

The Conundrum of US-China Trade Relations Through Game Theory Modelling

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The United States and China are the two largest economies in the world. However, multi-dimensional disputes put the U.S. and China onto the brink of trade war. To solve this difficult conundrum, each side seeks to profoundly change the adversary's strategic calculus at little cost and with little risk. The Trump Administration has revived protectionism to U.S. trade policy placing great uncertainty on US-China trade relations. This paper uses game theory to model and illustrate the possible actions and outcomes in the trade conduct between the U.S. and China for the implementation of border tariffs and sector targeted protectionism.

INTRODUCTION

The United States and China are the two largest economies in the world, and each are other's largest trading partners (Morrison, 2017a, 2018). Their trade relationship is mutually beneficial to both sides, making their economies "closely interconnected" to the point where both recognize each country has "a strong stake in economic prosperity of the other" (Office of the Press Secretary, 2016). However, this relationship is far from perfect, with several major trade issues becoming flashpoints for a trade war as the Trump administration has adopted a pro-protectionist stance in trade (Morrison, 2018; Trump 2017a). The large merchandise trade deficit the United States has with China, recorded at of \$347 billion and \$375 billion in 2016 and 2017 respectively, is asserted by President Trump and his key advisors as evidence for unfair trade practices by China (Morrison, 2017, 2018; Navarro and Ross 2016; Trump 2017b). Additionally, no bilateral free-trade agreement exists between them, and persistent unresolved trade issues continue to accumulate.

Trade with China was a major campaign issue of President Trump during the 2016 United States presidential election. His "Make America Great Again" campaign rhetoric focused on protectionism, signaling a shift in the United States' trade policy to resolve trade issues, such as, promoting job creation, and reducing the trade deficit, (Trump 2017b; Navarro and Ross, 2016). On the other hand, President Xi Jinping opening's speech at the 2017 World Economic Forum in Davos, supported the status quo of liberal trade policies, emphasizing the importance of globalization and trade to the global economy, while also denouncing trade wars, which was most likely made in response to Trump's protectionist threats (Xi, 2017). Because these trade paradigms fundamentally oppose each other in application there is a real possibility of the United States provoking a trade war with China as numerous trade issues between them remain unresolved (Morrison, 2018).

It is commonly accepted amongst economists that protectionism's loss of comparative advantage makes it sub-optimal to free trade, barring certain exceptional circumstances (Gilpin, 2001; Johnson, 1953-1954; Ossa, 2014). However, protectionism has political considerations that may transcend typical econometric measurements of GDP or welfare (Evans cited in Axelrod and Keohane, 1985; Gilpin, 2001). Threats of compellence, which seek change in a relationship's status quo, and threats of deterrence, which seek to maintain the status quo, are the primary political considerations we examine through game theory to construct a metaphorical model (Snidal, 1985; Treverton, 2000). We will treat a trade war as the chicken game and examine its outcomes, altering payoffs in the trade war outcome to correspond with GDP growth and welfare losses using data supported by analysis in recent forecast reports of the U.S.-China trade war. Two trade war scenarios will be analyzed: a trade war where border tariffs are implemented, and one where sector-sector targeted protectionism is utilized. Through this model, we will illustrate why the United States is issuing protectionist threats, and how China may respond to them, providing normative policy conclusions to this conundrum. Although a trade war is undeniably a negative outcome for each party involved, one player may be strategically postured to induce changes in the status quo at the other's expense if the trade war's losses are asymmetric. We intend to apply game theory to explain the conundrum of the trade conflicts between the two largest economies in the world.

LITERATURE REVIEW

There is a considerable amount of literature on game theory. We first reviewed game theory's modelling applications to international trade and negotiation, then reviewed various current events, and trade policies of the United States and China to establish our argument. Game theory's original purpose was to explain economic behavior through "mathematical notions of suitable games of strategy" by John von Neumann and Oskar Morgenstern in 1944 in *Theory of Games and Economic Behavior*, (1953) describing solution concepts through induction. John F. Nash showed that economic situations such as "states engaging in international trade," are "bargaining problems" that can be solved with non-zero sum two-person games (Nash, 1950). Snidal, (1985) Jervis (1978), Howard (1971), Turocy and von Stengel (2001) explain applications of game theory, with Snidal providing arguments on its modelling capability, Jervis describing how game theory could be applied as a metaphor, Howard defining the chicken game in a manner that emphasizes inducement, and Turocy and von Stengel citing key terms and definitions to assist in our model. Axelrod (2000) and Keohane (1985) address the value of cooperation in game theory applied to international relations. The 2007 World Trade Organization report on trade emphasized game theory's applications in the framework of a repeated game, while explaining its various applications to international trade cooperation (Bachetta, et al 2007). These sources provided the framework of our model, and the assisted in the procedure of backwards induction.

Although research is very limited on the impacts of a U.S.-China trade war, mainly due to its ripeness, there are some reports that provide quantitative data in the analysis of a trade war, along with qualitative conclusions. The most important works to support our argument are reports on the Trump administration's protectionist policies by Lai and Xia (2016), Noland, Hufbauer, Robinson and Moran (2016), Ha (2017a, 2017b), Hufbauer and Lowry (2011), Rosyadi and Widodo (2017), Bouët and Laborde (2017), and Bollen and Rojas-Romagosa (2018). These sources provide the data which we utilized to show the payoff alterations in our game model. These reports examined different impacts of a trade war between the United States and China using various models and methods to ascertain the impact of protectionism and retaliatory protectionism. Lai and Xia (2016), Noland, Hufbauer, Robinson and Moran (2016), Ha (2017a, 2017,b), Rosyadi and Widodo (2017), Bollen and Rojas-Romagosa utilized GDP as the primary measure of impact, while Bouët and Laborde (2017) utilized welfare as the primary measure of impact when border tariffs are implemented at a very high level of 45%. Noland, Hufbauer, Robinson and Moran (2016), Hufbauer and Lowry (2011) provided empirical evidence on the effect of sector targeted protectionism, which was also referenced in Noland, Hufbauer, Robinson and Moran (2016). We utilize these studies to allow us alterations in payoff assignment to analyze sector targeted protectionism.

Other research considerations included justifying the strategic position of the United States and China.

