



Investigating the Theory of Games in Stocks and Investments

Ava Farhadi Savadkoohi ^a

^a Faculty of Economics, Management and Administrative Sciences, Semnan University, Semnan, Iran.

ARTICLE INFO

Received: 2024/03/05

Revised: 2024/04/01

Accept: 2024/05/28

Keywords:

Game Theory, Stocks,
Investment, Economy.

ABSTRACT

In the challenging environment of today's world, an economic enterprise is strongly in competition with different competitors, and it is not possible to make the correct decisions by only using traditional decision-making methods in the conditions of certainty, risk and uncertainty to deal with domestic and foreign competitors. commented the recognition of new techniques is more felt in conflict situations to deal with competitors. The use of this group of techniques helps to evaluate the economic investment in stocks and helps in better decision-making. Because investment is developing due to the existence of many unknown variables with many risks and many competitors are also present in it, methods such as game theory and its application for success in front of many competitors. It seems necessary in the current markets. In this research, we intend to investigate the theory of games in stocks and investment.

1. Introduction

Investment is of special importance as the driving engine of economic growth and development in all countries of the world. Economic growth requires more production and more investment. Therefore, it must be said that economic growth and increasing public welfare in the long term are not possible without paying attention to investment and the important factors in the investment environment that affect it (Abzari et al., 2013). In their analysis, people ultimately hope to get a return commensurate with the investment risk. A careful study of investment analysis and the

^a Corresponding author email address: farhadi.ava22@yahoo.com (A. Farhadi Savadkoohi).

principles of asset portfolio management can lead to better management and an increase in investor wealth (Tehrani and Noorbakhsh, 1392).

The concepts of stock portfolio optimization and diversification have become a tool for the development and understanding of financial markets and financial decision-making. The publication of Harry Markowitz's stock portfolio theory was the main and most important success in this direction. Since Markowitz published his model, this model has created many changes and improvements in the way people view investments and stock portfolios, and has been used as an effective tool to optimize stock portfolios (Frites et al., 2009)

2. Literature and research background

Fallahpour et al. (2013) in research investigated the application of the stable model in choosing the optimal portfolio of stocks. and defines an uncertainty set for each parameter; The problem of portfolio selection has been investigated. The model presented in the article has a parameter that can control the investor's conservatism in portfolio selection. To check the performance of the model, the data of the 50 most active companies in the first three months of 2013 of the Tehran Stock Exchange have been used. The results of the out-of-sample test in the research showed that the stable portfolio performed better than the portfolio on the Markowitz efficient frontier (where the expected return is equal to the expected return of the stable portfolio) based on the Sharpe index.

Daryabar et al. (2015) in research titled Providing a model for portfolio optimization in the bubble space, and examining variables such as stock price, monthly stock returns and total market, standard deviation variance, VaR Downside Risk to provide a model in the bubble space for the period After 15 years (1380-1394) in Tehran Stock Exchange, after proving the bubble and identifying the periods for 7 periods and examining and analyzing the variables, he reached an optimization model with the approach of maximizing the return, which the optimal portfolio extracted from this model Other portfolios in non-bubble conditions, like the market portfolio, in criteria such as efficiency, Sharp Trainer and Jensen, give the investor a much more suitable situation. With the non-bubble atmosphere and achieving the desired results, the main hypothesis of the research was proved and the model he wanted was achieved.

Kocak (2014) in an article titled "Standard Coalition Game for Optimal Portfolio Formation" discussed the formation of the optimal hypothetical investment portfolio using the Standard Coalition Payment Game in the London Stock Exchange. Using the opinion of experts in estimating the earnings of each actor and using the Shepley value concept, he attempted to allocate resources to each share, but he did not prove the optimality of his chosen portfolio and was satisfied with the answers provided from the solution of the model.

Malafif and Avasti (2017) investigated the problem of investment portfolio selection by investors in research titled Dynamic Optimization of Investment Portfolio and provided a solution for this issue using the dynamic optimization model.

Zhou and Deng (2019) in an article entitled "Solving the Problem of Optimizing the Investment Portfolio Using Cooperative Behaviours" investigated the individual and coalition behaviour of two hypothetical investment managers. The results of their research showed that investment managers became cautious in cooperative situations. To cover the risk of their portfolio, they adopt hedging strategies.

Major achievements in game theory

It is agreed among game theorists that the first formal analysis of game theory occurred with the famous book by Van Neumann and Morgenstein titled "Game Theory and Economic Behavior" published in 1944. John Nash played an important role in the development of game theory by writing four fundamental articles between 1950 to 1953; However, there are different views and opinions related to the history of game theory, and thinkers, each based on their research, have different ideas related to its formation. For example, Martin Osborne (2000), the author of the book "Introduction to the Theory Game" briefly states in connection with the history of game theory that some thoughts in game theory can be attributed to the 18th century, but its main development is from the 1920s with the work of the mathematician Emil Bruhl (1871-1956) and also Van Neumann. (1903-1957) begins, But the important event in the development of game theory is the same book published by van Neumann and Morgenstein. Game theory models were used in economic theory and political science in the 1950s, and psychologists also began to investigate how the behaviour of humanity is examined in experimental games. In the 70s, game theory was first used as a tool in evolutionary biology. As a result, the framework of game theory penetrated micro theory and was used in many other branches of economics and a huge range of behavioral

