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Cooperative and Non-Cooperative Game Theory in Financial Accounting: Insights into Government Subsidies

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Abstract: To depict the dynamics between the two decision-makers in the research, two models are developed: one based on game theory and the other on cooperative dynamics. Russian water delivery networks as they stand right now, with a focus on the replacement of a large chunk to prevent disastrous repercussions. Government subsidies are used to build models of cooperative and non-cooperative games using an innovative approach to financial accounting. An investigation of the Volga River Water Diversion Project in the southwest of the country is conducted to demonstrate the effectiveness of the concept. The Volga River has ongoing challenges in its ability to purify itself and provide potable water as a result of pollution and diminishing resources, similar to other significant rivers in Europe. Currently, national goal programs are being put in place to guarantee the fast development of certain regions within the Russian Federation. These programs seek to provide the best possible environment for investment to flow into different areas of regional development. In theory, the Shapley value is defined by characteristics with appealing real-world implications; hence, its application in practical settings is easily justified. The Shapley value is an important solution idea in voting games in general, and optimal water supply and income rose in tandem with the number of subsidies, while water work costs fell.

Keywords: Shapley's value, non-cooperative and cooperative games Supply chain of water, Volga River Water Diversion Project

I. Introduction

The Soviet Union has colossal new surface water resources. In Soviet lakes and streams, one tenth of the world's absolute new water is contained [1]. Regardless, the distribution of these water assets in the USSR is unequal. The Icy and Pacific seas receive 84% of the country's annual stream spill, which flows north and east through an underdeveloped and financially immature region. The remaining 16% is distributed throughout the country's southern and western regions, which cover 75% of the country's population, 80% of financial activity, and 80% of cropland, including the most productive fields [2].Just about 15% of Russia's population lives in the Arctic and Pacific Ocean basins, which provide the vast majority of the country's water resources. The Volga River Water Division Project and the South to North Water Division Project are multi-objective water supply schemes that support urban industry while also considering agriculture and the environment, which are both operational and public welfare issues. The government's investment in these projects is intended to maximize their overall benefits. [3] revealed that from the perspectives of property rights life, central government interference, and market competition, researchers looked at the government's proclivity to subsidies firms with high losses and their economic ramifications. Domestic and foreign researchers have compiled a list of government incentives in the supply chain. Their research, which focuses on the effects of subsidies, subsidy products, and subsidy weight, relies heavily on the game [4]. [5] described that through three separate game relationships: the Nash game, the Stackelberg game, and unified supply chain decision-making, the government subsidies cooperative low-carbon supply chain emissions control investment. As a result, advancement does not indicate the application of better knowledge. Subsidies are the most direct way for the government to play a "helping hand" role in the transitional economy [6]. Organizations must evolve and keep ahead of the competition to secure their long-term existence by releasing new items or services, boosting the quality of their production measures. Using a Stackelberg decentralized and unified decision model of the supply chain under government subsidies, the impact of changing government subsidies on pricing decisions was examined.In recent years, creativity has come to be seen as a critical component in retaining seriousness in a globalized economy. Development can resurrect dormant consumer sectors and act as a framework for strengthening any organization's capacity to respond to evolving conditions [7]. A contract in which a company owner leases a piece of equipment to a buyer (renter) under a leasing agreement is known as hardware renting and businesses are increasingly renting equipment rather than purchasing it [8]. More than 80% of companies in the United States rent at least some of their facilities, and almost 90% say they would rent again if the chance existed [10]; [11];[12]and [13] have all studied policy blend and concluded that coordinating financial and monetary policies is advantageous and In the Euro zone, there are significant difficulties in coordinating policy mix [14]. This article contributes to the corpus of knowledge by focusing on ineffective sports. The adaptive utility game [15] and the non-adaptable utility game [16] are two categories of useful game theory. The result of the calculating designation game can be revised throughout the utility game procedure. [17] used various evolutionary equations and added option modules based on the game hypothesis to minimize the region minor expense of buyers. The instruments of this technique's arrangement are associated with decency, efficiency, and consistency in conveying settlements among specialists estimated the cost-effectiveness of various types of water used in the Volga River Division Project and proposed a government subsidy for farm water with low bearing capacity. [18]developed a three-stage game model for the green supply chain that takes into account commodity greenness and government subsidies. The outcome of each expert in an alliance in the NTU game is solely determined by the actions chosen by the specialists in the alliance. Shapley value is derived from Shapley's description of the arrangement concept in agreeable game hypothesis [19]. The Shapley value of a professional indicates its ability to play the game in a beneficial game hypothesis. It's useful because you choose to assign the importance that a group of players will achieve if they want to participate [20]. As the alliance's outcome distribution scheme based on game hypothesis, [21] [80] got Shapley values. [22]investigated the spatial relationship between estimation distribution and successful detection of wonders in the region. [23] used the Shapley value to transform the estimation allotment problem into a fun game. They discovered a number of consistent outcome allocations, such as universal beliefs that all specialists would adhere to. They presented a randomized methodology to process the predicted Shapley value within a reasonable time to avoid unmanageability in the estimation of correct Shapley value.In this modern technique, game theory, part strategy, and hypothesis of agreements were used extensively. [24] said that accountings have used these tools to reduce moral risk and anxiety for experts by shortening the timeline for delivery processes and agreements. How government subsidies should be used to align the needs of companies in the water transfer project value chain in underdeveloped areas in order to ensure long-term water supply has become a hot topic of debate. In this case, the agreeable game theory proposes various relationship ideas with appealing properties such as security, logical joint extension separation, and uniqueness to resolve the problem of partnership forming [25].Rivers freeze for up to eight months in northern Siberia and the Far East, ranging from one month in the southwest between the Caspian and the Black Sea to up to eight months and longer in the Far East. Ex-risk management of professionals via stochastic checking has replaced writing on the ex-post evaluation of accounting volatility. [26] proposed three-tiered guarantee administration contracts between the manufacturer, the specialist, and the client. They selected the best deal worth, guarantee time, and guarantee cost for the producer and the best support cost for the expert by increasing their benefits in numerous game-hypothetical games. [27] offered a layered showing engineering for unshakable quality, durability, and adaptation to internal failure investigations that includes dynamic half breed deficiency displaying and extend transformational game hypothesis. The engineering combines' endurance research and transformative game hypothesis with traditional half breed shortfall models and their applied imperatives in understanding calculations. To save energy, egotistical hubs will not forward packages to other hubs, causing the organization to stutter. Simultaneously, a few hubs may be nefarious, with the goal of causing harm to the organization. In this case, the helpful game hypothesis addresses the issue of alliance formation and proposes a variety of options with appealing qualities such as consistency, appropriate allocation of joint additions, and originality. [28] The beneficial game hypothesis differs from its non-agreeable counterpart in that it allows participants to shape formal arrangements, thus there is always a driving drive to collaborate in order to get the best overall result. Under a game hypothetical framework, [29] analyzed the collaboration incitement and security in self-coordinated distant groups. The adaptability to internal failure and security issues is shown as a non-agreeable game in which each participant increases their own utility capacity. Across the country, total water admission for domestic needs is just about 3% of the average annual stream. By the way, it accounts for 33% of total Russian water admittance in the Volga Stream bowl, and it exceeds the ecologically tolerable amount of water deliberation in several canal bowls [30]. The goal of this investigation is to pique the interest of a non-expert reader in why center cooperation is important in the study of bookkeeping wonders, the types of wonders that have been studied, the techniques and hypotheses used in the study of water plants, and the effects of various government appropriation sums and endowment modes on water supply amounts.

