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The Influence of Investment Rights and Interests on the Pricing Mechanism of International Trade Based on Mathematical Model

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ABSTRACT. *To further know the impact of investment rights and interests on international trade pricing of resource products and the internal mechanism, the relationship between investment rights and pricing of international trade of resource-based products was studied by constructing mathematical model. The pricing mechanism is studied by analyzing investment rights, futures market, negotiation mechanism, trade intermediary, and characteristics of resource-based products. The results showed that the investment rights and interests were obtained through foreign direct investment. Those who have the ownership of investment rights and interests could have the weight of game in the process of negotiation, and then have a greater voice, which is directly reflected in the right of control or income for the exploitation, distribution, and transportation of the invested resource-based products. The role of investment rights and interests in international trade pricing is a supplementary mechanism of trade intermediary. There is a maximum effect of investment equity on pricing power of trade products. Beyond the critical point, pricing power will be affected, because the investor role changes to the seller role. In a word, to a certain extent, increasing investment rights and interests can have a certain impact on the pricing of resource products. Foreign investment rights and interests are vital in national strategy and social stability. The impact of investment rights and interests on pricing mechanism is mainly realized through discourse power and product allocation power. The research on the impact of investment rights and interests on the pricing mechanism of international trade has a positive significance for the follow-up research.*

KEYWORDS: *investment rights and interests; pricing; trade; futures*

1. Introduction

As the globalization develops and society progresses, international trade is

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becoming more and more extensive. China has made great achievements in the economic level, people's living standards are getting higher, and there are more things to be chosen [1]. At present, China's economic development is mainly labor-intensive, the level of technology and productivity is relatively low, and there is no voice in many key resource areas. China's development speed is very fast, and its dependence on resources is very high, whether it is coal, oil, natural gas, iron ore, or copper ore. Hence, it is very difficult for China, which relies heavily on imports, not to grasp the discourse power of product pricing [2]. For the loss of discourse power of key resource products, it will lead to huge economic losses and bring huge security risks to the country. It is very important to master the weights and negotiation rights in the process of pricing related products through direct investment. Investment rights and interests are the rights to allocate, produce, and dispose of resources. Owning investment rights and interests can express the pricing of products in international trade to a certain extent and make decisions in line with their own interests. At present, China is also continuously strengthening its investment rights and interests in energy products [3-5]. Some countries, such as Japan, Europe, and the United States, have a larger power in the pricing of some key resource products. China is also constantly striving to enhance its investment rights and interests. If the energy rights and interests cannot be comprehensively improved, the pricing rights will be further away, and it cannot be effectively controlled. If this problem cannot be effectively solved, the economic loss of energy and various adverse factors will still exist, resulting in great losses [6].

Thus, based on this situation, a mathematical model analysis method is proposed to study the relationship between investment rights and international trade pricing of resource products. The contribution is to use a comprehensive and in-depth design model to study and analyze the impact of investment rights and interests on the pricing mechanism of international trade, and then comprehensively solve how investment rights and interests affect the pricing mechanism of international trade of resource products, and carry out a comprehensive understanding of investment rights and interests. The right to control the pricing mechanism of energy is of great significance in both the field of ordinary life and the science and technology.

To sum up, how the investment rights and interests affect the pricing mechanism of international trade of resource products is discussed. The innovation lies in the comprehensive analysis of investment rights and pricing mechanism from futures, negotiation, intermediary and other aspects, and the clear results of each analysis, which is of great significance for the follow-up analysis.

2. Method

2.1 Resource products

The resource-based products mentioned refer to the non-renewable and non-replicable natural resources that are directly mined from the surface or stratum. They are mainly used to produce raw materials or consumer goods in daily life

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required by industrial enterprises, which are mainly divided into two categories: bulk and rare [7]. Rare resources mainly include rare mineral products such as rare earth, and bulk resources mainly include energy and mineral products. Figure 1 shows the factors affecting the price of resource products.

