Cass Business School
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Model Risk Cultures

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Acknowledgments

- M Bruce Beck, Warnell School of Forestry and Natural Resources, University of Georgia
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- The Model Risk Working Party of the Institute and Faculty of Actuaries

What is model risk?

Office of the Comptroller of the Currency (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**.*

Questions

- Are there model risks not associated with **model error**?
- How do different **ways of using** models generate model risks?
- What is the **upside** of model risk?
- What sorts of **governance** responses do different model uses/risks necessitate?
- And what of **Risk Culture**?

Types of model risk

- **Technical**
  - Coding errors, approximations
  - Arising from model uncertainty
- **Behavioural**
  - Information rejection
  - Loss of accountability
- **Systemic**
  - Market use of same models (CAT models, ESGs)
  - Endogenous model risks (VaR trading limits)
  - *Can also be result of model-free strategies*

Model uncertainty (A)

A. ***Model uncertainty*** *refers to all the possible ways in which the model used diverges from some true but unknown model of the process under consideration*

- Under definition ***A.,*** we cannot know the extent of model uncertainty, but we can sometimes make informed guesses

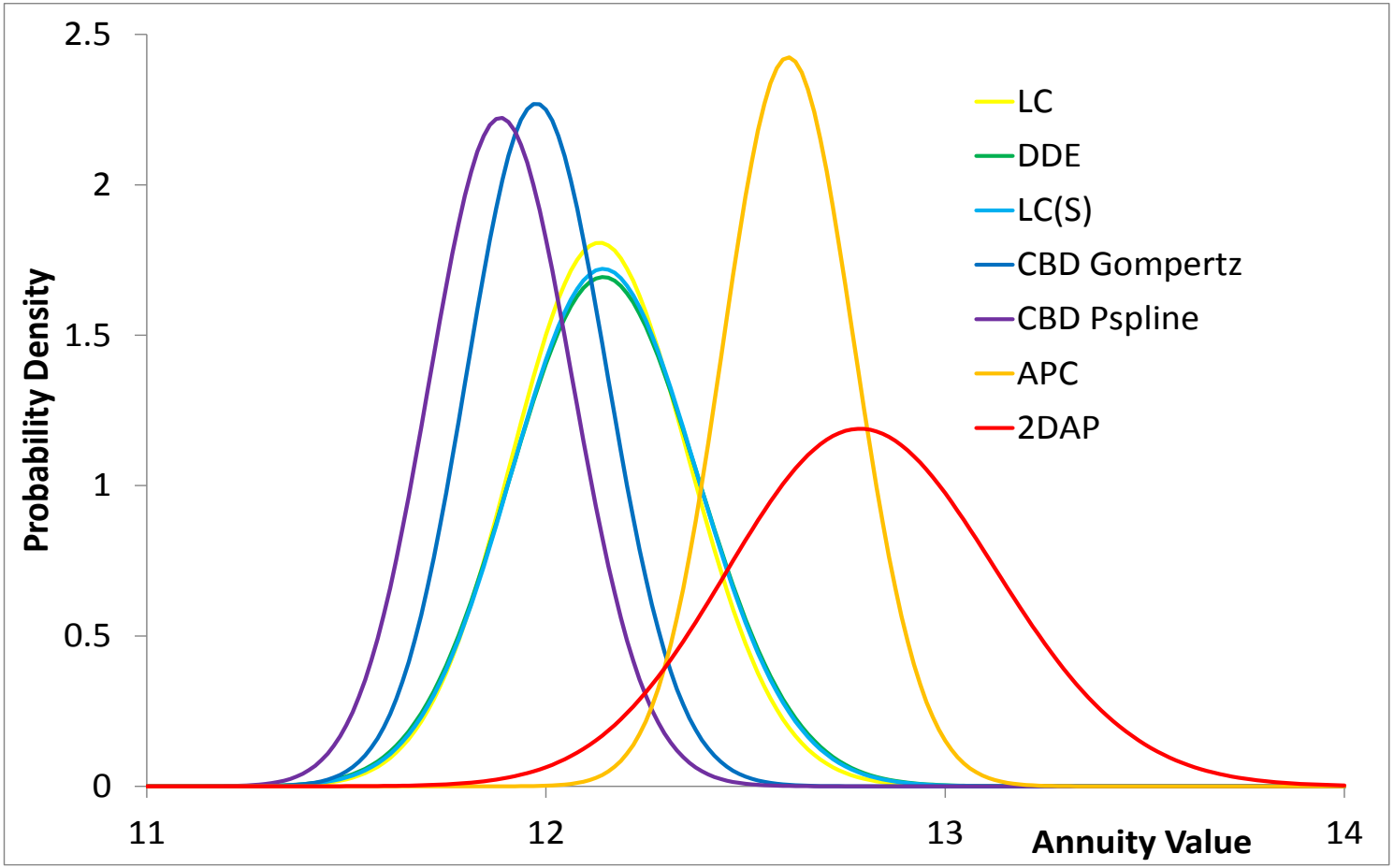
Model uncertainty (B)

B. ***Model uncertainty*** *refers to all the potential ways in which the model's inputs, outputs and structure may change under plausible changes in assumptions*

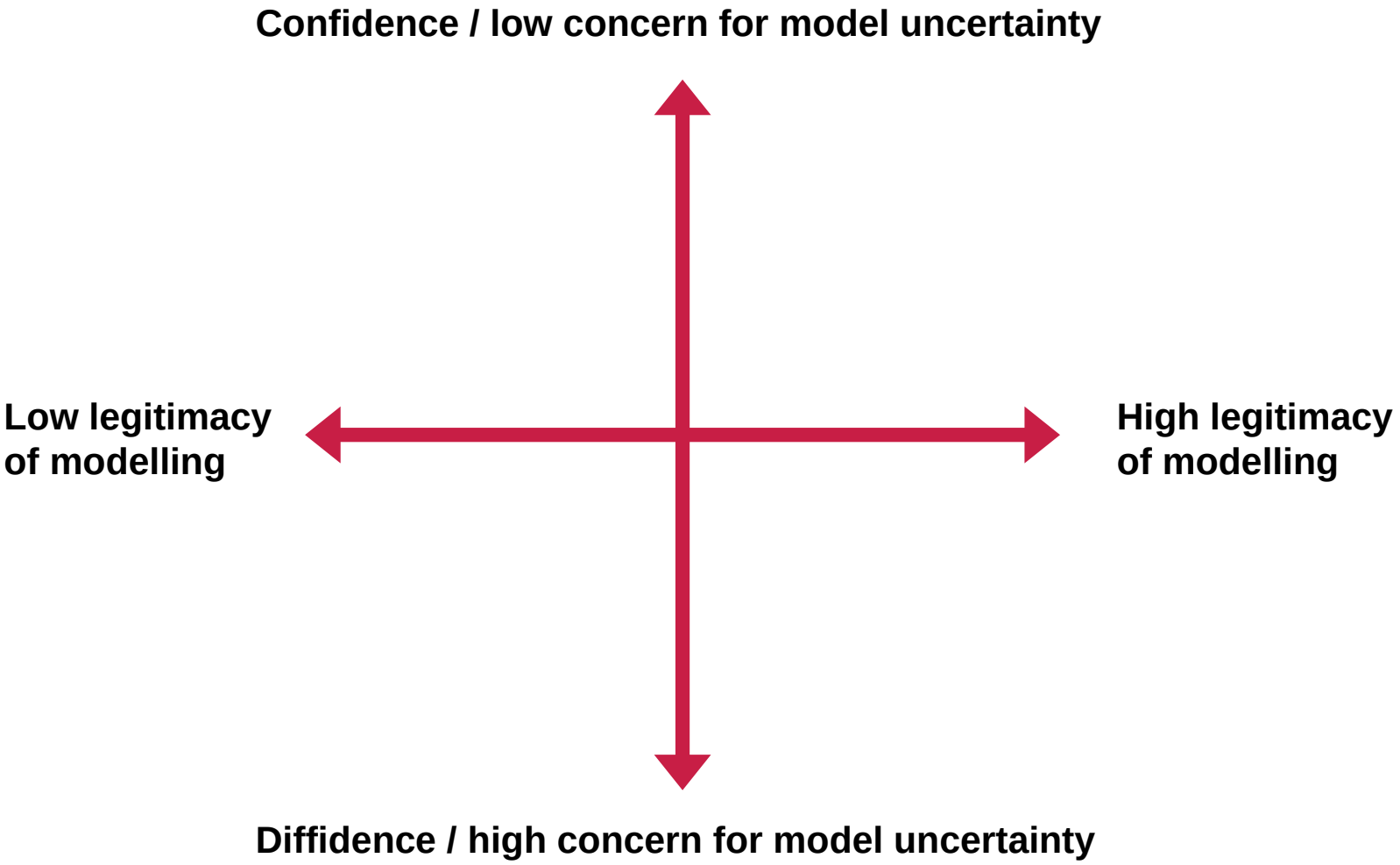
- Under definition ***B.,*** the extent of model uncertainty is revealed by **sensitivity analysis**
  - **Materiality** is application specific
  - **Plausibility** is not only a technical matter
  - See Beck (2014) for in-depth discussion