1.1 Volga River

The Volga River, also known as the Russian Volga, was formerly known as the ancient (Greek) Ra or (Tatar) Itil or Etil, and is Europe's longest river, as well as the major waterway of western Russia and the historic cradle of the Russian state. Its basin, which covers roughly two-fifths of Russia's European region, is home to about half of the Russian Republic's people. The Volga is one of the world's major rivers because of its tremendous economic, cultural, and historical significance, as well as the sheer magnitude of the river and its basin. The Volga River rises in the Valdai Hills northwest of Moscow and empties into the Caspian Sea[1],some 2,193 miles (3,530 kilometers) to the south. It drops slowly and majestically from its source 748 feet (228 meters) above sea level to its mouth 92 feet below sea level. In the process the Volga receives the water of some 200 tributaries, the majority of which join the river on its left bank. Its river system, comprising 151,000 rivers and permanent and intermittent streams, has a total length of about 357,000 miles.

1.2 Physical features of Volga River

The river basin stretches from the Valdai Hills and Central Russian Upland in the west to the Ural Mountains in the east and narrows dramatically at Saratov in the south, draining 533,000 square miles (1,380,000 square kilometers). The river runs for 400 kilometers from Kamyshin to its mouth, free of tributaries. Within the Volga basin, there are four distinct geographic zones: dense, marshy forest from the river's upper reaches to Nizhny Novgorod (formerly Gorky) and Kazan; forest steppe from there to Samara (formerly

Kuybyshev) and Saratov; steppe from there to Volgograd; and semi-desert lowlands southeast to the Caspian Sea[2].

