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The survival of the weakest: the echo of the Rio Summit principles in environmental treaties

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ABSTRACT

This article examines the influence of the 1992 United Nations Conference on Environment and Development, known as the Rio Summit, on the design of subsequent international environmental agreements (IEAs). In particular, it investigates the extent to which the principles outlined in the Rio Declaration were integrated into IEAs concluded in the following years. We focus our investigation on three principles: the precautionary principle, common but differentiated responsibilities, and the polluter pays principle. Analyzing a collection of 2,211 IEAs and their 509 amendments, we find that the Rio Summit catalyzed the dissemination of these principles. However, our study also reveals that the Rio Conference was an inflection point, wherein weaker expressions of these principles became more prevalent. Stronger expressions, which were included in some IEAs prior to the Rio Summit, became relatively less common thereafter. We call this evolutionary process the 'survival of the weakest'.

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Introduction

This article investigates the impact of the 1992 United Nations Conference on Environment and Development – the Rio Summit – on the design of international environmental agreements (IEAs). The Rio Declaration, which was a primary output from the Rio Summit, formalized some of the most fundamental principles of global environmental governance (Sands 2003).[1] Despite their vague nature and limited enforceability, these principles can provide useful guidance for the elaboration of more specific rules. The

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objective of this article is to assess the extent to which the principles outlined in the Rio Declaration are incorporated into legally-binding IEAs.[2]

There are good reasons to expect that the principles formalized in the Rio Declaration were included in subsequent IEAs. Previous studies have underscored the significance of the Rio Summit, which is associated with the establishment of environmental ministries, increased public awareness of environmental degradation, the internationalization of environmental non-governmental organizations, the conclusion of new IEAs, the creation of intergovernmental organizations, and the consecration of the liberal environmentalism paradigm (Fomerand 1996, Meyer *et al.* 1997, Bernstein 2001, Haas 2002, Busch and Jörgens 2005;, Aklin and Urpelainen 2014, Manulak 2020, 2022). However, the extent to which the principles formalized at Rio have influenced the design of IEAs concluded in the following years remains uncertain.

Most studies on IEA design pay surprisingly little attention to the influence of the Rio Summit. Building on the rational design literature (Koremenos *et al.* 2001), studies explain IEA design based on the structure of the problems they address (Mitchell 2006; Jinnah *et al.* 2021), their number of parties (Zawahri *et al.* 2016), their embedded power asymmetries (Marcoux 2009), and trade-offs with other design features (Boockmann and Thurner 2006; Morin *et al.* 2021). While these explanations offer persuasive insights, they provide an incomplete account. They treat IEAs as discrete negotiation outcomes, disconnected from their broader institutional context.

In reality, IEAs are not negotiated in an institutional vacuum (Raustiala and Victor 2004). They are embedded in a particular institutional and historical context. Acknowledging this contextuality, a recent generation of studies conceptualizes the design of institutions as a continuous process connecting various institutions to each other (Thompson 2010, Copelovitch and Putnam 2014, Fioretos 2017, Voeten 2019, Beaumier *et al.* 2023). For example, Abbott *et al.* (2016) explain the organizational form of newly created climate-related institutions by the density of existing organizations. In another recent study, Manulak (2020) argues that changes in the design of various environmental institutions tend to cluster around 'temporal focal points.' These studies emphasize the interconnectedness and evolution of institutions, shedding light on the broader dynamics shaping IEA design. This article contributes to this recent generation of studies on institutional design by contextualizing the design of IEAs in relation to the Rio Summit.

This article also contributes to the literature on norm dynamics. Finnemore and Sikkink (1998) have argued that the diffusion of international norms, such as principles of environmental governance, follows a certain life cycle pattern. They reason that 'an agreement among a critical mass of actors on some emergent norm can create a tipping point after which

agreement becomes widespread in many empirical cases' (1998: 893). However, this linear representation of norm dynamics has faced criticism in recent years for its oversimplification and limited attention to contestation and transformation (Sandholtz 2008, Krook and True 2010, Epstein 2012, Wiener 2014). Consequently, this article goes beyond mapping the quantitative diffusion of environmental principles following the Rio Summit and delves into an analysis of their qualitative transformation throughout this process. By considering both the quantitative diffusion and the qualitative changes, it offers a comprehensive understanding of the evolution of these principles, which does not follow a linear trajectory.

We focus our investigation on three principles associated with the Rio Declaration and of general application: the precautionary principle, common but differentiated responsibilities (CBDR), and the polluter pays principle.[3] For each of these principles, we examine their emergence and contested meanings prior to the Rio Summit. We then delve into the influence of the Rio Summit on the diffusion and specific expressions of these principles in subsequent IEAs. This empirical endeavor does not aim to test or develop a specific theory. Rather, our objective is to inductively uncover patterns of diffusion and transformation pertaining to these pivotal principles of environmental governance.