Sensitivity of annuity value to model choice

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



Perception of models



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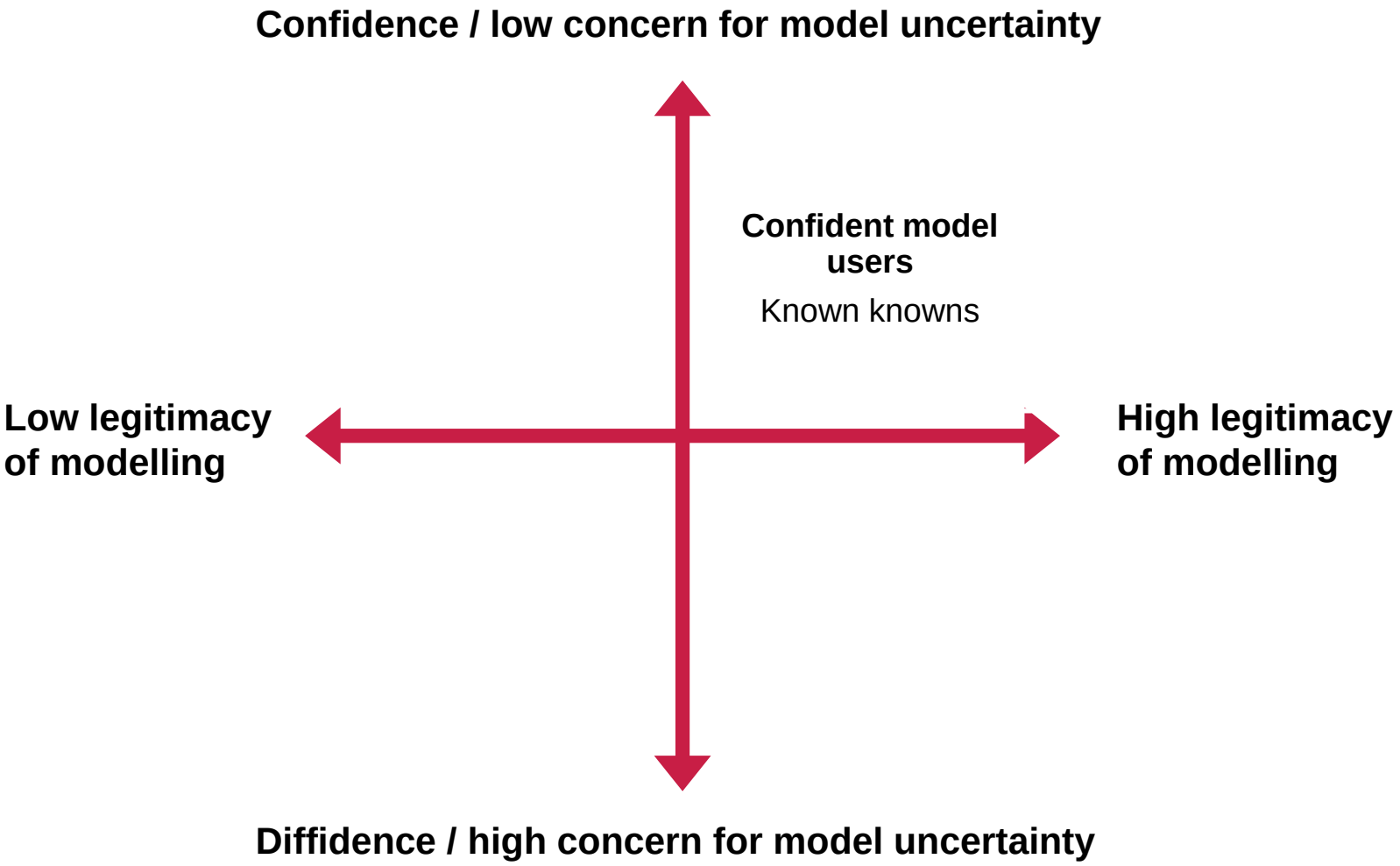

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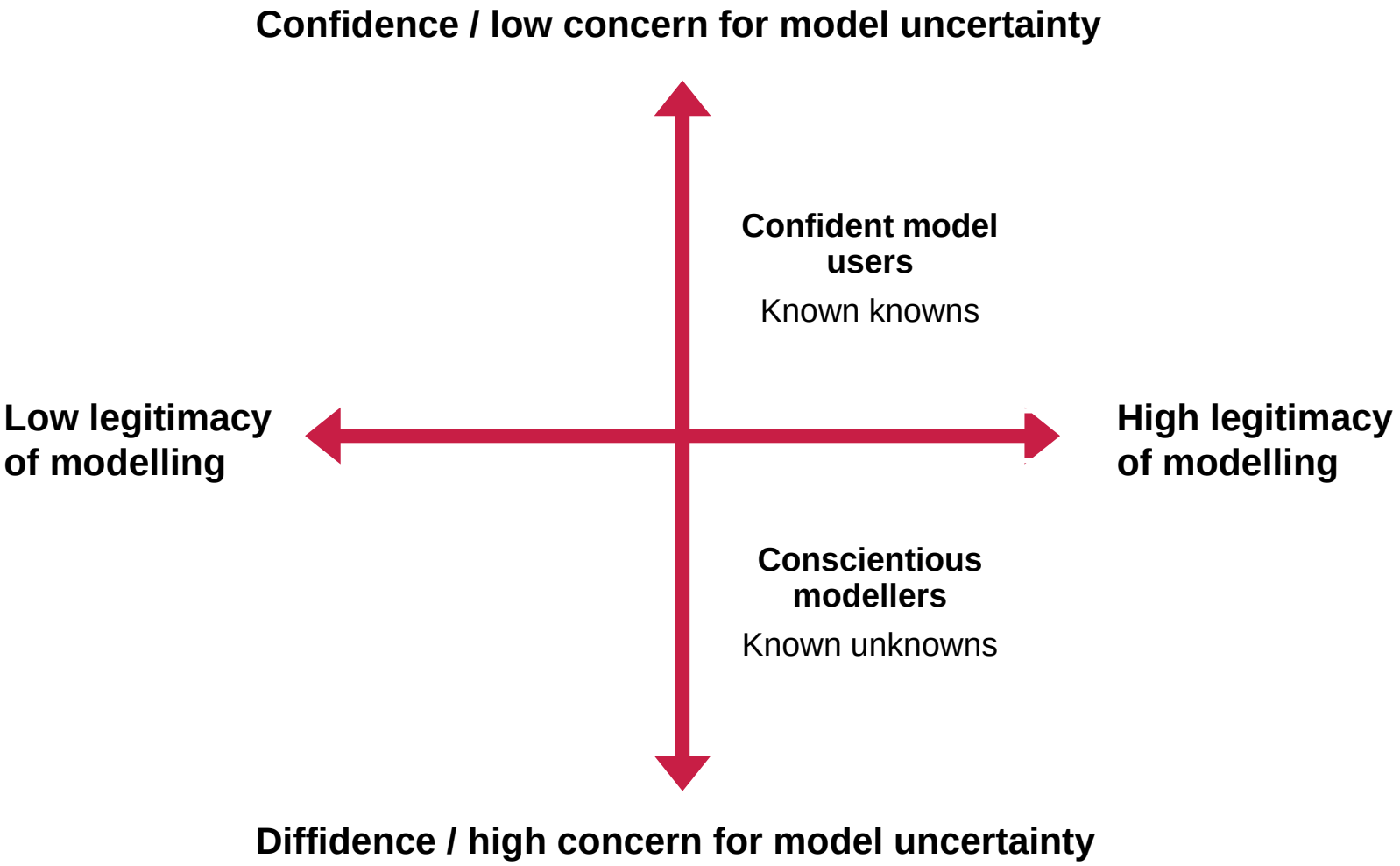