and social sciences. The 1994 Nobel Prize in Economics was awarded to three game theory theorists, John Harsney, John Nash, and Rihar. Selten was awarded (Martin, Osborne, 2000), but before the twentieth century, perhaps the greatest achievement in game theory can be attributed to the works of Cournot (1838) Demand and Demand (1996) in a book entitled "The history of game theory from its beginning Until 1944, they examined in detail the history of game theory before the achievements of van Neumann and Morgenstein. investigated. They state that Cournot's 1838 discussions on monopoly, bilateral monopoly and double monopoly played an incredibly important role in the mathematicalization of economic problems. One of the important discussions about the bilateral monopoly that has been repeatedly used in the concept of equilibrium in game theory, after Cournot, is the discussion of bilateral Cournot monopoly and Nash-Cournot equilibrium.

Friedman (1992) states that perhaps the first great theorist who expressed non-cooperative equilibrium in the industrial framework was Cournot. Cournot's description of non-cooperative equilibrium is the same definition shared by economists as the inability of players to make binding agreements with each other.

The foundation of game theory as a social science was established in the book "Game Theory and Economic Behavior" published by mathematician Van Neumann and economist Morgenstein at the end of World War II (1944) at Princeton University. Van Neumann (1957-1903), a genius in physics and mathematics, had great achievements in these fields, and on the other hand, Morgenstein (1977-1902) was a great German economist, as they say in their book Van Neumann in 1928. He published a fundamental article related to the theory of games and a book written in 1944 is a kind of generalization and expansion of the work that Van Neumann did in 1928. In an article related to receiving the Nobel Prize in Economics in 1994, Kahn states that it is a historical fact that the main financial support for game theory research was provided by the US military agency. Omen states that "the main application of the game theory was on military tactical issues such as missile defence and so on". Von Neumann was one of the main members of the Manhattan Project, which was involved in research and development in connection with the production of the first atomic weapons after World War II, which was carried out between 1942 and 1946 with the cooperation of the United States, England and Canada. Economic theorists of game theory have different theories regarding the achievements of Van Neumann and Morgenstein, But what is

agreed upon among these theorists is that many of the important concepts that are discussed in game theory today are due to the important achievements of Van Neumann in his article in 1928 and his collaboration with Morgenstein and the publication of the book in the year is 1944. Concepts such as two-player games with zero-sum, games in extended form and normal form, cooperative games, the concept of mini-max theorem, and the concept of solution and equilibrium are presented in this book.

Watson (2008) states that game theory became a specialized field with the work of van Neumann (1928) and the combination of his work with Morgenstein in 1944. In the 1944 book by van Neumann and Morgen, Stein formally defined the concept of the extended form of the game (based on the game tree) and the normal form of the game (based on the strategy), which were associated with the concept of strategy. They presented for the first time a general classification of the game as well as the definition of solutions and existence proofs using fixed point methods. They introduced the buyer. Also, they presented the theory of utility and decision-making under risky conditions (expected utility criterion) (Watson, 2008). Mirsin, (1999) examines the achievements of Van Neumann (1928) and Morgenstein and concludes that three important achievements In the works of Van Neumann and Morgenstein, these achievements include: 1- a complete description of the game in normal form and the concept of strategy independence; 2- Mini-max theorem and 3- axiomatic inference of maximizing expected utility with substitution reasoning.

However there were some objections to the theory of Van Neumann and Morgenstein. First, they do not propose any rational solution for non-zero-sum games in the absence of binding agreements. Second, in their method, there is no way to predict the outcome in connection with the bargaining problem of two players beyond the curve. Edgeworth (1881) predicted Also; they relied on transferable utility in their analysis. With the arrival of John Nash to Princeton University, many defects in Van Neumann's and Morgenstein's models were removed, he re-examined the structure of game theory and correctly presented a new classification of it.

The role of game theory in macroeconomics

After the game theory was used as a powerful tool to analyze the conflict of strategies, economists used this tool in the best way to investigate the conflict between monetary and fiscal policies in determining the optimal goals of inflation, output and also achieving rates. They used the budget deficit debt, money circulation, etc., and the basic articles that have been published so far about

