Restructuring and differentiated regulatory policies in China's petroleum industry

Wang Junhao, Mu Xiuzhen*

China's petroleum industry is monopolistic in its main business activities. However, the reasonability of this monopoly needs to be discussed according to its technical and economic characters. Research results show that the petroleum pipeline transportation business is naturally monopolistic while other businesses are competitive. Those business activities which can be open to competition but are in fact monopolistic are so owing to administrative order, and run inefficiently as a consequence. In order to improve productive efficiency and reduce efficiency losses, we propose three restructuring patterns of the petroleum industry—the Access Control Model, the Ownership Separation Model, and the Mutual-benefit Network Model. These three models have both advantages and disadvantages. Considering the prevailing practices in the petroleum industry in China, we think that the best choice is the Access Control Model. In order to improve restructuring effects of regulatory patterns, we design three differentiated regulatory policies, including differentiated entry regulation policies, differentiated price regulation policies, and differentiated distribution of different ownership enterprises policies.

Keywords: petroleum industry, efficiency loss, restructuring, differentiated regulation

1. Introduction

Because of the relationship between the petroleum industry, the national economy and people's livelihood, there have been endless arguments about competition, monopoly, and governmental control of the petroleum industry in the academic community. According to a general survey of the petroleum industries of different countries in the world, though there exist monopolies of varying degrees, an unreasonable monopoly would result in efficiency losses of the industry (Li, Guo & Zhou, 2012; Hu & Lin, 2012), thus impeding the progress of the industry. The best way to reduce monopolistic efficiency losses is to introduce competition and bring down the degree of monopoly control (Robinson, 2000). In a global sense, market restructuring has yielded good effects in many countries. For example, the petroleum industry in Mexico has gained a lot from both domestic and international markets by bringing in competition mechanisms through restructuring. In 2012, with the structural reform of the petroleum industry

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targeting the international market, Mexico expanded its cooperation with the UK, Brazil, Norway, and Canada in many aspects, including the exchange of technology and personnel (X. Y. Zhang & G. Z. Zhang, 2013). The restructuring of the petroleum industry in Holland was conducted in the context of the change of market supply and demand in Europe and the focus of the restructuring was to restructure the oil refining business in Holland and to formulate a package of clauses limiting the oil refining business from the perspective of environmental protection (Straaten, 2001). As early as 1911, one important event in the history of the petroleum industry's restructuring in the US was the dissolution of the Standard Oil. After dissolving this corporation into 37 smaller companies, the American petroleum market became more dynamic.

In recent years, the restructuring of the petroleum industry in many countries has been accompanied by privatization. Nevertheless, the restructuring of the petroleum industry in a country can be affected by various factors, such as technological progress, globalization, deregulation, industrial dynamics, a positive economic environment, and other factors (Weston, 1999). That means any country's restructuring of its petroleum industry must not copy the experiences of other countries. A negative illustration is the restructuring of the petroleum industry in Russia. The restructuring of Russia's petroleum industry went through privatization and formed a vertically-integrated joint-stock operation model, but in the process of the operation, the vertical-integration model was found to be very feeble (Locatelli, 1999). In order to resolve the problems arising from privatization, in 2007, Russia re-nationalized its petroleum resources. Thus it proves that the restructuring of the petroleum industry needs to be intensively studied according to the practical conditions of different countries (Helm, 2004).

As for the restructuring of China's petroleum industry, it has gone through a complex process. Before 1998, when the restructuring of the petroleum industry began, China National Petroleum Corporation (CNPC) and China National Offshore Oil Corporation (CNOOC) had dominated the land and offshore petroleum exploitation respectively; China Petrochemical Corporation (Sinopec) had operated all oil refinery businesses, which were the middle stream in the industrial chain and the down stream of the wholesale and retail markets for oil—the latter being operated by non-state-owned enterprises. All those enterprises monopolized all business in the up, middle, and down stream of the industrial chain and there was almost no competition. In 1998, the market restructuring of the petroleum industry first nationalized the wholesale and retail industry of petroleum and then started a multi-regional vertical-integration operation, which meant that CNPC, Sinopec and CNOOC would implement vertical-integration operation in the northern, southern, and offshore regions respectively. In 2001, although there was a lift of geographic restrictions, there were some overlapping parts among the main businesses of domestic petroleum enterprises, and it still remained a monopoly market (Yu & Zhong, 2010; Yan, Yu & Cong, 2014). There was still virtually no competition between the biggest petroleum enterprises. As a result, from 2001 to 2006, the efficiency losses caused by the monopoly of the petroleum industry accounted for 3.1% to 5.7% of GDP in the current period (Yu & Zhang, 2010). As the economy develops, the monopoly level in China's petroleum industry has not been reduced. In 2013, the

oil production and oil processing capacity of the three biggest petroleum enterprises amounted to 92.57% and 83.01% of the total available market, respectively. The problems resulting from the monopolized market structure have proved that oligopolistic enterprises can result in lower efficiency of resource allocation, which is mainly reflected by the concentration of profits, rent-seeking behaviors, and distortion of resource allocation caused by implicit economic surplus and deregulation of factor distribution (Young, 2000). According to the performance study of the restructuring of China's petroleum industry, the reduction of the degree of administrative monopolies can improve the efficiency of petroleum enterprises (Zhang & Cai, 2008). To improve the industrial efficiency, it is of great need for China's petroleum industry to carry out market restructuring, and the restructuring of the petroleum industry should be based on the cognition of the reality of the current monopoly of the industry.

Above all, the second part of this paper reviews the monopoly in China's petroleum industry and analyzes its efficiency loss; in the third part, it classifies the types of monopolies in the petroleum industry; it designs three basic models of market restructuring of the petroleum industry in the fourth part, and in the fifth part explores the differentiated control policies for the petroleum industry after restructuring.

