

Fairness conceptions and self-determined mitigation ambition under the Paris Agreement – is there a relationship?

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Abstract:

This paper investigates the empirical relationship between countries' expressed concerns with fairness and the ambition levels in their pledged contributions (NDCs) to the Paris Agreement, asking the following questions: 1) Are the NDCs of countries who express the most concern with fairness more or less ambitious than those of other countries? 2) Does the relationship between fairness and ambition vary across the three fairness principles: Responsibility, Capability, and Rights (needs)? and 3) Is there a tendency for countries to support the fairness principle that implies the largest emissions share for themselves if that principle were used to allocate emissions across countries? The analysis reveals considerable variation in both fairness concerns and assessed NDC ambitions, but no clear relationship between the two. Countries' expressed support for fairness principles does not correlate with the ambition levels of their NDCs, whether principles are aggregated or disaggregated. The analysis also finds no evidence that countries strategically advocate the fairness principle that allocates them the largest "fair" emissions share.

- The NDCs of parties that expressed the most concern with fairness when negotiating the Paris Agreement appear neither more nor less ambitious than those of other parties.
- Ranking of parties' ambitions is sensitive to which metric (relative to "fair shares," relative to baseline, or in terms of per-capita emissions) is used to quantify ambition.
- Fairness rhetoric during Paris negotiations was shaped by the ongoing transition from bifurcated differentiation to self-determination.

Fairness conceptions and self-determined mitigation ambition under the Paris Agreement: Is there a relationship?

1. Introduction

Equity and fairness¹ have always been central to climate negotiations under the UN (Bodansky, 1993). The UN Framework Convention on Climate Change (UNFCCC) states, “parties should protect the climate system [...] on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities” (UN, 1992 Art. 3.1). The second part of the sentence is known as the CBDR-RC principle, and establishes *Responsibility* and *Capability* as central fairness principles. Article 3.1 also refers to various development *Rights* and *Needs*, which jointly can be considered as a third widely accepted fairness principle in the negotiations (Underdal and Wei, 2015). The Convention lists “developed”² countries in its Annex I, for differentiating obligations. Hence, a binary differentiation (Annex I vs. non-Annex I) of efforts was justified regarding fairness principles.

While the above differentiation scheme featured prominently in both the Convention and the subsequent Kyoto Protocol (UN, 1997), the relationship between fairness principles and differentiation in the Paris Agreement (UNFCCC, 2015) is less clear: Each party determines its own contribution to achieving the Agreement’s goals, called Nationally Determined Contributions (NDC). This “self-differentiation” approach has been accredited for the Paris

¹ We use “equity” and “fairness” interchangeably even though Kallbekken, Sælen, and Underdal (2014) show that parties to the Paris negotiations did not, with most developed parties using “fairness” and most developing parties using “equity” consistently.

² This list included OECD members as of 1990 and former socialist countries of Eastern Europe and Central Asia.

negotiations' success because it helped avoid recriminations over the burden each party should bear (Breakey, 2016). When communicating these contributions, parties ought to justify them to be "fair and ambitious, in light of [...] national circumstances" (UNFCCC, 2015). This "self-justification" gives parties considerable leeway in conceptualizing fairness, and in relating it to their own efforts. Hence, parties determine and justify their efforts per their own fairness conceptions. Although the Agreement contains several references to CBDR-RC – with the new qualification "in light of national circumstances" – this principle's role has been reduced to disciplining self-differentiation (Rajamani, 2016) as opposed to providing the basis for strict bifurcation under the Convention and the Kyoto Protocol. Given this "self-differentiation" and "self-justification," we ask whether there are relationships between parties' expressed fairness conceptions and the ambition of their self-determined efforts.

During the Paris negotiations, several parties proposed an intergovernmental, formal review of intended contributions before they were finalized, regarding fairness and ambition (van Asselt, Sælen, and Pauw, 2014). However, when deciding on guidelines for first-round NDCs at COP20, parties agreed only to reviewing the aggregate effect of contributions, not the fairness and ambition of individual contributions (UNFCCC, 2014). In lieu of a formal review, researchers and civil society actors have delivered a growing number of assessments of parties' NDCs (discussed below). This study is the first attempt to link parties' own fairness conceptions, as communicated during the Paris negotiations, with third-party assessments of their NDCs. The purpose is to analyze relationships between parties' fairness conceptions and their NDCs' ambition, seeking to answer the following questions:

1. Are the NDCs of parties who express the most concern with fairness during negotiations more or less ambitious than those of other parties?
2. Does the relationship between fairness and ambition vary across the three fairness principles: *Responsibility, Capability, and Rights (needs)*?
3. Do parties tend to support the fairness principle that implies the largest emissions share for themselves?

Ambition is here quantified in three ways, as there is no consensus in the literature on how to measure it. Fairness conceptions are derived from content analysis of parties' submissions to the Paris negotiations. Statistical analysis is used to investigate the relationship between those variables.

We focus on climate equity in relation to mitigation. We acknowledge that equity is a much richer concept involving several other aspects, including, adaptation, climate finance, climate vulnerability, just transition, etc. For example, the global inability to achieve sufficient mitigation has transferred the adaptation burden inequitably across the globe, leading to discrepancies in how developed and developing parties treat adaptation (Pauw et al., 2018). Studies also assert that equity must be addressed more holistically at the UNFCCC (Morgan and Waskow, 2013). Limiting our scope risks rendering these multiple dimensions of equity invisible to the analysis. However, we hope that future studies can build on our methodological framework to include other aspects of equity.

Next, a brief summary of the literature on NDC assessments and on fairness in climate negotiations provides our study's context. Subsequently, we describe the methodology for the statistical analysis, and present and discuss results. The final section offers some concluding remarks.

2. Literature review

2.1. Assessments of NDCs

This paper builds on the small but growing literature that quantifies and assesses individual NDCs. Robiou du Pont et al. (2017) compare NDCs with “fair share” contributions to the 1.5°C and 2°C targets based on five “equity approaches,” focusing on the top four emitters individually and other groups on aggregate, with a supplement analyzing 171 parties. Given a 1.5°C goal, none of the top four emitters’ – and few others’ – NDCs are consistent with any of the equity approaches. However, given a 2°C goal, they find that the EU’s NDC is aligned with three approaches, the US’s with two, and India’s with one, while China’s falls short of all five. They also report that most developing parties’ conditional NDCs meet the average of the five “equity” benchmarks. Robiou du Pont (2017) applies the analysis to G20 parties, finding Brazil and Mexico to be the most ambitious, meeting three approaches. Conversely, Saudi Arabia, Turkey, and Russia—like China—fail to meet any of their benchmarks. Treating the five approaches as equal is, however, problematic. One of the chosen approaches is to maintain parties’ current shares of global emissions constant (“grandfathering”). As the authors note, this principle is not supported by any party in the climate negotiations and is criticized in the literature: “No moral and political philosopher (to my knowledge) defends grandfathering, presumably assuming that it is unjust” (Caney, 2009, p. 128), an exception being Knight (2013), who defends “moderate” grandfathering in combination with other fairness principles. Grandfathering is also implicit in two of the other approaches (“Equal Per Capita” and “Capability”), which include long transitions from the current emissions, meaning that nearly half the remaining emissions budget is grandfathered rather than allocated by their nominal equity approach (Kantha et al., 2018). The “rationale is questionable” (Fleurbaey et al., 2014, p. 320) for such transition periods when the

objective is to assign tradeable emissions allocations rather than physical emissions, as in Robiou du Pont et al. and the two studies discussed below. Consequently, three of the five “equity approaches” have a questionable ethical basis.

Höhne et al. (2018) compare the NDCs of the top three emitters with effort-sharing calculations based on over 40 effort-sharing studies, given the 2°C target. The ambition level of all three NDCs falls short of the reduction target calculated as the median across the studies, particularly for China. The variation across the studies’ results is large, and China ranks better on approaches based on equal per capita emissions, and those heavily weighting *Responsibility* and *Capability*. However, many underlying effort-sharing studies also involve grandfathering or transition periods, the shortcomings of which were discussed above. Furthermore, selecting the median as a single representative figure of a multitude of studies representing distinct ethical positions lacks a valid basis. Here, this is especially questionable because in the underlying sample of studies, some ethical positions are represented by many and others by only a few observations, likely introducing substantial bias (Clarke et al., 2014; Höhne et al., 2014, 2018; Kartha et al., 2018).

