



# Negotiating weights for burden sharing rules in international climate negotiations: an empirical analysis

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Received: 30 December 2019 / Accepted: 11 October 2020 / Published online: 3 November 2020  
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## Abstract

We have collected data from a world-wide survey among COP delegates to empirically investigate preferences for certain burden sharing rules among key groups in a setting that reflects the possibility of observing concessions from negotiating partners. In our survey, the participants had the opportunity to select and combine up to eight (pre-defined) burden sharing rules and to assign relative weights to the selected rules in their preferred bundle. We examine whether such a mechanism helps to overcome the currently strictly (self-interested) strategic claims on equity in the negotiation process. We observe that delegates from different groups of countries show a general willingness for concessions. However, the degree to which different burden sharing rules are taken into consideration partly differs between countries. As a key insight we report that the individual assessment of the polluter-pays rule based on current emissions does not only stress the persistence of the traditional Annex-B/Non-Annex-B division but also suggests tendencies for a more fragmented grouping with different positions between, for example, delegates from developing countries (i.e. G77 members) and emerging countries (i.e. BASIC). At the same time, we observe tendencies for a more harmonized view among key groups towards the ability-to-pay rule in a setting of weighted burden sharing rules.

**Keywords** International climate negotiations · Distributive justice · Equity preferences · Burden sharing rules

**JEL** D63 · H41 · Q54

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**Electronic supplementary material** The online version of this article (<https://doi.org/10.1007/s10018-020-00289-0>) contains supplementary material, which is available to authorized users.

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## 1 Introduction

The adoption of the first-ever global climate deal at COP-21, the Paris Agreement, in December 2015 (UNFCCC 2015) was achieved through a fundamental change in the climate policy architecture: Instead of trying to impose “top-down” targets for every country, the Paris Agreement builds on “bottom-up” nationally determined and sovereign commitments being voluntary and not enforceable. As from a current perspective, despite all efforts, the intended nationally determined contributions (INDC) under the Paris Agreement are not sufficient to achieve the ambitious target of limiting global warming to well below 2 °C above preindustrial levels, the agreement aims at stipulating the collective progress in the future through a dynamic review mechanism.<sup>1</sup> Based on an aggregate assessment, the so-called “global stocktake” will assess the achievement of the purpose of the agreement and its long-term goals every five years “in the light of equity and the best available science” (UNFCCC 2015, Article 14). While the current formulation of the stocktake principally does not preclude an assessment on an individual country level, the discussions during the Paris Agreement clearly stressed that, collectively, parties at that time were not willing to agree upon a process that explicitly targets the role of individual assessments in this process but postponed the debate (e.g., Holz and Ngwadla 2016).

As one of the key elements of the recently adopted Katowice climate package the agreed guidance describes how mitigation goals and activities are to be presented to make them comparable (UNFCCC 2018). Following the concept of the global stocktake as the central review mechanism to assess collective progress over time towards the globally agreed target, there remains skepticism whether countries will deviate from their sovereign commitments (e.g., Barrett and Dannenberg 2016). One potential reason for deviations from previous commitments could emerge from differences in the perception on how to share the burden of global mitigation efforts among the negotiation countries, as having been assessed empirically in previous rounds of climate negotiations (e.g., Lange et al. 2007, 2010).

Given the vital and controversial debates on how to compromise between the globally-aggregated review (which leaves behind the rather vague formulation “in the light of equity”) and the individual assessment of countries’ ambitions (where agreement still lacks upon) an assessment of group aggregates might help to foster the multilateral process (e.g., Holz and Ngwadla 2016). By reflecting a certain degree of relevant homogeneity within its members, these groups could both allow for comparisons within groups (i.e. group level-benchmarking) and for differentiation across groups. One of the key challenges in this framework is to identify a set of plausible and acceptable cost-sharing rules being capable to reach consensus and to guide the pathway between two baseline positions: An overarching view on justice as fairness behind the veil of ignorance on the one hand and the purely

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<sup>1</sup> According to recent assessments of Climate Action Tracker (CAT), an initiative that provides independent scientific analyses to track government climate ambitions and the comparability of efforts, under current pledges the world will warm by 2.8 °C by the end of the century (e.g., CAT 2019).

self-interested use of equity rules on the other hand. Winkler et al. (2018) analyze 163 INDC submissions and conclude that the level of substantiation and accompanying detail, provided to support that an INDC is a “fair” contribution, varies widely across submissions. Even a limited set of indicators including, for example, emissions per capita or emissions per unit of GDP are reported in a widely diverse manner. Winkler et al. (2018), therefore, suggest to agree upon a menu of indicators where countries could choose from. In this regard, our analysis can be considered as a first attempt to assess preferences for weighted or “staged approaches” (e.g., Höhne et al. 2014), where countries take differentiated commitments in various dimensions.

To address this challenge, in this paper we empirically investigate preferences for certain burden sharing rules among key groups in a setting that particularly addresses the need for relative assessments of certain rules and reflects on a possibility of observing concessions from negotiating partners. The previous empirical literature focused on preferences towards single principles that have been stated most frequently (e.g., Lange et al. 2007) or those inducing simultaneously the highest support and the lowest opposition rates (e.g., Hjerpe et al. 2011).<sup>2</sup> Bretschger (2017) investigates theoretically the mechanics of the convergence process of nationally determined climate policies and the role of equity-based signals. Anderson et al. (2017) explore the effects of different fairness principles on the willingness to pay of citizens for climate change mitigation in an online experiment. Our analyses empirically assess the role of burden sharing rules in the strengthening of national ambition levels by means of data from a world-wide survey.

We apply a percentage-weighted scheme of different burden sharing rules to examine whether such a mechanism helps to overcome the currently strictly (self-interested) strategic claims on equity in the negotiation process. In our survey, participants had the opportunity to select and combine up to eight different burden sharing rules (including seven pre-defined rules and one open-space category) and to assign relative weights to the selected rules of their preferred bundle. Our analysis is twofold: First, as a necessary condition for concessions, we investigate whether delegates are principally willing to assign a positive weight to more than one (i.e. their preferred) burden sharing rule. Second, if so, we focus on the distribution of these weights to identify potential burden sharing rules that are more likely to provide room for consensus.

Our empirical analysis is based on a comprehensive dataset from a world-wide survey among individuals involved in negotiations of the UN Framework Convention on Climate Change (UNFCCC) (i.e. COP-16 in Cancún, COP-17 in Durban). In addition to former studies (e.g., Lange et al 2007, 2010), we consider a larger number of different burden sharing rules including both a discussion of the role of historical emissions and consumption-based approaches. Our analysis shows how preferences differ among groups of key regions that may play an important role

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<sup>2</sup> Dannenberg et al. (2017) and Dannenberg and Zitzelsberger (2019) also provide empirical evidence from a survey on experts involved in climate negotiations but, instead of burden sharing approaches, these papers focus on the perceived success of climate negotiations and geoengineering.

in international climate negotiations. Our analysis moreover adds to the debate to eventually focus on few key principles to reduce the complexity of ongoing negotiations in order to lower negotiation costs and to enhance the political process (e.g., Bretschger 2013).