the optimal monetary policy and the confrontation of strategies between the government, the central bank, and economic agents can be categorized using game theory. The first category can be attributed to the seminal work of Kidd and Prescott (1977) in their famous paper entitled "Rules versus discretion on the time inconsistency of optimal schedules". This article was a turning point concerning the application of game theory in discussions of optimal monetary and financial policy. The achievements of Kidland and Prescott in 1977 presented a new perspective in the space of new classical economics. They introduced two important achievements: one was the problem of time inconsistency and the other was the discussion of regular monetary policy versus discretionary monetary policy. They stated that the implementation of a regular monetary policy by the monetary authority instead of a discretionary policy in a strategic game with forward-looking and informed private sector agents can have favourable results for the economy. Under these assumptions, Kidland and Prescott show that government policymaking is related to the problem of time inconsistency. After this great achievement, other fundamental articles were presented to expand and challenge these opinions, the most important of which can be found in the great works of Barrow and Gordon (1983), Canzoneri (1985), Rogoff (1985), Alsina and Tablini (1987), Lohmann (1992), Walsh (1995), Sonosen (1997) and others observed. Barrow and Gordon (1983) published two seminal papers, in both of these papers, following the work of Kidland and Prescott in the framework of game theory, they looked for solutions to solve the time inconsistency problem faced by discretionary and regular policies. First, Barrow and Gordon include a simple model of monetary policy with a time-inconsistency feature associated with optimal policy. The main concept in this model is that if the monetary policymaker lacks the ability for pre-commitment or credit, the inflation rate is too high. They show that in this framework, the inflation rate prevails in the balance of discretion and the real direction of the economy or the unemployment rate remains unchanged. This situation is considered ineffective from a social point of view. The results of the achievements of Kidland Prescott (1978) and the first article of Barrow Gordon (1983) show that discretionary monetary policies can cause inflation at a high level and inefficiency and inflationary distortion, and raises the question of what solutions can be used to deal with it. considered with it. Therefore, economists such as Barrow and Gerdon (1983), Rogoff (1985), Walsh (1995), Kanzuri (1985), etc. discovered ways to eliminate the problem of time inconsistency. "(delegation of authority), "trend", "contract" and so on. In the second article, Barrow and Gordon (1983) considered the reputation of the policymaker as one of the solutions to

prevent the formation of inflationary distortion and time inconsistency. From their point of view, a potential solution to solve the problem of inflation is to impose some costs on the central bank. If the central bank deviates from its announced policies on reducing inflation, this will increase the final cost of inflation. One of these methods of formation of these costs can be the damage caused by the reputation of the central bank. Next, Rogoff (1985) investigated the degree of independence of the central bank in the framework of game theory, and this great work was used as a basic article in the field of central bank independence and optimal monetary policy in the following years. Rogoff states that monetary policy should be delegated to an independent central bank that is more anti-inflationary than the government so that this independent central bank gives more weight to inflationary losses than the government. In this case, in the balance of conservatism, the central bank creates a lower inflationary burden than the government. Inflation and therefore expected inflation will be lower when monetary policy is controlled by someone, we know to be inflation-averse. In a seminal paper (1995) entitled "Optimal Contracts for Central Bankers", Walsh argued against Rogoff's view that monetary policy should be verbally contracted rather than left to an independent and conservative central bank. Be clear between the government and the central bank. Walsh stated that the government should define the final goals of the central bank to be implemented according to the contract and then allow the central bank to choose the means to implement these goals.

Walsh's theory is also known as the original agent theory. In this theory, the government (as the principal) signs a contract with the central bank (operator) that specifies monetary goals and incentives in this contract, and the central bank has the task of implementing these policies with the independent means that it chooses. Alsina and Tablini (1987) in a fundamental article in the framework of game theory investigated the source of time inconsistency in monetary and financial policies. They state the source of time inconsistency of the optimal monetary policy due to the effects of tax disturbances and in the framework of game theory they showed that if the monetary policy and finance are not coordinated, binding commitments to monetary rules do not necessarily improve welfare. Dixit Lambertini (2000 and 2003) investigated the conflict between the strategies of the government and the central bank. In these articles, Dixit and Lambertini, unlike other articles that considered an exogenous role for the financial authority (government) in the strategic game with the monetary authority, tried to assign an active role to the government and state that in reality, the confrontation between Monetary and financial policymakers lead to different consequences in

macroeconomic results. They assumed that the function of the policy objective is a financial function of social welfare. The monetary policymaker has independent tools in pursuing the goal of conservatism, each of the policymakers chooses their behaviour independently, therefore this type of confrontation is a non-cooperative game. The results of their achievements show that:

- 1- If there is no type of commitment policy or leadership in the game structure, the confrontation between the conservative central bank and the financial authority that maximizes social welfare will lead to sub-optimal and marginal consequences;
- 2- Fiscal policy leadership usually creates a more favourable product level than monetary leadership.
- 3- The problem of time consistency of monetary policy can be solved by committing to the rule.

Another category of studies can be presented by referring to the fundamental article of Sargent and Wallace (1981) entitled "Some Disadvantages of the Principles of Monetarists". In this article, by using the framework of game theory analysis in the space of Stackelberg games, they were able to analyze the ideas of the monetarist school and Friedman. To this issue, they deny that the monetary policy maker can have permanent control over inflation. After this great achievement, many articles criticized or expanded the work of Sargent and Wallace, which can be mentioned in the works of Darby (1984), Miller and Sargent (1984), Togo (2007), etc. In this article, Sargent and Wallace (1981) designed a model in the framework of Stackelberg games in which, under certain conditions, the monetary policymaker cannot have permanent control over inflation. This issue occurs when the financial policy prevails over the monetary policy; That is, the government acts as a leader and the central bank acts as a follower. This is Sargent and Wallace's point of view against Friedman's point of view; Because Friedman argues that the monetary policymaker can have permanent control over the inflation rate, especially in the long run; But in this article, Sargent and Wallace state that even in an economy where the assumptions of monetarist school supporters are satisfied, if monetary policy is interpreted as an open market operation, monetary policy is not able to permanently control inflation. One of the important assumptions in this model is that If the government creates a budget deficit, the sale of bonds to the public has an upper limit, public demand for bonds cannot continue forever, and the existence of demand for bonds in their model means that the productivity rate of bonds is greater than the growth rate. It is the economy.

