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Journal of Economic Behavior and Organization

journal homepage: www.elsevier.com/locate/jebo

International environmental agreements on climate protection: A Binary choice model with heterogeneous agents[☆]

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ARTICLE INFO

Article history:

Received 21 September 2017

Revised 10 August 2018

Accepted 12 August 2018

Keywords:

Climate change

Reciprocity

Heterogeneous agents

Strategic complementarity

ABSTRACT

Climate change poses a major challenge to present and future generations. Our analysis focuses on international environmental agreements (IEAs) entered into by countries that decide rationally and autonomously on whether to adopt a climate-friendly policy. This raises the question, how many and which countries will sign such an IEA? In addition to material incentives to combat climate change, issues pertaining to justice and fairness motivate reciprocal behavior, even during international negotiations. Integrating reciprocity preferences may stimulate cooperation and thus increase participation in an IEA. However, there is some evidence that fairness also stabilizes small-sized IEA coalitions. Hence, this gives rise to the following open question: under which conditions does reciprocity have an enhanced and harmful impact on an IEA? Furthermore, we introduce heterogeneity with respect to a country's emphasis on reciprocity, the costs it incurs when implementing a climate-friendly policy, its benefits from preventing negative consequences of climate change, and country size. In addition, the present paper examines which countries might or might not sign an IEA, and identifies the characteristics that determine a country's participation or non-participation in a coalition.

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1. Motivation

The supply of a public good normally falls below an efficient level when it is provided by autonomous agents. This inherent under-provision problem holds much practical importance, especially in the context of global public goods. In the international sphere, there is no supranational authority that can effectively enforce each country's public good contribution. Currently, the most prominent example of a global public good is climate protection. Several attempts have been made in recent decades to overcome the under-provision of the public good and to achieve international cooperation. The Kyoto protocol represents such an attempt, following a top-down approach. To a certain extent, it was considered a symbolic act (Böhringer and Vogt (2003)) where all countries agreed to cut their CO₂ emissions slightly below the 'business as usual'

[☆] Earlier versions of this paper benefitted from valuable comments by Silke Gottschalk and two anonymous referees. We also gratefully acknowledge financial support from the German Federal Ministry of Education and Research, FKZ01LA1139A.

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levels. From an economic perspective (see, e.g. [Finus and Elgar \(2001\)](#)), the negative outcome is not surprising because, from the outset, it is unlikely that an international environmental agreement (IEA), which implements an ambitious climate protection, would be stable. Therefore, a central and ongoing issue in the economics of climate change is the exploration of determinants and arrangements that will ensure the stability of an agreement and restrain participants from abandoning cooperation. In considering a bottom-up approach (see, e.g. [Ostrom \(2000\)](#)), applying the basic precepts that also form the most important components of the Paris Climate Agreement of 2015 is now considered an appropriate route for achieving this goal.

The major element of the bottom-up approach is the partial cooperation between countries, formed through self-enforcing coalitions. It is hoped that these small-size coalitions will eventually evolve into a grand coalition. However, prior studies have shown that the gains from collective action in small coalitions are rather low when countries pursue purely material interests (see, e.g. [Carraro and Siniscalco \(1993\)](#) and [Barrett \(1994, 2003\)](#)). Moreover, rather than occurring automatically, a merger of initially small coalitions would depend on specific motivations that go beyond the selfishness of the participating agents. In fact, there is some empirical evidence that other-regarding preferences (cf. [Lange et al. \(2007\)](#)), wherein issues related to justice and fairness motivate countries' behavior, even during international negotiations on climate protection.

With regard to fairness preferences, the literature distinguishes between *inequality aversion* (see [Bolton and Ockenfels \(2000\)](#) or [Fehr and Schmidt \(1999\)](#)) and *reciprocal fairness*, both of which motivate agents to repay mean (kind) intentions with mean (kind) actions (see [Rabin \(1993\)](#)). While the former is outcome-oriented, the latter builds on beliefs about the intentions of other agents. Nevertheless, as in an equilibrium expectations and real behavior coincide, *intrinsic reciprocity* (see, e.g. [Sobel \(2005\)](#)) boils down to a psychological evaluation of an individual's action in relation to the actual behavior of others (cf. [Camerer and Thaler \(2003\)](#)). In this case, either an own cooperative effort coincides with cooperation by others, which results in a positive feeling; or conversely, an individual expresses resentment when own cooperative efforts meet with non-cooperation from others. An individual's psychological utility also decreases if cooperation from others meets with non-cooperation from the former; this attitude reveals the individual's feeling of guilt.

