How Does China Respond to U.S. Trade Protection Policies?--
The Perspective of Game Theory

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Abstract. Why the United States took the lead in adopting trade protection policies is the most critical issues in studying Sino-US trade relations. This paper answers this question by constructing an economic game model and integrating political game ideas. That is to say, in the economic perspective, if the United States predicts that the protection strategy may bring great benefits to the country, adopting a free strategy will bring more benefits to the country, and it is expected that the protection measures taken by the country will cause the damage caused by the retaliatory actions of the other party to be small. The United States has a strong incentive to adopt trade protection. The political point of view is mainly the reasons for the United States' persistence of the "terrorism" mentality of the second country, the "first US" belief, and the intention to hold the Chinese technology throat.

1. Introduction

Since March 22, 2018, the United States announced that it intends to impose tariffs of 25% and 15% on imports of steel and aluminum from China, based on the results of the “232” investigation. The relationship between China and the United States has become a thin ice. It is worth pondering and discussing.

First, why the United States take the lead in adopting a trade protection policy? Is it because the existence of a poor trade between China and the United States, or President Trump’s election to stabilize the midterm elections in November, or other reasons?

Second, why should the United States impose tariff restrictions on high-tech manufacturing industries such as high-performance medical devices, new materials, industrial robots, new energy vehicles, and aerospace products in China, knowing that China’s counter-attacks will cause losses, and why trade?

Finally, the game between the two countries is not the end, then in the next game, how should China find a coping strategy? Next, this article discusses the above three issues.

2. Literature review

In the field of economics research, the trade friction between China and the United States belongs to the research field of international trade, and the direction of using game theory to analysis the choice of national trade policy can be summarized as the following two aspects. The first is the game analysis of trade policy choices; the second is the game analysis of trade friction.

Regarding the game analysis of trade policy choices, Liu Bing (2010) analysed through game theory that the country’s optimal choice in international trade is not the adoption of trade protectionism,
but the conclusion of a large and long-term trade protectionism. The reason for this is that unilateral trade liberalization is difficult to achieve in the case that every country has full freedom to choose its own trade policy. In the short term, countries will consider the maximization of their own interests. Then, they will choose a trade protection policy (Zhou Maorong, Du Li, 2004). However, trade policy is not constant. The trade policy game between the two models is an incomplete information game, a dynamic game, a zero-sum game and an infinite repeated game (Chen Lucu, 2001) [1]. Tian Haiyan and Wang Shijin (2007) found in the static game of the model that the Nash equilibrium solution of the trade policy decisions of the two sides of the game is (protection, protection), and in the case of dynamic non-repetitive games, national trade policies are likely to reverse. The key is that there is a legal or trustworthy promise between the players. This is the case when China and the United States formulate their own trade policy measures against each other. If the two sides repeatedly play against each other or have a long-term relationship, cooperation can become the final outcome (Liu Qin, 2001).

In the game analysis of trade friction between the two countries, mainly to sort out the literature on Sino-US trade relations, Yan Yanxiang (2010) analyzed the internal mechanism of trade friction between China and the United States with a multi-stage dynamic game model. The results show that the degree of interdependence and exit costs of the two economies are important factors influencing whether trade frictions escalate into trade wars [2]. Kong Qingfeng (2010) constructed a game model of trade policy choice under incomplete information conditions, and took the trade between China and the United States as an example to draw a response to China's trade protection policy [3].

Through the combing of the literature, this paper finds that in the selection analysis method, game theory is closer to reality in the research of national trade policy choices and other related issues, more rational and scientific. Therefore, in the following research, this paper constructs a trade policy choice game model between China and the United States under the incomplete information to analyze the reasons for the US to adopt a trade protection policy, and seek a Nash equilibrium solution. Based on this, the paper will seek to respond to China's future measures to reduce the probability of adopting a trade protection strategy.

3. Analyze the reasons why the United States adopts trade protectionism

The trade protectionist measures taken by the United States against China have intensified in recent years. On April 4, 2018, the US government announced that it would impose a 25% tariff on 1,300 imported goods originating in China according to the results of the 301 unilateral investigation, involving steel, high-tech, pharmaceutical and other industries. The export value of 50 billion U.S. dollars has a great impact on China. Through the combing of the literature, it can find that the trade war between China and the United States is harmful to both sides. Why should the United States take the lead in launching the first ring of trade wars? The game analysis method will be used to analyze this problem.