2. Measurements of monopoly and efficiency losses in China's petroleum industry

2.1. Measurements of monopoly in China's petroleum industry

With an attempt to measure the degree of monopoly in China's petroleum industry, we conduct quantitative analysis on main businesses of petroleum, except pipeline transportation (See Table 1).

Oligopoly status can be found industry-wide in the business of petroleum exploration and exploitation.[1] According to the data from 2007 to 2012, the lowest and highest concentration ratios of CNPC and Sinopec, the two largest petroleum enterprises in the business of crude oil exploration and exploitation, were 79.92% and 83.83%, respectively—making an average industrial concentration ratio of 82.27% in the 6 years studied, which indicates the existence of oligopoly in the business. We select data of the outputs of some main oil products (e.g. gasoline, diesel, and kerosene) for the measurement of the oil refinery business. The highest concentration ratio of oil refineries goes up to 87.30% in 2007, and the lowest is 79.51% in 2012. It is can be seen that though the monopoly degree in the business of oil refining keeps going down, there still remains an oligopolistic market. In the field of oil marketing, given the lack of oil sales data of the CNPC in 2007 and 2008, and national sales data of oil in 2012, we only make reference to the market concentration ratios from 2009 and 2011 as sales indicators. The concentration ratio of

[1] Currently in China, the petroleum exploitation party is the exploration party and there is no transfer of possession or employment of another enterprises for exploitation after the exploration of oil, so we combine the data together in data disposal.

oil sales increased from 84.31% in 2009 to 98.91% in 2011, so it can be concluded that there is double-oligarch monopolization in the business of petroleum sales in China.

Table 1
Measurement of the degree of monopoly in main businesses of the petroleum industry (10,000 tons, %)

Main businesses and enterprises		2007	2008	2009	2010	2011	2012	Conclusion
Exploration and exploitation	CNPC	11449.45	11783.73	11415.62	11607.80	11992.15	12403.57	Oligopoly
	Sinopec	4108.04	4180.28	4241.55	4617.61	4531.41	4623.66	
	National total	18631.82	19043.96	18949.00	20301.40	20287.60	20700.00	
	Proportion	83.50	83.83	82.63	79.92	81.45	82.26	
Oil refinery	CNPC	7138.10	7396.80	7319.50	7944.80	8715.00	9101.60	Oligopoly
	Sinopec	9828.00	10737.00	11369.00	12438.00	12800.00	13296.00	
	National total	19430.29	20915.23	23089.53	24209.24	25540.00	28170.70	
	Proportion	87.32	86.70	80.94	84.19	84.24	79.51	
Oil marketing	CNPC			10125.30	12083.30	14553.20	15327.70	Oligopoly
	Sinopec	7662.00	8410.00	7890.00	8763.00	10024.00	10785.00	
	National total	19259.48	20972.11	21368.74	23264.08	24847.78		
	Proportion			84.31	89.61	98.91		

Note: 1.Data selection: We take 2007 as the initial year because CNPC went public in 2007 and 2012 as the ending year because there is no new data of national totals available from the National Bureau of Statistics and CEInet Industrial Database for comparison. Some parts of the table are blank because there is no disclosed data of those years' sales. CNOOC is not listed in the table because there is no related data in the corporation's yearly report. Because of inadequate data regarding the pipeline transportation business, we can not conduct measurements by data. 2. Unit conversion: The oil production of all companies is calculated in terms of 10,000 tons. The conversion of units between tons and barrels is differentiated from different corporations. In the paper, we choose to follow the proportion published in the yearly reports of the respective corporations—for output and processing of crude oil in CNPC, 1 ton=7.389 barrels; for crude output in Sinopec, 1 ton=7.1 barrels, and for the processing of crude oil in Sinopec, 1 ton=7.35 barrels.

Source: The national data of all businesses comes from the National Bureau of Statistics and the data of enterprises comes from yearly reports of the listed companies.

2.2. Monopolistic efficiency losses in China's petroleum industry

The main businesses of China's petroleum industry are under monopolistic control, which has resulted in problems including low productivity (Li, Guo & Zhou, 2012), and has reduced efficiency, up to 6%-7% of business income according to some estimates (Hu & Lin 2012). What is noteworthy is that the monopoly-caused efficiency loss is not only reflected in the business income of enterprises, but also expressed in aspects such as the cost of production, asset utilization rate, monopoly profits, and other areas. On this basis, in this paper we divide the efficiency indicators of the industry into enterprise data and industrial data in accordance with the characters of the petroleum industry and conduct the measurement of monopoly-caused efficiency loss in the petroleum industry from those two angles.

When the output is set, enterprises that have high operation efficiency are certain to have relatively low input. Because the capital input of the petroleum industry tends to be high and the difference between industries in capital input is big, there is no point in comparing such figures between the petroleum industry and other industries. However, the comparison of labor input (i.e. labor cost) can be meaningful. Since the average salary occupies a high proportion in the labor cost of enterprises, the comparison between the average salary of the petroleum industry with that of the whole society can undoubtedly show the status of labor costs within the industry. When the output is set and there is no significant difference in the quality of labor, if the industry pays a higher average salary, the operation efficiency is low in the industry. Because of the big difference between state-owned enterprises and private enterprises in the average salary, in this paper, we classify the average salary of the whole society into two parts—the average salary of state-owned enterprises and the average salary of private enterprises—and compare them respectively with that of the three biggest petroleum enterprises. As Table 2 shows, the average salary of the three biggest petroleum enterprises is roughly 3 times of that of state-owned enterprises and over 4.5 times of that of private enterprises. According to the data of specific enterprises, the average salary of CNOOC is even 10.35 times of that of private enterprises. The average salary of CNOOC is also, surprisingly, 6.75 times of that of state-owned enterprises. Though the average salary of Sinopec is the lowest among the three biggest petroleum enterprises, compared with that of the whole society, it is still very high, 2.94 times of that of state-owned enterprises and 4.64 times of that of private enterprises. The data clearly show that the labor cost of the petroleum industry stands on the high side, which is a major cause of the high cost in China's petroleum industry.

