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Trade Disputes and Uncertainty Between the US and China

Using a Game of Incomplete Information

(Topic 4)

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1) Introduction

Since its commencement in 2018, the trade war between the United States (US) and China has been characterized by months of tense negotiations. Economists have been particularly interested in the substantial impacts that trade decisions will have on the economic growth of two of the world's largest economies. This paper aims to model the trade war using a game of incomplete information in order to demonstrate how strategic thinking forms the basis for trade negotiations. The paper will be structured as follows: Section 2 will provide a brief overview of existing literature where game theory has been applied to trade negotiations. Section 3 will introduce this paper's game theoretic model, and highlight the appropriateness of a Bayesian representation for trade conflict. Lastly, Section 4 will discuss the policy and implications of this approach, before offering concluding remarks in Section 5. Overall, this paper's findings suggest that while predicting the outcomes of a trade war is challenging, the Bayesian approach to this scenario does offer some valuable insight into why the Trump Administration have resorted towards protectionist strategies, and why China have reciprocated with similar impositions.

2) Literature Review

Globalization has increased the benefits of international trade, yet occasionally countries decide to enact protectionist policies. Analysing the optimality of these strategies requires a game theoretic approach. Harrison and Rutström (1991) used a non-cooperative static game of complete information to model a bilateral trade war, using the equivalent variation in income (in billions of U.S. dollars) as the payoffs for a game between the United States and EC (European Community).[1]In this game, the EC has a dominant strategy to always enact protectionist policies and as a response, which results in the US responding in the same manner (Harrison & Rutström, 1991). The presence of this suboptimal incentive illustrates the need for an external body to regulate trade, such as the WTO (MccGwire, 2018).

A number of other papers have used game theoretic approaches to model a bilateral trade war. The recent ongoing trade war between the US and China lends itself to such analyses. An earlier working paper by Ghoneim and Reda (2008) used a dynamic game of incomplete information, where the US was the first mover. In this scenario, the US either demands that China appreciates its currency by threatening to impose tariffs should they fail to do so, with

[1] The EC was formed after World War 2 in an attempt to unite European Countries. In 1993, the EC became the European Union (EU) after the community had substantially grown.

the alternative being they do not respond with protectionism. Should the US threaten with tariffs, China must then choose to either leave their currency as is, or to appreciate it.

If China chooses to give into the US' demands by appreciating their currency, they still have the discretion to decide to what extent they'll do so. The incomplete nature of information in this scenario lies in the fact that the probability of the US following through with their threat, in addition as to by how much the Chinese will appreciate the Yuan is determined randomly. Overall, the outcome in this scenario was that the US issues a threat to impose tariffs, and China responds with a 10% currency appreciation to meet the US' demands (Ghoneim & Reda, 2008).

Yin and Hamilton (2018) allow both players to make the decision to either cooperate or defect from their agreements under the WTO. This gives rise to a modified Prisoner's Dilemma, where both defecting then leads to a Chicken game. In this case the Chicken game is sequential as the US acts first and China decides whether to retaliate. Their analysis finds that the US has a first mover advantage when China reciprocates since import volumes from China are comparatively large. The US thus has credibility to its threats and will earn higher payoff from protectionist policies (Yin & Hamilton, 2018). However, Yin and Hamilton (2018) assume complete information which Ghoneim and Reda (2008), and MccGwire (2018) contradict. As such, it is evident that different modelling approaches and behavioural assumptions can yield various outcomes. The next section of this paper will use a game theoretic approach to the modelling of the current trade war between the US and China.

3) The Model

Matrix Representation – Prisoner's Dilemma

The bi-matrix format is an effective way to formulate the trade scenario between these two countries. Considering the context developed in the previous section, this section applies the seminal prisoner's dilemma framework developed by Flood *et al* (1950) to the trade negotiations. The initial assumptions of the model are characterised below, with the strategic representation of the game shown in figure 1.

1. There are two players in the game, China and the US.

2. Each player makes a choice between two actions, either to restrict trade with tariffs (T) or maintain free trade (F).

3. Each player wishes to maximise utility. The payoffs in the bi-matrix proxy the return on each country's primary equity index, i.e. the S&P 500 for the US and the SSE composite index for China.

4. Each player would prefer to impose tariffs and have their opponent maintain free trade. Conversely, the least preferable outcome for each player would be to maintain free trade and their opponent imposes tariffs on them.

