



## Analysis

Self-enforcing Biodiversity Agreements with Financial Support from North to South<sup>☆</sup>Thomas Eichner<sup>a,\*</sup>, Rüdiger Pethig<sup>b</sup><sup>a</sup> Department of Economics, University of Hagen, Universitätsstr. 41, Hagen 58097, Germany<sup>b</sup> Department of Economics, University of Siegen, Unteres Schloss 3, Siegen 57072, Germany

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## ABSTRACT

The present paper analyzes self-enforcing biodiversity agreements (or coalitions) in a multi-country general equilibrium model. Governments split up all land in unprotected and protected land, and there are internationally traded consumption goods that use either protected or unprotected land as an input in production. Global biodiversity is increasing in aggregate protected land. The willingness-to-pay for biodiversity (conservation) is larger in the ‘rich’ North than in the ‘poor’ South. There is an international market on which governments and possibly a coalition of northern countries may demand and/or offer unprotected land for conversion into protected land. If a coalition exists, it turns out to be the only demander on that market, and its demand is increasing in coalition size. We investigate the formation of self-enforcing coalitions when governments and the coalition either take prices as given or exert market power. We find that there are no such coalitions, when external biodiversity benefits are large, but there may be self-enforcing coalitions, even large ones, if these benefits are sufficiently small. Furthermore, it is possible that the South suffers a welfare loss when a self-enforcing coalition of northern countries pays for biodiversity conservation in the South.

## 1. Introduction

Humans have changed ecosystems more rapidly and extensively over the past 50 years than in any comparable period of time in human history (Millennium Ecosystem Assessment, 2005), and they continue to cause a massive decline of world-wide biodiversity despite major efforts to halt biodiversity losses (Naem et al., 2009; Butchart et al., 2010; Ceballos et al., 2015). The Convention on Biological Diversity (1992) aims to conserve the earth's biodiversity for future generations. Its financial mechanism, the Global Environment Facility, assists developing countries in meeting their obligations under the Convention and thus generates global benefits of biodiversity. Although the Global Environment Facility launched many projects<sup>1</sup> to prevent the loss of globally significant biodiversity, mainly in developing countries, the funding is too small to halt the decline of biodiversity. We take the view that the reason for the poor funding is the inadequacy of the prevailing institutional framework rather than an insufficient global willingness-to-pay for biodiversity conservation (BC for short). The Convention on Biological Diversity is not an effective international agreement as is required for the efficient provision of global public goods such as BC.

The analytical challenge is to characterize BC agreements that are self-enforcing and effective.

The present paper investigates the conditions for such BC agreements and the barriers to reach them. A major challenge for effective agreements is the fact that biodiversity is especially rich in developing countries and tends to be endangered due to these countries' priority to raise per capita income even at the expense of domestic biodiversity. The Convention on Biological Diversity acknowledges this dilemma and calls on developed country Parties in Article 20 to provide new and additional financial resources for support of BC in developing country Parties. Our paper seeks to capture the spirit of that Article by assuming that there are two groups or countries, called the South and the North, where the willingness-to-pay for world-wide BC is high in ‘rich’ North and low in ‘poor’ South. Vincent et al. (2014) find that in recent years the public demand for conservation has increased significantly within those tropical developing countries that have reached upper-middle-income status and contain the major share of biodiversity-rich tropical primary forests. However, altogether the call of Article 20 on the North to support BC in the South is still relevant for effective world-wide BC. The aim of our paper is to investigate the formation of self-enforcing BC

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<sup>1</sup> It carried out more than 700 projects that included safeguarding parks and protected areas that cover 300 million ha at some 1000 sites (Panayotou, 1994; Mee et al., 2008).

agreements, in which the North financially supports BC in the South. Based on the observation that a major reason for biodiversity decline is the loss of habitats through urbanization and land conversion into 'agroscares' (Swanson, 1994; Dailey et al., 1997), our analysis will take advantage of the land-use approach to BC (e.g. Panayotou, 1994; Montero and Perrings, 2011). We adopt the analytical framework of Eichner and Pethig (in press), in which each country splits up its total land into unprotected and protected land. The latter is effectively protected through land-use restrictions and therefore provides ecosystem services and local biodiversity. In contrast, land-use restrictions, if any, are assumed to be so weak on unprotected land that it lacks healthy habitats, ecosystem services and biodiversity.

Green goods such as ecotourism and goods from sustainable agriculture and forestry are produced with the input 'protected land' in all countries. Two more consumption goods are produced, different ones in North and South, that require unprotected land as an input. All these goods are traded on international markets and consumed in all countries. Finally, every country derives benefits from local and world-wide biodiversity, and these benefits are increasing in protected land (Montero and Perrings, 2011). It follows that in the absence of BC policies there are several kinds of un-internalized positive BC externalities. Each southern country's protected land creates external BC benefits in all northern countries and in all fellow southern countries, and likewise each northern country's protected land creates external BC benefits in all southern countries and in all fellow northern countries. The focus of our paper is on two institutional arrangements directed towards internalizing some of these BC externalities. First, northern countries may pay for BC in the South to (partly) internalize the external BC benefits it receives from the South, and second, some (or all) northern countries may form a voluntary BC coalition to internalize the external BC benefits each coalition member creates in its fellow coalition members. The larger such a coalition is, the greater is each of its members' willingness-to-pay for BC in the South as compared to the payments offered by northern countries outside a coalition. Thus, such a coalition not only internalizes BC benefits among coalition members, but also renders more effective the internalization of BC benefits the North receives from the South. It is straightforward to show that if the BC coalition consists of all northern countries and maximizes the aggregate welfare of its members and if all governments and the coalition take prices as given, then all external BC benefits are internalized except those each southern country receives from its fellow southern countries.