Our analysis draws on an extensive collection of 2,211 IEAs and 509 amendments (for a total of 2,720 distinct instruments) concluded between 1900 and 2016, extracted from the International Environmental Agreements Database (Mitchell 2002–2022).[4] These IEAs are all binding treaty instruments under international law and their primary purpose is either the protection of the natural world or the sustainable use of natural resources. They cover a wide variety of environmental issues, including fisheries, freshwater, biodiversity, agriculture, energy, and pollution emissions. A team of trained coders meticulously examined each of the 2,720 instruments to identify every occurrence of the precautionary principle, CBDR, and polluter pays principles (see Codebook in the online supplement).[5]

We analyzed these occurrences quantitatively and qualitatively. First, quantitatively, we examined changes in the relative frequency of these principles before and after the Rio summit, as depicted in Figure 1 and Table 1.[6] Second, qualitatively, we analyzed changes in the textual articulation of these principles and compared every occurrence with the specific expression found in the Rio Declaration.

Our analysis reveals that the 1992 Rio Summit catalyzed the dissemination of key principles in IEAs. As Figure 1 shows, the relative frequency of these three principles took off during the Rio preparatory process and continued to increase in the decade following the summit. To be clear, these principles predate the Rio Summit. For example, the 1987 'Brundtland Report' from the World Commission on Environment and Development emphasized the

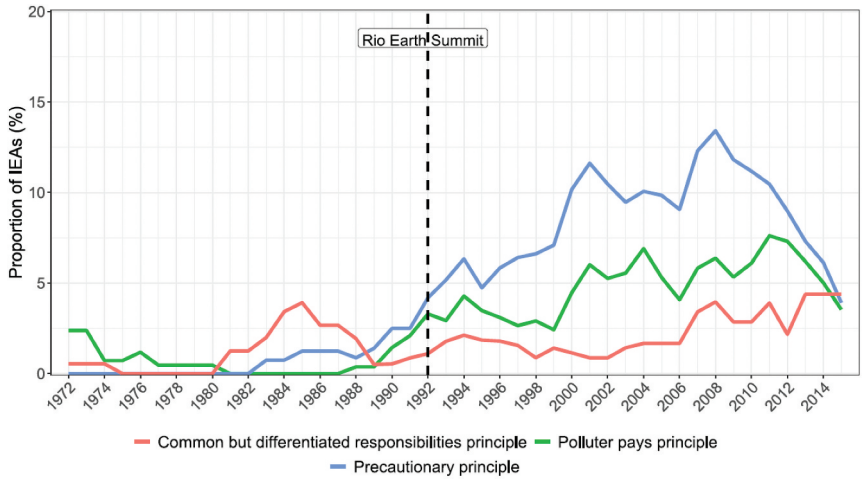

Figure 1. Proportion of instruments (IEAs and amendments) including specific principles (moving average of ± 2 years).

Table 1. Number of instruments (IEAs and amendments) with a key principle over the total number of instruments for the period.

	Instruments concluded before the Rio Summits (14 June 1992)	Instruments concluded since the Rio Summit (14 June 1992)
Precautionary principle	10/1425 = 0.7%	93/1295 = 7.2%
CBDR	12/1425 = 0.8%	36/1295 = 2.8%
Polluter pays	8/1425 = 0.6%	58/1295 = 4.5%

importance of precautionary measures and mentions the polluter pays principle. Certain IEAs had already incorporated these principles long before the Rio Declaration spotlighted them. However, we argue that the Rio Summit provided a platform for states to articulate a particular expression of these principles and the 'tipping point' for the 'diffusion cascade' of these principles to take place in several IEAs (Finnemore and Sikkink 1998). The impact of the Rio Summit is evident not only in the increased frequency of these principles but also in their specific formulation within subsequent agreements.

However, we also find that the Rio Summit primarily favored the diffusion of relatively weaker expressions of these principles. Stronger expressions that had already been present in certain IEAs prior to the Rio Summit became relatively less common afterwards. To suggest that there is a trade-off between the strength of a principle and the breath of its diffusion, echoing an observation that Hadden and Seybert made relative to the historical trajectory of the sustainable development norm (Hadden and Seybert 2016). We refer to this evolutionary process as the 'survival of the weakest'.[7] To explore this phenomenon in detail, the following three sections

successively discuss the impact of the Rio Summit on the evolution of the precautionary principle, the CBDR principle, and the polluter pays principle.

Precautionary principle

The precautionary principle is a prominent – and controversial – feature of international environmental law. Its expression in the 1992 Rio Declaration states that 'where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.' Unlike the prevention principle (Stockholm Declaration, principle 21), which is applicable when there is a known risk of harmful effects, the precautionary principle is invoked in the context of uncertainty, when science is unable to determine whether there is indeed a risk.

