Status and Problem Analysis of Da-industrial Salt Supply Chains in China

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Abstract: The traditional da-industrial salt supply chains in China cannot match supply and demand very well because of demand uncertainty, which causes huge losses to salt making enterprises and also influences the performance of the whole supply chain. How to deal with the demand uncertainty to improve the performance of the supply chain is an important subject for the da-industrial salt supply chain. In this paper, we introduce the traditional da-industrial salt supply chains in China and analyse the main problems in the operation mode as follows. One problem is that the traditional operations mode in da-industrial salt supply chains impacts the performance of the whole supply chain. The other one is that the high demand uncertainty brings damage and huge losses to the supply chain. To solve these problems, we propose supply contracts with options in da-industrial salt supply chains in China. Purchasing options enables the salt using enterprise to gain flexibility in the order decision-making, and to reduce forecasting error by further collecting demand information. For the salt making enterprise, she can be compensated from the revenue obtained from the options.

Key Words: Da-industrial salt, Supply contract, Options, Demand Uncertainty

1. Introduction

Da-industrial salt, an often used name in China, refers to the caustic soda (NaOH) and sodium carbonate (Na2CO3) etc., which are widely used in industry. As a kind of indispensable raw material in production, it plays an important role in many manufacturing industries, including the glass industry, light industry, building materials, chemicals, food, metallurgy, textiles, petroleum, medicines, paper, aluminum, tungsten smelting, artificial silk, rayon, soap and so on. In 1998, it was allowed that salt making enterprises in China could plan the production and sales of da-industrial salt according to the market demand by themselves. However, the demand of da-industrial salt is difficult to predict because it acts as a raw material for many industries, which may lead to a large forecast error and further the supply-demand mismatch. Such a problem has become a main subject for the da-industrial salt supply chain, especially for the salt making enterprise which is the core player in the supply chain.

When the market is in short supply, the salt price goes higher and leads to an increasing cost for downstream enterprises in da-industrial salt supply chains. As a result, the prices of end products are driven up, which may affect the development of the national economy and the people’s daily life. When the market is in oversupply, downstream enterprises will tend to squeeze prices down. To keep the existing market share, the salt making enterprises, confronted with an increasingly upgraded and complicated market competition, are forced to cut down the sales price regardless of the deficit. This may affect the sustainable development of the salt making enterprises and further the da-industrial salt industry in China.

Since da-industrial salt is a basic raw material for industrial production, the whole da-industrial salt supply chain is relatively long. It consists of raw materials suppliers, salt making enterprises, intermediate products manufacturers, and many other downstream enterprises. Salt making enterprises purchase raw materials from suppliers to produce da-industrial salt, and then sell it to salt using enterprises to produce intermediate or end products. These products are sold through the downstream enterprises (for example, manufacturers, distributors and retailers) until to consumers. Since da-industrial salt is a raw material for many industries, the supply chain structure of the da-industrial salt is highly complicated, which brings huge management difficulties to salt making enterprises.

A main difficulty for salt making enterprises in management is how to match supply and demand. Da-industrial salt is involved in a large number of industries. Since different industries vary in markets greatly, the da-industrial salt demand prediction is extremely difficult. Therefore, the production decision-making is apt to deviate from the market demand, which may make the enterprises suffer losses. If salt making enterprises are in overproduction, a serious backlog of inventory may occur, which not only causes the slow flow of funds but also increases storage costs. If in underproduction, the da-industrial salt production cannot satisfy the demand. The salt making enterprises will encounter a less profit and a rising shortage cost. Essentially, the cause mainly lies in the low capability to deal with demand uncertainty, which results in the supply-demand mismatch.

Traditionally, price control is a common method to balance the supply and demand in da-industrial salt supply chains. The salt making enterprises adjust the sales price to cope with the fluctuant market. This tactic, being an ex post method, can-
not fundamentally solve such problems. What’s more, it may trigger a variety of adverse reactions. For instance, if oversupply, some salt making enterprises may decrease the price, while other salt making enterprises will cut the price at a lower level to secure their existing market share. This may lead to a malignnant price war which will disrupt the market. Likewise, if short supply, salt making enterprises will raise the price to get more profit. Furthermore, salt using enterprises tend to transfer the increased cost to the customers. Therefore, it is better to prefer the ex ante method but not ex post one. Supply contracts have been proved to be an effective way to deal with such problems [7]. In this paper, we try to propose feasible supply contracts for traditional da-industrial salt supply chains.