1. The concept of investment and the basics of its evaluation

Investment is any sacrifice of value now (which is usually known) in the hope of obtaining any value in the future (which is usually unknown in quantity or quality), in other words, the investor sacrifices a certain value. To get the special value, he wants for it in the future. Roudpashti and Zamardian (2008) believe that investment in the economy only includes expenses that increase the stock of capital goods such as factories technical equipment or stock of goods.

Nazari (2005) believes that investing in the macro economy means increasing the productive capacity of the society, which is in three forms: 1- Investing in machinery; 2- Investment in building and 3- Investment in warehouse inventory. In macroeconomics, investment means only the purchase of new physical assets, and the purchase of existing physical assets or the purchase of financial assets (stocks, bonds) is not considered an investment. Investors believe that they invest their capital in more than one option to minimize the risk of any losses and reach a balance point compared to competitors so that all competitors benefit, so knowing the strategies of competitors in conflict conditions is necessary to benefit from it and it seems necessary.

Nouri Boroujerdi (2008) believes that the development period of an investment option can be divided into three parts: 1- before investment; 2- Investment and 3- Operational. Among the above three stages, pre-investment stage 3- is of special importance, and in fact, it is in this stage that various reviews and studies about the presented plans regarding the feasibility, implementation method and... A decision project is made, in fact, the life or non-life, the start or non-start of a project, is determined at this stage of the work. Although there is a possibility of modification in the next stages, using this possibility involves significant costs. Game theory is considered among rational choice theories, and it is also a specialized and mathematical form of the wise actor model in decision theories. This theory was first proposed by the great French mathematician Emile Burrell in 1921, and later by other theorists, including the mathematician John von Neumann (prover of the minimum theorem in 1928) and the economist Thomas Schelling. "(who expressed the bargaining theory) completed this theory.

The problem of game theory is that human social behaviour is calculated and rational, and it considers humans as rational beings; It means that man acts based on profit and cost and has a calculating economic and material behavior. One of the main assumptions of the theory of games is the principle of "minimum and maximum" that every player seeks to increase the minimum

score that he is sure to get and seeks to reduce the maximum loss that is unavoidable. Of course, this principle applies to the zero-sum game.

The theory of games seeks the question of how much an actor can present a logical and formal model. Or what should actors do to achieve their interests without resorting to war?

In response to the question, above the theory of games puts forward several hypotheses, of which we state two of them

- 1) Any rational actor will try to secure his interests even at the cost of war
- (2) If the actors pay attention to the strategies of their competitors and have common interests in mind, they can bargain without cost and avoid war and military confrontation.

In his theory, "Martin Shubek" proposes two types of game rules, the game with zero algebraic sum and the other game with non-zero algebraic sum in two-player and multi-player games.

Another interpretation of the theory of games that can be mentioned is the interpretation of "Thomas Schelling", who states that there are three types of games: one is a game with similar interests, the second is a game with opposite interests, and the third is a game with mixed interests.

Schelling adds the process of bargaining to the above and says that with bargaining, conflicting interests can be brought towards the homogenization of interests. Therefore, he used bargaining in two forms: counter-threat (the cowardly young man's riddle) and reward commitment (the prisoner's riddle). There are several options in the Cowardly Youth puzzle:

- 1- both actors have the ultimate conflict against each other, 2- both actors cooperate for each other's benefit, 3rd and 4th- both actors run away from fear of the other.

In the prisoner's dilemma, he describes four cases: (1) bilateral cooperation of silent bargaining, (2) non-cooperation of both, and (3) and (4) the strategy of non-cooperation of one and cooperation of the other.

The Nash equilibrium (1950) was proposed by John F. Nash, winner of the Nobel Prize in Economics in 1994. In this form of balance, each of the players without collusion or cooperation with others and regardless of the welfare of the society or any of the players, adopt the best possible strategy in line with their interests. For example, the equilibrium game of "Adam Smith" (invisible

hand) in which the competition between the producers with the motive of obtaining profit for themselves determines the price at the lowest level is a type of non-cooperative equilibrium that is efficient, because the abundant good at the lowest possible price. It ends in the benefit of people and consumers, but the game of environmental pollution or the arms race in which the competition between producers is at the expense of countries, people and consumers, are ineffective non-cooperative equilibrium type. Of course, arms control agreements can change this balance to a less ineffective non-cooperative balance and competitors can increase their security and welfare margin.

Gibson (1992) and Torkey (2001) believe that game theory is the formal study of conflict and economic enterprise, the theoretical concepts of games are used when the actions of several agents are independent of each other. These representatives can be individuals, groups, companies or any combination of them. The concept of game theory provides a language to structure, analyze and formulate strategic scenarios.

Asgharpour (2013) believes that according to the classical issues and the modern evolution of knowledge, games are analyzed today based on three abstract forms: normal form, coalition form and dynamic form. Players in the normal form decide to choose one of their strategies simultaneously and without cooperation, while the decision-making in the dynamic form is in the form of a "decision tree" and decisions are made sequentially (with information or adopted without knowing the competitor's decision in the previous stage. Some players join their desired coalition in a coalition form so that each coalition can obtain a special benefit that will be characteristic of that coalition by cooperating with its bringers.

