



**Cass Business School**  
CITY UNIVERSITY LONDON

# Model Risk Cultures

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# Acknowledgments

- Institute and Faculty of Actuaries WP on Model Risk
  - A Aggarwal, MB Beck, M Cann, T Ford, D Georgescu, N Morjaria, AD Smith, Y Taylor, AT, L Witts, I Ye
  - M Thompson, IIASA
- Output so far
  - *Model Risk: Daring to Open the Black Box – BAJ*
  - *Taming Uncertainty: The Limits to Quantification – ASTIN*

# Literatures

- Quantitative
  - Cairns (2000), Danielsson (2002), Cont et al. (2010), Bignozzi & T (2014a,b), Cambou and Filipović (2014), Barrieu & Scandolo (2015)
- Environmental & systems science
  - Holling (1973), Funtowicz & Ravetz (1990), Beck (2014)
- **Anthropology & sociology of finance**
  - **Thompson et al (1990)**, Power (2009), Mikes (2011), Ingram et al (2012), McKenzie & Spears (2014), Jarzabkowski et al. (2015)

# What is model risk?

(Federal Reserve, SR Letter 11-7, 2011)

***[T]he potential for adverse consequences from decisions based on incorrect or misused model outputs and reports.***

*Model risk occurs primarily for two reasons:*

- *The model may have **fundamental errors** and may produce inaccurate outputs when viewed against the design objective and intended business uses. [...]*
- *The model may be **used incorrectly** or inappropriately.*

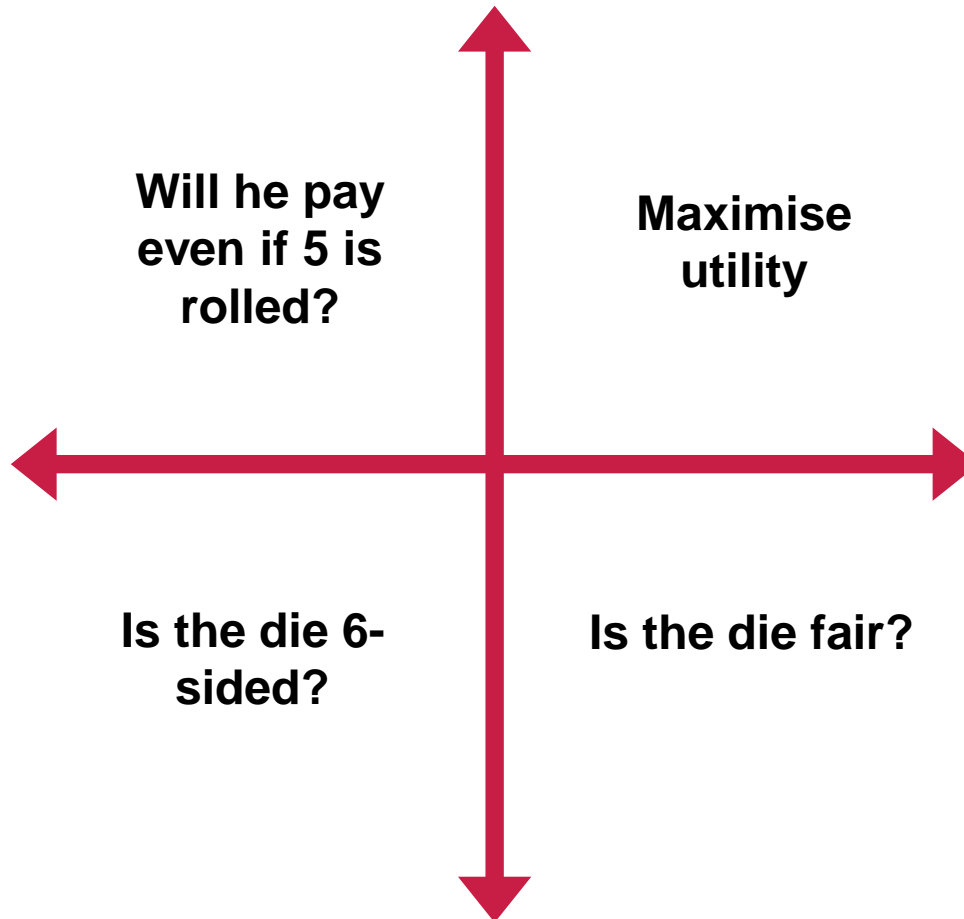
# Implicit assumptions

- Agreed-upon decision rule, mechanically followed
- “Correct model” (or something close to it) exists and is attainable
- Quantifiable financial impact of model error
- Risk is exogenous