Congressional Research Service reports by Morrison (2017, 2018), and Lewis (2016) provide in-depth analysis on U.S.-China trade issues, China's economy, and presidential authority on tariffs. We also examined statements by the Chinese and American government, mostly in the form of speeches and statements by their respective heads of state, Xi Jinping (2017) and Donald Trump (2017a, 2017b). One of the key pieces in the literature we referenced was Navarro and Ross's "Scoring the Trump Economic Plan" policy paper (2016), which was published during the campaign. It provides the reasoning behind his economic policies and articulates their value as a negotiation tool for inducing better trade terms. Treverton (2000) provides the definitions of compellence and deterrence, which we utilize in describing the strategic intent of the United States and China respectively. From these statements, we infer that the United States has priority to be active and initiate protectionist measures to compel China to change its terms of trade, while China is more reactive and defensive to the United States' threats, seeking to deter the trade conflicts by offering cooperation through compromise, while still maintaining essentially a tit-for-tat strategy in general.

BACKGROUND

Trump had campaigned on promises of protectionism, issuing numerous executive orders and memorandums in pursuit of such policies. Although the Trump administration has stated that it "does not want to be protectionist," it "reserves the right to be protectionist" when trade is not "free and fair" (Borak, 2017). During his presidential campaign, Trump frequently made accusations against China such as: the theft of American jobs, currency manipulation, dumping claims, and having unfair tariffs; and stated the intent to impose a 45% tariff on Chinese imports, and designate China as a currency manipulator (Time, 2015). Trump's inauguration speech also proclaimed an "America First" policy which outlined "two simple rules: buy American and hire American," and his speech at the joint session of Congress, quoted Abraham Lincoln to further justify the adoption of a protectionist trade policy (Trump, 2017a).

The purpose and goal of using such a provocative strategy is articulated in a paper published during Trump campaign by Peter Navarro, Director of the White House National Trade Council, and Wilbur Ross, Secretary of Commerce, that outlines the "Trump Economic Plan." The paper suggests that the current status quo is one where China "games the system" in its favor at the expense of the United States, which states that "tariffs will not be used as an endgame, but rather as a negotiation tool" (Navarro and Ross, 2016). The goal of this economic plan is to obtain better terms of trade for the United States through negotiation by issuing such protectionist threats. Navarro and Ross argue this will alleviate "structural trade problems" that causes "GDP drag," or GDP losses, and increase unemployment in the manufacturing sector (Navarro and Ross, 2016; Trump 2017). There is a strong belief by the Trump administration that China is cheating in its trade relations, which justify protectionism use (Navarro and Ross, 2016).

President Xi articulated the opposite kind of strategy in his speech at the Davos World Economic Forum, while Chinese state media issued similar statements, which signaled a tit-for-tat responses to protectionism to deter changes to the status quo (The Global Times, 2016; Xi, 2017). China's foreign policy goals, under Xi, are to promote and create win-win situations for China by spreading free trade and globalization with programs such as the "Belt and Road initiative" (The State Council, 2015; Xi 2017). China's stance follows typical economic arguments in favor of free trade accepted by most economists (Gilpin, 2001).

Major flashpoints exist between the United States and China could initiate a trade war, such as the Trump administration's embrace of protectionist trade policies, or China's intellectual property abuses (Morrison, 2018). Trump also has broad presidential authority over tariffs through four different sources of legislation (Lewis, 2016; Noland, 2017; Morrison, 2018). And despite repeated attempts at diplomacy with China on trade issues, the United States still issues presidential memorandums and executive orders that are protectionist in nature, such as countervailing investigations into steel and aluminum in 2017 (Office of Public Affairs, 2017; Bradsher and Swanson, 2017). The issues of the merchandise trade deficit, intellectual property, dumping and countervailing of goods, market economy status, and China's "state capitalism" remain unresolved (Morrison, 2018). North Korea's nuclear aggression is also linked to the U.S.-China

trade relationship, as Trump seeks China's proactive assistance in curbing North Korea's nuclear belligerence (Landler, 2017). While some progress was made on some trade issues, such as currency manipulation, minor trade deals, and business pacts, these agreements did not generate enough concessions for the Trump administration, leading to tariffs \$60 billion dollars of Chinese imports on July 6th, 2018, which was met with a response by China of reciprocal tariffs on American imports (Bradsher and Swanson, 2017; Landler, 2017; Lawder 2017).

GAME THEORY OF INTERNATIONAL TRADE

All trade relationships are based on reciprocity, granting parties in the relationship mutual gains in two main forms: economic efficiency through comparative advantage, and peace promotion through economic dependency (Bacchetta, et al, 2007). Although these benefits justify why states should engage in free trade, certain trade issues, and economic asymmetries, violations of terms of trade, or differences in gains and costs between trading countries can cause a free trade relationship to deteriorate. These trade issues and economic asymmetries can accumulate across a country's economy, creating economic damage in certain sectors or segments. Eventually these damages will become either economically or politically intolerable, forcing a state to change the status quo by imposing protectionism against its partner. When such protectionism is reciprocated by the partner they are in a state of a trade war.

Protectionism is accepted to be less optimal by economists, except in a handful of exceptions, (Gilpin, 2001; for examples see Johnson, 1953-1954). It is also often seen as having "no intrinsic economic value for a country that maintains them" because of the loss of economic efficiency from comparative advantage (Evans as cited in Axelrod and Keohane, 1985). However, there is value in such a strategy due to reciprocity in bargaining process that creates the trade relationship because of it is rational for countries to avoid economic losses and maximize utility when possible (Evans as cited in Axelrod and Keohane, 1985). Game theory's structure, which defines a set of rules, strategies, payoffs, and outcomes to a given scenario for a set of players, can assist in modelling behavior and showing solution concepts, and is used often for trade scenarios like the United States and China's trade relationship conundrums (Bachetta, et al, 2007; Nash, 1950; Snidal, 1985).

MODEL

As the United States and China are members of the World Trade Organization, they are entitled to the WTO's dispute settlement mechanism to provide solution to trade disputes. However, these states still engage in behavior that would be punished under the mechanism, often seeking alternative bargaining solutions outside the mechanism to resolve their grievances. If such were not the case the United States would not make threats to implement tariffs, but instead file its complaints to initiate the dispute settlement mechanism instead. This process seems to even favor the United States, as the mechanism was initiated 31 times between the United States and China, with most rulings going in favor of the United States (Morrison, 2018).