The competition between economic enterprises, both inside and outside the borders, has made it necessary to speed up and facilitate the accurate identification explanation and definition of issues, collect information and evaluate them, and choose the most appropriate solution in the decision-making process so that managers can Those who can keep pace with global developments and changes should be aware of the latest findings, the most advanced tools and the most logical quantitative methods such as mathematical models and apply them in response to the need for decision-making in practice. Game theory is one of the methods that managers use in conflict situations so that they can make rational decisions in front of their competitors. Game theory plays

a significant role in managers making rational decisions in confrontation with competitors by respecting the interests of the parties achieving utility and minimizing the risk.

3. Game theory and stock investment

Game theory is trying to use mathematics to estimate the behaviour in strategic situations or in a game in which the success of an actor in his choice depends on the choice of other actors, in other words when the profit of an entity depends only on his behaviour. is not affected by the behaviour of one or more other entities, and other decisions have a positive or negative effect on his profit, a game has been formed between two or more mentioned entities. Looking at the mechanism of the capital market, it can be seen that the actors of this market are actors of a static game with a conflict of interests. Game theory tries to use a mathematical technique to analyze problems that include conflict situations. This model was first introduced by Burrell in 1921 and developed by Van Neumann and Morgenstern (Asgharpour), 1393).

In the zero-sum game, the profit of the first player is the loss of the other player or players and vice versa, so the minimum profit of each player is the maximum expected profit of the competitor. They advance their profit-making and maximize their profit.

Games have many dimensions and different classifications can be made (Abdali, 2015);

a) static or dynamic game; In a static game, the actors play at the same time and none of them know what will happen in the opposite actor's movement, but in a dynamic game, the actors' movements will take turns.

b) Conflict of interest or the possibility of cooperation; In most games, the amount of a player's win is exactly equal to the amount of loss of the opponent or opponents, which is called zero-sum game correction. In such games, there is a complete conflict and conflict of interests, while sometimes, even though the interests of the actors may not be in line with each other, it becomes possible for the players to cooperate to obtain more resources. However, when dividing the results of the cooperation, the conflict of interests is revealed again.

c) cooperative or non-cooperative game; Games can be cooperative or non-cooperative. In the non-cooperative game, to maximize the result, according to the chosen strategies of the opponent or opponents, they may finally choose the strategy that does not lead to the greatest possible benefit,

therefore, in the cooperative game, the players try to They are getting higher benefits by using alliances with other actors.

The variety of investment methods and the complexity of these decisions have increased significantly in the last few decades. This extensive growth created an increasing need for comprehensive and integrated models, to meet this need, financial modelling has been created from the link between financial approach and mathematical planning. These models use advances in mathematical planning and financial issues in parallel. They say (Khodamoradi and Rai Ezzabadi, 2013) that the basic limitation that is often required in the practical application of the problem of choosing an investment portfolio limits the number of assets to the chosen investment portfolio, adding other limitations such as capital limitations increase the complexity. As a result, many efforts have been made to develop efficient innovative methods to solve the problem. (Golmakani, 2011).

There are two basic characteristics in financial markets. First, there is the problem of conflict between market players. In this market, the total performance of the capital market actors, or in other words, the total performance of the players, makes the market performance and general direction, and on the other hand, the performance of an affected player. from the general performance of the market or in other words the performance of other actors. The second characteristic of financial markets is uncertainty. These two characteristics are one of the main elements in game theory, which analyzes the optimal decision-making of an actor. It evaluates the results of people's transactions with other actors. It shows that special mathematical techniques have been developed for conflict analysis in competitive issues. Game theory provides an analytical framework for studying complex transactions between rational actors using mathematical tools (Osborne, 2004).

The purpose of the development of this theory is to evaluate the rational ways of confronting conflicting groups or individuals, from economics and engineering to political science, philosophy and even psychology, and to ensure that one of these actors wins (Myerson (1991), one of the techniques that has recently It has improved its position among the approaches of choosing the investment portfolio in the world.

A technical presentation game is a situation in which the result of each person's action depends not only on his own action, but also on the action of other people, so the optimal decision he makes is

related to his expectation from the actions of others. The condition of the game is that before making a decision, each player must analyze the reaction of others to his choice and decision, then make the decision that is best for him. The main goal of game theory is to develop reasonable criteria for choosing a policy or strategy. Is. In the framework of game theory, policies are defined as a set of decisions that an actor can choose in any decision situation. The development of criteria for choosing the optimal policy in game theory is based on two assumptions; The first is that all actors are wise and logical, and the second is to use all their strength against the opponent to achieve the best result. The meaning of acting wisely is that a person thinks deeply about it before taking action. slow down and consider his goals, preferences and limitations, then choose and act in such a way that he does not suffer (Abdali 2015)

In Iran, due to the youth of financial science, not only the problem of choosing the optimal portfolio but also the answer to this problem through game theory has been neglected, so the results of this research mainly provide a model for forming the optimal investment portfolio using the standard coalition game. Optimizing the portfolio of investors can lead to an increase in motivation and confidence and as a result, their presence in the financial markets increases information efficiency and allocation efficiency for financial markets and facilitates the transfer of society's resources to productive activities.

