An Analysis on the Facilitating Effect of Sino-Burmese oil and gas pipelines on the Regional Economy by System Dynamics

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Abstract

Based on system dynamic theory, this article analyzes the influence of the Sino-Burma pipelines on the southwest of China. Taking the Anning Refinery Project as an example, a model of economic development for oil refinery industry has been set up. The paper differentiates the causal relationship between Sino-Burma pipelines and refined oil price in Yunnan province, and analyzes the influence of Anning Refinery Project on Yunnan refined oil supply structure, refined oil price and the promotion of regional economy using Stella software. The results reveal inner mechanism and trends of fluctuations of refined oil price and economy development. It shows that the establishment of the Sino-Burma pipelines will change the structure of supply of energy in Southwest, alleviate the contradiction of supply and demand for energy, help to improve the comprehensive layout for the capacity of oil refining, and optimize resource allocation.

Keywords: system dynamics; Sino-Burmese oil and gas pipelines; southwest region, the Anning Refinery Project

1 Introduction

With the rapid development of economy in China, the demand of refined oil is increasing year by year. The demand is eased by the new operation of oil refining project and alternate energy to some extent, but the development of industry has brisk demand which leads to the large energy gap, so the demand of the crude oil import is further improved. At present, Chinese crude oil production areas are mainly concentrated in the northeast, northwest and North China, and the major refined corporations are centred in northeast, northwest and the coastal areas, forming the layout of "oil in north, carry to south". To improve the comprehensive layout of refining capacity in China and to reduce the risk of oil supply, the forth strategic gallery for energy import, Sino-Burmese oil and gas pipelines, came to build in 2010, and the supporting projects were decided to load in Caopu Industrial Zone in Anning, Kunming. Among these, the PX project had cause the discussion and attention by people in different fields. Objectively, Sino-Burmese oil and gas pipelines have significant meaning to the growth of economy and the energy security in the southwest. This paper tries to analyze how Sino-Burmese oil and gas pipelines influence the regional economy by system dynamics, without regard to the environmental and social factors. And explain the function of oil refining project for energy supply and local economic development in Yunnan by the data from Yunnan for this oil refining project settles in Kunming.

Since Sino-Burmese oil and gas pipelines are in trial operation period and the oil supply has not began, so the researches on the effect of Sino-Burmese oil and gas pipelines are less. The present researches mainly made qualitative analysis from international relationship, the oil security, the establishment of pipeline, the environment and so on. Yang thought the policy factors were very important to the transportation safety of Sino-Burmese oil and gas pipelines[1], and external power may influence Sino-Burmese oil and gas pipeline project by the means such as promoting the democracy reformation in Burma, supporting various non-government organizations in Burma or abroad, or release investment bans[2]. Xia considered that the establishment of Sino-Burmese oil and gas pipelines would help to alleviate the predicament of ocean shipping bottlenecks in Malacca, and motivate the formation of new situation for Chinese energy supply[3]. The cooperation in Sino-Burmese oil and gas has significant strategic meaning for implementing "going out" strategy, using the energy at home and abroad reasonably and making sure the energy supply security in China[4]. There are some researchers concentrating on mechanic parameters of rock mass, the treatment measures of sandy soil liquefaction for Sino-Burmese oil and gas pipelines and the problems in ecological problems[5-6]. System dynamics is a comprehensive way to study how to coordinate and manage the sub-system which are interconnected and affected each other and finally achieve the goal. It has a low request to data, and can exam the different situations of system according to different parameters input. The studies are rich for energy security, oil supply and oil markets which were based on system dynamics, including four aspects. The first is the impact of oil external dependence to domestic energy demand; the second is the impact of oil exploitation to the supply and demand in the domestic market; the third is the market impact which is from abroad to home, such as exchange, OPEC; the forth is the impact of policy factors to the oil supply and demand. It was Naill who first introduced system dynamics into energy field to study the natural gas industry in America[7]. Chen found that external dependence of the consumption of oil would rise when the speed of development of economy was increasing through forecasting some factors by oil demand system model based on system dynamics[8]. Zhang found the oil reserve had substantial and mental influence to international oil price by system dynamics and regression model[9]. Hou

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and Qi used the samples from America, fifteen countries in EU and China from 1980 to 2008, analyzed the correlative reasons between the fluctuations of oil price and the economic growth from the perspective of oil price impact[10]. Hao et al. made the empirical study to the system dynamic characteristics of oil price by the fractal and chaos theory, and found the characteristics of the fractal, the level of complexity and the types of system evolution[11]. Ju et al. set up the main economic index system which was easily influenced by the fluctuations of oil price including consumption, income, investment, trade and price. And they thought the increasing of international oil price would weaken the ability of economic growth in China and this would cause the inflation[12]. Chen and Zhang found the increasing of international oil price would lead to the increasing of domestic price of commodities, and influence the level of consumption through the effect of wealth and price by the analysis on the effect of fluctuation of international oil price to the mechanism in macro-economy[13]. Behdad and Mohammad did a study on the production and consumption policy in the field of oil and natural gas in Iran by system dynamics[14].

