Forecast of a hot future: Predicting decision–making at the climate negotiations

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The analysis of instances of international bargaining such as the current climate change negotiations requires a thorough comprehension of the underlying conflictive issues in order to coherently assess the effect of such variables as national preferences and international power balances. Research so far has produced major contributions to the identification of the dimensions at the UN Framework Convention for Climate Change (UNFCCC). And yet the complexity of climate change politics and the entanglement of different salient issues in them increasingly require a more rigorous and systematic understanding of this area of international relations. My paper 'unpacks' the underlying conflict at the UNFCCC by proposing the empirical examination of a novel dataset on bargaining positions at these negotiations. In particular, I use the dataset to test the effect of various facets of political power possibly in place at the climate negotiations. The departure point is the observation that the literature on the climate change negotiations is still a long way from empirically grounded explanations of their decision outcomes. To surmount this void, I perform analyses based on Nash Bargaining Solution models that weigh the relevance of distinct bargaining factors on agreements at past climate negotiations. The results qualify structural economic power and issue–specific saliency as the main explanations for the outcomes at such negotiations in the period 2001–04.

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1 Introduction

The UN-sponsored climate change negotiations are a phenomenon that has received increasing attention within the realm of bargaining analysis. As international trade rounds and European Union legislative meetings, the UN Framework Convention for Climate Change (UNFCCC) offers a view on inter-governmental interactions that involve many countries interested, in the specific case, in a common agreement over carbon cycles and climate sustainability. Also similarly to international trade and the EU, the climate change negotiations emerge as a complex mosaic of national preferences and encroaching issue positions that are far from easy to unravel in order to explain the outcomes finally undertaken.

To cite an example, the Durban agreement (2011) that supported the EU proposal for an extension of the Kyoto Protocol seems a far apart outcome from the position of countries such as the BASIC group (Brazil-South Africa-India-China), which proposed a new carbon budget to be allocated on the basis of historical per capita emissions (UCT BASIC Experts, 2011). And yet, the Durban Platform of the 2011 Conference of the Parties established a process for "a treaty, a legal instrument or an agreement with legal force" to which both EU and BASIC group agreed (UNFCCC, 2011). This raises the question of how an agreement could rise from two such different standpoints. Did the Durban outcome carry a fair division of spoils, or were there any factors in action that forged the agreement point and created "winners" and "losers" out of the negotiating process? If the latter were true, which factors would predict the Durban agreement as the reachable point in the bargaining space? Thus, put it more generally: what types of outcomes can be predicted when different features of the actors at the UNFCCC are taken into consideration? This paper tries to answer this last question by proposing an empirical examination of facets of political power in place at the climate negotiations.

The departure point is the observation that the literature on the topic is still a long way from empirically grounded explanations of decision-making outcomes. This is not to say that empirical data has not yet been used to test theories on how countries at the UNFCCC meet in agreements. In fact, both economists and political scientists have extensively explored inter–governmental climate change bargaining in different empirical formats (Forgo et al., 2005). My claim is rather that there is a gap in the analysis of bargaining models that raise knowledge on what empirical factors predict the observed outcomes at the UNFCCC. In other words, the approaches so far applied to explain decision-making at the climate negotiations still strike for their comparative limitations. Most articles consider a small portfolio of issue agreements (e.g. Hovi, 2001) and relate it to stylized bargaining solutions (e.g. Barrett, 1997). A minority focuses on issues that facilitate the empirical tests of the outcomes yet restrict the understanding of decision-making to specific preferences and positions (Nordhaus and Yang, 1996; Eyckmans and Finus, 2007). Finally, many studies address the actors' impact the decision-making process at the UNFCCC by means of case studies, thereby discounting the comparative scope of their inference (Boyd et al., 2008), or in the light of the procedures and rules at the UNFCCC (Hey, 2001; Pralle, 2009), thereby ignoring the effect of "power" on the set of reachable agreements. This paper fills this gap by systematically evaluating a novel dataset of bargaining positions with a battery of models that capture different politically relevant "power" factors. By so doing, the paper offers a review of the causal mechanisms useful to forecast outcomes at the UNFCCC negotiations.