This theory divides games into two general categories; Cooperative games and non-cooperative games. Collaborative games are a type of game in which players make alliances with each other to gain more utility. Considering that investors in a financial market participate in a big game, whose benefit and utility depend on the game of other investors and the market, forming a coalition among investors, can increase the collective utility of coalition members. Therefore, the cooperative game approach can provide a solution to find the optimal portfolio (Tataei and Roodpashti Rahnema, 2016).

4. Economic evaluation of investment options

Alwani (2008) believes that decision-making consists of choosing a solution from among different ways, as seen in this definition, the main job of the decision-maker is to receive the possible ways and the results resulting from them and choose the right one from among the different solutions. And if the manager can make this choice correctly and optimally, his decisions will be effective and productive.

Nikumram et al. (2008) believe that the financial manager plays a role in the optimal allocation of financial resources by interfering with how funds are spent. Getting to know the methods and techniques of evaluating capital options to determine their benefits and costs is effective in the optimal use of resources. The financial manager with a detailed knowledge of the capital market and various financial instruments can invest the surplus funds of the economic enterprise and these funds also be used in the best way, long-term investment evaluation, making decisions about the types of investments and choosing the most suitable project, constitute the capital budgeting process and are considered one of the most important topics of financial management, capital budgeting decisions, including Long-term decisions are for the continuation of economic enterprises. Such decisions are considered as one of the methods related to allocating funds to projects that have a long life. For example, production of new products, factory construction or equipment replacement decisions can be considered as capital budgeting decisions.

Investment planning is a process that determines the method and amount of current and future investment according to the financial situation, future financial goals, risk level and tax conditions. A successful investor needs time and careful planning. To get a good result from your investment, you should use a correct strategy that pays attention to the following points:

- 1) Having a long-term and short-term plan and constantly reviewing investment strategies;
- 2) paying attention to the methods of increasing capital return;
- 3) Investment risk management
- 4) Using diversity in investment.

Long-term investment requires the allocation of appropriate amounts of cash and also leads to the creation of long-term obligations, which are related to the basic decisions of the economic enterprise whose results are revealed in the long term. Decisions such as the construction of a factory or expansion and influence in the foreign market affect the performance of several periods of the economic enterprise. Such decisions are among the strategic decisions that are considered in the capital budgeting process.

One of the best ways to use financial resources and surplus funds is to buy shares of other companies and earn a good profit. Managers of industrial and service units can allocate their company's surplus funds to various sources by using decision-making techniques and making the

most of the opportunities in the capital market. Due to the sensitivity of investment, managers should be able to correctly apply the problems in investment and economic evaluation of capital options by applying and correctly using modern mathematical techniques, because risk and hazards are caused by decisions and it is possible. By making a wrong decision, an economic enterprise can lead to bankruptcy and destruction.

To optimally allocate financial resources and choose investment options, managers must have relative familiarity with decision-making and its types.

1- Decision-making in conditions of confidence

In this type of decision-making, there are no uncontrollable variables in the decision-making model. Modelling in such decisions is based on mathematical models. The techniques of this method are:

A- Various techniques of engineering economics such as the rate of return on investment, current value, cost and uniform annual income, the ratio of benefits to expenses and the period of return on investment;

B- Mathematical programming such as linear programming, zero-one programming and ideal programming;

C- point-to-point analysis;

D- replacement analysis;

2-Risk (conditions of uncertainty)

Nikumram et al. (2005) believe that risk conditions are conditions in which the decision-making method cannot be determined with certainty. For example, if a company invests in a project because the income and profits will be obtained in the coming years and the future cannot be predicted, it will be in a risky situation. Risk or hazard is a phenomenon that is defined based on the deviation in the results of investment with the expected values. In other words, the difference between the actual results and the expected results of the risk is defined.

Risk is mainly seen in decisions related to the future, and we must perform risk management in the economic evaluation of investment options. Risk is an inseparable factor in investment, and

decision-making under risk conditions is when past information helps to predict its probability. will do in the future It is very important to be aware of the risk tolerance of each person, choosing investments that are suitable for the risk tolerance of the person and determining the amount of participation according to his financial situation will allow the investor to benefit from the maximum return with the least tension and stress. Participating in investments that are more than a person's risk-taking ability or impose a lot of financial pressure on him, causes a person to feel at risk and suffer a lot of stress with a small change in the capital market. High stress will cause non-specialized, quick and short-term decisions. On the other hand, the investor will not have the necessary patience for the situation to return to normal. As a result, at the worst time when the rates are at their lowest level, he decides to exit the capital market and convert it into liquidity and incurs a double loss after deducting taxes or related crimes.

There are many cases of using risk in the economic evaluation of investment options and there are many documented methods:

A- Carrying out all the techniques mentioned in decision-making in conditions of certainty in a possible state;

B - Mathematical hope method of variance coefficient of variation and correlation coefficient;

C - Simulation models such as Monte Carlo;

T - Tree decision making;

D- Dynamic planning (dynamic system) and.....

E- Dynamic planning (dynamic system) and.....

3- Making decisions in conflict situations

Esco Nejad (1368) believes that this type of decision is related to the time when the recipient, competing strategies or competitors replace uncontrollable variables. Among the important techniques in this type of decision-making, we can mention "game theory".

