

## Research on Competitive Strategy of Energy Enterprises Based on Game

### Theory

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*Abstract: Classical economics argues that enterprises will make the decision of stopping production or withdrawing from the market when the commodity price is lower than its variable cost. However, the production scale of commodities is still expanding in bearish commodity markets (2011-2015) when the product cost is upside down. By taking the aluminum production enterprises as the research object, this paper analyzes the reasons why energy enterprises make decisions not conforming to economic principles (meaning to stop production when the selling price is lower than variable cost) to adopt the expansionary competitive strategy from the perspective of game theory, further proposes correct strategies of preventing and controlling financial risks, as well as promoting the sustainable and healthy development of enterprises, in order to provide the new vision for energy enterprises formulating effective competitive strategies in the inverse market cycle environment.*

*Keywords: Game theory, Energy enterprise, Counter-cyclical decision, Competitive strategy*

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## 1. INTRODUCTION

The aluminum price in China has dropped rapidly since the third quarter of 2008 due to the financial crisis, leading to more severe market environment in the next four or five years. Specifically, the aluminum price per ton dropped from 16,000 yuan in 2011 to 15,600 yuan in 2012, to 14,400 yuan in 2013, and even to less than 13,700 yuan in 2014, which has failed to reach the average cost of the whole industry, and in 2015, the price realized the new record and became 9960 Yuan. Aluminum industry is going downwards, and its production can no longer create huge returns, but huge losses. Especially CHALCO, a leader in this industry, also became the A-share “king of losses” due to the continuous huge losses, which suffered a loss of over 4 billion yuan and became the “king of losses” of A-share semi-annual report in the first half of 2014.

However, it is puzzling that there is basically no fluctuation in the capacity of aluminum industry along with its continuous declined price, but most Chinese enterprises still adhere to production, and compete against to be “king of losses”?

In recent years, the concept of cut excessive industrial capacity has become very popular with the transformation and upgrading of China's economy, as well as the deepened “supply-side” reform. However, part energy enterprises often make behaviors seemingly contrary to the market economy and not in line with the economic cost-effectiveness principle when facing production decisions.

Taking CHALCO as the research background, this paper analyzes and finds out the reasons why corporate managers make their production strategies from the perspective of game theory, as well as the motivation and cause for aluminum companies becoming the “king of losses” step by step.

## **2. PROPERTIES**

### **2.1 Literature review**

The increasingly matured theoretical system of game theory and its improved status in the economic field have made its research results become applicable to modern enterprise management directly. Thus, it has important and practical guiding significance to study the application of game theory in modern enterprise management.

In terms of financing decisions, Wang Lihui (2017) argued that it is necessary to conduct the theoretical reasoning analysis on the lending cooperative results between investors and SMEs (small and medium-sized enterprises). The cooperation possibility between investors and SMEs through Internet platform can be increased significantly based on the game theory, meanwhile, the investment analysis that enterprises utilize the decision-making model in game theory can further rationalize the investment process.

In terms of investment decision-making, Cao Boyang and Jiang Minghui (2015) believed that the combination of periodical investment opportunities with competitive behaviors under the investment environment of R & D projects with multiple risks can more accurately evaluate the project value and income, and then obtain Nash equilibrium through the game, which can obtain the best investment opportunities for the enterprises to maximize their own incomes.

In terms of price war, Zhang Wenyun (2014) argued that some industries in China often engage in various price wars, for example, the B2C website conducts advertising war at great cost and reduces its prices to attract and increase online shopping groups, but leading to the ultimate failure. However, consumers tend to receive the greatest benefits in this process. As the profits of both parties in the game are exactly zero, and the competition result is stable, the competition between these websites only forms the “Nash equilibrium”, and no one obtains benefits.

In short, the current scholars adopt the game theory more in the financing, investment and

pricing instead of production decision-making, especially the lack in energy companies although they have made many researches on the game of business management and further proposed suggestions and policies. The enterprises continue to study production when  $P$  (market price)  $< VC$  (variable cost), which has not yet been fully demonstrated. Therefore, this paper first builds a game model from the perspectives of different assumptions through the game theory tools, and further analyzes reasons why enterprises still choose the production from different perspectives in the case of losses. Secondly, with the combined practical application of production strategies in energy enterprises, it can provide help and guidance for Chinese enterprises to seek an independent development path and better realize their goals under the background of the global economic downturn, as well as the continuous attack and merger of foreign multinational corporations.

