



Economic analysis of international environmental agreements: lessons learnt 2000–2020

Nicky R. M. Pouw¹ · Hans-Peter Weikard² · Richard B. Howarth³

Accepted: 29 March 2022 / Published online: 15 April 2022
© The Author(s) 2022

Abstract

On the occasion of the 20th anniversary of *International Environmental Agreements: Politics, Law & Economics*, we conduct an extensive review of papers published in this journal that address the economic dimensions of international environmental agreements (IEAs). We focus particularly on the lessons learnt from this body of literature and the implications for the assessment and design of IEAs in relation to goals such as efficiency, effectiveness, and equity. Our key conclusions run as follows. First, at the international level, universal coalitions are more cost-efficient and effective than fragmented regimes, but more difficult to negotiate and less stable. Second, in developing countries, there is need for substantial external funding to cover the short-run costs of environmental compliance. Third, market-based solutions have been increasingly applied in international agreements but with mixed results. For example, cap-and-trade systems have the potential to achieve greenhouse gas emissions reductions and least economic cost. But in the provisioning of water services, private sector solutions often result in outcomes that are unaffordable for low-income groups or nonviable for businesses, suggesting well-designed public–private partnerships. At the international level, Green Bond markets can attract investors for climate and environmental projects, but implementation failures tend to weaken outcomes. Finally, in practical politics, economically optimal designs are rarely achieved. Future applied economic research should therefore critically investigate institutions and the scope for their reform. Gains in knowledge are expected to come from economic analyses taking a broader perspective on “the economy”, taking institutions and social and ecological relations into account from the start.

Keywords Economics of international environmental agreements · Lessons learnt · Market mechanisms · Efficiency · Effectiveness · Equity

Abbreviations

APEC	Asian Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
CDM	Clean Development Mechanisms
CGE	Computable General Equilibrium

✉ Nicky R. M. Pouw
n.r.m.pouw@uva.nl

Extended author information available on the last page of the article

CLRTAP	Convention on Long-Range Transboundary Air Pollution
EMEP	European Monitoring and Evaluation Programme
EU ETS	European Union Emission Trading Scheme
IEA	International Environmental Agreements
GDP	Gross Domestic Product
GEF	Global Environmental Facility
ODS	Ozone Depleting Substances
PPP	Public–Private Partnership
REDD	Reduced Emissions from Deforestation and Forest Degradation
UNEC	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNFCC	United Nations Framework Convention on Climate Change
WFD	Water Framework Directive
WTO	World Trade Organization

1 Introduction

The past 20 years of INEA (2000–2020) provide a rich literature on the economic aspects of international environmental agreements (IEAs). An economic perspective on IEAs is important to better understand strategies and policies, power relations, knowledge, norms and institutions, and their change over time. Economists have investigated IEAs through different methodologies, including general equilibrium modelling, game-theoretic approaches, social situations theory and behavioural economics, and through more descriptive empirical economic analyses at different levels. The topics addressed typically encompass incentives, welfare analysis, transfers and treaty design, transaction costs, finance, taxation, conflicts of interests, strategic dilemmas and institutional change related to climate change, resource use, and biodiversity conservation. Here, we focus on the questions: *What lessons can be learnt regarding the economic aspects of international environmental agreements, in particular how such agreements impact the efficiency, effectiveness, and equity of international environmental policy-making? What are the implications for transforming international and global environmental governance?* To answer these questions, this article reviews some 50 articles that have been published in INEA with keywords like market mechanisms, incentives, institutions, justice, agency, climate change, biodiversity, and water. The next section provides the background. Section 3 reviews the lessons learnt regarding international finance for sustainable development. Section 4 discusses lessons learnt on international climate policy design, distinguishing between universal and fragmented policy regimes. Section 5 reviews empirical analyses of actual cases of IEAs, their policies and instruments, to discern what their output, outcomes, and impact have been in terms of efficiency, effectiveness, and equity. Section 6 reviews articles that address questions of economic methodology and assess economic modelling approaches. Finally, Sect. 7 concludes.

2 Background

In the early economic literature on IEAs, game-theoretic approaches dominated the field (e.g. see DeCanio, 2003; Hovi & Areklett, 2004; Christiansen, 2004; Froyn & Aaheim, 2004). These approaches adopt the rational agent assumption. In practice, this means that

the decision-makers conduct a cost-benefit analysis for making the best (utility-maximizing) decision when, in our case, deciding about IEA membership or design elements of the agreement. With the help of game-theoretic models, the actions of agents involved can be modelled and the costs and benefits of outcomes can be predicted and compared. This provides the basis for assessing the incentives to negotiate an IEA and the impacts of its formation. The scope of this type of cost-benefit analysis varies across research in terms of the scope of welfare outcomes considered. Game-theoretic modelling of IEAs presumes that international agreements are best understood from the perspective that policymakers are primarily concerned with the welfare implications of cooperation. On the one hand, welfare analysis supported by cost-benefit analysis can contribute to the achievement of economic efficiency over intergenerational time-scales. On the other hand, decision-makers may face pressure to emphasize immediate considerations due to political cycles and rent-seeking by powerful actors. Although distortionary, these political economy considerations can drive outcomes related to the short-run costs and benefits of participation in a treaty, who gets to pay what and when, to whom accrue the benefits, and the structuring of financial arrangements.

Over the course of the past 20 years, however, we observe more encompassing economic approaches being deployed to the analysis of IEAs that pay greater attention to the role of (state and non-state) institutions and a broader range of welfare outcomes (Buchner & Carraro, 2006; Lejano, 2006; Eyckmans & Finus, 2006; Carbonell, 2016; Sælen, 2016; Van de Graaf & Van Asselt, 2017), entitlements and risks (Hof et al., 2016; Liu & Faure, 2018; Jiménez-Madrid et al., 2018; Reynolds, 2019), and issues of long-term sustainability (Chou & Sylla, 2008; Hof et al., 2008; Aglietta et al., 2015; Gellers, 2016; Hamdi-Cherif & Weisman, 2016). Institutional utilities and actors are heterogenous (Finus, 2008; Hagen, et al., 2020), whereby some aim for longer-term welfare benefits and others are geared towards short-term political gain. Within the field of international relations, from a political science perspective, Young (2013, p. 87) stated that “The basic message is that institutions are important determinants of human–environment relations but that they typically operate in conjunction with a variety of other drivers in a pattern best described as complex causation”. Since the contributions from a political science approach to IEA’s are reviewed by Kalfagianni and Young (this issue), we refrain from a comparison with economic approaches here. Instead, we observe that economic studies on IEAs, have increasingly recognized the role of international institutions first, and national and sub-national institutions later.