Our empirical results provide both insights for potential conflicts and pathways for stipulating (collective) progress through the global stocktake in the Paris Agreement. We observe that delegates from different groups of countries show a general willingness for concessions. However, the degree to which different burden sharing rules are taken into consideration partly differs between countries. As a key insight we report that, in line with previous studies, the individual assessment of the polluter-pays rule based on current emissions does not only stress the persistence of the traditional Annex-B/Non-Annex-B division but in addition suggests tendencies for a more fragmented grouping with different positions between, for example, delegates from developing countries (i.e. G77 members) and emerging countries (i.e. BASIC). At the same time, we observe tendencies for a more harmonized view among key groups towards the ability-to-pay rule.

## 2 Empirical analysis

### 2.1 Burden sharing rules

Recent developments in aspiration-based bargaining modelling (e.g., Ahlert 2007; Ahlert and Lajtos 2011) apply fundamental concepts from aspiration level theory (e.g., Selten 1998) to study the bargaining process in (international) negotiations. The main idea of this concept is to model negotiations as adaptation processes being characterized by a successive exchange of reciprocal concessions (e.g., Ahlert and Lajtos 2011). These concessions can be described as a gradual convergence from two opposing baseline positions. The different proposals crucially depend on certain aspiration levels such as the planned goal, the lowest acceptable agreement, and the planned (threat to) break off negotiations (e.g., Ahlert 2007). We consider the assessment of weights for different burden sharing rules as a possibility to observe first concessions from negotiating partners. Following the typology of Rose et al. (1998) and Ringius et al. (2002), we consider four burden sharing rules that are of particular interest in the political and academic debate: the egalitarian, the grandfathering, the ability-to-pay, and the polluter-pays rules.<sup>3</sup> These rules widely reflect

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<sup>3</sup> In addition to the rules we are focusing on, several other burden sharing approaches have been discussed in the literature. In an analytical review, Mattoo and Subramanian (2012) proposes to shift the discussion on equity issues in climate change negotiations from the fixed-emissions pie language to a setting of contributions of different countries in generating low-carbon technologies to shape international cooperation. Building up on a conflicting claim setting (i.e. agents claim a scarce resource—the carbon budget—such that there is not enough to honor the aggregate claim), Giménez-Gómez et al. (2016) argue that the Talmud rule turns out to be the most adequate burden sharing rule in international climate negotiations.

also the categorization (responsibility, capability, equality, cost effectiveness) proposed by Höhne et al. (2014) based on an extensive literature review.

Table OESM 1 (in the online appendix) summarizes the different burden sharing rules together with the verbatim description offered to the survey participants: All these burden sharing rules offer different entitlements for future emissions. We consider an egalitarian rule (EGA), a grandfathering rule (GRA), an ability-to-pay rule (ABI), polluter-pays rules based on current emissions (POL2011) or on average historical GHG emissions since 1990 (POL1990), and, equivalently, consumer-pays approaches (CON1990 or CON2011). In the corresponding survey question, participants were required to assign percentage weights to the seven single burden sharing rules (EGA, GRA, ABI, POL1990, POL2011, CON1990, CON2011) or an open-space category. In particular, they were asked which percentage weights should be given to the different burden sharing rules in the distribution of GHG emission reduction targets between countries in an international climate agreement. Total weights should sum up to 100%.<sup>4</sup> Participants were informed that we consider a time horizon up to 2050 and that tradability of emission entitlements between countries after the initial allocation was assumed.

## 2.2 Data description

For the empirical analysis we collected data from a world-wide survey conducted by means of a standardized questionnaire that was sent via email in a first wave to 5767 agents involved in climate policy.<sup>5</sup> We took the addresses from official UNFCCC lists of participants from COP-16 in Cancún and COP-17 in Durban. We conducted an extensive name-by-name web research of all names of the corresponding participation list to get individual contact information. We invited only delegation members of Parties and observer states but excluded United Nations Secretariats units and bodies, specialized agencies and related organizations, intergovernmental organizations and non-governmental organizations. In addition, we contacted all UNFCCC national focal points. All participants obtained an individual login to an online survey in order to control access and ensure that the questionnaire is only filled out once by each individual. In addition, we provided a fillable PDF form of the survey for participants with limited web access that could be sent back via email, postal mail, or fax. Two reminders (including some additional contact details obtained from the previous rounds) were mailed.

Out of a total of 5840 contacted individuals,<sup>6</sup> 498 participated in the survey. Since not all participants share their attitudes towards all parts of the survey, our analysis

<sup>4</sup> For 16 observations that enter our analysis, the sum of weights either falls below or exceeds 100% and is therefore rescaled manually to 100. We control for potential effects of readjustment in our analysis.

<sup>5</sup> This dataset is also used in Kesternich (2016) to assess preferences for different minimum participation rules.

<sup>6</sup> While in the first wave of the survey we sent out 5767 emails, we got feedback from some of the respondents and focal points sending us some additional contact information from additional people that were then included in the second and third wave. In the end, we approached 5840 individuals.

is based on 329 respondents from 112 countries. Overall, this is a fairly typical participation rate for surveys with individuals which are not interviewed face-to-face. There is no evidence that this sample is not representative for our target population of all participants from COP-16 and COP-17,<sup>7</sup> but we clearly cannot entirely rule out sample selection problems. However, according to Heckman (1979) (for linear regression models), the parameter estimates are only biased if the error term in the econometric equation on the basis of the restricted sample data is correlated with the sample selection rule, i.e. if the unobserved explanatory variables in the error term are correlated with the unobserved determinants of selection into the sample. In fact, we can speculate that, for example, the age and gender distribution in our sample is different from the distribution in the population. However, most potential determinants of the sampling selection rule are also explanatory variables in our population structural equation and thus are included in our econometric analysis. In sum, while the over- or underrepresentation of some specific population groups might possibly distort several descriptive statistics, we have no indication of strong sample selection biases in our main econometric analysis, although correlations between these unobserved variables as discussed above can naturally never be completely ruled out.<sup>8</sup>

In order to identify regional differences in the perception of different fairness concepts, we follow UNFCCC party groupings (UNFCCC 2013) and distinguish between five major groups with respect to substantive and political purpose: AOSIS, BASIC, EU27, UMBRELLA/EIG, and G77 (without AOSIS and BASIC members). Focusing on these five major groups of course imposes some simplifying assumption in contrast to the full picture of the negotiation process where several types of (overlapping) groupings (including ad-hoc formation) for different strands of the negotiation process are possible and occur during the negotiations.<sup>9</sup> In the following, we explain the five groups in more detail. AOSIS is a group of 43 small island countries sharing similar vulnerability levels with respect to expected climate change impacts (i.e. sea-level rise). The coalition, mainly consisting of G77 members, was among the first groups that explicitly called for cutting GHG emissions by 20% from 1990 levels by 2005 during the Kyoto Protocol negotiations (UNFCCC 2013).