The paper is structured as follows. In the first section I present the background to the study of decision-making at the UNFCCC. I thereby delineate the factors that the literature discusses as the main determinants of climate change agreements, and then propose to explain negotiation outcomes at the UNFCCC with the use of a Nash Bargaining Solution (NBS) as applied by the studies on the EU legislation rounds (Thomson et al., 2006; Schneider et al., 2010). In the second section I present the research design, and describe the dataset that I operationalize for my NBS predictions. In the third section I discuss the results, and assess the predictions with error evaluation, t-test statistics, and a regression analysis on factors affecting the failure of the prediction. In the fourth and final section I summarize the results and discuss my empirical analysis in light of the current understanding of bargaining resources and collective outcomes at the UNFCCC.

2 The analysis of cooperation at the UNFCCC

Works on the climate change negotiations evolved, as pointed out, like the equivalent literatures on trade and EU negotiations. Analogously, only a fraction of the body of this literature has so far focused on decision–making *outcomes* rather than other aspects of the negotiation process (i.e. agenda setting, issue advocacy, etc). Among the research aimed at explaining outcomes at the negotiating rounds of the UNFCCC, two main streams of publications have emerged.

The first branch is what Bodansky (2012) calls the 'prescriptive' school of climate negotiation analysis. This is made up mainly by international law studies drawn by normative questions regarding cooperation over climate change. This research aims at undergirding principles and proposals to be channeled back in the actual process of the negotiations (van Bodgandy and Venzke, 2011). While perhaps useful to underpin some controversial negotiation topics such as climate justice, the prescriptive school is inherently limited in predicting whether states agree or not on the spectrum of issues discussed at the UNFCCC. The second stream of research is more useful on these grounds: the so-called 'contractual' school of climate negotiation analysis (Helm, 2009; Bodansky, 2012) takes over the goal of explaining why potential outcomes that would yield a net global environmental benefit are met through international negotiations, and which incentives come into place and promote agreements. The group of 'contractual' works, heterogeneous as it is fed by both international politics and rational choice research, offers the basis of my study on the predictive accuracy of bargaining models of the UNFCCC.

Theoretical underpinnings for the study of climate change decisions

The assumption that climate change negotiations are predicated on a contractual theory of international interactions is shared among different types of researchers from economics to political science. Pinpointing the mechanisms of this body of analysis is what I undertake here, as this facilitates the definition of outcomes and, later on, the modelling of the determinants of decision–making at the UNFCCC.

Among the economic students of contractual decision–making, "international environmental cooperation" theorists (Neumayer, 2001) place great emphasis on climate change cooperation as an improvement over anarchy. Most of them draws the importance of "self-enforcement" and "renegotiation-proof" in climate change agreements (Heal, 1994). Many focus their research on developing conjectures that help predict full cooperation, such as the idea of efficient coalition (Carraro and Siniscalco, 1993) and the minimum participation solution (Barrett, 2001). More importantly for this paper, this theory emanates several formal arguments for what a systematic, observable outcome is. In these, three are the core assumptions that define outcomes in the study of negotiation agreements. First is the idea that international negotiations produce outcomes if these promote benefit-cost "effectiveness." Accordingly, agreements at the UNFCCC emerge only if the final decision allocates the burden of reducing emissions in such a way that the cost for each country of reducing emissions is less than the climate benefit it receives from the agreement (Barrett, 1999). Second is the assumption that only 'possible' outcomes can be analyzed. Outcomes exist when each participant thinks they will leave her better off. If such condition is not met, outcomes are no form of contract, and therefore cannot be objective of systematic analysis.[1] Finally, the theory of international environmental cooperation assumes that international outcomes carry with them a contract that defines reciprocal actions among the negotiating states. If negotiation outcomes do not formally establish a reciprocal behaviour, then the observation is no outcome. This assumption also provides the assurance of mutual compliance through the process of treaty commitment (Barrett and Stavins, 2003). Agreements that fit these conceptualizations can then be systematically analyzed, compared and predicted across negotiations and time.