3 International finance for sustainable development

Ever since the Brundtland report (World Commission on Environment & Development, 1987) sustainability has remained high on the agenda. Although in many cases the sustainability of resource use and socio-ecological systems are of local concern, more often the sustainability debate has considered international and indeed global issues. The stability of the earth’s climatic system is probably the single most important concern—to which we turn in the next section—but many other issues such as exploitation of marine and forest resources, biodiversity, freshwater supplies, and chemical pollution also pose important challenges to international policymakers. For the larger part of the global population, environmental concerns are coupled with development goals which, in turn, are coupled with technical and financial support for developing countries. Using a micro-economic model,

Rübbelke (2005) shows that foreign aid can improve the provisioning of global public goods if there are differences in the cost of provision. This result is interesting for at least two reasons. First, Warr (1983) had shown that income transfers between agents in a public goods game do not affect the provision level of the public good. Rübbelke (2005), on the other hand, shows that Warr's neutrality result does not generalize to settings with asymmetric agents. Income transfers to low-cost countries will not be neutral but will instead increase public goods provision. Second, it is remarkable that an unconditional income transfer can have such effects, while in the discussion of policy instruments for public goods provision transfers are usually conditioned on improved provision levels. The prime example here is the Clean Development Mechanism (CDM) in climate finance; see Paulsson (2009) for an overview. Developing countries have a cost advantage in carbon emission reduction. Hence, there are efficiency gains if these countries are offering emission reductions paid for by developed countries. Rübbelke (2005) shows that an alternative mechanism through unconditional aid can work to the same effect.

International aid, conditional or unconditional, has many facets and is often channelled through international institutions such as the World Bank, other development banks, the Global Environmental Facility (GEF)¹ or, related to climate finance particularly, payments for Reduced Emissions from Deforestation and forest Degradation (REDD). The institutional set-up and the effectiveness of such international financial transfer mechanisms have been scrutinized by a number of papers. Heggelund et al. (2005) assess the effectiveness of the GEF for China, one of the greatest beneficiaries of GEF projects. Based on expert interviews, they arrive at the conclusion that GEF projects were instrumental in awareness-building and for technology transfers to improve environmental conditions in China. Most projects have been targeting biodiversity or climate issues. Tacconi et al. (2008) suggest a GEF reform moving beyond project-based finance. They analyse the Association of South-east Asian Nations' (ASEAN) response to haze pollution from peatland fires and find the Agreement on Transboundary Haze Pollution underfunded. Since peatland fires are not just a source of regional air pollution but also a source of carbon emissions to the atmosphere, a global fund like GEF should support the efforts to control fires. As yet the GEF is not flexible enough to provide such support; see also Matz (2005) for a discussion of its legal framework.

A more fundamental critique of transnational funding connected to the provision of environmental services is put forward by McAfee (2016). She considers payments to developing countries meant to incentivize forest carbon storage under the REDD+ scheme.² Major problems of the scheme are: (i) potential leakage when forest protection in one location redirects exploitation to another location; (ii) questionable additionality; and (iii) perverse incentives, including situations in which forest owners could threaten to clear cut in order to extract conservation payments. Such challenges for the REDD+ scheme (and also other schemes of payments for environmental services) invite empirical assessments of their effectiveness and call for action to further develop REDD+ to effectively function as a "Coasean market-based mechanism" (see Loft, 2011). Weber (2018) examines case studies

¹ The Global Environmental Facility (GEF) is a funding mechanism supporting five conventions: Convention on Biological Diversity (CBD), United Nations Framework Convention on Climate Change (UNFCCC), Stockholm Convention on Persistent Organic Pollutants (POPs), UN Convention to Combat Desertification (UNCCD), and Minamata Convention on Mercury.

² The "+" sign is meant to indicate a broader perspective beyond deforestation and degradation towards the enhancement of forest carbon stocks.

of the behaviour of multinational corporations in the forest sector. Of these corporations, many have committed to sustainability goals, to a smaller or larger degree. She finds that reputation effects are an important driver of behaviour that is in line with conservation goals and safeguarded by the Corporate Social Responsibility (CSR) units of the multinational firms. This conclusion is supported by Basak and Van der Werf (2019) who find that civil society organizations can exert effective pressure to foster the effectiveness of the donor–recipient relation in climate finance.

Similar observations can be made in the water sector. Tecco (2008) examines the role of the private sector in the provision of water services in developing countries. Arguably, urgently needed investments in the water sector to provide clean water and sanitation for all can be greatly facilitated by private sector involvement. However, Tecco (2008) finds many examples where private provision of water services was introduced, but then suspended. Bringing private water services to the poor will violate at least one of two conditions: affordability for poor households and cost recovery for the firm. For that reason public–private partnerships (PPPs) are a more promising option where revenue gaps can be closed when water prices are to be kept low. At the same time, PPPs cannot serve as a substitute for but rather presuppose good governance as the proper functioning of PPPs hinges on a proper design and administration.

Still, market mechanisms and quasi-markets where the government procures environmental services have become more important in the domain of public and environmental goods, such as biodiversity conservation. Alvarado-Quesada and Weikard (2017) argue that an international biodiversity market could function as an efficient transfer mechanism between coalition countries with differing biodiversity endowments. This could ensure a more broad-based participation in a conservation agreement and be effective in terms of biodiversity gains (p. 750). Their results are derived from a game-theoretic analysis of international conservation agreements characterized by country-specific natural upper bounds of conservation, local benefits, and overlaps between countries' conservation plans that lead to a sub-additive global conservation function.

