Game theory for analysing China-Taiwan relations

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Abstract: The issue of Mainland China-Taiwan Island relations has lasted for almost 70 years, involving the game between China and the United States. China stands firm on this issue and regards peaceful reunification as its primary policy but rejects to give up solution through the use of force. Game theory can be used to provide an idea for this problem.

1. Introduction

Whether it is ancient or modern, the territorial issue has been valued by sovereign states, and even the state resolved conflicts for territorial ownership at all costs, from negotiation to war. There are many examples to prove the conflict between political entities caused by territory, including India and Pakistan, the violent of the Kuril Islands between Russia and Japan, China-India border conflict, and issues in Mainland China and Chinese Taiwan. All of above issues are border demarcation and island attribution of two neighbouring countries or regions. Territory has been deeply maintained by the state, because territory is not only the symbol of the national sovereign but also can provide sufficient resources for the development of a country, although a large area of land may bring management problems and maintenance costs to countries to some extent (Kydd 2015). The dispute over the issue of Taiwan Island has not been resolved and has lasted about 70 years, which involves two aspects of the game between China and the United States, and between Mainland China and Chinese Taiwan. The game-theoretic method as a branch of rational selection can be used to analyze and solve the conflict of Taiwan at the theoretical level, though in reality the two parties of the game may not take the results of game theory analysis. The essay will use the game theory to analyze to what extent China will be peaceful reunification or to analyze that if Mainland China cannot peacefully reunite with Taiwan Island, where is it most likely to launch war in Taiwan area, including three parts in the main body: there is a simple historical background of Taiwan provided in the first section; the second section will be concerned with a normal form game that used to analyze the real-world case; in the final section, this part will give merits and limitations of the game-theoretical frame that critically analyze to what extent this approach could help students.

2. The historical background of Chinese Taiwan and the conflict between Mainland China and Chinese Taiwan

The clear historical records of Taiwan can be traced back to the feudal rule of China and more than two hundred years ago. The history of Taiwan can be roughly divided into three stages: 1624-1945, 1949-1988 and 1988-now (Jacobs 2011).

Firstly, from 1624 to 1945, during this period, Taiwan was ruled by colonists and China feudal regimes. Although before the invasion of the Dutch colonists, the Chinese ruler did not pay more attention to Taiwan for geographical reasons, it had been under the jurisdiction of the Chinese feudal regime. In 1624, with the discovery of geography and the beginning of globalization, Dutch colonists began to colonize Taiwan, under which many Han Chinese people (around one thousand and five hundred) poured into this region (Dick et.al 1984; Shepherd 1993); then the Ming Dynasty sent Zheng Chenggong, an army general of the Ming Dynasty, to recapture Taiwan, which made more population flow into Taiwan (Rubinstein 2007); after that, Taiwan was again under Japanese colonial rule in 1895, and although the modernization level improved during this period, the Han

people existed as second-class people and suffered oppression politically (Chow 2008).

Secondly, with the victory of the Second World and Chinese new-democratic revolution, Japan withdrew from China in 1945 and the Nationalist Party of China led by Chiang Kai-shek was defeated from the mainland of China and retreated to Taiwan land in 1949, after which the land was governed by Chiang Kai-shek and his son nearly 40 years. Even if mainland China and Taiwan were in a situation of confrontation accompanied by small-scale military conflicts during this historical stage, both sides adhere to the policy that there is only one China in the world and China is integrated only when it includes Taiwan and its affiliated islands (China yearbook 1959; Chinese White Paper 1993). From these historical events, it was shown that Taiwan is part of the mainland of China and shown the "One-China Principle" (2000), but some leaders of the Taiwan region tried to subvert these policies and principles.

Finally, in 1988, president Chiang Ching-Kuo died in Taipei, and his successors Li Denghui and Chen shui-bian, who support Taiwan to become a country began to enter the political arena of Taiwan. The democratization process of Taiwan was accelerated significantly during these decades, allowing citizens to elected their president by voting; however, the identity of Han and Taiwan established by Chiang family started to disintegrate (Dawley 2009), and these elected presidents attempted to change the One-China principle recognized in the word and tried to transform Taiwan's identity from a region to a country, especially in the regime of Tsai Ing-wen, an elected leader in Taiwan area, who publicly rebuked mainland China (Kuo 2020). Therefore, the history of Taiwan could be considered as a history of resistance in a colony, and Taiwan is part of China, which is the bottom line of China government; the subversion of the perception may lead to war.

