

TO EXPLORE NATURAL GAS PRICING POSSIBILITY BY MAJOR GAS BUYERS USING GAME THEORY MODELS IN A WIN - WIN FORM

Mohammad Heidari

Department of Economy, Faculty of Economy and Accountancy, Islamic Azad University Central Tehran Branch, Tehran, Iran

Abstract:

Studies on OPEC organizational behavior have used numerous games. The games as games theory are effective in solving many macroeconomic issues. Furthermore, there are different pricing policies designed for public sector activities that often follow monopolistic conditions in different countries. Iran is the world's largest gas exporter in the world after Russia, and Qatar comes at third level; therefore Russia, Iran and Qatar are the key players in determining the gas price. This study aims to investigate and explain the role of these three countries in determining the gas price.

Keywords: Natural Gas Pricing, Major Purchaser of Gas, Game Theory Model, Win - win Game

Introduction :

In the years after the Islamic revolution in Iran, about 87% of the export value IS THAT of oil and gas¹. Therefore, changes in gas prices and how to determine the price is an important issue in the country. Capital and intermediate goods imports are highly dependent on the revenues by natural gas, and natural gas price changes lead to volatility in capital and intermediate goods imports and domestic economy will be faced with crisis. Therefore, the proceeds from the sale of gas are important in governmental planning and budgeting and so the price changes leads to the disruption of government programs and budgets.

Gas has no global market and by and large is traded regionally. Various methods are defined for the natural gas pricing, some of these methods, however, are not use :

- 1- Cost-based pricing: in this method pricing take place based on the cost of gas at the wellhead that the method was common until before 1960's. at this time, low gas prices was one of the characteristics of the gas market since that time, the gas supply was mainly associated gas (Khaleghi, 2006: 2, quoted from Noubakht and Marashi, 2009: 31).

¹ Central bank database

- 2- V
alue-based pricing: in this method gas price the price is on combustion point related to the cost of the best alternative fuel (typically a product of the distillation of crude oil). gas price must set higher than the combustion point due to being cleaner, and more easily accessible than the fuel oil and other products of the distillation. The concept of price equality at combustion point was the basis of many 1970s negotiations (Khaleghi, 2006: 2, quoted from Noubakht and Marashi, 2009: 32).
- 3- P
arity- pricing: This concept is based on the perception that "energy is energy regardless of from ". In this view, thermal value of each energy carrier is the same, this theory is optimistic and changes in oil and gas prices has not been fully realized in this concept.
- 4- E
quivalent Border Pricing: in this concept price will be the same based on all imported gas, regardless of the source of supply, at pipeline network inlet point.
- 5- R
eplacement Cost Pricing: currently, all pricing concepts based on equity and net back consider crude oil, petroleum products and domestic natural gas production as alternative fuel for imported gas as the base price for the energy (Khaleghi, 2006: 2, quoted from Noubakht and Marashi, 2009: 32).

Thus, gas strategy is driven by a different motivation followed by two active groups in the organization and that this strategy is closer to demands of each group is related to the bargaining power of each. The bargaining power may be a function of market share, unused production capacity and financial needs of each of these groups.

Studies that have investigated the behavior of OPEC organizational behavior have used several games most important ones include Iterative Finite Game, Dynamic Game, Repeated Game with Incomplete Information, Evolutionary Game, and Dominant Firm. Iterative Finite Game is largely documented on stable and equilibrium solution of Repeated Prisoner's Dilemma Game that according Selten's Theorem the unique equilibrium solution equivalent to a solution is achieved in each Sub - Game.

Griffin, J.M. & W.S.Nielson (1994), Griffin, J.M & W.Xiong (1997), Pindyck (1978), and Geroski, P.Ulph, A & Ulph, D (1987) are among those who have studied OPEC behavior in this framework. Griffin, J.M. & W.S.Nielson and Griffin, J.M & W.Xiong studies show that the formation of cartels and adherence to the principle of cooperation increases interests of all OPEC members, in comparison with the competing status. However, members always have an incentive to deceive others to increase their short-term interests by production, but what prevents this action is the fear of the behavior of reprisals by other members in response to deception that reduces long-term benefits.

