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Econophysics: from Game Theory and Information Theory to Quantum Mechanics

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Abstract

Rationality is the universal invariant among human behavior, universe physical laws and ordered and complex biological systems. Econophysics isboth the use of physical concepts in Finance and Economics, and the use of Information Economics in Physics. In special, we will show that it is possible to obtain the Quantum Mechanics principles using Information and Game Theory.

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1. Introduction

At the moment, Information Theory is studied or utilized by multiple perspectives (Economics, Game Theory, Physics, Mathematics, and Computer Science). Our goal

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in this paper is to present the different focuses about information and to select the main ones, to apply them in Economics of Information and Game Theory. Economics and Game Theory[1] are interested in the use of information and order state, in order to maximize the utility functions of the rational[2] and intelligent[3] players, which are part of an interest conflict. The players gather and process information. The information can be perfect[4] and complete[5] see Refs. [1–4], (Sorin, 1992). On the other hand, Mathematics, Physics and Computer Science are all interested in information representation, entropy (disorder measurement), optimality of physical laws and in the living beings' internal order see Refs. [5–7]. Finally, information is stored, transmitted and processed by physical means. Thus, the concept of information and computation can be formulated not only in the context of Economics, Game Theory and Mathematics, but also in the context of physical theory. Therefore, the study of information ultimately requires experimentation and some multidisciplinary approaches such as the introduction of the Optimality Concept [8].

The Optimality Concept is the essence of the economic and natural sciences [9,10]. Economics introduces the optimality concept (maximum utility and minimum risk) as equivalent of rationality and Physics understands action minimum principle, and maximum entropy (maximum information) as the explanation of nature laws [11,36]. If the two sciences have a common backbone, then they should allow certain analogies and to share other elements such us: equilibrium conditions, evolution, uncertainty measurement and the entropy concept. In this paper, the contributions of Physics (Quantum Information Theory)[6] and Mathematics (Classical Information Theory)[7] are used in Game Theory and Economics being able to explain mixed

[1]Game Theory can be defined as the study of mathematical models of conflict and cooperation among intelligent rational decision-makers.

[2]A decision-maker is rational if he makes decision in pursuit of his own objectives. It is normal to assume that each player's objective is to maximize the expected utility value of his own payoff.

[3]A player in the game is intelligent if he knows everything that we know about the game and he can make inferences about the situation that we can make.

[4]Perfect information means that at each time only one of the players moves, that the game depends only on their choices, they remember the past information (utilities, strategies), and in principle they know all possible futures of the game [1].

[5]In games of incomplete information the state of the nature is fixed but not know to all players. In repeated games of incomplete information, the changes in time is each player's knowledge about the other players' past actions, which affects his beliefs about the (fixed) state of nature.

Games of incomplete information are usually classified according to the nature of the three important elements of the model, namely players and payoffs (within the two-person games: zero-sum games and non-zero-sum games), prior information on the state of the nature (within two-person games: incomplete information on one side and incomplete information on two sides), and signaling structure (full monitoring and state independent signals) [2,3,37].

[6]Quantum Information Theory is fundamentally richer than Classical Information Theory, because quantum mechanics includes so many more elementary classes of static and dynamic resources—not only does it support all the familiar classical types, but there are entirely new classes such as the static resource of entanglement (correlated equilibria) to make life even more interesting that it is classically.

[7]Classical Information Theory is mostly concerned with the problems of sending Classical Information-letters in an alphabet, speech, strings of bits—over communications channels which operate within the laws of classical physics.