Pan et al. (2017) compare the NDCs of eight major emitters with six fairness approaches. India’s NDC is considered the most ambitious, with the most optimistic interpretation of its NDC consistent with five approaches under both 1.5°C and 2°C. The NDCs of Brazil, China, Japan, and Russia fall short according to all approaches under either temperature target. The EU’s and the US’s NDCs fall short of 1.5°C, according to all approaches, while for 2°C, the EU’s is compatible with two approaches and the US’s with one. However, these approaches contain partial grandfathering. The most optimistic interpretation of South Africa’s NDC is compatible

with one approach under 1.5°C and with two approaches given the 2°C target. The NDC and baseline quantifications underlying Höhne et al. and Pan et al. are available online for a wider set of parties (PBL, 2017), and are used as inputs to the current analysis.

Holz, Kartha, and Athanasiou (2018) compare NDCs with parties' fair-share contributions of 1.5°C-consistent global mitigation and serve as a central data source for the current analysis.³ Their *Climate Equity Reference framework* (CERf) calculates parties' fair-share efforts, based on users' normative positions vis-à-vis relevant ethical choices, which, for their study, were made through deliberative processes involving a large coalition of civil society organizations (Lahn, 2018). Mitigation efforts are defined relative to projected “no-policy” baseline emissions. This makes the results highly sensitive to the baseline projections (Meinshausen et al., 2015, figure S8), for which no generally agreed algorithm exists, resulting in high uncertainty – a shortcoming of this approach. The global effort is shared in proportion to parties' *Responsibility* and *Capability*, reflecting CBDR-RC. The CERf defines *Responsibility* as cumulative historical emissions, and *Capability* as parties' economic capacity to contribute to mitigation, using GDP per capita as proxy, taking national income distributions into account. Crucially, CERf incorporates the principle of *Rights (needs)* by protecting the poorest people in each country through an exemption for emissions and incomes up to specified thresholds in calculating *Responsibility* and *Capability*, respectively. A consequence of the exemption is that countries

³ While this analysis uses 1.5°C-consistent benchmarks, parties were arguably targeting 2°C when developing their NDCs in 2015. However, for the current paper, this difference is not critical for our study since most dependent variables are continuous. Therefore, changing the mitigation benchmark affects all NDCs proportionally and therefore not the statistical results presented here.

with more unequal income distributions have more stringent fair-shares benchmarks than more equal countries do, other things being equal, as Supplementary Text 3 shows.

The aforementioned deliberative process produced two benchmarks, “1850/high-progressivity” and “1950/medium-progressivity,” differing in the start year for historical emissions and in their treatment of poor people’s income and emissions; equal weights were chosen for *Responsibility* and *Capability*. Comparing NDCs with these benchmarks shows a substantial ambition shortfall for “wealthier” parties both in aggregate and individually. In contrast, China’s effort exceeds both benchmarks, while the high-ambition end of India’s NDC range meets one benchmark. Brazil’s effort falls somewhat short. “Poorer” parties’ efforts on aggregate exceed their fair share, even when only unconditional pledges are included, although some individual parties’ efforts fall short. The assessment of China, in particular, differs from assessments of China in the rest of the literature reviewed above, as does the assessment of “wealthier” countries to the extent that they meet benchmarks in other studies.

Unlike several of the other approaches discussed, the CERf allocates the global mitigation *effort* to countries, instead of, for example, a carbon budget or emissions rights. Because effort is defined as the deviation from baseline emissions and because the global effort is initially only a small deviation from baseline, near-term emissions allocations are close to today’s emissions levels. In addition, long-term allocations are influenced by baseline trajectories. Like the grandfathering of emissions allocations criticized above, this approach produces continuous emissions trajectories. However, unlike other approaches where allocations are initially based on grandfathering as an allocation principle, which is then gradually phased out during a transition

period while another allocation principle is phased in, the CERf applies its allocation principle (allocation of global effort according to Responsibility, Capacity and Need) immediately without any transition period.

Two additional sources also provide useful assessments: Meinshausen and Alexander (2016) quantify the complete set of NDCs (162). The Climate Action Tracker (CAT) has rated 33 NDCs on a six-point scale, using aggregated results from other effort-sharing studies.⁴ While some of these results are from the peer-reviewed literature, many others come from proprietary calculations of the CAT partners, and the aggregation methodology is not peer reviewed (Parra et al., 2017). According to CAT's ranking, no NDC achieves the top score; however, Morocco's and Gambia's are rated consistent with 1.5°C, while five additional parties' NDCs are rated 2°C-consistent (CAT, 2017).

2.2. Parties' use of fairness principles in climate negotiations

Fairness principles are here understood as broad prescriptive categories for determining how burdens associated with addressing climate change and its effects should be distributed fairly.⁵ Such principles play a particularly important role in climate negotiations (Young, 2014; Tørstad and Sælen, 2017). This study focuses on parties' expressed support for three overarching fairness principles frequently invoked and rarely disputed in climate negotiations: *Responsibility* for

⁴ Some of which rely on grandfathering, as critiqued above.

⁵ In this article, the term *fairness principle* is reserved for a general understanding of distributional norms, while operationalizations of the three fairness principles are called *equity principles* (Supplementary Text 1). Fairness principles may relate to a range of different climate policy areas, including, but not limited to, mitigation, adaptation, technology, loss and damage, and finance. This article focuses on mitigation, and therefore does not analyze documents that exclusively address other issues.

damage caused, *Capability* to solve the problem, and development *Rights (needs)* (Underdal and Wei, 2015).

The *Responsibility* principle demands that climate change be mitigated by those responsible for causing it. *Capability* requires those able to mitigate climate change do so. Finally, the *Rights (needs)* principle broadly reflects actors' *right* to sustainable development (Gupta and Arts, 2018), which can be expressed by considering developmental *needs* associated with this right.

These three principles are enshrined in Articles 3.1–3.5 of the Convention (UNFCCC, 1992) and Article 4 in the Paris Agreement (UNFCCC, 2015). They correspond to the basic fairness principles in the distributive justice tradition in philosophy (Caney, 2006), capture the most discussed notions of fairness in the environmental economics literature (Kverndokk and Rose, 2008), and subsume most or all of the more specific “equity principles” and burden-sharing rules in the literature on fairness in climate negotiations (e.g., Ringius, Torvanger, and Underdal, 2002; Lange et al., 2007). The IPCC's fifth assessment report refers to four fairness principles – *Responsibility*, *Capability*, *Equality*, and *Right to development* (Fleurbaey et al., 2014). The discussion under *Equality* centers on equal rights (e.g., to emit) and also refers to needs. In our categorization, both *Equality* and *Right to development* are subsumed under *Rights (needs)*.

Several empirical studies have assessed variations in parties' support for fairness principles in climate negotiations, and suggested explanations for such variation (Lange et al., 2007; Hjerpe et al., 2011; Lange et al., 2010; Tørstad and Sælen, 2017; Winkler et al., 2018). Lange et al. (2007) survey individuals involved in climate negotiations, and regress respondents' support for burden-

sharing rules on, inter alia, characteristics of respondents' home countries. Lange et al. (2010) compare survey responses with abatement costs for four regions. Both studies find that potential material interests largely explain perceived support for different equity principles. Hjerpe et al. (2011) survey fairness preferences among participants at COP15 in 2009, measuring support for eight equity principles. In line with material interest, EU delegates expressed less support than others for a principle of historical responsibility, while G77+China delegates expressed stronger support for a needs-based principle.

More recently, Tørstad and Sælen (2017) use content analysis of submissions to the pre-Paris negotiations to infer fairness conceptions of all participating parties, and test a range of hypotheses. In contrast to most previous studies, which largely suggest that fairness considerations are shaped by material variables such as historical emissions and capacity to pay, Tørstad and Sælen (2017) find that parties' status as Annex I or non-Annex I parties (i.e., "developed" or "developing") is the strongest predictor. Many non-Annex I parties preferred to maintain Annex-based differentiation in the Paris Agreement, whereas Annex I parties generally advocated its removal. Given this, Tørstad and Sælen's findings suggest that parties invoke fairness principles to advance their own interests.

Finally, Winkler et al. (2018) assess how parties justify the fairness and ambition of their commitments as expressed in their NDCs. Their analysis suggests, inter alia, that parties selectively choose to use equity indicators in their NDCs, largely on unsubstantiated grounds, and primarily relating to responsibility. The authors propose that indicators used by parties in

their NDCs could be used to establish, in a bottom-up fashion, a menu of indicators for expressing fairness and ambition in NDCs.

3. Methodology

This analysis integrates four types of data. First, quantifications of NDCs as emissions in the target year; second, quantifications of “fair share” emissions; third, estimates of baseline emissions (i.e., emissions levels to be expected in the absence of mitigation activities); and finally, parties’ references to fairness principles in official negotiation documents. The first three are obtained from published studies and are used to assess the ambition of NDCs in three ways. The final type is obtained through content analysis and is used as a measure of parties’ fairness conceptions.