In dynamic games given that oil is an exhaustible source and OPEC members reserves will vary from period to another, it is not possible to generalize the solution obtained in any sub-game to the whole game. Henylicza, E. & R.S.Pindyck (1976), Mason F.M. & S.Polasky (1998) and

Benoit, J.P & K. Krishna (1985), (1987) have studied the internal behavior of OPEC in this framework. Benoit, J.P & K. Krishna using Chain Store Paradox Game showed that this game for exhaustible resources is a one-shot multiple equilibrium that the result in the early stages of the game is a collaboration solution. But with declining reserves and increasing importance of short-term benefits, the solution is a competitive solution in final sub games. Kreps, D.P. Milgrom... (1982), Andreoni (1990),

Andreoni & Miller(1993) and Mc Kelvey & Palfrey (1992) examined OPEC's behavior theoretically from the perspective of repeated games with incomplete information. Andreoni concluded that in this game cooperation continues to the final stages.

Mabro (1991), Askari (1991), Cremer, J & Salehi – Isfahani, D. (1991) and Griffin, J.M. (1985) studied OPEC behavior in the case of Saudi Arabia's leadership role as the dominant firm. Studied conducted on the OPEC and non-OPEC behaviors have used different games. Raily (1991) in the form of a Sum – Zero Repeated Game have studied OPEC and non-OPEC behaviors where there is no leadership powers. Gilbert.R. (1978) and

Salant S.W. (1979) studied OPEC as a dominant organization and non-OPEC as a Competitive Fringe in a Repeated Game with Unique Solution – Variable Sum. Changes in gas prices induce a zero-sum game between buyers and sellers, i.e. assuming other conditions' stability, an increase in gas price to the benefit of seller, the buyer will suffer loss and vice versa. But the whole game has a non-zero sum, because both buyers and sellers benefit from crude oil in exchange.

Abrishami, Hamid, Golestani Shahram (2004) in a study titled, "The study of two OPEC and OECD behavior in the framework of bilateral monopoly game and how to divide the oil trade gains among them" studied both OPEC and OECD behavior as key players in the global market using a monopoly bilateral iterative finite game and referring to Schelling Point Solutions presented in the game, OPEC has attended as a weak bargainer as a result of applying a consistent and long-term strategies by both players, in comparison with OECD member states accounted for a smaller share of the benefits. Abdoli Ghahraman and Nakhoda Mohammad Javad (2009) in a study titled "Application of Feron Theory in the Study of OPEC Stability: the theory of repeated games" investigated two main topics of studied literature of international cooperation. Firstly, a simple model, bargaining and Feron enforcement is presented in which impatience (which is implicit in the discount factor) is a source of bargaining power, and the outcome of this phase is followed by the implementation phase, as the prisoner's dilemma. Then it is shown that how this model answers the question of benefits sharing of the organization of petroleum exporting countries (OPEC) taking the time horizons and bargaining power into account. OPEC historical evidence of approximately 50 years has been used to demonstrate the empirical content, and the result is that countries that heavily discount the future, desire to have more oil entitlement. Empirical evidence of one model test reinforces the result obtained by the theoretical model; on the other hand, member states with more oil revenue need will be allowed to produce more.

Golombek and Hoel (1987) in an article introduced the price of natural gas as the weighted average alternative energies such as oil and coal, etc.

Different countries have different pricing policies for public sector activities that often follow monopolistic firm's conditions. Such are cost pricing, increasing block, pricing lowering block,

block pricing, the pricing is fixed (the best one), Diminished block Pricing, Fixed block Pricing, Marginal Cost Pricing (first optimal), Parity Pricing, Peak Load Pricing, Optimal Two-Part Tariffs, Value-Based Pricing, and Ramsey Pricing (Guido and Bert, 2005).

Hole et al (1987) stating the theoretical natural gas market as a bargaining market studied structures of the four main natural gas market exporting countries in Western Europe (the Netherlands, Algeria, Russia and Norway) and four major importing countries (West Germany, France, Italy and Britain) in 1980s. The authors investigated the bargaining model as a multilateral monopoly market and thus proved that the best bargain solution "Nash" is the equilibrium solution. The quantitative study of opinions expressed in the, assuming the game between the seller (Russia and Norway) and the buyer (Europe and UK), they predicted the price received by sellers in 2010, according to the game.

Fuchs and Skrzypacz (2007) in their review article studied a dynamic bargaining model between a seller and a buyer, assuming the arrival of a competitor for the purchase or sale of natural gas. The authors showed that increasing the rate of entry of natural gas new buyers increases price and leads to longer exchange time. This also will affect new buyer's decision on entering the market, as well.