# A game

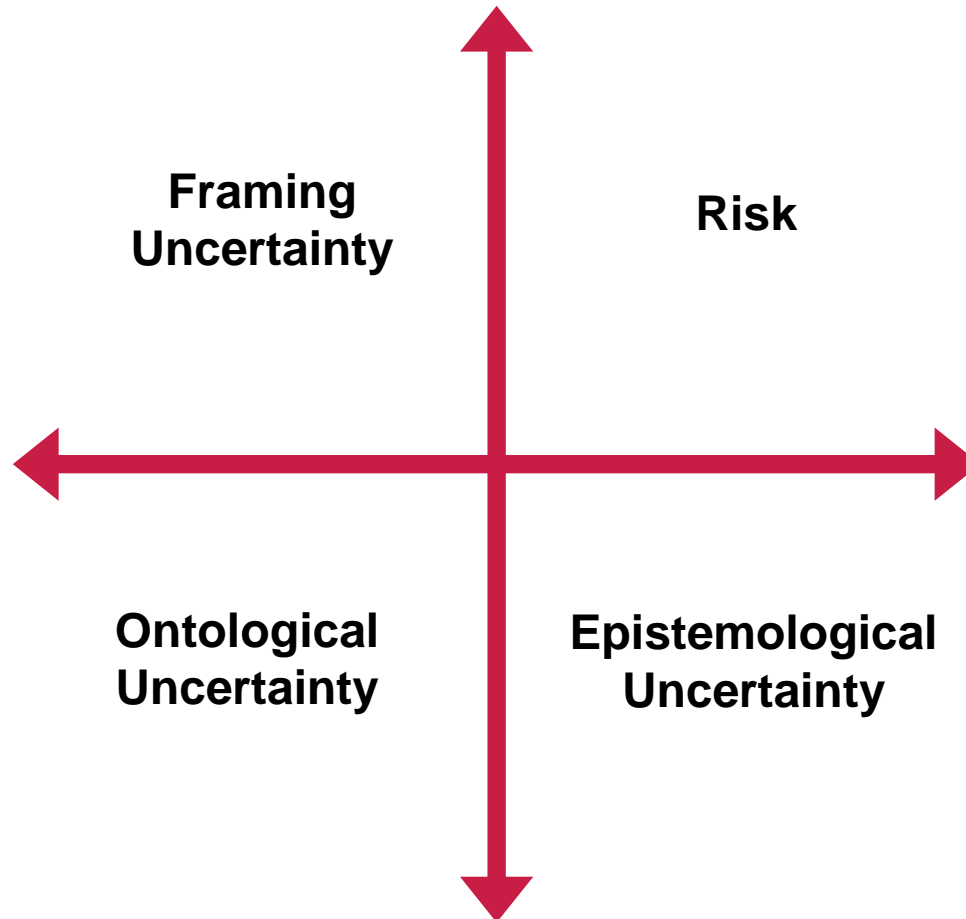
- I will roll a die
- If you roll a 5, I give you £10m
- Otherwise you give me £1m
  
- Should you take the bet?

# How to respond?



# Uncertainties

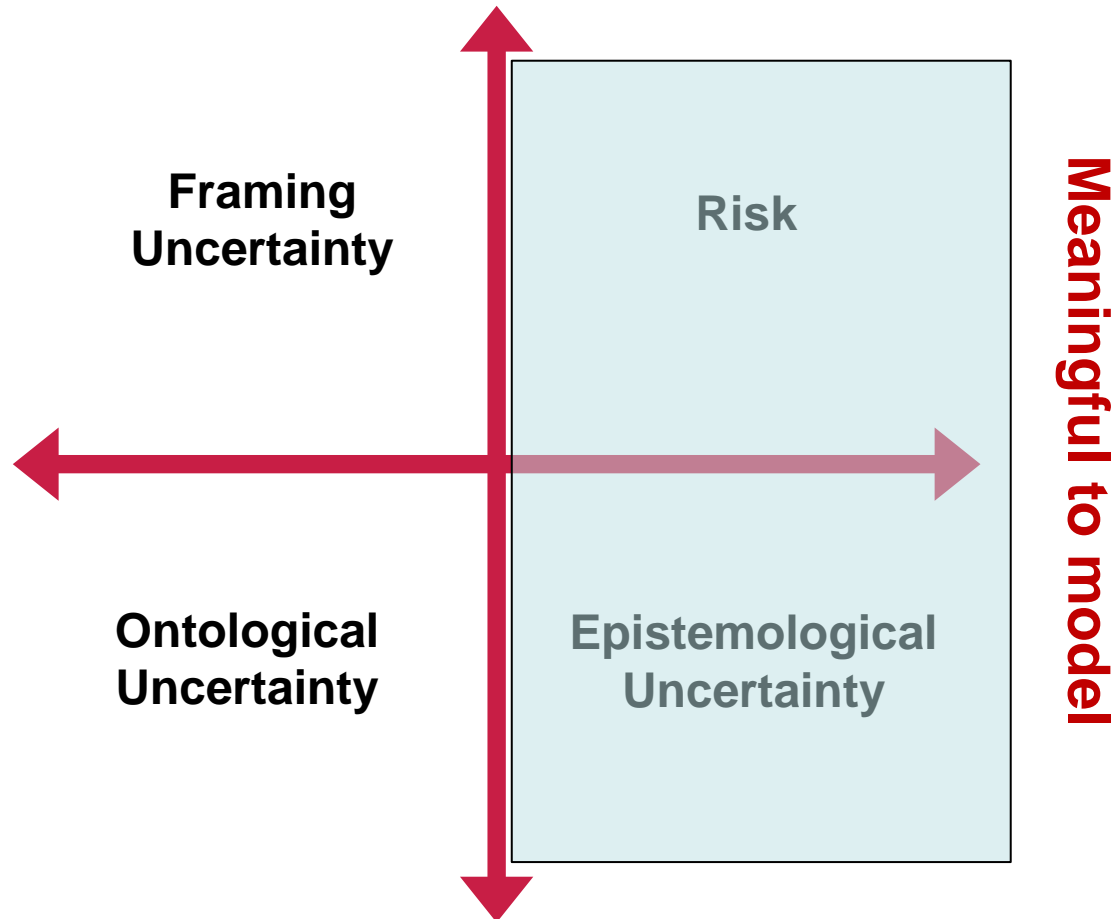
Knight (1921), Lane & Maxfield (2005), Skidelsky (2009)