3. The use of game-theoretical approach in conflict

Game theory based on mathematics and rational choice theory is used by political scientists as a helpful tool for analysing the real world in political science and international relations theory (Moore & Siegel 2013; McCarty & Meirowitz 2014; Osborn 2009). Although this method may have some limitations because it as a strategic interaction depend heavily on the rational calculation of players which means that players need to know what the other's player's preferences are (Browne et.al 2000b), the theory provides a theoretical method for studying the behaviour of states. The game theory includes private information and certain information that will be used in this easy. The private information means that the two sides of the game are not sur about each other's strategy, and the certain information means that both sides know each other's strategic choices. Law (2018) concluded that there are five simple models in the normal form: the prisoner's dilemma, the assurance game, coordination, chicken and matching pennies.

3.1 The prisoner's dilemma

3.1.1 The initial model of the prisoner's dilemma

		Prisoner 2	
		D	F
Prisoner 1	D	5,5	1,6
	F	6,1	2,2

Figure 1

In this model, Prisoner 1 and Prisoner 2 were put in different detention rooms, and the police interrogated the two men separately. Both of them can make a choice between Deny (D for Deny) and Frank (F for Frank). Numbers in the Figure 1 represent the gains they made after making the choice. If they choose to deny the facts of the crime in this interrogation, each of them will obtain 5 benefits; on the contrary, if they all frank the facts, they will get 2 payoffs. If prisoner 1 chooses D strategy and prisoner 2 select F strategy, their payoffs are (1,6); in other words, prisoner 1 gets 6 points payoffs and prisoner 2 receives only 1. In theory, if both of them choose D strategy, the result will make them better off, however, in reality, because they do not know whether the other

player will choose cooperation, players will choose the strategy that is most beneficial to them., so mutual confession is the final result and a Nash equilibrium.

3.1.2 The application of real-world case

This game form will be employed in the conflict between Mainland China and Taiwan Island supported by the United States (US). The main reason why Taiwan independence forces are becoming more rampant and dare to provoke Mainland China is that US support for Taiwan continues to increase, such as selling high-end military weapons to Taiwan (Jain 2007). However, in order to realize the rejuvenation of the Chinese nation, Mainland China regards the return of Taiwan as a top priority in its strategic tasks and uses the "one country, two systems" policy that is a little bit different from Hongkong and Macao to ensure peaceful reunification. According to the Thucydides trap, the rise of one country will inevitably lead to hostility from another powerful country (Allison 2014), so in order to ensure that its own interests are not violated, US will intervene in China domestic affairs and hinder the process of China's reunification.

Set of strategy:

This game-theoretical frame is showed as a normal form where one party has two strategic choices. These four strategies are listed below:

Mainland China

Peaceful Strategy = use "one country, two systems" policy, and even allow Taiwan to retain its own army

War Strategy = economic sanctions against Taiwan, eventually launch war to solve the Taiwan issue

Taiwan Island

Cooperation Strategy = keep status quo, or accept the conditions of the mainland

Tough Strategy = publicly recognize Taiwan as an independent country

		Taiwan Island	
		CS	TS
Mainland	PS	b-c, b-c	-c, b
China	WS	b, -c	0,0

Figure 2. The payoff matrix of the conflict

*CS: Cooperation Strategy
PS: Peaceful Strategy
TS: Tough Strategy
WS: War Strategy
b: benefit
c: cost for war
The preference order: b > b-c > 0 > -c