3.1. Quantifications of ambition in the NDCs

As mentioned, several studies have quantified and assessed NDCs. Here, PBL (2017) and Holz et al. (2018) are useful, because they cover most NDCs and provide consistent data on baseline emissions and/or “fair share” allocations.

3.1.1. Ambition relative to “fair shares”

The first approach compares NDCs to the fair-share benchmarks derived by Holz et al. (2018) as outlined above. NDCs that meet or exceed at least one of two 1.5°C-compliant benchmarks are considered fair, which is the case for 80 of 162 NDCs⁶ (Holz et al., 2018, supplementary

⁶ Holz et al. (2018) quantified the benchmarks and baseline emissions for all 162 parties (treating the EU as a single entity), and the emission implications of 91 NDCs. For the remaining NDCs, they used data from Meinshausen and Alexander (2016).

spreadsheet). Our analysis uses both this binary variable and a continuous variable derived from the same data by subtracting the NDC-implied emissions level from the average of the two benchmarks, and normalizing by dividing by baseline emissions. Higher values thus imply higher ambition. Using the average is a shortcut to avoid judging the relative merits of two benchmarks that both emerged as valid from a deliberative process involving civil society.⁷ Land-use emissions are included to reflect the full extent of countries' historical, current, and projected future responsibility for emissions⁸ (further methodological details in Holz et al., 2018, supplementary text 2).

When analyzing whether parties support fairness principles best serving their self-interest, we use the Climate Equity Reference calculator (CERc) (Kemp-Benedict et al., 2017) to obtain values for two additional, alternative calculations of fair shares, one considering only *Capability*, the other considering only *Responsibility*, with all other settings matching the “1950/medium-progressivity” benchmark.

3.1.2. Ambition relative to baseline emissions

The second approach compares NDCs to baseline emissions in the target year and expressed as the percentage reduction in emissions level they imply relative to the baseline. This metric can serve as a crude measure of the effort parties pledge to undertake, though it does not account for

⁷ Repeating the analysis with either benchmark leads to only minor changes in results and does not alter any conclusions.

⁸ For the period from 1990, the CERc uses Annex I parties' self-reported values for land-use and forestry emissions and the CAIT dataset (WRI, 2015) for all other countries. Pre-1990, a more complex approach is used (Holz et al., 2018, supplementary text 2).

differences in responsibility or capability, nor is it based on a notion of equal rights.⁹ Regarding the first ambition metric, this reduces the possibility that any positive correlation between fairness support and ambition is driven by self-interested countries with low responsibility and capability supporting these principles because they imply a lenient target for themselves. Conversely, this second metric is more likely to identify a negative correlation between fairness support and ambition.

The articles that serve as data sources (PBL, 2017; Holz et al., 2018, henceforth also “CERP,” for Climate Equity Reference Project) provide further details on their baseline methodologies. The PBL dataset includes fewer NDCs: 111 compared with CERP’s 162. However, the smaller dataset has the benefit of avoiding extreme values. The CERP data include 54 cases where NDCs translate into emissions higher than baseline (compared to 32 in the PBL dataset), and 14 cases where they translate into negative emissions (1 in PBL). Nonetheless, to avoid implausible values, pledges are constrained not to exceed these baseline levels (also see supplementary text 2).

3.1.3. Ambition as per-capita emissions implied by the NDC

Finally, NDCs are compared in terms of the per-capita emissions they imply in the target year. Measuring ambition in this way reflects the idea of equal rights to emit, which falls under the *Rights (needs)* principle as here categorized. Although some contend this per-capita principle is the most persuasive “on ethical grounds” (Paterson, 2001), the principle scores low on political

⁹ A principle to equalize this metric would entail a form of grandfathering based on projected emissions, thus lacking an ethical foundation (Caney, 2009).

acceptability because it entails large redistributions relative to the status quo. The same data sources are used for this metric as before.

3.2. Conditionality in NDCs

Many NDCs contain both an unconditional pledge and a stronger pledge conditional on international support. PBL contains separate estimates for unconditional and conditional pledges in such instances. We analyze unconditional and conditional pledges separately. For fully unconditional NDCs, both versions are equal. For fully conditional NDCs, the unconditional pledge is set to baseline emissions, as these NDCs contain no promise to do anything unconditionally. CERP also contains upper and lower estimates for NDC-implied emissions, sometimes referring to unconditional versus conditional pledges, other times reflecting ranges of ambition specified in NDCs. From CERP, we use only the high-emissions (low-ambition) estimate, excluding conditional elements.

3.3. Quantification of parties' support for fairness principles

The explanatory variables of this study are parties' expressed support for the three fairness principles outlined above. Parties' support is inferred through content analysis of their NDCs and their written submissions during negotiations leading to the Paris Agreement, from 2012 to 2015 under the Ad-Hoc Working Group on the Durban Platform for Enhanced Action.

Manual content analysis was used to establish the frequency with which parties refer to fairness principles in their position documents. Precise analytical categories based on the fairness principles were defined and employed to systematically include and exclude content from the

analysis. Coding instructions are defined in a codebook presented in Supplementary Text 1, along with a discussion of methodological choices and limitations.

The number of submissions varied greatly between parties.¹⁰ To adjust for this, concern for fairness is operationalized as the number of fairness references per document. Both the sum of references to the three principles and references to each principle separately are used in the analysis. Group submissions are counted for each group member. The dataset includes 372 submissions representing 163 actors, in addition to 162 NDCs. Summary statistics are in Supplementary Table 1.

3.4. Statistical analysis

Standard statistical methods are used to investigate the relationship between fairness references and NDC ambition level, with each variable defined as explained above and listed in Table 1. Most of the outcome variables in the analysis are continuous. For analyzing their relationship with the sum of fairness references, we used correlation analysis. To investigate the separate effects of references to each principle, ordinary least squares (OLS) regression was used. The exception is the binary variable that measures whether NDCs are consistent with “fair shares,” for which the logit model is preferable to OLS regression (Hill et al., 2008). The logit model estimates the relationship between a party’s number of fairness references and the probability that its NDC is considered “fair.”

¹⁰ The range is 0 to 28, and the average is 10.6.

Because the analysis includes virtually the whole population of NDCs, not just a sample, statistical tests are not needed for drawing inferences from sample to population. Standard t-tests of whether regression and correlation coefficients are different from zero are nevertheless performed, because these indicate how reliable the estimated coefficients are. For ease of understanding, the p-values obtained in the tests are reported and can be compared to conventional confidence levels used for making statistical inference. Lower values indicate that the relationship measured by the coefficient is reliable. The reliability of the estimates is also illustrated in Figures 1–6, which show two-dimensional scatterplots with fitted regression lines. High dispersion of observations around the line means that the relationship between the two variables is not systematic.

4. Results and discussion of quantitative analysis

4.1. Relationship between fairness references and NDCs' fulfilment of "fair shares"
Are NDCs of parties that refer frequently to fairness principles more or less likely to be assessed as fair? First, a county's emphasis on fairness overall does not appear to have any relation with the assessment of its NDC. The logit regression reported in Table 2 measures the effect of the total number of fairness references per document on the probability that an NDC is assessed as fair. The coefficient is small and the p-value is large, indicating a weak relationship. The same results are found for the continuous measure of NDC ambition (coefficient = 0.03, p-value = 0.66), as illustrated in Figure 1 by the nearly flat regression line. An example may help interpret this figure and illustrate the lack of relationship between fairness references and fulfilment of fair shares. The rightmost extreme dot represents Albania, with 15 fairness references per submission. Its NDC is slightly less ambitious than its fair-share allocation, giving a negative y-value (-17%), which does not stand out from other NDCs. Thus, the country referring most

frequently to fairness appears no better nor worse than others in fulfilling its fair share of mitigation.

	Coefficient	p-value
All fairness principles	-.027	.578
Constant	-.012	.969
Observations ¹¹	161	
Pseudo R ²	.0014	

Table 1: Logit regression. Dependent variable: NDC classified as fair. Independent variable: References to fairness principles.