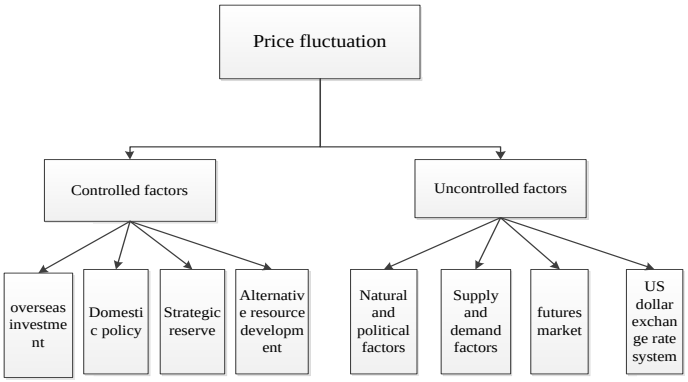

Figure. 1 Factors affecting the price of resource products

2.2 The influence of special attributes of resource products on pricing power

First, resource products are non-renewable and scarce. Due to the special formation process of resource products, they are non-renewable [8]. The fossil energy seen in daily life, such as coal, oil, and natural gas, are the enrichment products generated by the remains of ancient animals and plants buried in a special geological environment after tens of millions or even hundreds of millions of years of chemical and physical reactions. When they are excavated and burned, they are basically impossible to regenerate in a short time. The iron ore, copper mine, aluminum mine, and other mineral resources are also generated after a long time of complex biochemical reaction in a special environment, and they cannot be created by human efforts [9].

The distribution of global reserves of resource products is very uneven. Resource products are generally concentrated in specific regions or countries, and the proportion of resource products ranks the first in the global energy products. Among them, resource products such as oil, iron ore, and rare earth only exist in a few countries and regions [10].

Demand rigidity of resource products. Due to the high demand and non-substitutability of resource products in real life, as well as the wide application, short life cycle, and small price fluctuation, the price elasticity of world oil consumption demand from 1976 to 2011 can be calculated by the demand elasticity equation. Through analysis, it can be found that the absolute price elasticity of world oil demand except 2002 is lower than 1, which fully shows that the demand price elasticity of resource products is relatively small [11]. In addition, the price elasticity

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of demand in some years is greater than 0, which shows that people's demand for resource products changes positively with the change of price. Thus, the demand rigidity of resource products promotes the influence of oligopoly suppliers of resource products on their prices. Figure 2 shows the resource market equilibrium.

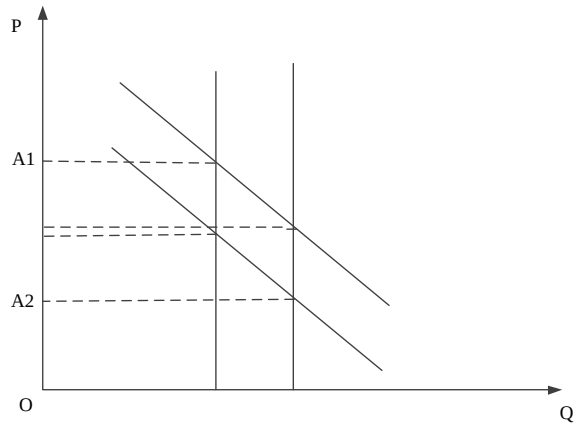

Figure. 2 Resource market equilibrium

2.3 Influence of investment interests on pricing mechanism

In general, the right of control or the right of return on the exploitation, distribution and transportation of the invested products under the condition of direct investment is called as investment interests. In the resource product industry, it is usually through purchasing the equity of foreign resource enterprises or purchasing the equity of enterprises providing production and transportation of new resource products, thus obtaining the disposal right and distribution right of the invested resource products [12]. Specifically, it is to acquire the disposal right, distribution right, and additional interests of mineral resources by purchasing the stock rights of mineral enterprises. The so-called share oil refers to the investment country participating in the development of overseas oil resources through equity participation, investment or technical services, and obtaining stable share oil according to the share contract signed in the early stage [13]. It needs to be clear that the investment rights and interests of overseas resource products have gradually become an important factor affecting the international pricing of resource products, and the equity minerals and share oil have become the main channel and form of pricing of resource products in this process. Figure 3 shows the path of price influencing the investment interests.

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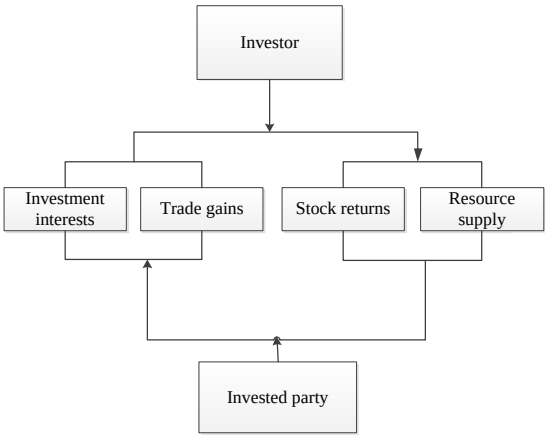

Figure. 3 Path of the impact of investment interests on price formation

The reason why investment rights and interests can take the lead in the price war is that investors can take the leading advantage by increasing investment shares. This way has become a bargaining chip in the resource commodity trading and a main means to regulate supply and demand, which can form a good control over resource product trading [14,15]. In this process, China should try to find a balance between the amount of overseas investment and the demand for domestic resources under the condition of ensuring that the resource products are fully supplied. Under the development strategy of "going out", China should try to encourage the development of overseas key resource industries and obtain key resources, thereby guaranteeing the growing demand for resource products in China [16].