II. Description of the Basic Concepts

2.1 Explanation of Research Methodology

In a non-helpful game, players make decisions independently of one another. In our model, the government and the central bank are separate experts pursuing specific objectives. The government is committed to achieving the highest possible rate of Gross Domestic Product growth, while the central bank works to keep inflation on track in order to ensure price stability. To accomplish their objectives, each role employs a different strategy apparatus: the public authority's budgetary surplus and the national bank's loan costs. The new research takes a unique approach to the development of calculation standards and accounting procedures. Rather than chronicling and analyzing ex-post results, the focus is on contracting and motivators, as well as the control of human behavior. As a result of the development of various national undertakings, cross-regional water transfer schemes are becoming more common in Russia. They have a variety of effects on macroeconomic elements as a result of their respective objectives, and hence have an influence on each other's arrangements. The primary test in demonstrating a disagreeable game is to improve the objective work in terms of imperatives. Below is a step-by-step explanation of the development approach.

2.1.1 Definition of Game Theory

The dialogue between at least two players is modeled by the Game Hypothesis. The hypothesis aims to create a model to predict the outcome of a disagreement between ordinary people, which often involves vulnerability and data disparity. We agree that the players are reasonable and that they all need to increase their daily usefulness. In game hypothesis, everybody is aware of the methodologies and changes that are available to them. Regardless, they have no idea what the other players' machine choices are. The outcome of one match has an effect on a large number of other players. Game Hypothesis may be classified as either beneficial or unhelpful. When playing a helpful game, the teams are in a situation where they have reached an official agreement. There is no official agreement between the participants in a non-helpful game.

2.1.2 Non-Cooperative Game Model

The Scott text uses the example of a financial sponsor and an administrator to demonstrateexample of how this model works. The buyer needs altogether relevant and reliable information about the car in order to assess the vehicle's average value and the risk of the transaction. The merchant does not want to know all of the bad information about his car. The car may become more difficult to sell, he may need to spend money on repairs, or the buyer may want to shop elsewhere. The two players are aware of each other's processes and possible answers. This is a useless game because there isn't even an official agreement between the merchant and the buyer. There are two processes available to the merchant. He will either exaggerate the condition of his trade-in car or make it seem better than it is. The theory further demonstrates how difficult it is to try to implement new methods and processes with low board settlements. The Game Hypothesis may also be used to demonstrate the dangers of not weighing the needs of all parties affected by strategy choices that are difficult to implement.

2.1.3 Cooperative Game Theory Model

Agreements are agreements that are seen as limiting by major players in a game situation. In monetary accounting theory, there are two types of deals that are particularly important: commercial contracts – between the company and the administrator – and loaning contracts – between the chief and the bondholder, the regular and expert, separately. The roles of these players are focused on office hypothesis, a branch of game hypothesis that examines the plan of negotiations to motivate a rational expert to follow up with a main where the specialist's benefits conflict with those of the head in some way.

2.2 Method of Shapley value

Shapely [31] proposed the Shapley value scheme in 1953 to address the problem of profit sharing in multi-person cooperative sports. A player's Shapley value represents how much value the professional brings to a partnership. A specialist with low Shapley value never contributes much, whereas a specialist with high Shapley value regularly makes a vital contribution. In this case, a player's Shapley value is determined by the level of contribution he makes as a person from an alliance; the more significant the commitment, the higher its value. When a group of ***N*** people engages in economic activity, each type of partnership among them produces a set of benefits. When people's interests are not antagonistic, an increase in the number of people cooperating does not result in a reduction in profits, and the cooperation of all ***N*** persons brings the greatest gain. In other words, as a group of ***N*** people forms a coalition, they will reap the greatest gain. The Shapley value system is a method for redistributing the maximum amount of money to participants. Its significance is as follows: Let set*T*:{ 1 , 2 , … , ***N***} if everysubset ***'Y'*** (instead ofseveralpermutation in the set of ***N*** people, also identified as aalliance)of***T***exchange letters to a real-valued function, *u(Y)*gratifying the $u(\varphi) = 0$ (1)

$u(Y_1 \cup Y_2) \geq u(Y_1) + (Y_2),\ Y_1 \cap Y_2 = \varphi$ (2)

