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A research on the gravity model of China's oil trade in the strategic context of "One Belt One Road"

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With the increasing energy demand along with China's economic development, the external dependence on China's oil supply keeps rising. In the foreseeable future, China's oil trade will still center on importing. Under the background of China's "One Belt One Road" strategy, the essay establishes a trade gravity model for oil importing trade in China. Through multiple linear regression analysis and empirical study, the key elements in China's oil importing trade are summed up. From the data of 10 countries selected, Phase 1 (2008 to 2012) and Phase 2 (2013 to 2015) results revealed that with the deepening of the OBOR strategy, China's oil import source countries are changing; the countries on the "One Belt One Road" are becoming China's main sources of oil import. Conversely, China's imported oil from Saudi Arabia declines by nearly 36% over the same period. Also, the essay puts forward suggestions to advance the oil trade between China and other countries on the One Belt One Road.

Key words: The One Belt One Road strategy, oil trade, trade gravity model.

INTRODUCTION

Energy is an important material of social development, and energy cooperation is one of the important contents of the "One Belt One Road" (OBOR) strategy. Strengthening energy cooperation based on the OBOR will lead to bigger regional cooperation, and promote the world's economy prosperity (National Development and Reform Commission, National Energy Administration, 2017). It is necessary for China's energy development to strengthen energy cooperation based on the One Belt One Road, as well as the synergetic development of the world's energy.

Currently, China's energy development is highly interrelated with the world. China's demand for oil is gradually increasing, since it became the net oil importer in 1993. The amount of net oil import arrived at 3.34 hundred million tons in 2015, and the external dependents on oil reached 60%, and are still rising. Given the fast development of China's economy and continuous adjustment of the industrial structures, the demand for oil and other energy keeps expanding.

Middle East, Africa, Middle Asia, Russia and Southeast Asia countries on the One Belt One Road are one of the

areas richly endowed with oil and gas all over the world. The implementation of OBOR strategy is important as it improves energy trade, and energy cooperation among China and the countries on OBOR, it deeply integrates energy market between China and the rest of the world, enhances optimal configuration and supply capacity of China energy, meets the needs of the increasing consumption of energy, promotes the security level of energy, and promotes better economic and social development of China. (China signed a standardized cooperation agreement with 21 countries along the One Belt and One Road in 2017).Therefore, it is of great necessity to make a deep research on the issues of the world oil trade under the background of the One Belt One Road.

In the late 1970s, economists began to look for a basis for the trade gravity model. Anderson (1979) took the lead in deducing the gravity equation under the product difference hypothesis premise. Bergstrand (1985, 1989), using the monopoly competition model of simple framework based on trade gravity model, theoretically discussed the key factors of bilateral trade.

Anderson (2011) deduced the gravity model with strong maneuverability on the basis of constant replacement of elastic expenditure system. These theories not only provide theoretical support for the trade gravity model, but also help to explain the empirical application problems and differences. As a result, the trade gravity model gradually moved away due to a "lack of theoretical basis" predicament. In China's international trade, the application of the theoretical basis of gravitational model, according to Shi et al. (2005) and Gu (2006), has been systematically summarized.

There exist vast literatures on oil trade. For instance, Roberson (2003) argues that uncertain factors have a significant influence on oil trade. The study noted that a nation's oil trade strategy should be made by considering the changes in its energy investment in order to safeguard the national petroleum security.

Diversification of petroleum import is believed to be one of the main methods to avoid oil price fluctuations and emergencies in countries with high dependence on oil. The relationship between oil import trade and trade geography has been further studied by Huang (2009). Wang (2006) analyzes the structure and present situation of petroleum trade in China; he puts forward the counter-measures of China's oil trade development, namely through commercialization, globalization and diversification to improve the market competitiveness of China's oil enterprises.

Huang and Chen (2007) analyze the global oil geopolitics and oil trade pattern in China; they put forward China's oil geopolitical strategy, using the geographical advantages of Shanghai Cooperation Organization and promote the diversification of China's oil imports. China is the world's largest energy consumer. In the implementation of the strategy of OBOR, China's oil

import trade situation will directly affect the in-depth implementation of the OBOR strategy, the whole import trade and even the whole national economy.