<sup>7</sup> As discussed below, we have only slightly higher shares of survey participants from EU27 compared to the corresponding share in the underlying population.

<sup>8</sup> One potential candidate of unobserved variables in our sample are general preferences for environmental outcomes. On the one hand, one might argue that these effects are at least partly captured by the indicator variable *NGO* in our analyses. On the other hand, we do not have insights from previous studies whether environmental preferences are important determinants of selection into the sample.

<sup>9</sup> As discussed by Blaxekjær and Nielsen (2015) after COP-15 the UNFCCC organizational landscape became more fragmented. In addition to the groups we consider in our analysis, further political groups established and probably will become more important in the process in the future. These groups include the African Group (AG), the Bolivarian Alliance of Our America (ALBA), the Central American Integration System, Central Asia, the Caucasus, Albania and Moldova Group (CACAM), the Coalition for Rainforest Nations (CfRN), the League of Arab States, sometimes known as the Arab Group (LAS), the Least Developed Countries (LDCs), the Organization of the Petroleum Exporting Countries (OPEC), Small Island Developing States (SIDS), the Climate Vulnerable Forum (CVF), the Cartagena Dialogue for Progressive Action, the Durban Alliance (DA), the Like-Minded Developing Countries (LMDC) and the Association of Independent Latin American and Caribbean States (AILAC).

The BASIC group (Brazil, South Africa, India, and China) is a coalition of four large emerging countries out of the G77 alliance initially formed during the negotiations on the Copenhagen Accord in November 2009 (e.g., Olsson et al. 2010). The group was initiated and headed by China to commit and lead its members to a joint strategy in international climate treaty formation. It should be noted that in our analysis, the BASIC group does not include observations from India.<sup>10</sup> Therefore, when we refer to BASIC in our analysis in the following, the results do not include the Indian position within the group. Happaerts and Bruyninckx (2013) argue that BASIC can be considered as a new coalition in the climate change regime because (i) the positions of the four group members converged during coalition formation, (ii) its influence was established shortly after its creation when the Copenhagen Accord was negotiated, (iii) coalition members officially speak in behalf of the coalition, and (iv) the BASIC group is recognized by external actors.<sup>11</sup> The reason why Russia is not part of the BASIC group—and, therefore, the rather known BRIC group does not appear in climate change negotiations—is due to the fact that Russia is an Annex I country and thus represents a different position within the UNFCCC framework compared to the remaining emerging countries (e.g., Happaerts and Bruyninckx 2013).

EU27 represents the European Union and its member states. It is considered as an economic integration organization and is, therefore, a single party in international meetings. However, apart from its member states, it is without any additional voting rights. UMBRELLA/EIG (former JUSSCANNZ group) is a loose alliance of industrialized countries which are not members of the EU. The non-formal member list includes Australia, Canada, Japan, New Zealand, Norway, Russia, Ukraine, and the US, additionally supported by the members of the Environmental Integrity Group (EIG) (formed in 2000) consisting of Mexico, Liechtenstein, Monaco, the Republic of Korea, and Switzerland. The name UMBRELLA has been established based on the negotiation position presented by these countries that was supposed to protect them—or in other words, to put them under a joint umbrella—from EU propositions (e.g., Gnas 2015). The G77 group, founded in 1964 during UN Conference on Trade and Development, traditionally reflects a common negotiation position of the developing countries. We provide an overview of the different groups in Table OESM 2 (in the online appendix).

By analyzing countries' fairness conceptions as expressed in official position documents submitted during the process leading to the Paris Agreement, Tørstad and Sælen (2017) find that the Annex/Non-Annex division is still the most consistent

<sup>10</sup> We achieved to collect personal contact details from more than 60 members of the Indian delegation but nobody followed our invitation to take part in the survey.

<sup>11</sup> In a recent contribution, Hochstetler and Milkoreit (2015) observe that cooperation and coordination among BASIC members has been declined since 2012, in particular because BASIC countries seem not yet prepared to take a lead in the climate negotiations even though their economic power enables them to do so. Nevertheless, as the authors argue, the emergence of the BASIC group indicated a departure of the traditional North–South divide into a system with at least three categories of countries: Developed, developing, and emerging countries which might create more flexibility for possible burden-sharing arrangements in an international climate treaty.



explanatory variable for predicting differences in fairness views even though the Paris Agreement omits reference to this dichotomy structure.<sup>12</sup> As a further robustness check, we, therefore, distinguish between Annex-B (i.e. those 37 countries with binding commitments in the Kyoto Protocol) (including UMBRELLA, EIT, and EU) and Non-Annex-B countries (including AOSIS, BASIC, G77, and China) in our econometric analyses.<sup>13</sup>

### 2.3 Empirical strategy, econometric models, and variables

We apply a relative weighting scheme to investigate whether such a mechanism helps to overcome the strictly (self-interested) strategic claims on equity in the negotiation process. In particular, our dependent variables are derived from a survey question in which participants were asked to provide a percentage-weighted distribution of the different burden sharing rules discussed in Sect. 2.1 summing up to 100% (see Table OESM 3 in the online appendix for the exact question setting). Our analysis is twofold: First, as a necessary condition for concessions, we examine whether delegates are principally willing to assign a positive weight to more than one (i.e. their preferred) burden sharing rule. Second, if so, we focus on the distribution of these weights to identify potential burden sharing rules that are more likely to provide room for consensus. In particular, we investigate the perception towards two concrete burden sharing rules, POL2011 and ABI, having shown the highest support and the lowest opponent rates in the descriptive statistics in our sample.

The first part of our econometric analysis is based on a zero-truncated Poisson model (e.g., Long and Freese 2006) as the dependent variable  $y_i$  for individual  $i = 1, \dots, N$  of the number of burden sharing rules can take the values  $j = 1, \dots, 8$ . This means  $y_i$  equals to one if an individual assigns a 100% weight to one single rule and it takes the value eight if a positive weight is assigned to all given burden sharing rules and to the open space category.<sup>14</sup> The probability that the dependent variable takes specific values is given by

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<sup>12</sup> We are fully aware that the distinction between “developing countries” and “developed countries” is a simplification at this stage of the analysis. As described by Najam (2005), over the last thirty years a transformation of the global environmental discourse can be clearly observed. “Developing countries” have been more engaged in the discourse and the discourse itself has changed. Inter alia, “developing countries” consider ecological concerns as a necessary part of sustainable development but these should be considered together with developmental and equity concerns.