2.4 Definition of pricing power

The pricing power of commodities in the world is mainly related to the international influence of the corresponding countries and the fluctuation range they can bring to the prices. After all, pricing power is the embodiment of an organization's or a region's comprehensive strength. It has a relatively strong comprehensive strength, a relatively large impact on the pricing power of products, a small comprehensive strength and a relatively small impact on products. There are special parameters for the influence of pricing power in the world. The value of the right quotient is not only related to the international influence, but also to the investment rights and interests. The equation of power quotient index V of international pricing power is $V = \left(C_x * H_x + C_m * H_m\right) / \left(H_x + H_m\right)$, where, C_x and C_m represents the ratio of the country's imports and exports of a certain commodity in the international market, while, H_x and H_m represents the HHI index of buyers and sellers in the international market. The greater the V value is,

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the greater the influence of a country on the international pricing of a product is. Figure 4 shows the dynamic change trend of resource prices.

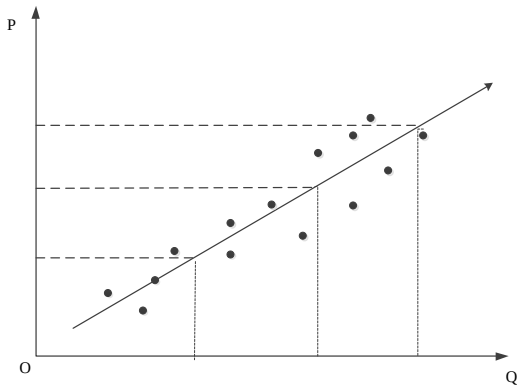

Figure. 4 Dynamic change trend of resource price

2.5 Mathematical analysis model

The equity investment situation of domestic downstream enterprise D_1 of resource products, which invests in U_B's equity and then exports consumer manufactured goods, and the equity of non-investment enterprise U_B directly imports resource products are analyzed.

The model is divided into four stages: (1) in the first stage, domestic downstream enterprises D_1 choose the mode: do not to invest in foreign upstream enterprises, but directly import resource products; invest in foreign upstream enterprises; (2) in the second stage, domestic downstream enterprises D_1 position their sales products, that is, determine their own market position; (3) in the third stage, U_AU_B, a domestic and foreign upstream enterprise of resource products, selects their wholesale prices for downstream enterprises of resource products; (4) in the fourth stage, based on the wholesale price of the resource products set by the upstream enterprises, the downstream enterprises of the resource products select the upstream enterprises with low wholesale price and determine the price p of their own sales products.

The whole model is similar to the dynamic game model. The reverse induction method is used to analyze the whole model: assuming that the consumers of the products produced by the domestic and foreign downstream enterprises based on the resource products are evenly distributed in [0,1], for a consumer in the x position to purchase products from the downstream enterprises D_1 and D_2, not only the commodity price p_1, p_2, but also the transportation cost should be paid. The transportation cost is directly proportional to the square of the distance, as shown in equation (1).

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$$t\left(l_1 - x\right)^2 , t\left(1 - l_2 - x\right)^2 \tag{1}$$

It is concluded from $t\left(x - l_1\right)^2 + p_1 = t\left(1 - l_2 - x\right)^2 + p_2$ that when consumers are in position, the utility of purchasing goods downstream of D_1, D_2 is equal. Then, the profits of the two enterprises are shown in equation (2).

$$\begin{aligned} \pi_{d1} &= \left(p_1 - w_1\right)\left(\frac{1 + l_1 - l_2}{2} + \frac{p_2 - p_1}{2t\left(1 - l_1 - l_2\right)}\right) \\ \pi_{d2} &= \left(p_2 - w_2\right)\left(\frac{1 - l_1 + l_2}{2} + \frac{p_1 - p_2}{2t\left(1 - l_1 - l_2\right)}\right) \end{aligned} \tag{2}$$

