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THE QUANTUM FOUNDATIONS OF UTILITY: RESOLVING THE INCOMPLETENESS OF ECONOMIC THEORY

Cal Abel

Signal Power and Light, Inc., Cordova, Alabama, USA

ABSTRACT

Modern economic theory rests upon the von Neumann and Morgenstern axioms of Game Theory. With the rapid development of quantum computing, these familiar axioms fundamentally limit the strategy space to purely classical strategies. To resolve this deficiency, we propose a set of axioms for game theory that are based upon the axioms of quantum mechanics. We recover classical game theory at the classical limit of a quantum system. We find that utility under these more general axioms can be represented as any quantum observable and propose using the Hamiltonian as the unique quantum observable defining utility.

Using empirical data, we show that classical preference is canonically distributed, justifying the use of the Hamiltonian as utility. Under this formalism, we see that the Allais paradox is a system of a mixture of two different strategies and propose that the reason for the two strategies is that what the players in the game are considering is the Helmholtz potential, which is dependent upon utility, the risk preference (temperature), and the entropy (uncertainty) of the game.

With the foundations of microeconomics firmly in place we formally extend microeconomic theory to macroeconomics using the independence and indistinguishability principles. These principles in the general class of non-cooperative games results in people being characterized as bosons.

This new formulation of economic theory is known as statistical economics.

Keywords: quantum mechanics, game theory, Allais paradox, entropy, statistical economics

Corresponding Author E-Mail: crabel@signalpowerandlight.com | Phone: +1 (860) 984-5041