<sup>13</sup> Analyzing official statements from COP-17 to COP-19 Blaxekjær and Nielsen (2015) show differences in narratives among Non-Annex-B countries. While BASIC and the LMDC countries tend to uphold the “North/South” division by defending the “differentiated responsibility” narrative, other groups including CVF, CD, DA, and AILAC align on a narrative of ‘shared responsibility across the North – South divide’.

<sup>14</sup> Since only a small minority of the sample makes use of the open space category by suggesting an additional burden sharing rule, we have additionally considered a model that excludes this open category so that the dependent variable only takes values between zero and seven. We do not include the underlying tables in the paper since this does not change our main results. We provide these results upon request.



$$\Pr(y_i = j | j > 0, x_i) = \frac{\Pr(y_i = j | x_i)}{1 - \exp(-\mu_i)}, \quad (1)$$

with  $\Pr(y_i = j | x_i) = \frac{\exp(-\mu_i)\mu_i^j}{j!}$  and  $\mu_i = \exp(x_i'\beta)$  indicating the expected number of occurrence.  $x_i$  is the vector of explanatory variables and  $\beta$  the related vector of coefficients. The model relies on the Poisson model restriction of equidispersion, i.e. the equality of conditional mean and variance. A likelihood-ratio test after the estimation of a zero-truncated negative binomial model does not provide evidence for overdispersion.

The second part of the econometric analysis focuses on the distribution of the weights. We analyze to what extent individuals deviate from only one preferred burden sharing rule.<sup>15</sup> We use a Tobit model with a lower limit of 0 and an upper limit of 87.5 for the econometric analysis. The observed dependent variable  $y_i$  relates to the unobserved latent variable  $y_i^* = x_i'\beta + \varepsilon_i$  with  $\varepsilon_i \sim N(0, \sigma^2)$  as follows:

$$y_i = \begin{cases} 0 & \text{if } y_i^* \leq 0 \\ y_i^* & \text{if } 0 < y_i^* \leq 87.5 \\ 87.5 & \text{if } y_i^* > 87.5 \end{cases} \quad (2)$$

In the third part, the econometric analysis turns towards attitudes on POL2011 and ABI because these two rules receive on average the highest support and the lowest opponent rates in our sample. Our dependent variable is then the weight in percentages which is assigned to a certain rule. Since it is limited between 0 and 100, we apply a Tobit model with the corresponding lower and upper limits.<sup>16</sup> In all econometric models, the unknown parameters were estimated with the maximum likelihood method (ML). Furthermore, we report robust standard errors for the ML parameter estimates.

The main focus of our econometric analysis is to identify potential differences on the perception of weighted burden sharing rules among key regions. We amplify our analysis by successively introducing a series of control variables either taken from external data sources or from self-reported information of participants in the final section of the questionnaire. Our empirical strategy is related to the studies by Beron et al. (2003) on the ratification decisions of countries to the Montreal Protocol and by Lange et al. (2007) who, as discussed previously, analyze attitudes towards single burden sharing rules. In a related study based on the same dataset as being used in this paper, Kesternich (2016) investigates the perception for different minimum participation rules for a future climate treaty among key players by successively

<sup>15</sup> For example, if an individual assigned 60% to the most preferred burden sharing rule, the deviation would amount to  $100 - 60 = 40$  percentage points. If weights were equally distributed across all eight response categories, an average weight of 12.5% would be reached and, consequently, a maximum deviation of  $100 - 12.5 = 87.5$  percentage points. Analogously, if 100% were assigned to one single burden sharing rule, the minimum deviation would equal to 0 percentage points.

<sup>16</sup> As a robustness check, we also consider binary logit models on opposition rates (=zero weights) against these two rules.

introducing a series of control variables. In the following, we discuss the different groups of explanatory variables being used for our analysis.<sup>17</sup>

*Country groupings:* To capture regional differences on fairness, we distinguish between the five major key regions as discussed in the previous section. The binary variables *AOSIS*, *EU27*, *BASIC*, and *UMBRELLA/EIG* take the value one if the respondent's stated home country is a member of the respective groups of countries.<sup>18</sup> In our econometric models, the *G77* group (without its *AOSIS* and *BASIC* members) serves as the base category. Throughout the paper, we refer to “*G77*” when making comparisons between the estimated coefficients for regional indicator variables and the base category.

*Economic or emissions performance indicators:* The variable *GDP per capita* contains World Bank data on per capita GDP for 2011 or latest available data (in current \$1,000) for the respondent's home country (The World Bank 2012). *CO<sub>2</sub> per capita* covers CO<sub>2</sub> emissions for 2011 on a per capita base (in t CO<sub>2</sub>). Emission data are taken from the European Commission Emission Database for Global Atmospheric Research (EDGAR 2011) and population data are taken from the World Bank (2014).

*Vulnerability to climate change:* According to IPCC assessments, developing countries are expected to suffer most from potential impacts and risks of climate change. In our analysis, we include the 2011 vulnerability score (varying between 0 and 1) (*VULNARABILITY*) of the Notre Dame Global Adaptation Index (ND-GAIN) which provides a measure of a country's exposure, sensitivity, and capacity to adapt to the negative effects of climate change.<sup>19</sup> As indicated by the IPCC, global mean sea levels, for example, are expected to rise in the future such that potential impacts as submergence, coastal flooding, or erosion will particularly hit low-lying areas such as the *AOSIS* states.

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<sup>17</sup> The reason for the inclusion of several control variables is to reduce possible biases from omitted variables, which are correlated with both the main explanatory variables and the dependent variables. We cannot fully rule out such biases. However, we are confident that, given the available data, we have included the most relevant control variables on the basis of previous studies. It might be argued that some unobserved variables like individual environmental preferences are correlated with other explanatory variables (e.g., working for a NGO, the vulnerability of the country to climate change, or the freedom status of the country). While there is mixed evidence from the literature to what extent individual environmental preferences among citizens are potentially correlated with preferences for certain burden sharing rules (e.g., Lange and Schwirplies 2017), we are not aware of any empirical study which assesses a potential correlation between environmental preferences of COP delegates and their preferences for certain burden sharing rules. As a consequence, we are not able to further evaluate the direction or strength of possible biases if they nevertheless should exist.

<sup>18</sup> In our robustness check, the binary variable Annex-B takes the value one of the respondent's home country is among those 37 countries with binding commitments in the Kyoto Protocol.

<sup>19</sup> The vulnerability score of the Notre Dame Global Adaptation Index (ND-GAIN) considers overall vulnerability by taking into consideration six life-supporting sectors including food, water, health, ecosystem services, human habitat, and infrastructure (e.g., Chen et al. 2015). In our sample, the index suggests Norway (0.27) to have the lowest degree of vulnerability, while it is highest for Niger (0.67). The average value for our sample used in the analysis is 0.42.