## 2.2 Establishment and analysis of game model

Game theory mainly studies how the rational actors make decisions and reach the equilibrium under the interaction between decision-making behaviors of all relevant actors. And usually a complete game includes participant, action, message, strategy, return, outcome and equilibrium, and the derivation of the game model actually requires strict assumptions and parameters. The author conducts the following model according to the market and policy environment that the enterprises face, as well as the psychological motion of the decisions.

### ( I ) Hypothetical situation of game model

Suppose the game behavior is based on the following three market environments:

1. Situation 1:  $P$  (market price)  $< VC$  (variable cost) in a fully competitive marketplace.
2. Situation 2: There are many factors affecting the decision-making of enterprises, including financial subsidy of the government for the loss-making enterprises, more social responsibilities assumed by the enterprises, as well as the increased output for the shared unit costs.
3. Situation 3: Market prices can achieve the phased rebound, thus releasing pre-hoarding capacity (inventory).

### ( II ) Parameters of game model

To simplify the behavioral data of market participants, the following hypotheses are made for the manufacturers:

1. The fixed cost is -1.
2. 2 units of variable costs can be reduced and marginal contribution can be changed into -1 unit with an increase of 1 unit when enterprises sell products in the case of price-cost inversion.
3. 1 unit can be increased when enterprises obtain government subsidies.
4. When the market represents the phased rebound, the companies can have gains of +1 for the sale of low-cost inventories, while those stopping production fail to meet the orders needs and have gains of -3 due to lack of stock.

### ( III ) Nash equilibrium under different hypothetical situations

1. The market represents the oversupply and the market price is lower than variable cost of enterprises ( $VC < P$ ) when meeting the situation 1, then the market competitive strategy analysis of A and B enterprises is shown below:

Table 1 Nash equilibrium under the hypothetical situation 1

A enterprise	B enterprise		
	Strategy	Production	Suspended production
	Production	-3, -3	-2, -1
	Suspended production	-1, -2	-1, -1

According to Table 1, it can be found that the worst yield between A and B enterprises is (-3, -3) when they choose production, and A can achieve the smallest loss for suspended production (-1) no matter what the other party chooses, in order to form dominant strategy, which is also the same for B. Therefore, both sides will choose to suspend production and form Nash equilibrium (-1, -1). In this way, the ultimate result is to suspend production based on the principle of cost-effectiveness in a fully competitive market no matter what the other party chooses when the market price is lower than the variable cost.

2. The market is still in oversupply and the market price is lower than variable cost ( $VC < P$ ) when meeting the situation 2, but A receives 1 unit favorable factor (SOE A receives government subsidies or keeps production to reduce social employment pressure) while B remains unchanged (B is the private enterprise and without assuming social responsibilities). Then the market competitive strategy analysis of A and B enterprises is shown below:

Table 2 Nash equilibrium under the hypothetical situation 2

A state-owned enterprise	B private enterprise		
	Strategy	Production	Suspended production
	Production	-2, -3	-1, -1
	Suspended production	-1, -2	-1, -1

According to Table 2, it can be seen that the continuous production costs of A can be declined after A obtains 1 unit of favorable factor (such as considering political factors and receiving government subsidies). Due to political factors, it can face great pressure of suspended production and further form new strategic equilibrium (A is in production, while B is in suspended production), forming the equilibrium point (-1, -1) in the upper right. Thus, there are still some other factors that make enterprises continue production even when  $P$  (market price)  $< VC$  (variable cost).

3. The above two situations are the equilibrium that appears without the staged rebound

expectation or the cyclical decline channel for commodities. However, the periodic rebound in the market can be reached, and the earlier stockpiled inventories can be released due to the increase in price and demand when meeting the situation 3. Then the market competitive strategy analysis of A and B enterprises is shown below:

Table 3 Nash equilibrium under the hypothetical situation 3

A enterprise	Benterprise		
	Strategy	Production	Suspended production
Production		1, 1	1, -3
Suspended production		-3, 1	-3, -3

It can be found from the above table that the expected A and B enterprises can transform the production income (-3, -3) (Table 1) to (1, 1) (Table 3) in situation 1, while A and B enterprises without production can change from (-1, 1) (Table 1) to (-3, -3) (Table 3) when the price and the demand increase at the same time. Therefore, A and B can compete for production when there is greater expectation on the market.

The possible reasons for the expectation mainly include:

Firstly, the probability of price rebound increases greatly when the market has maintained its long-term downturn, and the price is far away from the production cost;

Secondly, enterprises that lack capital and financing abilities are forcibly withdrawn from the market, leading to the constant decrease in the supply of production capacity;

Thirdly, lower prices can reduce the cost of downstream enterprises or attract the early buy-in of value investors and value discoverers.

