



Game Theory Perspective of Sino-US Relations: Complex Intertwining of Cooperation and Competition

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KEYWORDS	ABSTRACT
<p>Competition; cooperate Sino-US relations; Game theory;</p>	<p>As one of the most important bilateral relations in the world, Sino-US relations present a complicated situation of co-existence of cooperation and competition. Using the analytical framework of game theory, this paper deeply discusses the interaction between China and the United States in economic, political, military, scientific and technological fields. Through the classic model of game theory, this paper analyzes the motives and results of strategic choice between the two countries in different situations. It is found that although there are many interests differences and competitions between China and the United States, under the impetus of global public affairs, economic interdependence and other factors, cooperation is still the best solution in line with the long-term interests of both sides. Finally, the paper puts forward some policy suggestions based on game theory for the construction of healthy and stable bilateral relations between China and the United States.</p>
ARTICLE HISTORY	
Received: 09/15/2025	
Revised: 09/18/2025	
Accepted: 09/23/2025	

1. The concept of game theory and its analytical framework

In today's era of globalization, game theory provides a unique and profound perspective to analyze international relations, especially the interaction mode between big countries. As the two largest economies in the world, the relationship between China and the United States undoubtedly has a far-reaching impact on the global political, economic and security pattern. In recent years, with the rapid improvement of China's comprehensive national strength and the increasing international influence, the interaction between China and the United States in the fields of economy, politics, military affairs, science and technology has become more frequent and complicated.



There are competitive factors such as trade frictions and geopolitical games, and there is also room for cooperation in dealing with global challenges such as climate change and global public health crisis. Sino-US relations have entered a new and more complicated stage, and the core feature of this relationship can be described by the mode of "cooperation and competition coexist" in game theory. This not only reflects the intertwined interests of the two countries in key areas, but also reveals the complexity and multidimensional nature of cooperation and competition among major powers under the current international system.

The core research content of game theory is that in an interactive situation involving at least two participants, each participant formulates and implements corresponding strategies according to his own expectations of other participants' behaviors and the goal of maximizing his own interests, and finally forms an interactive equilibrium state based on conflict and cooperation. In the game process, it includes key elements such as participants, strategy sets and revenue functions. Participants are the actors who participate in the game. In the game scene of Sino-US relations, China and the United States are the main participants. Strategy set refers to the set of all action plans that each participant can choose in the game. For example, in the field of trade, the strategies that China and the United States can choose include lowering tariffs, raising tariffs, setting trade barriers, and negotiating free trade agreements. The income function defines the income of each participant under different strategy combinations, which is an important basis for participants to choose strategies. Game theory can be divided into many types according to different classification standards, such as one-time game and repeated game according to the number of games; According to the participants' mastery of information, it can be divided into complete information game and incomplete information game; According to whether the participants can reach a binding agreement, it can be divided into cooperative games and non-cooperative games. Different types of games have their own unique characteristics and analysis methods, which are suitable for explaining the interactive behavior of Sino-US relations in different situations.

Game theory, as a theory to study rational decision-making behavior, provides an important analytical tool to explain and predict the interaction between China and the United States in different fields and situations. This analysis is of great significance in understanding how the two countries maintain and develop bilateral relations while pursuing their respective national interests. The interaction between China and the United States presents classic models in game theory, such as prisoner's dilemma and non-zero-sum game. These models reveal the delicate balance between cooperation and competition, and how to influence the decisions and actions of both sides through strategic interaction. The prisoner's dilemma is particularly evident in Sino-US relations. In key areas such as trade, network security and technological innovation, both sides may face a choice: to pursue the greatest interests unilaterally at the expense of cooperation, or to seek a win-win cooperation plan. In this situation, the decision-making of both sides is strongly influenced by the behavior of the other side, and often leads to suspicion and confrontation because of uncertainty about the intention of the other side.

However, Sino-US relations are not a pure zero-sum game. In many aspects, such as climate change, global health, anti-terrorism and other issues, both sides have the motivation and demand for cooperation. These are typical non-zero-sum game scenarios, in which cooperation between the two sides can bring common interests, while confrontation may lead to a lose-lose result. Therefore, to analyze Sino-US relations from the perspective of game theory, we need to consider this dynamic and multi-level interaction mode. Whether China and the United States can effectively manage their differences and establish a more stable cooperation mechanism depends not only on their respective domestic policies and international strategies, but also on their strategic choices and mutual adaptability in the game process. This complex game relationship is not only related to the future of China and the United States, but also will profoundly affect global stability and prosperity.

