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REPRESENTING DECISIONS IN HILBERT SPACE: FOUNDATIONS AND APPLICATIONS

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ABSTRACT

We elaborate a *general mathematical framework* to represent attitudes towards uncertainty that uses the mathematical formalism of quantum theory in Hilbert space. We show that the quantum-theoretic framework enables modelling of the *Ellsberg paradox*, which is problematical from the point of view of *expected utility theory*. We then apply the quantum-theoretic framework to concrete decision-making situations also involving financial and managerial decisions. More specifically, we work out a mathematical representation of various empirical studies which reveal that the attitudes of managers towards uncertainty shift from *ambiguity seeking* to *ambiguity aversion*, and vice versa, thus exhibiting both *hope* and *fear effects*.

The present framework provides a new promising direction towards the development of a *unified quantum-based theory of human decision making*, in which individuals take the decision that maximizes expected utility with respect to a quantum probability measure. Furthermore, the results presented here support a successful research programme that investigates quantum structures, as *entanglement*, *emergence*, and *interference*, outside the microscopic world of quantum physics.

Keywords: quantum structures, human decision-making, Ellsberg paradox, quantum uncertainty

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