The precautionary principle predates the 1992 Rio Summit. The literature traces its origin to the 1970s, when the similar concept of *vorsorgeprinzip* was incorporated in West Germany's environmental law (De Sadeleer 2020, p. 137). The 1985 Vienna Convention, which was concluded at a time when the causes of ozone degradation were still disputed, became the first IEA to refer to 'precautionary measures'.[8]

Yet, the Rio Declaration represented a 'tipping point' (Finnemore and Sikkink 1998) in the diffusion of a particular expression of the precautionary principle. It started with the two conventions agreed at Rio, the United Nations Framework Convention on Climate Change (art. 3.3) and the Convention on Biological Diversity (preamble), which both refer to the precautionary principle. Then, immediately after the Rio Summit, several IEAs started to refer to 'the precautionary principle.' At least 12 IEAs specifically refer to principle 15 of the Rio Declaration. This is the case, for example, of the 2001 Agreement on the Conservation of Albatrosses and Petrels and the 2009 Convention for the Safe and Environmentally Sound Recycling of Ships. Other IEAs, including the 1995 Waigani Convention on hazardous wastes and the 2006 Convention for the Protection of the environment in Central Asia, reproduce the exact wording of the Rio Declaration. Some IEAs concluded prior to the Rio Summit, such as the 1949 Convention for the Northwest Atlantic Fisheries and the 1976 Convention on the Prevention of Marine Pollution, were amended to incorporate the precautionary principle. Parties to other agreements, such as the Convention on International Trade in Endangered Species (CITES), adopted resolutions to incorporate the precautionary principle in their decision making. Our data reveal that, in the two decades following the Rio Summit, at least one new IEA invoking the precautionary approach was adopted every year, with a peak of 8 IEAs for the single year of 2002. As a result, the precautionary principle pollinated several fields of environmental governance, including

fisheries, transboundary watercourse, biosafety, air pollution, endangered species, protected areas, and hazardous wastes.

In total, we find 103 instruments (IEAs and their amendments) that include the precautionary principle. Relative to the 2,720 instruments that have been analyzed for this study, this is a relatively small proportion (3.8%).[9] However, it is significantly more than the previous estimate of 53 legal binding instruments (Trouwborst 2002). As Figure 1 shows, the precautionary principle is also more frequently incorporated in IEAs than other well-known principles from the Rio Declaration, including the polluter-pays principles and the CBDR principle.

The precautionary principle has received broad support from all world regions. It is sometimes assumed that the EU is a global crusader for the precautionary principle while the US only accepts it reluctantly (De Sadeleer 2020, p. 136). This is the impression that might transpire from transatlantic disputes over hormone-treated beef and genetically modified organisms.[10] However, it would be an oversimplification to conclude that European and American positions in these trade disputes reflect their general attitude toward precaution (Di Salvo and Raymond 2010). Both the EU and the US have been, at times, strong advocates of the precautionary principle. Whereas the former insisted on its inclusion in the Cartagena Protocol on biosafety issues, the latter was a proponent of its inclusion in the Montreal Protocol on the ozone layer (Wiener *et al.* 2011). Although David Vogel (2012) argues that a transatlantic shift occurred in the 1990s, when the strongest advocate of the precautionary approach became the EU, we do not find evidence of this sequence in the set of IEAs ratified by the US and the EU. Overall, the US has signed 26 IEAs that include the precautionary principle, which is more than most countries. The precautionary principle is found in a slightly greater share of IEAs signed by the US than in the IEAs not signed by the US.

As a reflection of its broad support, the precautionary principle is disproportionally found in multilateral agreements (three parties or more). While only 42% of IEAs are multilateral, 89% of the IEAs that include the precautionary principle are multilateral. Moreover, the few bilateral agreements that include the precautionary principle are not centered around a particular state. Both the EU and the US have signed bilateral agreements with the precautionary principle. The precautionary principle is also found in more than 30 regional IEAs that include neither the EU nor the US. These regional agreements include the 2003 Convention on the Sustainable Management of Lake Tanganyika and the 1992 Central American Regional Agreement on the Transboundary Movement of Hazardous Waste. In fact, the precautionary principle is two times more common in IEAs uniting exclusively developing countries than in IEAs among developed countries. The universal reach of the precautionary principle is such that several legal experts argue that it should be considered a rule of customary international

law (Cameron and Abouchar 1996, McIntyre and Mosedal 1997, Applegate 2002, p. 14, Sands 2003, p. 272;, De Sadeleer 2020, p. 153).

However, we find that the Rio Declaration promotes only a relatively weak expression of the precautionary principle (Bodansky 2004, Wiener 2008). According to the Rio Declaration, the triggers for precautionary actions are 'threats of serious or irreversible damage', which is a higher threshold than other expressions of the principle. Yet, when this threshold is met, the Rio Declaration neither calls for the adoption of preventive measures nor explicitly authorizes such measures but merely states that the 'lack of full scientific certainty shall not be used as a reason for postponing' them. The phrase 'lack of full scientific certainty' suggests that at least some scientific evidence should indicate that the threat is plausible. Moreover, according to the Rio expression of the precautionary principle, preventive measures are expected to be 'cost-effective', which can be interpreted as a limitation on the scope of preventive measures. This expression of the precautionary principle is so weak that Sunstein considers it a truism, one that its sole purpose is to refute the misperception that policy action requires unambiguous evidence of harm, 'which no rational society requires' anyways (2003: 1016).

Stronger expressions of the precautionary principle were known and available to (boundedly rational) negotiators of the Rio Declaration, particularly those from developing countries (Bodansky 2004, Wiener 2008). One of these stronger expressions is encapsulated in the 1991 Bamako Convention on hazardous wastes: it urges states to prevent the release into the environment of any substance 'which may cause harm', even if there is no risk of 'serious or irreversible damage'; it calls states to implement preventive measures instead of merely taking away a possible justification if they choose to remain inactive; and it specifically requires for the application of 'clean production methods' instead of 'cost-effective' measures.

