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Study on the Oil Import/Export Quota Allocation Mechanism in China by Using a Dynamic Game-Theoretic Model

Siyuan Chen[a], Mingtong Li[a] ,Qi Zhang[a*] , Hailong Li[b]

[a]*Academy of Chinese Energy Strategy,China University of Petroleum-Beijing, 18 Fuxue Road, Changping 102249, Beijing, China*
[b]*School of Business, Socity and Engineeirng, Mälardalen University, Sweden*

Abstract

With the rapid progress of oil market reform in China, independent refineries (small companies) get more and more oil import/export quotas, which will bring big impacts on the whole market and society. However, whether the impacts are positive or negative is highly dependent on the quota allocation mechanism and prices in global/domestic market markets. Therefore, in the present study, considering the game relationships among the six agents including state-owned companies, independent refineries, domestic and foreign oil product consumers, and domestic and foreign crude oil producers, in order to calculate the detailed impacts, a game-theoretic analysis model was developed. The impacts of different quota mechanism are analyzed and compared, and the optimal quota mechanism in different price scenarios is obtained based on the developed model.

1. Introduction

As the key resource of energy for the industrialized nations, oil plays an important role in almost all productive activities at present and in tens of year future. According to the statistic, oil accounts for 17% in total primary energy supply in China, which was consumed in transportation, manufacturing, infrastructure construction, agriculture and other fields. The efficiency improvement in oil industry and market can reduce oil consumption and increase social welfare. In China, the upstream, midstream and downstream of oil industry are almost monopolized by state-owned companies. The independent refineries cannot contribute to the market due to the lack of a stable source of raw materials, thus proposing an optimal quota allocation mechanism to give import and export right to independent refineries' development is important.

There have been some studies analyzing the oil market and the oil import-export right. Wan and Wang (2010) analyzed the behaviors of the two oligopolies, then they concluded that output game will not appear recently and price game will make the enterprise into the prisoner's dilemma [1]. Duan (2015) studied closed or open market environment and downstream petroleum enterprise ownership structure's

influence on upstream and downstream oil business pricing decisions [2]. Oladunjoye O. (2008) used an econometric model to re-examine the issue of price adjustment in the transmission of upstream price shocks to downstream gasoline prices by investigating how market structure affects the adjustment of wholesale gasoline prices to crude price shocks [3]. Zhou and Xie (2015) suggested that we should further promote the market-oriented reform of petroleum and natural gas exploitation, and abolish the formation of monopoly approval limits and privilege, introduce of competition [4]. Some scholars, such as Zhang and Wang (2011) [5], Lin Jianmin (2012) [6], Li Xuehui (2012) [7], learned from the experiences of other countries to propose that it is necessary to improve the international competitive ability of Chinese petroleum enterprises, but also to promote effective competition in the oil industry. Domestic scholars mainly concentrated on the qualitative analysis of the current situation of the development of the domestic refineries. For example, Ke (2015) introduced its problems and challenges [8], Wang (2015) analyzed the existence of external risk factors [9], Dai Lin (2002) gave some suggestions to improve the competitiveness [10]. In terms of the oil import-export right, since the implementation time of the policy is relatively short, domestic and international related research is less. Abdessalem Abbassi and Lota D. Tamini (2015) analyzes the impact of import quotas on the welfare of different regions in a single country and determine the optimal import quotas and the best way to allocate import permits between regions [11].

Obviously, there are game relationships among state owned companies and independent companies, because they compete directly in a same market with same consumers, and they separately pursuit their own maximum benefit. Therefore, in present study, a game-theoretic model with two markets is proposed to quantify the impacts of opening import-export right, and find out the optimal import-export quota combination to maximize the independent refinery's profit and total social welfare. Such game-theoretical model can consider all the market participants' individual interest and social welfare rather than maximizing/minimizing an objective function in traditional optimal models.

2. The model

2.1 Notations

In what follows, we first introduce the notations that we use, including acronyms, parameters, and variables.

Nomenclature			
Acronyms:		Indices:	
SOR	State-owned refineries	i=s/n	Kind of oil refineries
IR	Independent refineries	j=f/d	Source of crude oil or destination of oil product
Parameters:			
M	Maximum crude oil exploitation capacity	ε_i	Refining efficiency
$\bar{M}_i$	Maximum refining capacity	mrc_i	Marginal refining cost
cpw	International crude oil price	opw	International oil product price
$\bar{I}$	Import quota vector	$\bar{E}$	Export quota vector
Variables:			
CQ(i,j)	Crude oil quantity bought by i from j	OQ(i,j)	Oil product quantity sold by i to j
CP_d	Domestic crude oil price	P(i)	Domestic oil product price
OQN	Oil product quantity that local refineries sell to state refineries		
OPN	Price of oil product that local refineries to state refineries		
OQS	Oil product quantity that state refineries want to buy from local refineries		
OPS	Price of oil product that state refineries want to buy from local refineries		