When analyzing this relationship, we should not only pay attention to the current competitive situation, but also deeply discuss how China and the United States can shape each other's policies and strategies through games in the context of increasingly close global ties. This requires us to comprehensively consider the historical, political, economic and cultural aspects, in order to understand and predict the complex and dynamic relationship between these two great powers more comprehensively. Next, we will analyze the relationship between the two countries from the perspective of game theory from the perspectives of economy, military and science and technology (He, 2021).

2.Characteristics of Sino-US Relations as Game Scenes

2.1 The strength and influence of the participants

Both China and the United States occupy a pivotal position in the global political and economic arena. From the economic perspective, the two countries are the top two economies in the world. In 2024, China's total GDP reached US\$ 20.5 trillion, accounting for about 20% of the global GDP, while the United States' total GDP was US\$ 27.4 trillion, accounting for about 27% of the global GDP. The bilateral trade volume was as high as US\$ 700 billion, and the stock of mutual investment exceeded US\$ 240 billion. The interdependence between China and the United States was extremely high, and any adjustment of economic policies would have a significant impact on the global economy. In the political field, the United States is a permanent member of the UN Security Council, which has long dominated the international political order, and has an extensive ally system and a strong voice in international affairs. In recent years, China's influence in the international political arena is also increasing day by day, actively promoting the development of multilateralism, advocating the building of a community of human destiny, and playing an increasingly important role in international peacekeeping, humanitarian relief and other affairs. Militarily, China and the United States are both military powers, with advanced weapons and huge military strength, and military confrontation and cooperation coexist. This powerful strength and extensive influence make China and

the United States become decisive key participants in the game of bilateral relations, and every strategic decision of both sides may trigger a chain reaction on a global scale.

2.2 Diversity and complexity of interest demands

The interests of China and the United States are highly diverse and complex. In the economic field, the United States expects to protect its domestic traditional industries, such as manufacturing and agriculture, through trade policies, while maintaining its global leading position in high-tech industries, such as semiconductors, artificial intelligence and biomedicine, and ensuring high profits brought by technology monopoly; China is committed to promoting industrial upgrading, expanding the export market, enhancing its position in the global industrial chain and value chain, realizing high-quality and sustainable economic development, and at the same time, ensuring domestic people's livelihood needs and improving people's living standards. On the political level, the United States tries to maintain its global hegemonic position, promote its democratic values and political system, has prejudice and misunderstanding about China's political system, and tries to curb China's development by means of political interference and public opinion smearing. China firmly safeguards national sovereignty, security and development interests, advocates the democratization of international relations, and promotes the construction of a fairer and more rational new international political order. In terms of culture, the United States relies on its powerful cultural industries, such as Hollywood movies, pop music, social media, etc., to export culture around the world and try to shape the global cultural discourse right; China strives to inherit and carry forward China's excellent traditional culture, push Chinese culture to the world, and enhance the country's cultural soft power. In addition, in the field of global public affairs, such as climate change, public health and security, anti-terrorism, etc., China and the United States have both cooperative needs to jointly meet global challenges and competitive relations in cooperation dominance and resource allocation. This diverse and complex interest demand makes the game of Sino-US relations full of variables and uncertainties. (Zhang, 2019)

2.3 Information asymmetry and strategic uncertainty

In the game of Sino-US relations, information asymmetry and strategic uncertainty are two notable features. Information asymmetry is reflected in many aspects. For example, in the military field, information such as military strategy, research and development progress of weapons and equipment, and military deployment between China and the United States are often highly confidential, and it is difficult for both sides to fully grasp each other's true military intentions and capabilities. In the field of science and technology, the United States keeps its high-end technology research and development plan, technology patent layout and other information strictly confidential, while China also keeps certain information closed on the research and development of