Table 2
Comparison of indicators of petroleum industry in 2012 (10,000 yuan, %)

Enterprise data	Average salary	Comparison with state-owned enterprises	Comparison with private enterprises
CNPC	19.71	4.21 times	6.64 times
Sinopec	13.76	2.94 times	4.64 times
CNOOC	30.73	6.54 times	10.35 times
Industrial data	Business of petroleum exploitation	Social average index	Business of petroleum exploitation comparing with social average index
Main business profits ratio	36.6	15.25	2.40 times
Ratio of profits to cost	77.25	6.6	11.70 times
Asset-liability ratio	44	57.84	0.76 times
Hedging and proliferation ratio	111.7	113.03	0.99 times

Note: Because of the limitations of access to public data and the lack of individual data in other businesses, we only select the business of petroleum exploitation for the industrial data.

Source: Indicators of average salary are attributed to *China Statistical Yearbook* and industrial data comes from CEInet Industrial Database.

In comparing industrial data, we select the main financial indicators including main business profits ratio, ratio of profits to cost, asset-liability ratio, and the hedging and proliferation ratios, in an attempt to illustrate the profit ratio, debt paying ability and growth potential of petroleum through comparisons with the social average level. The main business profits ratio and ratio of profits to the cost of the petroleum exploitation industry in China are respectively 2.4 times and 11.70 times of those of the whole society and the profitability of petroleum exploitation is multiple times of that of the whole society, which also means the petroleum exploitation industry has high profits. The asset-liability ratio of the petroleum exploitation industry is only 0.76 time as much as that of the whole society and that means a weak debt paying ability for the petroleum exploitation industry. Though the hedging and proliferation ratios of the petroleum exploitation industry stand almost at the same level as that of the whole society, given the high monopoly level and high profitability of the petroleum exploitation industry, the same level of hedging and proliferation ratios is indicative of a low growth potential in the petroleum exploitation industry. So, in the context of high profitability, the low average debt paying ability and growth ability are the important symptoms of the monopoly-caused efficiency loss in China's petroleum industry.

According to both the enterprise and industrial data, efficiency loss is caused by the monopoly in China's petroleum industry. However, do all the businesses on the petroleum industrial chain have unreasonable monopoly levels? To answer that question, we should not only examine the main businesses on the petroleum industrial chain individually, but also need to differentiate the monopolies in the industry.

3. Type analysis of monopolies in China's petroleum industry

In a specific industry, monopoly is either administrative or natural. Administrative monopoly, set off by national policies (Jin, Chen & Lu, 2006), is an act of the government using its administrative power to exclude or restrict the market competition (J. H. Wang & J. M. Wang, 2007). Different types of monopolies exert different influence on the efficiency of the petroleum industry. The administrative monopoly has a negative impact on the efficiency of petroleum industry, while natural monopoly plays a positive role in resource allocation in the petroleum industry (Yu, Liu & Wang, 2009). So it is necessary to distinguish between different types of monopolies in the main businesses of petroleum industry. The main businesses of the petroleum industry include exploration and exploitation, pipeline transportation, storage, refineries, and sales. We conduct a brief analysis of monopoly types in the main businesses of the petroleum industry as follows.

Though the business of petroleum exploration and exploitation has characteristics of high sunk costs, intensive capital, and technology, it is still a competitive business. Since the sinking of costs in oil production mainly happens in the stage of crude oil exploitation, the sunk cost is unavoidable. For example, in the stage of petroleum exploration, if the there is no petroleum

in a well, then the input will become a sunk cost. The petroleum exploration and exploitation process can be easily mistaken for a monopolistic business for its characters of being capital and technology intensive, but as a matter of fact, the two characteristics are not the reasons for its monopoly. Limitation on market access is the real cause of the monopoly in the business. According to *Catalog of Government Approved Investment Projects* published by the National Development and Reform Commission, the market access to the business of petroleum exploration and exploitation should be approved by the government. The exploration and exploitation projects of oil fields with an annual output of 1 million tons or more need to get the approval from the department in charge of investment of State Council. Projects of annual output of less than 1 million tons can be permitted by enterprises that have qualifications for petroleum exploitation themselves, but should at the same time be reported to the department in charge of investments of State Council for record keeping purposes. Currently, there are only four companies in China that have the qualifications for petroleum exploitation, which are CNPC, Sinopec, CNOOC, and Yanchang Petroleum. As a result, the limitation has restricted the access of other enterprises into the business of petroleum exploration and exploitation.

The business of petroleum pipeline transportation features an economy of scale, economy of network, and a long investment payback period. The economy of scale and network of petroleum pipeline transportation are reflected in the increasing marginal revenue of pipeline transportation. The pipeline for transporting oil can only be used for oil transportation and cannot be used for transporting gas. Crude oil and refined oil cannot also use the same pipeline for transportation. We can see that the technological and economic character of the petroleum pipeline transportation business has determined the development of natural monopoly in the business. To improve industrial efficiency, we must give full play to the economy of the network of petroleum pipeline transportation. Certainly, it does not mean that there is no administrative monopoly in the business of oil transportation. The administrative monopoly in this business is mainly expressed by the market access limitations imposed by the government. For example, construction permission of large-scale oil pipelines (especially projects of trans-provincial trunk lines) must be approved of by the investment controlling department of the State Council. From here we can see that though natural monopoly and administrative monopoly co-exist in the business of oil pipeline transportation, the administrative monopoly is based on the natural monopoly, so it has its rationality.