Then the ***[T, u]*** is described***N***people cooperationcounteract procedures, where***u*** is the distinctive function of supportiveoffset procedures. In this article, we employ$\varphi_i(u)$ to signify***'i'*** members' profitsdue by ***T***associates from the most profit***u****(T)* of assistance. The set of the portion of*n*-person accommodatingcontradict events is$\psi(u)$= $\varphi_1(u),\ \varphi_2(u),\ \Lambda, \ldots \varphi_n(u)$. The achievement of cooperationshouldconvince the subsequentsituation:

$$\sum_{i=1}^{n} \varphi_i(u) = u(T), \text{且} \varphi_i(u) \geq u(i), i = 1,2,\ldots N \quad (3)$$

The Shapley worth refers to the benefit sharing of each cooperating partner. The Shapley value is expressed as follows:

$$\varphi_i(u) = \sum_{X \subseteq N} \frac{(|Y|-1)!(N-|Y|)!}{N!}[u(Y) - u(Y - \{i\})], \forall i \in N \quad (4)$$

This expression$\varphi_i(u)$represents the Shapley value of the*i*thmember in the supply chain.|***Y***| is the number of members in the*Y* subset, n is the total number of members in the supply chain, ***u****(Y)*is the profit value of the***Y***supply chain subset, and***v(Y***−{***i***})is***'i'*** profit value not included in the '**Y**'supply chain subset.

2.3 A new method for the approximate Shapley value

This section elucidates the paper's main point, especially another technique for determining the approximated Shapley value. The technique is based on casual computations, which are one of the most often used methodologies for estimating answers to problems whose intricate arrangements are difficult to comprehend. A casual calculation, furthermore, is one that settles on irregular conclusions during a piece of its methods. Furthermore, because such computations result in sloppy arrangements, their presentation is usually judged on the basis of two models, their time complexity, and their estimation error. We propose another arbitrary computation for tracking down the inexact Shapley an incentive for a weighted democratic game based on this foundation. We next extend this method to k-greater component games.

2.3.1 For a weighted voting game

The following is the reasoning behind the proposed approach to determine a player's Shapley value it track down its small commitment to every possible alliance. There are 2^{m-1}possible alliances for *m* players. It is computationally impossible to determine a player's lowest commitment to each of these 2^{m-1}prospective coalitions. The way to track out every possible alliance's peripheral commitment and perhaps it should consider *m* arbitrary alliances. The primary alliance is of size one, the secondary alliance is of size two, and so on. A player's inexact insignificant commitment to each of these *m*alliances is discovered. The player's assessed Shapley value is determined by the average of this load of small obligations. In what follows, $\emptyset_i(\overline{\emptyset}_i)$denotes the exact Shapley value for player *i* for a weighted voting game. Also, the approximate marginal contribution of player *i* to a random coalition of size *Y*is denoted$G\Delta_i^Y$.For an *m* player weighted voting game with mean weight ∂ and varianceσ, player *i*'s approximate marginal contribution $G\,\Delta_i^Y$to a random coalition of size Y ($1 \leq Y \leq m$) is:

$$G\,\Delta_i^Y = \frac{1}{\sqrt{(2\pi\sigma/Y)}}\int_b^a e^{-Y\frac{(y-\mu)^2}{2\sigma}}dx,$$

Where$a = (p - v_i)/Y$, $b = (p - \varepsilon)/Y$, and v_i is player *i*'s weight.

2.4Model analysis

The Northern River reversal, also known as the Siberian River reversal, was a large-scale effort in the Soviet Union to redirect the flow of the Northern Rivers, which "uselessly" drain into the Arctic Ocean, southwards to populous agricultural areas in Central Asia in need of water [32]. Domestic water in rural and urban regions, as well as industrial water, has a bearing power higher than the overall cost of the supply chain, as evidenced by the Volga River Diversion Project and how the government may subsidies losses to keep the water diversion supply chain functioning smoothly [33]. Interest in the Siberian "water return" project was revived in the early twenty-first century, and the Central Asian governments convened an informal conference with Russia and China to explore the proposal. Moscow may possibly [34], one of Russia's most powerful leaders at the time, reacted enthusiastically to these plans.Because fixed costs are a sunk cost, the total cost of the water transfer project supply chain may be divided into two parts: fixed costs and variable costs, with the latter occurring if there is no water source. The variable cost would be utilized in the case of water delivery, regardless of whether node business utilize water or not. If $\boldsymbol{P_c}$and$\boldsymbol{P_s}$are used to represent the unit variable cost of the water transfer company and water plant, respectively,$\boldsymbol{D}$is the market demand for water supply,$\boldsymbol{W}$ is the water price of the water plant. When the fixed cost is not considered$\boldsymbol{\gamma_c}$and$\boldsymbol{\gamma_s}$is used to represent the income of the water transfer company and the water plant respectively.