Firstly, assuming that Mainland China's military power is slightly stronger than Taiwan Island is reasonable, because if there is a war happening, US will provide military support to Taiwan and even send aircraft carriers to the Taiwan Strait. Strategic analysis and choices are put follow: 1. Both Mainland China and Taiwan Island choose to cooperate with each other to solve the Taiwan Issus peacefully, the payoffs for both parties are b-c; 2. nevertheless, this strategy is neither in the interest of US nor in the interest of Taiwan, because when Mainland China adopts PS, it will adopt a friendly attitude towards Taiwan Island, so Taiwan Island will utilize the gentle attitude of the Mainland China to maximize its own interests while gaining the support of US, and Taiwan Island will definitely adopt TS; 3. If Mainland China takes the lead in choosing WS, Mainland China will maximize its benefits and realize national unification; however, in this situation Mainland China may not be the first to wage war, according to China's consistent performance, unless Mainland China is more powerful than US, so it may adopt economic sanctions to give Taiwan pressure; 4. Based on the original form discussed above, both parties (Mainland China and Taiwan Island) involved in the prisoner's dilemma do not expect their own profits to be damaged and do expect to

get their maximum payoffs, so the players' payoffs are (0,0). Therefore, the defects of the game can be solved by repeating the game and negotiating to achieve the purpose of cooperation and Pareto-optimal result, including Contrite Tit for Tat; Nevertheless, in a real-world case, Mainland China has always adopted a soft policy towards Taiwan Island and endured Taiwan Island that challenges the bottom line of Mainland China, so the assumptions in theory may not become a reality.

3.2 The Matching Pennies

This type of game can be applied for war environment and territorial defence where the initiator of the war expects to attack the place that the guardian does not protect, and guardians are willing to match initiators (Kydd 2015). There is no doubt that Matching Pennies is a zero-sum game in which the victory of one side leads to the failure of the other side and has a unique Nash equilibrium in which as a mixed strategy, the sum of probability of two parties who possess pure strategies is one (Belot, Crawford & Heyes 2013). In addition, because of independence and randomness, participants do not know the strategic distribution of other participants, so the first make the most favourable choice for themselves and then they can update their beliefs (McCabe, Mukherji & Runkle 2000). Next, consider the situation of a real war:

3.2.1 Summing a real war between China and Taiwan

In order to solve the relationship between Mainland China and Taiwan region, this essay will assume that Mainland China will use military force to achieve reunification when it cannot bear Taiwan's challenge to the bottom line and assume that China will not use strategic missiles to attack Taiwan Island. There are 3 places to attack: Taipei, Taichung and Tainan City. For winning the war, Mainland China has to choose one of the following three cities as the main location. If the place where Mainland China wishes to attack is matched and guarded by Taiwan Island, Mainland China will fail to occupy Taiwan Island and the latter may establish the country; otherwise, Mainland China will achieve the goal.

Tainan City is located farthest from the Chinese naval base, so the loss of attacking that city is the highest (l_h). There is no additional loss invading the Taichung City, because the distance between them is almost negligible. Taipei is a political centre and has a certain number of garrison troops, which will bring the loss l_m to attack. In this game, the loss ordering is $l_h > l_m > 0$. The payoff matrix is present in Figure 3.

		Taiwan Island		
		Guard TaiChung	Guard TaiPei	Guard TaiNan
Mainland	Invade TaiChung	0,1	1,0	1,0
China	Invade TaiPei	$1 - l_m$,0	$-l_m$, 1	$1 - l_m$,0
	Invade TaiNan	$1 - l_h$, 0	$1 - l_h$, 0	$-l_h$, 1

Figure 3 The payoff matrix

The possibility of Chinese invasion is expressed as p_c, p_t is the probability of defence for Taiwan. China's attack does not need to consider Taiwan's defence:

Guard Taichung Guard Taipei
p_c (TC) 1 + p_c (TP) (0) + p_c (TN) (0) = p_c (TC) (0) + p_c (TP) 1 + p_c (TN) (0)
Guard Tainan
= p_c (TC) (0) + p_c (TP) (0) + p_c (TN) 1
So, equation is p_c (TC) + p_c (TB) + p_c (TN) = 1/3

Which can illustrate that the probability of China invading any place is the same.
The probability of Taiwan guarding three cities is presented:

Invade Taichung Invade Taipei
p_t (TC) (0) + p_t (TP) 1 + p_t (TN) 1 = p_t (TC) 1 + p_t (TP) (0) + p_t (TN) $1 - l_m$
Invade Tainan