Fourthly, the government will impose policy restrictions on low-end and inefficient capacity, thus leading to the reduction in the overall supply.

### 2.3 Research on competitive strategy of energy enterprises based on game theory——illustrated bythe case of CHALCO

#### ( I ) Research background

Aluminum Corporation of China Limited (hereinafter referred to as “CHALCO”), founded on September 10, 2001 in the People's Republic of China, and owns the controlling shareholder of Aluminum Corporation of China. CHALCO is not only the giant enterprise in China's non-ferrous metals industry with its comprehensive strength ranking among the top of the global aluminum industry, but the only major production and management enterprise integrated with the exploration and exploitation of bauxite, coal and other resources, production, sale and technology development of alumina, primary aluminum and aluminum alloy products, international trade, logistics industry, thermal power generation, as well as new energy generation. It currently owns 39 companies, including 18 wholly owned subsidiaries

and 21 holding subsidiaries. And the shares of CHALCO have been listed on the New York Stock Exchange (stock code: ACH), Hong Kong Stock Exchange (stock code: 2600) and Shanghai Stock Exchange (stock code: 601600) respectively.

Electrolytic aluminum project can produce high-temperature liquid aluminum by adopting advanced and large 330kA prebaked electrolytic cell, independent innovative configuration of heterogeneous cathodes and other energy-saving technologies through cryolite—alumina electrolysis. Then in this way, the vacuum lift method can make it directly into the foundry, process into billets and profiles after clarification and direct casting in the furnace, thus leading to lower iron content and less impurities.

As an important basic industry in China, aluminum industry has faced the declined price of electrolytic aluminum from 17,800 yuan / ton in 2011 to 9965 yuan / ton in 2015 due to repeated construction and overcapacity, thus leading to great losses in the electrolytic aluminum processing industry. In addition, the cost has basically maintained at 14,500 yuan, while variable cost is about 10,875 yuan and accounts for about 75%.

Taking CHALCO as an example, this paper adopts game theory to analyze the reason why enterprises still adhere to electrolytic aluminum project production under the condition of losses. And the game of electrolysis aluminum project is to continue its production or stop production when the industry faces great losses.

## (II) Research on competitive strategy of electrolytic aluminum project in CHALCO

1. It is necessary to consider the suspended production (-1, -1) according to the cost-effectiveness and model 1 when the price of electrolytic aluminum is 9,965 yuan / ton (market price) < its price 10,875 yuan / ton (variable cost) with reference to the situation in 2015 in the fully market competition.

2. However, as a large state-owned enterprise, there are other factors affecting production decision-making of CHALCO, mainly including:

- (1) Enterprises can obtain government subsidies and tax incentives through production.
- (2) Social stability factor. Suspended production may lead to unemployment and reduced income for employees.
- (3) Affecting local GDP, and leading to “policy losses.”
- (4) Equipment idle risk. Many large-scale production equipment must be run all day, or the restart costs will be higher, and private enterprises are less likely to receive government subsidies and policy support compared with state-owned enterprises. Therefore, the current round of game will be carried out among state-owned and private enterprises through considering government subsidies and other factors (stability, GDP). According to the Model 2, the cost of continuous production will be declined with the government subsidies and tax incentives, and the pressure to stop production can be increased and formed the new strategic equilibrium (state-owned enterprises are in production, while and private enterprises are in suspended production) due to the political and social factors, which is shown in Table 2 (situation 2) and in the upper right (-1, -1).

3. Sometimes, it is essential to use our wisdom to predict others thinking when we make

decisions, and this is game thinking. First of all, the potential for market growth is still high, and has development opportunities from the perspective of the electrolytic aluminum industry, thus leading to the increased aluminum consumption. On the other hand, there is still a huge gap in terms of resource ownership and per capita consumption between China and developed countries and the application of aluminum products and market space potential are larger. And it is estimated that electrolytic aluminum production will reach about 42 million tons, and the price can gradually recover to 16,500 yuan / ton by 2021, therefore, some large-capacity enterprises will continue to expand their production to share the costs and further form competitive advantages.