Yunnan is at the end of the refined oil supply chain in China, and the entrance of refined oil production is limited by the condition of traffic. The instability and delay of refined oil supply will cause the fluctuation of oil price, and seriously hurt the healthy development of society and economy in Yunnan. However, the establishment of oil refining project in Anning will have a remarkable effect on the instability and shortage of refined oil supply. Based on these discussions above, this paper will set up the model to study the influence of Sino-Burmese oil and gas pipelines on the refined oil supply, the change of oil price and the regional economic development by the system dynamics theory and method.

2 System dynamics model

2.1 BACKGROUND OF SINO-BURMESE OIL AND GAS PIPELINES

The consumption of crude oil increased from 432,452,000 tons in 2010 to 680,056,000 tons in 2012 in China, and the oil external dependence has exceeded 50% year after year, according to statistical yearbook in 2013.

Uncertain factors deeply influence the energy supply security in China such as the high level of oil external dependence, complicated international events and military geopolitics. To insure energy security and expand geopolitical influence, China cost a lot to build Sino-Burmese oil and gas pipelines. July 28th in 2013, Sino-Burmese gas pipelines, constructed by China, Burma, Korea and India, put into operation, which meant that Sino-Burmese gas pipelines got periodical achievement through 3 years' hard construction. And after the accomplishment of Sino-Burmese oil pipelines, the oil imports in China will form the pattern which relays on four major paths (Fig. 1), and this will relieve the risk of energy security. Four major paths include overseas oil path which enters from Guangdong and then goes through Malacca; Sino-Burmese oil and gas path which enters from Ruili then goes through Bengal and Burma (the southwest oil channel), the oil path between China and Kazakhstan which is from Xinjiang then goes through Central Asia (the northwest oil channel), Sino-Russian oil path which is from northeast then goes through Russia (the northeast oil channel). The oil channel at sea makes oil, which is from the Middle East and Africa cross Indian Ocean, via the straits of Malacca, finally enter into China from eastern coastal cities.

The whole way goes by sea and has low transportation cost, but it is terribly influenced by the sea weather, sea rovers and the geopolitical relationship in different areas. Especially for the straits of Malacca, this area is the throat of import path at sea, and interfered by various forces. The northwest and northeast oil channel are mainly on land and carry oil by pipe, so the cost is higher than that at sea but face to less risk. Sino-Burmese oil and gas pipelines merge the two ways, and certainly face to the risk from both sides. Compared to the passageway via Malacca, the strength is that it shortens the journey by 1200 sea miles since it is from the Persian Gulf to Burma, not to the southeast coastal cities in China. The construction of Sino-Burmese oil and gas pipelines offers a new way to energy import for China, and makes it more independence on Malacca.

FIGURE 1 The paths for oil transport in China

2.2 THE CAUSATION BETWEEN REGIONAL ECONOMY AND OIL REFINING INDUSTRY AND THE MODEL

The system of oil refining industry economic development is complex and comprehensive. This system combines every factor into an organic entirety which has mutual influence and mutual restriction inside by the swap and conversion among martial, message and energy. Sino-Burmese oil and gas pipelines make themselves as the guarantees for oil refining in Anning. This paper mainly analyzes the influence of construction of oil refining project on the refined oil supply and consumption, and studies promote effect brought by these influence. We give full considerations to the refined oil supply, the demand of industry development, GDP and the mechanism of feedback among them. Besides, the actual situations and the characteristics in different regions are also included.

According the views of system dynamics, the development level of regional economy, the development of oil refining industry, the supply and demand of refined oil and the refined oil price in Yunnan form a kind of loop feedback system. The feedback paths are as following:

(1) The positive feedback: GDP in Yunnan --- demand of refined oil --- investment of oil industry --- capacity of oil refining --- price of refined oil --- consumption of refined oil --- GDP in Yunnan

The economic development increases the demand of refined oil. To reduce the instability brought by the shortage of oil, the investment of oil industry will increase relatively. And this will promote the capacity of oil refining, stabilize oil supply and promote the economic development.