4 International climate policy regimes

In the broad literature on climate policy regimes a distinction is made between universal and fragmented regimes (Hof et al., 2008; Verbruggen, 2011). Universal regimes imply a single treaty in which all countries participate, whereas fragmented regimes accommodate multiple treaties or a single treaty with participating and non-participating countries as actors. In the late 2000s, Hof et al. (2008, p. 39) argued that the post-2012 climate policy regime could evolve in either direction. In their extensive review of the economic literature on this topic, they concluded that, in a universal regime, the costs of stabilizing GHG concentrations are lower than in a fragmented regime, where the reductions must be achieved by a smaller number of countries and opportunities to find the cheapest mitigation opportunities are more limited. Yet, free-riding is more likely in a universal regime, if global agreements cannot be made binding. Hof et al. (2008) predicted that a transitional fragmented regime was the most feasible trajectory: “[T]his regime should preferably be larger than the countries with reduction commitments in the Kyoto Protocol. Such a coalition could provide the basis for a larger, universal regime in the long term” (p. 59).

Accordingly, several studies have analysed fragmented regimes which are called “partial coalitions” in a game-theoretic strand of literature. Klis (2019) considers the stability of

fragmented regimes when a proportional treatment of heterogeneous countries is agreed upon. Her results do not support the idea that a universal regime (or grand coalition) could grow out of a fragmented regime (or partial coalition). Nagashima and Dellink (2008) arrive at similar results. They consider technological change and, in particular, technological spillovers and find that spillovers can facilitate the abatement of GHGs. However, the stability of larger coalitions is hampered by strong free-rider incentives. It should be noted that these studies neither address issues of international equity nor the role of institutional quality. Having witnessed the ratification of the Paris Agreement in 2016, one year after its adoption, what we observe is a “regime complex” (Pattberg & Widerberg, 2018) that brings together “the broad activities of smaller groups of states as well as non-party actors, such as cities, regions, companies, and non-governmental organizations along with United Nations agencies” (p.2). The Paris Agreement, although universal in nature, emerged partially from a bottom-up process whereby the Nationally Determined Contributions (NDCs) have played a central role. Each country makes an effort to reduce GHG emissions and invests in climate change adaptation. This is clearly different from the top-down orchestrated Kyoto 2012 agreement that imposed legally binding commitments for a number of participating countries.³

As pointed out by Pillay and Viñuales (2016, p. 933), three issues have historically challenged negotiations over climate policy regimes: state sovereignty, climate finance, and the inclusion of big polluting nations. The NDCs seem to be an innovative response to each of these three issues. Although NDCs were not immediately on the radar of economic modelling of treaty design, they are now understood as useful instruments in climate negotiations allowing for stepwise contributions and conditional commitments. Winkler et al. (2018) observe, based on an analysis of 163 NDCs, that equity concerns are rather informally represented by a range of different indicators, including a country’s “small share”, per capita emissions, adaptation, and vulnerability. Claims to “equity” are not substantiated or are narrowly based on empirical assessment by country experts. None of the NDCs explore the consequences of generalizing their approach to all countries. Given that fair contributions would facilitate a stepwise strengthening of commitments—in line with the architecture of the Paris Agreement—Winkler et al. (2018) conclude that more and more consistent information on “equity” is needed.

In an analysis of 154 countries’ treaty ratifications concerning 178 IEAs (from 1950 to 2011) Mohrenberg et al. (2019) find that a formal funding mechanism should be incorporated in the design in order to balance costs and benefits across participants. The authors conclude that contributions and entitlements towards such funding mechanisms should be voluntary. The latter helps maintain national sovereignty to some degree and thus lowers the hurdles to participation. In other words, if IEAs comprise mechanisms to protect rights, chances of participation are expected to increase. When equity and institutional feasibility are taken into account in addition to cost-effectiveness and efficiency, universal treaties can be criticized for negating diversity and state sovereignty, as has been argued by Verbruggen (2011). Universal treaties may even not be as efficient as presumed in most economic models, since a global carbon tax is hard to agree upon in a diverse and conflicting world. Uniform regimes may exacerbate equity conflicts rather than lessen them. Conflicts are costly and a source of delay; something countries cannot afford in the process of climate change mitigation. In the light of this, Verbruggen (2011) advises to “give first and full preference

³ Admittedly, the enforcement mechanisms had little bite.

to the transformation of the energy systems, putting other drivers of climate change and imperatives of sustainable development in second order” (p. 292).

Chester and Moomaw (2008) propose a matrix to categorize different regime designs in terms of type of collaboration (Type 1: governmental; Type 2: governmental & non-state; and 3: non-state) and geographical type (A: domestic; B: transborder; and C: interstate/transnational), thus providing a more nuanced framework for mapping differences across regime designs than the universal-fragmented distinction. One advantage of this approach is that the role of NGOs and other non-state actors is best understood in terms of actors that can perform certain governance functions regionally and internationally “without threatening the essence of state sovereignty” (p. 202). Likewise, Roggero et al. (2019) characterize smaller regional governance arrangements (fragmented regimes) with multiple stakeholders involved as being effective to improve cooperation in IEAs and for the development of climate adaptation strategies.

Thus, over the past 20 years, institutional context and feasibility at multiple levels of governance have drawn increasing attention of economists as an important piece of the puzzle in understanding climate policy regime design. Institutions are recognized as important conditioning and mediating factors that influence the efficiency, effectiveness, and equity of IEA policy outputs, outcomes, and impact, which brings us back to Young’s (2013) statement on the important role of institutions in IEAs (2013). We shall now turn to reviewing the empirical economic literature on each of these factors.

5 Assessing IEAs: efficiency, effectiveness, and equity

In this section, we review a selection of INEA studies on the efficiency, effectiveness, and equity of IEAs, including the European Water Framework Directive, the EU Emission Trading Scheme, Green Bond markets, and others.

The objective to phase-out and manage Ozone Depleting Substances (ODS) within the EU Member States has found broad-based agreement in a long series of EU agreements and regulations. As described by Næss (2004, p. 51), the EU ozone policy has developed in line with other international negotiations on ODS (i.e. Vienna Convention 1985; Montreal Protocol 1987) in its early stages.