The business of petroleum refineries has recently taken on the feature of large scale equipment and refining-chemical integration, which is expressed by large-scale petroleum refinery enterprises merging small ones. It is noteworthy that it does not all result from fair competition in the market. The reasons are as follows. First, many oil refinery plants (especially the non-state-owned ones) cannot use as much imported crude oil as they need. According to *Trial Measures of Import Business Management for State-run Trade of Crude Oil, Refined Oil, and Chemical Fertilizers* published by the former Ministry of Foreign Trade and Economic Cooperation in 2002, the non-state-owned oil refinery plants would not be granted more permits once their

utilization of imported crude oil reaches the quota, which to some extent restrict the development of non-state-owned oil refinery plants. Second, many oil refinery plants cannot fully follow market orientation in their production because for some oil products that have market demand, most of the enterprises have no rights for production. For example, in accordance with the *Pilot Scheme for Expansion of Ethanol Gasoline for Motor Vehicles* and *Implementing Regulations of Pilot Work on Expansion of Ethanol Gasoline for Motor Vehicles* published by the National Development and Reform Commission in 2004, only the two biggest companies, CNPC and Sinopec, are approved to produce and supply ethanol gasoline for motor vehicles. Owning to related policies and regulations, monopoly has been brought about in the business of the petroleum refinery and nevertheless, the business in fact should be a competitive one.

The business of petroleum sales is characteristically diverse and timeless, and that character has determined the business of oil sales be a competitive business. However, as a matter of fact, there still exists an administrative monopoly in current business of oil sales in China. For example, for the links for wholesale, according to *Refined Oil Market Management Measures* published before 2007, private enterprises were not allowed to engage in the business of refined oil wholesale and even though the regulation was terminated in 2007, the access threshold to the wholesale of refined oil was then elevated with many strict conditions needing to be met by applicant enterprises. From the retail perspective, according to the *Refined Oil Market Management Measures* published by the Ministry of Commerce in 2007, enterprises that met the retail qualification must have a long-term and stable refined oil supply channel and have signed a fixed term contract with refined oil wholesale enterprises for no less than 3 years. The implementation of all these rules has undoubtedly impeded private enterprises from accessing oil wholesale and retail links in the petroleum industry.

After the analysis of the technological character of the main businesses in the petroleum industry, we find that only the business of petroleum pipeline transportation has both a natural and administrative monopoly, and for the rest of the businesses, they are all competitive businesses with administrative monopolies (See Table 3).

Table 3
Monopoly types in the main businesses of petroleum industry

Main business	Technological and economic character	Type of monopoly
Petroleum exploration and exploitation	Intensive capitals, intensive technology, high sunk cost	Contestable, administrative monopoly
Petroleum pipeline transportation	Economy of scale, economy of network	Natural monopoly, administrative monopoly
Petroleum refinery	Large-scale equipment, refining-chemical integration	Contestable, administrative monopoly
Petroleum sales	Diverse business and timeliness	Contestable, administrative monopoly

Source: Compiled by the authors.

Since the degree of administrative monopoly has negative relationship with the efficiency of petroleum industry (Yu, Liu & Wang, 2009), competition should be introduced into the businesses with administrative monopoly. To enhance competition and break the administrative monopoly, we must carry out market restructuring in the petroleum industry and ensure the market can better play a decisive role in resource allocation.

4. Market restructuring patterns of China's petroleum industry

The market restructuring patterns of China's petroleum industry should be made upon the comprehensive consideration of the technological and economic characters of different businesses in the petroleum industrial chain and the types of monopolies involved. For example, since the business of petroleum pipeline transportation has both natural and administrative monopolies, in designing a restructuring, we should not only preserve the scale-based economic effects brought about by a natural monopoly, but also need to reduce the degree of administrative monopoly. For the rest of the businesses that are contestable, the focus of the restructuring pattern design should be laid on reducing administrative monopoly and enhancing competition. To that end, in the paper we design three market restructuring patterns for the petroleum industry.

4.1. Access control model

Access Control Model is the short form of relaxed entry control and enhanced access control and the character of this model can be illustrated in Figure 1. As original petroleum enterprises still maintain their vertical-integration operation of natural monopolistic business and competitive