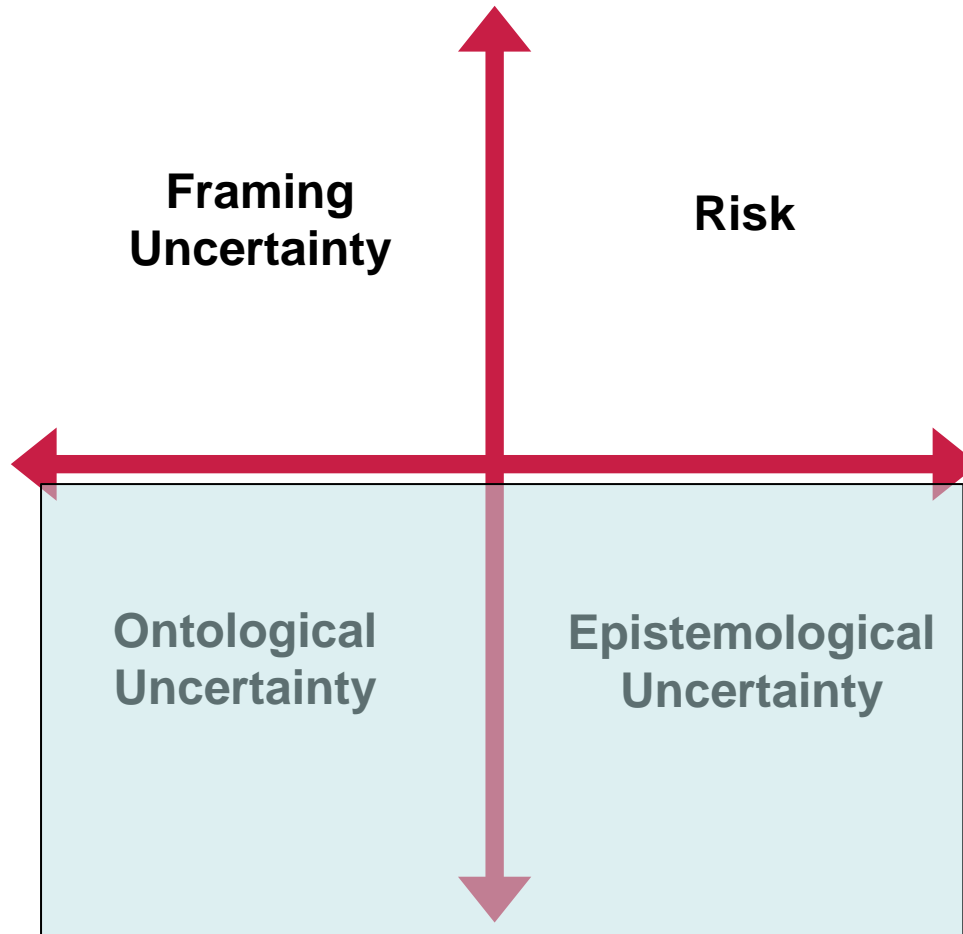
# Uncertainties

Knight (1921), Lane & Maxfield (2005), Skidelsky (2009)