Additionally, the Trump administration does not value the WTO's governance as a tool in its policy interests, as Trump has implied that the United States may withdraw from the WTO following a review of its rules, as such intentions were articulated during his campaign (Dyer 2016; Whitehouse 2017; Reuters Staff, 2018). On the other hand, China seeks to advance its role in the WTO by seeking Market Economy Status, as promised during negotiations for its ascension to WTO, as it grants China a voice in the international trade regime, granted it most-favored-nation status among major trading partners, and subjects its trade agreements to the rule of law through the dispute resolution mechanism (Yin and Lee, 2002; Xi, 2017). This conflict in the WTO's role in pursuance of national interest is not only an additional flashpoint for conflict, but clearly shows weakness in pure analysis of WTO dispute resolution in this trade conundrum.

We do not contest that the dispute settlement mechanism may provide solutions to trade disputes. However, we acknowledge there are also problems in its structure that make it ineffective in preventing

such disputes besides the United States' threat to withdraw. First, the nature of this process is reactionary to the implementation of protectionism and requires at least one year to produce a solution (World Trade Organization, 2017). Table 1 below outlines the process's timeline.

TABLE 1
WORLD TRADE ORGANIZATION DISPUTE RESOLUTION TIMEFRAME

WTO Dispute Settlement Mechanism	Time Period
Consultations, mediation, etc.	60 Days
Panel set up and panelists appointed	45 days
Final panel report to parties	6 months
Final Report to WTO members	3 weeks
Total time without appeal	1 year
Appeals Report	60-90 days
Dispute Settlement Body adopts appeals report	30 days
Total Time with Appeal	1 year 3 months

Source WTO Website.

Second, the process does not stop a party from continuing to inflict economic damage until the ruling is produced, which countries must endure. Third, the United States and China can always resolve the issue before a panel ruling is made, which did occur in some of the past WTO dispute cases (Morrison, 2018). The WTO dispute settlement process does nothing to address problems of the trade relationship's status quo between these large countries outside the trade context. Therefore, we argue that game theory is an appropriate analytical tool to analyze the U.S.-China trade conundrum because of those problems and its ability to emphasize why countries make decisions that risk conflict when they pursue national interests. As trade dilemma between the United States and China is economic problem in nature, game theory is an appropriate tool to analyze the strategic behavior that the United States and China can employ to generate outcomes that serve their respective national interests.

The primary contribution our analysis provides is a game set-up that represents a metaphorical model for the current trade scenario of the United States and China by addressing elements of both the typically used repeated prisoner's dilemmas and the chicken game models. The repeated prisoner's dilemma is the nonzero-sum game that models international trade and cooperation between countries as a two-player game with two strategies: either cooperate with each other for economic efficiency and peaceful relations or defection from the opportunity to cooperate through by implementing protectionism (Bachetta, et al, 2007). Depending on what strategy is chosen by each player there are four outcomes that reflect certain payoffs to each respective player in that given outcome. When both states are cooperating, they engage in peaceful, mutually beneficial trade. If one state defects while the other is cooperating, that cooperating state is being exploited by the defector player (Jervis, 1978). If both states are engaging in defection, they are engaging in a trade war. The game repeats infinitely modelling the fact that states must continue to deal with each other as long as they exist (Oye, 1985).

To enforce cooperation in the relationship, states sometimes shift to defection strategies to punish the other player for defection, but because of free trade's greater incentive of comparative advantage this punishment is usually temporary (Fudenberg and Maskin, 1986). However, these strategic shifts in the repeated prisoner's dilemma model can be problematic because its reciprocal trigger strategies, both grim-trigger" and "tit-for-tat," create an "echo effect," preventing cooperation from resuming due to signaling problems and flaws in repeated play structure (Axelrod, 2000). Therefore, to avoid such problems, when instances of mutual defection in the status quo occur, the game shifts to a chicken game instead, representing the dilemma of a trade war between both parties (Jervis, 1978). Table 2 shown below shows the metaphor of the repeated prisoner's dilemma with a shift to the chicken game in the mutual defection outcome:

TABLE 2
A MODIFIED PRISONER'S DILEMMA MATRIX, WITH A CHICKEN GAME MATRIX AS A
“SUBGAME” IN THE EVENT OF MUTUAL DEFECTION OUTCOME

China United States	Cooperate	Defect		
Cooperate	4	3		
Defect	4	0		
	0	China		
		United States	Turn	Stay
		Turn	0	-1
	3	Stay	-1	-10
			1	10

Sequential Chicken Game

The chicken game is a two-player, simultaneous play, non-cooperative game that has two strategy choices for each player labelled: Stay (S) or Turn (T). It is modelled after a game in which two people drive cars head on at each other. The first person to turn is a “chicken” and loses the game, or the pride of victory, but if both players stay they risk death by crashing their cars into each other (Howard, 1971). The ordinal preferences in the chicken game are: ST>TT>TS>SS. The ST and TS outcomes are pure strategy Nash equilibria outcomes, in addition to one mixed strategy Nash equilibrium outcome. The pure strategy Nash equilibria in the chicken game, are also asymmetric outcomes for each player, while the prisoner’s dilemma’s asymmetric outcomes are not. This allows us to model inducement, because while the stay strategy is the only winning strategy, a player must believe the other player will commit to the turn strategy, lest risk mutual destruction. To increase the probability that the other player will turn instead of stay requires signaling of intent and greater leverage.

The Trump administration has stated in its economic plan that the true intent of protectionist trade policies is to induce China to stop what it perceives as unfair trade practices (Navarro and Ross, 2016; Trump 2017a). On the other hand, China has signaled only retaliatory threats to deter such protectionism by the United States (The Global Times, 2016; Xi, 2017). This is important to note as it supports our reasoning to analyze the chicken game in sequential form, instead of normal form. First, the United States continuously signals proactive, compellent threats, while China has only signaled retaliatory, deterring threats. From we can infer that an element of sequential play exists in the scenario, with the United States as the first mover. Our sequential analysis of the chicken game will utilize the following game set-up:

1. This trade game is modelled after the chicken game ordinal preferences, with its payoffs altered to reflect different trade actions. Stay or S represents maintain protectionism. Turn or T represents conceding terms.
2. The game will be analyzed in sequential form using decision trees.
3. Players have symmetric perfect information regarding each country’s trade policies when implemented.