The strong language of the Bamako Convention was not widely replicated in other IEAs following the Rio Declaration. Only 19 IEAs provide that scientific uncertainty requires preventive action. Out of these 19 IEAs, 8 are related to fisheries, perhaps because the causes and the magnitude of fish stock depletion are, in most cases, relatively well known. There are also a few IEAs related to chemicals and hazardous waste that include a strong expression of the precautionary principle, presumably because this form of pollution puts human health particularly at risk.

As Table 2 indicates, the most commonly found expression of the precautionary principle is also its most ill-defined. At least 42 IEAs incorporate the precautionary principle simply by evoking its name. For example, the 1996 Agreement on the Conservation of Cetaceans of the Black Sea and the Mediterranean Sea provides that 'Parties shall apply the precautionary principle', without offering any operational guidance. This imprecision sustains a persistent ambiguity over the meaning of the precautionary principle: does

Table 2. Typology of precautionary principles and distribution ($N = 103$).

Categorization	Description	# of instruments pre-Rio (%)	# of instruments post-Rio (%)
Weak	Conditions and restrictions, such references to "cost-effective measures" or "threats of serious and irreversible damage"	1 (.9%)	39 (37.9%)
Moderate	Vague or ill-defined.	6 (5.8%)	40 (38.8%)
Strong	Scientific uncertainty requires preventive action	3 (2.9%)	14 (13.6%)

scientific uncertainty call for preventive actions or simply does not justify inaction? The Rio Declaration has failed to provide a convergence of understandings of the meaning of the precautionary principle. Even if several IEAs refer to Principle 15 of the Rio Declaration or copy some of its phrasing, there remains significant diversity in the expression of the precautionary principle. Only 23 IEAs that include the precautionary principle employ an expression similar to the Rio Declaration.

If anything, the Rio Declaration provided model phrases to water down the precautionary principle with restrictive criteria and conditions. For example, 19 IEAs use its phrase 'serious and irreversible damage', 22 IEAs refer to 'lack of full scientific certainty', and 8 replicate the concept of 'cost-effective measure'. As Applegate notes, 'strong expressions of the principle have been systematically tamed-reduced, as it were, from a tiger to a house cat' (2002: 16)

The sustained ambiguity of the precautionary principle opens the door for academic and political debates over its meaning. Even though few IEAs provide an explicitly strong expression of the precautionary principle, some activists and scholars insist that it fundamentally implies a reversal of the burden of proof from regulators to polluters (Tickner and Raffensperger 1998, Di Salvo and Raymond 2010). This extensive interpretation accentuated the wariness of some negotiators who oppose a strong expression of the precautionary principle (Godard 2006: 84). In turn, negotiators concerned about the ambiguity of the precautionary principle are likely to add new conditions and restrictions, accentuating its diversity of expression and gradual erosion. The principle's ambiguity is both the ground and the product of political debates of its meaning (Applegate 2002, p. 24). Thus, while the Rio Declaration has contributed to the diffusion of the precautionary principle in IEAs and its salience in public debates, it neither strengthened nor clarified its meaning. In fact, it is one of the weakest versions of principle that survive in the most recent IEAs.

Common but differentiated responsibilities

Differentiation is a long-standing principle of international environmental law. The Stockholm Declaration placed environmental protection as the

'duty of all Governments,' but clarified that 'the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment.' Twenty years later, differentiation as an idea became more formally articulated as 'common but differentiated responsibilities' in Rio. There are two ideas underpinning the CBDR principle: (1) there is a shared responsibility among countries for ensuring public goods; and (2) the responsibilities are unevenly distributed. These two foundational components of the CBDR principle can be traced back to the delicate compromise reached in Stockholm that sought to balance the developed countries' call for a shared environmental ethic with developing countries' calls for economic development (Rajamani 2012).

CBDR was operationalized as a guiding idea in environmental politics long before it was specifically formulated and named at the Rio Summit (Rajamani 2012). We find 48 instances of the principle in the dataset; only 10 IEAs and three amendments specifically invoke the phrase. CBDR appears in a small percentage of IEAs, roughly 2.8%. Yet, it has attracted considerable attention among researchers, policymakers, and even the media. Arguably, this is due to its contested nature in the climate change regime, rather than its prevalence in environmental law.

Although CBDR is a relative rarity in IEAs, our collection of IEAs reveals that it is used in a wide variety of contexts. It appears across issues areas, including agreements governing aspects of the marine environment, biodiversity, and forests. Most commonly, CBDR appears in the context of pollution, especially within the regimes on climate change, chemical management, mercury, and ozone depletion. Over 9% of pollution-related IEAs feature CBDR.

Unsurprisingly, CBDR is invoked more often when inequalities among parties are more apparent. Larger IEAs with more than 30 parties feature the principle more often than IEAs with smaller membership, 8.46% (31+ parties) compared to 3.23% (11–30 parties) or 2.13% (3–10 parties). It appears in instruments with a membership that draws from both the Global North and South more often: 2.3% of North-South IEAs have an expression of CBDR compared to 0.78% of South-South IEAs. Notably, when the US is a party, CBDR is nearly three times more common than when it is absent (3.23% vs 0.82%).