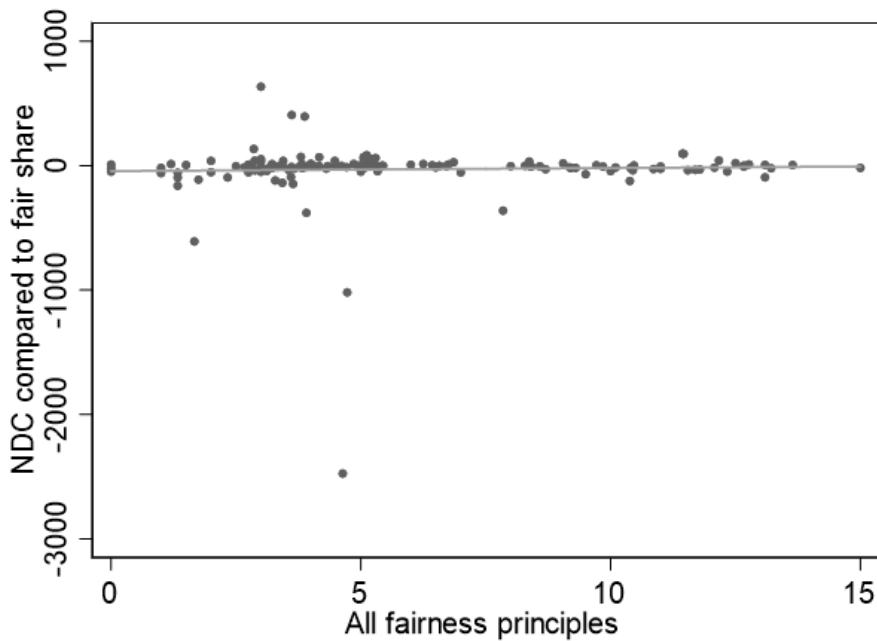


Figure 1: Relationship between the number of references to all fairness principles per document (x axis) and assessed fairness of NDCs (measured as fair-share emissions allocations minus emissions implied by NDCs normalized by business-as-usual emissions).

¹¹ Serbia is excluded due to data idiosyncrasies related to land-use emissions data.

Two other regressions (Table 3) investigate the separate effects of references to the three main fairness principles. Again, there are no strong relationships, either on the binary explanatory variable (columns 2 and 3) or on the continuous variable (columns 4 and 5). The regression shows the effect of each principle controlled for the other two. Figure 2 illustrates the effects on the continuous variable in two-dimensional scatterplots, without controlling for the remaining two variables. The figure shows considerable variation in both fairness perceptions (x axes) and fairness assessments (y axis), while hardly any covariance. In summary, these analyses fail to find any systematic relationship between parties’ frequencies of fairness references and the assessed fairness of their NDCs.

	Logit		OLS	
	Coefficient	p-value	Coefficient	p-value
Rights (needs)	.035	.169	-44.79	.111
Capability	-.142	.389	13.65	.425
Responsibility	.164	.277	10.44	.528
Constant	0.039	.909	38.91	.302
Observations	161		161	
(Pseudo) R ²	.0207		.0342	

Table 2: Regressions where the dependent variable is whether the NDC is classified as fair (columns 2 and 3); and fair-share emissions allocations minus emissions implied by NDCs normalized by business-as-usual emissions (columns 4 and 5). Independent variables: References to each fairness principle per document.

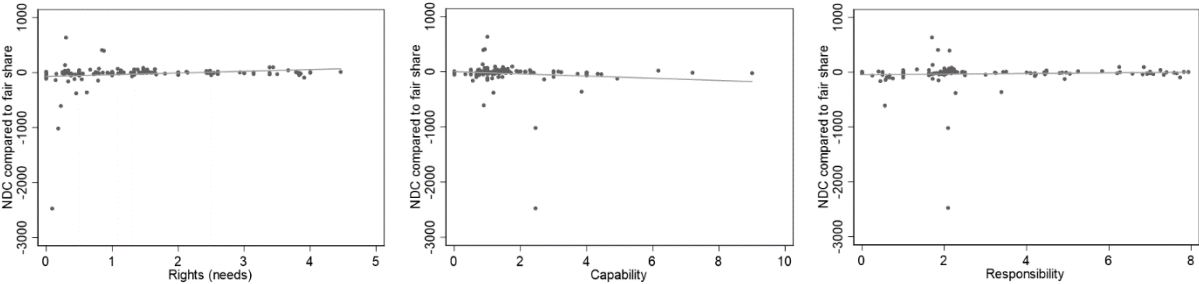


Figure 2: Relationship between references to each fairness principle per document (x axes) and assessed fairness of NDCs (measured as fair-share emissions allocations minus emissions implied by NDCs normalized by business-as-usual emissions). Source of emissions data: CERP.

4.2. Relationship between fairness references and NDCs relative to baselines

Next, the dependent variable is the percentage emissions reduction below baseline implied by NDCs. Only a weak correlation between total fairness references and this variable is found using either data source, as shown in Table 3 and Figure 3.

Data source	Correlation coefficient	p-value	Observations
CERP	-.08	.30	161
PBL unconditional	-.14	.14	109 ¹²
PBL conditional	-.13	.16	109

Table 3: Correlations between total fairness references and NDC ambition relative to business-as-usual.

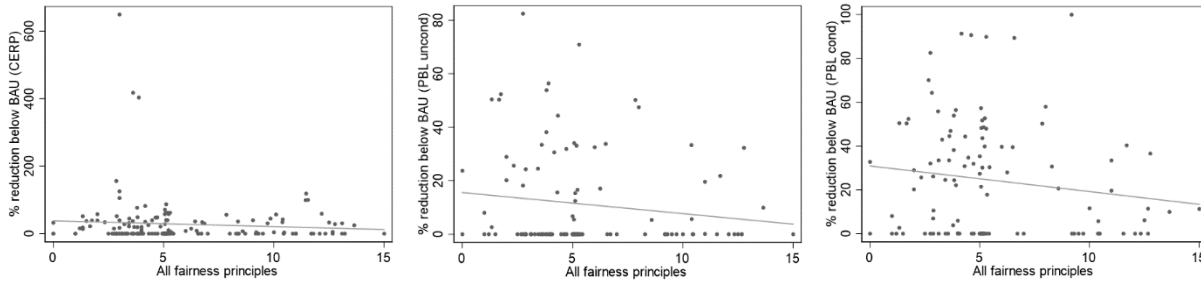


Figure 3: Relationship between references to all fairness principles per document (x axes) and NDC assessments relative to business-as-usual. Source of emissions data left: CERP; middle: PBL unconditional pledges; right: PBL conditional pledges.

Regressing this dependent variable on references to each fairness principle similarly yields weak relationships, as shown in Table 4 and Figure 4. The tests hence fail to identify any systematic relationship between parties’ frequencies of fairness references and ambition in their NDCs as measured relative to baseline emissions.

¹² Taiwan and Tajikistan are excluded because they were not included in the database on fairness conceptions.

	CERP		PBL unconditional		PBL conditional	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Rights (needs)	-12.27	.204	-.88	.768	2.61	.530
Capability	-7.05	.231	-.29	.852	-.23	.621
Responsibility	2.35	.679	-1.00	.568	-2.88	.241
Constant	65.94	.000	15.40	.000	29.53	.000
Observations	161		109		109	
R ²	.0241		.0221		.0255	

Table 4: OLS regressions. Dependent variable: NDC expressed as percentage reduction relative to business-as-usual. Independent variables: References to each fairness principle.