In the context of One Belt And One Road strategy, there have been an increasing number of studies on the factors affecting oil import trade. Feng (2014), (Liu et al., 2016), Wang (2016), Zhu (2016), Wu (2016) and other scholars put forward concrete counter- measures and suggestions under the background of One Belt And One Road strategy to the energy trade between China and those countries on OBOR.

After a comprehensive survey of the related research articles on oil trade home and abroad, many research achievements have been made. However, the researches lack quantitative analysis and system study. This paper, combining the strategy of OBOR, builds the trade gravity model, and applies this model to analyze the related influencing factors of China's oil imports; it puts forward the counter-measures and suggestions for China to cooperate with other countries based on OBOR on oil trade.

AN ANALYSIS OF CHINA'S OIL IMPORT STATUS

Since China's reform and opening-up policy from 1978, the demand for energy has been increasing. Between 1980 and 1990, China's total energy production was greater than its total consumption. From 1990 when the total energy consumption in China began to get close to the total energy production, the energy imports have risen sharply. Untill 1992, China's total energy consumption was slightly higher than the total energy production. Since then, the energy production and consumption gap widened gradually. By 1993, China's oil consumption was greater than oil production and became a net oil importer.

Since China has been a net oil importer in 1993, oil imports increased year by year. China's net oil imports reached 9.88 million tons in 1993. The year 1996 saw negative increase both in China's oil trade and oil products trade; and China became a full sense of the net oil importer (net imports of 13.95 million tons).

Since the beginning of the 21st century, China has joined the WTO, and the demand for energy has increased further. China's oil imports have gradually increased, as shown in Figure 1. China accounted for 20.3% of global energy consumption in 2010, surpassing the United States as the world's largest energy consumer. It is forecast that China will import more than 500 million tons of oil by 2020, and the foreign dependency will reach 70%. Oil supply and demand are more prominent, and oil resources will seriously hamper the development of China's economy.

From the 1990s, China gradually imported oil and related products from regions such as the Middle East. The Middle East gradually became the largest source of
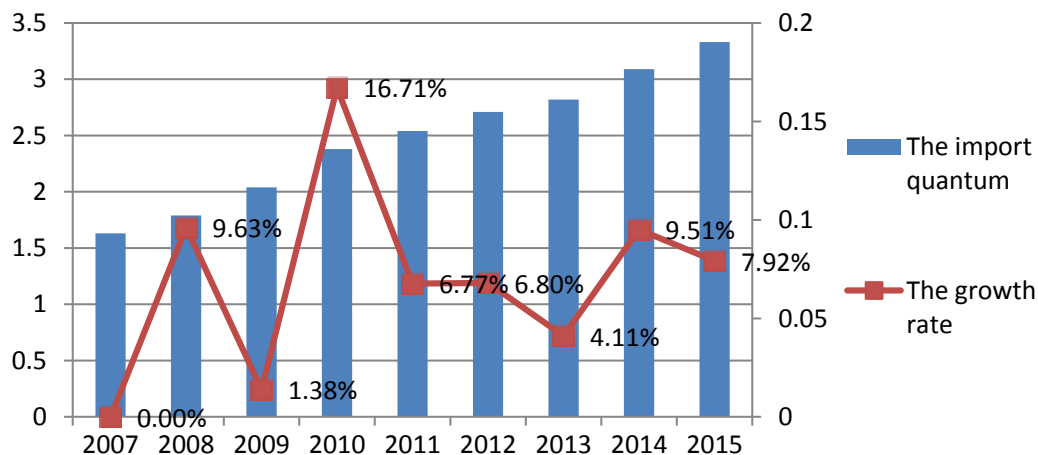
Figure 1. China's oil imports quantum and growth rate (unit: billion tons).
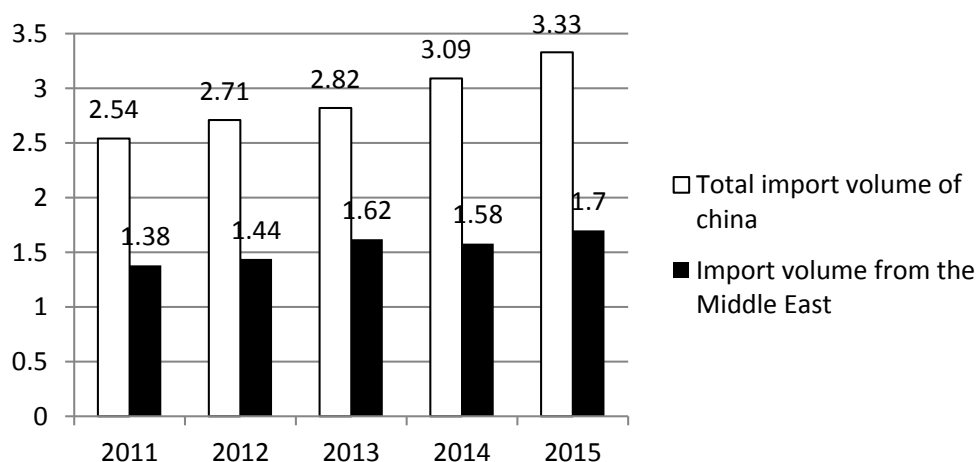