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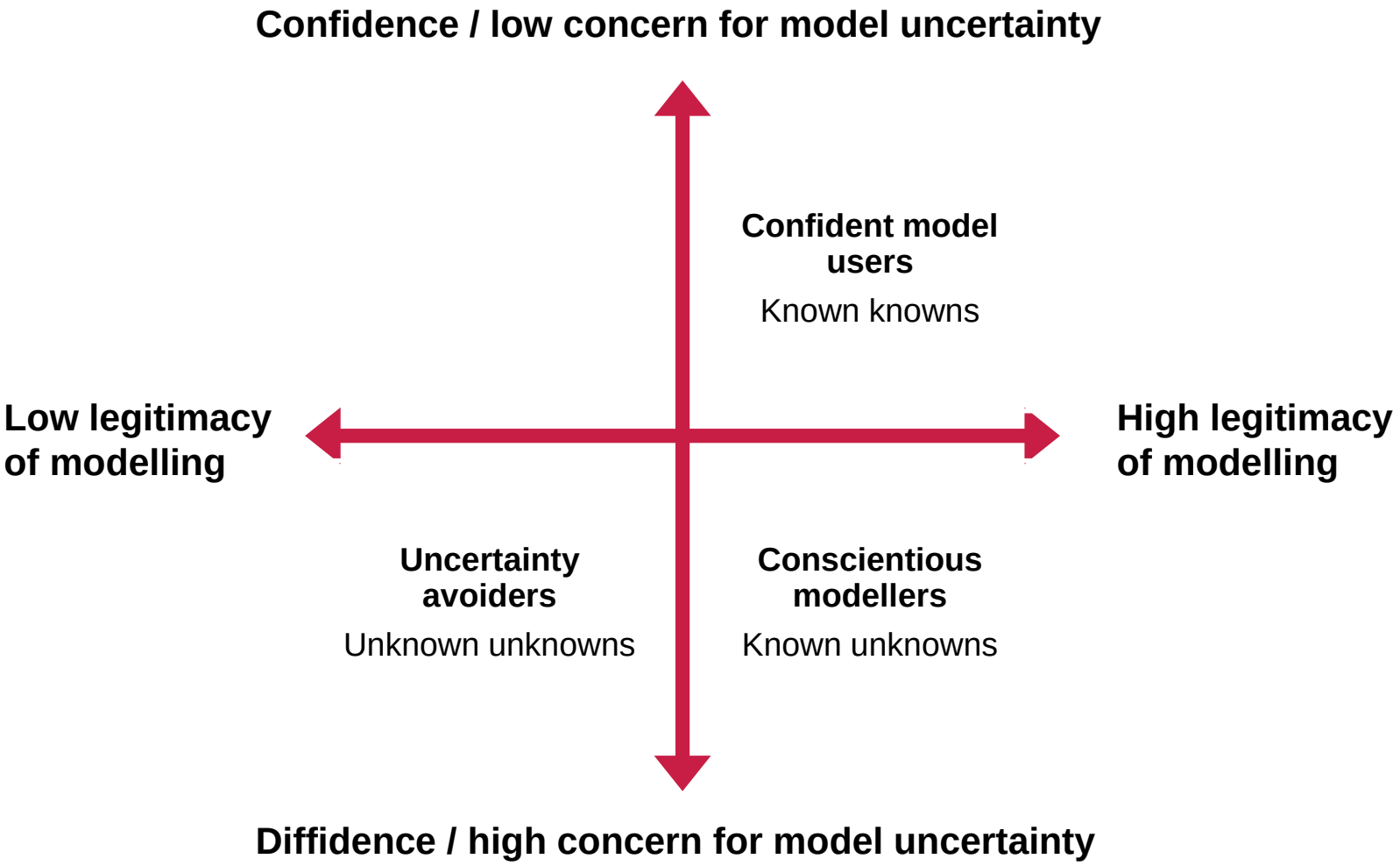

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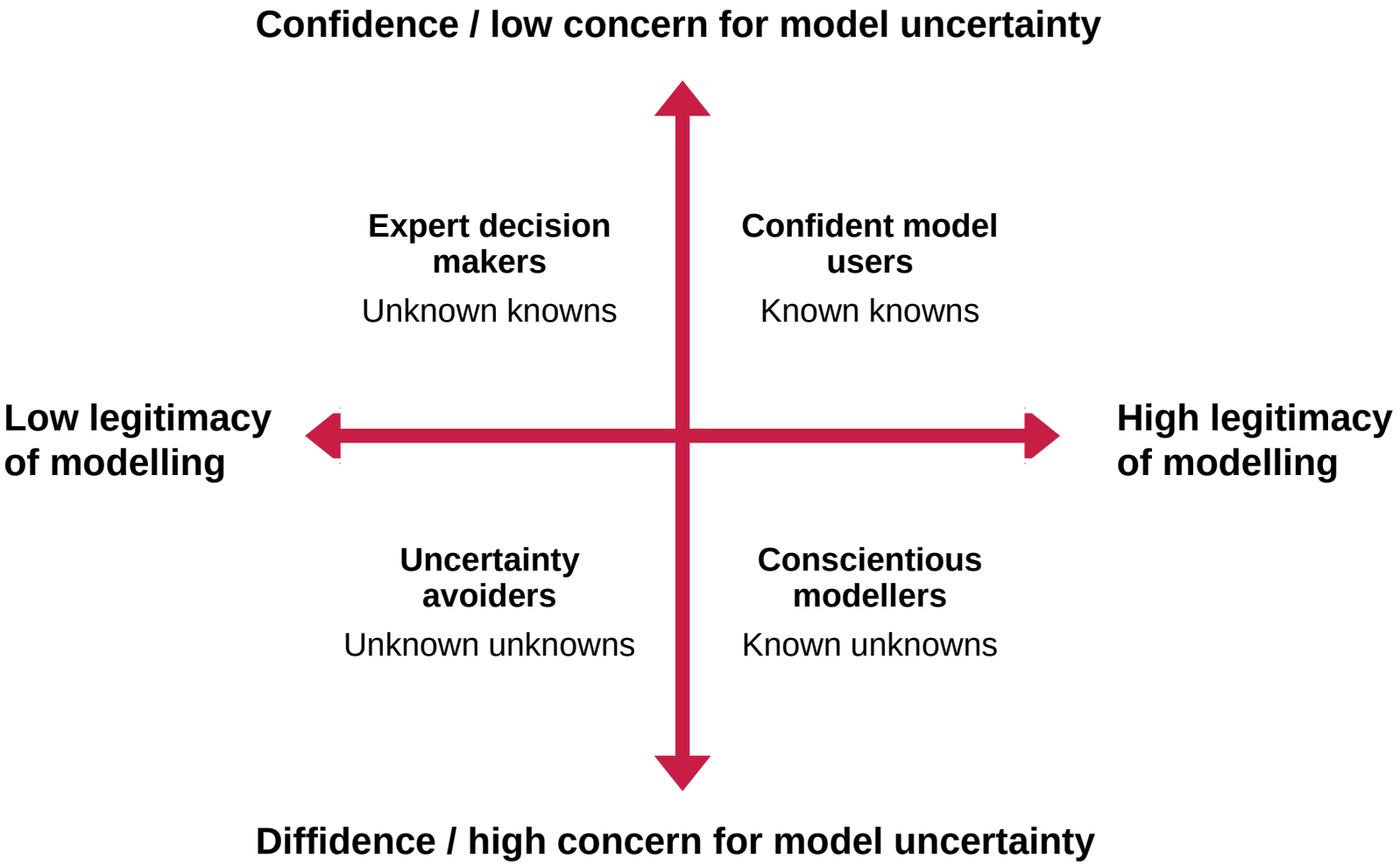
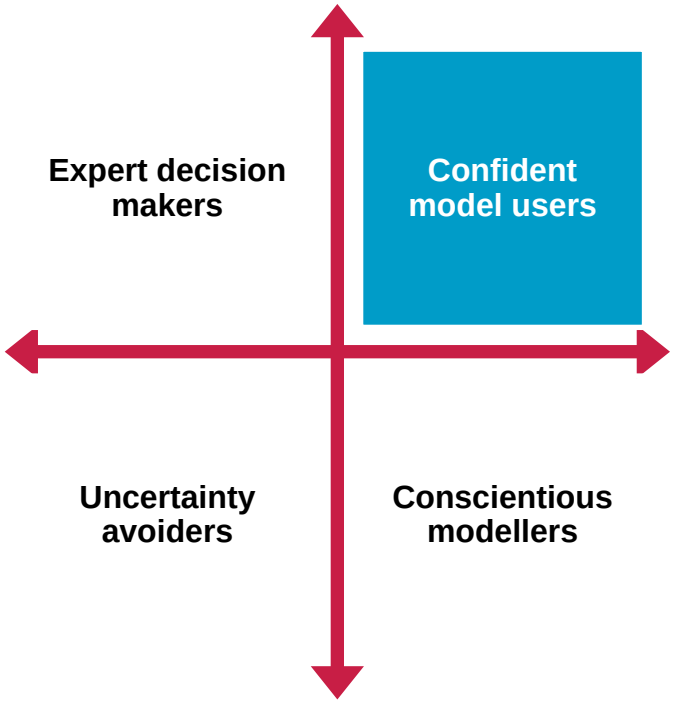