The European Union Emission Trading Scheme (EU ETS) can be considered a relatively recent result of IEA formation which—since its inception in 2005—has constituted an important market for CO₂ emission allowances. It took the EU ETS some time to become effective to fulfil emission reduction targets. The market of emission trading was unstable and not effective because the emissions cap was not sufficiently stringent. In the analysis by Galán-Valdivieso et al. (2018) two phases are discerned. During the first phase, from 2005 to 2012, the pattern of the EU ETS trading is described as “erratic” due to “discretionary policies, an oversupply of allowances and reduced economic activity due to the global crisis” (p. 689). But the second phase, from 2013 onwards, proved to be more stable and supported by greater trust, due to a series of market regulation mechanisms. This shows that the full impact of an IEA needs to be assessed over the long run, as adequate responses to intermediate institutional and contextual changes need to be developed over time. The equitability of the EU ETS at the global level remains an open question.

Green Bond markets are internationally perceived as an effective instrument to attract diverse and long-term investors to invest in climate and environmental projects. The first Green Bond was introduced by the World Bank in 2009. Favourable tax exemption

measures aim to create economic incentives to invest in Green Bonds worldwide. However, the efficiency of Green Bond markets varies across countries and regions due to differences in political regulation. For example, there is no room for soft laws in each and every country. In China, the near future of the world's largest Green Bond market is seen to be hampered by regulatory arbitrage and implementation defects (Huang & Yue, 2020, p. 99), despite its rapid initial growth. Adequate responses to this impasse may be more difficult to achieve in the mid-term within a top-down directed economy such as China, compared to a bottom-up governance context.

The European Water Framework Directive (WFD)—first put in place in the year 2000—is an agreement that seeks to protect freshwater resources from pollution and deterioration uniformly across EU member state countries. The WFD is different from other IEAs in the sense that the WFD is grounded in a federal system, in which there is a transnational government with a constitution and with legislative and executive powers. This is safeguarding measures to protect freshwater resources and preserve them for human consumption with direct impacts on land-use and production activities. The impacts of safeguarding zones are commonly measured in terms of short-term income loss across agriculture and industries (GDP loss). In addition, positive and negative social goods are assessed. For example, Jiménez-Madrid et al. (2018) assess the balance between economic and social losses (compensation costs) and social goods by means of assigning a monetary value to the preserved hydrological resource in the context of the Jarama–Tajuña body of alluvial water in central Spain. Their empirical application shows that large external funding is needed to cover the immediate GDP losses. Yet, the question remains how to compare gains and losses over the long run?

Last but not least, energy subsidies have been scrutinized in multiple INEA contributions for their impact on fossil fuel extraction and consumption and the transition towards renewable energy industries, including in a special issue (Smith & Urpelainen, 2017; Van de Graaf & Van Asselt, 2017; Skovgaard, 2017; Van Asselt & Kulovesi, 2017; Young, 2017; Meyer, 2017; DeBievre et al., 2017; Kalimo et al., 2017). The economic debate on energy subsidies hitherto has focused on: (i) the phasing out of (harmful) fossil fuel subsidies; (ii) which subsidies work; (iii) the adoption of renewable energy subsidies; and (iii) what institutions could and/or should play a role. The Paris Agreement does not explicitly call for the phasing out of fossil fuel subsidies, yet according to Van Asselt and Kulovesi (2017) it “offers an important signal that the world is moving towards a low-carbon future” (p. 323). Energy subsidies (or “support”) are a highly politicized topic, which in part explains the many different context-specific approaches taken to study their phase out/in, as well as the lack of comprehensive impact assessments. Instead, the INEA literature thus far has focused primarily on the role that different institutions could play in making progress in this realm (Van de Graaf & Van Asselt, 2017).

Young (2017) suggests that most progress can be achieved through regional collaboration, rather than multilateral efforts. In the June 2017 special issue of INEA on this topic, Van de Graaf and Van Asselt (2017) conclude that considerable knowledge on the role of relevant institutions to address energy subsidies has been accumulated, but “it remains unclear how the regime complex for energy subsidies functions as a whole” (Van de Graaf & Van Asselt, 2017, p. 324). This is due, not the least, to lack of coherence of the definition and measurement of energy subsidies (Van de Graaf & Van Asselt, 2017, p. 317). Dominant methods for measurement usually take a price gap or inventory approach. The price gap approach simply quantifies the net effect of various support measures on the consumer price. The inventory approach accounts for the various forms of support to consumers and producers. The difficulty lies in the assessment of different subsets being labelled as

subsidy, or not. Furthermore, in the same special issue it is noted that support of renewable energy is continuously challenged (Van de Graaf & Van Asselt, 2017, 321), in contrast to long-standing support of fossil fuels. However, calls for reform are increasing and mainly targeted at national or sub-national state entities, since they are in charge of implementing energy subsidies. But they are not the only actors called upon in the “regime complex” (p. 324). Multilateral institutions and strategic platforms can signal energy subsidy reform needs and assist in implementation. Moreover, organizations such as WTO play a role in redirecting financial investments from (harmful) fossil fuels subsidies towards renewable energies (De Bièvre et al., 2017). Kalimo et al. (2017), however, see a less pronounced role for the WTO dispute settlement mechanism: member states themselves should regulate the balancing of economic and environmental values under the WTO Agreement on Subsidies and Countervailing Measures. Multilateral institutions and platforms are furthermore found to be important for building-up a knowledge base, enhancing transparency, and collaborating effectively in PPP’s (Van de Graaf & Van Asselt, p. 321).

In each of the above studies, equity or fairness results have been addressed to a limited extent by discussing transfer schemes to resolve certain initial differences between countries. However, these transfers were discussed in the light of their (hypothesized) impact on coalition formation, and not so much in terms of empirical outcomes or impacts. Like Goncenc et al. (2020) rightfully observe, although fairness and equity are emerging themes in the economic analysis of IEAs, “critical questions about [impacts on] vulnerable groups” (e.g. indigenous communities) and “potential pathways for more equitable sharing of benefits and burdens” remain to be an under-researched area in the current literature. Moreover, often empirical economic analysis seeks to quantify observed effects—which is easier for efficiency or effectiveness than for equity. More efforts are needed, therefore, by economic research to employ appropriate indicators to investigate and assess equity impacts of IEAs.

6 Methodological lessons learnt

Turning to issues of methodology, the goal of this section is twofold. First, we offer a brief survey of contributions to INEA that directly address methodological questions. We assess these contributions on their potential impact on research agendas. Second, although INEA, by its set-up as a multidisciplinary journal, could also serve as a platform for interdisciplinary work, we observe that virtually all papers remain in their respective disciplinary domain. In particular, an economics-political science integration is hardly observed. We identify opportunities for interdisciplinary research synergies.