# Uncertainties

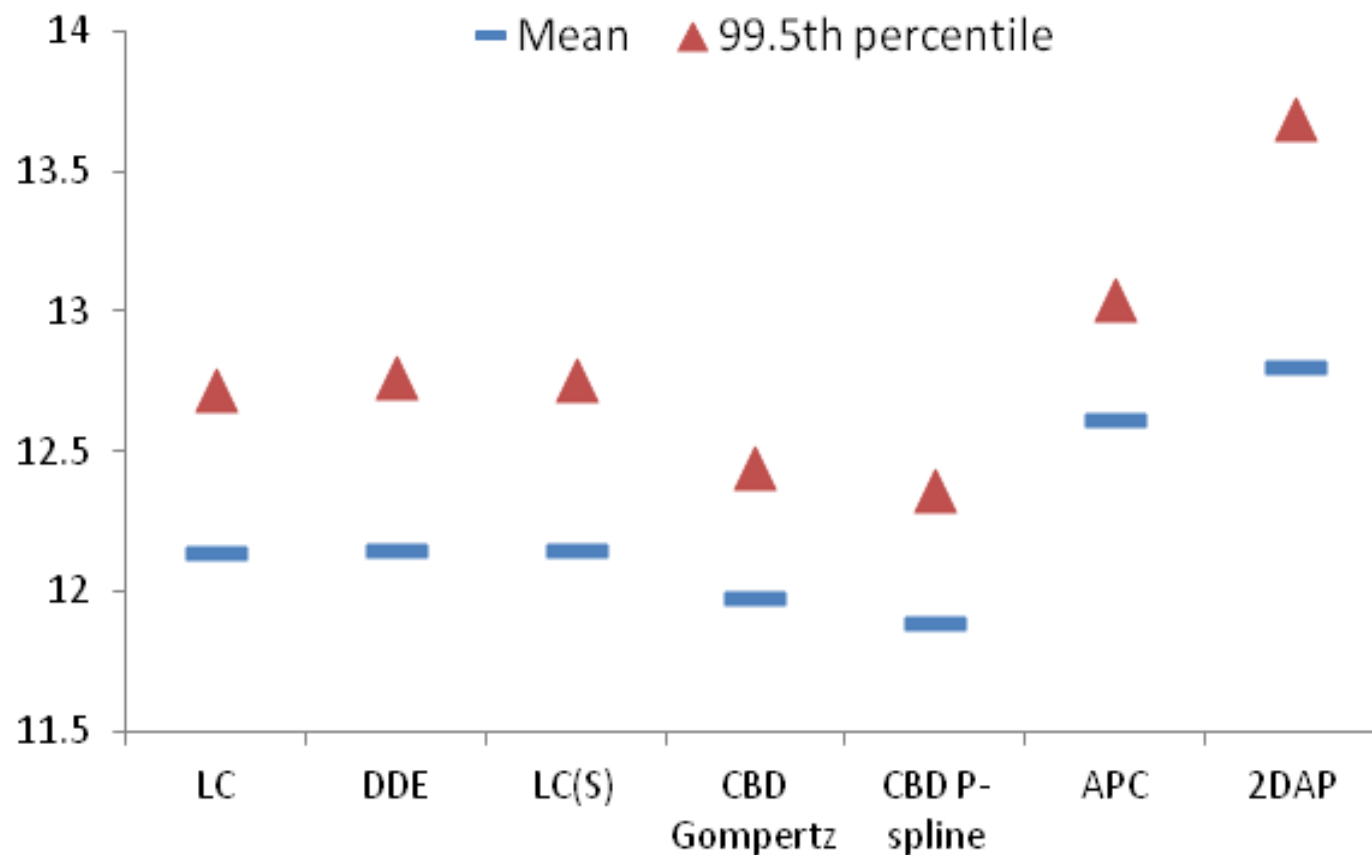
Knight (1921), Lane & Maxfield (2005), Skidelsky (2009)