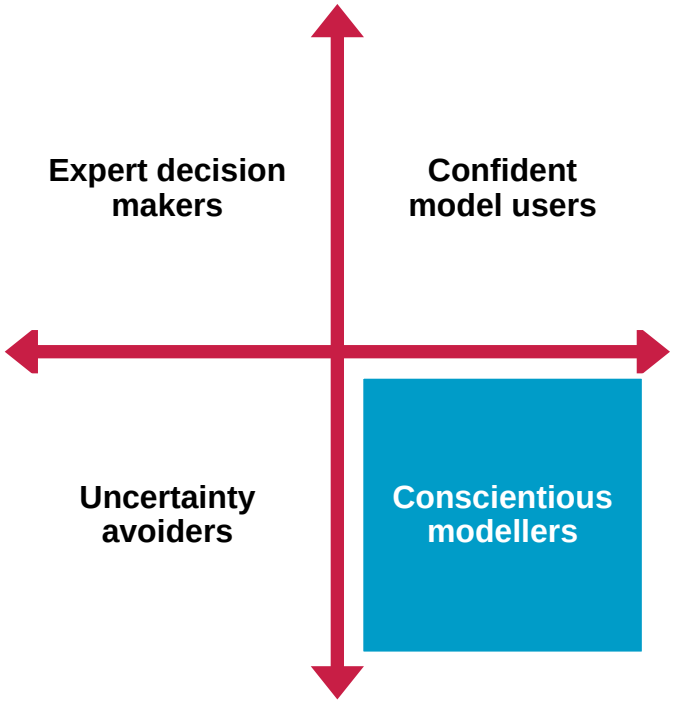
Confident model users: *optimality*

- Model drives decisions
- Focus on using model to identify and exploit opportunities
- Information discordant with model is ignored
- **Risk: world behaves very differently to what model predicts**



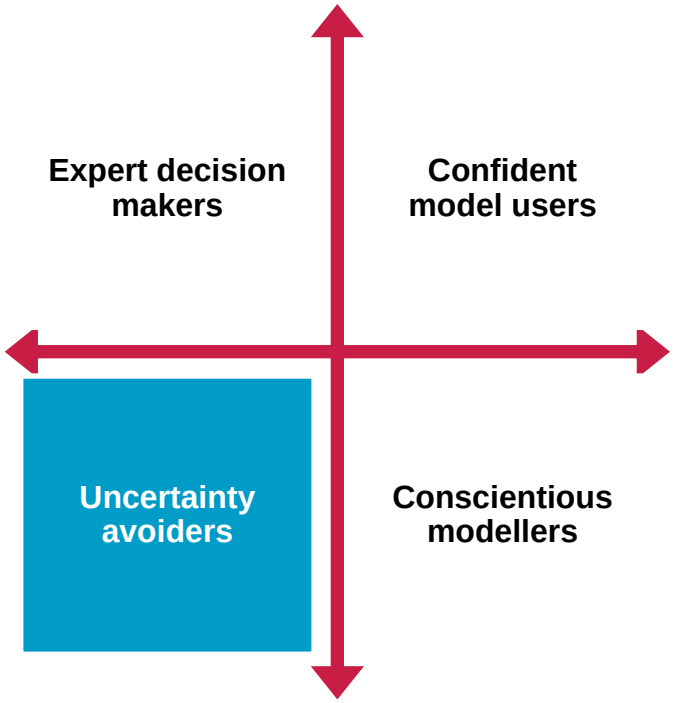
Conscientious modellers: *fitness for purpose*

- Model may inform some decisions but not others
- Focus on stating uncertainties / delimiting fitness of purpose
- While uncertainty is high, overall paradigm is appropriate
- **Risk: constraints on model use / suboptimal strategy**
- **Risk: paradigm is wrong**



Uncertainty avoiders: *robustness*

- Models are never good enough to drive decisions
- Focus on adverse scenarios, structural changes, interconnectedness of risks
- Conservative strategies that are robust to model uncertainty
- **Risk: highly suboptimal decisions**

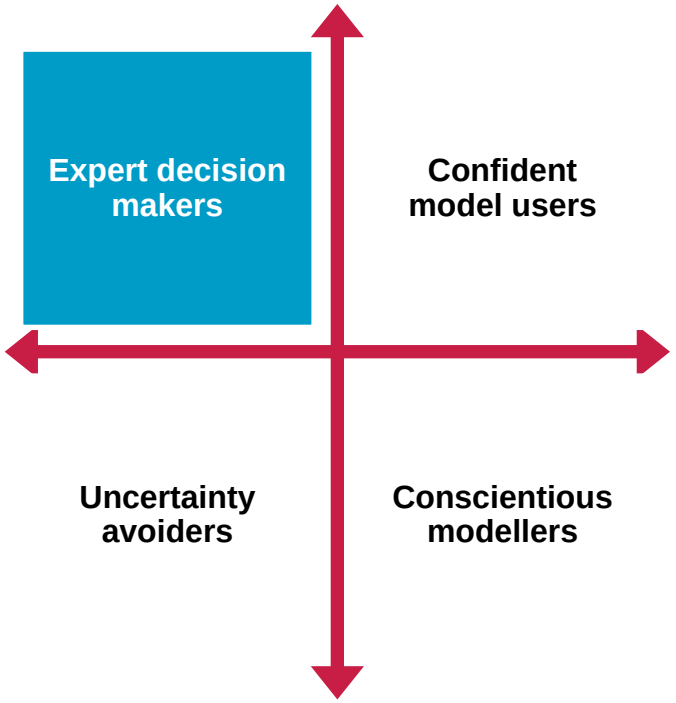


Expert decision makers: *intuition*

- Decisions driven by management expertise alone

  [But model may be manipulated to produce convenient answers]

- Information discordant with intuition is ignored
- **Risk: missing dangers and opportunities that model could identify**
- ***[Risk: loss of accountability]***



On individuals

- The classification reflects ways of thinking about models, **not** individual psychological profiles
- People may hold different views depending e.g. on context and professional affiliation
  - Or indeed entertain conflicting views
- Each perspective challenges the other three
  - Twelve challenges in total