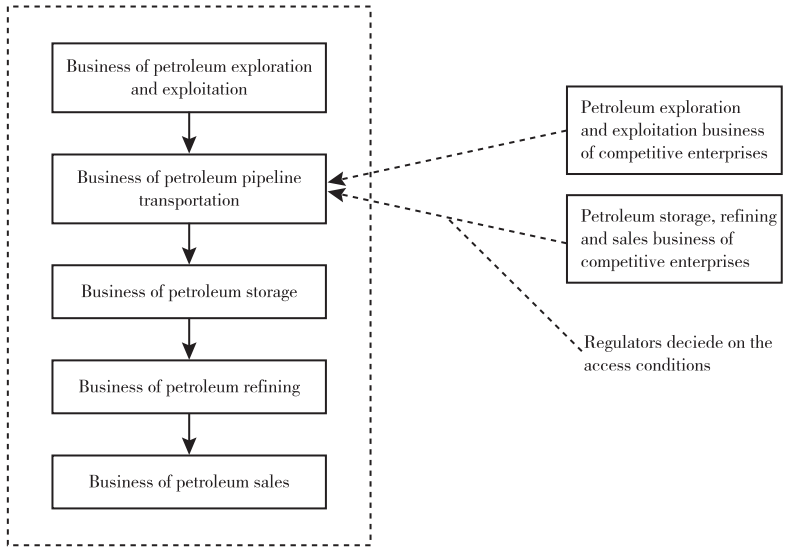

Figure 1. Access control mode

business, the government adopts relaxed entry control policies, allowing some new enterprises to enter the field of competitive businesses. At the same time, the government should compulsively require the original enterprises to provide the newly-entered competitive enterprises with access services in a fair manner. In the access process, regulators should decide on the access conditions (especially the cost price for pipeline transportation) to promote the original enterprises to open up the pipeline transportation network to other competitive enterprises in a fair fashion. The advantage of this model is that it can help preserve the scope economy of the original enterprises and avoid the dissolution of the original vertically-integrated enterprises, thus avoiding a huge dissolution cost. Because the newly-entered enterprises will experience the repulsion from the original enterprises and encounter discriminatory behaviors, much governmental regulation work should be done to ensure the fair competition among enterprises. In 2014, *Supervision and Control Measures for Open Access of Oil and Gas Network Facilities (Trial)* was printed and distributed by the National Energy Administration and it will be beneficial to the open access of the petroleum pipeline network and to promote fair competition in the petroleum industry.

4.2. Ownership separation model

Ownership Separation Model is the abbreviated form of ownership separation in the natural monopolistic businesses and competitive businesses and the character of the model can be illustrated in Figure 2. Segmentation policies are adopted on the original vertically-integrated petroleum enterprises and ownership separation is carried out on the original monopolistic enterprises in the petroleum industry according to the types of businesses. As a result, the naturally monopolistic business of petroleum pipeline transportation should be operated by very few enterprises (2 companies, as shown in Figure 2) while competitive business in the petroleum industry should be undertaken by a number of enterprises. Enterprises that operate the business of petroleum pipeline transportation should not undertake any competitive business simultaneously,

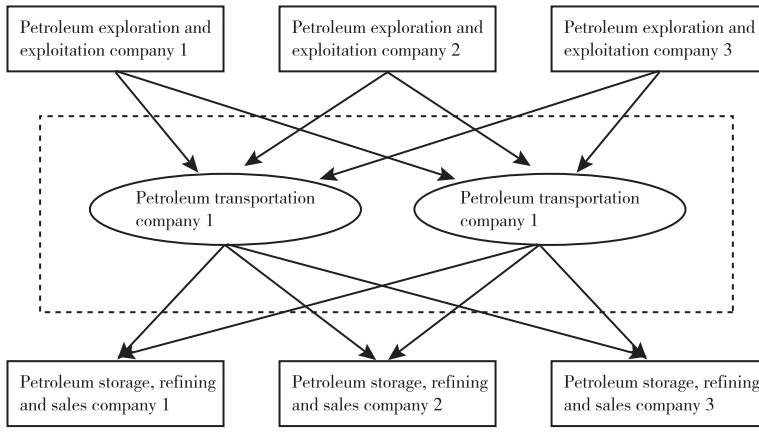

Figure 2. Ownership separation mode

in order to prevent the behavior of cross-subsidization from happening between the business of petroleum pipeline transportation and other businesses. The advantage of this model is that it can eliminate discriminatory behaviors—i.e. the original enterprises' exclusionary acts against the newly-entered enterprises, which are likely to happen in the Access Control Model, so the model can promote fair competition among competitive businesses. The disadvantage of the model is the sacrifice of the scope economy of petroleum enterprises to some degree because of the separated operation of the correlated businesses by different enterprises.

4.3. Mutual-benefit network model

The character of the Mutual-benefit Network Model can be seen in Figure 3. The government dissolves the original petroleum enterprises into a number of companies of basically the same size (Figure 3 shows two companies in a simplified version) and each company still implements the vertically-integrated operation in which they operate both the natural monopolistic business of petroleum pipeline transportation and the competitive business of petroleum exploration and exploitation. Because the petroleum transportation network has positive externalities, which are shown by the huge extension of petroleum transportation coverage of each company after the transportation network being shared by different companies, petroleum transportation becomes more convenient and the amount of petroleum transported gets larger. When the cost of petroleum pipeline construction is set, the bigger the petroleum transportation volume is, and the lower the per unit cost will be. That brings about the positive externalities of petroleum transportation network. The positive externalities will urge the dissolved companies to share the petroleum pipeline network proactively, creating a interconnected and inter-working pipeline network. The

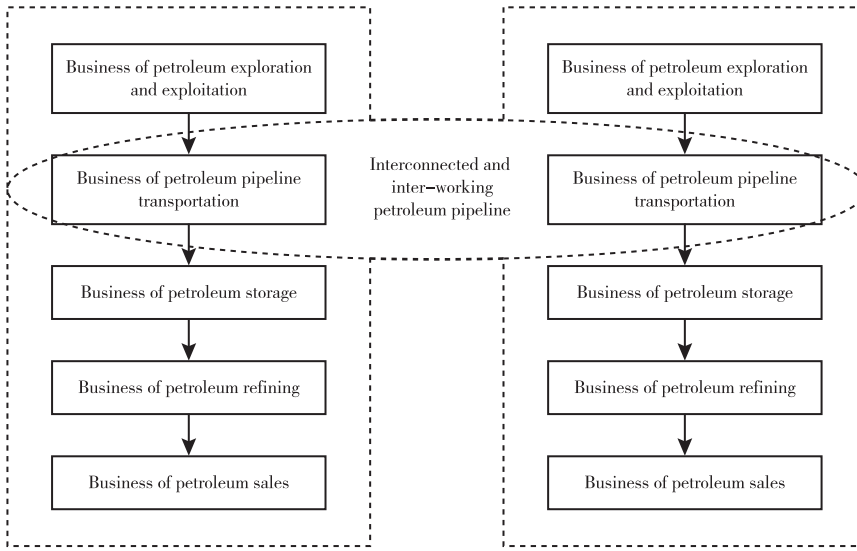

Figure 3. Mutual-benefit network mode

advantage of this model is that it not only is helpful to promote competition among enterprises in competitive businesses, but also promote the share of the petroleum pipeline network by different companies and help form competition in the business of pipeline transportation to some extent. However, this model has its limitations. Only when the dissolved companies have the same size transportation networks, can they interconnect and share the pipeline network of petroleum transportation in a fair manner. If the dissolved companies have different sizes of pipeline network, then the enterprises with large-sized network would repel those enterprises with small-sized networks by a variety of means, therefore impeding the interconnection and inter-working of the network.