*Form of government:* A series of empirical studies investigate the relationship between the form of government and the pollution level.<sup>20</sup> A common finding of this literature is that authoritarian regimes rather prefer short term decisions compared to long-term commitments due to future uncertainties. Considering our framework, countries with less democratic forms of government are, therefore, expected to be less likely to deviate from their preferred baseline position. We include a binary variable *FREE* that equals to one for countries with the highest freedom status both for political rights and civil liberty as reported by Freedom House (2014).<sup>21</sup>

We include sociodemographic information as additional control variables as discussed above. We look at potential age effects on attitudes towards burden sharing rules (*AGE*, measured in years) and we take into account that the perception of fairness may differ between males and females (binary variable *FEMALE*).<sup>22</sup> Moreover, we control for the educational background such that the variable *ECON* equals to one if individual's highest degree is obtained in the field of economics or business administration<sup>23</sup> and *NGO* equals to one if the respondent works for a nongovernmental organization. Note again that we focused on delegation members of Parties only and did not sample intergovernmental and non-governmental organizations. Not very surprisingly, however, some Parties officially announce NGO representatives as delegation members to count on their expertise. We control for this in our empirical analysis.<sup>24</sup> Furthermore, the binary variable *COPPARTY* controls for the participants' positions during COP-16 and COP-17 and takes the value one if the respondent reported in the survey that she was actually present as a delegation member of a party at COP-16 or/and COP-17 (and not listed only in the preliminary participation list).

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<sup>20</sup> For example, Barrett and Graddy (2000) report evidence that an increase in civil and political freedom reduces the degree of several air pollutants. Neumayer (2000) studies the ratification of different multilateral environmental agreements and, except for the Rotterdam Convention, shows that civil and political freedom leads to stronger international commitments. In line with this finding, Beron et al. (2003) confirm the relationship between political freedom and joining of international treaties for the Montreal Protocol.

<sup>21</sup> The variable is constructed based on a three-point scale (not free, partly free, free).

<sup>22</sup> There is evidence from the experimental literature that gender might play a role for distributional preferences. For instance, Sharma (2015) reports evidence from a dictator game showing that men dictators keep a greater share of the pie than females. Similarly, Croson and Buchan (1999) suggest that women in a trust game return significantly more of their wealth than men. Cadsby and Maynes (1998) show that female groups are significantly better able to coordinate around a selected equilibrium in a threshold public good game (which shares some similarities to the climate change dilemma) than men.

<sup>23</sup> Individual assessments of different burden sharing rules might potentially be related to different educational backgrounds. For instance, there exists a broad experimental literature which reports differences in cooperative behavior between economists and non-economists (e.g., Marwell and Ames 1981, Frank et al. 1993, 1996, Frank and Schulze 2000) which may be attributed to self-selection (e.g., Frey and Meier 2005).

<sup>24</sup> The main reason for including this control variable is to address the concern that individuals working for a NGO (and being a member of a Party delegation and not a NGO delegate) might be overrepresented in our sample. They might therefore affect response behavior since representatives from NGO might have a stronger position on fairness concerns and the need for an international agreement on these within delegations compared to other representatives. To address these potential concerns we control for these positions (10% of our sample) in our analyses but do not find any significant effects of this variable.

Throughout the discussion of the econometric results in Sect. 2.5, the chronological order of explanatory variables remains the same in order to facilitate the interpretation of the estimation results: Column 1 controls for country group specific effects with (mainly) G77 countries without AOSIS and BASIC members representing the base category. In columns 2 and 3, in a first step, we successively introduce one of the two economic or emission performance indicators (*GDP per capita* or *CO<sub>2</sub> per capita*) to address potential multicollinearity problems. These may arise due to correlations either within the two performance indicators or between them and the country group indicator variables. In the fourth column, we jointly consider country group effects together with *GDP per capita*.<sup>25</sup> We combine these variables to identify the predominant explanatory source. In each model specification, we additionally control for sociodemographic information, vulnerability to climate change, the form of government, and the adjustment indicator.<sup>26</sup> In our robustness checks, we replace the country groups with the binary variable *Annex-B* variable (columns 5 and 6).

## 2.4 Descriptive statistics

Table OESM 4 (in the online appendix) shows that 5.2% of the respondents live within AOSIS, 10.3% within BASIC, 21.3% within EU27, 12.8% within UMBRELLA/EIG, and thus 46.4% in G77 (without AOSIS and BASIC members).<sup>27</sup> The respective frequencies for the underlying population (i.e. for those delegates we obtained contact details) are 9.6%, 13.4%, 17.4%, 14.0%, and 42.5%. That is, we have slightly higher shares for EU27 survey participants in our econometric analysis in contrast to our initial list. A large majority of the respondents makes use of diversification and assign a positive weight to several burden sharing rules. Less

<sup>25</sup> A postestimation analysis on multicollinearity between explanatory variables suggests rather weak evidence for potential multicollinearity problems in our models, never exceeding a mean variance inflation indicator (vif) of 1.69. For instance, the corresponding test after Table 2, column 4 indicates a mean variance inflation factor (vif) of 1.69 being highest for the variable *GDP per capita* (3.38) meaning that  $1/vif=0.30$  of the effect of *GDP per capita* on the dependent variable is independent from all explanatory variables. In the econometric literature, a vif of 4 (or even 10) has been used as a rule of thumb to indicate serious multicollinearity concerns (see O'Brien 2007 for a critical discussion). We choose *GDP per capita* in column 4 since the maximum value of the log-likelihood function for a model with *GDP per capita* except for Table 2 is always higher for *GDP per capita* than for *CO<sub>2</sub> per capita*.

<sup>26</sup> In addition, the indicator variable *ADJUSTED* is introduced for technical reasons. For 16 observations that enter our analysis, the sum of weights either falls below or exceeds 100% and is therefore rescaled manually to 100. We control for potential effects of this readjustment: *ADJUSTED* takes the value 1 if the sum of weights initially did not sum up exactly to 100.

<sup>27</sup> In some cases, delegation members worked for different parties in COP-16 and COP-17. We chose the stated home country as the appropriate variable for assigning the participants to the different country groups. In most of our observations (95.4%), delegation members represented their home country in COP-16 and/or COP-17. Only in 15 cases, respondents in both COP were delegation members of a party which was not his or her stated home country or region. As an additional robustness check, we exclude these observations from the analysis. This does, however, not affect our main results. Throughout the paper, our discussion is based on the full sample. The underlying tables for the econometric results are not included in the paper. We provide these results upon request.

than 3% of the respondents restrict their choices to one single rule, whereas more than 80% assign a positive weight to at least half of all fairness rules. If we consider the assignment of weights to different burden sharing rules as a way to pledge first concessions, there is evidence that delegates appear not to persist in their baseline positions.