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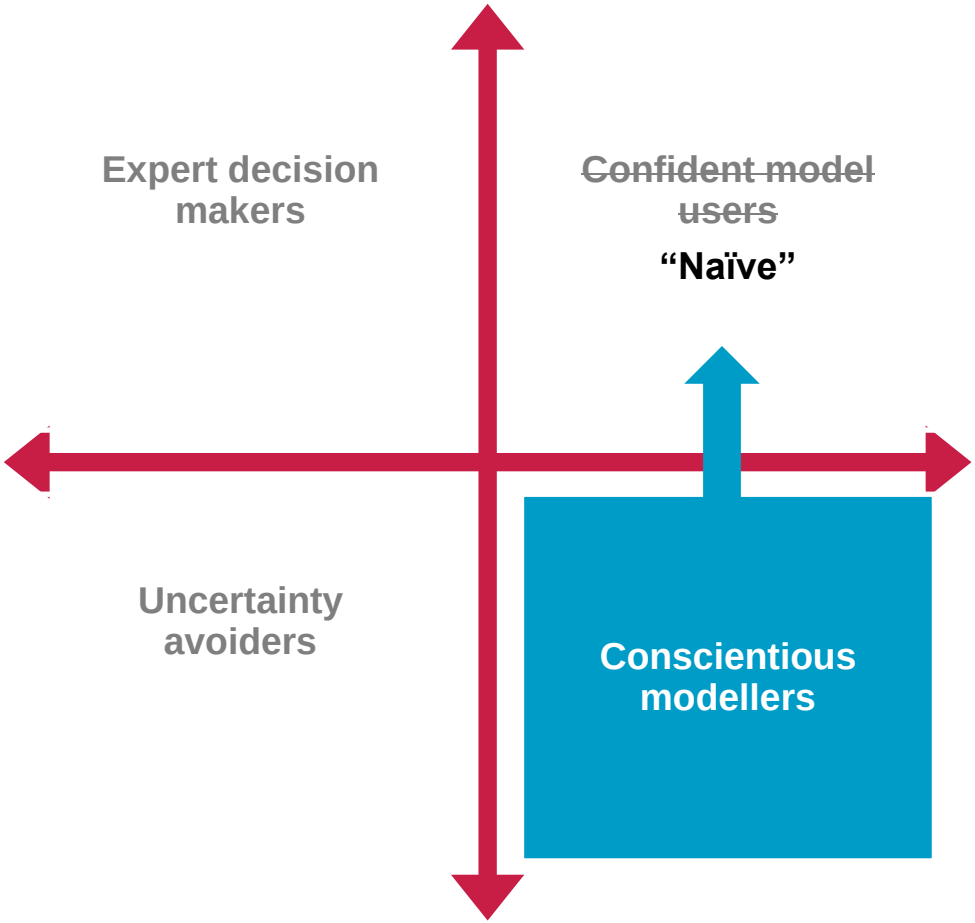
  - Twelve challenges in total
- People may be **responsive** to those who hold different views or instead...

What “we” may say about “them”



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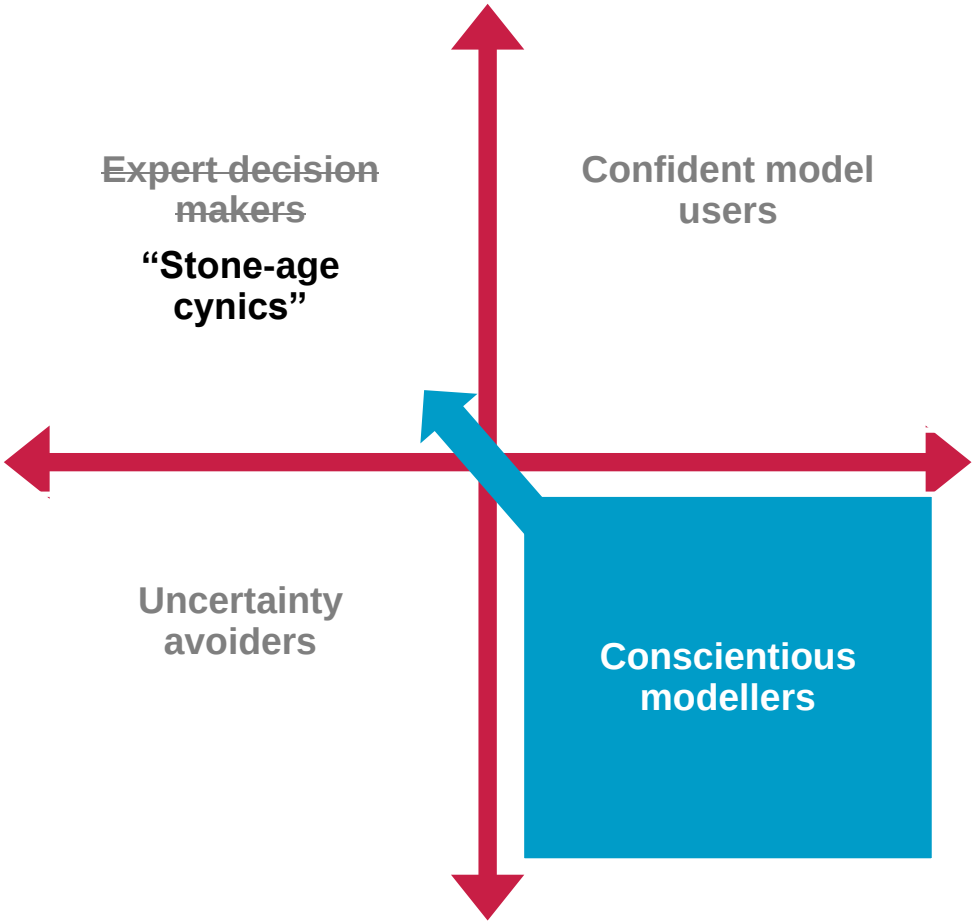

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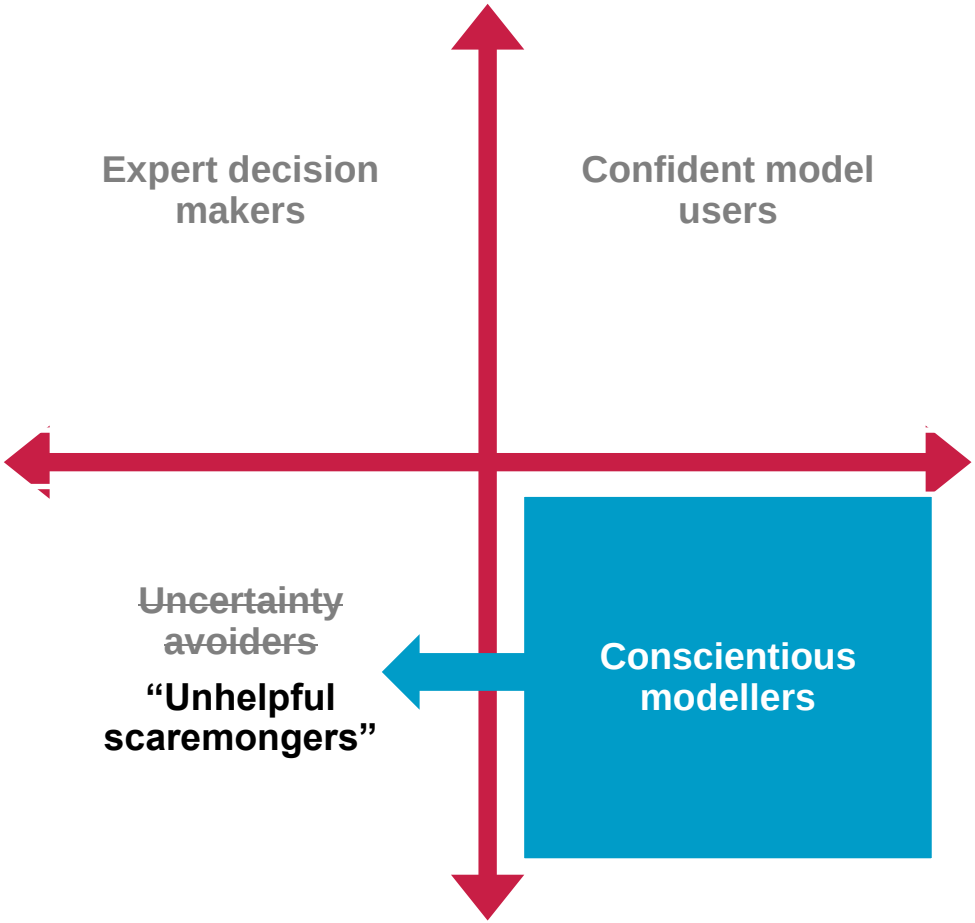

