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May 19, 2025

Game Theory and the Stock Market

Game theory is the meaningful and complex study of strategic decision-making, and how the decisions of people can depend and be influenced by the decision-making of others. Game theory isn't just about abstract math, rather interdependence, where outcomes hinge not only on one's own actions but how others may choose to act. This multifaceted framework provides a powerful and illuminating lens into understanding the complexities of the modern-day stock market, where investors, buyers, and traders will consistently and assuredly react to, anticipate, and manipulate the behavior of other traders. Subsequently, the stock market becomes a real-life experiment for game theory-dynamics, where investors and traders will ask the constant and critical questions of *what is going to happen* and *what does everyone believe is going to happen?* Therefore, it is worthwhile to explore the intricate and crucial key concepts in relation to game theory, such as Nash equilibrium, signaling, and incomplete information. Doing so, this paper will aim to explore how game theory not only explains the rationality –logic or otherwise– behind stock market trading, but predicts it as well.

To understand how game theory influences stock market behavior and trading, we must first examine the foundational principles of game theory itself and how it operates within everyday decision-making. As Amnon Rapoport (1999), the quantitative psychologist and leading researcher in decision theory and behavioral psychology, notes, "Important areas of applications include social psychology, political science, sociology, evolutionary biology, and branches of philosophy such as ethics and epistemology. By far, the largest single area of application of game theory has been economics. Many modern textbooks in microeconomics [...]

and most of the theoretical journals in this discipline present or discuss game theoretical models in one form or another" (p. 143). Rapoport's comments highlight the remarkable versatility and multifacetedness of game theory, whose concepts expound far beyond the axioms of mathematics and into the core workings of strategic interaction in human affairs—including, most significantly, economic behavior and day-trading. This is a noteworthy point, and a critical concept to consider. Nevertheless, game theory's foundational principles give us key insights into the rationale behind strategic decision making, so it is salient to analyze these concepts.

To begin with, game theory is built upon the basic tenets of players (N), strategies, payoffs (payoff functions), rationality, equilibrium (Nash equilibrium to be exact), and most importantly, interdependence. These pillars form almost all game-theoretic models, which could range from paying a bill with your friends at dinner, a military conflict with nuclear weapons, to market speculation and attempting to pin-point the volatility of the market. The basic structure we can abide by goes as follows. Imagine there are four players at a restaurant who agree to split the bill evenly. Player 1 orders a modest meal of $10, where players 2 through 4 all order meals for $20 each. At the end of the meal when the bill is finally split, player 1 ends up subsidizing the other players and makes up for the difference within the check. Aggravated, player 1 reasons, "Why should I hold back when I am paying extra?"...Now imagine each player thinks this way. As each player orders increasingly expensive entrees and meals to ensure they get their "fair share", the overall bill balloons and inflates for the whole system of players. This ultimately costs everyone more than if they had all just paid individually. This, simply put, is game theory in practice.

The prior scenario lands each of the players into what is called the *Nash equilibrium.* Nash equilibrium, to summarize, is a state where no player has an incentive to change their

strategy within the game, as doing so would result in a worse outcome for that player. Even though the whole system is worse-off, a stand-off of sorts occurs between each player. Rapoport (1999) goes onto reason such, saying, “Nash (1951) proved that in a finite player and finite action game there always exist at least one Nash equilibrium (there may be many)” (p. 148). When interdependent, rational and self-interested decision-making can lead to suboptimal outcomes –such as each player paying a higher bill– yet stable, nonetheless. Within the stock market, the same logic applies.

Within the stock market, investors and traders anticipate the investments of others. This is apparent when they buy in anticipation of others buying, or when they sense panic, selling frantically. Subsequently, this strategic behavior creates equilibrium states within the market, where various investors have difficulty improving their position unilaterally, despite looming bubbles, crashes, or recessions. These equilibria, while stable, are suboptimal for investors and traders, illuminating the paradox at the heart of game theory and Nash equilibrium. This being said, traditional game theory will assume that the players involved are perfectly rational, while this is not a perfect representation of real-world applications and behavior within the stock market.

Investors that have their stake in the stock market and its volatility often make decisions under stress, uncertainty, and emotion. To deepen and broaden the discussion, it is also critical to observe neuroeconomics and its implications. By exploring how the brain processes and understands value, strategic behavior, and risk within the stock market, then we can better understand the environment in which financial decisions are made. Firstly, it would be nice to assume that financial decisions and day trading are done within the sterile vacuum of rational logic. However, due to stress (highly influenced by the cortisol hormone), anticipation (perhaps

from the dopamine hormone), and the overwhelming fear of losing money, this proves to be untrue. Even within a Nash equilibrium, traders and investors may diverge and act differently due to a flawed perception of risk, overconfidence, and group-think. Alan G. Sanfey et al., from the journal of *Social Decision-Making: Insights from Game Theory and Neuroscience,* comments on this interestingly, reasoning, "Neuroeconomic research tries to illuminate the process by which we encode decision outcomes and how this might, in turn, guide our future choices... It is widely hypothesized that the brain uses a common-reward metric, which is crucial for a system to choose between rewards delivered in different modalities" (Sanfey et al., 2007). That is to say, the brain will reduce different choice metrics such as money, value, status, and safety into a holistic internal matrix. If we understand this concept, we can then understand why investors or traders will act on an award that *could be* or that is perceived, rather than a mathematical certainty. For this reason, neuroeconomics doesn't trump game theory, it completes it and humanizes it. It shows that equilibrium models must account for the messy and complex reality of the human mind.

Game theory, when applied to stock market behavior, has intriguing implications for the way people act. While it provides the structure for comprehending rational choice in a closed and sterile system, neuroeconomics adds a salient layer of information: examining the *why* behind human choice. A key insight, as noted from Sanfey et al. (2007), is that, "...the human striatum appears to be centrally involved in social decisions, above and beyond any financial outcome that may accrue to the player" (p. 599). This means that inside traders and investors aren't just observing market data –they're observing other people. This phenomena explains also why investors will try to "beat" the market, or outsmart it. They will engage in bubbles such as meme stocks, panic-selling, or bandwagon-investing (such as Bitcoin-buying frenzies) in stocks that

may or may not have inherent value. While game theory sets the foundation for the behavior of stock trading, neuroeconomics takes it a step further.

To recapitulate, think of the stock market as a giant “game”. The investors and traders are the players. The payoffs are the increase in stock value, and the Nash equilibrium is the different investors settling into predictable strategies which are based on the behavior and selling of other’s stocks. That is to say, investors have no incentive to change their position unless others do. Because of this, no one can improve their stake or position alone.

Game theory offers more than just abstract matrixes and puzzles –instead, a robust and multifaceted framework for investors to engage in when trading, selling, and buying stock within the market. By analyzing how individuals will make choices based on the choices of others, game theory can explain how certain trading strategies merge into equilibrium states (dinner example with the bill is applied here). However, through the viewpoint of neuroeconomics, humans are not rational, and this reflects in the decision-making. We can look to cognitive biases, brain-networks and reward systems, panic-selling, bandwagon-investing, and social influences to explain the shift in human behavior. Ultimately, the stock market is not just an arena for financial acquisition, rather a large-scale game of perception and risk to reward, governed by human neuroscience and strategy.

Work Cited

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