Figure 2. The total import oil quantity of China and the import amount from the Middle East (Unit: billion tons).

China's oil imports. The data that China imported oil from the Middle East in recent years are shown in Figure 2. In the regional structure of China's petroleum import, the Middle East, Africa and the Commonwealth of the Independent States are the three main sources of China oil import, accounting for 47.8, 30.1 and 10.5%, respectively of China's total oil imports. In relation to countries, the oil producers in Arab are the main source of China's oil imports.

Before 2000, the first two countries where China's oil imports most from the Middle East are Oman and Yemen. In 2001, Iran and Saudi Arabia surpassed Oman and Yemen, and became the two major oil suppliers in China. From 2002 to 2009 Saudi became China's largest oil supplier with obvious advantages. In 2009, the countries where China's oil imports more than 1 million tons of countries from are nine countries: Saudi Arabia, Oman, Iraq, Kuwait, United Arab Emirates, Yemen and Algeria,

Sudan, and Libya, including six oil producer countries in the gulf. In 2011, China imported about 130 million tons of oil from the Middle East, accounting for more than 50 percent of total imports of the year. In 2013, China imported 146.54 million tons of oil from the Middle East (8.6 %), accounting for 52 percent of total oil imports.

In recent years, from the petroleum products from different countries and the growing demand for refined products, a certain research survey forecasts that China's oil demand is expected to reach 1.05 billion tons by 2020, but the domestic oil production cannot meet the current demand. Since 1993 when China became a net importer of oil, its oil imports have been increasing yearly. According to the report in the Wall Street Journal of October 2013, China's oil imports amount arrived at 6.3 million barrels during the month, exceeded the United States, which is 624 barrels a day, and replaced USA as the world's largest net importer of oil. Figure 3 describes
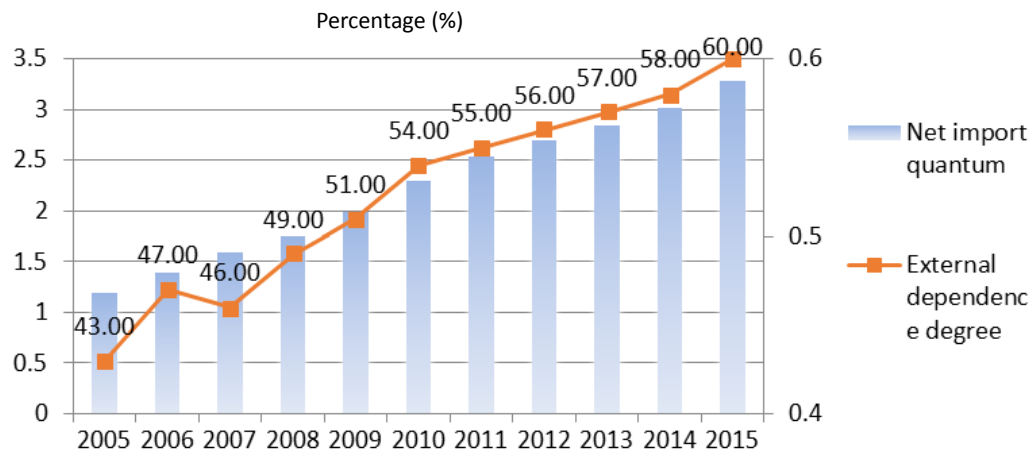
Figure 3. China's oil external dependence degree and net import quantum (Unit: billion tons).

the change of China's foreign oil dependency and net imports.