On the end of political science, the study of contractual behaviour at the climate change negotiations is undertaken by international regime theorists as well as international relations scholars. Here international decisions are intended as "benefit sharing" problems, where regime theory understands outcomes as formulas for the distribution of common wealth (Young, 1989), while international relations theory looks at them as an expression of countries' strengths and weaknesses, or in other words national "success" (Milner, 1992).

Together, the two schools shed light over two configurations of negotiation outcomes that are important for the systematic study of UNFCCC decision–making. First, regime theory claims that if the "division of the cake" in the negotiations' departure point is very different from the one prescribed in possible outcomes, the outcomes will be hardly predictable (Sebenius, 1991). This claim has to do with the idea that international agreements must be benefit–cost efficient not only from an economic allocation standpoint but also from a political point of view. Along similar lines, Putnam (1988) argues that decision–makers at the international table need to lobby for a "share" that will appease the domestic counterparts. As the game is played simultaneously abroad and at home, decision–makers are faced by incentives that make them consistently supportive of benefits that favour domestic preferences, otherwise defaulting in the disagreement point.

This sensitivity problem leads to the second point regarding the study of negotiation outcomes as a reflection of national preferences. Following the spatial conceptualization of issue–voting in Downs (1957), negotiators pivot their ideal position on their internal preference point. If the distribution of benefits in an agreement is too unbalanced or far off from the departure point, the negotiating parties may not meet their *a priori* choices and therefore refuse to agree to anything but the departure point. However, this position may depend not only on the actors' actual preferences (Frieden, 1999) but also on how these

[1] This is what game theorists refer to as the existence of a bargaining 'win–set.'

are manoeuvred by factors that affect the nature of the negotiations – be them structural (exogenous) or strategic (endogenous) (Bailer, 2004).

The arguments raised by the voices in economics and political science, pointing to different denominators of decision–making outcomes, offer a comprehensive depiction of what international climate change agreements are from a "contractual" standpoint. And yet, these insights have found little exploration beyond theoretical propositions. In other words, this literature has been rarely applied to solve those puzzles that emerge from the empirical observations of climate change bargaining. While identifying the outcomes that best fit the described theoretical definitions has become a fairly common research exercise, less investigated is the explanation of how the UNFCCC outcomes come about, and what makes them more or less predictable. In order to engage in these questions, I now turn to the research that infers causal mechanisms at the UNFCCC from empirical observations. From there I draw the main factors that I will integrate in my prediction models.

Explaining outcomes at the UNFCCC: which factors matter?

Forecasts in the social sciences are deeply rooted in explanatory power (Achen, 2006a). Therefore, the predictors of a forecasting analysis of UNFCCC agreements should reflect the variables most pointed to as explanatory factors of climate change bargaining. Of course, just as in the literature on the EU inter-governmental negotiations, the explanations of negotiation outcomes are closely related to explanations of bargaining success (Weiler, 2012). This is not controversial, as the solidifying conviction in political science is that power facilitates countries' success in the form of preference attainment. Since outcomes are a function of a country's abilities to 'pull' the final agreement close to its preferences, both outcomes and success are a consequence of "power" (Bailer and Schneider, 2006). The following discussion will then assume that the identified factors can be interpreted as different facets of power, and can be weighted as such in the predicting models.

Articles specialized in the factors that explain outcomes at the UNFCCC have exponentially increased in the past decade (Grubb, 2010). The first explanatory factor emerging from these is the endowment of economic resources, otherwise referred to as economic *capabilities*. This is a crucial driver of (dis)agreement at the UNFCCC according to those studies that portray climate change as a ground for distributive conflict (Grundig, 2006). In support of this argument is the observation that 'rich' states face the highest opportunity costs from bargaining, which leads them to have more influential positions over climate policy integration than ‘poor’ states (Ott et al., 2008). Along the same lines, Carraro and Siniscalco (1993) claim that the general concern for relative gains at the climate negotiations is what has driven the coalition “shuffling” in the twenty years of UNFCCC. On the same page, integrationist researchers focus on the logic of ‘hard power’ to explain value creation at the UNFCCC (Sebenius, 1991). Accordingly, the instances of issue stalling at the more recent negotiations are explained as the overcoming of rich countries. For example, the Copenhagen conference (2009) saw EU and US pushing the discussion on the ‘universal duty’ of abating emissions. While discussing other obligations would have perhaps better fulfilled the normative goal of the negotiations, the COP final text saw EU and US positions dominating the agreement, thereby stressing the “reconsideration of abatement duties” across the Copenhagen Accord (Bernstein et al., 2010).