In the economic mainstream, a workhorse model for the analysis of international environmental agreements has become established over the last 25 years. The model applies a two-stage game to analyse countries’ incentives to cooperate; see Carraro and Siniscalco (1993) and Barrett (1994) for seminal papers and Hagen et al. (2020) for a recent survey. This well-established model generally assumes rational agents, often in conjunction with perfect information. Several papers published in INEA have been moving beyond this model framework by modifying fundamental assumptions or even paving the way to alternative approaches. The Theory of Social Situations introduced by Greenberg (1990) is employed by Lise and Tol (2004) to study international cooperation on climate policies. Greenberg’s theory offers a richer environment than standard game theory. It considers “social situations” which represent the social environments of agents including their information. This allows in particular for a representation of institutions that guide agents’

behaviours and of collective behaviour of subgroups of agents. Using this framework Lise and Tol (2004) examine the ratification of the Kyoto Protocol. They find game outcomes with a larger degree of cooperation compared with the standard analysis, and thus more support for the Kyoto Protocol which entered into force in 2005. We do not know of any other application of Greenberg's Theory of Social Situations to climate policy-making and speculate that its complexity hampers more wide-spread application and lack of acceptance among economists.

The last decade has seen a “behavioural turn” in economic methodology (Truc et al., 2021), i.e. mainstream economics has increasingly employed experimental methods and explored the consequences of behavioural assumptions that are incompatible with standard assumptions on consistency of preferences and rational behaviour. Several publications have been contributing to this literature. Gsottbauer and Van den Bergh (2013) review the most important behavioural deviations from standard theory, such as equity preferences, altruism and envy, loss aversion, and myopia in order to explore their impacts for climate negotiations. While equity preferences and altruism can be expected to foster cooperation (see also Grüning & Peters, 2010; Van der Pol et al., 2012), biases in decision-making are likely to weaken and delay cooperation as it is obvious for myopic behaviour when future climate damages are undervalued.

Behavioural assumptions also play a decisive role in the analysis of environmental policy-making when the agents considered are not individuals but political or institutional entities such as states, municipalities, governments, firms, lobby groups, or others. Brandt and Svendsen (2004) consider industry and environmental lobbies' cooperation to promote renewable energies. Their argument uses standard assumptions about preferences, and therefore behaviour, of the industrial lobby but assumes moral motives that drive environmentalists' behaviour. Similarly, Anger et al. (2016) consider the impact of special interest groups on policy outcomes (the European Union's Emissions Trading Scheme, EU ETS). Interest groups are collective agents characterized by their behavioural features while the collective decision-making within an interest group is not considered. In the same manner Hagen, Altamirano Cabrera, et al. (2020) examine the stability of international climate coalitions when governments are influenced by competing industry and environmental lobbies. Such models seek to offer explanations for observations that remain unexplained under standard assumptions of rational, welfare-maximizing governments. Clearly, the ideas date back to political economy models of the 1950s and 60 s (e.g. Downs, 1957) but appear in a new light when viewed through a behavioural economics lens. The political economy of international environmental agreements has been identified as an under-researched area by Wangler et al. (2013) and this has not changed much since then. The adoption of insights from behavioural economics could give a new push to political economy research through investigation of the behaviours of groups and institutional entities.

Reflections on economic methodology are driven by the question of successful explanation. DeCanio (2005) distinguishes descriptive and conceptual economic models. The former aim at descriptive accuracy, that is a good fit with observed phenomena. Ultimately such models would be used for forecasting. The paradigm example, according to DeCanio, is the use of large-scale computable general equilibrium (CGE) models, where the economy is represented by multiple sectors with their respective technologies. DeCanio is critical of this modelling approach—at least in the domain of climate policy analysis—since the long-term impacts of climate change and therefore the benefits of climate action are hard to assess. Consequently, the focus of such models has been on the cost side, leading to biased results. By contrast, DeCanio (2005) is positive about conceptual models. These models can be described as thought experiments to explore the impacts of normative and

other assumptions, although not in a quantitative way. It can be added that conceptual models reveal mechanisms in an economic system, while the mechanisms at work in large-scale numerical (simulation) models are often hidden if not impossible to recover.

Tveit (2018) examines the explanatory power of Chayes and Chayes's (1993) influential theory of non-compliance with international agreements. Explanations offered by this theory refer to ambiguity of contracts and lack of state capacity. Tveit's scrutiny of the Gothenburg protocol on addressing acid rain provides no evidence for this theory of non-compliance. The findings rather suggest that simply the absence of enforcement (i.e. incentives to comply) explains non-compliance, but the empirical data are not conclusive to fully confirm this.

In recent years, the landscape of interdisciplinary research has gained importance (Buyalskaya et al., 2021). This opens opportunities for a multidisciplinary journal such as INEA. As yet, with few exceptions from the intersection of law and economics (e.g. Halvorssen & Hovi, 2006; Reynolds, 2019), most research continues to take disciplinary approaches. We expect to see this changing, facilitated by the rise of behavioural economics, and INEA as becoming a target journal for integrated work on law and economics as well as governance and economics.

7 Conclusion

Surveying papers over two decades shows that economic analysis has focused on institutional design questions of international environmental agreements. Employing Buchanan's (1975) famous distinction between *choice of rules* and *choice within rules*, institutional design problems concern the former, but the answers are only found when considering the latter. Institutions for international cooperation must set incentives for individuals to provide for the common good. In game-theoretic terms, a model tries to capture a strategic situation, and while it examines the outcomes of the interaction under different rules, the institutional design problem is addressed which facilitates the choice of the rules of the game. Incentives then play at two levels. First, within an agreement, incentives for compliance matter to bring about what has been agreed upon. Second, even if an agreement is fully functioning, there must be incentives to participate in the first place. A strand of largely theoretical research has addressed such optimal design questions, focusing on quantifiable efficiency and effectiveness outcomes and less so on issues addressing equity and justice.