To the best of our knowledge, there is no literature on supply contracts for da-industrial salt supply chains in China. In this paper, after analysing the present situation and problems of the da-industrial salt supply chain, we propose a flexible supply contract with options to cope with the demand uncertainty, which may improve the performance of the supply chain. The rest of the paper is organized as follows. We present a literature review in Section 2. Section 3 analyses the status and problems of the traditional da-industrial salt supply chain. In Section 4, we propose a flexible supply contract with options as the solution. Finally, we provide a brief summary of our conclusions and suggestions for future research in Section 5.

2. Literature Review

In fact, supply-demand mismatch also exists in many other industries. To solve such problems, many scholars have introduced supply contracts to improve the performance because supply contracts are convenient to implement and will not change the structure of the supply chain. And supply contracts now have been applied in different industries (e.g. fast moving consumer goods, semiconductor, etc.) and achieved good results. There are many different types of supply contracts. Option contracts are the ones that appear frequently in the literature. To introduce supply contracts with options in salt industry, we review the literature both in the salt industry and in the field of supply contract with options.

Many scholars have studied on salt industry. Most of them concentrate in table salt. Some research (Cheng and Zeng (2011) [10], Chen and Yang (2008) [8], Yang (2011) [20], Zeng (2012) [21]) study the salt industry as well as the disadvantages of the supply system and propose reformative suggestions from different perspectives. However, they consider the problems from macro perspectives. A few scholars in China also have studied the salt supply chain from micro perspectives. Zhang and Deng (2004) [25] propose that the integration of the salt supply chain is an indispensably important solution to reengineer salt making enterprises. Zhao (2008) [22] analyses the risk of salt supply chain of Jiangsu province and provides the risk-aversion strategies. Zhao (2012) [24] surveys the salt supply chain of Sichuan province and derives a scheduling solution for both usual situation and emergency through simulation. It can be seen as a reference to enhance the emergency response ability of salt industry in Sichuan province. However, few scholars do research on da-industrial salt industry in China. We only find that Yang (2011) [19], Lv and Zeng (2012) [15] study da-industrial salt supply chains from the perspective of macro economy.

A lot of research has proved that option contracts can provide flexibility to cope with demand uncertainty and improve the performance of the supply chain. Wang and Tsao (2006) [17], Wang and Liu (2007) [18] propose supply contracts with options from the perspective of flexible supply chain. It has been identified that this mechanism can respond to demand uncertainty in a better way so as to improve the performance of supply chain. Cui and Liu (2009) [9] prove that the supply contracts mechanism with options can realize the coordination between logistics integrator and subcontractor, and improve their profits. Zhao (2010) [23] applies option contracts in a supply chain consisting of one farmer and one processing enterprise, and proves that option contracts can coordinate agricultural supply chains and benefit the farmer. Liu et al. (2013) [16] use option contracts in a two-stage container leasing service supply chain, and draw a conclusion that profits of both the container owner and the rental can be enhanced.

3. Status and problem analysis

The performance of the da-industrial salt supply chain in China is not very well. There are both internal and external reasons. The internal reason is the traditional operations mode in da-industrial salt supply chains, while the external reason is the high market demand uncertainty.

Generally, salt making enterprises play an important role in the operations of the supply chain. In the traditional operations mode, the salt making enterprises usually make the production plan after receiving order commitments for the next year. The downstream enterprises need not to pay for the order commitment. After entering the next year, the salt making enterprise produces and delivers according to the final order from downstream enterprises monthly. At the end of the next year, the salt making enterprises will examine whether actual demand from the downstream enterprises reaches the commitment quantity. If ordering up to the commitment quantity, the downstream enterprises will be allowed to make an order commitments by themselves in the next years. Otherwise, the downstream enterprises will lose reputation and the salt making enterprises will limit the quantity of the orders or order commitments.