Figure 1 – Strategic Form Representation

US	China		
		T	**F**
	T	**4, 4**	**10, 0**
	F	**0, 10**	**8, 8**

Note: China Payoffs are in Dark Blue, US Payoffs are in Light Blue

Using best response analysis, the optimal strategy for each player would be to impose tariffs on their counterpart, resulting in a Nash Equilibrium (NE) of {**TT**} with payoffs of {**4**,**4**} for each. Despite the fact that neither player has the incentive to deviate from imposing tariffs on their counterpart, this NE is clearly a suboptimal outcome. If both countries opted to co-ordinate and keep trade unrestricted, they each would obtain higher payoffs. Contextualising this further, Edwards & Van Wijnbergen (1987) essentially advocate for this idea of coordination by showing countries with a higher openness to trade tend to enjoy higher utility.

It is important to analyse the impacts which the above scenario would have on each economy. To explain this, let's assume that the US decide on putting up tariffs on Chinese imports, but China do not act in the same manner. This would imply that US exports would be unaffected, with tariffs increasing the cost of their imports from China, therefore reducing the demand for these foreign products and increasing domestic output in the process.[2]

[2] This is assuming that the loss in foreign demanded goods translates into a proportional increase in domestic ones

Inversely, China's domestic output would fall because they're exporting less, therefore shrinking their trade surplus. This phenomenon whereby the US reduce the size of their trade deficit with China has been central to Trump's reasoning for imposing tariffs, in the hopes of stimulating domestic growth. Given the fact that China are so heavily reliant on export-fuelled growth, this outcome will prove to be detrimental to their economic aspirations.

Extensive Form with Incomplete Information

It would be more realistic to assume the US have an incomplete understanding of the direction of China's trade policy because they censor much of their media outlets. Therefore, the trade scenario needs to be viewed from an asymmetric information perspective, and this paper employs the seminal techniques developed by Harsanyi (1967) to achieve this. Putting this into context, the paper will now distinguish between two "types" of Chinese government, namely a combative and a strategic type.

The combative type incorporates themes from an analysis of the 1930 Smoot-Hawley Tariff, where Irwin (2011) explained how various countries adopted an aggressive protectionist approach against the US in response to what they perceived as unfair trade policy imposed on them. A combative Chinese government reacts similarly to the above mentioned case, with a tit for tat response to any tariffs imposed on them, irrespective of the ramifications which arise from this.

The strategic type assumes that China adopt a more tactical approach by exploiting the asymmetric information problem which the US has, by responding to tariffs with alternative measures. The paper includes an assumption that the strategic Chinese type will devalue the Yuan in the event of any tariffs imposed on their exports, which prevents them from earning zero (or negative) payoffs if they opt to keep trading freely. The consideration of Chinese currency manipulation (which was one of the factors initially prompting President Trump to launch a trade war), implies that China always obtains a higher payoff than the US if both countries decide to trade freely.

Another way in which the strategic Chinese type can increase its payoffs is through capitalising on any trade deals which fall through between the US and other countries. To put this into context, Trump recently announced tariffs on $7.5 Billion worth of European imports which will commence on the 18th of October 2019, in response to a dispute over the EU's subsidisation of Airbus (which

is Boeing's largest competitor) (Wiseman & Keaten, 2019). The strategic Chinese type could swoop in and agree a trade deal with Europe, which has two important implications. Firstly, an additional market to export to will increase Chinese company earnings (which implies higher payoffs), and US payoffs will fall because of a lost trade partner. Similar to the Prisoner's dilemma case which was unpacked earlier, the sequential format of this scenario suggests that both countries end up being worse off should they decide to impose tariffs on each other.