In Figure 3, during 2005 to 2010, China's oil foreign dependency increased rapidly, with an average annual growth rate of 2.6%. The oil imports increased significantly, due to China's rapid economic development. As the oil demand increased, the oil refinery processing was improved; but it is difficult to increase production for the existing big oilfield, which has gone to the late development period. The existing equipment and exploration technology restricted the proven oil reserves increase pace. In addition, China has gradually unbound the international trade restrictions after joining the World Trade Organization, and the continuous improvement of oil and trade conditions has provided a favorable environment for oil imports. After 2011, the growth of oil external dependency slowed down, the increase amount in imports decreased. In addition, a lot of alternative energy sources such as gas increase suspend the growth in oil demand.

Although nowadays part of the oil products such as diesel demand is becoming saturated in China, China's new industries such as automobile and aviation are developing rapidly. The resulting demand for gasoline and kerosene oil products steadily grows yearly. Therefore, even if all kinds of the alternative fuels develop rapidly in a quite long foreseeable future, gasoline, diesel, kerosene and other petroleum products will still be the mainstay of China's energy. As a result, it is expected that China's oil gap will grow more and more in the future, and oil imports will continue to grow.

Therefore, China's oil trade imports and growth rate of internal factors have become an urgent problem to be solved. Integrated with the current trade development process, and to further determine its specific impact factors and internal relations between the various factors, this paper introduces the oil import trade gravitational model for research and analysis.

CONSTRUCTION OF GRAVITY MODEL OF OIL IMPORT TRADE

Variable selection

From the perspective of the practice of the world's oil trade, per capita gross domestic product (GDP), the exporter of oil products, the distance between the two countries, trade cooperation agreement signed or not, etc. are the main factors affecting oil imports. Therefore, the study's variables selected in this paper are: per capita GDP, distance between the two countries (D), oil output from exporting countries (P), and whether trade countries have signed trade agreements with China or not.

Gross domestic product per capita (GDP)

The gross domestic product is the core index of national economic accounting, which is of great significance to the measurement of the economic situation and development level of a country. This can effectively reflect the overall economic situation of a country. The higher the per capita GDP of a country and the more prosperous it is, the greater the possibility that the country will conduct international trade. This is especially true for oil trade. With the augmentation of the national economy and people's living standard, the country's economic development and people's oil consumption will continue to rise, thus one can expect GDP coefficient to be positive.

Distance between the two countries (D)

The distance between the two countries is often positively correlated with transportation costs. The greater the distance between the two countries, the higher would be the cost of transportation. The main route for China's oil imports is pipeline and sea transport. The fixed investment of pipeline transport is large. In order to realize continuous transportation, intermediate repository and pump stations should also be set up to promote smooth pipeline transport. The characteristics of sea transport are: it is slow, risky and uncertain. For oil transportation, characterized with large import quantity, transportation difficulty and high risk, greater distance, the demand for safety and protection measures in transportation will be high. This will greatly increase the production costs. These factors will hinder oil trade, so the distance between the two countries can be expected to have a negative correlation

Table 1. Variable assignment table.

The index name	Name
China's oil import quantum	LNP
China's GDP	LNGDP
The distance between China and oil exporters	LND
The oil production quantity of oil exporters	LNP
The trade agreement	X4

with the volume of trade.

Oil production of exporting countries (P)

For oil exporters, oil output reflects the export capacity of oil-exporting countries. The higher the output of oil producing countries, the stronger the export capacity, and the greater the amount of oil available for export. For Chinese oil import demand, oil import trade will be based on the export -ability of the country; therefore, export of oil products is one of the important factors affecting China's oil imports; therefore, the export of oil production is an important factor which will affect China's oil imports.

Whether the trading nation signs a trade agreement with China or not, since the implementation of One Belt And One Road, China has signed trade cooperation agreements with more than 40 countries based on One Belt And One Road, and also signed standardized cooperation agreements with 21 countries. Therefore, the study of China's oil import trade under the "One Belt And One Road" strategy will represent an important research variable for the trade agreement with China.