(2) The negative feedback: GDP in Yunnan --- gross demand of energy --- demand of refined oil --- price of refined oil --- underlying consumption of refined oil --- GDP in Yunnan

The economic development has positive relationship with the gross demand of energy. If there lacks of refined oil, the price and the cost for using refined oil will rise, and at the same time, it will limit the development and hinder the growth of GDP.

(3) The negative feedback: Price of refined oil --- fluctuations of oil price --- refined oil demand --- gap between supply and demand --- Price of refined oil

To some extent, the supply and demand in the market determine the price. The growth of refined oil price has varying impact to the cost of consumption in the primary industry, the secondary industry and the tertiary industry, and it will decrease the oil consumption and form supply surplus, and then the refined oil price will fall until a new equilibrium has been reached.

(4) The positive feedback: GDP in Yunnan ---investment of oil industry --- supply of refined oil --- import cost outside province --- price of refined oil --- actual consumption --- GDP in Yunnan

The investment of oil refining industry in Anning will increase the supply of refined oil in the future in Yunnan, and reduce the import oil from other provinces. It will decrease the cost of transport and the cost for using oil, and also remit the shortage of oil, which will promote further development of economy.

According to system dynamics, thinking about the acquirement of data, set up the model of oil refining industry economic development (Fig. 2) after explicit mechanism of feedback. In the Fig. 2, the mathematical relationship, which every arrow connects two variables, is based on the tested data, and then make simulation. 27 variables are included in the model, and 3 of which are stock; 4 are flow; 20 are instrumental variable.

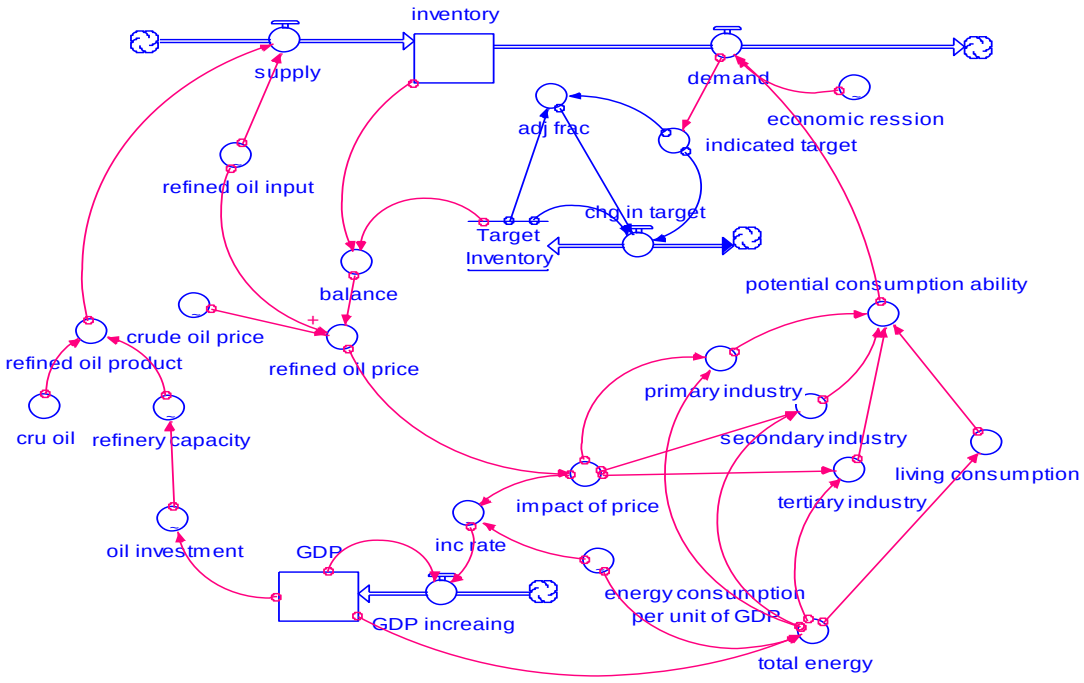

FIGURE 2 The flow chart of refined oil and regional economic development

3 Parameters setting and simulation

According to this model, we simulate the model by Stella. The data came from China energy information network, Chinese petroleum information network, State Administration of Foreign Exchange, Statistical Yearbook of Yunnan Province, Development and Reform Commission of Yunnan Province and oil management information system of Yunnan, etc.

3.1 PARAMETERS SETTING

The time for simulation began from 2005, taking one year as unit. Totally there are 24 units to be simulated. The main parameters are judged as following:

(1) The original value of GDP is 3461.71; the original value of reserve is 30, which are all from Statistical Yearbook of Yunnan.