Shahriyar et al (2007) examined the natural gas market in Western Europe and Russia competing with Iran. The author uses a vector error correction model in an attempt to forecast natural gas prices in Russia as the largest Iran competitor in the export of natural gas to Western Europe and eventually predicts the upper and lower bounds for bargain deals with Iran in 2010.

Accordingly, the main problem which will be examined in this study is that how gains from gas trade is divided between buyers and sellers and whether it is possible to increase mutual trade gains of gas exchange as a win - win game?

Materials and Methods

In this study, and in order to select the most important and winning criteria in the game match algorithm and weighting them, Yu method was used due to the many benefits and compliance with the objectives of this study. Yu model shows properties for its conservative compromise solution including: practicality, personal logic, the least lost group desirability, non-dictatorial Pareto optimality, uniqueness, symmetry and independence of irrelevant options. In addition, this approach enables the possibility of better decisions and choices between all options with different criteria (multi-criteria decision).

Yu (1973) for solving n-person games uses desirability intervals ($f_i = u_i$) for every player towards a utopia point in conservative compromise model. Utopia (u^*), is an absolute effective solution that all players are in agreement and consent with (that is desirability optimal for that point simultaneously is as the following equation for all players) (Yu, 1973, p 940):

$$\text{Min} : D_p = \left\{ \sum_{i=1}^n |u_i^* - u_i|^p \right\}^{\frac{1}{p}}, 1 \leq p \leq \infty$$

$$\text{s.t} : u_i \in U$$

$$i = 1, \dots, n$$

However, if p tends to infinity, the resulting D_p is as follows:

$$\lim_{p \rightarrow \infty} D_p = \max |u_i^* - u_i|$$

I is the number of players, u_i is the i 's player desirability, and u is desirability matrix of all players under the different combined strategies.

$U^* = \{u_1^*, \dots, u_n^*\}$ vector indicates the optimal desirability for each of the players, so everyone will be satisfied.

$|u_i^* - u_i|^p$ indicate lost desirability for i_{th} player, so, the total lost desirability (for $p = 1$) through (1) is minimal and on the other hand the maximum lost desirability lost among all the lost desirability (for $p = \infty$) will also be minimal. Hence, p has a balancing role between the players group and the maximum lost desirability (Asghar Poor, 2003, p43).

The larger p is, then $|u_i^* - u_i|^p$ that means the lost desirability of each player shows the greater impact, in fact, more emphasis is on the lost desirability of players.

$$D_p = \left\{ \sum_{i=1}^n |u_i^* - u_i|^p \right\}^{\frac{1}{p}}$$

If the p -value is very large and as to tend to infinity, then the product of

with the limit is $\max_i |u_i^* - u_i|$, that minimizing of this expression actually the strategy with minimum lost desirability of players is selected among a combination of strategies (Chopra, Meindl, 2000, p 1037).

In simple terms, first lost desirability of each player is calculated separately for each combination of strategy and then the highest is selected among lost desirability, then among the highest ones the strategy combination with the lowest lost desirability is selected, i.e. here the status of each player is important and emphasize is on the lowest personal loss, so the model has great flexibility. Indeed, in a game it may be possible to gain the same results using either case that is Pareto solution.

Conservative compromise solution for a multi criteria game (choice of competitive factors according to various criteria) can be formulated as follows (Moss Kollet, 2009, p 37):

$$\text{Min} : D_p = \left\{ \sum_{i=1}^n \sum_{l=1}^h |u_{il}^* - u_{il}|^p \right\}^{\frac{1}{p}}, 1 \leq p \leq \infty$$

$$\text{s.t.} : u_{il} \in U, \begin{cases} i = 1, 2, \dots, n \\ l = 1, 2, \dots, h \end{cases}$$

Where i is players (competitive factor) and l represents the criteria (criteria for selection factors) and also u_{ji} is the personal desirability of i_{th} individual with criteria l and u_{li}^* is the desirability agreed to all players.