More than half of the sample clearly identifies one single burden sharing rule (mostly POL1990) to be the most important rule within the bundle. About 40% of the respondents do not highlight one single rule, but rather give an equal highest weight to at least two different fairness rules (mostly POL1990 and POL2011). Mean weights for the different burden sharing mechanisms across all participants separated according to the key regions are shown in Table 1. Averaged over all participants, the highest weight is assigned to POL, both in the 2011 (19.3%) and 1990 version (18.8%), followed by ABI (14.0%). This is in line with the empirical findings of Lange et al. (2007) and Hjerpe et al. (2011). Interestingly, all burden sharing rules on average receive a weight larger than 10%. That is, many participants support the different approaches to some extent. Surprisingly, in contrast to previous empirical results, there is evidence that the equal-per capita emissions approach is a concept that is rather supported in developed countries (EU27: 20.3%, UMBRELLA/EIG: 19.1%), while support tend to be rather low in developing countries (AOSIS: 5.5%, BASIC: 9.2%, G77: 9.5%).

According to Table OESM 5 (in the online appendix), zero-weights are most likely for GRA and EGA. More than a fourth of all respondents do not include these rules into their preferred bundle, which can be either interpreted as an explicit opposition towards these rules or simply mean that these rules are the least attractive rules. Zero-weights on average are lowest for ABI and POL2011 (14%, respectively).

## 2.5 Econometric results

In line with the descriptive statistics on the number of different burden sharing rules that receive a positive weight, our first econometric analysis with zero-truncated Poisson models indicates regional differences. These turn out to be statistically significant predominantly for the Annex-B/Non-Annex-B differentiation (Table 2, column 5).<sup>28</sup> Moreover, Table 2 suggests that economic performance indicators shed further light on negotiation positions towards weighted burden sharing rules. Participants from countries with high GDP per capita levels are significantly more likely to select fewer rules ( $p < 0.01$ ) (Table 2, column 1). If country groups and GDP per capita enter simultaneously into the model, the results suggest rather differences

<sup>28</sup> In order to detect differences within the respective regions beyond those to the base category, (i.e., G77 without AOSIS and BASIC members) we have considered a series of pairwise Wald tests on differences in estimated coefficients of the corresponding country groups. For instance, we find that participants from EU27 assign positive weights to significantly fewer rules than participants from the BASIC group ( $p < 0.05$ ) (Table 2, column 1).

in wealth positions ( $p < 0.01$ ) than party groupings to predominantly explain differences in response behavior (Table 2, columns 4 and 6). As expected, we find a significantly positive effect of the degree of vulnerability on the number of burden sharing rules being chosen, but this effect appears not to be robust across the different model specifications. No further robust significant effects of the remaining control variables can be observed in our sample.

If we consider deviations from baseline positions (i.e. assigning a 100% weight to one single rule) there is no statistical evidence for differences between the different country groups in our sample. We only find a weakly significantly positive relationship between CO<sub>2</sub> per capita and the degree of deviation (Table OESM 6, column 3 in the online appendix).

**Result 1** *Delegates from different groups of countries show a general willingness for concessions, but the degree to which different burden sharing rules are taken into consideration partly differs between countries. Representatives from economically powerful regions are more likely to focus on a smaller number of different burden sharing rules for the distribution of GHG emission reduction targets between countries in an international climate agreement. We do, however, not find any statistically significant evidence for differences between country groups with respect to deviations from the most preferred burden sharing rule.*

Even though there is evidence that delegates pledge first concessions that deviate from their baseline positions, our results can be interpreted in a way that economically powerful players tend to rather focus on a few key principles in order to reduce complexity and to enhance the future bargaining process. Whether this is a promising approach crucially depends on the question whether the selection mainly excludes burden sharing rules being of low interest among all negotiating parties or whether the aim of the selection is to exclude principles that are mainly appealing for opponents. To address this question, we now turn our discussion towards two principles that receive high support and low opponent rates, POL2011 and ABI. Table 3 depicts results from Tobit models for weights for the POL2011 principle.<sup>29</sup> The results indicate that countries that faced CO<sub>2</sub> mitigation targets under the Kyoto Protocol are more likely to support the POL2011 principle than the remaining countries ( $p < 0.05$ ) (Table 3, columns 5 and 6) thereby stressing the persistent dichotomy between the traditional Annex-B/Non-Annex-B division for this burden sharing concept.

A more nuanced view provides, however, evidence that the support for POL2011 from participants from BASIC ( $p < 0.05$ , columns 1 and 4) is significantly lower than from delegates representing the G77. This result stresses ongoing shifts in bargaining positions in current negotiations as stressed by Blaxekjær and Nielsen (2015). Developing countries as a rather homogeneous group broadly supported the

<sup>29</sup> It should be noted that a higher percentage weight for one burden sharing rule leads to lower percentage weights for all other six rules together by definition, which necessarily leads to correlations between these weights. As a consequence, the results in Table 3 do not only refer to the effects on a higher support for the POL2011 principle, but implicitly also to the effects on a lower support for the other six burden sharing rules together. The estimation results in Table 4 as discussed below have to be interpreted similarly.

**Table 1** Mean weights for burden sharing rules across different regions

	EGA	GRA	ABI	POL 2011	POL 1990	CON 2011	CON 1990	Other(s)	Total
All (329 respondents)	12.7%	10.0%	14.0%	18.8%	19.3%	11.5%	11.2%	2.6%	100%
AOSIS (17 respondents)	5.5%	16.6%	14.5%	19.2%	23.8%	9.2%	11.1%	0.2%	100%
BASIC (34 respondents)	9.2%	8.4%	15.2%	14.0%	21.2%	12.6%	14.9%	4.7%	100%
EU27 (70 respondents)	20.3%	7.2%	15.5%	20.3%	12.5%	12.8%	9.9%	1.4%	100%
UMBRELLA/EIG (42 respondents)	19.1%	10.8%	15.5%	15.3%	11.9%	14.0%	9.0%	4.4%	100%
G77 (141 respondents)	9.5%	9.7%	11.7%	19.8%	24.7%	9.4%	12.3%	2.9%	100%
Annex B (102 respondents)	20.0%	8.5%	16.0%	19.8%	11.1%	13.5%	8.7%	2.4%	100%
Diff	14.8	9.4	4.4	6.3	14.2	7.9	6.1	4.5	

Diff: difference in percentage points between regions (AOSIS, BASIC, EU27, UMBRELLA/EIG, G77) with highest and lowest share

claims for historical responsibility in the Kyoto process by calling for a polluter-pays rule based on accumulated emissions since the industrial revolution. In contrast, our results indicate that there is a more controversial debate among developing and emerging countries on the role of the polluter-pays principle based on current emission levels. In line with material self-interest, the fast growing emerging members (Brazil, South Africa, India, and China) of the group of developing countries rather try to avoid a predominant role of the polluter-pays principle based on current emissions. The estimation results from binary logit models on opposition rates against POL2011 (dependent variable = 1 if weight for POL2011 = 0) in Table OESM 7 (in the online appendix) reveal that countries with high vulnerability levels are significantly less likely to oppose POL2011 (at least  $p < 0.05$ ). This result can be traced back to the frequent call that the strongest current emitters should have a responsibility to pay for the damages resulting from climate change which are particularly severe for the most vulnerable countries.