(2) The capacity of oil refining = GRAPH (delay (investment of oil industry, 3)), as oil refinery is predicted to be finished in 2015.

(3) The energy consumption per GDP = GRAPH (TIME)(2005, 0.127), (2008, 0.248), (2010, 0.111), (2013, 0.104), (2015, 0.9),(2018, 0.087), (2020, 0.078), (2023, 0.07), (2025, 0.075), (2028, 0.069), (2030, 0.076).

(4) As the supporting project of Sino-Burmese oil and gas pipelines, this oil refining project, 10,000,000 tons per year in Yunnan, is predicted to be finished in 2015. After finished, the capacity of refining oil will be 10,000,000 tons per year, and all the capacity are expected to produce petrol: 3,320,000 tons, diesel: 5,960,000 tons, Jet fuel: 1,000,000 tons. The total number will reach 10,280,000 tons. Before these, the supply of refined oil in Yunnan relays on other provinces. In 2012, the sales volume of refined oil was 9,400,000 tons, which were all from other provinces. So the production quantity of refined oil in Yunnan almost equals zero before 2015, and later, the production quantity of refined oil is related to the capacity of refining oil and the oil import.

(5) The price of crude oil use Brent crude oil price, which is from Energy and metals consultancy Platts. The exchange data come from State Administration of Foreign Exchange. The conversions of unit are: 1 ton = 7.3 bbl, 1bbl = 0.14 ton, 1000L = 6.290 bbl.

(6) We take the annual average price of petrol 93 # as the price of refined oil since the price of that was at the middle level from October in 2010 to February in 2014, and take the sum of different kinds of refined oil (including diesel 0 #, petrol 90 # and 97 #) as the number of refined oil to accomplish the simulation.

(7) Referring to the price of refined oil in all the provinces in China, the prices are all above 6 yuan/L. The accomplishment of oil refining project will make crude oil process and converse locally and then supply the oil to provinces in the southwest. It will shorten the distance by 2500 to 3000 km compared the way now and the cost of transport will be lower more than 200 RMB. So the price of refined oil in Yunnan is related to the price of crude oil, oil supply and demand, and also is influenced by the quantity of import oil from other provinces.

3.2 VALIDITY TEST

Take the actual GDP in Yunnan, the price of refined oil and the oil supply and demand from 2005 to 2012 to do validity test of history data (Table 1). From Table 1, the absolute value of relatively error is almost lower than 10% compared the result of simulation with the true data. That means the forecast ability of this model is good, and this model is fit to the reality. It shows practical significance to the society.

TABLE 1 The results of validity test

year	Real GDP	GDP value of simulation	Relative error values	Petrol price actual value	Petrol price value of simulation	Relative error values	Demand actual value	Demand value of simulation	Relative error values
2005	3,461.73	3,461.73	0.00	4,570	4,016.69	-0.12	439.47	436.29	-0.01
2006	2,011.09	4,086.49	1.03	5,200	4,991.13	-0.04	499.56	555.71	0.11
2007	4,772.52	4,809.16	0.01	5,230	5,914.48	0.13	581.48	600.8	0.03
2008	5,692.12	5,642.18	-0.01	6,030	6,652.92	0.10	634.2	637.79	0.01
2009	6,169.75	6,618.39	0.07	6,383.75	6,873.00	0.08	673.37	725.71	0.08
2010	7,224.18	7,784.95	0.08	7,395	7,059.34	-0.05	847.59	760.49	-0.10
2011	8,893.12	9,182.34	0.03	8,813.3	8,139.20	-0.08	913.89	947.8	0.04
2012	10309.47	10,840.49	0.05	10,349.32	9,383.28	-0.09	1069	1,140.21	0.07

4 Simulation Results

It can be seen that the price of refined oil has positive relationship with the international price of crude oil in the Fig. 3. The line 1 stands for GDP; the line 2 means refined oil price and the line 3 is crude oil price. With the development of economy, the refined oil price increases more quickly and the gap between the price of crude oil and refined oil enlarges. One reason is that the scarcity and strategy of oil make the strict monitoring for the consumption of oil products. Influenced by the circumstance of economy and the demand, the price rises rapidly. The

price volatility of refined oil is small compared with the price volatility of crude oil. As what shows in the Fig.3, after 2015, the increasing speed of the refined oil price in Yunnan will slow down while the growth of GDP will speed up. The output of oil refining project has significant effect on the economic development and the supply of refined oil, but it just meets the demand of Yunnan. The potential consumption of refined oil is large, so although this project alleviates the shortage of oil, the consumption still relays on the import from other provinces.