Table.1. Income matrix 1 of water transfer companies and waterworks

	Water Works		
Water Transfer Company	***Tactics***	***Water Utilization***	***No Water Utilization***
	Water Utilization	$\varkappa_c$,$\varkappa_r$	$-P_c$,D,0
	No Water Utilization	0,$-P_c$,D	0,0

In the case of $W < P_c + P_r$, $\gamma_c + \gamma_s = WD - (P_c + P_s)D < 0$, If the waterworks' water price is less than the value of the water diversion company's, the benefit sharing laws are employed by both parties and the fluctuating expenses of the water plant, at least one side's income will be negative, and the party with the lowest income will eventually vote for the no-water-supply policy.

Hypothesis: The theory of the water Transfer Project Supply Chain's eventual collapse, as well as a game study of supply chain advantages

The income matrix for each group is shown in Table 2.

Table.2. Power transfer providers and waterworks have a second income matrix

	Water Works		
Water transfer	***Tactics***	***Water Utilization***	***No Water Utilization***
	Water Utilization	*0, 0*	$-P_c$,*D*,*0*
	No Water Utilization	*0*,$-P_c$,*D*	*0, 0*

The safest solution for the other party is to not utilise or supply any water, resulting in a loss of money. Government subsidies for public-benefit water transfer projects must be approved in emerging countries, allowing water division companies and water plants to choose their strategic mix.

III. Model hypothesis and variable description

3.1Model hypothesis

Members of the game include the nation, water transport companies, and waterworks. Since the public authority just assumes an administrative role, the fundamental game is only between the water step organization and the water factory, which are both limited, sensible monetary persons. Second, once the public authority appropriations are added, the public authority's strategy package is all endowments, only to water move companies, only to waterworks, no sponsorships; the complex request is the public authority's water move company water plant. Third, rather than the water redirection agency, there is no other source of water for the waterworks. Fourth, the interest on tap water is a decreasing capacity of the retail rate, and the interest work is as follows:

$$D = D_0 - \alpha W \quad (5)$$

In other words, $D_0$is the exposure coefficient of sales volume to the price of tap water, which reflects the highest retail demand α >0; D>0is the same as the water farm, the water transfer company's water source, and the water demand?

3.2 Variable description

After deducting devaluation of fixed resources and partitioning them into unit inadequate costs as per the calculation of water, this paper used the financial accounting measure to quantify the flawed expense of the water Move Company and waterworks.

$$c_n = (C_{n1} + C_{n2})/D \quad (6)$$

$$C_{n1} = C_{n11} + C_{n12} + C_{n13} + C_{n14} + C_{n15} \quad (7)$$

$$c_s = (C_{s1} + C_{s2} + C_{s3})/D \quad (8)$$

$$C_{s1} = C_{s21} + C_{s22} + C_{s23} \quad (9)$$

The water price of the water transfer company isW_n, and that of the water plant is$W$. The total amount of government subsidies is$R = R_n + R_s$, that of water transfer companies is $R_s = (1-a)R$, $0 \le a \le 1$,$a = 1$ is to subsidize the water transfer company alone, a =0 is to subsidize the water company only, 0<a<1 is to subsidize the water transfer company and the water supply company.

3.3 Model construction and solution

3.3.1 Model construction

The profit function of a water transfer company is as follows:

$$\Omega_n = (D_n + aR - C_n) * (D_0 - \alpha W) \quad (6)$$

The profit function of waterworks is as follows:

$$\Omega_s = [W + (1-a)R - W_n - C_s] * (D_0 - \alpha W) \quad (7)$$

The gross profit function is as follows:

$$\Omega = (W + R - C_n - C_s) * (D_0 - \alpha W) \quad (8)$$

3.3.2 Model solution

The non-cooperative game of the water transfer firm and the water plant is investigated. When a water transfer company sets a price for water, the water company sets a market price depending on the water transfer company's price and other factors, forming a Stackelberg game agreement between the two parties. Formula (7) derives the first derivative of W,$\frac{\delta\Omega_s}{\delta W} = D_0 - 2\alpha W + \alpha Wn + \alpha Cs - \alpha(1-b)R$, let$\frac{\delta\Omega_s}{\delta W} = 0$. The optimal water price for a water company in a non-cooperative game is obtained as follows:

$$W^{non-co} = \frac{D_0 + \alpha Wn + \alpha Cs - \alpha(1-b)R}{2\alpha} (9)$$

The benefit function of the water diversion corporation is obtained by substituting Formula (9) into Formula (6):

$$\Omega_n^{n-co} = \frac{1}{2}[D_0 - \alpha Wn - \alpha Cs + \alpha(1-b)R](Wn + aR - Cn) \quad (10)$$