4. The United States will have priority action, and that implements some form of protectionist policy.
5. China responds from that point in our analysis, i.e. always acting reactively.
6. Players are assumed to be strategic, forward-thinking, rational actors, limited only to pure strategies.

The chicken game is considered resolved when a Nash equilibria outcome is chosen, as it implies that a player has leverage over the other that can induce the necessary changes to return relations to the cooperative status quo, shifting the game back to the repeated prisoner's dilemma. Instances where both players utilize Stay will be treated as a trade war outcome, where both are experiencing a loss of GDP growth. Instances of both players utilizing Turn will be disregarded, as analyzed through sequential form, this would suggest a preference towards the status in our trade metaphor, which contradicts the interest, intent, and sequential position of the United States to utilize protectionism as a compelling threat to China.

Players are assumed to be strategic, forward-thinking, rational actors, and shall be limited to pure strategies. We disregard the mixed strategy solution, or a probabilistic solution, following an argument made by Nigel Howard (1971) in his attempt to modify game theory to refine its methods of analysis which proposes "no player has any reason to play a mixed strategy" because a player "can always do as well for himself by playing a pure strategy choice as any mixed strategy choice" (Howard, 1971). The argument Howard (1971) makes against mixed strategies is that a random choice over a probability distribution of outcomes will be just as good as the pure strategy because that strategy choice will still have a probability of failing, regardless of being mixed or pure. Because a mixed strategy is merely a random choice of strategy over this probability distribution, we reject its application to our metaphor because of the consequential nature of these trade disputes, which are not solved in the real world by merely rolling a die, or flipping a coin, but through reason, and rigorous cost-benefit analysis.

PAYOFF ALTERATION PROCEDURE

Threat Credibility

Evaluating the credibility of the United States' and China's threats is key for understanding the U.S.-China trade conundrum because a credible threat implies having leverage in the event of a trade war, or a belief in the higher probability of victory. Evaluating credibility is done through backwards induction in sequential form games, which is a process that: "considers the moves that are the last in the game, and determines the best move for the player in each case. Then, taking these as given future actions, it proceeds backwards in time, again determining the best move for the respective player, until the beginning of the game is reached" (Turocy and von Stengel, 2008). Payoffs will be assigned according to the Von Neumann-Morgenstern Expected Utility Function (von Neumann and Morgernstern, 1953; Nash 1950):

$$u \rightarrow p = v(r) \tag{1}$$

where, $u > v$, u =expected utility of an outcome, p = preferences over a probability distribution of lotteries in a space of a set of finite outcomes, $v(r)$ = a real number.

A real number can be assigned to payoffs as long as players have a set of ordinal preferences that conform to four axioms of completeness, transitivity, continuity, and independence over irrelevant alternatives (von Neumann and Morgernstern, 1953). The assigned real numbers serve as arbitrary representations of the outcome's preference ranking (Nash 1950). Alterations to payoffs can be made through affine transformation, as long as they do not violate the initial preference order (von Neumann and Morgernstern, 1953).

BACKWARDS INDUCTION PROCEDURE

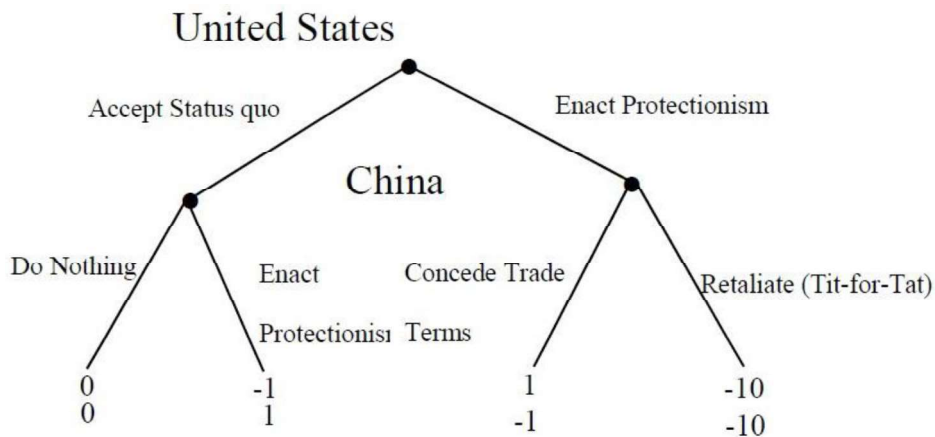
The traditional chicken game follows the Von Neumann-Morgenstern Expected Utility Function, and has the ordinal preferences $ST > TT > TS > SS$ which typically correspond with the payoffs of: $[1,0] > [0,0] > [0,1] > [-10, -10]$ respectively. The payoff structure's numerical values will be assigned in a manner reflecting the model's metaphor where: a payoff of 1 represents successfully gaining beneficial terms of trade and a return to cooperation in the status quo, a payoff of 0 represents no change, a payoff of -1 represents slight economic loss from unfavorable terms of trade, and the payoff of -10 represents severe losses from the trade war. The SS outcome can sometimes represent even greater losses, and is usually symmetrical to represent an outcome that is detrimental to both parties. As mentioned earlier, the chicken game is also a more accurate to the current situation which is outlined in Table 3:

**TABLE 3
CHICKEN GAME AS A TRADE DILEMMA MODEL**

Chicken Game as a Trade Dilemma
Player 1 ↔ United States (Always acts First)
Player 2 ↔ China (Always acts Second)
Stay Strategy (S) ↔ Protectionist Policy
Turn Strategy (T) ↔ Concede Terms of Trade
Stay/Turn (S/T) ↔ Compellent Outcome (U.S. Preferred Outcome)
Turn/Turn (T/T) ↔ Previous Status Quo (No Issues Resolved)
Turn/Stay (T/S) ↔ Deterrent Outcome (China's Preferred Outcome)
Stay/Stay (S/S) ↔ Trade War Outcome (Mutual Trade and GDP Loss)

Thus, we can create a model that corresponds with the metaphor in Table 2 that resembles the following decision tree (Figure 1):