In Fig.4, the line 1 stands for the oil supply, the line 2 for GDP, the line 3 for the primary industry and the line 4 means the secondary industry; the line 5 is the tertiary industry. As what shows in Fig.4, the supply of refined oil has the most important effect on the tertiary industry, and then is the secondary industry, the primary industry last. For instance, the transportation, chemical industry and electricity are the gas-guzzling parts, which will be influenced by the supply and price of refined oil directly. And they become important middle industries in the transmission mechanism of refined oil fluctuation. This fluctuation has effect on the price of production factors in the markets and their equilibrium value, and it transmits to the process of production and consumption and then affects the whole economy.

Lacking of oil and gas will restrain the regional economic development. The oil refining project in Anning insures the consumption in people's daily life and reduces the cost of production. What's more, it drives the investment of downstream industry chain, and offer support to the development of Yunnan, making GDP increasing more quickly.

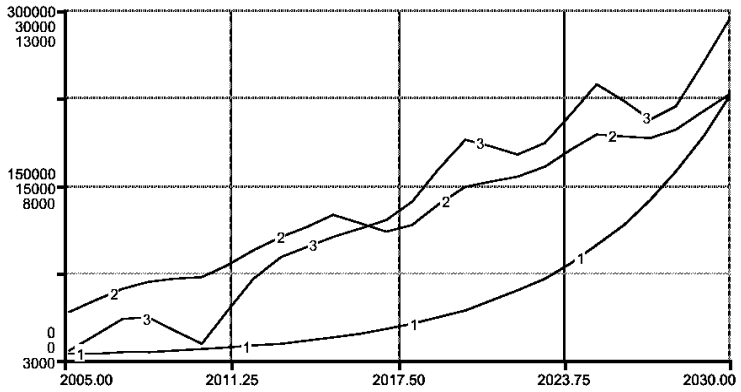

FIGURE 3 The price of refined oil, crude oil and GDP in Yunnan

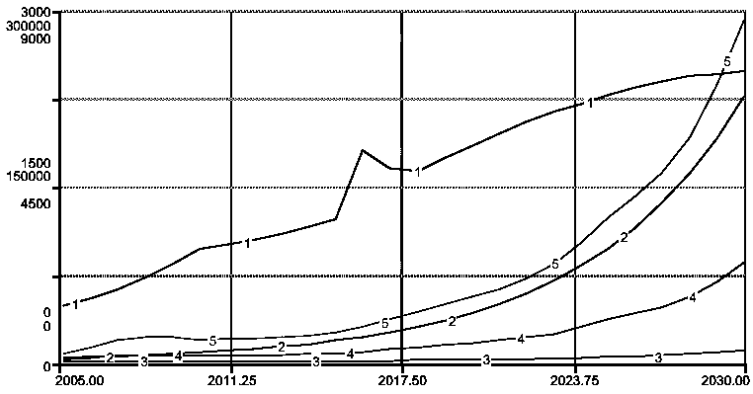

FIGURE 4 The supply and underlying consumption of refined oil in different industries

5 Conclusions

Through the study, we can get the conclusions as following:

(1) The model we build is reasonable and effective. It can simulate the relationship in the system and reflects the situation of supply of refined oil and the development of region clearly. The results of this simulation offer directions to the government policy and related practices.

(2) Sino-Burmese oil and gas pipelines change the structure of energy supply in Southwest, alleviate the contradiction of supply and demand for energy, reduce the cost for using refined oil, and are helpful to the development of regional economy. However, present scale and efficiency of refining oil cannot satisfy the need to develop economy since the economy develops very fast. So the government should guide consumption, improve energy utilization and enhance the ability to offer oil.

(3) Sino-Burmese oil and gas pipelines will make up to the shortage of refined oil production, and promote the development of chemical industry, light industry and spinning industry downstream. Via 4 district cities,

23 prefecture-level cities, 73 county-level cities in Yunnan, Guizhou, Guangxi, Chongqing, Sino-Burmese oil and gas pipelines have the important practical meaning for the regulation of the economic structure and growth way, and also for progress of the society. In the long sight, China can explore the cities along Sino-Burmese oil and gas pipelines further, such as Kyaukpyu, making it becoming the goods change station for the southwest to export to South Asia, West Asia, Euro and Africa, which can promote the foreign trade.

(4) The construction of oil refining project will help to improve the comprehensive layout for the capacity of oil refining, optimize resource allocation. It will promote the development sustainable, rapid and healthy, and then make contributions to carrying out the general plan in the West Development Strategy in China.

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