Greatly affected by the traditional operations mode, the performance of the whole da-industrial salt supply chain is not very well. The da-industrial salt market in China has encountered three times of sudden change. In 1998, the total production of da-industrial salt was far more than the demand, which caused a heavy overstocks and huge losses of the salt making enterprises. The price of da-industrial salt came down in Chinese market. The sodium carbonate’s selling price, usually about 1000 yuan per ton, reduced to about 600 yuan per ton. Some salt making enterprises were unwilling to sale da-industrial salt at a low price, and kept to await a higher price in the near future, which resulted in a serious surplus. However, considering the local economy, it is not allowed to cut down the production. This, of course, leads to overproduction and then a heavy overstock. Generally, the production of da-industrial salt may increase with GDP at a certain rate. When the production rises at a relatively high rate, overproduction will occur and the selling price will fall in order to reduce the inventory. For example, in the case that GDP raises at about 7% whereas the social consumption increases at only 5%, the social consumption is at a low level. The insufficient demand will result in the decrease of...
the selling price. The salt making enterprises will cut down the price in succession which may cause a cut-throat competition and a vicious environment in the industry.

For the external reason, the demand of da-industrial salt is easily affected by many other industries, which leads to the high demand uncertainty of da-industrial salt. We take the glass industry as an example. The glass, which is widely used in construction and manufacturing, requires large quantity of da-industrial salt. The fluctuant glass demand has a significant impact on da-industrial salt demand. With the growth of the economy, the real estate industry develops quickly and citizens have a growing appetite for purchasing new houses, which results in a rising glass demand in construction and then pulls the demand of da-industrial salt. However, in recent years, the government has set a number of regulatory policy such as home buying restrictions, which probably puts da-industrial salt demand in a negative situation. Considering another glass demand industry—liquor industry. It influences the demand of da-industrial salt as well.

As liquor sales continue to grow, the demand of wine bottle grows, which enhances the demand of glass. This also pulls the demand for da-industrial salt. However, with the effects of prohibition of alcohol policy and restriction on Three public consumptions (overseas travel, receptions and official cars), some liquor supply chains hold overage inventory, bringing about the rapid decline of demand for liquor bottles and then da-industrial salt.

In a single salt making enterprise and a single glass enterprise supply chain, its traditional operation mode (see Figure 1) lacks flexibility in dealing with demand uncertainty. The sustainable growing glass demand drives up the demand for da-industrial salt. The salt making enterprise will increase production to cope with the increased demand. Due to periodic production, it is difficult to respond to the increased demand quickly. The salt making enterprise will face problems whether the production can be increased or not. Even can, it will also confront additional production cost. In the case when the production cannot be increased, the glass enterprise will suffer losses because of shortage. Otherwise, the glass enterprise will face higher prices for da-industrial salt. If the demand falls in the future, the glass enterprise will place a less order. Since producing based on the order commitment, the salt making enterprise inevitably encounters overproduction, great inventory cost and much liquid capital occupied.

To solve such a problem, we consider the introduction of option contracts into da-industrial salt supply chain in China. Typical options include the option to decide the timing of investment, the option to hold or abandon an active project, the option to expand or to reduce the production capacity, or the option to choose the production technology, products and markets. Options include financial options and real options. Financial options are options on financial assets. A call option gives the holder the right to buy a stock, and a put option gives the holder the right to sell a stock. If the option can be exercised before maturity, it is called an American option and if only at maturity, a European option. The call option is particularly relevant to project investment evaluation [12]. Real options are options on real assets, which can be defined simply as opportunities to respond to changing circumstances of a project by management. These opportunities to change are rights but not obligations to take some action in the future [11]. Real options in option thinking are based on the same principles as financial options. To have a real option means to have the possibility for a certain period to either choose for or against something, without binding oneself up-front. Real options are valuable because they incorporate flexibility and potentials. However, the fact that real options are like financial options does not mean that they are the same. The major difference between financial options (e.g. stock options) and real options is that real options are applicable to real assets [13]. A real asset is usually something tangible, such as a factory, machinery, etc., while a financial asset typically consists of stocks, bonds, currency, etc. Therefore, introducing real options in da-industrial salt supply chain in China is a possible way.