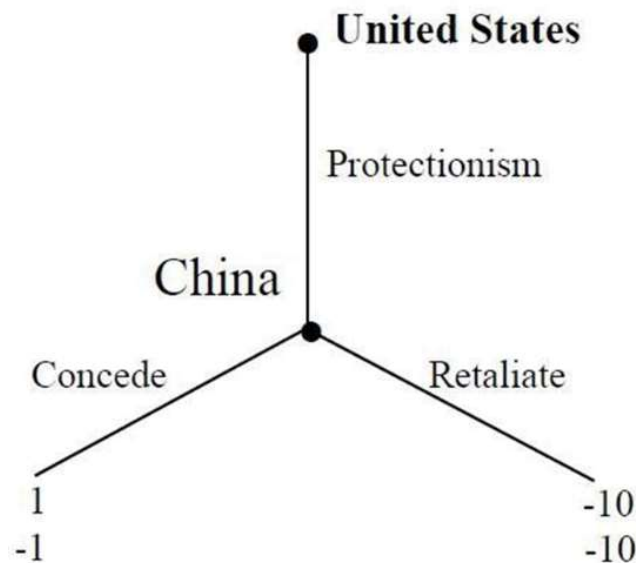
**FIGURE 1
SEQUENTIAL GAME FORM OF THE CHICKEN GAME**



This allows us to analyze our model through backwards induction in its sequential form. We divide the game into its respective subgames of certain outcomes to determine if the outcome is sequentially rational, or if the play in response to a strategy in the given sequence of game play. When the outcome in the subgame is also a Nash Equilibrium in the game's original form, it is considered a subgame perfect Nash equilibrium, which implies a credible threat.

Since we want to examine China's response to the United States' implementation of protectionism, following the model's defined structure, we analyze the following subgame (Figure 2):

FIGURE 2
SUBGAME OF THE SEQUENTIAL FORM CHICKEN GAME



The payoff of -10 for each country represents the negative losses a trade war creates for both the United States and China, which was articulated numerous times by China to deter the United States' protectionist policies. A U.S.-China trade war gives no side any mutual gain in any scenario (Bouët and Laborde, 2017; Ha, 2016; Noland, 2017; Rosyadi and Widodo, 2017), even in the case of Nash tariffs being implemented (Ossa, 2014).

However, the first mover advantage of the United States' makes China's deterrence threat non-credible because the -10 payoff it would suffer through reciprocation is a greater loss than if it would have chosen a strategy of concession, as $-1 > -10$. Therefore, although both sides suffer the same losses, we deduce the tit-for-tat reciprocal protectionist response of China is non-credible, and the United States' threat credible because of this difference in losses between the "concede" and "implement protectionism" outcomes. The sequentially rational choice is not made relative to the losses of the opponent, but losses relative to the value of alternative outcomes.

The next section will analyze sequential form chicken games in the same manner, except with the alterations trade war outcomes' payoffs. This is important because the previous analysis demonstrates if China does decide to reciprocate, the losses suffered by both sides are symmetric losses. However, such symmetry is not an accurate reflection the potential losses suffered by each country in a trade war. Those losses should not be symmetric due to the differences in their economies' production and specialization. Altering the payoffs in the trade war outcome is intended to reflect the economic damage a trade war creates, which may also change behavior depending the differences in asymmetry in those losses.

We shall apply this model to two different scenarios of conflict: one where the United States implements border tariffs on Chinese imports, the other where the United States utilizes sector-targeted

protectionism. Border tariffs are a percentage tax added on all imports, and will be analyzed at 10% and 45%, respectively. Sector targeted protectionism is a set of all forms of protectionism that can be enacted from tariffs and quotas on specific goods, disruption of supply chains, subsidies, currency controls or bond dumping, etc., besides border tariffs (Noland, Hufbauer, Sherman, Moran 2016).

PAYOFF ANALYSIS

Border Tariffs

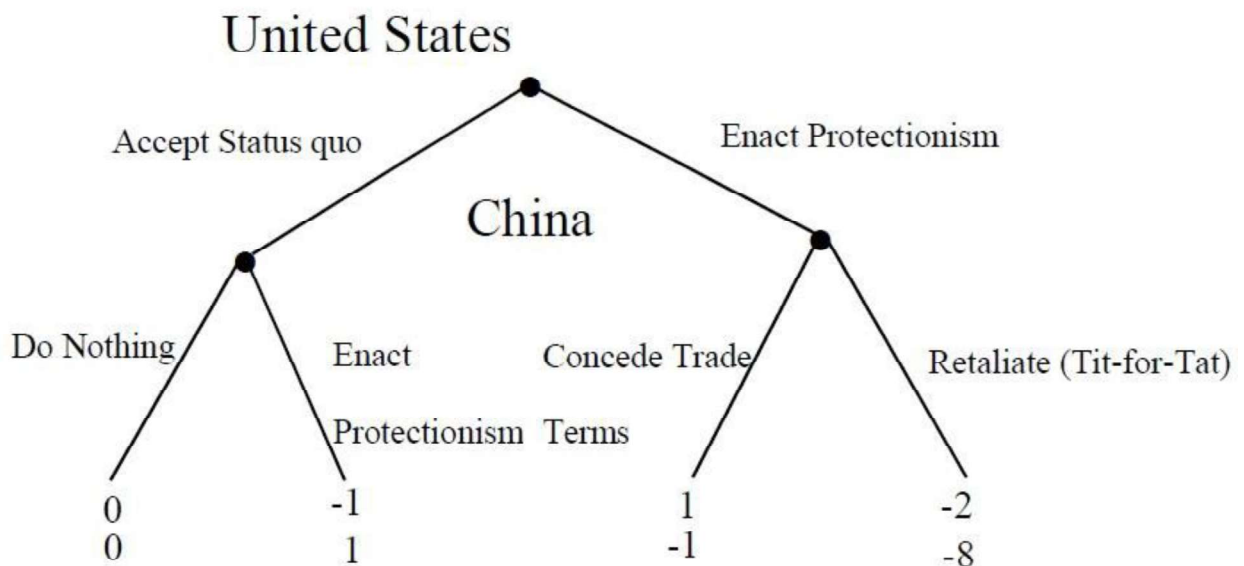
During the campaign, President Trump threatened to place a border tariff on Chinese imports as high as 45%, to induce a change in its currency policies, and implement “fairer” trade terms for the United States. Research that models GDP loss in a trade war is limited. Reports by Lai and Xia (2016), Ha (2017a, 2017b), Noland, et al (2016), and Bollen and Rojas Romagosa (2018) are the strongest publications that project GDP loss figures for a trade conflict, using different models, tariff rates, and retaliation assumptions. Bouët and Laborde (2017), utilize welfare projections to help explain optimal tariff levels and Nash equilibrium tariffs in studying the effects of a trade war (Johnson, 1953-1954). Rosyadi and Widodo (2017) examine both projections. In our payoff alteration, we choose to ignore findings that use welfare projections to determine trade war payoff assignments. This is due to the large differences in scale depending on the modelling used in determining welfare, and that welfare is not defined sufficiently in the literature to be applied as measure for purposes. The existence of Nash tariffs is also not important in our analysis because we are assuming that protectionism is implemented for compelling threats, not for optimization. Thus, we only utilize the general conclusions from the studies utilizing GDP projections.