3.1. Model construction

3.1.1 Model assumptions

(1) Both China and the United States are pursuers of maximizing profits;

(2) Both China and the United States have the policy of free choice of trade protection or trade freedom;

(3) The information is incomplete, and the game between the two is an incomplete information game;

(4) In a completely free trade, the United States receives a return of X1, and China receives a return of X2;

(5) The United States imposes tariffs on China unilaterally. If China does not counterattack, it will cause a loss of A dollars to China and a domestic income of B dollars.
(6) China imposes tariffs on the United States unilaterally. If the United States does not counterattack, it will cause a loss of C dollars to the United States and a domestic benefit of D dollars.

(7) If the United States imposes tariffs on China, China will strongly counterattack, which will cause the United States to lose its domestic losses to E dollars and China to cause domestic losses of F dollars.

3.1.2 Model establishment

Table 1. Game Analysis of Trade Policy under Incomplete Information between China and the US (Pure Strategy)

|          | Trade protection | Free trade  |
|----------|------------------|-------------|
| **US**   | **CHN**          |             |
| Trade protection | X₂+D-F, X₁+B-E | X₂+D, X₁-C |
| Free trade  | X₁-A, X₂+B      | X₁, X₁     |

Table 1 clearly shows the benefits of China and the United States in trade policy choices, but the model does not have a pure strategy Nash equilibrium solution. The reason is that the value of B-E and the value of C cannot be determined, and the value of D-F and the magnitude of A cannot be determined. According to the existence theorem of Nash equilibrium, there is at least one pure strategy or mixed strategy Nash equilibrium in each finite game. The pure strategy Nash equilibrium cannot be determined. Below the paper analyses the Nash equilibrium of the hybrid strategy. The specific benefits are shown in Table 2.

Table 2. Game Analysis of Trade Policy under Incomplete Information between China and the US (Mixed Strategy)

|          | Trade protection | Free trade  |
|----------|------------------|-------------|
| **US**   | **CHN**          |             |
| Trade protection (p) | X₂+D-F, X₁+B-E | X₂+D, X₁-C |
| Free trade  (1-q) | X₁-A, X₂+B      | X₁, X₁     |

As can be seen from Table 2, the probability of US trade protection is p, and the probability of China adopting trade protection is q; then the probability of US trade freedom is 1-p, and the probability of China adopting trade freedom is 1-q.

Then the expected benefit of the United States choosing trade freedom is

\[ E_{(US \, trade \, freedom)} = q \times (X₂-C) + (1-q) \times X₁ \]  

(1)

The expected return of the United States to choose trade protection is

\[ E_{(US \, trade \, protection)} = q \times (X₁+B-E) + (1-q) \times (X₁ + B) \]  

(2)

According to utility theory, the expected utility function of the United States is

\[ U_{(US)} = p \times E_{(US \, trade \, protection)} + (1-p) \times E_{(US \, trade \, freedom)} = X₂+Bp-Epq+Cpq-qc \]  

(3)

The first-order condition of American strategic choice optimization is

\[ \frac{\partial U_{(US)}}{\partial q} = Cq - Eq + B = 0 \Rightarrow q \]  

(4)

The optimal solution is q*=B/(EC), and its economic meaning is that under the condition that China adopts the strategy set (q*, 1-q*), the United States seeks to make the country's utility p* the most. If China’s probability of adopting a trade protection policy for the United States is q>B/(EC), the optimal strategy adopted by the United States is freedom of trade; if China’s probability of adopting a trade protection policy against the United States is q<B/(EC), the optimal strategy adopted by the United States is trade protection;

Similarly, when the probability of the US adopting the trade freedom strategy is p, the expected return of China's choice of trade freedom is

\[ E_{(China \, trade \, freedom)} = (1-p) \times X₂ + p \times (X₂-A) \]  

(5)

The expected return of China's choice of trade protection is

\[ E_{(China \, Trade \, Protection)} = (1-p) \times (X₂ + D) + p \times (X₂ + D-F) \]  

(6)

According to utility theory, China’s expected utility function is
\[ U_{\text{CHN}} = q \times E_{\text{China Trade Protection}} + (1-q) \times E_{\text{China Trade Freedom}} = Dq - Fp + X_2 - Ap + Apq \]  