4. Solution

Real option gives the buyer the right, but not the obligation, to adjust initial order at a predetermined price just before the supplier’s delivery, one for each option. There are several kinds of real options such as call, put, bidirectional, defer, time or stage,
explore, lease, and so on. Call, put and bidirectional options are the most common ones. Call options and put options are often used to avoid one-way supply risk (supply excess or shortage), while bidirectional options can be used to evade bidirectional risk (both excess and shortage). Defer options enable management to defer investment and benefit from more information. The management, with this kind of option, can wait x years to see if output prices justify constructing a building or a plant or developing a field [3]. Time or stage (stop-resume) means when an investment can be seen as a series of outlays, the stage option creates the opportunity to abandon the project in midstream if new information are unfavorable. Each stage can be viewed as an option on the value of subsequent stages and valued as compound option [4]. An explore option is possible to realize a project on prototype scale. Both the costs that the payoff the prototype is proportional to those of the project realized on real scale. Observed the prototype results and on the base of the consequent results the management will decide if reply the project on real scale [14]. With lease option, it is possible leasing or renting a property with an option to buy it at a future date. The future price of the property should be fixed at the time the lease-option is signed. Usually there is an up-front payment of some amount to purchase the option. The amount can vary. Sometimes the monthly payment is larger than normal and the excess is used to purchase the option [5].

With option contracts, salt making enterprises can adjust the initial order quantity at a predetermined price after the demand forecast is updated. Call options or put options can increase or reduce the initial order quantity respectively, while bidirectional options can both increase and reduce the initial order quantities. At present, option contracts have been widely adopted in many industries such as toys (Barnes-Schuster et al., 2002 [1]), electronics (Billington, 2002 [2]) and aerospace (Cole, 1998 [6]).

To illustrate the operation in detail, we introduce call options in a supply chain that has one salt making enterprise and one glass enterprise. The glass enterprise purchases da-industrial salt from the salt making enterprise to produce glass. And then the glass will be sold to the downstream enterprises such as construction enterprises, bottle manufacturers and so on.

With call options, decision-making of the salt making enterprise and glass enterprise will be divided into two stages (see Figure 2). At the beginning of the planning horizon, the salt making enterprise provides the supply contract with call options (including the wholesale price, option price and option exercise price) to the glass enterprise. According to the demand forecast, the glass enterprise places an initial order with a wholesale price and purchases options in case to increase the initial order. During the lead-time, the salt making enterprise produces up to the quantity that all options are exercised, i.e., the initial order quantity plus the number of options purchased. And the glass enterprise continues to collect demand information from the downstream market to update forecast. At the beginning of the selling season, according to the updated demand information, the glass enterprise exercises options if necessary. And the salt making enterprise delivers to the glass enterprise based on the adjusted order quantity. At the end of the selling season, the glass enterprise salvages the products at a certain price if there is any surplus.

Purchasing options enables the glass enterprise to gain flexibility in the order decision-making, and to reduce forecasting error by further collecting demand information. The glass enterprise can choose whether to exercise the options or not after the demand forecast is updated. The additional revenue obtained from the options, on the other hand, can compensate the salt making enterprise. In fact, the glass enterprise transfers the risk of demand uncertainty partially to the salt making enterprise by using options. This transfer may be advantageous to both parties, especially if the salt making enterprise is large and is more able to absorb the risk. Additionally, purchasing options enables the glass enterprise to determine the extent of flexibility. Because the glass enterprises are closer to customers, they frequently have better demand information than the salt making enterprises do. Therefore, it is to the whole supply chain’s advantage to let the glass enterprise determine the extent of flexibility. However, flexibility is limited by the quantity of options purchased. This is reasonable since the limited adjustment is realizable because the salt making enterprises always have limited capacity and the salt making enterprises will not bear all overage risks. According to this limitation, the salt
making enterprise can know the adjustment range of the glass enterprise, which is important for the salt making enterprise to decide the production quantity.

5. Conclusion

In this paper, we introduce the traditional da-industrial salt supply chains in China and analyse the main problems in the operation mode as follows. One problem is that the traditional operations mode in da-industrial salt supply chains impacts the performance of the whole supply chain. The other one is that the high demand uncertainty brings damage and huge losses to the supply chain, especially for the salt making enterprises. To solve these problems, we propose supply contracts with options in da-industrial salt supply chains in China. Option gives the salt using enterprises the right, but not the obligation, to adjust initial order at a predetermined price just before the salt making enterprises’ delivery, one for each option. Purchasing options enables the salt using enterprise to gain flexibility in the order decision-making, and to reduce forecasting error by further collecting demand information. For the salt making enterprise, she can be compensated from the revenue obtained from the options. In addition, using options can make the salt making enterprise know the adjustment range of the salt using enterprise, which is important for the salt making enterprise to decide the production quantity.

For future work, we may introduce supply contract model with options into a case study in a da-industrial salt supply chain to investigate the benefit quantitatively.

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