Formula (10) obtains the first derivative ofWn,$\frac{\delta\Omega_n^{non-co}}{\delta Wn} = \frac{1}{2}(D_0 + +\alpha Cn - \alpha R - 2\alpha Wn - \alpha Cs)$.Let$\frac{\delta\Omega_n^{n-co}}{\delta Wn} = 0$, the water transfer company's optimum sale price is calculated as follows:

$$W_n^{non-co} = \frac{Q_0 + \alpha C_{m+} \alpha(1-2b)S - \alpha C_r}{2\alpha} (11)$$

Since Equation (11) is substituted for Equation (9, the optimum water price for a water firm is:

$$W^{non-co} = \frac{3D + \alpha C_n + \alpha C_s - \alpha R}{4\alpha} \quad (12)$$

Equation (12) can be substituted into Equation (5) to quantify the market demand for tap water:

$$D^{non-co} = \frac{1}{4}[D_0 + \alpha R - \alpha Cn - \alpha Cs] \quad (13)$$

The net revenues of the water diversion company, water facility, and supply chain are calculated by substituting Formulas (11), (12), and (13) into Formulas (6), (7), and (8), respectively:

$$\Omega_n^{non-co} = \frac{[D_0 + \alpha R - \alpha Cn - \alpha Cs]^2}{8\alpha} \quad (14)$$

$$\Omega_s^{non-co} = \frac{[D_0 + \alpha R - \alpha Cn - \alpha Cs]^2}{16\alpha} \quad (15)$$

$$\Omega^{non-co} = \frac{3(D_0+\alpha R-\alpha Cn-\alpha Cs)^2}{16\alpha} \quad (16)$$

The derivative of Equation (12) to R is obtained $\frac{\delta W^{non-co}}{\delta R} = -\frac{1}{4} < 0$ and as government subsidies rise, the cost of waterworks will decline. Formula (13) derives R and obtains $\frac{\delta non-co}{\delta R} = \frac{\alpha}{4} > 0$, That is, as government subsidies grow; the market for tap water will rise. (2) A study of the water transmission company's and the water plant's cooperative game. The first derivative of price is calculated using Formula (8) W, $\frac{\delta\Omega}{\delta W} = D_0 + \alpha Cn + \alpha Cs - 2\alpha W - \alpha R$ .Let $\frac{\delta\Omega}{\delta W} = 0$, the optimal water price for a water company in the case of cooperation is as follows:

$$W^{co} = \frac{D_0+\alpha Cn+\alpha Cs-\alpha R}{2\alpha} \quad (17)$$

To obtain the amount of tap water needed in the case of cooperation, substitute Formula (17) into Formula (5):

$$D = \frac{1}{2}(D_0 - \alpha C_n - \alpha C_s + \alpha R) \quad (18)$$

Substitute Formula (17) for Formula (6), and the water diversion company's benefit in the event of cooperation is:

$$\Omega_n^{co} = \frac{1}{2}(D_0 - \alpha Cn - \alpha Cs + \alpha R)(Wn - Cn + \alpha R) \quad (19)$$

Due to the substitution of Formulas (17) and (18) into Formula (8), the net optimal value to all parties is:

$$\Omega^{co} = \frac{(D_0+\alpha R-\alpha Cn-\alpha Cs)^2}{4\alpha} \quad (20)$$

From Equation (20) minus Equation (16):

$$\Omega^{co} - \Omega^{non-co} = \frac{(D_0+\alpha R-\alpha Cn-\alpha Cs)^2}{16\alpha} > 0 \quad (21)$$

By subtracting Formula (13) from Equation (18), the following can be obtained:

$$D^{co} - D^{non-co} = \frac{1}{4}(D_0 + \alpha R - \alpha Cn - \alpha Cs > 0$$

From Equation (17) minus Equation (12)

$$W^{co} - W^{non-co} = \frac{1}{4}(D_0 + \alpha R - \alpha Cn - \alpha Cs) > 0$$

The net profit and supply of the cooperative water supply company and the water diversion company are higher than that of the non-cooperative water supply firms, and the cooperative water supply plant's output is lower than that of the non-cooperative water supply companies.Formula (17) derives $R$and obtains $\frac{\delta W^{co}}{\delta R} = -\frac{1}{2} < 0$, That is, the price of water plants falls as government subsidies rise, and the rate of decline is higher than in the absence of cooperation. Formula (18) derives R and obtains $\frac{\delta W^{co}}{\delta R} = \frac{\alpha}{2} > 0$, that is, as government subsidies are increased, demand for clean water increases faster than when people fail to comply. In multiplayer games, the Shapley worth method is used to divide profits. The net benefit value must be calculated equally as water suppliers and water plants cooperate. In this article, the Shapely value method is used to allocate the overall value of the supply chain. As previously said, the Shapely value approach has the following expression:

$$\varphi_i(u) = \sum_{Y \subseteq N} \frac{(|Y|-1)!(N-|Y|)!}{N!}[u(Y)-u(Y-i)], \forall i \in N$$