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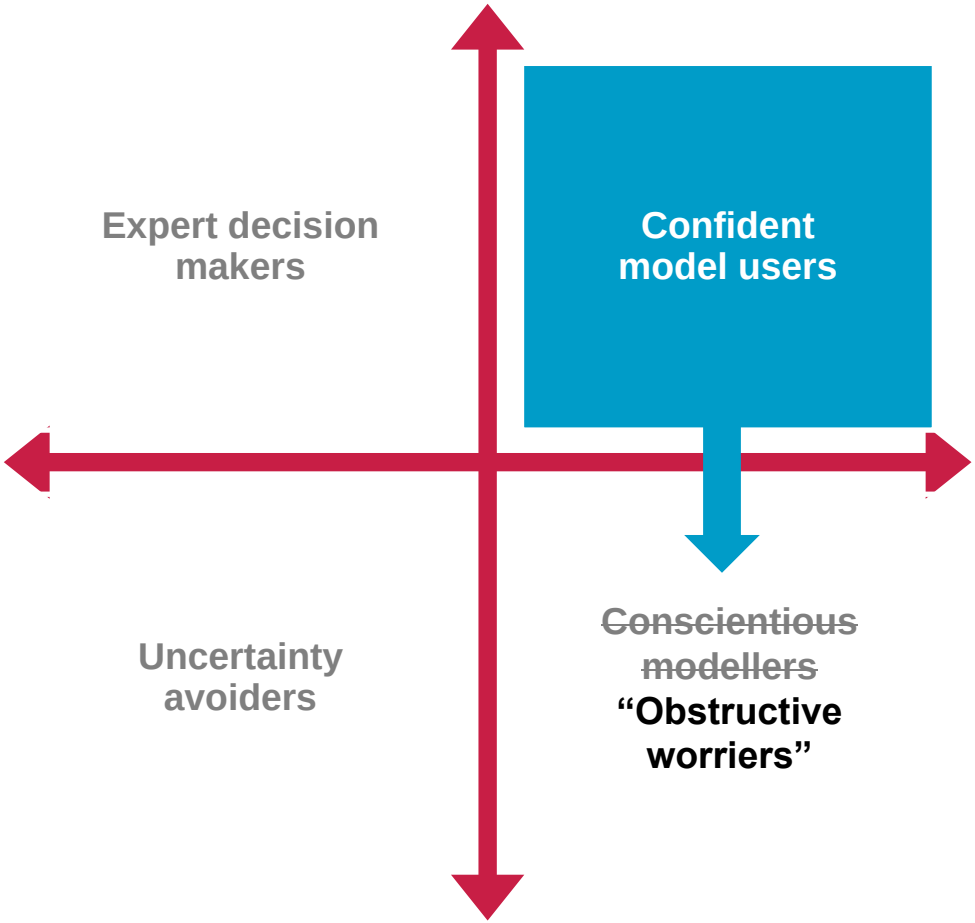

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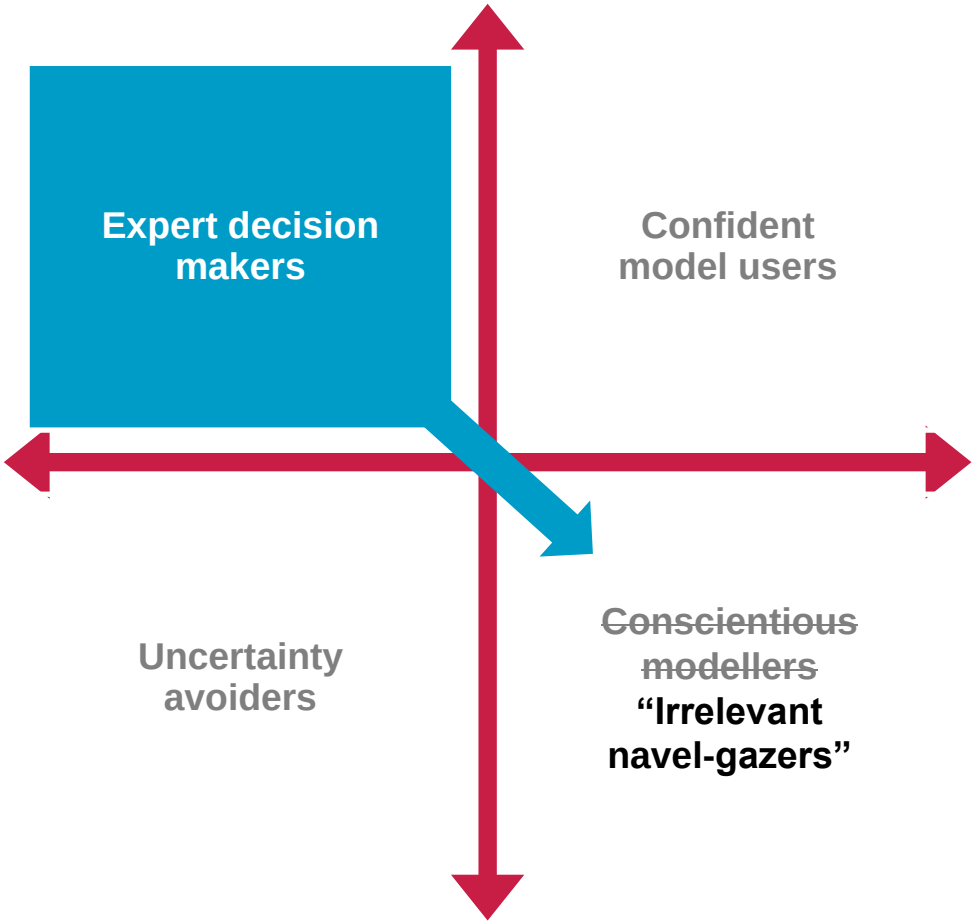

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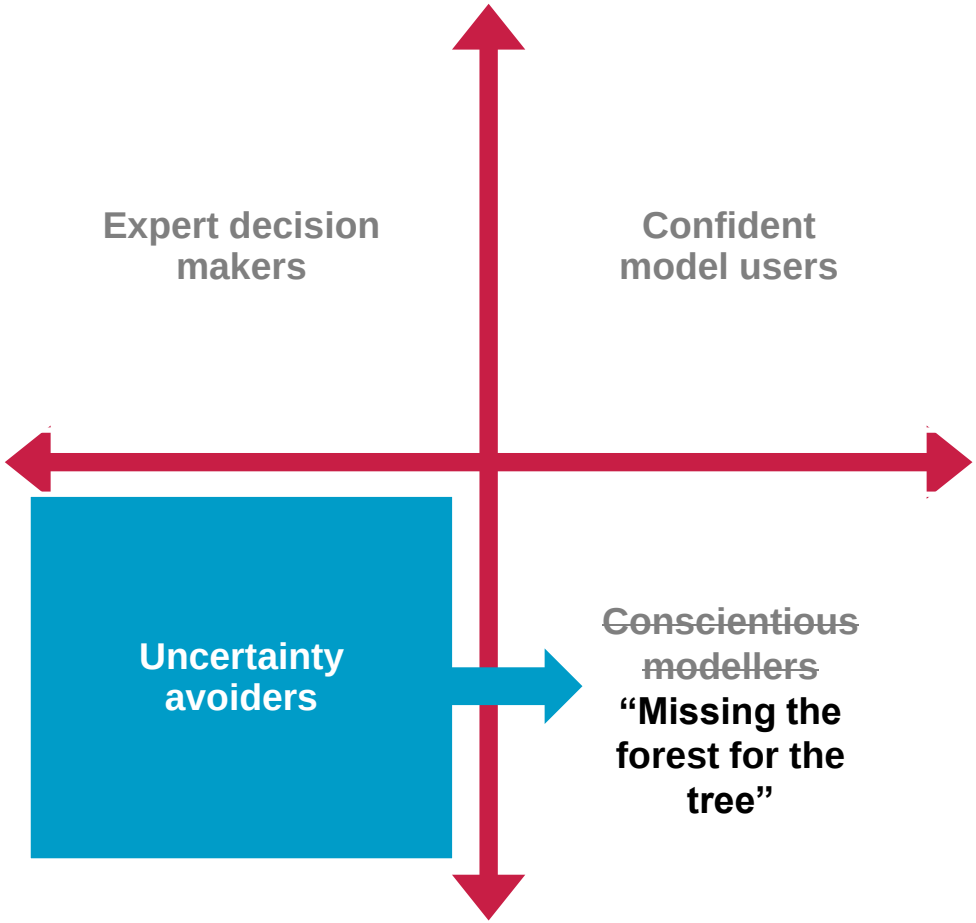

Model specification and delivery
("us" vs. Confident model users)

- Technical modellers now recognize how model complexity ("granularity") increases sensitivity
  - E.g. in hierarchical dependence modelling
- Management information, reporting requirements, model embedding, require **more detail**
- Statistical inference, sensitivity analysis, may point out the need for **less detail**

Paradigm challenge
("us" vs. Uncertainty avoiders)

- Economic **theory is flawed** (rational agents, frictionless markets, linear valuation functionals...)
- **Endogeneity** of financial risk
- Claims generating processes undergo unobservable **structural changes**
- But how can we quantify uncertainty without employing a paradigm?
- How can we think outside the box, without a box?