(7)

The first-order condition for the optimization of China's strategic choice is

\[ \frac{\partial U_{\text{CHN}}}{\partial q} = Ap - Fp + D = 0 \Rightarrow p \]  

(8)

The optimal solution \( p^* = D/(F-A) \) has the economic meaning. In the United States, under the condition that the strategy set is \((p^*, 1-p^*)\), China seeks to maximize the effectiveness of its own \( q^* \), if the probability of the US adopting a trade protection policy against China is \( p^* = D/(F-A) \), the optimal strategy adopted by China is freedom of trade; If the probability of the US adopting a trade protection policy against China is \( p < D/(F-A) \), the optimal strategy adopted by China is trade protection.

From this, the Nash equilibrium solution of the hybrid strategy can be obtained as \((p^*, q^*) = (D/(F-A), B/(E-C)) \). That is, the United States chooses the trade protection policy with the probability of \( D/(F-A) \), and China chooses the trade protection policy with the probability of \( B/(E-C) \). By analysing this Nash equilibrium solution, it can be found that when the United States predicts that the greater the benefits \( B \) that a protection strategy may bring to the country, or the more of reducing the benefits \( C \) of adopting a free strategy to the country. And the damage \( E \) caused by the retaliatory acts of the other party expected to take protective measures in the country, the smaller the \( E \). There will be stronger incentives for trade protection.

3.2 Game result analyze

First look at the portion of income \( B \). For example, the United States believes that increasing tariffs on China's high-tech industries and steel industry may significantly increase domestic revenues. The logic is as follows: In 2016, the United States imported US$462.81 billion from China and exported US$115.78 billion to China. The Sino-US trade deficit accounted for 47% of its US foreign trade deficit. In November 2017, the US trade deficit with China climbed to 50.5 billion US dollars, and the deficit expanded by 3.2%, a record high since September 2015. The major industries that constitute a trade deficit are auto parts, construction equipment, smart grids, and high-tech industries. According to statistics, China is the third largest export market for auto parts in the United States, the second largest export market for construction equipment, and the seventh largest export market for smart grid products. These industries use steel as an intermediate product, and the demand for steel is huge. According to a report released by the American Iron and Steel Institute in 2017, the US steel industry currently employs approximately 140,000 people directly, and the industry directly or indirectly supports nearly 1 million US jobs. If China's steel products are subject to a 25% tariff, China's steel exports are limited. While resolving the trade deficit, it will promote another revitalization of the US steel industry, which will greatly increase the income of the US manufacturing industry, and the \( B \) value will increase. According to the data reality of China's steel industry, this trade protection policy to increase tariffs has indeed brought great impact to China's steel industry. From January to February 2018, China exported 9.497 million tons of steel, down 27.1% year-on-year.

Then analysis the part of \( C \). For example, on January 18, 2018, the United States launched a "double-reverse investigation" on China's plastic decorative ribbons. It believes that if the product adopts a free trade strategy, it will reduce domestic income. The logic is as follows, according to statistics. In 2017, the amount of plastic decorative ribbon products imported from the United States reached US$ 18.1 million. Plastic decorative ribbon products are characterized by low cost, high price, high profit, and large scale returns. If the United States adopts a free trade strategy for the industry, China's such products exported will occupy the US market, and this part of the US revenue will be greatly reduced, and the value of \( C \) will increase.

Finally, analysis the part of \( E \). For example, the United States has added trade barriers to China’s high-tech industry. The economic thinking logic of this behavior is as follows. The US high-tech industry has comparative advantages, but to prevent China from mastering core technologies, export to China. Less than the rest of the world. At present, China’s urgent need for market-for-technology has made the United States realize that even if China chooses a trade protection policy, it is impossible to set up barriers in the high-tech industry for the United States. Most of the sources of US profits are
high-tech industries. Other industries outside China have less damage to their barriers, that is, the E value is small.

From the above analysis, it can be seen that the increase of B, the decrease of E and the increase of C increase the value of $q^*$, making $q < B/(EC)$, when the probability of using trade protection policy in the United States is $q < B/(EC)$. The optimal strategy adopted by the United States is trade protection, which explains from an economic perspective why the United States adopts a trade protection strategy.