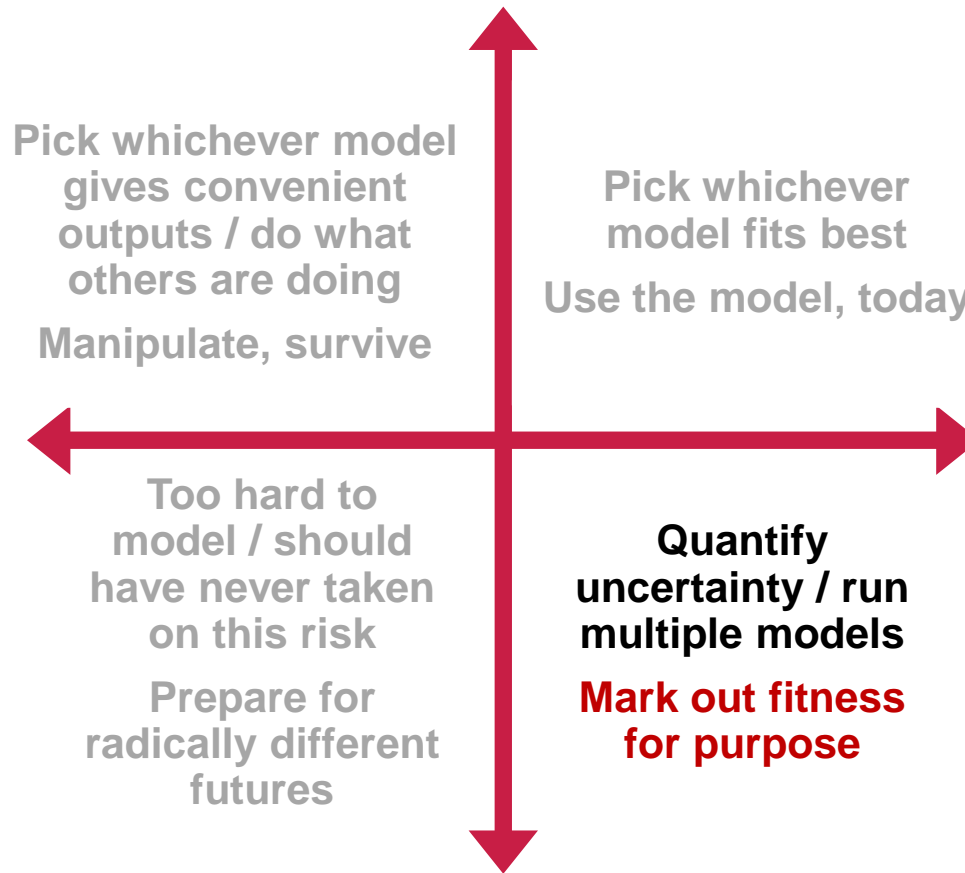
**Worried about model uncertainty**

# Sensitivity of annuity value to model choice

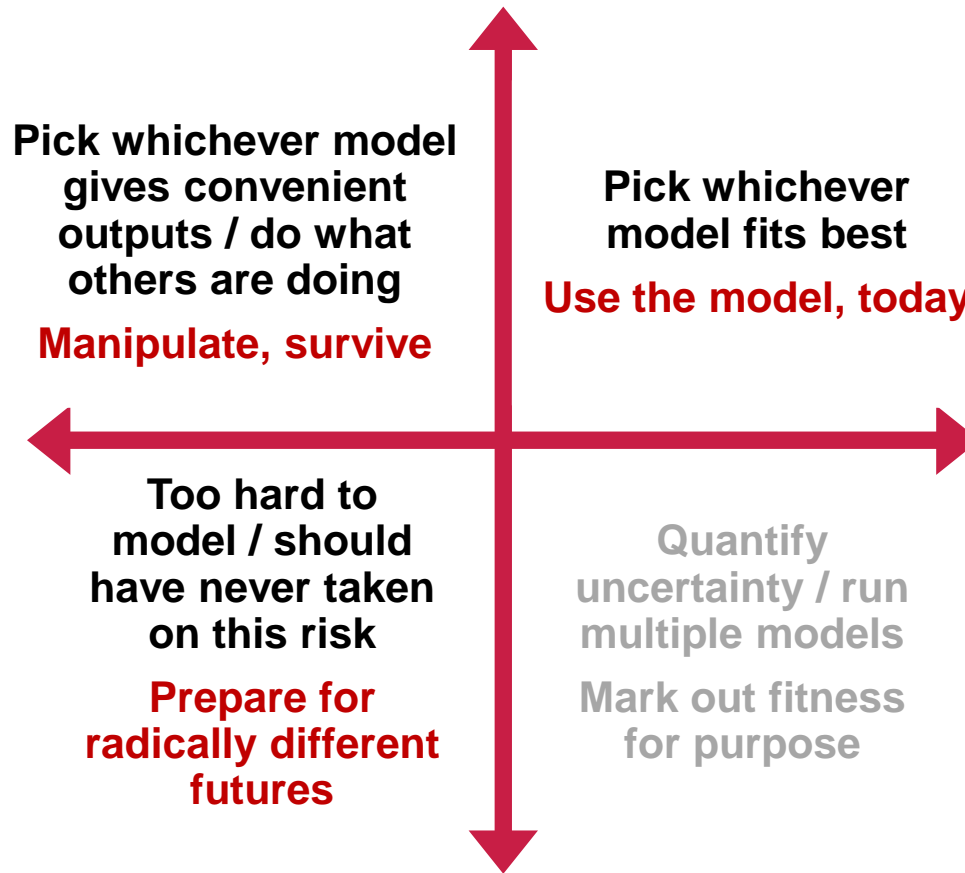
(70 year old male, discount at 3%; Richards et al, 2013)