If p tends to infinity, D_p expression product is as the following (Branzei et al, 2008, p 61):

$$\lim_{p \rightarrow \infty} D_p = \max_{il} \sum_{l=1}^h |u_{il}^* - u_{il}|$$

In general, cooperative game consists of a set of players and a characteristic function. Characteristic function determines the value generated by the subsets of players in the game. Suppose $N = \{1, 2, \dots, n\}$ is a finite set of players and $v(S)$ is the characteristic function of the game that indicates V is connected to each any subset S of N . $V(S)$ can be interpreted as a value that is created when the members of S unite together and interact. Values are determined depending on the player's participation on earning more (Fagnelli, Moretti 2007). One of the important concepts in cooperative game is the marginal benefit (marginal contribution). In fact, in a cooperative game, the question is always posed that how to share profit from the game among all players. In fact, marginal benefit is defined as the amount deducted from total created amount when a particular player leaves game.

Transferable utility game: TU-GAME is expressed with the ordered pair (v, N) . N is players set and v is characteristic function $v: 2^N \rightarrow \mathbb{R}$, so that $v(\emptyset) = 0$. $V(S)$ as the highest value or cost savings is considered for S coalition. One solution for TU-game (N, v) is ψ function, where each player is allocated a $\psi(v)$ profits vector. Shapley value that was raised first by Shapley is one of the best and most popular solutions in a TU-game. This solution allocates each player at all possible modes (displacement players) their own marginal benefit (Fagnelli, Moretti 2007).

Suppose $G = (N, v)$ is a game. In this game, each player is supposed to be $i \in N$. Shapley value allocated to each of the players is as follows (Branzei, 2008& Shapley, 1953):

$$\phi_i(v) = \frac{1}{n} \sum_{\pi} (v(P(\pi, i) \cup \{i\}) - v(P(\pi, i)))$$

Where π is permutations players $p(\pi, i)$ is the set of players that precede player i_{th} at π permutations. If two players i, j are symmetrical, i.e. $v(S \cup \{i\}) = v(S \cup \{j\})$, $\forall S \subseteq N \setminus \{i, j\}$ is the relation, then $\phi_i(v) = \phi_j(v)$. When the player lacks marginal benefit, $v(S \cup \{i\}) = v(S)$, $\forall S \subseteq N \setminus \{i\}$, then $\phi_i(v) = 0$. (Branzei R., Dimitrov, 2008, p 29).

In most games, a player intends to choose the strategy that not predicted by the player contenders. Obviously, in such games no player wants its choice to be predicted by contenders. Thus, selects a strategy with probability p . Such a strategy is called a mixed strategy. If, R is a set of pure strategies available to player A, the set of mixed strategies for player A, is the set of all probability distributions in the R domain. Probabilities are calculated based on observed frequency. Probability of playing strategy r in R for player A is P_r . Also, probability to play a strategy c by player B, equal to the P_c . To solve the game, we should find a set of mixed strategies (P_r, P_c) to the extent that they are in balance (Gibbons, 2000, p 101).

Since, player A select without knowing player B choice, player A more likely outcome is on the net $P_r \Pi_C(r, c)$. This probability is equal to the probability that player A has played a strategy r , multiplied by the subjective probability of player A on player B plays strategy C. Hence, the aim of player A to select the probability distribution (P_r) is to maximize the following function:

$$\sum_r \sum_c p_r \Pi_c I_r(r, c) \geq E = \text{Player A expected income}$$

$$\sum_c \sum_r p_c \Pi_r I_c(r, c) \leq E = \text{Player B expected loss}$$

If both players use their optimal probability, the expected outcome for both players equals the value of the game. If player A use its optimal possibilities, expected income cannot be less than the value of play E , no matter what strategy player B selects. Player A expecting income will be greater than player B's, when player B uses a series of non-optimal possibilities.

Results:

Russia, Iran and Qatar are the three major gas exporter; respectively; that supply more than half the world's gas. Game theory approach using and integrating math and economics studies the behavior of strategy player s. Behavior is proactive strategy that calculates not only the favorability and purpose of each player behavior by not merely its own choice of strategies but considering the strategy chosen by the other. The important point in this context is the concept of "balancing act" that defers to a combination of strategies that the strategy of each player is an optimal response to the strategy of the other players and as a result, no one has an incentive to deviate from this point. Accordingly, as shown in Figure 1, a scenario can be drawn is that each player chooses a strategy to maximize their own interests, to produce and export, and it is assumed that its behavior does not charge any harm to the others.

Indeed, within this scenario there is the possibility that all three players in Figure 1 the box A¹B¹, produces and the benefits are as 125_125 for all three is desirable.