$= p_t (TC) 1 + p_t (TP) 1 + p_t (TN) (0) - l_h,$

which is simplified to the following:

$p_t (TP) + p_t (TN) = p_t (TC) + p_t (TN) - l_m = p_t (TC) + p_t (TP) - l_h$

According to the principle of mix strategy, $p_t (TC) + p_t (TP) + p_t (TN) = 1$, so $p_t (TN) = 1 - p_t (TC) - p_t (TP)$, which can be established:

$p_t (TP) + 1 - p_t (TC) - p_t (TP) = p_t (TC) + 1 - p_t (TC) - p_t (TP) - l_m$
$$= p_t (TC) + p_t (TP) - l_h$$

This equation can be simplifying to

$1 - p_t (TC) = 1 - p_t (TP) - l_m = p_t (TC) + p_t (TP) - l_h$

Based on the first equation, $p_t (TP) = p_t (TC) - l_m$. Combing these equations, the result is $1 - p_t (TC) = p_t (TC) + p_t (TC) - l_m - l_h$.

So, $p_t (TC) = (1 + l_m + l_h) / 3$, from which the equation can be get:

$p_t (TP) = (1 + l_m + l_h) / 3 - l_m$ and $p_t (TN) = (1 + l_m + l_h) / 3 - l_h$

Under which the preference of Taiwan defending cities is $p_t (TC) > p_t (TP) > p_t (TN)$. Therefore, Taiwan Island may concentrate the majority of army in Taichung City, which means that Mainland China should attack Taipei and Tainan City, but because of the importance of Taipei City, Mainland China should give priority to that city. Without considering other external factors, China's attack on Taiwan Island is rather similar to the invasion of Normandy in 1944 (Kydd 2015).

4. Benefits and limitation of game-theoretical approach

Game theory is a useful tool based on mathematics and rationality to help understand empirical cases and to predict what might happen by analyzing players' behaviour. However, it is like the pros and cons of a coin, possessing advantages and disadvantages.

Advantage: firstly, the application of game theory is rather wide, not only limited to political science. For example, Rubinstein (2012) argued that it originated in economics and then entered the core field of economics, and later has made great progress in the analysis of international relations and climate change. Moreover, as a strategic interaction, learning game theory can make people think in a logical and strategic way (Rubinstein 2012).

Disadvantage: firstly, game theory as a subset of rational choice as has the latter's shortcomings. For example, not all people are rational in reality, they may take irrational actions (Grafstein 1987); simultaneously, it is impossible for players to know all the opponent's preferences and preference ranking. Secondly, the game-theoretic model is used to simplify the real-world complex situation, ignoring the complexity of the external environment, and there might not be enough data to support empirical research (Morton 1999). Finally, Munck (2001) thought that the theoretical basis of game theory has some flaws, and although it made a contribution to the theory of behaviour, it lacks adaptability in important areas.

Therefore, students whose major is political science or economics should learn the logic and strategy of game theory, learn to apply this knowledge to their future professional life and notice these limitations.

5. Conclusion

In conclusion, although the framework of game theory has some limitations, it can still be used as an effective tool to supplement political science. As mentioned above, territorial disputes can trigger conflicts between different powers, which is well proven in the relationship between Mainland China and Taiwan Island, leading to a 70-year split in cross-strait relations. This essay mainly focuses on the application of game theory in a real-world case, the conflict between Mainland China and Taiwan Island. For the introduction of Taiwan's historical background in the main body, the contradiction between them is clear: One-China principle. The use of the prisoner's dilemma presents that the two players will maintain the status quo in the future, and there will be some diplomatic frictions but no war, unless Mainland China is powerful enough to keep balance with US; the Matching Pennies illustrates that if Mainland China cannot bear to launch a war

against Taiwan Island, it is more likely to attack which of the three sites (Taipei, Taichung and Tainan Cities) to occupy Taiwan Island. The normal form is a simple model to analyze the real-world, so if students wish to predict the behaviour of both parties more accurately, they need to consider more information and context or use complex model.

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