**Result 2** *The individual assessment of the polluter-pays rule based on current emissions (POL2011) suggests that the dichotomy between Annex-B/Non-Annex B countries persists with respect to this burden sharing principle: Participants from Annex-B (“developed countries”) are more likely to assign a higher weight to this rule than Non-Annex B representatives (“developing countries”). A more nuanced consideration, however, points out room for disagreement among the group of Non-Annex-B countries. Out of this group, the emerging economies being represented by the BASIC group are less likely to stress the need for this rule than the remaining G77 members.*



**Table 2** Maximum likelihood estimates in zero-truncated Poisson models, dependent variable: number of rules with a weight > 0%

	(1)	(2)	(3)	(4)	(5)	(6)
AOSIS	– 0.054 (0.082)			– 0.070 (0.084)		
BASIC	0.038 (0.070)			0.005 (0.070)		
EU27	– 0.128 (0.083)			– 0.057 (0.087)		
UMBRELLA/EIG	– 0.082			0.055		
ANNEX B					– 0.126** (0.062)	– 0.007 (0.077)
GDP per capita		– 0.005*** (0.002)		– 0.005*** (0.002)		– 0.005*** (0.002)
CO <sub>2</sub> per capita			0.004 (0.005)			
VULNERABILITY	0.742** (0.304)	0.389 (0.274)	1.151*** (0.282)	0.401 (0.320)	0.709*** (0.256)	0.387 (0.276)
FREE	– 0.026 (0.050)	– 0.008 (0.047)	– 0.048 (0.049)	0.020 (0.050)	– 0.016 (0.049)	– 0.007 (0.048)
AGE	– 0.003 (0.002)	– 0.002 (0.002)	– 0.002 (0.002)	– 0.003 (0.002)	– 0.002 (0.002)	– 0.002 (0.002)
FEMALE	0.048 (0.042)	0.041 (0.041)	0.054 (0.042)	0.043 (0.041)	0.045 (0.042)	0.041 (0.041)
ECON	– 0.038 (0.048)	– 0.035 (0.049)	– 0.039 (0.049)	– 0.041 (0.049)	– 0.043 (0.048)	– 0.035 (0.050)
NGO	– 0.030 (0.059)	0.006 (0.060)	– 0.025 (0.059)	– 0.006 (0.061)	– 0.016 (0.058)	0.006 (0.060)
COPPARTY	– 0.001 (0.048)	0.005 (0.047)	– 0.002 (0.048)	0.007 (0.048)	0.000 (0.047)	0.005 (0.047)
ADJUSTED	0.007 (0.082)	– 0.000 (0.081)	– 0.005 (0.085)	– 0.002 (0.082)	– 0.006 (0.082)	– 0.001 (0.081)
Constant	1.599*** (0.205)	1.771*** (0.185)	1.374*** (0.192)	1.767*** (0.209)	1.604*** (0.179)	1.772*** (0.186)
Observations	278	276	275	276	278	276

Robust standard errors in parentheses, \*\*\* $p < 0.01$ , \*\* $p < 0.05$

Turning towards the ability-to-pay rule (ABI), the estimation results from Tobit models in Table 4 suggest positions among party groups to be less controversial than among the polluter-pays rule. Counterintuitive to economic intuition, there is even (weakly significant) evidence that delegates from the UMBRELLA/EIG group are more likely to assign a higher average weight to that rule than G77 members. This observation also holds in our zero-weight specification (Table OESM 8, columns 1 and 4 in the online appendix). As an extension to our previous result we formulate our third observation.

**Table 3** Maximum likelihood estimates in Tobit models, dependent variable: weight for POL 2011

	(1)	(2)	(3)	(4)	(5)	(6)
AOSIS	– 4.076 (4.310)			– 4.287 (4.406)		
BASIC	– 9.401** (4.579)			– 9.845** (4.589)		
EU27	– 0.511 (5.330)			0.369 (6.043)		
UMBRELLA/EIG	– 6.073 (5.083)			– 4.477 (5.662)		
ANNEX B					7.886** (3.732)	12.930** (5.678)
GDP per capita		– 0.021 (0.116)		– 0.058 (0.147)		– 0.191 (0.167)
CO <sub>2</sub> per capita			0.417 (0.298)			
VULNERABILITY	27.401 (18.940)	29.559 (19.841)	44.677** (17.631)	23.130 (20.898)	51.447*** (17.007)	36.950* (19.121)
FREE	4.901 (3.510)	3.411 (3.092)	2.986 (2.899)	5.467 (3.585)	1.124 (2.921)	1.540 (2.926)
AGE	0.320*** (0.121)	0.339*** (0.125)	0.327** (0.127)	0.326*** (0.121)	0.340*** (0.120)	0.344*** (0.121)
FEMALE	1.442 (2.689)	1.683 (2.740)	1.813 (2.666)	1.343 (2.717)	2.200 (2.665)	1.947 (2.678)
ECON	3.127 (3.218)	2.512 (3.358)	2.577 (3.295)	3.156 (3.285)	2.831 (3.190)	3.352 (3.355)
NGO	– 1.291 (2.958)	– 1.375 (3.052)	– 1.328 (2.953)	– 0.943 (3.197)	– 2.026 (2.963)	– 0.801 (3.280)
COPPARTY	– 1.054 (3.125)	– 0.023 (3.199)	0.145 (3.071)	– 0.941 (3.273)	– 0.457 (2.982)	– 0.206 (3.216)
ADJUSTED	0.632 (4.360)	1.779 (4.509)	1.388 (4.565)	0.540 (4.341)	2.105 (4.415)	2.334 (4.344)
Constant	– 8.593 (12.378)	– 12.187 (12.607)	– 20.289* (11.265)	– 6.724 (13.286)	– 22.949** (11.396)	– 15.764 (12.308)
Observations	278	276	275	276	278	276

Robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

**Result 3** *We observe tendencies to a more harmonized view towards the ability-to-pay rule (ABI) rule compared to the polluter-pays-principle between the different country groups.*

One might argue that the polluter-pays principle based on current emissions and the ability-to-pay rule basically coincide in their distribution of mitigation efforts among key regions. Lange et al. (2010) estimate the economic costs of different equity principles based on projected marginal abatement costs for 2020. According to their findings, the economic costs for groups of developed countries (e.g., EU) are higher if the ability-to-pay criterion is applied in contrast to the polluter-pays-rule. For the group of developing countries, both rules impose relative high costs