We identify a number of key findings coming out of 20 years of economic research within INEA. First, at the international level, game-theoretic analyses conclude that universal coalitions offer efficiency gains compared to fragmented regimes. The prominent example is the case of stabilizing GHG concentrations. However, universal regimes are more difficult to negotiate and their stability is undermined by strong free-rider incentives. One way to resolve this is by bottom-up climate change negotiations. Yet, bottom-up processes may end up sacrificing both equity and effectiveness.

Second, in developing countries there is need for large external funding to cover immediate GDP losses in transition processes. This is because of a general lack of capital and the need to alleviate poverty related to higher energy prices in a transition period. However, this is also the case for certain population subgroups and regions within high-income countries. The GEF has demonstrated to be instrumental in awareness-building and (limited) technology transfers to improve environmental conditions in the case of

China, but the resources available and the complex procedures have hampered a take-off of sustainability measures in the global South. The legitimacy of the GEF is important for realizing effective outcomes in terms of improved environmental standards.

Third, market-based solutions have been increasingly applied in international agreements but with mixed results. The EU ETS, after having travelled an erratic learning path, functions well among like-minded partners. But it cannot be easily scaled up to a global market since allocating emissions globally involves unresolved equity issues. While the CDM has enabled project-based emission reductions in middle-income countries and generated cost-efficiency gains by offering low-cost carbon emission reductions to high-income countries, it has been ineffective in slowing down the rise of emissions in low-income countries.

Finally, in the case of water service delivery to low-income groups, private provision is found to be violating an affordability criterion for the poor, and/or business viability. PPPs constitute a more promising option where revenue gaps can be closed when water prices are to be kept low. However weak governance will undermine the effectiveness of PPPs. At the national level, energy subsidies are problematic as there is lack of agreement on the proper definition and measurement of energy subsidies that complicates comparative analysis. Overall, support of renewable energy is challenged, whereas support of fossil fuels is not. All actors and institutions need to be engaged with reforming the energy subsidy regime complex into more inclusive and sustainable schemes. At the international and national level, Green Bond markets can attract diverse and long-term investors for climate and environmental projects, but defects in the implementation of these projects weaken the outcomes.

In practical politics, optimal designs are rarely achieved. A major task of applied research is therefore the critical assessment of institutions and of the scope for their reform. While welfare economic assessments have dominated this research, they have been complemented by political economy and behavioural economics approaches. Key findings stemming from the economic analysis that has featured in INEA are that: (a) institutional context and design have become the focus of IEA research; (b) efficiency and effectiveness featured prominently in economic analysis; (c) market mechanisms have become more important in the domain of public and environmental goods; (d) this has opened-up broad-based participation in climate mitigation and biodiversity conservation; (e) the need for institutional reform remains a recurrent issue; and (f) there is more room for interdisciplinary work, including measurement of impacts of policies on equity.

Following up on these findings, although INEA offers a rich portfolio of economic research on international environmental cooperation, three research gaps can be identified. First, in the theoretical analysis of IEAs models from non-cooperative game theory are dominating the field. These, with few exceptions, assume rational agents, which reflects a narrow perspective on the economy. Social choice approaches that consider institutional design principles beyond efficiency, namely conditions of equal treatment or equal access to resources have hardly been explored in the domain of IEAs. Second, the behavioural turn in economics is only just gaining pace in environmental economics and the analysis of IEAs. We expect that contributions from behavioural economics will take a growing share of INEA publications in the future. Third, although its importance is widely acknowledged, interdisciplinary work that bridges between economic, political, and social science perspectives on IEAs is still a small niche of research. INEA, by its very nature a multidisciplinary journal, will be regarded as an ideal target journal for interdisciplinary work in the decades to come.

Acknowledgements We gratefully acknowledge valuable comments by two anonymous reviewers and the editor.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Aglietta, M., Hourcade, J. C., Jaeger, C., & Fabert, B. P. (2015). Financing transition in an adverse context: Climate finance beyond carbon finance. *International Environmental Agreements: Politics, Law and Economics*, 15(4), 403–420.
- Alvarado-Quesada, I., & Weikard, H.-P. (2017). International Environmental Agreements for biodiversity conservation: A game theoretic analysis. *International Environmental Agreements: Politics, Law and Economics*, 17(5), 731–754.
- Anger, N., Asane-Otoo, E., Böhringer, C., & Oberndorfer, U. (2016). Public interest versus interest groups: A political economy analysis of allowance allocation under the EU emissions trading scheme. *International Environmental Agreements: Politics, Law and Economics*, 16(5), 621–638.
- Barrett, S. (1994). Self-enforcing international environmental agreements. *Oxford Economic Papers*, 46, 878–894.
- Basak, R., & van der Werf, E. (2019). Accountability mechanisms in international climate change financing. *International Environmental Agreements: Politics, Law and Economics*, 19(3), 297–313.
- Brandt, U. S., & Svendsen, G. T. (2004). Fighting windmills: The coalition of industrialists and environmentalists in the climate change issue. *International Environmental Agreements: Politics, Law and Economics*, 4(4), 327–337.
- Buchanan, J. M. (1975). *The limits of liberty. Between anarchy and leviathan*. University of Chicago Press.
- Buchner, B., & Carraro, C. (2006). US, China and the economics of climate negotiations. *International Environmental Agreements: Politics, Law and Economics*, 6(1), 63–89.
- Buyalskaya, A., Gallo, M., & Camerer, C. F. (2021). The golden age of social science. *Proceedings of the National Academy of Sciences*, 118(5).
- Carbonell, J. R. (2016). Military spending, liberal institutions and state compliance with international environmental agreements. *International Environmental Agreements: Politics, Law and Economics*, 16(5), 691–719.
- Carraro, C., & Siniscalco, D. (1993). Strategies for the international protection of the environment. *Journal of Public Economics*, 52(3), 309–328.
- Chayes, A., & Chayes, A. H. (1993). On compliance. *International Organization*, 47(2), 175–205.
- Chester, C. C., & Moomaw, W. R. (2008). A taxonomy of collaborative governance: A guide to understanding the diversity of international and domestic conservation accords. *International Environmental Agreements: Politics, Law and Economics*, 8(3), 187–206.
- Chou, P. B., & Sylla, C. (2008). The formation of an international environmental agreement as a two-stage exclusive cartel formation game with transferable utilities. *International Environmental Agreements: Politics, Law and Economics*, 8(4), 317–341.
- Christiansen, A. C. (2004). The role of flexibility mechanisms in EU climate strategy: Lessons learned and future challenges? *International Environmental Agreements: Politics, Law and Economics*, 4(1), 27–46.
- De Bièvre, D., Espa, I., & Poletti, A. (2017). No iceberg in sight: On the absence of WTO disputes challenging fossil fuel subsidies. *International Environmental Agreements: Politics, Law and Economics*, 17(3), 411–425.
- DeCanio, S. J. (2003). Economic analysis, environmental policy, and intergenerational justice in the Reagan administration the case of the Montreal protocol. *International Environmental Agreements: Politics, Law and Economics*, 3(4), 299–321.
- DeCanio, S. J. (2005). Descriptive or conceptual models? Contributions of economics to the climate policy debate. *International Environmental Agreements: Politics, Law and Economics*, 5(4), 415–427.