3.3 Political Game Analysis

The game between China and the United States is not a game between two enterprises. Apart from economic reasons, as a political system, there are political games that are worth pondering. The author believes that the reasons for the US to adopt the trade protection policy can be summarized as the following three aspects:

First, the "fear of super" mentality of the second country. The United States has always been the leader of world economic politics. Although the US economy has been in a downturn since the 2008 financial crisis, it has always maintained its leading position. Since China's reform and opening up, its economic and military strength has gradually risen to the second place in the world. The rapid growth rate has shocked the world and still maintains a relatively high growth rate compared with the United States. The growth rate of the first place is falling, and the second place is bravely moving forward. This is similar to the US trade sanctions against Japan in the 1980s. During this period, the United States signed a US$300 million export to the United States. The memory imposes a 100% tariff on unilaterally sanctioned luxury cars, and prohibits all Toshiba Group products from entering the US market within 5 years. At the same time, it retaliates against Japanese timber, environment, paper, computers, telecommunications, and insurance. In this way, in the 21st century, in order to avoid the second country's strength to catch up with the United States, it is not surprising that the United States took the lead in adopting a strategy against China.

Second, the persistence of the "American First" belief. From the list of US tariff increases to China, it can be seen that China's high-performance medical devices, biomedicine, new materials, agricultural machinery, aviation, new energy vehicles and other industries have been restricted, and these industries happen to be "Made in China 2025" In the high-tech industry, which is planned to be developed mainly, it is not only possible to think about the reasons why the United States adopts trade protection policies against China from the Sino-US trade deficit. The trade deficit is only a trigger because the United States has been in the United States since the mid-1970s. A continuous trade deficit began to emerge. In the 1980s, the US trade deficit accounted for 3.1% of GDP. This record was broken until 2006, when the US trade deficit accounted for nearly 5.5% of GDP. In other words, before the rapid rise of China, the United States had an external imbalance and its scale was expanding. This situation lasted for more than 40 years. It is unreasonable to attribute the reasons to the Sino-US trade deficit. Therefore, this action by the United States to narrow the trade gap between the United States and China is only one of the goals. The more important goal is to protect the Chinese revival and to protect the status of the "American First".

Third, the intention is to hold the Chinese technology throat. From the smile curve theory, the middle of the smile curve is manufacturing; the left is R&D, which is a global competition; the right is marketing, mainly local competition. With the face of global competition, it do not consider local competitive marketing links. The current division of products is mainly responsible for manufacturing in China. The United States is mainly responsible for technology research and development, and the most lucrative areas of products are concentrated at both ends of the value chain. that is, the R&D area occupied by the United States. In China with overcapacity, what urgently need to do now is to transform and upgrade the industry. From China's manufacturing upgrade to China's creation, the two sides of the value chain will climb, that is, strengthen research and development to create intellectual property rights on the left. Inevitably, this will greatly touch the interests of the United States. The most important aspect is that if China revives and catches up with the United States in high and new technology, although the manufacturing area in the middle can be replaced by other developing
countries, the high-tech area will be The original one became an oligarchy, and with the support of the only polity and a strong economy, it is only a matter of time for China’s national strength to catch up with the United States. This is the result that the United States does not want to see. From the United States’ attitude toward China, It is clear that the United States has always been paying close attention to China's high-tech industry and will not give up any opportunity to suppress it. Although China has always stimulated the introduction of high technology by means of market-for-technology, the United States remains unwavering. This is why, after China proposed "Made in China 2025", the United States adopted a series of "301" and "232" anti-dumping investigations, and a 7-year technical blockade of ZTE, a representative enterprise of Chinese technology.

4. China's response strategy
At the moment when the Sino-US trade war is on fire, China should accelerate the pace of independent research and development to improve product quality, continue to complete the tough tasks in the cutting-edge field, and enhance the added value of products to promote the transformation and upgrading of processing trade and gradually progress to the upstream of the industrial chain.

5. Conclusion
There is no pure strategy Nash equilibrium in the game of Sino-US trade policy, but a mixed strategy Nash equilibrium exist in it.

The "fear of super" mentality of the second country, the persistence of the "American First" belief and the United States Intent to hold the Chinese technical throat. These factors are political reasons for the adoption of trade protection strategies in the United States.

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