vendée	Talmont-Saint-Hilaire	12.0€	10.7€	4.8€	5.1€	3.5€	2.0€
	Noirmoutier-en-l'Île	12.0€	10.7€	8.5€	5.1€	3.5€	2.0€
	La Faute-sur-Mer	12.0€	10.7€	275.1€	142.3€	88.5€	52.1€

Table 3: Comparing premiums, in €, in nine cities, in Var, Pays-de-Loire and Vendée.

Flood Risk in France [13]

		Uniform			Two-Zone Model		
		Country	Region	Municipality	$\alpha = 95\%$	$\alpha = 90\%$	$\alpha = 80\%$
Var	Fréjus	6.9%	17.5%	9%	2.9%	2.0%	29.8 %
	Grimaud	6.9%	17.5%	48.2%	81.3%	50.6%	29.8 %
	Puget-sur-Argens	6.9%	17.5%	76.1%	81.3%	50.6%	29.8 %
Pays Loire	Assérac	6.9%	2%	3.8%	2.9%	2.0%	1.1 %
	Mesquer	6.9%	2%	5.8%	2.9%	2.0%	1.1 %
	Le Croisic	6.9%	2%	14.8%	2.9%	50.6%	29.8 %
Vendée	Talmont-Saint-Hilaire	6.9%	6.1%	2.7%	2.9%	2.0%	1.5 %
	Noirmoutier-en-l'Île	6.9%	6.1%	4.9%	2.9%	2.0%	1.1 %
	La Faute-sur-Mer	6.9%	6.1%	157.2%	81.3%	50.6%	29.8 %

Table 4: Comparing premiums, in percent of the household premium, in nine cities, in Var, Pays-de-Loire and Vendée.

Flood Risk in France [14]

		Hierarchical Model $\gamma = 20\%$			Hierarchical Model $\gamma = 40\%$		
		$\beta = 10\%$	$\beta = 20\%$	$\beta = 50\%$	$\beta = 10\%$	$\beta = 20\%$	$\beta = 50\%$
Var	Fréjus	14.7%	13.7%	12%	12.7%	12.0%	10.7 %
	Grimaud	17.8%	21.5%	27.7%	15.1%	17.8%	22.5 %
	Puget-sur-Argens	20.1%	27.1%	38.8%	16.8%	22.0%	30.8 %
Pays Loire	Assérac	3.2%	3.4%	3.7%	4.1%	4.2%	4.5 %
	Mesquer	3.3%	3.8%	4.5%	4.2%	4.5%	5.1 %
	Le Croisic	4.0%	5.6%	8.1%	4.7%	5.9%	7.8 %
Vendée	Talmont-Saint-Hilaire	6%	5.6%	4.9%	6.2%	5.9%	5.4 %
	Noirmoutier-en-l'Île	6.2%	6.0%	5.8%	6.3%	6.2%	6.0 %
	La Faute-sur-Mer	18.3%	36.5%	66.7%	15.5%	29.1%	51.7 %

Table 5: γ: national, $(1-\gamma)\beta$: municipality.

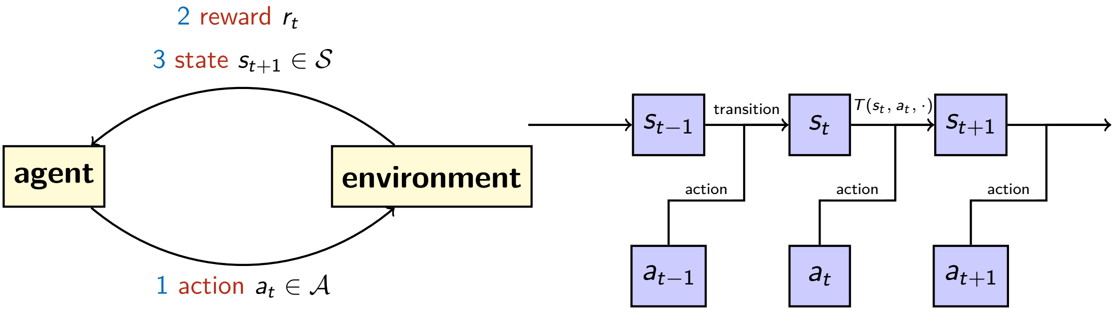
Flood Risk in France [15]

- Tradeoff: risk vs. welfare / wealth
- Prevention cannot be done at the individual level, even cities...
- Hierarchical approach: city / region / country

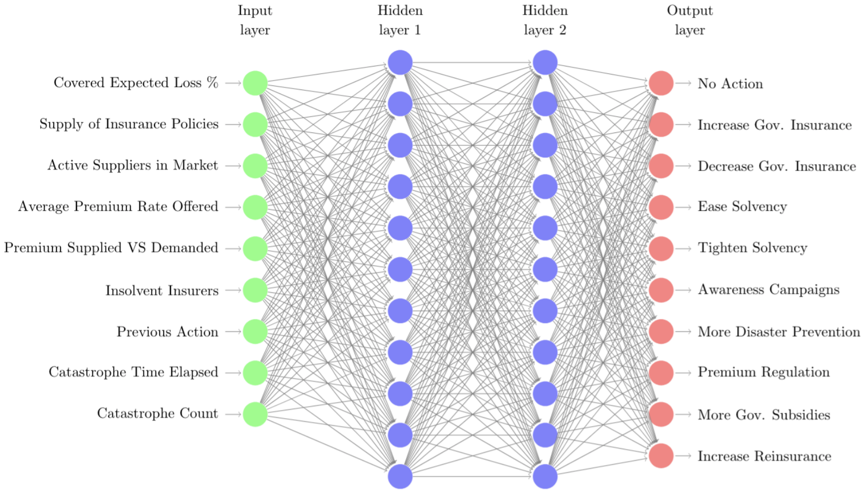
A. Charpentier, L. Barry, and M. James. "Insurance against Natural Catastrophes: Balancing Actuarial Fairness and Social Solidarity". In: *Geneva Papers on Risk & Insurance* (2021). DOI: 10.1057/s41288-021-00233-7.

On Government Intervention [1]

Joint work with Nouri Sakr (Columbia) and Mennatalla Mohamed Hassan (American University in Cairo).



On Government Intervention [2]



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- A. Charpentier. "Assurance et discrimination, quel rôle pour les actuaires ?" In: *Risques* (2021).

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- A. Charpentier, L. Barry, and M. James. "Insurance against Natural Catastrophes: Balancing Actuarial Fairness and Social Solidarity". In: *Geneva Papers on Risk & Insurance* (2021). DOI: 10.1057/s41288-021-00233-7.
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- A. Charpentier, R. Élie, and C. Remlinger. "Reinforcement Learning in Economics and Finance". In: *Computational Economics* (2021). DOI: 10.1007/s10614-021-10119-4.
- A. Charpentier and E. Flachaire. "Pareto models for risk management". In: *Recent Econometric Techniques for Macroeconomic and Financial Data*. Ed. by G. Dufrénot and T. Matsuki. Springer Verlag, 2021.

References [3]

A. Charpentier, M. Hassan, and N. Sakr. "Government Intervention in Society Under Catastrophe Risk: A Reinforcement Learning Approach". In: Journal of Public Economics (submitted) (2022).

X. Landes. "How fair is actuarial fairness?" In: *Journal of Business Ethics* 128.3 (2015), pp. 519–533.

A. Maynard. "Pricing, insurance and the National Health Service". In: *Journal of Social Policy* 8.2 (1979), pp. 157–176.