Figure 1 (based on findings)

B2	*B1	
75-150	** 125-125	*A1
40-70	150-75	A1

Player A

* Dominant strategy for each player

** Equilibrium point

The fact is that, as described in the preceding sections, rules governing the gas market in terms of demand capacity, exporting players and variety of interests show that absorptive capacity of the gas market is not that of to maximize the benefits and select a comprehensive approach. However, this scenario assumes that there is some Pareto space optimization and there is no conflict between the interests and strategies of each state and each can produce at maximum capacity, but the resultant of this strategy selection is not player's interest's square achievement and it should be expected to fulfill the worse conditions.

Another scenario facing the three countries can be drawn such that each of the players selects their possible strategies given the competing approach with no strategy to maximize in its agenda is or need to cooperate with others, i.e. as Figure 2 shows, the player A prefer to produce option A, if the player B chooses option B' or vice versa, player B also prefers to produce at level B', if the player A, selects A'. Perspective of the equation, too, cannot lead to achieve mutual benefit and reach to equilibrium in the gas market to the benefit of each.

As described in political economy approach by Russian ,Iran and Qatar ,the dependency of foreign exchange revenues from gas sales for the three countries is of great importance that their preferred strategy is producing at maximum capacity. Naturally, if all three players rely on the others strategies to select their owns, this scenario like the first scenario will lead to oversupply and outcomes; Hence, the author believes that the mentioned scenario is not likely in the future market of gas in the relations between the three countries.

Figure 2 (based on findings)

Player B		
B2	B1	
75-150	125-125	A1
100-100	150-75	A1

Player A

As shown in the figure above ,A1B1 box, players looking at the behavior of other players and postponing its decision to the other parties behavior without being in a partnership framework has no outcome except market volatility, oversupply and competition intensifies. The continuation of this behavior may lead each of the parties to either A2B1 or B2A1scenario where as Figure 3 shows, A has the maximum interest in the former and B has the minimum (75_150) and vice versa in the latter interests will be at maximum and minimum (75_150).

In this scenario that assumes the increased competition and maximized production and marketing strategies by the three players (currently Russia, Qatar and Iran), one party can gain the maximum market share with reasonable price or incurs minimal harm of the maximum amount available; or conversely, the other party as the loser will earn less profit or will suffer the greatest losses .It seems that the likelihood of this scenario (win-loss) is very weak in the trade between the three countries, because:

First ,currently each of the parties for a variety of reasons, including reserves and production capabilities, especially Russia and Qatar are balanced that in terms of intense completion can neutralize each other power to the benefit of the consumer.

Second, as mentioned earlier, in each of the player's political economy approach, there is a political-economic perspective to gas that forecloses the possibility of self-centeredness and free movement of each.

Third ,interests of each in interaction with other have various aspects that vulnerability of each has become multi-dimensional. If players choose self-centeredness, the most likely scenario for them is the box in figure 3 that leads to a negative outcome for the parties. It seems that gas producers are unfamiliar with this simple rule of markets.

Figure 3 (based on findings)

Player B		
B2	B1	
75-150	125-125	A1
-50, -50	150-75	A1

Player A

What seems plausible in accordance to the framework of game theory in the relations between the three countries and in defense of the research hypothesis ,as shown in Figure 8 ,is a model of strategic behavior that each of the major players of the natural gas producer consider rational behavior, with regard to the achievement of the cooperative approach to their interests an the interests of the other party to reach equilibrium within a double sum game one.

Figure 4

Player B		
*B2	B1	
75-150	125-125	A1
**100-100	150-75	*A1

Player A

*Strategy to maximize the production power and export of players in the conflict model

*The balance point of the partnership model

It seems that A2B2 option that brings 100_100 benefits to players is a strategy that players follow through considering the interests of the other party. The resultant of this matter is the formation of a framework of cooperation in which the interests of the members are met and unilateralism as A1B2, B1A2 and secrecy is avoided.

Cunclusion

Because every year, prices are revised in contracts ;So the players choosing a price strategy every year ,before the revision ,play a game similar to that of Bertrand and adopt the best strategy and response gain the best outcome and market share .So we can assume that in each period, there is Nash equilibrium (Redvondo, 2005). Since, the global demand for gas is increasing up to 2050; venture capital in this section can bear numerous benefits.

Iran has a high capacity to interact with the world . Due to the recent problems in Russia in connection with the crisis in Ukraine and due to the high volume of Russian gas exports to Europe and Russian contracts for gas supplies to Europe by more than 30 percent, it seems that there are new horizons in the field of gas export for Iran.

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