some key core technologies to protect its own technological innovation achievements and industrial safety. In terms of political decision-making, the domestic political forces in the United States are complicated, and different political factions and interest groups have different attitudes and policy propositions towards China. It is difficult for China to accurately predict the direction of the US government's China policy. China's political decision-making process and policy adjustment are based on its own national conditions and development needs, and the United States often has misunderstandings due to lack of in-depth understanding. This kind of information asymmetry leads both sides to make strategic decisions based on limited information and subjective judgment, which increases the risk of strategic misjudgment. Strategic uncertainty stems from the changes in interests of China and the United States in different fields and the dynamic evolution of the international situation. With the rapid development of China's economy and the improvement of its comprehensive national strength, its role and influence in international affairs are constantly expanding. The United States has doubts about China's future development direction and strategic intention, and is worried that China will challenge its global hegemony. It is also difficult for China to accurately grasp the strategic bottom line of the United States in containing China's development and when and how to adjust its China policy. Changes in the international situation, such as the adjustment of the global economic structure, the outbreak of regional conflicts, and the breakthrough of emerging technologies, will also have an impact on the strategic decisions of China and the United States, further aggravating strategic uncertainty and making the game of Sino-US relations more complicated and changeable. (Zhang, 2022)

3. Game analysis between China and the United States in different fields

3.1 Economic field:

In the economic field, the game between China and the United States presents a complex interactive model. According to game theory, this relationship can be regarded as "repeated game". In this model, China and the United States constantly adjust their strategies in multiple rounds of games, taking into account both immediate interests and long-term relations. Focus on trade, investment, technological innovation and market access.

Trade is the core of the economic game between China and the United States. In pursuit of trade balance, the United States has repeatedly imposed high tariffs on China's goods, trying to reduce the trade deficit and protect its own industries in this way. China, on the other hand, adjusted its export structure and increased its imports of agricultural products and other commodities to the United States to reduce the trade imbalance. This trade game embodies the characteristics of "prisoner's dilemma", and it is difficult for both sides to reach the optimal state at the same time in a short period of time, so they need to seek long-term cooperation and compromise; In terms of investment, the United States has restricted its investment in China in some key areas, and for national security reasons, it has restricted China enterprises from investing in

the United States for mergers and acquisitions, especially in high-tech fields. China, on the other hand, used market access as a bargaining chip, demanding foreign-funded enterprises to share technology, which caused resentment in the United States. The investment game embodies the "threat game in game theory", in which both sides try to influence each other's decision-making by demonstrating their own abilities and wishes; Technological innovation is the new focus of the game. The United States tries to maintain its technological superiority by restricting the sales of products from China technology companies such as Huawei in the US market. China, on the other hand, has increased its investment in R&D and strived to catch up in the fields of artificial intelligence and 5G. In this process, both sides realize the importance of technological advantages for economic development and constantly adjust their strategies to gain competitive advantages; Market access is also a key point. The United States complains about the restrictions on foreign-funded enterprises in the China market, while China accuses the United States of unfair trade practices. Both countries use market access as bargaining chips to try to seek greater economic benefits.

The game between China and the United States in the economic field is long-term and complicated, involving multiple levels of interaction. The highly complementary economies of the two countries make it impossible for both sides to completely decouple, which requires both sides to find a balance between cooperation and competition.

3.2 Military field

The game in the military field is an important aspect in Sino-US relations. According to game theory, this can be regarded as a "zero-sum game", in which the gains of one party often mean the losses of the other party. (Liu, 2015).

The United States has always been the leader of global military power, with the most powerful army and the most advanced military technology in the world. However, with the acceleration of China's military modernization, the United States began to feel pressure. China's military modernization includes improving the quality and quantity of its nuclear arsenal, developing its cyber warfare capability and strengthening its naval forces, all of which have challenged the military superiority of the United States to some extent. In the Asia-Pacific region, the military game between the two countries is particularly obvious. The United States maintains its influence by strengthening its military presence in the region, such as through military bases and joint military exercises. At the same time, China has strengthened its control over the South China Sea by strengthening its military deployment; The military game between China and the United States also includes the game of arms control. Although both countries have participated in multilateral arms control negotiations, they still have major differences on some key issues, such as missile defense system and space weapons. These games often involve complex strategic calculations and mutual trust issues; Information warfare and cyber warfare are also emerging game fields. In this field, both sides are striving to improve their capabilities

and try to influence each other's military and civilian facilities through cyberspace.