- Downs, A. (1957). *An economic theory of democracy*. Harper & Row.
- Eyckmans, J., & Finus, M. (2006). New roads to international environmental agreements: The case of global warming. *Environmental Economics and Policy Studies*, 7(4), 391–414.
- Finus, M. (2008). Game theoretic research on the design of international environmental agreements: Insights, critical remarks, and future challenges. *International Review of Environmental and Resource Economics*, 2(1), 29–67.
- Froyen, C. B., & Aaheim, H. A. (2004). Sectoral opposition to carbon taxes in the EU—A myopic economic approach. *International Environmental Agreements: Politics, Law and Economics*, 4(3), 279–302.
- Galán-Valdivieso, F., Villar-Rubio, E., & Huete-Morales, M. D. (2018). The erratic behaviour of the EU ETS on the path towards consolidation and price stability. *International Environmental Agreements: Politics, Law and Economics*, 18(5), 689–706.
- Gellers, J. C. (2016). Crowdsourcing global governance: Sustainable development goals, civil society, and the pursuit of democratic legitimacy. *International Environmental Agreements: Politics, Law and Economics*, 16(3), 415–432.
- Gonenc, D., Piselli, D., & Sun, Y. (2020). The global economic system and access and allocation in earth system governance. *International Environmental Agreements: Politics, Law and Economics*, 20(2), 223–238.
- Greenberg, J. (1990). *The theory of social situations*. Cambridge University Press.
- Grüning, C., & Peters, W. (2010). Can justice and fairness enlarge international environmental agreements? *Games*, 1(2), 137–158.
- Gsottbauer, E., & Van den Bergh, J. C. (2013). Bounded rationality and social interaction in negotiating a climate agreement. *International Environmental Agreements: Politics, Law and Economics*, 13(3), 225–249.
- Hagen, A., Altamirano Cabrera, J. C., & Weikard, H.-P. (2020a). The influence of political pressure groups on the stability of international environmental agreements. *International Environmental Agreements: Politics, Law and Economics*. <https://doi.org/10.1007/s10784-020-09520-5>
- Hagen, A., von Mouche, P., & Weikard, H.-P. (2020b). The two-stage game approach to coalition formation: Where we stand and ways to go. *Games*, 11(1), 3.
- Halvorssen, A., & Hovi, J. (2006). The nature, origin and impact of legally binding consequences: The case of the climate regime. *International Environmental Agreements: Politics, Law and Economics*, 6(2), 157–171.
- Hamdi-Cherif, M., & Waisman, H. (2016). Global carbon pricing and the “Common But Differentiated Responsibilities”: The case of China. *International Environmental Agreements: Politics, Law and Economics*, 16(5), 671–689.
- Hegglund, G., Andresen, S., & Ying, S. (2005). Performance of the global environmental facility (GEF) in China: Achievements and challenges as seen by the Chinese. *International Environmental Agreements: Politics, Law and Economics*, 5(3), 323–348.
- Hof, A. F., Den Elzen, M. G. J., & Beltran, A. M. (2016). The EU 40% greenhouse gas emission reduction target by 2030 in perspective. *International Environmental Agreements: Politics, Law and Economics*, 16(3), 375–392.
- Hof, A. F., den Elzen, M. G., & van Vuuren, D. P. (2008). Analysing the costs and benefits of climate policy: Value judgements and scientific uncertainties. *Global Environmental Change*, 18(3), 412–424.
- Hovi, J., & Areklett, I. (2004). Enforcing the climate regime: Game theory and the Marrakesh accords. *International Environmental Agreements: Politics, Law and Economics*, 4(1), 1–26.
- Huang, T., & Yue, Q. (2020). How the game changer was generated? An analysis on the legal rules and development of China’s green bond market. *International Environmental Agreements: Politics, Law and Economics*, 20(1), 85–102.
- Jiménez-Madrid, A., Gómez, S., Gémar, G., & Martínez, C. (2018). A proposed methodology for assessing the economic needs of safeguard zones protecting groundwater intended for human consumption within the context of the European Water Framework Directive. *International Environmental Agreements: Politics, Law and Economics*, 18(5), 723–742.
- Kalimo, H., Sedefov, F., & Jansson, M. S. (2017). Market definition as value reconciliation: The case of renewable energy promotion under the WTO Agreement on Subsidies and Countervailing Measures. *International Environmental Agreements: Politics, Law and Economics*, 17(3), 427–443.
- Klis, A. A. (2019). Identity and equal treatment in negative externality agreements. *International Environmental Agreements: Politics, Law and Economics*, 19(6), 615–630.
- Lejano, R. P. (2006). The design of environmental regimes: Social construction, contextuality, and improvisation. *International Environmental Agreements: Politics, Law and Economics*, 6(2), 187–207.
- Lise, W., & Tol, R. S. (2004). Attainability of international environmental agreements as a social situation. *International Environmental Agreements: Politics, Law and Economics*, 4(3), 253–277.