Among them, W_1 and W_2 are the costs of raw materials purchased by upstream enterprises from downstream enterprises, and the optimal profit of the two enterprises can be calculated through partial derivation.

$$\begin{aligned} \pi_{d1} &= \frac{\left[\left(1 - l_1 - l_2\right)\left(3 + l_1 - l_2\right)t - w_1 + w_2\right]^2}{18\left(1 - l_1 - l_2\right)t} \\ \pi_{d2} &= \frac{\left[\left(1 - l_1 - l_2\right)\left(3 - l_1 + l_2\right)t + w_1 - w_2\right]^2}{18\left(1 - l_1 - l_2\right)t} \end{aligned} \tag{3}$$

Among them, l_1, l_2 are the parameters, calculated by value W_1, W_2, the raw material cost of upstream enterprises to downstream enterprises is obtained. Assuming that upstream enterprises of resource products compete with each other in Bertrand price, that is, when the cost of resource products provided by upstream enterprises of resource products to downstream enterprises (sales price assumed transportation cost) is lower than that of their competitors, the upstream enterprises will set the price of resource products at the cost level of their competitors. Then, the price U_A and U_B of upstream enterprises of resource products are calculated, respectively:

$$\begin{aligned} U_A : w_{A1} &= \max\left\{\tau\left(l_1 - h\right)^2 , \tau\left(1 - l_1 - h\right)^2\right\} \\ U_A : w_{A2} &= \max\left\{\tau\left(1 - l_2 - h\right)^2 , \tau\left(l_2 - h\right)^2\right\} \\ U_B : w_{B1} &= \max\left\{\tau\left(l_1 - h\right)^2 , \tau\left(1 - l_1 - h\right)^2\right\} \\ U_B : w_{B2} &= \max\left\{\tau\left(1 - l_2 - h\right)^2 , \tau\left(l_2 - h\right)^2\right\} \end{aligned} \tag{4}$$

τ can be regarded as a measure of the pricing power of upstream enterprises. The greater the pricing power of upstream enterprises is, the higher the price of resource products sold is.

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$$\begin{aligned} U_A : w_{A1} &= \max\left\{\tau l_1^2, \tau\left(1 - l_1\right)^2\right\} \\ U_A : w_{A2} &= \max\left\{\tau, 0\right\} \\ U_B : w_{B1} &= \max\left\{\tau l_1^2, \tau\left(1 - l_1\right)^2\right\} \\ U_B : w_{B2} &= \max\left\{\tau, 0\right\} \end{aligned} \tag{5}$$

If D_1 takes part of the profits to purchase U_B shares, among which, λ is the leverage ratio when purchasing shares, and θ is the proportion when the enterprise purchases shares of a foreign company, then the equity profit is calculated as equation (6).

$$\theta\lambda w_B - \theta\left(p_1 - w_1\right)\left(\frac{1 + l_1 - l_2}{2} + \frac{p_2 - p_1}{2\left(1 - l_1\right)}\right) \tag{6}$$

The original profit is shown in equation (7):

$$\left(1 - \theta\right)\left(p_1 - w_1\right)\left(\frac{1 + l_1 - l_2}{2} + \frac{p_2 - p_1}{2\left(1 - l_1\right)}\right) \tag{7}$$

Then, the total profit of domestic downstream enterprise D_1 of resource products who chooses to purchase U_B equity of upstream enterprise of resource products is shown in equation (8).

$$\begin{aligned} \pi_{1B} = {} & \theta\lambda w_B - \theta\left(p_1 - w_1\right)\left(\frac{1 + l_1 - l_2}{2} + \frac{p_2 - p_1}{2\left(1 - l_1\right)}\right) + \\ & \left(1 - \theta\right)\left(p_1 - w_1\right)\left(\frac{1 + l_1 - l_2}{2} + \frac{p_2 - p_1}{2\left(1 - l_1\right)}\right) \end{aligned} \tag{8}$$

According to the results of the above model analysis, it is seen that through equity investment in resource energy to obtain relevant rights and interests, suppliers and enterprises can be connected with relatively low labor force to a certain extent, and the interdependence is enhanced. Through investment rights and interests, the suppliers and enterprises can learn from each other's strengths and make up for the weaknesses to the greatest extent, reduce risks and mutual costs, and finally achieve a win-win situation. Investment rights and interests can improve the international status of domestic enterprises, which is of great help to the subsequent international development of enterprises and the negotiation needed.