For the supply chain of water diversion project, N =2,the subset of water diversion company includes Y_n ={water diversion company}, Y_{ns} ={water diversion company, water supply company}, and the subset of water supply company includes Y_s ={water supply company} and Y_s ={water diversion company, water supply company}. In the case of $|Y_n|$=1,$|Y_s|$=1, $|Y_{ns}|$=2, the profit allocation values of the water diversion company and the water supply plant are as follows:

$$\varphi_n(u) = \frac{(1-1)!(2-1)!}{2!}[u(Y_n)-0] + \frac{(2-1)!(2-2)!}{2!}[u(Y_{ns})-u(Y_s)] \quad (21)$$

$$\varphi_s(u) = \frac{(1-1)!(2-1)!}{2!}[u(R_s)-0] + \frac{(2-1)!(2-2)!}{2!}[u(Y_{ns})-u(Y_n)] \quad (22)$$

At this time, $u(Y_n) = \Omega_n^{non-co}$, $u(Y_{ns}) = \Omega_s^{co}$, and $u(Y_s) = \Omega_r^{non-co}$. Substituting Formulas (14), (15), and (20) for formulas (21) and (20), the benefit sharing values of the water transport corporation and the tap water plant are received (22).

$$\Omega^{co}\ n = \phi n\ (u) = \frac{1}{2}\Omega' n + \frac{1}{2}[\Omega^{co} - \Omega' s] = \frac{5(D_0 + \alpha R - \alpha Cn - \alpha Cs)^2}{32\alpha} \quad (23)$$

$$\Omega^{co}\ s = \phi s\ (u) = \frac{1}{2}\Omega' s + \frac{1}{2}(\Omega^{co} - \Omega' n) = \frac{3(D_0 + \alpha R - \alpha Cn - \alpha Cs)^2}{32\alpha} \quad (24)$$

The water transfer corporation and the water supply company work together to determine the tap water outlet costs, ensuring that both firms' profits are equal. As a result, Formulas (23) and (19) are equal, and the water price charged by the water transport provider in a cooperative situation is:

$$W^{co}\ n = \frac{5D_0 - 5\alpha R + 11\alpha Cn + 5\alpha Cs}{16\alpha} \quad (25)$$

3.4 Statistical Description

The article uses data from the Volga River water diversion project's water price scheme as an example. The bearing power and demand of agricultural water, as well as the incomplete cost of water supply per unit of water transport firms and water plants are shown in Table 3.

Table.3. Demonstratesthe Volga River Diversion Project's cost and demand datasheet (RUB/m^3)

Constriction	Volga corporation's unit price is short c_n (RUB/m^3)	Farmer Water Consumer Organization's unit water allocation price c_s (RUB/m^3)	HighestRequirement D_0(100000m^3)
Price	0.39	0.04	523500

Tables 4 and 5 display the estimation results after substituting the above data into the model solution.

Table.4. The effects of the calculations and model solution

S = 0	W_n (RUB/m^3)	W (RUB/m^3)	Ω_n (100000RUB)	Ω_n(100000RUB)	Ω (100000RU	D (100000m^3
Non-Cooperation	209.71	334.92	281998.37	37565.92	403745.87	124500.7
Cooperation	0.9780	20.72	350277.37	210208.93	540952.39	241089.5

From the perspective of the supply chain, the cost is calculated using data from Renewable Surface Water Resources by major river basin on the water price structure of a multi-objective water diversion project.