Investing in any project is associated with risk conditions, and it is not possible to determine whether or not projects are economical with simple engineering economics methods (such as rate of return on investment, current value, uniform annual cost and income, ratio of benefits to

expenses and duration return on investment) is enough and the initial investment in each project needs to know competitors' strategies in decision-making so that we can make optimal decisions. Sometimes, to reduce the investment risk, the investor allocates his resources to several investment projects, in other words, he forms an investment portfolio. Hosseini (2008) believes that in a limited field, humans can control the repetition of possible consequences well. Investments that are made to reduce a large number of unpredictable consequences are called means of risk reduction. In this situation, there is competition between profitability and risk, and our optimal point should give us the lowest total cost. (or the most profit if income or benefits are desired)

2. Classic model based on game theory

Dynamic form

This form of game is known as "tree form" and the existing strategy of competitors in this form is not adopted simultaneously. The dynamic form of a game usually includes the most description of the conditions of that game, but the analysis and calculations of this form of game are not easily possible, especially for cases where the number of players and their strategies are large.

In real conditions and at the time of buying and selling this form of the game happens many times, the buyer of shares in the capital market among the shares of many companies that are presented in the market, must decide which shares to buy according to the collected information. to buy, and the seller of shares is subject to the prevailing market conditions in selling shares. The seller and the buyer are looking for the maximum benefit (profit) from playing this game. To learn more about dynamic games, we present an example of investing in the stock market.

In the capital market, one side is always the seller of shares and the other side is the buyer of shares, the condition of playing this game is that the seller presents his shares in the capital market and the buyer on the other hand is willing to buy those shares.

Player A is the seller of shares and player B is the buyer of said shares (a two-player game in normal form). In this game, the buyer and the seller of stocks each have two strategies.

Seller\Buyer	B1	B2
A1	12*,7	4*,9*
A2	10,10*	4,8

Figure 1: Game (1)-(seller and buyer of shares)

It can be seen that (A1, B2) represents the Nash equilibrium point of this game in normal form (both players' preferences for this point are "marked" at the same time. Let's assume that game (1) is a game considered a tree, such that A is the first decision maker and B is the second decision maker. Let the game (1) be considered as a tree game player or a natural move and the branches represent chosen strategies or random options (Asgharpour, 2001, p. 364) Game (2) includes two players A with two strategies (A1, A2) and B with two strategies (B1, B2) so that A (stock seller) is the game starter and the first decision maker, and B is the second decision maker and after A makes a decision, he chooses one of his strategies. At the time of making the decision, player B is aware of the strategy chosen by A and knows which of the points to make the decision, but if B is not aware of his position and the strategy Chosen by A is unaware (while knowing, A has made a decision) the conditions will also be different. For example, in the stock market, it can be seen that the queues for buying shares of some companies are very long, while the sellers of those shares do not want to sell them, which leads to an increase in the price of that company's shares. Now the buyer must decide whether to buy the shares of the said company at a high price and bear the risk of paying the high price, or whether to buy the shares of another company. On the other hand, the stock seller is facing a similar problem and the seller must decide whether selling the stock at the mentioned price will get the most benefit or whether there is a possibility that the price of the stock will decrease in the future. Dynamic games help to make the right decision in such issues.

B (buyer of shares) due to the knowledge of the decision taken by A (seller of shares); 2 will select B if A1 is adopted and B1 if A2 is adopted. Therefore, based on CKR logic, A chooses 2 A from the first rank. It means that (A2, B1) in the dynamic state represents the equilibrium point, which is different from the normal state. Game analysis (2) using the backward method and CKR logic has led to access to the equilibrium point of that game. This analysis leads to a correction of the Nash point for a dynamic game.

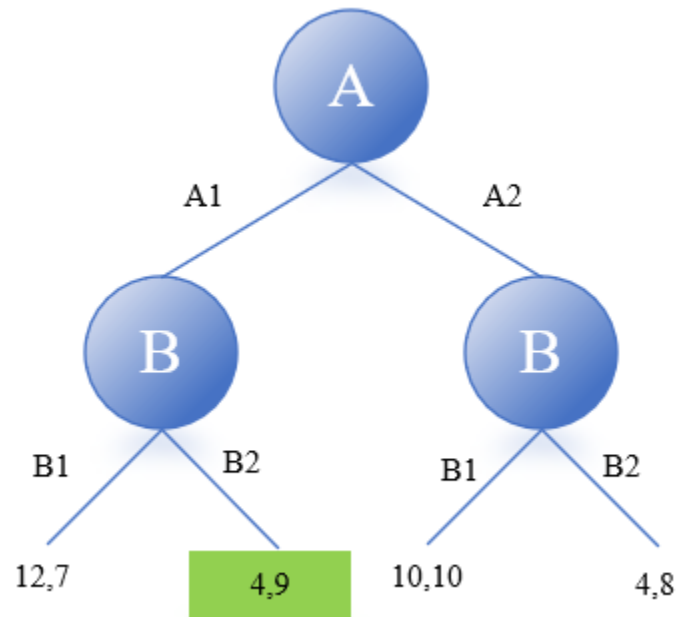


Figure 2: Game (2)- (B makes a decision knowing A's decision)

5. Conclusion

As stated, economic enterprises have to make correct and timely decisions to fight against their competitors to hope for their survival in the future. The prevailing trends in the capital markets (securities, housing, etc.) all indicate that knowing the behaviour of competitors can help investors to get the most profit and benefit from their capital. In this article, we are trying to use the theory of games to provide appropriate and correct reactions to competitors' moves in the evaluation of investment options in stocks and provide the necessary answers simultaneously with competitors' (simultaneous games) cooperative games. (Coalition form) and dynamic data games and achieve a balance with our competitors in the markets in such a way that all competitors get the necessary benefit from it.