The Rio Summit was pivotal in the 'norm dynamics' of this principle, in that it gave it a name and amplified its use. CBDR was first coined during the negotiations for the forest treaty that some hoped to sign in Rio. The G-77 and China formulated 'common but differentiated responsibility' to directly counter developed countries' preferred language framing forests as a 'common responsibility' or 'common heritage' of all countries during the forest negotiations (Humphreys 1993). Although CBDR appears in the UNFCCC, accounts of the UNFCCC negotiations do not mention the term at all (cf Bodansky 1993). As negotiations for the two issues were kept separate leading to the Rio Conference (Gupta 2014), it is plausible that

CBDR diffused from forests to climate change at or just prior to UNCED. Since the Rio Summit, CBDR has diffused to a variety of issue areas, including some beyond the environment (Williams and Montes 2016).

Like the precautionary principle, the Rio Summit popularized a relatively weak expression of the principle. Table 3 below seems to show an increase in strong uses of CBDR relative to the total number of occurrences of the CBDR principle ($N = 48$). However, 15 of the 17 instruments that differentiate obligations were amendments to the Montreal Protocol, a pre-1992 agreement that sets out differing schedules for developed and developing countries to phase out ozone-depleting substances. Instead, in giving CBDR its name, the Rio Summit seemed to have promoted a weak expression of the principle, which recognizes that differences exist but does not operationalize them in any way. Most recognize that some countries may face constraints in their ability to implement an agreement, or simply state CBDR without defining what it means in the specific IEA context.

The three legally-binding treaties of the climate regime are the only instruments to explicitly invoke CBDR and operationalize the term. The UNFCCC and Kyoto Protocol set out different expectations for Annex I and non-Annex I countries. The Paris Agreement has a fuzzier line between commitments, with nuanced differentiation between the nationally determined contributions and national reports submitted by developed and developing countries. While much of the work on CBDR has bettered our understanding of climate politics (cf Jinnah 2017), these treaties may be unique in terms of how they invoke and use the principle.

Other instruments that explicitly state CBDR, such as the 2010 Stockholm Convention on Persistent Organic Pollutants (POPs), the 2013 Minamata Convention on Mercury, and the 1995 Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean, use the term without operationalizing differentiation. These IEAs have similar expectations for developed and developing countries, including the same timelines for phasing down or ceasing the production of chemicals or products. CBDR was re-invoked when the Stockholm Convention updated its list of POPs slated for elimination or restriction. This suggests that in naming CBDR, the Rio Summit created a new focal point of political

Table 3. Typology of CBDR and distribution ($N = 48$).

Categorization	Description	# of instruments pre-Rio (%)	# of instruments post-Rio (%)
Weak	Recognizes differing capacities or vulnerabilities	7 (14.6%)	10 (2.1%)
Moderate	Vague/ill-defined principle, same obligations	0 (.0%)	9 (18.8%)
Strong	Differentiates obligations among parties	4 (8.3%)	17 (35.4%)

contestation. India and China invoked CBDR in a bilateral agreement on climate change to signal their position as developing countries when developed countries should take the lead in reducing emissions. This politicization perhaps had the unintended effect of dampening the principle's reach by making it much more difficult to operationalize as countries saw real potential impacts on their interests. The term CBDR became a stand-in for identifying the differences among parties.

We identify three ways that differentiation was expressed that were available to negotiators in Rio because they were articulated in pre-1992 instruments. Each reflects tensions first identified at the Stockholm Conference (see Table 4). Our analysis identifies that differential treatment was justified by: (1) disproportional impact of a treaty's measures, especially as related to potential impacts on economies; (2) differential capacity to implement a treaty; and (3) different status in the treaty's context, such as being categorized as a developing country. These bases are not necessarily mutually exclusive, and some instruments expressed differentiation in multiple ways. Therefore, we cite the instances of each across all the instruments below. We find ten instances where differentiation is invoked after Rio, without any clear basis, perhaps again pointing to a weakening of the overall principle after Rio.

The Stockholm Declaration set out all these ideas, but it appears that capacity differences and status had more traction. The Declaration recognizes that environmental politics should not 'adversely affect' development trajectories (Principles 11 and 23), and the limited capacities of developing countries. Similarly, the Stockholm Declaration recognized that developing countries 'must direct their efforts towards development, bearing in mind their priorities and the need to safeguard and improve the environment.' (Preamble para 4). In contrast, 'industrialized' countries 'should make efforts to reduce the gap between themselves and the developing countries' (Preamble, para 4).

Only after Rio did some agreements recognize that the global rules on fishing, climate change, or trade in forest products, for example, will disproportionately affect economies and livelihoods reliant on fish, fossil fuels, or forests respectively. The 2006 International Tropical Timber Agreement is

Table 4. Typology of CBDR Rational and distribution ($N = 124$).