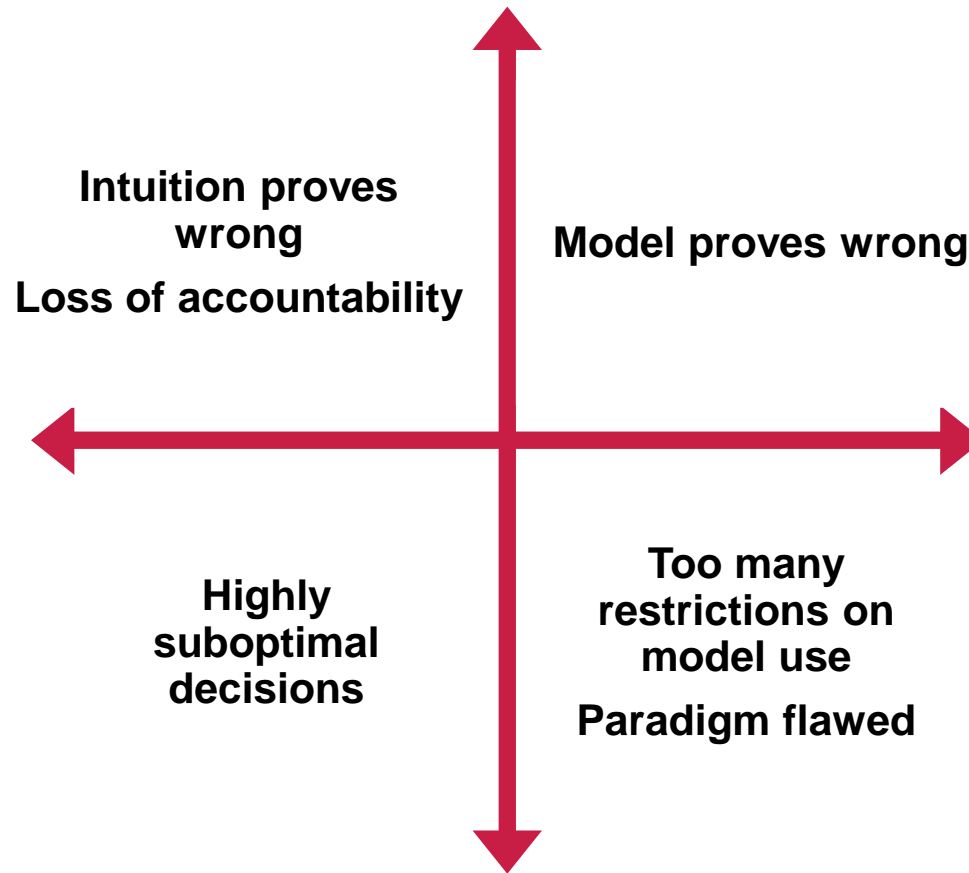
# How to respond



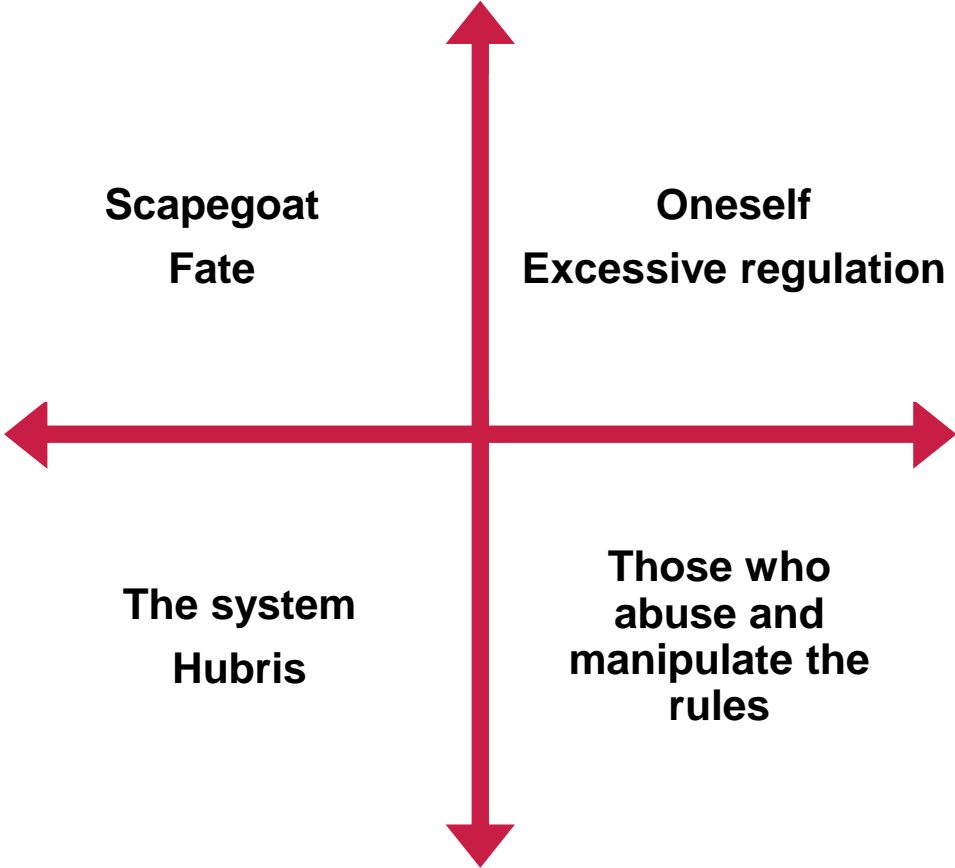
# How to respond



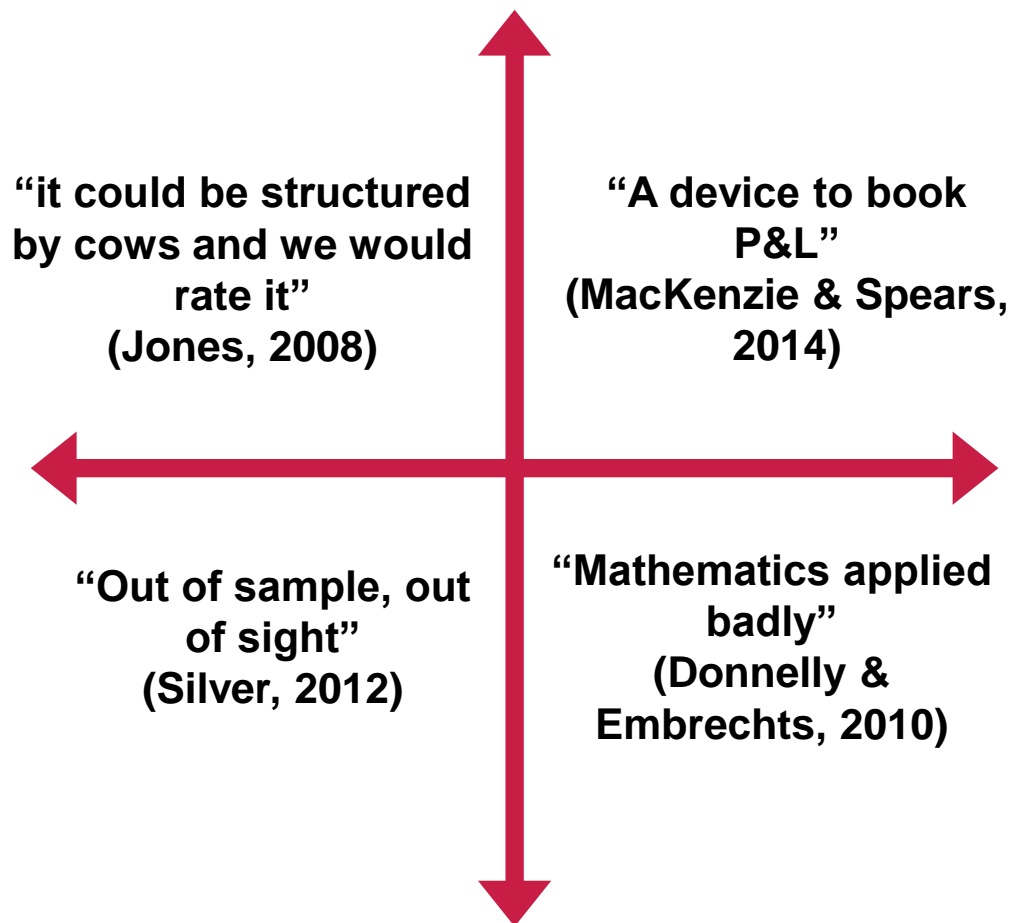
# (Non-)Model Risks



# Blame

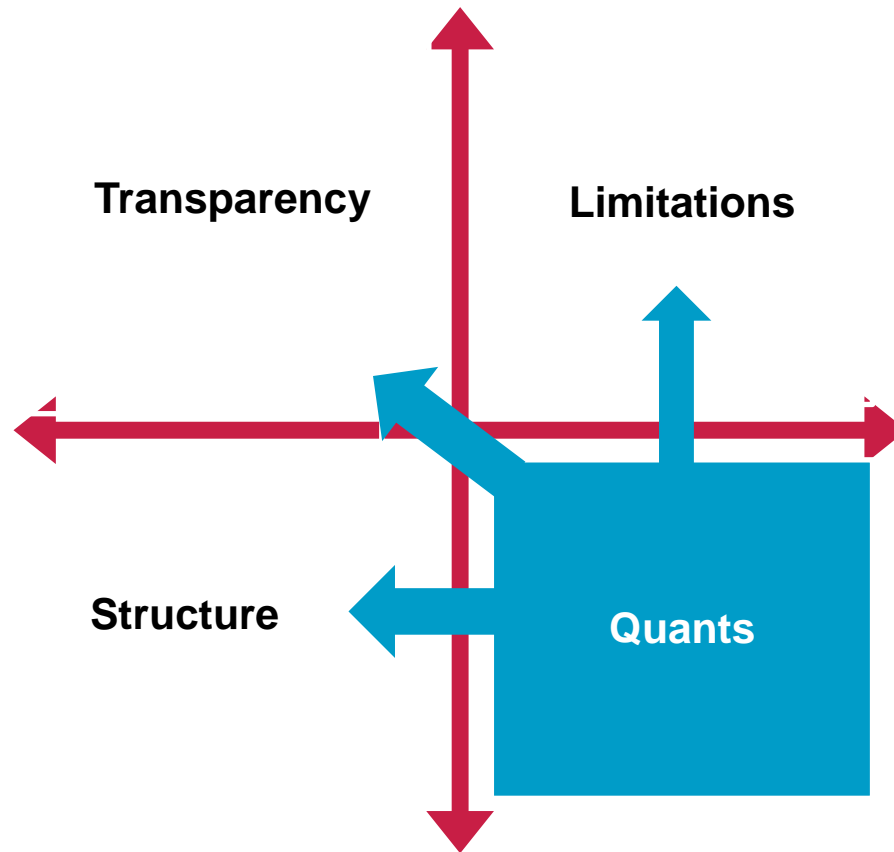


# Gaussian copulas, CDOs and the crisis

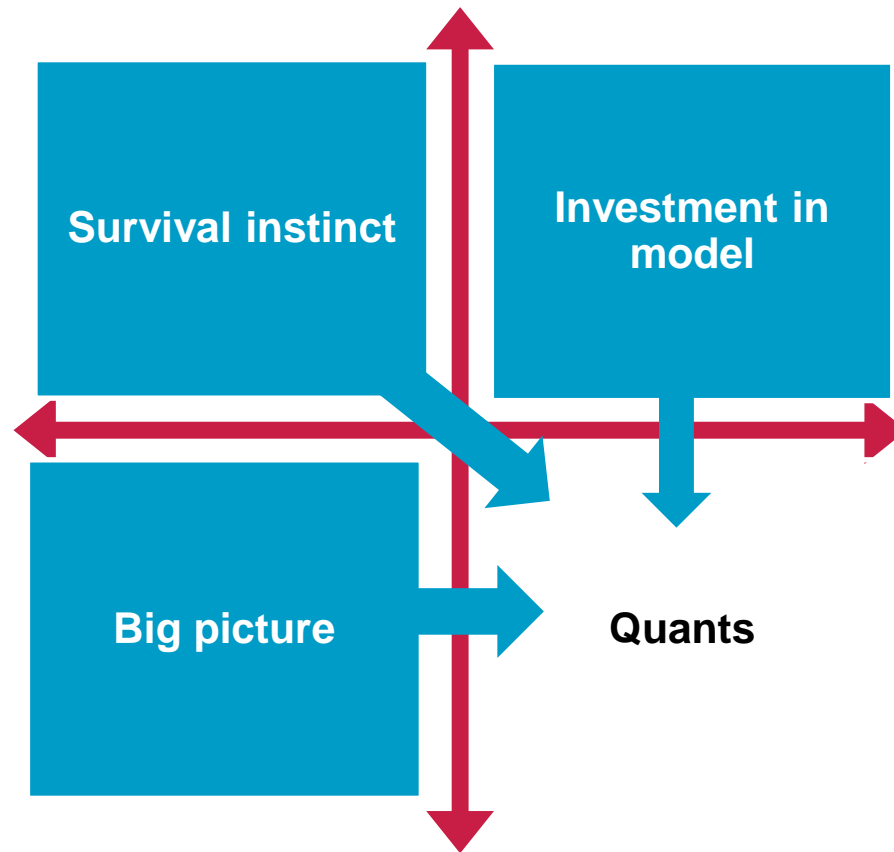




# Governance: what “we” offer to “them”



# Governance: what “they” offer to “us”



## What regulators say (1)

*A guiding principle for managing model risk is "effective challenge" of models, that is, critical analysis by **objective, informed parties** [...]*

