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Sustainable Odds: Towards Quantitative Decision Support when Relevant Probabilities are not Available

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There is, at present, no attractive foundation for quantitative probabilistic decision support in the face of model inadequacy, or given ambiguity (deep uncertainty) regarding the relative likelihood of various outcomes, known or unknown. True model error arguably precludes the extraction of objective probabilities from an ensemble of model runs drawn from an available (inadequate) model class, while the acknowledgement of incomplete understanding precludes the justified use of (if not the very formation of) an individual's subjective probabilities.

An alternative approach based on Sustainable Odds is proposed and investigated. Sustainable Odds differ from "fair odds" (and are easily distinguished any claim which implying well defined probabilities) as the probabilities implied by sustainable odds summed over all outcomes is expected to exceed one. Traditionally, a person's fair odds are found by identifying the probability level at which one would happily accept either side of a bet, thus the probabilities implied by fair odds always sum to one. Knowing that one has incomplete information and perhaps even erroneous beliefs, there is no compelling reason a rational agent should accept the constraint implied by "fair odds" in any bet. Rather, a rational agent might insist on longer odds both on the event and against the event in order to account for acknowledged ignorance. Let probabilistic odds imply any set of odds for which the implied probabilities sum to one; once model error is acknowledged can one rationally demand non-probabilistic odds?

The danger of using fair odds (or probabilities) in decision making is illustrated by considering the risk of ruin a cooperative insurance scheme using probabilistic odds is exposed to. Cases where knowing merely that the insurer's model is imperfect, and nothing else, is sufficient to place bets which drive the insurer to an unexpectedly early ruin are presented. Methodologies which allow the insurer to avoid this early ruin are explored; those which prevent early ruin are said to provide "sustainable odds", and it is suggested that these must be non-probabilistic. The aim here is not for the insurance cooperative to make a profit in the long run (or to form a book in any one round) but rather to increase the chance that the cooperative will not go bust, merely breaking even in the long run and thereby continuing to provide a service. In the perfect model scenario, with complete knowledge of all uncertainties and unlimited computational resources, fair odds may prove to be sustainable.

The implications these results hold in the case of games against nature, which is perhaps a more relevant context for decision makers concerned with geophysical systems, are discussed. The claim that acknowledged model error makes fair (probabilistic) odds an irrational aim is considered, as are the challenges of working within the framework of sustainable (but non-probabilistic) odds.