- Liu, J., & Faure, M. (2018). Risk-sharing agreements to cover environmental damage: Theory and practice. *International Environmental Agreements: Politics, Law and Economics*, 18(2), 255–273.
- Loft, L. (2011). Market mechanisms for financing the reduction of emissions from deforestation and degradation in developing countries (REDD)—learning from payments for ecosystem services schemes. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 7(3), 204–216.
- Matz, N. (2005). Financial institutions between effectiveness and legitimacy—a legal analysis of the World Bank, Global Environment Facility and Prototype Carbon Fund. *International Environmental Agreements: Politics, Law and Economics*, 5(3), 265–302.
- McAfee, K. (2016). Green economy and carbon markets for conservation and development: A critical view. *International Environmental Agreements: Politics, Law and Economics*, 16(3), 333–353.
- Meyer, T. (2017). Explaining energy disputes at the World Trade Organization. *International Environmental Agreements: Politics, Law and Economics*, 17(3), 391–410.
- Mohrenberg, S., Koubi, V., & Bernauer, T. (2019). Effects of funding mechanisms on participation in multilateral environmental agreements. *International Environmental Agreements: Politics, Law and Economics*, 19(1), 1–18.
- Næss, T. (2004). The effectiveness of the EU’s ozone policy. *International Environmental Agreements: Politics, Law and Economics*, 4(1), 47–63.
- Nagashima, M., & Dellink, R. (2008). Technology spillovers and stability of international climate coalitions. *International Environmental Agreements: Politics, Law and Economics*, 8(4), 343–365.
- Pattberg, P., & Widerberg, O. (2018). The climate change regime. In Von Storch (Ed.), *Oxford research encyclopedia of climate science*. Oxford University Press.
- Paulsson, E. (2009). A review of the CDM literature: From fine-tuning to critical scrutiny? *International Environmental Agreements: Politics, Law and Economics*, 9(1), 63–80.
- Pillay, K., & Viñuales, J. E. (2016). “Monetary” rules for a linked system of offset credits. *International Environmental Agreements: Politics, Law and Economics*, 16(6), 933–951.
- Reynolds, J. L. (2019). An economic analysis of international environmental rights. *International Environmental Agreements: Politics, Law and Economics*, 19(6), 557–575.
- Roggero, M., Kähler, L., & Hagen, A. (2019). Strategic cooperation for transnational adaptation: Lessons from the economics of climate change mitigation. *International Environmental Agreements: Politics, Law and Economics*, 19(4), 395–410.
- Rübelke, D. T. (2005). Foreign aid and global public goods: Impure publicness, cost differentials and negative conjectures. *International Environmental Agreements: Politics, Law and Economics*, 5(2), 151–173.
- Sælen, H. (2016). Side-payments: An effective instrument for building climate clubs? *International Environmental Agreements: Politics, Law and Economics*, 16(6), 909–932.
- Skovgaard, J. (2017). The devil lies in the definition: Competing approaches to fossil fuel subsidies at the IMF and the OECD. *International Environmental Agreements: Politics, Law and Economics*, 17(3), 341–353.
- Smith, J. E., & Urpelainen, J. (2017). Removing fuel subsidies: How can international organizations support national policy reforms? *International Environmental Agreements: Politics, Law and Economics*, 17(3), 327–340.
- Tacconi, L., Jotzo, F., & Grafton, R. Q. (2008). Local causes, regional cooperation and global financing for environmental problems: The case of Southeast Asian Haze pollution. *International Environmental Agreements: Politics, Law and Economics*, 8(1), 1–16.
- Tecco, N. (2008). Financially sustainable investments in developing countries’ water sectors: What conditions could promote private sector involvement? *International Environmental Agreements: Politics, Law and Economics*, 8(2), 129–142.
- Truc, A., Claveau, F., & Santerre, O. (2021). Economic methodology: A bibliometric perspective. *Journal of Economic Methodology*, 28(1), 67–78. <https://doi.org/10.1080/1350178X.2020.1868774>
- Tveit, A. K. (2018). Can the management school explain noncompliance with international environmental agreements? *International Environmental Agreements: Politics, Law and Economics*, 18(4), 491–512.
- Van Asselt, H., & Kulovesi, K. (2017). Seizing the opportunity: Tackling fossil fuel subsidies under the UNFCCC. *International Environmental Agreements: Politics, Law and Economics*, 17(3), 357–370.
- Van de Graaf, T., & van Asselt, H. (2017). Introduction to the special issue: Energy subsidies at the intersection of climate, energy, and trade governance. *International Environmental Agreements: Politics, Law and Economics*, 17(3), 313–326.
- Van der Pol, T., Weikard, H. P., & van Ierland, E. C. (2012). Can altruism stabilise international climate agreements? *Ecological Economics*, 81, 112–120.
- Verbruggen, A. (2011). Preparing the design of robust climate policy architectures. *International Environmental Agreements: Politics, Law and Economics*, 11(4), 275–295.

- Warr, P. G. (1983). The private provision of a public good is independent of the distribution of income. *Economics Letters*, 13, 207–211.
- Weber, A. K. (2018). The revival of the Honourable Merchant? Analysing private forest governance at firm level. *International Environmental Agreements: Politics, Law and Economics*, 18(4), 619–634.
- Winkler, H., Höhne, N., Cunliffe, G., Kuramochi, T., April, A., & de Villafranca Casas, M. J. (2018). Countries start to explain how their climate contributions are fair: More rigour needed. *International Environmental Agreements: Politics, Law and Economics*, 18(1), 99–115.
- World Commission on Environment and Development. (1987). *Our common future - the "Brundtland Report."* Oxford University Press.
- Young, O. R. (2013). Sugaring off: Enduring insights from long-term research on environmental governance. *International Environmental Agreements: Politics, Law and Economics*, 13(1), 87–105.
- Young, Oran R. (2017). The politics of international regime formation: Managing natural resources and the environment. In P. M. Haas (Ed.), *International Environmental Governance*. Routledge.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors and Affiliations

Nicky R. M. Pouw¹  · Hans-Peter Weikard² · Richard B. Howarth³

Hans-Peter Weikard
hans-peter.weikard@wur.nl

Richard B. Howarth
richard.b.howarth@dartmouth.edu

¹ Governance and Inclusive Development, University of Amsterdam, 1018 WV Amsterdam, The Netherlands

² Department of Social Sciences, Economics Section, Wageningen University, Hollandseweg 1, 6706 KN Wageningen, The Netherlands

³ Environmental Studies, Dartmouth University, 106 Fairchild, HB 6182, Hanover, NH 03755, USA