Categorization	Description	# of instances pre-Rio (%)	# of instances post-Rio (%)
Response measures	Some countries will be disproportionately impacted by the measures in the instrument	0 (0%)	3 (.02%)
Lack of capacity to implement	Some countries lack financial, technical, or other means to implement	7 (.06%)	23 (18.5%)
Status	General invocation of status as defined in the treaty	29 (23.3%)	52 (41.9%)
Unclear	Unclear from context basis for differentiation	0 (0%)	10 (.08%)

unique in that it operationalizes differentiation in a way that allows for a mechanism for redress. Consumer members (i.e. timber importers) that are developing countries can apply for 'appropriate and differential remedial measures' (Article 32) if their interests are adversely affected by measures taken under the agreement. The agreement also allows for least developed country members to apply for special measures under the agreement (Article 32).

Use of the second expression of differentiation increased rapidly after Rio. Some of the growth is attributed to the climate regime, which recognizes CBDR and respective capacities (CBDR-RC). Eleven of the instruments using this type of differentiation are regional, where countries may have more similar capacities. A broad-brush invocation of developing country status would not suffice in some regions to separate those with more or less capacity to implement. Such instruments had to be more specific about why some countries may not be able to fulfill their obligations.

Since Rio, the most common expression of differentiation is also the least specific. It draws a line between developed and developing countries (and sometimes economies in transition). Some instruments, including the UNFCCC, and the Basel Convention, categorize and differentiate between groups of countries in Annexes. Other instruments simply use the terms 'developing,' 'developed' and/or 'industrialized' countries without any specific identification. We see this type of differentiation throughout the Stockholm Declaration, wherein the terms 'developing' and 'industrialized' countries are used to identify differing priorities between countries.

Differentiation of this type is often most strongly invoked in the context of increasing obligations for developing countries. Dynamic treaties, such as the Montreal Protocol, account for a large share of the mentions of this expression of differentiation, as it invokes and operationalizes the CBDR principle when adding chemicals to their control regimes or accelerating the phase-out of chemicals. The UNFCCC and Kyoto Protocol specify different commitment types with different legal implications for Annex I and non-Annex I countries.

While the Stockholm Declaration and subsequent agreements and amendments articulated various expressions of differentiation, it seems the Rio Conference marked a 'tipping point'. After Rio, we see a weaker expression of CBDR used, mostly in name only. We also see a shift in the design of IEAs, toward a broad-brush approach to differentiation, based on developing country status as defined in the agreements rather than considering why a country may require differential treatment.

Polluter pays

As with CBDR and precaution, the polluter pays principle is an important feature of international environmental law. Although the principle is rarely

defined, in essence, this principle attempts to allocate the costs of pollution. It does this by encouraging polluters, rather than governments or other actors, pay for the costs of pollution. As enshrined in Principle 16 of the Rio Declaration it states that 'National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.' However, the normative interpretation of this principle and how it should be implemented in practice is contested and has changed over time. It has evolved from a weak expression aimed at preventing pollution by removing subsidies and thus allocating costs of control to polluters, to a strong one requiring polluters to internalize the full range of costs, including paying for clean-up costs and through liability regimes, which compensate victims of pollution (Wirth 1995, Nash 2000, Woerdman *et al*. 2008, Zhu and Zhao 2015). Although our analysis similarly finds an uptick of a strong expression in more recent years, we would not characterize it as an evolution towards this expression per se. Rather, our data reveal a substantial dominance of the moderate expression in the post-Rio period.

The polluter pays principle pre-dates the Rio Declaration by several decades. It is also hinted at within the 1971 Agreement between Finland and Sweden Concerning Frontier Waters, which required hydraulic construction companies to bear the costs of any associated harm to fishing. However, it was first explicitly coined in 1972 when the Organization for Economic Cooperation and Development (OECD) incorporated it into their *Guiding Principles Concerning International Economic Aspects of Environmental Policies* (OECD 1972). This early iteration was a reaction to the rise in domestic environmental laws in the early 1970s in many countries and associated complaints about the increased costs of production and ensuing impacts on the global trade system if countries followed different cost allocation strategies (Gaines 1991). This weak expression of the principle sought to allocate costs by guiding governments away from subsidizing private entities for pollution control (Stephens 1994). The 1972 OECD expression was later reiterated as a 'fundamental principle for allocating costs of pollution prevention and control measures,' and expanded to include some exceptions, such as when subsidies might be appropriate (OECD 1974). The European Community also endorsed a weak 'no-subsidy' expression of the principle in its 1984 Directive on the topic, noting that the 'costs of implementing the notification procedure, including the costs of control and analysis, should be borne by the holder and/or the producer of the waste' (European Community 1984). In 1989 the OECD extended the principle further to include guidelines for liability and compensation, which reflect a much stronger expression of the principle (OECD 1989). The articulation

in the 1992 Rio Declaration has been characterized by some as a strong expression, in its call for the use of economic instruments to ensure that the internalization of environmental costs are borne by the polluter (Wirth 1995). Yet, it does not specifically call for a liability regime, which, as we explain below, is necessary in our coding scheme for such a characterization.

Other debates surrounding the implementation of the polluter pays principle contest who the polluter is and how much they should pay (De Sadeleer 2020). This debate pre-dates the 1972 OECD Principles. For example, the 1971 Convention on International Oil Pollution and Damage says that the polluter should bear some, but not all, of the costs of pollution. Rather, the Convention says the costs of oil pollution at sea should be paid in part by the shipping industry but also shared by oil cargo interests, expanding the scope of who should be defined as the 'polluter.'