Input/output feedback
("us" vs. Expert decision makers)

- We know that portfolio risk can greatly vary with small changes in hard-to-validate dependence assumptions
- Statistically plausible risk metrics (reserve estimates, portfolio VaRs...), when linked to decisions, can be **commercially unviable**
- Model uncertainty allows choice of dependence parameters that give **reasonable outputs**
- Reasonableness is a **social construct**

Input/output feedback
("us" vs. Expert decision makers)

"Both groups have difficulty recognizing the ways in which the process subtly interweaves truth seeking and advantage seeking, leaving each somewhat compromised by the other, even as each somewhat serves the other."

(March, 1994)

Basket of 5 defaultable securities

p=5%, Beta-binomial dependence

Number of Defaults	Probability (corr=0)	Multiplier (corr=1%)	Multiplier (corr=5%)	Multiplier (corr=10%)
5	0.0000313%	4.44	84.68	508.53
4	0.00297%	2.45	16.25	51.42
3	0.113%	1.54	4.13	7.49
2	2.14%	1.12	1.48	1.70
1	20.4%	0.96	0.84	0.71
0	77.4%	1.01	1.02	1.04

Hegemony eats itself

“Why didn't rating agencies build in some cushion for this sensitivity to a house-price-depreciation scenario? Because if they had, ***they would have never rated a single mortgage-backed CDO****.”* (Salmon, 2009)

“Where is the liquidity crisis supposed to come from?” *somebody asked in the meeting. No one could give a good answer. [...] In their eyes, we were not earning money for the bank. Worse, we had the power to say no and therefore prevent business from being done.* ***Traders saw us as obstructive and a hindrance to their ability to earn higher bonuses.”*** *(Confessions of a risk manager, Economist, 2008)*

Echoes of Cultural Theory

Thompson et al (1990); Ingram et al (2012)

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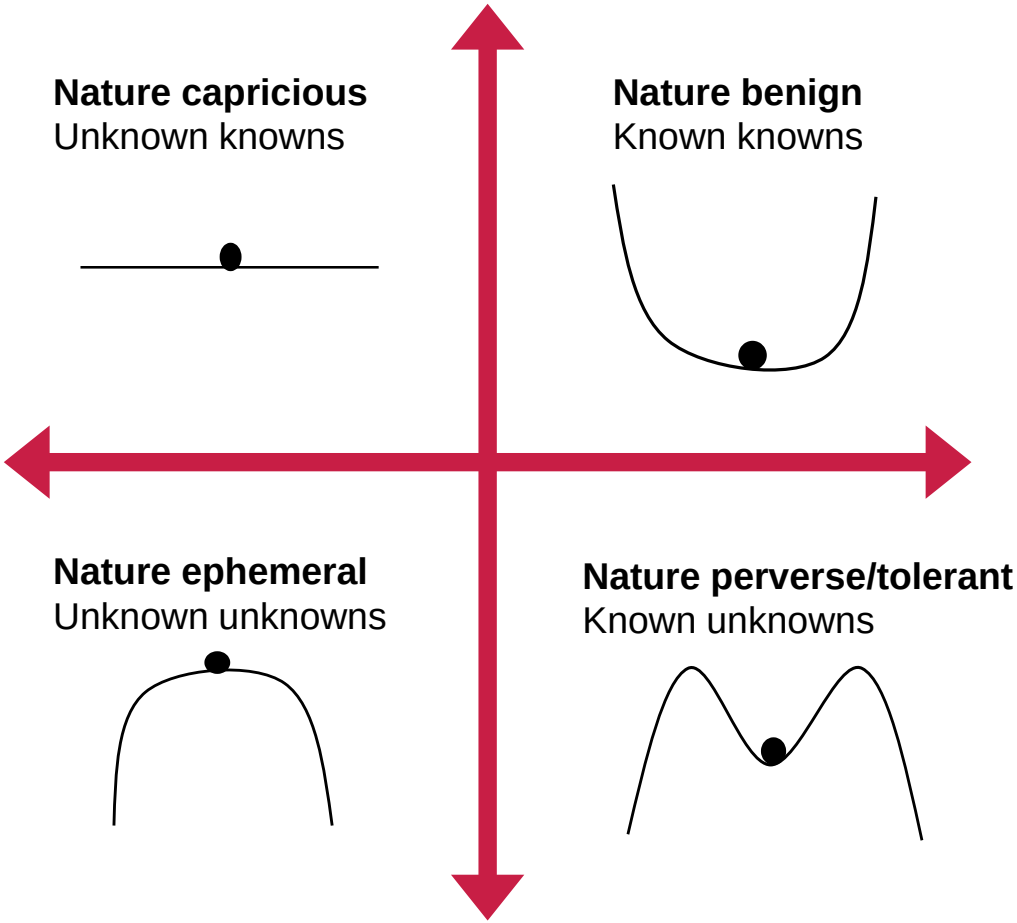
3. Each of these Risk Cultures represents a distinct form of human wisdom. But they are also mutually incompatible – **consensus is not possible**.
4. An institution committed to only one of these Risk Cultures is not viable. **Each way of life needs the presence of all others** to be viable.

Myths of nature



Clumsy solutions

- Lack of consensus means that viable solutions will have to be **clumsy** rather than **elegant**
- Different rationalities need to be **represented**, have **access** to decision making and be **responsive** to each other

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- Different rationalities need to be **represented**, have **access** to decision making and be **responsive** to each other
- **The people of Davos have managed such pluralism for many years (Thompson, 2002)**
  - Private property
  - *Wald-* and *Alpgenossenschaften*
  - Avalanche control
  - Casual labour

Model governance

- Current best-practice
  - Model inventory and documentation standards
  - Improved articulation of model limitations
  - Requirements and restrictions on model use
  - Independent model validation process