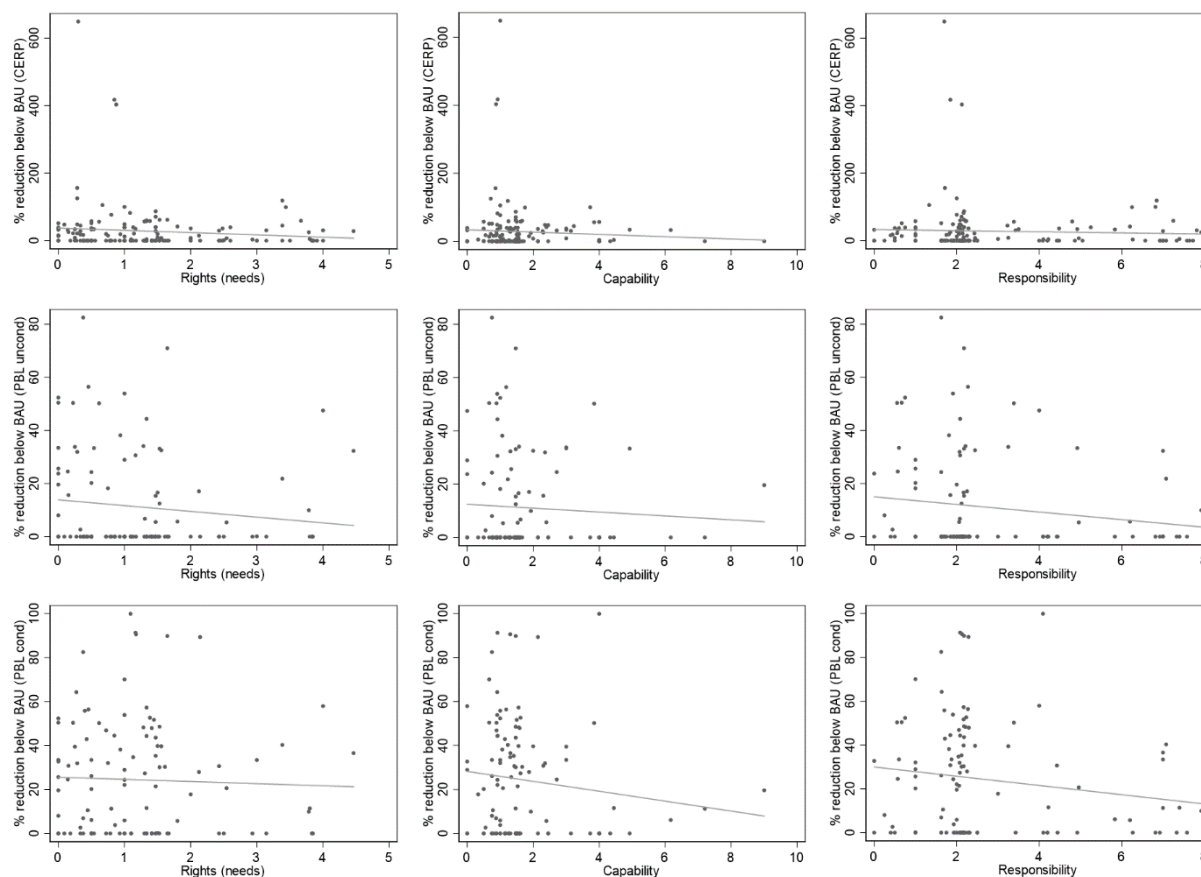


Figure 4: Relationship between references to each fairness principle and NDC assessments relative to baseline. Source of emissions data top row: CERP; middle row: PBL unconditional pledges; bottom row: PBL conditional pledges.

4.3. Relationship between fairness references and NDCs as emissions per capita

Finally, NDCs are quantified as the per capita emissions they imply in the target year. Unlike the previous two independent variables, smaller figures imply lower emissions; hence, coefficients' signs have the opposite interpretation from earlier. The analysis yields no significant coefficients whether looking at total or disaggregated fairness references (Tables/ 5-6 and Figures 5–6), and irrespective of the dataset used. Hence, there appears to be no systematic relationship between the frequency of fairness references and ambition measured as per capita emissions either.

Data source	Correlation coefficient	p-value	Observations
CERP	-.01	.88	161
PBL unconditional	-.07	.46	109
PBL conditional	-.06	.52	109

Table 5: Correlations between total fairness references and NDC emissions levels per capita.

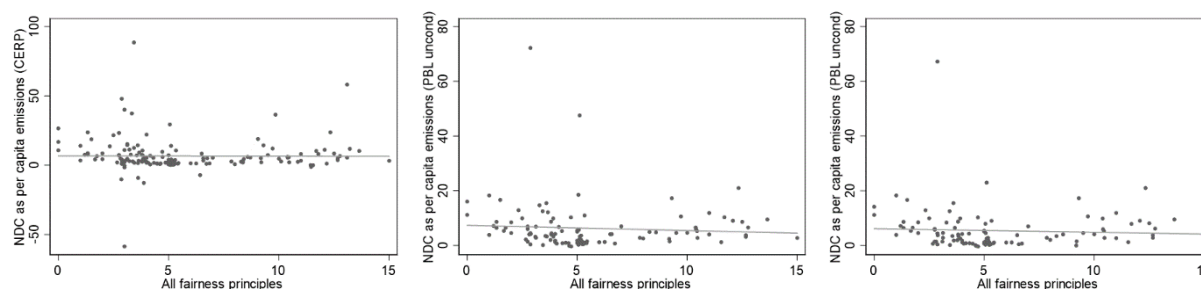
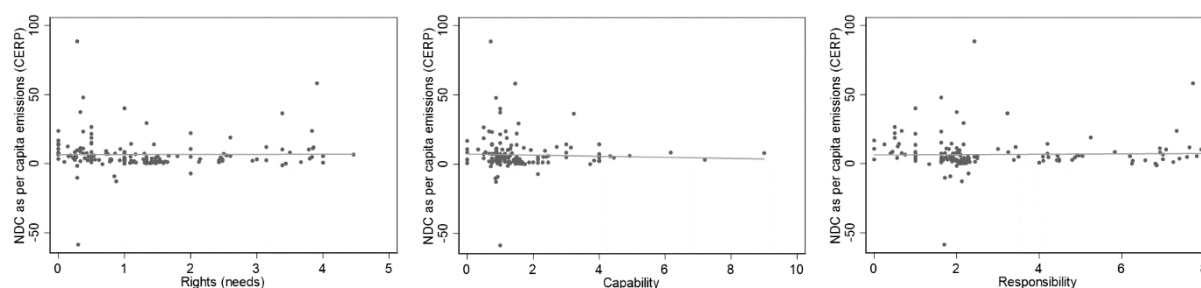


Figure 5: Relationship between references to all fairness principles and per capita emission implied by NDCs. Source of emissions data left: CERP; middle: PBL unconditional pledges; right: PBL conditional pledges.

	CERP		PBL unconditional		PBL conditional	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Rights (needs)	-.73	.627	-1.25	.389	-1.41	.259
Capability	-.64	.486	-.41	.591	-.33	.621
Responsibility	.51	.563	-.34	.849	.45	.539
Constant	7.15	.001	7.62	.000	7.09	.000
Observations	161		109		109	
R ²	.0035		.0104		.0147	

Table 6: OLS regressions. Dependent variable: NDC expressed as per capita emissions in the target year. Independent variables: References to each fairness principle.



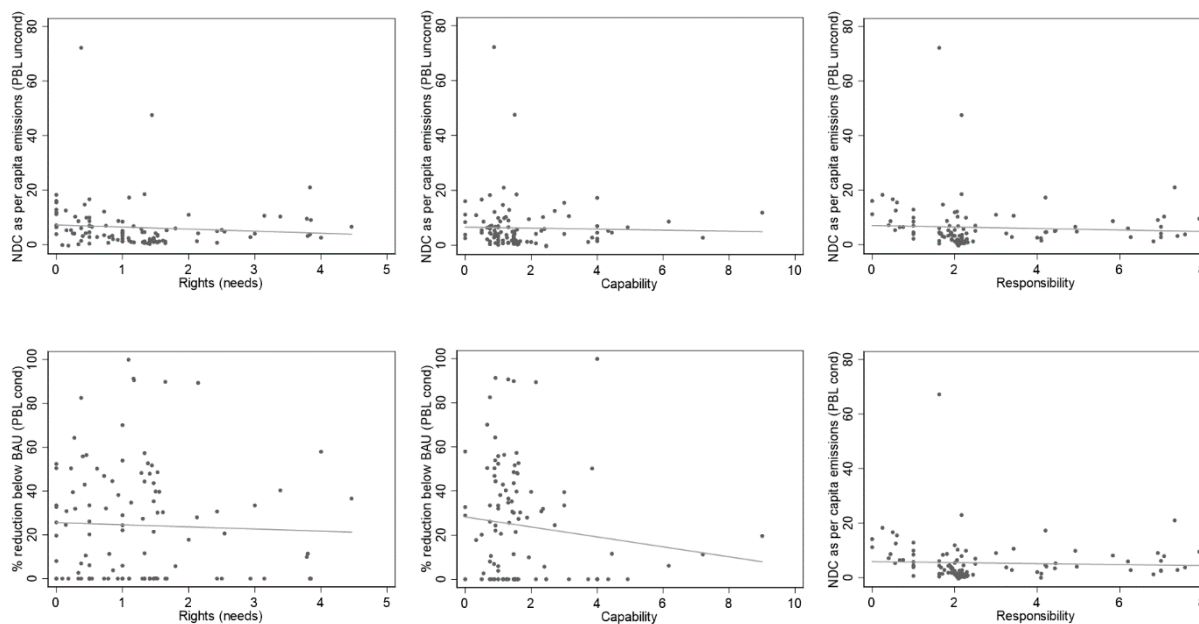


Figure 6: Relationship between references to each fairness principle and NDCs assessed as per capita emissions in the target year. Source of emissions data top row: CERP; middle row: PBL unconditional pledges; bottom row: PBL conditional pledges.