As such, over time, the polluter pays principle has evolved significantly from a weak expression seeking only to internalize the costs of pollution control through the elimination of subsidies (OECD 1972, 1974, 1989), to a stronger one that points to a much fuller cost-internalization by, for example, creating responsibility to compensate victims for damages caused by pollution (OECD 1989, Ambec and Ehlers 2016). Albeit via differing mechanisms, these expressions seek both efficiency in achieving environmental standards and equity between trading partners in uniformly allocating costs to polluting entities (Gaines 1991).

Some developing countries have further expanded the interpretation of the polluter pays principle through their domestic law and policy to require government liability when polluters cannot be identified (Luppi *et al.* 2012). Others have further emphasized the equity dimension in advocating for an interpretation that expands to include the 'ability to pay' (Khan 2012). Importantly, although parties considered incorporation of the polluter pays principle when negotiating the Kyoto Protocol in the late 1990s, it was rejected in favor of CBDR (Khan 2012), which is more vague in terms of how responsibility should be allocated, allowing for heated debates surrounding who is responsible, when were they responsible, and how much payment should be required and to whom (Bushey and Jinnah 2010, Jinnah 2017).

Influenced by their normative environment, treaty negotiators increasingly include the polluter pays principle in their design of IEAs (see Figure 1). The first appearances in our dataset were in the 1970s, when the principle appeared in 2.03% of all environmental instruments. This number increased more than threefold by 2015, when 6.72% of all environmental instruments referenced the principle. Unsurprisingly, the polluter pays principle is most commonly seen in instruments addressing pollution (8.29%), followed by those addressing oceans and habitat (7.63%), freshwater (6.37%), and general environmental cooperation (3.04%). It rarely appears in other issue areas, if it appears at all. Between 1970 and 2015 the principle appears in

Table 5. Typology of polluter pays principles expressions and distribution. ($N = 54$).[12.]

Categorization	Description	# of instruments pre-Rio (%)	# of instruments post-Rio (%)
Weak	Mentions principle with no detail or definition	2 (3.7%)	1 (1.9%)
Moderate	Calls for cost internationalization include environmental clean-up costs.	3 (5.6%)	41 (75.9%)
Strong	Calls specifically for a liability regime and compensation for victims of pollution	2 (3.7%)	5 (9.3%)

roughly equal proportions in north-north, south-south, and north-south agreements.

In analyzing the various expressions of the principle in these instruments, we built on, but adapted, the binary weak/strong categorization proposed by Wirth (1995) and subsequently by Nash (2000). Our typology is detailed in Table 5 below, along with a summary of the distribution of these expressions within our sample. It's worth noting that using this typology, the Rio Declaration is categorized as moderate because it does not explicitly call for liability and compensation.[11]

The moderate expression clearly dominates our set of IEAs. Of the 54 instruments that articulate the polluter pays principle in some way, 44 (81.5%) frame it clearly and exclusively about prevention and control, with an additional 7 (13.0%) that include an element of liability. Only 3 instruments fall into the weak category, which only mentions the principle with no explanation of its meaning.

Taken together, these trends suggest that the Rio Conference catalyzed a significant diffusion of the moderate expression of the polluter pays principle in environmental instruments. However, it is unlikely that the Rio Summit had any influence in strengthening the principle in most environmental instruments. Rather, the Rio Declaration was likely more influential in reinforcing a moderate expression that allowed for much interpretation and flexibility, leaving the stronger liability expression to instruments specifically designed for that purpose.

Conclusion

In the twenty-year period between the Stockholm and the Rio Conferences, IEA negotiators experimented with various new principles governing environmental protection. Some of them were ambitious, others were ambiguous, and still others were meaningless. We find that the Rio Summit has a systemic impact on this normative ecosystem by accelerating the broad diffusion of relatively weak expressions of these principles. We refer to this process as the 'survival of the weakest.'

Our analysis contributes to the existing literature in several ways. Firstly, it sheds light on the normative influence of UN summits, emphasizing that these conferences have a lasting impact on global governance. This is a timely reminder at a time when there is growing skepticism about multilateral governance and global conferences. Far from being just media circuses allowing heads of state to express lofty goals, summits can influence the design of institutions concluded decades afterwards (Seyfang and Jordan 2002). However, summits can accelerate the dissemination of relatively weak commitments, potentially overshadowing more ambitious versions.

Secondly, we contribute to the literature on factors that shape the design of international institutions. Contrary to earlier assumptions of purely rational actors detached from their historical context, our study demonstrates that the design of agreements is context-dependent (Copelovitch and Putnam 2014). The negotiators of IEAs are not simply calculating machines but boundedly rational social creatures. The observation that post-Rio IEAs are more likely to incorporate the Rio principles, yet less likely to exhibit innovation by articulating ambitious expressions of these principles, highlights the role of historical context in treaty negotiations.