From this very small sample of projections, we can reasonably assign a new payoff value by analyzing the losses incurred in each study. GDP projections follow a pattern that suggests the United States will suffer fewer losses than China in a ratio of 1:4, United States to China, when both sides engage reciprocal protectionism. Ha (2017a, 2017b) projects losses of .1% to .25% for the United States and .4% to 1% for China using a value-added model to measure GDP losses from export and import changes, at 10% tariff levels. Rosyadi and Widodo (2017) project losses of .91% GDP losses for the United States and 4.1% for China at 45% tariff levels using the GTAP model to obtain their results. Lai and Xia (2016) and Noland, et al (2016), did not examine tariff effects on both countries, however, Lai and Xia’s projections, which use a multiplier effect to account for GDP losses’ effect on jobs, consumption, investment, etc., which shows a 4.82% loss at 45% tariff levels. Lai and Xia also note that the United States’ will be affected less than China’s losses, reasoning that China imports from the United States are a quarter less than that of its exports (Lai and Xia, 2016). It would suggest that in the case of reciprocal protectionism, trade volume will influence the ratio of GDP loss between the United States and China. The projections by Noland, et al, measure a “full-scale trade war,” where Mexico and China simultaneously retaliate against the United States, which makes their projections of GDP for China difficult to ascertain, as they did not separate rates by country in their analysis. However, Rosyadi and Widodo’s analysis claims their projections are consistent with Noland, et al, which gives stronger support to their projections being valid (Noland, et al, 2016; Rosyadi and Widodo, 2017).

The most recent report that uses GDP losses by Bollen and Rojas-Romagosa (2018) using a Computational General Equilibrium (GCE) model of trade for the published lists of the United States and China’s intended tariffs in April 2018 if trade deal negotiation failed to resolve disputes, which would implement 25% tariffs on various products that each equate to \$50 billion dollars. The authors note due to “time constraints” they model reciprocal tariffs that ignore updates to additional threats after April 2018. Although their study does not implement reciprocal border tariff rates, the equivalent intended damage of tariffs applied to \$50 billion dollars is similar to the implementation of border tariffs being reciprocally implemented. Their model accounts for both initial and escalation of trade tariffs applied, which find that reciprocal tariffs equate to a time lagged .3% GDP loss for the United States, and 1.2% GDP loss for China, the same as Ha’s (2017a, 2017b) projections, and consistent with Noland et. al (2016), Lai and Xia (2016), and Rosyadi and Widodo (2017).

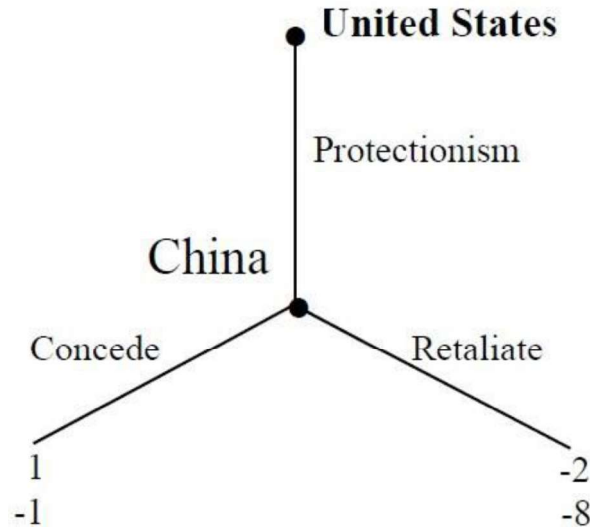
These studies support our payoff alteration to reflect an asymmetric negative payoff in a trade war scenario is appropriate to model the trade war outcome. Therefore, we assert that it is acceptable to assign a modified payoff in a ratio of 1:4, United States to China, to model GDP loss is consistent with the findings of the previous studies. Conclusions made by Bouët and Laborde (2017) also follow the other studies that project greater losses in GDP for China relative to the United States. Thus, we construct the following decision tree:

FIGURE 3
CHICKEN GAME WITH PAYOFF ALTERATION IN TRADE WAR OUTCOME WHERE CHINA RETALIATES



We assign the expected utility values of -2 for the United States and -8 for China following this ratio. This also does not alter the preference order of the set of outcomes. While we have already determined that a China's deterrent threat is non-credible in the form of the chicken game with no payoff alterations due to the United States' first mover advantage, the asymmetrical GDP loss between both countries only further incentivizes China concede terms of trade instead of fighting a trade war. This is because the ratio of damage is detrimental to sustain it for even one year which would not only be too high of a cost, but would also fail to inflict equal harm. China could possibly respond with higher reciprocal border tariff rates, but this would enable the president to have complete authority to implement even more severe economic punishment in response as a threat to its national security, causing the trade war to only escalate in scale (Lewis, 2016). Therefore, we can conclude in this situation that China's sequentially rational response to the United States is to concede terms of trade because it cannot overcome the United States' first mover advantage from the greater, asymmetrical GDP loss it would suffer in a trade war, which is expressed in the subgame below:

FIGURE 4
SUBGAME OF CHICKEN GAME WITH ALTERED PAYOFFS



Sector Targeted Protectionism

The United States and China also have other means of protectionism besides border tariffs at their disposal. China has expressed the termination of Boeing’s contract as a retaliatory measure, while United States Trade Representative Robert Lighthizer has expressed interest in “finding other ways to defend [United States] companies, workers, farmers, and [its] economic system” (Center for Strategic and International Studies, 2017). Countervailing investigations by the Commerce department are ongoing as well (Office of Public Affairs, 2017). Thus, it is important to address possible non-border tariff measures because while negative impact maybe relatively less than border tariffs, there is a wider range of options sector targeted protectionism, which can expose risks border tariffs cannot (Noland, 2017). Sector target protectionism is also harder to challenge under WTO’s dispute resolution mechanism, and more difficult to analyze due to its large variety options (Magnier, 2016; Noland, et al, 2016). It is very likely that China retaliates with forms of sector targeted protectionist, as evidenced by an editorial in The Global Times, a Chinese government sponsored media source, which suggests termination of Boeing’s aircraft order (The Global Times, 2016).

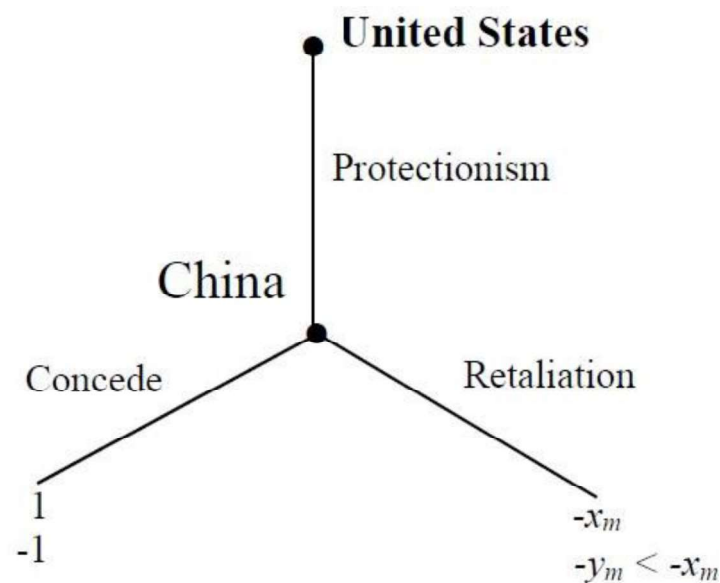
To analyze sector targeted protectionism, we shall first define it as various forms of protectionism a state has at its disposal that may implement in any given combination and rate. Some protectionist actions that could be considered sector targeted protectionism include the following: quotas tariff rates in given a sector or sectors; enacting protectionism across multiple sectors; terminate business agreements or purchases; deny access to components in the supply chain; or other forms of non-tariff protectionism, such as safety claims (Noland, et al, 2016; Magnier, 2016). Some of these actions, especially non-tariff protectionist measures, and business agreement terminations, cannot be resolved through WTO’s dispute resolution mechanism. This makes the strategy profile set of sector targeted protectionism equal to every possible combination of these elements which we express as:

$$S_i = (s_i^{(t(n))} \dots s_i^{(T)}) \tag{2}$$

where S_i is the sector targeted protectionism strategy profile for i player, T is the set of all available forms sector target protectionism, $\binom{T}{k}$ is all combinations of T , and $\binom{t(n)}{k}$ the combination of n elements of T .

This is further simplified by denoting the United States' respective payoff as $-x_m$, and China's payoff as $-y_m$ which correspond to elements in the strategy profile. Payoffs cannot be assigned in the same manner of the previous analysis due to the uncertain nature of which protectionist actions can be implemented from the strategy profile. The $-x_m$ and $-y_m$ variables will be utilized as placeholders in the model while we explain what an ideal outcome in a sector targeted protectionist scenario ought to be, which imply certain payoffs that correspond with elements of the strategy profile. An action of sector targeted protectionism that can be implemented is a strategy or element of a country's respective strategy profile. Strategies in this profile will be utilized at each stage of the game. Additional stages in this game escalate the trade war further, with every action creating additional losses for each side to incur, in addition to the losses at previous stages. The structure of this game's decision tree can be seen below (Figure 5):

FIGURE 5
SUBGAME WITH VARIABLE PAYOFFS FOR SECTOR TARGETED
PROTECTIONISM MODEL



In comparison to the border tariff analysis, losses in a trade war are more likely to vary. The ability to pick and choose targets does give countries a much greater degree of control over the direction of economic damage over the course of the trade conflict. While economic damage could be relatively less than border tariffs when sector targeted protectionism is enacted, as the tariffs do not affect the entire economy, it could also be equal or greater than border tariffs, as economic damage is dependent on which sectors are targeted, and the level or rate of the protectionist measures implemented. For instance, the GCE model of Bollen and Rojas-Romagosa (2018), found that economic damage of GDP loss was comparable to border tariff projected measure of Ha (2017a, 2017b) when sector targeted protectionism is reciprocated equivalently at a set of traded products.

Although this still does not make fighting a trade war rational behavior in our model, if sector protectionism is implemented, it may be less costly than implementing border tariffs, depending on how far the war escalates. This incentivizes both countries to engage in this type of trade war, rather than implement border tariffs. An example of sector targeted protectionism trade war occurred during the Obama administration in 2009. The United States imposed a protective tariff on Chinese tire imports, attempting to create American jobs in that sector. China had retaliated, following its tit-for-tat deterrence strategy, by imposing anti-dumping tariffs and countervailing tariffs on poultry products to China from United States, increasing these rates from 50.3 to 105.4%, and from 4.0-30.3% respectively. The United States' poultry

industry would \$1 billion dollars in their exports to China from this retaliatory action (Hufbauer and Lowry, 2012).