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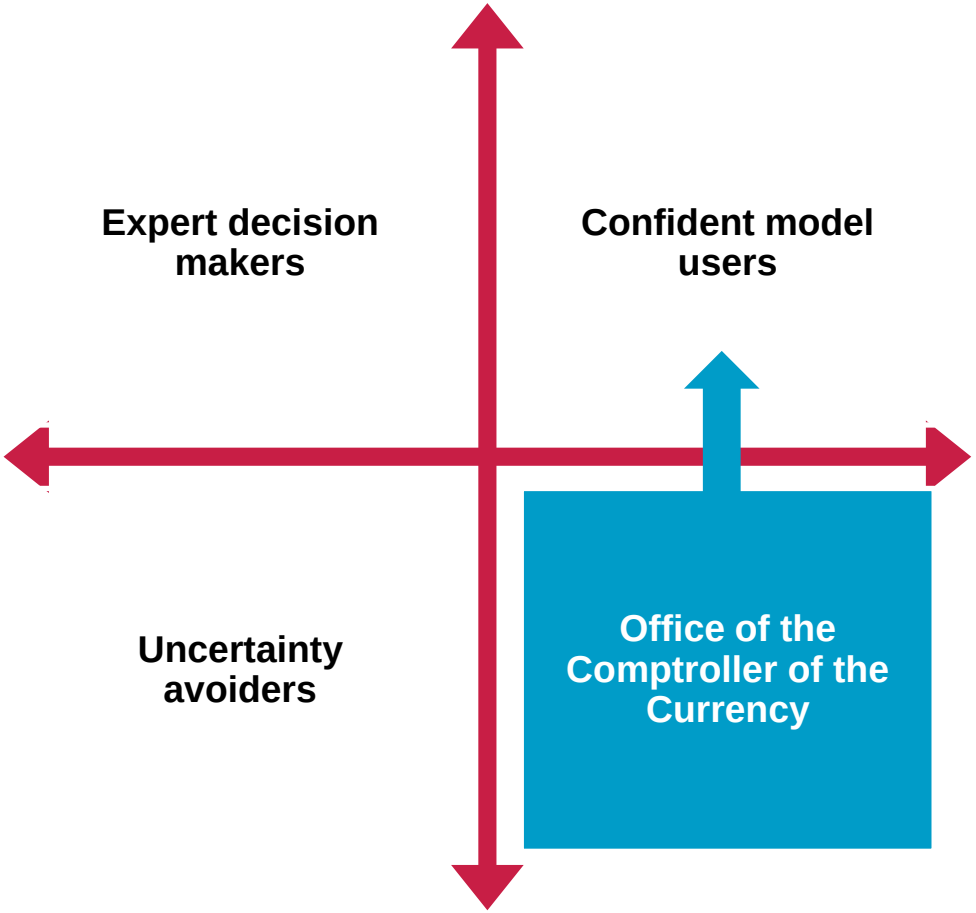
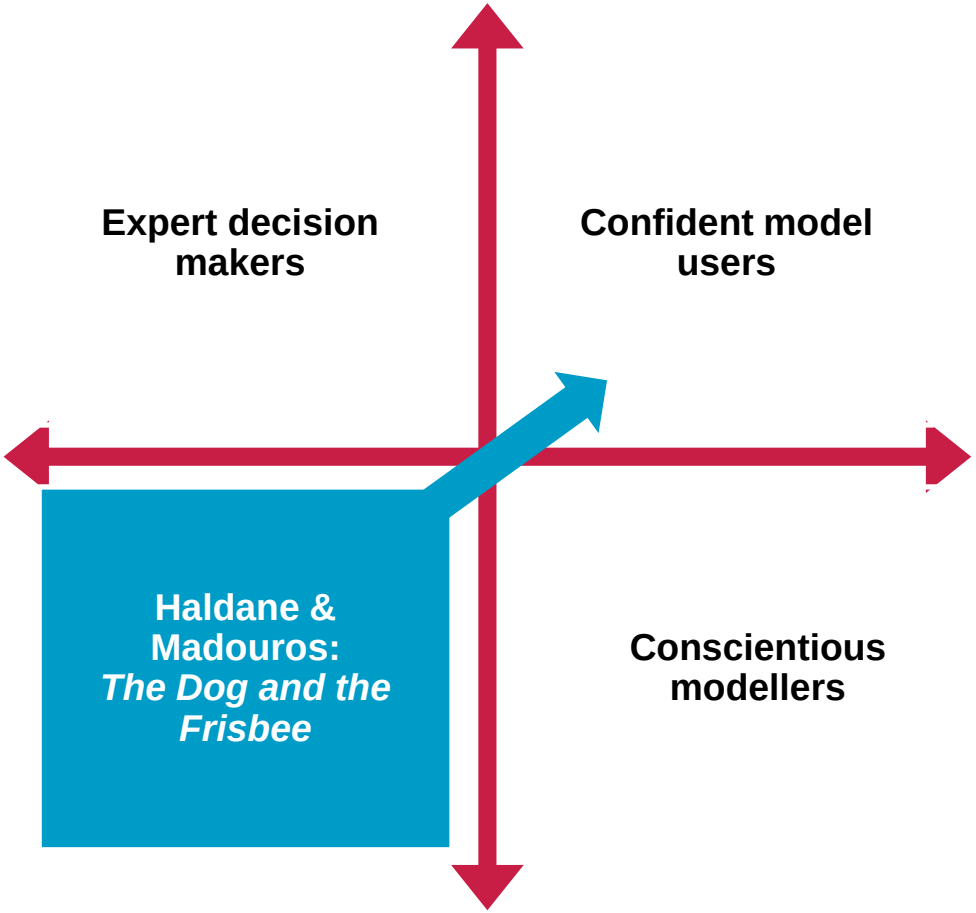
  - Independent model validation process
- “Culturally aware governance”
  - Multi-way challenge
  - **Accessibility** and **responsiveness**

Regulatory guidance: 1-way challenge



Regulatory guidance: 1-way challenge



Challenges to “conscientious modelling”

- Conditions for embedding in decisions and attracting investment in the model
  - Model user friendly, addresses business issues, released on time
  - Test output against expert opinion and commercial implications
  - Extended peer review

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- Conditions for embedding in decisions and attracting investment in the model
  - Model user friendly, addresses business issues, released on time
  - Test output against expert opinion and commercial implications
  - Extended peer review
- But we also need strong challenges to **model-bashing** and manipulation

The quest for openness

- Should we (?) be able to **openly** say this:

  "Assumptions are consistent with empirical evidence and best modelling practice. Model uncertainty remains high. The precise model calibration is such that ***standard outputs are also consistent with senior management's perspective of*** *a commercially reasonable capital requirement."*

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- If we acknowledge the legitimacy of such concerns, will this improve scientific integrity?
  - To ask hard questions, we need to be unafraid of the answers

Yes but...

- Why would Expert Decision Makers choose to manipulate models
  - Why use a model at all?
- In the face of deep uncertainties, what exactly do Conscientious Modellers have to offer?
  - Apart from: “sorry can’t answer this question”...

Yes but...

- Why would Expert Decision Makers choose to manipulate models
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- In the face of deep uncertainties, what exactly do Conscientious Modellers have to offer?
  - Apart from: “sorry can’t answer this question”...
- **If we had better data / models / software etc, could we all agree what to do?**

Decision principles

- To make a decision we need
  - Technical (probability) assessment
  - **Decision principle**
- Disagreement can be in respect of either element
- Sensitivity of decision to model changes reveals **materiality** of model uncertainty
- Rigid application of some sanctioned decision principle is a form of **hegemony**

Fields of contestation (how we often think)

	Science contested	**Principle contested**
Simple problems	No	No
Model risk	Yes	No
Ecstasy v horse-riding	No	Yes
Climate change	Yes	Yes

Fields of contestation (how things are)

	Science contested	**Principle contested**
Simple problems	No	No
Model risk	Yes	~~No~~ **Yes**
Ecstasy v horse-riding	~~No~~ **Yes**	Yes
Climate change	Yes	Yes

Rebellious rationalities

- **Conscientious modellers**
  - Re-define purpose of modelling!
  - (Protect integrity and need for expertise)
- **Uncertainty avoiders**
  - Change decision principle!
  - (Protect enterprise or market)
- **Expert decision makers**
  - Rig the model to get the answers I want!
  - (Survive by manipulation)

Conclusions

- Governance should encourage multi-way challenges to model (non-)use as **legitimate**
  - Are **all** perspectives heard?
  - Do all perspectives **respond** to others?
- Not easy to distinguish contestation of models from contestation of decision principles
- How does model governance improve accountability?
- Acknowledging the **political** nature of risk
  - Less politics → worse science

References

1. Beck (2014), “Handling uncertainty in environmental models at the science-policy-society interfaces,” in Boumans, Hon, and Petersen, (eds), *Error and Uncertainty in Scientific Practice*, Pickering & Chatto, pp 97-135.
2. Haldane and Madouros (2012) “The dog and the frisbee”, *Federal Reserve Bank of Kansas City’s 36th economic policy symposium.*
3. Ingram, Tayler, and Thompson (2012), “Surprise, surprise: from neoclassical economics to e-life”, *ASTIN Bulletin* 42 (2), 389-411.
4. March (1994), *A Primer on Decision Making: How Decisions Happen*, Simon & Schuster.

References

5. Office of the Comptroller of the Currency (2012), “Supervisory guidance on model risk management”, *Report OCC 2011-22*, Board of Governors of the Federal Reserve System
6. Richards, Currie, and Ritchie (2013) “A Value-at-Risk framework for longevity trend risk” *British Actuarial Journal* 19(01), 116-139.
7. Thompson (2002), “Man and nature as a single but complex system,” in Munn (ed), *Encyclopedia of Global Environmental Change*, Vol 5, Wiley, pp 384-393.
8. Thompson, Ellis, and Wildavsky (1990), Cultural Theory, Westview Press.