Thirdly, our findings engage with the literature on the norm dynamics life circle. While we acknowledge the 'tipping point' concept proposed by Finnemore and Sikkink (1998), our study also supports recent criticisms of the linear nature of norm diffusion theories. The trajectory of environmental law principles is far from being self-reinforcing and linear. Instead, we observe that the prevailing understanding and legal embodiment of these principles have undergone changes over time, often becoming weaker and diluted (Sandholtz 2008, Krook and True 2010, Epstein 2012, Wiener 2014).

Fourth, our findings align with the idea that there is a trade-off between the strength of a principle and the breath of its diffusion (Hadden and Seybert 2016). We find that only relatively weak expressions of the Rio principles experienced widespread diffusion. This suggests that the broad dissemination of these principles come at the cost of their dilution. This trade-off echoes the participation versus depth dilemma faced by IEA negotiators (Bernauer *et al.* 2013). Exploring the potential trade-offs among the principles themselves, such as the interaction between CBDR and the polluter pays principle, could be a valuable avenue for future research.

To further enhance our understanding, future research should delve into the specific causal pathways connecting the Rio Declaration to the design of IEAs. While our study assessed the extent of the Rio Declaration's influence, the precise causal mechanism remains undetermined. At least three pathways are plausible.[13] Firstly, declarations can enhance the perceived legitimacy of a principle, creating an impression of global consensus and influencing IEA negotiators' beliefs and expectations. Secondly, declarations may contribute to the development of

customary international law or reinforce specific interpretations of existing treaties. In these cases, negotiators might feel compelled to align their agreements with the principles outlined in the declaration. Lastly, declarations can reduce transaction costs by providing a focal point and shared normative framework, facilitating negotiations and increasing the likelihood of successful conclusion of IEAs. Identifying which of these causal pathways plays a predominant role in explaining our diffusion findings, as well as their implications for the watering down of principles, requires further investigation.

Finally, future research could conduct an evolutionary analysis of how IEAs have operationalized these broad principles into specific rules and procedures. It is possible that the greater homogeneity of principles has led to increased diversity at the level of specific rules and procedures. This analysis would provide valuable insights into the implementation and practical implications of these principles in different environmental contexts.

Notes

1. For an overview of the Rio Summit, its historical context, and its primary outputs, see (Chasek and Wagner 2012), pp.1–16.
2. This paper is limited to the study of the diffusion of principles in IEAs. It does not explore their operationalization nor their implementation.
3. Future research could look at the fate of other principles, such sovereignty over natural resources, gender equality, or liability in case of environmental damage.
4. Our dataset does not include IEAs concluded since 2016. This limitation is justified for three reasons: 1) the reliability of the IEADB dataset is reduced for recent years; 2) the number of missing IEAs is expected to be limited since the average number of IEAs per year has significantly dropped over the last two decades; 3) This paper is interested in long-term trends, not circumstantial variations.
5. We double-checked the selected provisions to weed out false positives and a different coder coded 10% of our collection of instruments a second time in order to assess the frequency of false negatives. The Kappa value of this double coding is 0,83, which is considered as an 'almost perfect' intercoder reliability (Landis and Koch 1977).
6. The decline of the relative frequency of principles in IEAs since 2008 is related to the changing proportion of protocols and amendments over base agreements. Base agreements represented 66% of the instruments in the 1990s and only 51% in the 2010s, whereas amendments represented 17% of instruments in the 1990s and 30% in the 2010s. Principles are more likely to be found in base agreements than in protocols and amendments, as repeating the principles is often unnecessary. Therefore, it is unsurprising that the frequency of principles relative to the total number of instruments (including treaties, protocols, and amendments) has declined.

7. Other studies have evoked theories of biological evolution to understand international institutions. See (Florini 1996) and (Gilady and Hoffmann 2013).
8. Earlier IEAs rest on a 'precautionary logic', such as the 1952 International Convention for the High Seas Fisheries of the North Pacific Ocean, but they do not articulate it as a principle. The 1987 Brundtland report refers to 'precautionary measures' in its annex on proposed legal principles but it does not refer to uncertainty and appears similar to the prevention principle.
9. De Sadeleer estimates that, 'since the 1992 Rio Conference, the [precautionary principle] has been taken up in the majority of bilateral and multilateral environmental agreements' (2020: 138). Our own account differs significantly. If we consider only IEAs concluded since 1992, we find the precautionary principle in 8.3% of IEAs.
10. There is also a transatlantic discussion as to whether the principle 15 of the Rio Declaration refers to a principle of general application or to an approach among others. The official translation of the Rio Declaration is inconsistent in this regard.
11. Although Principle 10 does call for a liability regime, it does not specify compensation for victims of pollution.
12. There is a total of 59 instruments in this sample. However, 5 instruments were excluded. In one case, it was due to a coding error. The other 4 instruments were excluded because there was not a searchable or full text expression of the treaty available. In the results presented here, if a treaty contained more than one expression of the principle it is counted in the strongest category only.
13. The literatures on historical institutionalism (Fioretos 2017) and institutional isomorphism (DiMaggio and Powell 1983) seem particularly promising to hypothesize on these causal mechanisms.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Data availability statement

The data that support the findings of this study will be made openly available at https://iea.uoregon.edu/codings-IEA-design-features with the publication of this article.

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