Free trade area (FTA) in a broad and narrow sense

The generalized free trade zone refers to two or more countries or separate custom territories where tariffs and other non-tariff restrictions are eliminated; it is the protection given to them outside their regions like trade special economic zone or economic group. The free zones include North American Free Trade Area (including the United States, Canada, Mexico), the EU Free Trade Area (including Europe, the Middle East and North Africa 35 countries forming a pan-European - Mediterranean Free Trade Area); narrow free trade zone, or separate custom zones established in the fence isolation, located outside the jurisdiction of the special economic areas. The regions give foreign ships free access, duty-free imports to foreign goods, and the abolition of the import of goods quota control is a further extension of the free port. Therefore, the signing of FTA can be expected to be positively correlated with the trade volume.

Construction of trade gravity model

The gravity model of ideas and concepts is derived from the law of universal gravitation proposed by Newton in 1687 in gravitational attraction between two objects, where the quality of two objects is proportional to their size, and the distance between two objects is inversely proportional to their distance. It is generally believed that the gravity model is used to study the international trade of Tinbergen (1962) and Poyhonen (1963); it is analyzed by using the gravity model of bilateral trade flows, where bilateral trade scale is proportional to their economy, and inversely proportional to the distance between two countries. Berstrand (1989) went further to

replace population with per-capita income. At home, Wan (2017) based on the gravity model of China's central and Europe along the country's forest products trade potential study, for the application of gravity model in the domestic academia laid a foundation. Due to gravity model, the data need to be strong, and have credibility. The application of the trade gravity model is more and more becoming the main empirical research tool of international trade flows. Someone vividly called it the gravity model "bilateral trade flow empirical research workhorse". The original form of the gravity model can generally be expressed as:

$$T_{ij} = A(Y_i \times Y_j \div D_{ij}) \tag{1}$$

Where T_{ij} represents the volume of trade between the two countries, Y_i is the GDP of the i country, Y_j is the GDP of the j country, and D_{ij} is the distance between the two countries, and A is the proportionality coefficient.

This study makes an econometric analysis of the relationships between China's oil imports, China's GDP, the distance between China and oil exporters, the oil production of exporters, the trade agreements with China; it also builds a relevant model, to test the four influence factors on the impact of China's oil imports. Considering China's GDP, the distance between China and oil exporters, it was found out that China's oil import is bigger numerically. To avoid the volatility of the data to the model, it was analyzed by taking its natural logarithm. After taking the logarithm, the specific variables are presented in Table 1. The model is built as follows:

$$LNP = \beta_0 + \beta_1 \times LNGDP + \beta_2 \times LND + \beta_3 \times LND + \beta_1 \times X_4 + \varepsilon \tag{2}$$

β_0 as constant, β_1-β_4 for China's GDP, the distance between China and exporters of oil products, the influence of the trade agreement for China's oil imports coefficient values, and ε as residual error of the model.

EMPIRICAL ANALYSIS OF PETROLEUM IMPORT

This article selects 10 countries , Russia, Saudi Arabia, Yemen, Oman, Iran, Indonesia, Iraq, the United Arab Emirates, Kuwait and Angola (the top countries where China's oil imports larger) as the research objects, and uses data of 2008 to 2015 (source: chinaxinxi.org).

Two regression analyses are respectively used to analyze the influence factors of China's oil imports through multiple linear regression analysis. This analysis is divided into two phases: Phase 1 is 2008 to 2012 before the implementation of OBOR strategy. Phase 2 is 2013 to 2015 after the strategy implementation, and comparison analysis is also conducted. Input data of the oil trade gravity model of formula (2) was analyzed with Eviews 8.0 software. The results are shown in Table 2.

As can be seen from the linear regression results in phase 1, the F value of the model is 96.949, and the corresponding P value is less than the significance level of 0.05. This indicates that the model equation is formed. Furthermore, the adjustment of the model R square is 0.662, indicating that the model has better explanatory power.

In phase 1, China's GDP to the dependent variable

Table 2. The result of multiple linear regression analysis of phase 1.

Variable	Coefficient	Standard error	T Value	P Value
Constant term	-40.725	5.896	-6.907	0.000
LNGDP	5.078	1.861	2.728	0.006
LND	-3.167	1.706	-1.856	0.064
LNP	1.357	0.121	11.215	0.000
X4	0.578	0.023	25.130	0.000
F VALUE			96.949	
Corresponding P value			0.000	
Adjust the R square			0.662	

Table 3. The result of multiple linear regression analysis of phase 2.