Hence it can be seen that the three restructuring models for China's petroleum industry all have both advantages and disadvantages—we can make different choices according to different policy objectives. If the government is inclined to preserve the scope economy of petroleum industry and avoid the dissolution of the original enterprises, the Access Control Model is an ideal choice. If the government's policy objective aims to promote fair competition among enterprises, first priority can be given to Ownership Separation Model. If the government wishes to advance the interconnection and inter-working of petroleum pipeline networks and to avoid repeated construction, we can choose a Mutual-benefit Network Model. We synthesize the advantages and disadvantages of the three restructuring models in Table 4 for policy makers to make an optimal selection.

Table 4
Advantages and disadvantages of three market restructuring models for petroleum industry

Restructuring patterns	Advantages	Disadvantages
Access control model	Preserving the scope economy of enterprises, avoiding huge Segmentation cost	Much regulation work needs to be done by government; vertically-integrated enterprises would adopt a variety of discriminatory acts
Ownership separation model	Helping to eliminate the exclusionary behaviors of enterprises and cross-subsidization behavior within businesses	Scope economy is sacrificed to some extent; certain amount of segmentation cost will be afforded
Mutual-benefit network model	Promoting competition among enterprises in competitive fields and forming competition in the business of pipeline transportation	Requiring sizes of pipeline network of each company dissolved from restructuring to be basically the same, and otherwise companies with large-sized network will repel those companies with small-sized network by a variety of means

Source: Compiled by the authors.

According to the reality of China's petroleum industry and considering the international competitiveness of the petroleum industry, we believe the first restructuring model (i.e. Access Control Model) is the most suitable one for China's present national conditions. Currently, China's petroleum industry is dominated by the three biggest petroleum enterprises, so if the second restructuring model (i.e. Ownership Separation Model) is selected, then judging from

the perspective of feasibility, the model will face the biggest resistance in the process of market restructuring, sacrifice the scope economy to a considerable extent, and likely compromise the international competitiveness of the petroleum industry. The third restructuring model (i.e. the Mutual-benefit Network Model) would become a game among the current three biggest petroleum enterprises and would not allow for the access of new enterprises. Though the resistance this model will face will be smaller than that faced by the Ownership Separation Model, this model is not the best choice, because compared with Access Control Model, this model can play a very limited role in bringing in competition mechanisms. Therefore, the Access Control Model is the optimum choice.

5. Differentiated regulatory policies following market restructuring of China's petroleum industry

According to the analysis in Section 4, the optimum choice for market restructuring is the Access Control Model, and it is noteworthy that a great deal of government regulation work should be done to support the Access Control Model in order to guarantee fair competition. Practice has proven that the achievement of reform of monopoly industries to a considerable extent is dependent upon the effectiveness of post-restructure government regulatory policies and those government regulatory policies include differentiated regulatory policies and coordinated policies (Wang, 2005). The same is true for the petroleum industry. In order to achieve good results in market restructuring, we need to conduct differentiated regulation on the restructured petroleum industry. Due to the different characteristics of the main businesses of the restructured petroleum industry, it is of necessity to carry out differentiated regulation on the naturally monopolistic business of petroleum pipeline transportation and competitive businesses (petroleum exploration and exploitation, refinery, storage, and sales). Many aspects, such as the differentiated regulatory policies for China's restructured petroleum industry, get little consideration due to space limitations. In this paper, we develop the discussion mainly from three points of focus, including differentiated entry of regulation policies, differentiated price regulation policies, and differentiated distribution of different ownership enterprise policies.

5.1. Differentiated access regulation polices of China's petroleum industry

To implement differentiated regulation policies of China's petroleum industry is to, based on the different types of businesses in the industry, respectively carry out differentiated access control on different enterprises that are ready to enter the industry. The naturally monopolistic and competitive industries will co-exist in the restructured petroleum industry and due to the different economic characters of the two types of businesses, it is necessary to conduct differentiated access control policies for them. As for the naturally monopolistic business of petroleum pipeline transportation, because of the economy of network of petroleum pipeline network transportation,

it is not economical to have multiple enterprises build their respective petroleum transportation pipelines separately, as it involves large costs for petroleum pipeline construction and a high cost of maintenance. So, the entry of new enterprises should be strictly controlled so that only very few enterprises can be granted entry to the business. For competitive businesses such as petroleum exploration and exploitation, storage, refining, and sales, access control should be relaxed to different extents in order to promote competition. Competitive as the business of petroleum exploration and exploitation is, it still has a significant scale economy, so the access control should be loosened step by step. The business of petroleum storage and refining also has some scale economy, so the access control should be relaxed based on the minimum economic size. Because the business of petroleum sales does have an obvious economy of scale, the access control can be lifted for full competition. The focuses of post-restructuring differentiated access regulation policies are shown in Table 5.

Table 5
Differentiated access regulation policies of China's petroleum industry

Main business	Nature of business before restructuring	Nature of business after restructuring	Focuses of differentiated access regulation policies
Petroleum exploration and exploitation	Administrative monopoly	Competitive	Relaxing access control step by step
Petroleum storage	Administrative monopoly	Competitive	Relaxing access control based on the minimum economic size
Petroleum pipeline transportation	Natural monopoly, administrative monopoly	Oligopoly	Implementing strict access control and guarantee the open access of pipeline network facilities
Petroleum refining	Administrative monopoly	Competitive	Relaxing access control based on the minimum economic size
Petroleum sales	Administrative monopoly	Competitive	Lifting the access control for full competition

Source: Compiled by the authors.