3. Results and discussion

Figure 5 shows the comparative study of China's crude oil import and consumption data in the past 20 years. The analysis suggests that in the past 20 years, the quantity of China's crude oil import and consumption has increased in a straight line, and the demand is very large. Thus, it is very important to compete for the

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pricing power of other products such as resource product crude oil. If China has no certain pricing right, it will suffer a great loss in the price level and lose the initiative. Hence, increasing investment rights and then mastering more pricing power of resource products greatly affect the development of the country and people's lives.

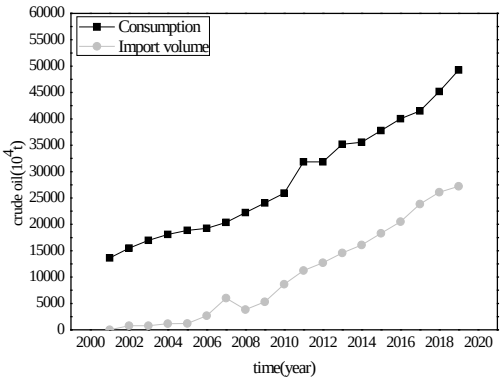

Figure. 5 A comparative study of China's crude oil import and consumption data in the past 20 years

Figure 6 shows the comparative study of China's copper and copper imports in 2009-2018. The data analysis indicates that in 2008-2018, China's demand for copper wire dropped significantly, with a very large range. On the other hand, the demand for copper wire was increased. This phenomenon is mainly due to China holding certain product pricing power and discourse power through foreign investment in ore enterprises, which is more advantageous at the price level. It can be seen that it is of great significance for the national strategic security and social development to participate in and negotiate the pricing of resource products through foreign direct investment and then through investment equity.

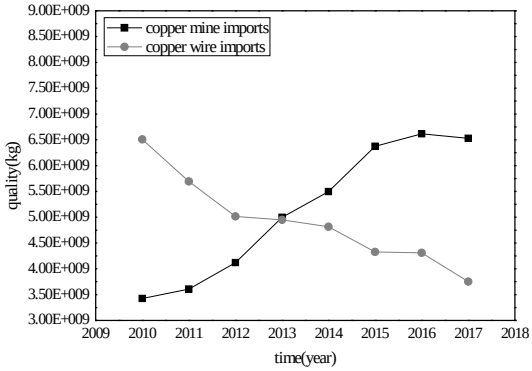

Figure. 6 A comparative study of China's copper and copper imports in 2009-2018

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Figure 7 shows the comparison of China's crude oil and product oil imports in 2010-2018. China's demand for refined oil has remained at a relatively low level in 2008-2018, with a significant increase in crude oil imports. This situation is mainly because China has more power in the price of resource-based products under the trade intermediary through investment rights and interests. On the other hand, crude oil can be used as asphalt or other products after processing by-products, which can achieve diversified applications. It can be seen that the increase of crude oil import is more in the interests of the country.

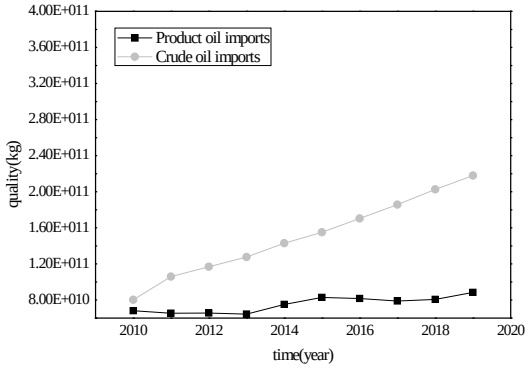

Figure. 7 Comparison of China's crude oil and product oil imports in 2010-2018

4. Conclusion

This paper mainly studies how the investment rights and interests affect the pricing mechanism of international trade of resource products. The core is to study the pricing mechanism by analyzing the investment rights and interests, futures market, negotiation mechanism, trade intermediary, and characteristics of resource-based products. The results show that owning investment rights and interests can control the right of exploitation, distribution, and transportation of resource-based products, and then affect the right of pricing. The impact of investment equity on the pricing power of trade products has a maximum value. If it exceeds the critical point, the pricing power will decline. However, there are still some limitations. For instance, because the pricing mechanism of real resource products is very complex and unstable, some factors are ignored, and the results are a little less convincing. Additionally, as some aspects of the data accuracy is not enough, a stereotyped conclusion cannot be obtained. The follow-up research can be more in-depth and more comprehensively, which will reduce the interference brought by some other factors.

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