4.4. Do parties support self-serving fairness principles?

The CERc (Kemp-Benedict et al., 2017) can calculate parties' fair-share emissions allocations under different weightings of *Responsibility* and *Capability*. The following analysis uses the CERc to calculate allocations when all weight is given either to *Responsibility* or to *Capability*, respectively, to assess whether parties express support for the principle that assigns them the largest allocation. The content analysis shows that the vast majority of parties refer to *Responsibility* more often than to *Capability*. Paradoxically, for most of these parties, the CERc calculations result in higher allocations under the *Capability* principle than under the *Responsibility* principle. Table 7 shows the joint distribution of parties' supported principle, and their self-serving principle. The two distributions are essentially uncorrelated, with a coefficient of 0.03 and a p-value of 0.67. Hence, there is no indication that parties support the principle that results in the highest emissions allocation for themselves.

Supported principle	Self-serving principle			Total
	Capability	Equal allocation	Responsibility	
Capability	14	0	8	22
Equal support	10	0	3	13
Responsibility	83	1	43	127
Total	107	1	54	162

Table 7: Joint distribution of the fairness principle a party supports and the fairness principle that implies the highest share of the global emissions budget for that party.

4.5. Discussion of the quantitative analysis

The analysis revealed no systematic relationships between parties’ fairness conceptions and various measures of the ambition level in their NDCs. Parties that invoke fairness principles more frequently appear neither more nor less ambitious than parties overall. The absence of a negative relationship is most remarkable for ambition measured compared to baseline emissions, because, as argued above, this is the metric most likely to identify such a relationship if there were one. The absence of a positive relationship is most remarkable for ambition measured relative to “fair shares” and as per capita emissions in the target year. Because poor parties generally score well on these metrics, and tend to be most concerned with fairness, a positive relationship might have been expected between fairness concern and ambition measured on these metrics.

Analyzing the fairness principles of *Responsibility*, *Capability*, and *Rights (needs)* separately also yields few significant findings. Support for different principles appears to affect ambition in different directions, which helps explain why there is no significant relationship when the principles are aggregated. Furthermore, the direction of the same principle’s effect sometimes varies across different ambition metrics. For example, support for *Responsibility* correlates positively with ambition relative to fair shares but negatively with ambition relative to baseline.

Such variation rules out any conclusions on whether proponents of a specific principle are more or less ambitious than other parties. Including conditional elements of NDCs does not make the relationship with fairness conceptions any stronger than when including only unconditional elements.

Lastly, the analysis also fails to find evidence that parties strategically advocate the fairness principle that prescribes them the lowest effort. One possible reason is that parties do not share assessments of “fair shares” that the analysis is based on. However, the finding is consistent with the analysis by Tørstad and Sælen (2017) showing that fairness conceptions are more closely linked to parties’ status as Annex I or non-Annex I parties than with measures of their actual responsibility and capability. In negotiations, *Responsibility* and *Capability* are used more as political code words than as quantifiable metrics. *Capability* is used by developed parties to highlight that emerging economies have greater capability now than they had when Annex I was established, while *Responsibility* is used by developing parties to draw attention to historical emissions, which change less rapidly. The roles of the CBDR-RC principle and of the Annexes were central and contested issues in negotiations until Paris and shaped the fairness debate. Hence, a party’s reference to these principles may mean something quite different than how these principles are operationalized in the CERc.

Furthermore, even if self-serving partiality does not dictate the selection of fairness principles, it may affect the way a given principle is used rhetorically, which would not be picked up by our

analysis¹³. As Klinsky et al. (2017) note, justice claims can be used both to promote and to undermine climate action. Fairness principles can serve not only to constrain self-interests (Barry, 1989) but also to enable self-interested behavior. Evidence suggests humans are naturally self-righteous, and moral reasoning is typically ex-post justification rather than an ex-ante reason for action (Haidt, 2012). Even criminals often speak of their crimes in moral language, formulating excuses that acknowledge prevailing moral rules while exempting their own actions (Heath, 2008). In this light, it is not surprising that unambitious countries refer to fairness principles about as often as ambitious countries do.

5. Concluding remarks

Under the Paris Agreement, parties “self-determine” their contributions, and “self-justify” why their contributions are fair. This study analyzes parties’ fairness conceptions as communicated during negotiations in the period 2012–2015 and tests whether there is any relationship between these conceptions and the ambition of NDCs. No systematic relationship is found, meaning that those who express the most concern with fairness appear neither more nor less ambitious than other parties. The analysis also fails to find evidence that parties strategically advocate the fairness principle that prescribes them the lowest effort.

The negotiation period assessed was part of a transition from bifurcated differentiation grounded in the Convention’s fairness principles to the new system of self-differentiation, where it is not

¹³ We thank a reviewer for raising the points discussed in this paragraph.

clear yet how salient the Convention's fairness principles will remain. As this analysis indicates that fairness concerns—at least as expressed in submissions to the UNFCCC—are not significant drivers of ambition in NDCs, another question for future research is to assess other possible drivers of climate ambition, for example, national economic interests, domestic interest groups, and public opinion.

Finally, the analysis highlights that assessments and rankings of NDC ambition vary considerably across different metrics to measure ambition. Such variation is also evident in the reviewed literature. In choosing between different metrics, normative decisions are necessary and should be made transparently.

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Supplementary Material to

Fairness and ambition in self-differentiated contributions to the Paris Agreement
– is there a relationship?

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Supplementary Text 1 – Methodological appendix for content analysis

Our approach to content analysis

Parties' support for fairness principles is inferred through a content analysis of parties' written submissions to the Ad-Hoc Working Group on the Durban Platform for Enhanced Action (ADP) and the subsequent Nationally Determined Contributions (NDCs). Submissions are written proposals submitted prior to or during negotiation sessions, while NDCs are the nationally determined climate actions that the parties plan to undertake. The corpus of this analysis consists of all submissions over the duration of the ADP (2012–2015) and all countries' NDCs which were subsequently submitted to the UNFCCC website. All submissions and NDCs were retrieved from www.unfccc.int.

Content analysis is a research method for systematic and quantitative description of the manifest content of communication (Berelson, 1952). Ideally, it is a deductive, systematic, and objective technique for making replicable and valid inferences from texts (Hardy, Harley & Phillips, 2004; Krippendorff, 2013). We use manual content analysis to count the frequency of which parties refer to fairness and equity principles in submissions and NDCs. Categories of these principles and the specific rules that are used for including and excluding content, are defined in the coding scheme below. We coded both references to broad fairness principles and more specific equity principles but merged the references to equity principles into broader categories of fairness principles and used the broader category as a basis for the statistical analysis. There are two reasons behind this choice. First, the discourse in the position documents we coded corresponds much more closely to fairness principles than to equity principles: parties refer often to broad fairness principles but rarely to specific equity principles. Second, in general, parties' references to equity principles also correspond closely to their references to fairness principles. This suggests that the three-fold classification is sound for the purposes of our analysis.

It should be noted that there are significant differences in distributional consequences both across fairness principles and across different operationalizations of the same principle (Underdal and Wei 2015). While we chose the categorization based on the literature not based on distributional consequences, this choice has implications for the results of the quantitative analysis.

The validity of manual content analysis depends on high correspondence between the theoretical categories defined in the coding scheme and the actual content that is coded in the documents. To achieve such correspondence, we first test-coded a part of the data material and modified the coding scheme based on the language that parties use in the documents, to ensure that we would capture all references to the different fairness and equity principles. Furthermore, the manual content analysis allowed us to exclude text in sections and documents not directly related to burden sharing of mitigation.

That said, our content analysis has limitations, some of which we have attempted to correct for. First, our analysis only captures positive fairness/equity references, and not discounting references (e.g., ‘Country X does not accept any historical responsibility’). In principle, negative references could also be coded, and the frequency of negative references counted. However, through the process of manual coding we found extremely few such occurrences in the documents that we coded. Hence, in this analysis we do not incorporate negative references. That said, the manual analysis ensures that negative references are not mistaken for positive references.

Second, content analysis will by definition not interpret the different contexts in which fairness references are made. Such interpretation could have shed light on how exactly a fairness/equity principle is being understood by the country in question. However, this limitation is inherent to all content analysis, which is a method for classifying content without ascribing any meaning to it. The minimizing of interpretation is what gives content analysis its descriptive character and allows it to quantify occurrences of words or text (Hardy et al. 2004: 20).

Third, in the quantitative analysis we use fairness references per document to measure fairness conceptions, to control for cross-country variation in the number submission. However, this metric is sensitive to submission length, which is a factor irrelevant to our analysis as documents vary somewhat in length, but not substantially or in ways that would systematically affect our results. The NDCs do vary substantially in length, but for these documents we only code certain sections which are common to all of them: 1) the introductions and 2) the section in which countries justify why their NDC is “fair and

ambitious”. This way, we only capture fairness references that are relevant to our analysis and avoids the problem of different length of NDCs.