5.2. Differentiated price regulation policies

To implement differentiated prices regulation policies is to, based on the different types of businesses in the petroleum industry, formulate differentiated price regulation policies for businesses at different stages of the industry. The design of the differentiated price regulation policies should be conducted in accordance with the main types of businesses on the petroleum industrial chain. As shown in Table 6, currently, pricing in the business of petroleum exploration and exploitation is made independently by enterprises themselves with reference to the prices in the international market, so current enterprises have strong powers to manipulate the price of crude oil. But the business of petroleum exploration and exploitation is competitive after restructuring and the price of crude oil should be gradually in line with that of the international market. The

business of petroleum pipeline transportation currently adopts the self-established and self-use models with transfer transactions fulfilled within enterprises and doesn't have nationally unified pricing. After restructuring, the business of petroleum pipeline transportation should be operated by very few enterprises, but that will possibly lead to the enterprises' manipulation of the prices of petroleum pipeline transportation, damaging social welfare. The price ceiling should be set in the business of petroleum pipeline transportation to prevent enterprises from making monopolistically high prices. The products of the petroleum refinery business include chemical products, gasoline, and diesel. The chemical products have been priced according to market orientation, but gasoline, diesel, and other products still follow government pricing or government guided pricing. So, after restructuring, the focus of differentiated prices regulation policy for the business of petroleum refineries should be canceling government pricing and government guided pricing and lift price controls on gasoline, diesel, and other petroleum products. Presently for the business of petroleum sales, National Development and Reform Commission sets the highest retail prices, and in some regions the prices vary from province to province. After market restructuring, the business of petroleum sales will be a competitive market, so price control can be gradually phased out.

Table 6
Differentiated price regulation polices for China's petroleum industry

Business related to petroleum industry	Current pricing mechanism	Differentiated price regulation policies
Petroleum exploration and exploitation	Enterprises independently make prices with reference to the international market price	Gradually in line with international market crude oil price
Petroleum pipeline transportation	Petroleum pipeline transportation adopts the self-established and self-use model and there is no national unified pricing mechanism	Set price ceiling for pipeline transportation and prevent enterprises from making monopolistic high price
Petroleum refining	Gasoline, diesel and other products follow government pricing or government guided pricing; chemical products follow prices with market orientation	Cancel government pricing or government guided pricing and lift the price control for gasoline, diesel and other products
Petroleum sales	National Development and Reform Commission sets the highest retail price and in some regions, prices vary from province to province	Gradually cancel price control

Source: Current pricing mechanisms are attributable to *Petroleum Prices Management Measures* (*Trial*) formulated by National Development and Reform Commission in 2013.

5.3. Differentiated distribution of different ownership enterprises policies

To implement differentiated distribution of different ownership enterprises policies is to differentiate the nature of ownership of enterprises in different business fields of the petroleum industry. How to distribute the state-owned enterprises and other types of enterprises—i.e. the distribution of enterprises of different ownership in the petroleum industry, is the prominent

issue to be faced by the petroleum industry after restructuring. We believe that, as this paper holds, the basic principle for reasonable distribution of enterprises of different ownership is that, as naturally monopolistic business, petroleum pipeline transportation should be in the holding of state-owned capital with a moderate introduction of social public capital holding stake. While in the field of competitive businesses, non-state-owned capitals or social capitals should be actively introduced and the proportion of state-owned capital should be gradually reduced.

Currently, the business of petroleum exploration and exploitation is under the control of state-owned enterprises and only through certain forms of cooperation with state-owned enterprises, can other enterprises take part in the business. Introducing non-state-owned enterprises and social capital into this business model will be favorable to the optimization of ownership structures, so during the initial period after restructuring, the business of petroleum exploration and exploitation will be led by state-owned enterprises, while non-state-owned enterprises and social capital should be actively brought in. The business of petroleum transportation should be given strict control over the qualifications and number of the entering enterprises. After the restructuring of the petroleum industry, determined by the natural monopoly of pipeline transportation business, state-owned enterprises should control the operations, and social capital should also be moderately drawn into the construction of the pipeline network. The businesses of petroleum storage and petroleum refineries have a certain economy of scale, so they should get open access to all the enterprises that have reached the minimum economic size and there should not be any differentiation between state-owned enterprises and other types of enterprises. The business of petroleum sales requires enterprises to have a strong ability to respond to market change. Private enterprises usually have more operation efficiency than state-owned enterprises, so these types of businesses can be fully opened to non-state-owned enterprises (See Table 7).

Table 7
Different distribution of different ownership enterprises policies

Main business	Current types of petroleum enterprises	Distribution of different ownership enterprises after restructuring
Petroleum exploration and exploitation	Petroleum exploration is controlled by state-owned enterprises and only by certain forms of cooperation with state-owned enterprises, can other enterprises take part in the business	State-owned enterprises will take the lead in the initial period and non-state owned enterprises and social capitals should be actively brought in
Petroleum pipeline transportation	Operated solely by state-owned enterprises	Should be in the holding of state-owned capitals and social capital should be moderately drawn in
Petroleum storage	Most part of the business is operated by state-owned enterprises	Open access should be offered to enterprises that have reached the minimum economic scale and there should be no differentiation between state-owned enterprises and other types of enterprises

Main business	Current types of petroleum enterprises	Distribution of different ownership enterprises after restructuring
Petroleum refining	State-owned refining enterprises occupy a large proportion	Open access should be offered to enterprises that have reached the minimum economic scale of petroleum refinery and there should be no differentiation between state-owned enterprises and other types of enterprises
Petroleum sales	Most part of the business is still operated by state-owned enterprises	Open access should be fully offered to non-state owned enterprises

Source: Compiled by the authors.