Figure 2 – Extensive Sequential Format of the model

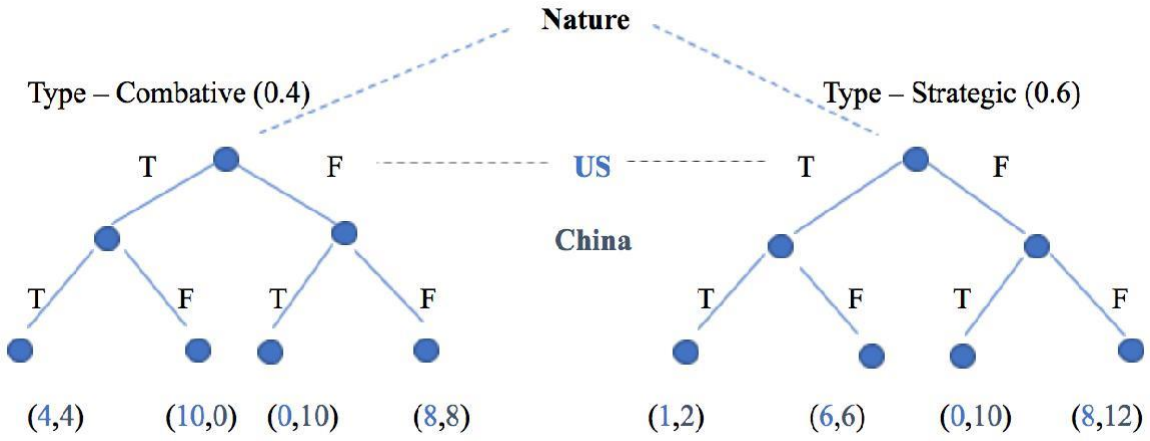

Figure 2 represents the sequential form of the trade scenario with incomplete information. From this, it is evident that the US's payoffs differ contingent on the Chinese government's type. Because the US are unsure which of these types they're facing, they have to use Bayesian probabilities to compute their expected payoffs under each scenario[3]. The paper uses a further assumption that the probability of the Chinese government being a combative type is 0.4, with a probability of them being strategic equal to 0.6.

In each subgame, depending on their type, China's best response strategy is {**T,T,F,F**}. The US are aware of what China's best response strategy is, and can calculate their expected payoffs based on this. If the US opts to impose tariffs on China, they obtain an expected return of 5.2. Should they decide to maintain free trade, their expected return is 4.8. Based on these outcomes,

[3] This game can be extended to include an option for China to signal their type by choosing a particular action, which allows for more strategic behaviour on their part, however this also increases the complexity of the game

we can conclude that the Trump Administration will choose to set tariffs on Chinese imports. The game's NE can be computed as {**T**, **TTFF**}. This game has one Bayesian NE, {**T**,**TF**}.

4) Implications of the Game Theoretic Approach

An important insight was made by Box and Draper (1987) that all models are oversimplified and limited in their depiction of reality. Thus, although policy implications are not entirely out of reach, they should be treated with caution. This caveat is especially salient in a situation characterised by limited information, such as the international trade arena. The use of threats (both credible and noncredible), as well as hidden payoff structures, often disguise the long-term strategies of players, making it difficult to predict reactions and outcomes. However, when games of incomplete information are played repeatedly, some conclusions can be made with relative certainty:

Firstly, trust is important. At each stage of the game, actions and threats are being analysed and used to update strategies. Cooperative behaviour without credible policy measures or threats of punishment is almost impossible, which reduces the likelihood of productive trade negotiations. Whilst it is almost certainly the case that players do not trust one another, there must be an element of reliability in the actions and constraints of each player's strategy set, in order for negotiations or actions to take place. Secondly, welfare losses are certain. Trade wars often have a low probability of producing a mutually beneficial outcome, since a resolution to the game is usually preceded by tariffs (which increase the transaction costs of international trade), and increasing uncertainty in the global trade arena (which may reduce risk-seeking behaviour, lowering the prevalence of investment in emerging markets) (Harrison & Rustrom, 1991).

A game theory analysis of a trade war, using a game of incomplete information, proves valuable as an insight into human behaviour. The beginning of a trade war places strategic importance on counteractions, once the first player acts and the war has begun. Throughout the game, there must be a credible hope of achieving a liberalized market which yields the highest payoffs, which prevents the game from becoming a Prisoner's Dilemma. The preference for tit for tat strategies explains why there is a tendency for players to oscillate between trade liberalization on one hand and protectionism on the other.

5) Conclusion

In conclusion, it is clear that a model of incomplete information provides valuable insight into the strategic thinking behind the US and China's trade decisions. By introducing two types of Chinese government, the model highlights the reality of uncertainty during trade wars, and how the US uses this to choose whether to impose tariffs or maintain free trade. In terms of policy implications, the use of threats, as well as hidden payoff structures, often disguise the long-term strategies of players, making it difficult to predict reactions and outcomes. Despite this, game theory provides a valuable contribution to how negotiations progress.

Both economies are under intense pressure to curtail recessionary pressures by coming to some form of resolution, however neither are willing to compromise on a deal which is not lopsided in their favour. Trump recently announced a three phase deal agreed in principle between the two counterparts. However, with very little indication on this deal addressing the issues central to the trade dispute, we can expect global uncertainty to continue.[4] Without a doubt, these trade negotiations will shape the trajectory of global growth for time to come.

[4] On the 11th of October 2019, President Trump announced phase one of the agreement centred around agricultural trade between the two countries. However, none of the intellectual property or currency manipulation issues which fuelled much of the dispute's genesis appear to have been addressed. Furthermore, some of the tariffs which have been in place have not been eliminated

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