Fourth, countries have different means of expressing their positions, some using more fairness-laden language than others. Content analysis is based on the assumption that unobservable attitudes are made observable through communication and can be measured through frequencies. However, this assumption may not always hold: Higher numbers of fairness references may reflect confidence with the use of fairness and equity language rather than any actual commitment to fairness.

Fifth, the way we conceptualize our coding categories may leave out certain countervailing ethical concepts or principles that are not defined as a part of our fairness categorization but may nevertheless be present in submissions. To avoid this problem as far as possible, we continuously evaluated whether any recurring concepts in the documents corresponded to fairness concepts in the coding scheme. However, there may still be concepts we overlooked or did not include in our coding scheme or analysis.

Codebook

Coding instructions for the context unit: Fairness references are only made when the parties are discussing either the general principles/structures/guidelines of the Paris Agreement, or which normatively relevant criteria should be used for deciding how mitigation commitments are to be undertaken.

Coding instructions for the coding unit follow below. Note that, in this article, the term *fairness principle* is reserved for a general understanding of distributional norms, while operationalizations of fairness principles are called *equity principles*. Both types of principles are coded.

1.0 The fairness principle ‘Responsibility’

Definition and coding instructions: Mitigation burdens should be distributed in accordance with parties’ respective responsibilities for causing climate change. A coding unit shall be classified as a reference to the principle of responsibility if one of the following criteria is fulfilled:

- (i) It refers to ‘differentiated responsibilities’, or similar, without further specification of why the responsibilities are differentiated.
- (ii) It states that some countries are more to blame than others for the climate change problems.

1.1 ‘Responsibility’ equity principles:

1.1) *Historical responsibility* suggests that those countries that have emitted most greenhouse gases in the past have a bigger responsibility to mitigate than others, because they have contributed more to the problem.

A coding unit shall be classified in the sub-category of ‘historical responsibility’ if one of the following criteria is fulfilled:

- (i) It contains a reference to who has ‘caused’ or ‘contributed’ to the problem.
- (ii) It contains a reference to who is historically most responsible for climate change.
- (iii) It contains a reference to ‘cumulative greenhouse gas emissions’ or ‘the cumulative sum of intergenerational emissions’.
- (iv) It states that some countries’ industrial activity over the years have contributed to climate change.
- (v) It states that ‘responsibility is reflected in a country’s past’.
- (vi) It contains a reference to ‘previous’, ‘historic’, or ‘historical’ responsibility.
- (vii) It states that countries need to take responsibility for previous emissions.
- (viii) It contains a specific reference to a date in the past.

1.2) *Polluter pays* suggests that responsibilities for costs and mitigation related to climate change shall be proportionally distributed to the proportion of current emissions of the actor.

A coding unit shall be classified in the sub-category of ‘polluter pays’ if one of the following criteria is fulfilled:

- (i) It contains a reference to ‘share’ in ‘global emissions’, ‘total emissions’ or similar.
- (ii) It contains a reference to ‘current’ or ‘present’ emissions, responsibility or similar.
- (iii) It contains a reference to ‘responsibility’ in terms of ‘greenhouse gas emissions’ or similar.
- (iv) It contains a reference to ‘polluter pays’ or similar.
- (v) It contains a reference to which parties (currently) emit the most or the least greenhouse gases.

1.3) *Evolving responsibility (projected emissions)* suggests that responsibilities for costs and mitigation related to climate change shall be proportionally distributed to the proportion of projected emissions of the actor. A coding unit shall be classified as a reference to the principle of evolving responsibility if one or both of the following criteria are fulfilled:

- (i) It contains a reference to ‘changing’ or ‘evolving’ responsibilities or emissions, or similar.

- (ii) It contains a reference to ‘future’ or ‘projected’ responsibilities or emissions.

2.0 The fairness principle ‘Capability’

Definition and coding instructions: Mitigation burdens should be distributed in accordance with parties’ different capabilities to mitigate. A coding unit shall be classified in the category of capability if it refers to ‘capability’, ‘capacity’, ‘ability’ or any other synonym that can relate to the principle of capability, without further specifications.

2.1 ‘Capability’ equity principles

2.1.1) *Capacity to pay* suggests that mitigation burdens should be distributed in accordance with parties’ capacities to mitigate.

A coding unit shall be classified in the sub-category of ‘capacity to pay’ if one of the following criteria is fulfilled:

- (i) It refers to a country’s financial capacities or level of economic development as being decisive for responsibility to undertake mitigation, e.g. by referring to ‘resources’ (or synonyms such as ‘rich’), ‘GDP’ or other measures of financial resources.
- (ii) It refers specifically to ‘capacity to pay’.

2.1.2) *Transformation capacity* suggests that mitigation burdens should be distributed in accordance with parties’ capacities to transform their energy systems or industries.

A coding unit shall be classified in the sub-category of ‘transformation capacity’ if one of the following criteria is fulfilled:

- (i) The unit contains a reference to ‘renewable energy’, ‘transformation capacity’ or similar.
- (ii) It contains a reference to ‘mitigation potential’ or ‘mitigation opportunities’ or similar.
- (iii) It contains a reference to ‘industrial and trade structures’ or similar.

3.0 The fairness principle ‘Rights (needs)’

Definition and coding instructions: The *Rights (needs)* principle broadly suggests that an actor is *entitled* either to enjoy a given amount of the good in question, or to be exempted from undertaking provisions. A coding unit shall be classified as a reference to the principle of rights (needs) if it contains a general reference to specific countries having a right to emit greenhouse gases or a right to exemption from some or all regulations, without specifying the normative relevant criteria for why, or if it contains a general reference to specific countries

having a need to emit greenhouse gases or to be exempt from certain or all provisions, without specifying the normative relevant criteria for why.

3.1 'Rights (needs)' equity principles:

3.1.1) *The need for exemption* suggests that some countries score so low on normatively relevant criteria, for example living standards, that they should be exempted from contributing to mitigation efforts.

A coding unit shall be classified as a reference to the principle of the need for exemption if one or several of the following criteria are fulfilled:

- (i) It contains a reference to 'small' or 'limited' 'emissions' and 'capabilities/capacities' in the same coding unit.
- (ii) It states that the parties scoring low on normatively relevant criteria, could communicate other types of contributions, e.g. 'qualitative' contributions.
- (iii) It contains a specific reference to 'flexibility' for parties who score low on normatively relevant criteria.
- (iv) It contains a reference to rules of exemption or special rules for the most vulnerable parties on the negotiations, e.g. 'SIDS' or 'LDCs'.
- (v) It contains specific references to 'exemption' for specific parties.

3.1.2) *Poverty eradication* suggests that some countries need to prioritize the eradication of poverty over the mitigation of climate change. A coding unit shall be classified as a reference to the principle of poverty eradication if it contains a reference to:

- (i) 'The eradication of poverty', 'eradicate poverty', 'poverty eradication', 'poverty alleviation' or similarly formulated concepts.

3.1.3) The *egalitarian principle* suggests that all human beings have an equal right to the atmosphere, implying an equal right to emit greenhouse gases for all people. A coding unit shall be classified as a reference to the egalitarian principle if one or more of the following criteria are fulfilled:

- (i) It contains a reference to 'per capita emissions', 'emissions per capita' or similar.
- (ii) It contains a reference to 'atmospheric space' or similar.
- (iii) It contains a reference to the idea that the remaining carbon budget should be divided equally in the sense that each human being should have an equal emissions quota.

3.1.4) The principle of *equitable access to sustainable development (EASD)* suggests that all countries have a right to ‘equitable access to sustainable development’. A coding unit shall be classified as a reference to EASD if it refers specifically to ‘equitable access to sustainable development’.

3.1.5) The *right to development* principle suggests that all countries have a right to economic and/or social development, with the implication that this is the overriding priority for the country. A coding unit shall be classified as a reference to ‘right to development’ if one of the following two criteria is fulfilled:

- (i) It contains a reference to the ‘right to develop’, or the right to ‘achieve’ ‘economic’ and/or ‘social’ ‘development’ or similar.
- (ii) It contains a reference to ‘social and economic development’.

Supplementary Table 1 – Descriptive statistics

	Mean	St.dev.	No. of zero obs.	Max value
<i>Rights (needs)</i>	1.3	1.1	12	4.5
<i>Capability</i>	1.6	1.3	6	9.0
<i>Responsibility</i>	2.8	2.0	3	8.0
All principles	5.7	3.4	3	15.0

Fairness references per document. Summary statistics.