In that case, we can see the United States' first mover advantage is diminished relative to the border tariff scenario because the United States' strategy can be retaliated with a greater, asymmetric response by China. However, the United States may also do so in response to that retaliation as well, escalating the scale of the trade war further, but this cannot go on indefinitely. Each side must be conscious of the costs it pays, when implementing its strategy, do not outweigh the damage inflicted from sector targeted protectionism. Economic losses from loss of comparative are costs that must be considered in strategic decision-making relative to both the losses it suffers from the opponent's strategy and the economic damage it seeks to inflict from that strategy. The sector targeted protectionist strategy implementation always minimizes its costs, or economic losses, while maximizing the other player's loss. Thus, their costs paid should always be lower than the damage inflicted to the other party, while acting rationally that is similar to the minimax solution concept in zero-sum games (Von Neumann and Morgenstern, 1953). In addition, every strategy spends elements of the strategy profile once executed, meaning that no unique element can be implemented twice, and that options available to each player decrease with every move made at every game stage. This implies that each player must consider imposing too many elements of their strategy profile in one move means they will have less ability to respond in the future stages of the game, while also managing the costs it pays to execute that given strategy. Therefore, this should prevent an option that merely enacts all elements of the strategy profile from being a viable response, or something similar in magnitude from being implemented as each player is assumed to be a strategic, forward thinking, rational actor. Following these considerations, we assert that the best strategic response for a player in the game creates an asymmetrical payoff outcome: $-x_m < -y_m$ for China, and $-x_m > -y_m$ for the United States, respectively.

The game's sequential structure also gives more power to the second mover, and leverage to the side with the larger strategy profile of protectionist options, which in both instances is China. The nature of the Chinese economy's "state capitalism" gives it an inherently larger strategy profile than the United States because it has more control over its business actions, as SOEs comprise roughly 60% of its economy. The United States' does not control its private sector in such a manner, which implies it has a smaller strategy profile available to it. Additionally, the two-party democratic process, where the private sector has immense lobbying power in politics, also decreases the strategy profile further, as there are more sources of political risk cost that decrease the probability of strategies being viable to inflict damage onto China. While China must consider similar political risks, this concept is emphasized because it implies any decrease in a strategy profile due to domestic political considerations will increase the strategy profile size for the opponent as well. The more targets available for attack, the larger the strategy profile will be.

Although it is impossible to precisely determine which elements of the United States or China's strategy profile will be implemented, there are sectors that reasonably have more value as targets than others. The initial tariffs implemented by the United States would most likely be placed on sectors that would promote job creation in the United States according to analysis by Helen Qiao, a China economist at Bank of America Merrill Lynch. Proposed tariffs on metal and metal products, chemicals, machinery and equipment, and auto parts to be levied on China, which are a part of the manufacturing supply chain (Chang, 2017). In her analysis, Qiao (in Chang, 2017) examined swing states that saw "substantial job losses" in those industries, weighing the political support Trump would need in a 2020 run to secure a second term in her selection of these sectors.

The Peterson Institute for International Economics' trade report proposes three probable scenarios of sector targeted protectionism China is likely to pursue: ending imports of American aircraft; reducing the purchase of American business services, such as enterprise software and financial services, by state-owned enterprises; and ending imports of soybeans, one the largest merchandise products imported by the United States. Ending the imports of aircraft would hurt American jobs substituting Boeing for Airbus, decreasing exports, and consumer demand in the United States (Noland, et al, 2016). Their research also estimated that such a cut in demand for aircraft would result in the loss of 179,000 jobs across the nation, stifling a key United States' interest in the process. The similar effects would occur in the case of SOEs ending their purchases of United States services. Attacks on soybeans are also very probable, because they produced

mostly in Republican states that are key to the Trump campaign reelection efforts (Magnier, 2016; Noland, et al, 2016). Sector target protectionism exposes risks that border tariffs do not, which can cause economic harm in specific and asymmetric capacities against a state.

In the case of a sector targeted protectionism trade war, China could be able to deter major changes to the trade status quo because it has the advantage of a larger strategy profile of options available, and it can respond with strategies that cause asymmetrical losses against the United States. However, if it does not respond with strategies that cause asymmetric losses China will not be able to deter the United States. This is reflected by Bollen and Roja-Romagosa's (2018) findings which model escalation when tariffs are applied reciprocally. Thus, it is key that retaliation occurs at a higher level than what is being responded to because their findings show asymmetric measures do not equate into asymmetric economic damage. As stated before, China's GDP loss was projected at 1.2%, while the United States GDP loss was projected at .3%, showing that reciprocal tariff levels do not equate to symmetrical losses. This diminishes the value of the United States' first mover advantage. Therefore, we can assert that the threat of deterrence is more credible for China if it utilizes sector targeted protectionism instead of border tariffs if and only if it generates a greater asymmetric loss for the United States and maintains the possibility of escalating economic damage in the trade war in future rounds by not overly exhausting its options. In this case, it is rational for the United States to concede terms of trade rather than to fight a trade war in this scenario because it can only escalate further economic harm, and is exposed to a greater variety risks than China when sector targeted protectionism is utilized in retaliation as we assert China has more options available to fight a trade war than the United States. However, if the United States chooses to escalate further, the first and second mover advantages become irrelevant, with victory being entirely dependent on which side has the larger set of protectionist options, and how it wields such weapons as the trade war escalates.

CONCLUSION

We have shown that in a trade war the United States enjoys first mover advantage when its protectionist border tariffs are reciprocated by China at similar levels due to the greater trade volume of imports from China relative to its exports. Thus, there is credibility to the Trump administration's protectionist threats. However, China does have the ability to respond with sector targeted protectionism to create greater asymmetric losses to the United States, which makes deterrence credible if it can threaten higher costs by escalating the trade war. However, retaliatory escalation by the United States can also be applied as a countermove, reversing strategic consideration between both parties until escalating such a trade war becomes pyrrhic. In normal cases, first mover advantage would simply imply the United States is the victor, acting rational in its protectionist trade strategy, as China should concede terms of trade to avoid the greater losses from the trade war. However, because a trade war's real losses are asymmetric, unlike the normal model's payoffs, simply examining order of play does not determine the victory. Therefore, it is important to examine the protectionist policies being utilized in relation to the order of play. Sector target protectionism's ability to generate economic damage is difficult to examine because of the large combinations of protectionist actions a state can employ at once, but we assert it is a powerful tool that should be further examined, as it exposes different risks to the other's economy that can increase the leverage a state has in its trade strategy. A trade war is not a favorable position for any state to be in, but if a state must engage in protectionism, it should only do so if it can ensure that it can inflict greater asymmetric losses to the opposing state relative to its own losses from retaliatory protectionism and a loss of comparative advantage

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