Variable	Coefficient	Standard error	T Value	P Value
Constant term	-38.765	-5.495	7.055	0.000
LNGDP	5.356	1.899	2.820	0.005
LND	-4.098	1.570	-2.610	0.009
LNP	1.864	0.170	10.965	0.000
X4	0.672	0.027	24.889	0.000
F Value			68.182	
Corresponding P value			0.000	
Adjust the R square			0.698	

coefficient, China's oil imports test t value is 2.728, and the corresponding P value is smaller than the significance level of 0.05. It means that China's GDP is statistically significant with the dependent variable, the impact of China's oil imports. According to the coefficient value of 5.078, as China's GDP increases by 1 unit, the dependent variable, China's oil import rises by 5.078 units.

In phase 1, the test t value for the influence coefficient of the distance between China and oil exporting countries in relation to the impact variable, China's oil imports is-1.856, and the corresponding P value is greater than the significance level of 0.05. That is to say there is no statistical significance in the distance between China and oil exporters in relation to the influence variable, China's oil imports.

In phase 1, the test t value for the influence coefficient of the exported oil products in relation to the impact variable, China's oil imports is 11.215; the corresponding P value is smaller than the significance level of 0.05. This is to say that the impact from the exporting countries' oil output is statistically significant with the dependent variable, China's oil imports. According to the coefficient value of 1.357, as the oil output of exporting countries increases by 1 unit, the dependent variable, China oil import rises by 1.357 units.

In phase 1, the test t value for the influence coefficient of the trade agreement for the dependent variable,

China's oil imports is 25.130, and the corresponding P value is smaller than the significance level of 0.05. That is the trade agreement in the dependent variable, impact of China's oil imports is statistically significant. Based on the coefficient value of 5.078, it can be seen that China imported much more oil from those countries which signed bilateral trade agreements than those that did not comparatively (Table 3).

It can be seen from the linear regression results that the F value of the model is 68.182, the corresponding P value is less than the significance level of 0.05, and the model equation is established. Furthermore, the adjustment of the model is 0.698, indicating that the model has better explanatory power.

In phase 2, the test t value for the influence coefficient of China's GDP in the dependent variable, China's oil imports is 2.820, and the corresponding P value is smaller than the significance level of 0.05. That is, China's GDP in the dependent variable, the impact of China's oil imports is statistically significant. According to the coefficient value of 5.356, it can be seen that as China's GDP rises by 1 unit, the imports of Chinese petroleum in the dependent variable rise by 5.356 units.

In phase 2, the test t value for the influence coefficient of the distance between China and oil exporters in the dependent variable, China's oil imports is -2.610, and the corresponding P value is smaller than the significance level of 0.05. According to the coefficient value of -4.098,

as the distance between China and oil exports rise by 1 unit, the dependent variable, China's oil imports declines by 4.098 units.

In phase 2, the test t value for the influence coefficient of the oil products exporters in the dependent variable, China's oil imports is 10.965. The corresponding P value is smaller than the significance level of 0.05; the impact from the exporting countries' oil is statistically significant with the dependent variable. According to the coefficient value of 1.864, it can be seen that as the oil output of exporting countries increases by 1 unit, China's import oil increases by 1.864 units.

In phase 2, the test t value for the influence coefficient of the trade agreements in relation to the dependent variable, China's oil imports is 24.889, and the corresponding P value is smaller than the significance level of 0.05. That is the trade agreement in relation to the dependent variable, China's oil imports is statistically significant. According to the coefficient value of 0.672, China imported much oil from those countries that signed bilateral trade agreements than those that did not sign comparatively.

According to the results of two regressions (Table 3) prior to the implementation of the OBOR strategy from 2008 to 2012, China's per capita GDP has significant positive effects on China's oil imports, and there is no significant negative correlation in the distance between the two countries for China's oil imports. Whether there is a signed trade agreement with China or not it still has a positive influence on China's oil imports.