The crucial question is whether the northern countries have an incentive to form a BC coalition and how the outcome changes when countries and the coalition exert market power. Our paper will focus on these issues. Whether the incentives to form a BC coalition are strong enough is not trivial since in the absence of supranational enforcement, sovereign countries stay in a coalition only if leaving makes them worse off (internal stability), and they stay outside the coalition only, if they would be worse off when joining it (external stability). If both conditions are satisfied, a coalition – or a BC agreement – is said to be self-enforcing or stable.<sup>2</sup> Unfortunately, our numerical results hardly provide support for the desired outcome of large self-enforcing BC coalitions. By and large, we arrive at the proposition that appears to be the thrust of the extant literature on self-enforcing environmental agreements: There tend to be no stable coalition at all, when it is most urgently needed – which is when external environmental benefits are large. The smaller the external benefits, the more favorable are the conditions for the formation of a stable coalition.<sup>3</sup> Thus, the paper offers no convincing theoretical support for the view that a self-enforcing

BC agreement capable to halt the ongoing biodiversity decline will readily form in practice.

Interestingly, this pattern turns out to be similar in the scenarios where countries and the coalition either take prices as given or act strategically in the sense that they seek to manipulate the terms-of-trade in their own favor. However, in the latter case the conditions for stable coalitions get worse. If stable coalitions exist at all, they tend to be smaller than in case of price taking.

Another remarkable result is that the South may suffer a welfare loss in the transition from the economy without cooperation to the economy with the stable coalition. That outcome is disturbing, because one would have expected that combining the North's financial support of BC in the South with cooperation among northern countries would benefit the South or would at least prevent its welfare from declining.

Although the literature on international environmental agreements is quite large (Barrett, 1994a; Rubio and Ulph, 2006; Karp and Simon, 2013; Eichner and Pethig, 2013), there are only four theoretical papers on self-enforcing biodiversity agreements to the best of our knowledge. Barrett (1994b) considers a model in which identical developed countries promote BC in developing countries via financial transfers. He assumes that some developed countries form a coalition that interacts strategically with the developed countries outside the coalition, and finds that coalitions of any size are unstable in his basic game.<sup>4</sup> Winands et al. (2013) extend Barrett's (1994b) model to heterogeneous countries. They account for land conversion, opportunity costs of land conversion, resilience thresholds in ecosystems, and local and global benefits of conserving land. They investigate the formation of coalitions in a Stackelberg game with four countries that are heterogeneous with respect to wealth and biodiversity richness, and they show in numerical simulations that heterogeneity destabilizes the grand coalition. However, if monetary transfers among coalition countries are allowed for, the grand coalition turns out to be always stable. It remains unclear how robust these results are in economies with more than four countries. Alvarado-Quesada and Weikard (2017b) reinterpret Barrett's (1994a) emissions-abatement model as biodiversity conservation model and augment it by a natural upper bound of conservation in each country, by local benefits and modify the assumptions on the shape of the global conservation function. In their model, the stable coalition consists of at most two signatories, if countries are symmetric. In case of asymmetric countries, larger stable coalitions can be achieved if local benefits are large relative to global benefits. Furthermore, transfers may increase the size of the stable coalition. Alvarado-Quesada and Weikard (2017a) analyze self-enforcing biodiversity agreements in a circular spatial structure model with local, regional and global benefits of biodiversity conservation. They find that stable coalitions consists of maximally two members independently of whether countries are symmetric or asymmetric. In this setting, transfer schemes do not improve the size and number of stable coalitions.

As mentioned above, we adopt the analytical framework of Eichner and Pethig (in press), which differs from, and is more complex than, that of Barrett (1994b), Winands et al. (2013) and Alvarado-Quesada and Weikard (2017a,b). In contrast to their models, we apply a land-use approach and consider international markets for consumption goods that play a major role for the outcome in particular, when governments and the coalition exert market power in the form of terms-of-trade manipulation. Eichner and Pethig (in press) focus on the characterization and comparison of three regimes. The world economy *without* BC market (Regime 1), the world economy *with* BC market and with northern countries that form either no coalition (Regime 2) or the coalition consisting of all northern countries (Regime 3). Their analysis leaves unanswered the crucial question whether the formation of

<sup>2</sup> A formal definition of self-enforcement is given in Section 4 below. We use the notions 'self-enforcing' and 'stable' as synonyms.

<sup>3</sup> If external benefits are extremely small, a large coalition and even the grand coalition may be stable. However, below we also present examples in which no stable coalition exists, no matter how small the external benefits are.

<sup>4</sup> Barrett (1994b) proceeds from his basic (one-shot static) game to an analysis of infinitely repeated games and shows that the grand coalition may be stable in such games. The exclusive focus of the present paper is on one-shot games.

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