The game between China and the United States in the military field is complex and changeable, involving the traditional balance of power, as well as emerging technical and strategic fields. This game has a far-reaching impact on bilateral relations and even global security.

3.3 Science and technology

The field of science and technology is another key battlefield of the game between China and the United States. In this field, game theory can help us understand the interaction between the two sides in technological innovation and intellectual property rights.

The United States has long been a global leader in scientific and technological innovation, but in recent years, China has made remarkable progress in some scientific and technological fields, especially in artificial intelligence, 5G, quantum computing and renewable energy. This technological catch-up has challenged the leading position of the United States to some extent. In the game of science and technology, intellectual property has become a key issue. The United States accuses China of stealing its intellectual property rights and technology, while China thinks that the United States is too harsh on this issue, which restricts normal technical exchanges and cooperation. This dispute reflects the conflict of interests between the two sides in the field of science and technology; On the other hand, both Chinese and American governments are actively investing in scientific research and development to improve their innovation ability. This includes providing financial support at the national level, formulating favorable policies and establishing innovation platforms. This kind of competition is not only carried out at the national level, but also penetrated into the private sector, such as the global R&D investment and innovation activities of large technology companies; The game of science and technology under the background of globalization also involves the competition of technical standards. For example, in the aspect of 5G communication technology, China enterprises such as Huawei promote their technical standards on a global scale, while the United States tries to promote different technical standards to maintain its influence in the global communication network.

In the game in the field of science and technology, both sides are trying to gain an advantage by improving their technological capabilities. This includes not only developing new technologies, but also implementing influence strategies on a global scale, such as influencing the adoption of certain technologies by other countries through foreign and trade policies. At the same time, the two countries are also trying to attract and train top scientific and technological talents to support their vision of scientific and technological innovation (Gala, 2023).

Sino-US relations have always been one of the most complicated and striking relationships in the international political and economic fields. Under the background of globalization, China and the United States have both competition and cooperation in economy, security, science and technology. For example, in the economic field,

China and the United States are both major economies in the world, and the trade and investment relations between the two countries are complicated. From the perspective of game theory, this relationship can be regarded as a kind of "prisoner's dilemma", that is, if both sides adopt cooperative strategy, they will gain more benefits on the whole, but due to the lack of trust and the temptation of short-term interests, both sides tend to choose non-cooperative strategy, which leads to a lose-lose situation. The trade war initiated by the United States against China and China's countermeasures are all manifestations of this prisoner's dilemma; The security field is more complicated. The strategic competition between China and the United States in the Asia-Pacific region, such as the South China Sea and the Taiwan Province issue, constitutes another kind of game. In this game, both sides try to improve their bargaining power by showing their military strength and establishing alliances. However, due to the existence of nuclear weapons, this game is also a "dove game", that is, both sides understand that direct military conflict will lead to disastrous consequences, so despite the pressure on the edge, they all try to avoid the direct outbreak of conflict; In the fields of global governance, such as climate change and public health, China and the United States present more possibilities for cooperation. These fields are characterized by "non-zero-sum game", that is, the results of cooperation can benefit both sides, while confrontation will lead to mutual losses. In dealing with global challenges, Sino-US cooperation is not only beneficial to both sides, but also the expectation of the international community.

However, even if there is potential for cooperation in these areas, the interaction between the two sides is affected by mutual strategic doubts. This mutual suspicion stems from the realistic logic of international politics, that is, countries always consider their own security and interests first. The technological competition between China and the United States, especially in high-tech fields, such as 5G and artificial intelligence, is a reflection of this mutual suspicion. In this kind of competition, both sides try to ensure their dominant position in key technical fields to protect their own security and economic interests.

Generally speaking, Sino-US relations are a complicated relationship of "cooperation and competition coexist". In different fields and at different time points, this relationship presents different characteristics. From the perspective of game theory, this relationship has the characteristics of both prisoner's dilemma and non-zero-sum game. The future development of Sino-US relations will depend on whether the two countries can effectively manage differences, enhance mutual trust and find more space for cooperation, which is not only related to the interests of China and the United States, but also to the stability and prosperity of the entire international community.

Conflict of interests

The author has no conflicts of interest to report.

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