Supplementary Table 2 – Variables, operationalizations and data sources

Variable name	Operationalization	Data source
Ambition relative to fair shares (binary)	Binary classification of NDC targets (1=fair, 0=unfair)	CERP*
Ambition relative to fair shares (continuous)	The difference between the emissions level implied by the NDC and the average of the two “fair share” benchmarks, measured in percentage of business-as-usual emissions	CERP
Ambition relative to business-as-usual	NDCs mitigation targets compared to business-as-usual emissions in the target year, and expressed as the percentage reduction in emissions level they imply relative to the business-as-usual	PBL**; CERP
Ambition as per-capita emissions	NDC expressed as per capita emissions in the target year	PBL; CERP
Fairness references	A party’s references to the fairness principles ‘Responsibility’, ‘Capability’, and ‘Rights (needs)’ divided by the amount of its submitted documents	Content analysis of submissions and NDCs
Responsibility	A party’s references to the fairness principle ‘Responsibility’ divided by the amount of its submitted documents	Content analysis of submissions and NDCs
Capability	A party’s references to the fairness principle ‘Capability’ divided by the amount of its submitted documents	Content analysis of submissions and NDCs
Rights (needs)	A party’s references to the fairness principle ‘Rights (needs)’ divided by the amount of its submitted documents	Content analysis of submissions and NDCs

* CERP=Holz et al. 2018; ** PBL=PBL 2017

Supplementary Text 2 – Emissions levels in NDCs and baselines

There are several explanations for NDC pledges translating into higher-than-baseline emissions. First, parties set targets relative to own baseline projections, which imply larger emissions than the projections by CERP and PBL, for example due more optimistic assumptions about economic growth (e.g., Ethiopia’s economic growth assumptions envision nearly a tripling of baseline emissions within 20 years (UNFCCC, 2016a), a projection which neither CERP nor PBL share). Second, countries like Russia and Ukraine traditionally set their emissions targets relative to 1990, just before the post-cold-war collapse of much of their industrial sectors and the associated emissions, leading to what has been called “hot air” targets well above baseline (den Elzen, Roelfsema & Slingerland, 2009). Russia’s INDC (UNFCCC, 2016b) suggests that this practice continues for its 2030 target. These examples illustrate that baseline projections are uncertain and contentious. For consistency across parties, our assessment uses the projections by CERP and PBL rather than those by individual parties. Results are therefore sensitive to the estimation method for baseline levels, which are inherently unknowable. Nonetheless, to avoid implausible values, in our analysis, pledges are constrained not to exceed these baseline levels, which is equivalent to a mitigation contribution of zero.

Supplementary Text 3 – Impacts of intranational inequality on the Climate Equity Reference framework results

Given the structure of the CERP framework, results are sensitive to internal inequality within countries. This is an intentional feature of the framework, reflecting the “need” element of the overall “Responsibility-Capability-Need” ethical perspective taken by the framework, which posits that it is appropriate for poorer individuals to prioritize developmental needs relating, for example, to nutrition, health, housing, employment and education, over a contribution to global mitigation. As a result, countries with the same total GDP, population and emissions, but with a different national income distribution can have substantially different fair share benchmarks under the framework.

To illustrate these effects and to assess the sensitivity of the calculations to national inequality, we performed a series of experiments with the CERc, wherein we analysed the contributions to global mitigation of three hypothetical countries, with identical population, GDP and emissions, but with different Gini coefficients under three different scenarios of average per capita income. The Gini coefficients were chosen to roughly reflect the range of current real-world Gini coefficients and the three income levels roughly reflect the projected average per capita income of High Income (\$50,000), Upper Middle Income (\$15,000) and Lower Middle and Lower Income (\$4,000) countries according to current Worldbank classification. Supplementary Table 3 contains the results of these experiments and reports, for each of these scenarios and for both of the main equity benchmarks used in the main text, the share for each of the three hypothetical countries of global mitigation as well as the percentage of each country’s population above the development threshold (\$7,500 per capita).

Supplementary Table 3: Results of experimental runs of the Climate Equity Calculator

Average income	Equity Benchmark	Share of Global Effort			Population above development threshold		
		Unfairland	Midland	Fairland	Unfairland	Midland	Fairland
\$50,000 per capita	1950-M.P.	33.7%	33.2%	33.1%	78.1%	96.6%	100.0%
	1850-H.P.	43.5%	32.6%	23.9%			
\$15,000 per capita	1950-M.P.	38.0%	32.6%	29.4%	44.6%	65.4%	90.5%
	1850-H.P.	55.0%	28.8%	16.2%			
\$4,000 per capita	1950-M.P.	66.1%	29.3%	4.6%	12.8%	12.2%	5.3%
	1850-H.P.	81.3%	9.8%	0.9%			

Hypothetical world with three countries, each with one third of global emissions, population and GDP. Global historical, projected baseline and mitigation scenario emissions as in main analysis. Global GDP determined by three scenarios of global average per capita income as listed in the table. Countries only differ in their Gini coefficients, with values chosen to roughly represent spread in the real world: Fairland=0.25 (similar to real world Iceland), Midland=0.45 (similar to the USA), and Unfairland=0.65 (similar to South Africa). “1950-M.P.” represents the “1950/medium-progressivity” and “1850-H.P.” the “1850/high-progressivity” parameterizations of the Climate Equity Reference Calculator, see main text for details.

The results show that in each of the scenarios, the country with the highest inequality, “Unfairland,” is allocated the largest share of the global mitigation effort. In other words, Unfairland’s mitigation contribution would have to be larger than that of the other countries to receive an “equitable” rating. However, it is also clear that the degree of the difference between the countries varies substantially across different equity setting and average income levels.

Specifically, the level of inequality impacts allocations of effort more in poorer countries than it does in richer countries. This is consistent with the framework: in poor but equal countries, the incomes of a larger share of the population falls under the development threshold. In the case of \$4,000 average income, nearly 95% of Fairland’s population earns incomes below the threshold and is thus exempt from contributing to climate action, while in Unfairland a larger share of the national income is captured by the relatively wealthier part of its population, ensuring that nearly 13% of the population earns incomes above the threshold and thus contributes to the global climate effort. Conversely, in a wealthier world (with \$50,000 average per capita income) most (or all, in the case of Fairland) individuals earn incomes above the development threshold, regardless of income distribution, which results in shares of the global effort to be relatively insensitive to Gini coefficients.

Further, the sensitivity of results to Gini coefficients is also strongly influenced by the choice of the specific equity settings for the CERc. The “1850/high-progressivity” benchmark differs from the “1950/medium-progressivity” benchmark in its treatment of incomes above the

development threshold by introducing a second threshold called “luxury threshold,” here set at \$50,000 per capita. While the latter benchmark fully counts all income above the development threshold toward a country’s capacity, the former fully counts all income above the luxury threshold, while a weight, linearly increasing from 0 to 1.0 is applied to the income between the thresholds. In other words, most of the income just above the development threshold is still exempt. This reflects the treatment of income in many income tax codes, where gradually increasing marginal tax rates are applied as individuals’ incomes increase. This reflects a more progressive approach to effort sharing as wealthier individuals are expected to contribute a higher share to the global effort than in the other benchmark. In the sensitivity analysis, we find that the impact of inequality on the effort sharing calculations is amplified by introducing this second threshold. In more unequal societies, even at the same level of total income, a larger share of the national income is captured by wealthier individuals than in more equal ones, and because the more progressive treatment of income in calculating capacity shifts more of the global effort to wealthier individuals, these unequal societies have more of the global effort allocated to them.

Finally, the results in the \$50,000 and \$14,000 per capita worlds under the 1950/medium-progressivity benchmark deserve some additional scrutiny as it might be counterintuitive that despite having the smallest fraction of population with incomes above the development threshold, Unfairland is expected to contribute the largest share to the global effort. This is due to the implementation of the development threshold, where the selected level of exemption (here: \$7,500) applies to all individuals of a country, regardless of their total income. In other words, the first \$7,500 of an individual earning \$7,501 will be exempted just as the first \$7,500 earned by a millionaire. Consequently, for individuals earning below the threshold, the entire income is exempt. This mimics the treatment of individual income in many income tax codes where an amount roughly equivalent to the cost living at a very basic subsistence level is exempt from income taxation (e.g. the personal exemption in place in the USA until the 2017 tax reform, the *Grundfreibetrag* in Germany, the basic personal amount in Canada, or *personfradrag* in Norway). In the results reported above for the \$50,000 world, all individuals in Fairland earn incomes above the development threshold of \$7,500 which means this amount is exempted from everyone’s income. On the other hand, 22% of Unfairlanders earn incomes below the development threshold, and while their income is fully exempted, the exemption amounts to less than \$7,500 in such cases. As a result, the total amount of Unfairland’s national income that is not considered in the calculations of the country’s

capacity is smaller than in Fairland, resulting in a larger capacity for Unfairland and subsequently the assignment of a higher share of the global mitigation effort.