Considering that investment decisions are among the most important decisions that have become inevitable in economic business and are formulated and implemented in the framework of strategic planning, therefore, it is very important to know the methods of dealing with competitors' strategies in the economic world. (domestic and foreign) play a significant role in directing investment options and they can guide the capital market in the path of prosperity and growth with proper competition.

References

- [1] Abzari, M. A book, Abbasi A. (2008). Optimizing the investment portfolio using linear programming methods and presenting an application model, special issue of the Accounting Journal of Social Sciences and Humanities, Shiraz University 22-22
- [2] Eskonejad, Mohammad Mehdi (1998). Engineering Economics, Amirkabir University of Technology Publications.
- [3] Asgharpour Mohammad Javad (2008). Group decision-making and game theory with a research perspective in Tehran publishing operations.
- [4] Asgharpour, M. (2013). Group decision-making and game theory with an operational research approach. Tehran: Tehran University Press
- [5] Alwani, Seyyed Mehdi, (2013), Public Management, Ney Publishing
- [6] Tatai P; Guide to Rudpashti F. (2016). Market failure using the recommended portfolio based on the financial engineering and securities management alliance game 24-1
- [7] Tehrani R.; Noorbakhsh A. (2012). Financial theories of advanced financial management). The look of knowledge.
- [8] Hosseini, Seyyed Mohammad and Amouzgar, Morteza (2018). Engineering Economics and Decision Analysis, University of Science and Technology Publications
- [9] Devotion S.; Rai Ezzabadi. M. (2013) Designing a mathematical model of optimal financing in industrial holding companies (the internal capital market approach of financial engineering and securities management 18-1
- [10] Daryabar A. (1395). Providing a model for portfolio optimization in the bubble space. Ph.D. Thesis
- [11] Abdali. Q. (2015). The theory of games and the application of those static and dynamic games with complete information). Tehran: University of Tehran Jihad Publications
- [12] Abdoli. Q. (2015) Theory of games and its applications, incomplete evolutionary and cooperative information games, Tehran, Samt Publications.
- [13] Falahpur. s. stenographer ..f; Hashmi, S. (2014). Optimizing index tracker portfolio using stable single index model based on index of 50 most active companies of Tehran Stock Exchange. Quarterly Journal of Financial Engineering and Securities Management of Central Tehran Faculty of Management
- [14] Nikumram, Hashem and Rahnamai Roud, Pashti Fereydoun and Hibti Farshad, (2008). Fundamentals of Management, Finance Volumes I and II, Terme Publications.
- [15] Alesina, A. and Tabellini, G. (1987). Rules and Discretion with No Coordinated Monetary and Fiscal Policies. Economic Inquiry, 25(4), 619-630
- [16] Darby, M. (1984). Some pleasant monetarist arithmetic, Federal Reserve bank of Minneapolis Quarterly Review, vol 8 No 2.
- [17] Gibson, R.; 1992. "Game Theory for Applied Economics", Princeton University Press, Princeton, New Jersey.
- [18] Golmakani, H., & Fazel, M. (2011). Constrained portfolio selection using particle swarm optimization. Expert system with application, 8327-8335
- [19] Kocak, H. (2014). Canonical Coalition Game Theory for Optimal Portfolio Selection. Asian Economic and Financial Review, 1245-1259.
- [20] Kuhn, H.; Harsanyi, J.; Selten, R.; Weibull, J.; Van Damme, E. and Nash, J. (1994). The work of John Nash in game theory, Nobel Seminar
- [21] Malafeyev, O., & Awasthi, A. (2017). Dynamic optimization of a portfolio. Saint Petersburg
- [22] Miller, P. and Sargent, T. (1984). A reply to Darby, Federal Reserve Bank of Minneapolis Quarterly Review, Vol 8, No 2.

- [23] Myerson, R. (1999). Nash Equilibrium and the History of Economic Theory, *Journal of Economic Literature*, 37(3): 1067-1082.
- [24] Myerson, R. N. (1991). *Game Theory, analysis of conflict*. Harvard University. Press
- [25] Osborne, M. (2004). *An introduction to game theory*. New York: Oxford University Press.
- [26] Togo, E. (2007). *Coordinating Public Debt Management with Fiscal and Monetary Policies: An Analytical Framework*, Policy Research Working Paper 4369.
- [27] Turocy L.T.; (2001). "Game Theory"; *Encyclopedia of Information System*, Academic Press, appeared in 2002.
- [28] Walsh, C. E. (1995). Optimal contracts for central bankers. *American Economic Review* 85, 150-167
- [29] Watson, J. (2008). Nash, John Forbes (born 1928), *From the New Palgrave Dictionary of Economics*, Second Edition.
- [30] Zhang, X., Zhang, W., & Xu, W. (2011). An optimization model of the portfolio adjusting problem with fuzzy return and a SMO algorithm. *Expert Systems with Applications*, 3069–3074.