***Unexpectedly large changes in outputs in response to small changes in inputs** can indicate an unstable model.[...] If testing indicates that the model may be inaccurate or unstable [...], management should consider modifying certain model properties. [...], placing **limits on model use**, or developing a new approach.*

(Federal Reserve, SR Letter 11-7, 2011)

## What regulators say (2)

*A useful starting point might be to take a more sceptical view of the role and robustness of internal risk models in the regulatory framework. [...]*

*Only by **removing internal models from the regulatory framework** can [simplifying the regulatory architecture] be achieved. As an alternative foundation stone, simplified, standardised approaches [...] could be used.*

(Haldane and Madouros, The Dog and the Frisbee, 2012)

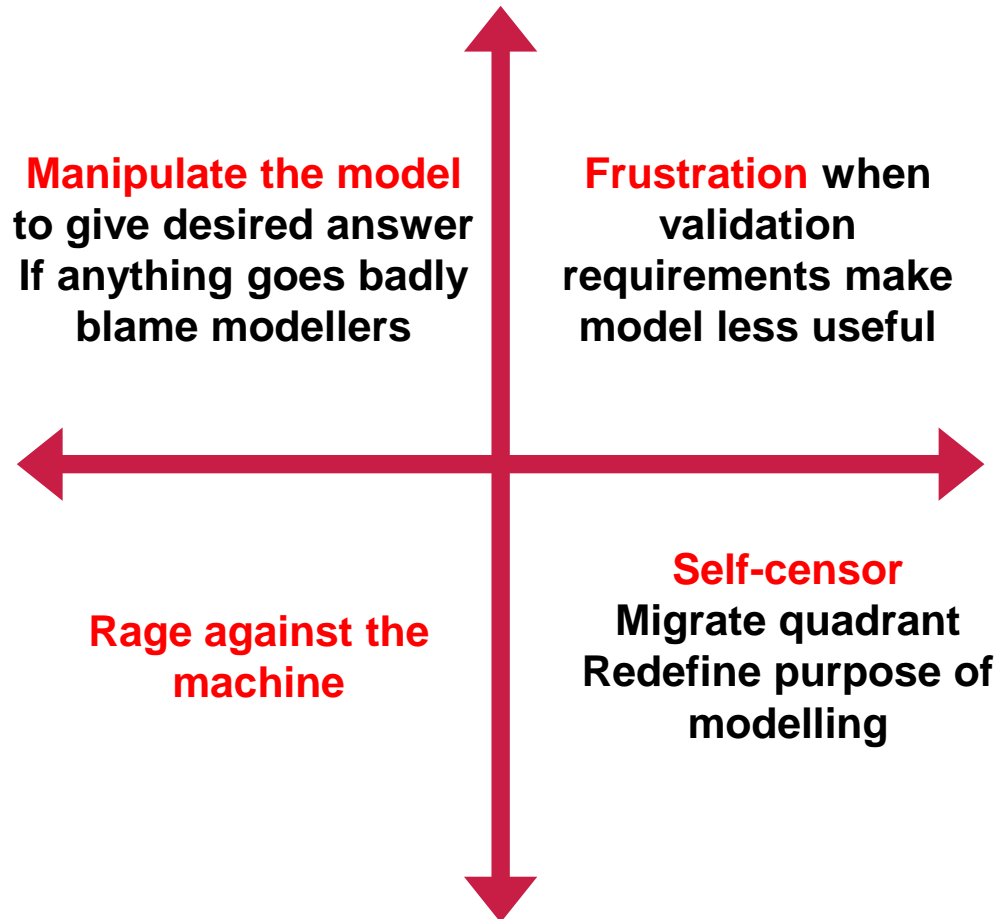
## What regulators say (3)

*Actuarial and statistical techniques shall only be considered adequate [if...]*

- *the outputs of the internal model are **stable** in relation to changes in the input data [...];*
- *the internal model captures **all the relevant characteristics** of the risk profile [...];*
- *the outputs of the internal model **do not include a material model error** [...]; the probability distribution forecast shall be adjusted to account for model and estimation errors.*

(Solvency II Delegated Acts, October 2014)

# Reactions to model-driven regulation



THANK YOU FOR YOUR ATTENTION!