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An analysis of the climate change architecture

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ABSTRACT

This paper examines the complexity of the current negotiations to avert climate change under the United Nations Framework Convention on Climate Change. Drawing on economic game theory modelling, it interprets the latest developments within the international negotiations and provides a political economy analysis of the climate change architecture. It places the pursuit of international co-operation, via the Kyoto Protocol's second commitment period, in the context of a country's maintenance of national interest and a flexible emissions abatement strategy.

Accepting that countries will reject an international agreement or obligation that is seen as inimical to their economic competitiveness, it incorporates a new game theory model, considers how learning from such models can influence agreement design and proposes a new approach from a non-monotonic polluting payoff function. Attention is placed on enabling conditions that entice countries to ratify a climate agreement, thereby encouraging participation and accelerating a near term deployment of low carbon technologies.

Contents

1. Introduction

Climate change is an important foreign policy for global leaders, where the power to make agreements often includes concerns that derive from individual nations. It is a collective action problem [1] that represents a significant market failure [2]. Achieving an international agreement can only happen if the various interests of

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Table 1
The Game Matrix (after Ciscar's multi-region exercise, 2000).

	c	*bau*	*si*
Comply with climate agreement (*c*)	*c*, *c*	*c*, *bau*	*c*, *si*
Business as usual (*bau*) [i.e. continue to pollute and apply no new policies/measures so maximises utility function without emissions reductions]	*bau*, *c*	*bau*, *bau*	*bau*, *c*
Self-interest (*si*) [i.e. consideration of climate change in context of the impact on own economy so maximises own utility function]	*si*, *c*	*si*, *bau*	*si*, *si*

Table 2
Abate/Pollute Game (after DeCanio et al. [9]).

U.S. strategy	Chinese strategy: Abate	Chinese strategy: Pollute
Abate	a, w	b, x
Pollute	c, y	d, z

Abate refers to early mitigation in current or near term, and Pollute refers to no mitigation.

In this game, *a* in the upper left hand segment is the payoff for the U.S., if the U.S. chooses the strategy *Abate*, and China chooses the strategy *Abate*. China's payoff is *w* from this pair of strategy choice. The payoffs to each of the players in the game are measured by order, so (a, b, c, d) and (*w*, *x*, *y*, *z*) can take on numeric values of (4, 3, 2, 1), with 4 as the most favourable outcome reducing to 1 as the least favourable outcome. Let us first assume, that the *Abate*: *Abate* outcome is preferred outcome for both parties, so no economic benefit arises if both *Pollute* instead of choosing *Abate*. Say, if the decision of neither party's pollution benefits the other party, then it is difficult to see if any benefit could be derived from emissions reductions resulting in either China or the United States [9]. As a result of the economic restrictions the decision *a* would also be greater than *d* ($a > d$, and $w > z$), while the no pollution restriction means $a > b$, $c > d$, and $w > y$, $x > z$.

individual nation states are met, while cost-effectiveness and overall national competitiveness is protected and maintained. Such economic considerations are very relevant as the only chance we have to curb climate change is to accelerate the growth of clean energy economies [3]. Progress and agreement depend on our understanding of how policy at a national level, and collective action at an international level, support and encourage each other [4]. This paper considers how to best achieve an agreement by reviewing existing game theory models, in light of the climate negotiations and by proposing a new approach with non-monotonic payoff function.

While climate change is an interconnected global problem where 'conflicts of interest are international and intergenerational' [5], it remains a geopolitical issue. The International Energy Agency (IEA) estimate that CO_2 emissions will double over the next four decades, a rise in average global temperatures of between three and six degrees [6]. Governments and policymakers are being urgently asked to act to reverse these trends and let scientific evidence inform their pathway. There is international acceptance that a global response to tackling climate change requires international collaboration that reflects the idea of a balanced and fair agreement. Achieving consensus surrounding climate is a significant collective action problem, where benefits are internalised within a country and the costs are evenly spread out globally. This raises issues concerning how best to reframe such an agreement, and what considerations to make in shaping its architecture.

2. Learning from game theory concepts

Throughout the past 50 years, game theoretical models have been applied to interconnected global problems, including financial markets, trade, biodiversity, international relations and, more recently, climate change negotiations. The business community relies heavily on game theoretical models (for example in market entry/exit, mergers and acquisitions and pricing) in terms of making decisions and or choosing a strategy they consider the potential choices of others. As an enterprise presents a willingness to co-operate, they heighten the chances of future co-operation and so reinforce a positive reputation that may influence future actions of other enterprises. Therefore, the dependency of future actions based on past outcomes informs the current choice of players[1] [7]. These theoretical models are useful in that they acknowledge that individual decisions depend on the expected reactions of others, allowing policy makers to form more effective and efficient policy mechanisms that focus on incentives. This had led Forgo, Fulop and Prill, [8 p. 252], to comment:

> 'It is hard to find a better testing ground for various game theoretic models than climate change negotiations where the conflict character of the situation is apparent not only for the specialists but also for concerned citizens.'

A player's (or a country's) decision is automatically informed by the decisions of another player, as a player aims to maximise their utility function, seek self-interest, and engage in 'free-riding'.

2.1. Applying game theory to the climate negotiations

Game-theoretical models provide an elegant formalisation of strategic interactions across the climate negotiations [9] whose application can inform parties' decisions given certain circumstances. A number of key assumptions surround the application of game theory to the climate negotiations, namely that countries will act rationally and will all share the objective of climate protection. Table 1 outlines the various combinations of strategies that parties can pursue, structured around three cases: compliance with agreement, continuing business as usual and applying self-interest strategies. Ciscar [10] found that the emissions levels of parties were similar in cases in which a strategy of self-interest (*si*) and compliance (*c*) with a climate agreement were pursued. Furthermore, in scenarios where one party followed a business as usual (*bau*), the other party followed a *si* strategy. From a game theory 'realism' perspective and using 2×2 order games, each

[1] 'For example, a manufacturer and a supplier will continue to do business as long as the supplier meets certain quality standards and the manufacturer pays a good price and provides sufficient volume' [7 p. 24].