Table.5. The water transfer project's subsidy and water price benefit at (0.10 RUB/m^3)

Calculation items	$R=0.1$					
	$a=1$		$a=0$		$a=0.5$	
	Non-Cooperation	**Cooperation**	**Non-Cooperation**	**Cooperation**	**Non-Cooperation**	**Cooperation**
W_n **(RUB/m^3)**	2.57	0.85	2.67	1.00	2.62	0.95
W (RUB/m^3)	3.78	2.59	3.78	2.59	3.78	2.59
Ω_n**(100000RUB)**	2851.27	3564.09	2851.27	3564.09	2851.27	3564.09
Ω_s **(100000RUB)**	1425.64	2138.45	1425.64	2138.45	1425.64	2138.45
Ω (100000RUB)	4276.91	5702.54	4276.91	5702.54	4276.91	5702.54
***D* (100000m^3)**	1169.5	2339	1169.5	2339	1169.5	2339

From the perspective of supply quantity, when *R* = 0, the *D* under non-cooperation and cooperation are 1169 (10,000 m^3) and 2338 (10,000 m^3), respectively. When *D*= 0.1, the *D* under non-cooperation and cooperation are 1169.3 (10,000 m^3) and 2338.6 (10,000 m^3), respectively, the *D* under non-cooperation and cooperation are 1169.5 (10,000 m^3) and 2339 (10,000 m^3), respectively, which indicates that the larger the *R*, the larger the *D*. When *D* is under certain conditions, no matter how much *D* is taken, it is always stable and *D* under cooperation is always greater than that under non-cooperation. From the point of view of water price, *W* always decreases with the increase of *R*, and non-cooperative *W*is always greater than cooperative *W*, while W_n exhibits certain fluctuation with the change of a. Taking *R = 0.07* as an example, we can see that *W* stays at 3.86 and 2.56 under cooperation and non-cooperation, respectively, while W_n is 2.73 and 0.94 at a = 0, 2.75 and 0.92 at a = 0.7 and 2.94 and 0.95 at *a* = 1. Under a certain condition of *R*, the higher the b is, the lower W_n is, and under non-cooperation W_n is always greater than under cooperation. From the point of view of profit distribution, with the change of *R*from 0 to 0.1, the total supply chain profit Ω, the profit Ω_n of the water transfer company, and the profit Ω_s of the water plant are all increasing. When S under certain conditions, *a* takes different values, and will always be$\Omega^{co} > \Omega^{non-co}$, $\Omega_n^{co} > \Omega_n^{co}$, $\Omega_s^{co} > \Omega_s^{co}$ and $\Omega, \Omega_n, \Omega_s$ are stable because when *a* = 0 increases to a = 1, W_n is gradually reduced, thereby maintaining the stability of the internal profit distribution.

IV. Conclusions

The article develops and addresses a non-cooperative game paradigm as well as participation in the auxiliary development network of water move organization and waterworks. The water flow, estimating, and wages of the two meetings haveorganized since the appropriations were obtained. The inventory network's advantage participation and agency appropriations have recently become hot topics. Instructions to enter government motivations to improve water quality and deliver pay in the inventory network are the keys to ensuring a safe and beneficial operation of water move plans in immature regions with powerless water value resistance. The results show that as sponsorship volume increases, the ideal water source sum of the water redirection plot and the profits of the two players increase, the water cost of the water plant decreases, and the water cost of the water Move Organization is also influenced by the public authority appropriation policy, indicating weakness. The water plant's water expense becomes constant as the sponsorship amount is set, and the water move firm's valuation will adjust with the appropriation degree due to its dominant position and if the project is funded by the government, the net benefit from cooperation exceeds that of non-cooperative. The benefit sharing outcome of the Shapley value appropriation model allows the two players' bid profit to be greater than if they didn't collaborate, satisfies both individual and absolute soundness and achieves Pareto optimality. The measuring object is a single water transportation company and a single water ranch, and the reality of the water transportation initiative is that a disjointed store network made up of a few water plants and rancher water client affiliations defies a water transportation relationship. Any boundary projections used in the study are flawed, and more research is needed to see the goal for the water move venture's inventory network.Consider instances where there are several players with varying reward parameters as an intriguing topic for future research. The creation of such models will provide light on how greater competition affects lease contracting.

Conflict of interest:

All the authors declare no conflict of interest.

Data Availability Statement:

Data used in this research is available online atNational Bureau of Statistics of Malaysia http://www.fao.org and https://www.statista.com.

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List of Abbreviations

c_n = The unit cost of water transfer company

C_{n1}= operating cost of company

C_{n2} = interest on fluid capital of company

D = Demand of water of company

C_{n1} = operating cost of company

C_{n11} = engineering maintenance cost of company

C_{n12} = wage welfare fee of company

C_{n13}= project management fee of company

C_{n14}= power cost of company

C_{n15} = other expenses of company

c_s = unit water distribution cost of water plant

C_{s1} = main business cost of water plant

C_{s2} = period cost of water plant

C_{s3} = other expenses of water plant

C_{s1} = period cost of water plant

C_{s21} = management expense of water plant

C_{s22} = operating expense of water plant

C_{s23} = financial expense of water plant

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