When previous studies on climate negotiations take psychological fairness preferences into account, they tend to analyze their impact on the size of an IEA. While, in this context, the studies by [Lange and Vogt \(2003\)](#) and [Lange \(2006\)](#) are based on the idea of *inequality aversion*, [Pittel and Rübhelke \(2012, 2013\)](#), [Grüning and Peters \(2010\)](#) as well as [Nyborg \(2017\)](#) are motivated by *reciprocal fairness*. These studies share the idea that fairness has some cooperation-enhancing effect and thus helps to improve climate protection. However, in this paper, we show that an emphasis on fairness in the form of reciprocity may also have the opposite effect, namely, that of destabilizing larger coalitions.

Furthermore, for ease of tractability, most previous papers assume that all countries to be perfectly alike. However, this raises a question on participation incentives when countries differ in some respect. Which characteristics drive a country to join a coalition or to stay away from it? These questions are also addressed in this paper. Until now, a general result and its intuitive reasoning regarding the participation of heterogeneous countries in an IEA has remained an open question.¹

The present bottom-up approach shows the impact of reciprocity on the participation ratio in climate protection. Countries autonomously decide whether to sign an IEA. A country that signs the IEA makes a commitment to avoid greenhouse gas emissions. Hence, signatories reorganize their domestic industries in the direction of a carbon-extensive production by promoting the use of renewable resources, wind energy, or photovoltaics. All of these measures determine a country's cost of becoming a member of an IEA.

Climate-friendly countries form a coalition by signing an IEA. As in [Barrett \(1994\)](#), the agreement remains stable if it is self-enforcing – no signatory has an incentive to break the agreement and, simultaneously, non-signatories have no incentive to join. Furthermore, we introduce heterogeneity with respect to a country's emphasis on reciprocity, the costs it incurs when implementing a climate-friendly policy, its benefits from preventing negative consequences of climate change, and country size.

This paper does not seek to inform decision-makers about how to use their reciprocity behavior or their evaluation of benefits from climate protection strategically, as [Lange and Schwirplies \(2017\)](#) do. Instead, we aim to provide an understanding of how different attitudes towards reciprocity, costs, and benefits can change the outcome of an IEA.

Subsequently, [Section 2](#) presents an extended binary-choice model, which introduces reciprocity in a multi-player context. [Section 3](#) illustrates the stability analysis of IEAs, showing that a strong emphasis on reciprocity stabilizes either no or full participation in an IEA, but destabilizes medium-sized coalitions. Furthermore, we analyze the conditions under which reciprocity has a positive impact on an IEA, and show that stronger reciprocity may yield an inferior outcome for climate protection. Thereafter, in [Section 4](#), we focus on heterogeneity. Here, we examine which countries are more likely to sign an IEA and which characteristics may hamper participation. A short summary in [Section 5](#) concludes the paper.

¹ Most of the literature on countries' heterogeneity and IEAs is empirically oriented and is based on simulations (cf. [Botteon and Carraro \(1997\)](#); [Finus et al. \(2005\)](#); [McGinty \(2007\)](#), or [Bahn et al. \(2009\)](#)). As a result, they do not provide general analytical results. There are only a few theoretical papers that focus on countries which differ in some respect (cf. [Barrett \(1997\)](#); [Fuentes-Albero and Rubio \(2010\)](#); [Pavlova and de Zeeuw \(2012\)](#) or [Kolstad \(2011, 2014\)](#)). Although there is some evidence that the signatories in an IEA are rather similar, even for heterogeneous countries, coalitions of mixed types cannot be excluded.

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