Secondly, it is possible for those enterprises adhering to continuous production to obtain rich returns if other companies are expected to quit: 1. Seize market share and even form the monopoly. 2. Receive more discourse power in the upstream supply chain. However, it may face the following losses if the enterprise chooses to quit: 1. the cost of reproduction will be larger than losses of continuous operation and even enter the industry barrier when the economy recovers. 2. Lose market share and existing customers. 2. The scale effect of enterprises can be affected. Finally, as a large state-owned enterprise, CHALCO must also assume its responsibility to protect and utilize Chinese mineral resources. And as an industry affecting the national economy and even national security, aluminum industry can't be easily given up, but continuously improve its technical level and reduce its production costs only in the production process. According to Model 3, it can be seen that the profits of CHALCO should be larger than that of its suspended production, no matter what the other party chooses to produce or stop production, corresponding to (1,1) or (1,3).

CHALCO, a subsidiary of Aluminum Corporation of China, indeed has the financial advantage over some companies. Once the project financing can be effectively guaranteed and the cash flow is relatively abundant, the continuous production of electrolytic aluminum according to the game model 3 can achieve success even if it may encounter the temporary losses, thus ultimately becoming the winner.

The fact also proves the judgment under the game theory. And its revenue has reached 91.31 billion with an increase of 83% in the first half of 2017, while its net profit has achieved 751 million with 10.06 times year on year according to the recent news released by CHALCO. And the performance in the first half of this year of CHALCO has set a new high record since 2009, making "the king of losses" have increased ten times net profits.

### **3. CONCLUSION**

#### **3.1 Enlightenment**

##### **1. Static and dynamic thinking**

Cost-volume-profit analysis ( $P < VC$ ) is static, while the market and competitors are dynamic in time and space. Specifically, in time aspect, the best strategy for enterprises with

the financial strength and strong background is to adhere to “life-or-death struggle”. In space aspect, the industrial chain integration at both the upstream and downstream can be easier to reduce procurement costs and increase market share, and further squeeze opponents, thus concluding that the suspended production of loss-making enterprises may result in unscientific and irrational decision-making.

#### 2. Bad money driving out good

The government subsidies and political impact (taxes of employees, GDP pressure) to state-owned enterprises will have an impact on the corporate strategy, thus creating a new equilibrium, and state-owned enterprises will continue the production, while private enterprises choose suspended production or withdraw from the market. And the squeeze for the living space of private enterprises may make those with high efficiency withdraw from the market first and form the result of “bad money driving out good”. And for the government, the policy support for high-tech or energy-saving and emission reduction enterprises while making state-owned enterprises become real “market players” can improve effective and high-end supply through “supply-side structural reform”, in order to effectively eliminate ineffective supply.

#### 3. Expected effect in game

The expectations for increased product markets, the gradual quit of competitors from the market and the high complex production cost due to shutdown can make enterprises constantly maintain new capacity, thus delaying the real realization of expectations (the market rebound in phrase). However, the real “bottom” can come when the market is gradually quiet and the enterprises no longer have the expectations. Therefore, enterprises can receive their spring and become the final winner if they maintain adequate strength and cash, continue to reduce management costs to better integrate mergers and acquisitions activities.

#### 4. Cash is king, and seeking transformation and upgrading

Enterprises must conduct recombination or transformation when funds and other previous accumulated resources fail to guarantee the constant operation, and they lose financing capacity, and further form the industry decline cycle. To cope with the overcapacity crisis, the best method for enterprises is to adhere to the production and reform, and further improve technology upgrading and management level instead of expecting the market reversion and suspended operation. And the sustained improved technology and management methods (reduced VC), the seeking of strategic move and new profit growth points (increase P), as well as the locked risk through hedging and other methods can effectively cope with problems and receive the dawn.

### **3.2 Conclusion**

It is worthwhile for the business managers to think how to guide enterprises to make effective decisions with the game theory, and after all, game theory is an effective tool for formulating competitive strategies. And the first is the macroeconomic factor changes at home and abroad



for energy enterprises, such as the introduction of China's supply-side structural reform, direct supply and environmental protection policies. While the second is to pay close attention to motivations and strategies of competitors, for instance, China Hongqiao Group has arranged thermal power plants in Mongolia and Xinjiang when coal and aluminum prices are in a downturn, in order to reduce price fluctuations and procurement costs of raw materials.

Big era requires big pattern, while big pattern requires big wisdom. The competitive strategy in energy enterprises has shown that short-term gains and losses are not enough to support long-term decisions, but unrealistic expectations and hasty preparations can lead to bottomless abyss.

“The world cannot compete with them if he does not contend”. Only being well-grounded and forming profound insight can enterprises always maintain their development vitality while achieving great progress.

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