According to the results of two regressions as shown in Table 3 after the implementation of the OBOR strategy from 2013 to 2015, China's per capita GDP has significant positive effects on China's oil imports; the distance between the two countries for China's oil imports has significant negative correlation. The oil of exporters significantly influences China's oil imports. Whether there is a signed trade agreement with China or not it still has a significantly positive influence on China's oil imports.

Conclusions

Through the theoretical analysis and empirical test of the influential factors of China's oil imports under the background of the OBOR strategy, it can be concluded that, with the deepening of the OBOR strategy, China's oil import source countries are changing; the countries on the "One Belt One Road" are becoming China's main sources of oil import.

Data show that as the world's largest oil exporter, Saudi Arabia has always been at the top of China's oil import. In 2014, total oil output of Saudi Arabia to China is 49.67 million tons, accounting for 16.11% of its oil exports. The second is Angola, which exported 41 million tons oil to China in 2014, accounting for 13.18% of its total oil output. The third is Russia, which exported 33 million tons

oil to China in 2014, accounting for 10.74% of the country's total oil output. It was also a relatively fixed ranking for years, but with the deepening of the One Belt One Road strategy, this state was broken in May 2016.

According to the data released by the General Customs Office, China's oil import from Russia in May 2016 is 3.92 million tons, equivalent to 927,000 barrels a day. Russia replaced Saudi Arabia as China's largest oil supplier. In 2014, China's monthly average import from Russia was only about 2.75 million tons, equivalent to 650,000 b/d. That is to say, from May 2016 till date, China's oil imports from Russia have increased by almost 43% yearly. On the other hand, China's imported oil from Saudi Arabia declines by nearly 36% over the same period. Based on the OBOR strategy, the paper takes China's oil import trade as the research object.

Suggestions

First, China should actively build a diversified oil import pattern. Currently, China mainly imports oil from a few countries. The imported oil from these countries accounted for the total China's oil import proportion, which means that China's oil import source is comparatively single and one fold. According to the statistics from China Customs Office, the quantity of China's imported oil from those six countries (Saudi Arabia, Russia, Angola, Oman, Iraq and Iran in 2014) accounted for over 50% of the total oil imports of the whole year. Therefore, as China continues to consolidate its existing sources of oil imports, it should vigorously develop the oil and trade markets in countries and regions based on the "One Belt One Road" that are closer to China.

Secondly, China should act actively with the "One Belt One Road", sign a trade cooperation agreement, and build a cooperative network. China should seize the "One Belt One Road" strategic opportunities to seek breakthrough like: "construct all roads, strengthen the oil trade between countries and interconnection relationship, build the corresponding all multi-level, complex interconnection network to achieve diversification, autonomy, balance and sustainable development of many countries, promote strategic cooperation between China and the countries on the "One Belt One Road" to promote energy international cooperation. More than 30 countries have signed a joint statement with China; since then more than 60 countries have responded positively and proceeded to promote the construction of the relevant projects. At the same time, China has also reached a large number of agreements with relevant countries in trade facilitation, currency exchange, investment and construction. This has laid a solid foundation for cooperation in the development of China's oil import trade under the strategy of "One Belt One Road", creating a favorable international environment.

Thirdly, China should accelerate the realization of mutual benefit and win-win situation. On one hand, the "One Belt One Road" initiative is in line with the strategic concept of Russia's "Eurasian Economic Community" Russia, Belarus, Kazakhstan and Kyrgyzstan signed an agreement to establish a four (4)-nation customs union coordinate the four countries' economic reform process and accelerate the process of integration. And the EU "Juncker Plan together created online digital Silk Road and many other countries and regions of the strategic concept of the opposite".

On the other hand, there is indeed a lot of mutual economic need. Kazakhstan, for example, in oil, gas, minerals, agriculture and other areas has obvious comparative advantages, but its railways, highways, oil and gas pipelines and other infrastructure are in great demand for construction, and this is precisely China's strengths. With the strong combination of the two sides, comparative advantages are very good. "One Belt One Road" will further strengthen cooperation and exchanges between China and the countries on the route, promote development and radiation in other countries and regions, help to deepen the opening up of China's coastal areas and promote the opening and development of the central and western regions. It will help domestic and foreign resources, talent, comprehensive docking, national oil trade cooperation, comparative advantages, resource sharing, and win-win cooperation.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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