**Table 4** Maximum likelihood estimates in Tobit models, dependent variable: weight for ABI

	(1)	(2)	(3)	(4)	(5)	(6)
AOSIS	– 0.099 (3.218)			– 0.151 (3.212)		
BASIC	1.395 (3.030)			1.495 (3.028)		
EU27	1.990 (3.381)			1.634 (3.717)		
UMBRELLA/EIG	4.655* (2.687)			4.185 (3.349)		
ANNEX B					2.954 (2.452)	2.389 (3.456)
GDP per capita		0.052 (0.060)		0.017 (0.079)		0.020 (0.083)
CO <sub>2</sub> per capita			0.183 (0.246)			
VULNERABILITY	17.170 (12.429)	15.093 (10.882)	12.106 (12.070)	18.958 (12.399)	14.297 (10.558)	16.444 (10.833)
FREE	3.738* (2.016)	3.459* (2.022)	3.754** (1.904)	3.545 (2.192)	3.221* (1.938)	3.117 (1.973)
AGE	– 0.071 (0.079)	– 0.088 (0.079)	– 0.097 (0.080)	– 0.079 (0.080)	– 0.080 (0.077)	– 0.087 (0.078)
FEMALE	0.457 (1.957)	0.340 (1.971)	0.211 (1.983)	0.458 (1.965)	0.398 (1.959)	0.395 (1.967)
ECON	2.012 (1.997)	2.423 (1.972)	2.556 (1.988)	2.211 (2.021)	2.430 (1.975)	2.588 (2.000)
NGO	– 3.171 (2.499)	– 3.308 (2.457)	– 2.728 (2.510)	– 3.355 (2.494)	– 3.024 (2.491)	– 3.224 (2.457)
COPPARTY	– 0.432 (2.326)	– 0.683 (2.229)	– 0.449 (2.220)	– 0.446 (2.313)	– 0.710 (2.245)	– 0.716 (2.234)
ADJUSTED	0.993 (3.006)	0.944 (2.921)	0.801 (2.913)	0.996 (2.995)	1.110 (3.033)	1.056 (3.009)
Constant	5.429 (8.087)	7.648 (6.983)	9.025 (7.528)	4.952 (8.113)	7.756 (6.689)	7.012 (6.921)
Observations	278	276	275	276	278	276

Robust standard errors in parentheses, \*\*  $p < 0.05$ , \*  $p < 0.1$

in contrast to, for example, the egalitarian rule, due to the predicted high economic growth and the large increase in emissions. Based on these cost assessments, we consider the rather harmonized view towards the ability-to-pay rule which stresses the role for *needs* rather than *culpabilities* as rather surprising.<sup>30</sup>

<sup>30</sup> An equity rule based on needs requires a satisfaction of basic needs such as food, shelter, and clothes for all individuals even if this minimum threshold cannot be achieved by own efforts. This approach shifts abatement efforts mainly towards the developed countries with high economic capacities. This corresponds to an equality norm dating back to Mill's concept of "equality of sacrifice" being initially advocated as a principle for tax distributions aiming at harmonizing payoffs among citizens (like the ability-to-pay rule).

### 3 Conclusion

Given the vital and controversial debates on how to compromise between the globally-aggregated review of the Paris Agreement and the individual assessment of countries' ambitions, an assessment of group aggregates might help to foster the multilateral process (e.g., Holz and Ngwadla 2016). By reflecting a certain degree of relevant homogeneity within its members, these groups could both allow for comparisons within groups (i.e. group level-benchmarking) and for differentiation across groups. We have collected data from a survey among COP participants to investigate preferences for certain burden sharing rules among key groups in a setting that reflects the possibility of observing concessions from negotiating partners. We apply a relative weighting scheme to investigate whether such a mechanism helps to overcome the current (self-interested) strategic claims on equity in the negotiation process.

We observe that delegates from different groups of countries show a general willingness for concessions. However, the degree to which different burden sharing rules are taken into consideration partly differs between countries. Our empirical results indicate that the grandfathering rule attracts rather modest support among all partners. Surprisingly, in contrast to previous empirical results, there is evidence that the convergence equal-per capita emissions approach is a concept that is rather supported in developed countries, while there is substantial opposition against this approach in developing countries.

This observation mirrors the complex dynamics of per capita emissions at a global scale. There is an increasingly rich empirical literature that investigates the convergence of CO<sub>2</sub> emissions among countries globally. Larger wealth transfers under an equal per capita emissions rule are only to be expected if per capita emissions are not going to converge, for example, via cross-border knowledge spillovers and policy convergence. However, several developing countries like India, China, and African countries witnessed large economic growth and increasing emission intensity, while many developed countries, for example, in Europe, were able to reduce per capita emissions. There is empirical evidence for the convergence of per capita emissions especially between developed countries (e.g., Acar et al. 2018). With a global convergence of per capita emissions, other burden sharing rules would lead to larger budgets or emissions allowances for developing countries. In line with this argument, van den Berg et al. (2019) show that, for example, rules being based on responsibilities and capacity can be better for developing countries.

As a key insight we report that the individual assessment of the polluter-pays rule based on current emissions does not only stress the persistence of the traditional Annex-B/Non-Annex-B division but suggests tendencies for a more fragmented

grouping with different positions between, for example, delegates from developing countries (i.e. G77 members) and emerging countries (i.e. BASIC). At the same time, we observe tendencies for a more harmonized view among key groups towards the ability-to-pay rule in a setting of weighted burden sharing rules.

The Paris Agreement has initiated a long term process to achieve ambitious climate targets. This process will be shaped not only by efficiency considerations, but also to a large extent by fairness concerns. As Breakey (2016) points out, the stocktake of the Paris Agreement “will not need to take a single authoritative position on what equity requires. It can still drive improved ambition even if it allows countries substantial flexibility in how they understand and apply equity principles”. Our empirical evidence on a relative weighting scheme supports this long-term bargaining process initiated through the Paris Agreement and stresses the need for the dialogue initiated through the Katowice climate package. We consider our analysis as a first attempt to empirically assess preferences for different burden sharing rules in a weighted or staged approach, which could principally enter the menu of quantitative indicators where countries could choose from in the future stocktake. However, our study does not contribute to the question which set of weighted burden sharing rules will make the race at the end in the negotiations since both information on the underlying procedure and potential differences in bargaining positions among key players are not assessed.

As the global stocktake is expected to advance with a first planned assessment in 2023, further research should provide more empirical insights into potential pathways for staged burden sharing approaches within this process. These should include analyses on potential procedures on how to agree to a final balanced approach, thereby taking into account both new alliances with respect to party groupings (e.g., the climate coalition of the willing, small island developing states, Asian States, and African States) and potential differences in equity preferences within countries (e.g., Lange and Schwirplies 2017) and COP delegates (e.g., from different ministries or departments).

**Funding** Open Access funding enabled and organized by Projekt DEAL. Financial support by the German Federal Ministry of Education and Research (FKZ 01UN1016A and FKZ 01LA1825A) is gratefully acknowledged. Andreas Löschel acknowledges support from the 111 Project [grant number B18014] by the Chinese Ministry of Education and the State Administration of Foreign Experts Affairs.

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