6. Research conclusions

The unreasonable monopoly in China's petroleum industry has caused major efficiency losses, and in accordance with the technological and economic characters of the main businesses in the petroleum industry, in this paper we make a classification as to the types of monopolies in an attempt to provide some theoretical support for the market restructuring of the petroleum industry.

In this paper, we propose three industry restructuring models, which are Access Control Model, Ownership Separation Model, and Mutual-benefit Network Model. The three models have their respective advantages and disadvantages and the choice should be made based on different policy objectives. The Access Control Model can preserve the scope economy of petroleum industry and avoid dissolution of the industry. The Ownership Separation Model focuses more on fair competition. The Mutual-benefit Network Model can not only avoid repeated construction, but also advance the interconnection and inter-working of petroleum pipeline networks, but it requires equality of network scale of each enterprise. Given the reality of China's petroleum industry and taking the international competitiveness of the petroleum industry into consideration, in this paper we believe the Access Control Model is the optimum choice at the moment.

To support the Access Control Model as a restructuring model to achieve good restructuring results, in this paper we design post-restructuring differentiated regulation policies; they are differentiated access regulation polices, differentiated price regulation policies, and differentiated distribution of different ownership enterprises policies. The emphasis of differentiated access regulation policies is to put strict control over the entry of enterprises into the business of petroleum pipeline transportation and at the same time guarantee open access to the transportation pipeline network, to gradually relax the access control in the business of petroleum exploration and exploitation, to relax access control according to the minimum economic scale in the business of petroleum storage and refining, and to fully lift the entry control in the business of petroleum sales. The focal points of differentiated price regulation policies for the petroleum industry are to set the price ceiling in the business of

petroleum pipeline transportation, to get in line with international market prices in the business of petroleum exploration and exploitation, and to incrementally lift the price controls in the business of petroleum refineries and sales. The key points of differentiated distribution of different ownership enterprise policies are to let the business of petroleum pipeline transportation still stay in the holding of state-owned capital and moderately bring in public capital, to let state-owned enterprises lead in the initial period in the business of petroleum exploration and exploitation and gradually offer open access, to offer open access to enterprises that have reached the minimum economic scale in the business of petroleum storage and refining, and to fully open access to non-state owned enterprises.

References

Helm, D. (2004). *Energy, the state and the market: British energy policy since* 1979, Oxford, UK: Oxford University Press.

Hu, D. B., & Lin, N. (2013). Measurement of welfare losses in China's petroleum industry: from the perspective of relaxing regulation. *Review of Industrial Economics(Chanye Jingji Pinglun)*, *12* (4), 155-168.

Jin, Y., Chen, Z., & Lu, M. (2006). Industry agglomeration in China: economic geography, new economic geography and policy. *Economic Research Journal(Jingji Yanjiu)*, 4, 79-89.

Laguna, N. M. (2004). Petroleum policies and privatization strategies in Mexico: implications for the petrochemical sector and its production spaces. *Energy Policy*, *32* (18), 2035-2047.

Li, Z. G., Guo, J. G., & Zhou, D. T. (2012). An empirical study on administrative monopoly of China's petroleum industry and its performance. *Contemporary Finance and Economics(Dangdai Caijing)*, 6, 89-101.

Locatelli, C. (1999). The Russian petroleum industry restructuration: towards the emergency of western type enterprises? *Energy Policy, 27*(8), 435-449.

Robinson, C. (2000). Energy economics and economic liberalism. *Energy Journal*, *21*(2), 1-22.

Straaten, J.V. (2001). *Petroleum refineries in the Netherlands*. Berlin: Springer Berlin Heidelberg.

Wang, J. H. (2005). Differentiated regulation and coordinated policies after market restructuring of China's monopoly industries. *China's Industrial Economics(Zhongguo Gongye Jingji)*, 11, 67-73.

Wang, J. H., & Wang, J. M. (2007). Administrative monopoly of China's monopoly industries and its regulation policies. *China's Industrial Economics(Zhongguo Gongye Jingji)*, 12, 30-37.

Weston, J. F., Johnson, B. A., & Siu, J. A. (1999). Mergers and restructuring in the world petroleum industry. *Journal of Energy Finance & Development*, *4*(2), 149-183.

Yan, X. Z., Yu, Z. H., & Cong, Q. (2014). The extent of oligopoly and market competition in

petroleum industry, *International Petroleum Economics(Guoji Shiyou Jingji)*, 22, 1-8.

Young, A. (2000). The razor's edge: distortions and incremental reform in the People's Republic of China. *The Quarterly Journal of Economics*, *115*(4), 1091-1135.

Yu, X. Z., Liu, H. Y. & Wang, J. (2009). A study on operating efficiency of oligopoly in petroleum industry. *Reform of Economic System(Jingji Tizhi Gaige)*, 6, 71-75.

Yu, X. Z., & Zhong, C. B. (2010). Vertical comparison analysis of operating efficiency of monopoly of state prices petroleum resources. *Inquiry into Economic Issues(Jingji Wenti Tansuo)*, 1, 68-74.

Yu, L .C, & Zhang, W. (2010). Intensity and efficiency loss of administrative monopoly industry in China. *Economic Research Journal(Jingji Yanjiu)*, 3, 16-27.

Zhang, X. Y., & Zhang, G. Z. (2013). Privatization appears in Mexico. *China Petroleum (Zhongguo Shiyou Shihua)*, 8, 56-57.

Zhang, Y. H., & Li, X. S. (2008). Administrative monopoly, relaxing regulation and industrial performance—an empirical analysis based on petroleum exploration and exploitation. *Contemporary Finance and Economics(Dangdai Caijing)*, 2, 80-86.