A second factor emerging in the literature of the climate change negotiations is the risk of natural devastation, or what can be referred to as climate *vulnerability*. This factor, contingent to climate change, represents a strong bargaining power if one assumes that the urgency of action that one country expects from the UNFCCC can have a large impact on that country’s strength at the negotiations and its ability to forge the outcome (Weiler, 2012). Vulnerability therefore captures the type of actor-specific salience that affects a country’s incentive to lobby for its environmental concerns or, as for some islands, sovereignty. Vulnerability is finally different from capabilities, because it is an indicator of the ‘flow’ of natural resources compared to the ‘stock’ of economic wealth. According to Bodansky (2010), this factor explains why the Umbrella Group, founded in the 1990s by a section of the Annex I countries, has increasingly faded away with the evolution of climate change (given the increasing gap between more threatened countries like Canada and less threatened ones like Australia). It may also explain why the BASIC group (Brasil-South Africa-India-China), which is the main consumer of green funds for sustainable development, has been successful at the UNFCCC negotiations, as well as the AOSIS block, which features environmental risks and is rooted on strong territorial concerns (Betzold, 2010).

A third factor explaining outcomes at the climate negotiations points to multi-level decision making, and in particular to the effect of *domestic constraints*. Here commentators refer to the theory of two-level games (Putnam, 1988) and the role of domestic politics in explaining the determination of outcomes. If the bargaining progress can be conceptualized as the effect of lobbies and constituencies at home (Mayer, 1992), then negotiations are the product of domestic power balances. Two examples assist this view: the 2001 US Senate’s strike at the Kyoto Protocol, scorned as a market threat by the American petroleum industry (Lisowski, 2002); and 2004 Russia, which signed the Kyoto Protocol in exchange of lots of free emission credits to distribute among the remaining post-Soviet metallurgic firms (Michaelowa, 1998). Congruently, the two–level game reasoning could explain why some countries at these negotiations have shifted from more to less successful. Changing executive governments and the rise of "voluntary" regulations (plus, of course, the impact of the 2009 financial crisis on national budgets) arguably shuffled domestic beliefs on leadership and global responsibility (Young, 1989). This explanation works to explain Annex I countries' upcoming interest in changing the status quo with the proposal to iclude more players in the compulsory abatement scheme – something that has not yet been edited in the covenant of the UNFCCC as of 2012.

A fourth explanation of outcomes at the UNFCCC is finally the *salience* over the objects of the bargaining. The importance attached to the negotiation agenda can arguably justify strong positions and a 'stubborn' bargaining behavior. The case of forests is an exemplary one. The principle of Land Use, Land-Use Change and Forestry (LULUCF) was agreed upon at the seventh conference of the parties in 2001 (ENB, 2001). While in its draft version it included the G77 suggestion to systematically monitor reductions from deforestation, this was abandoned in the writing of the accords under the pressure of Australia (Boyd et al., 2008). The Marrakech agreement recorded no new mention on the practice of deforestation monitoring (Hovi and Areklett, 2004). And yet, the year after many highly concerned developing countries raised again the issue of deforestation. This became a source of power for some Rainforest countries, and inevitably affected the boundaries of cooperation.

The discussed factors are drawn from *ex post* analyses of the negotiation processes at the UNFCCC. However, the interest of this paper is to assess the predictive capacity of each of these variables in a comparative format. In order to do so, I follow the procedure of 'weighing' these variables against different forecasting models so to produce *ex ante* outcome estimations, and then compare these to the actual observed outcomes. Game theory modelling is the best candidate for setting up this type of solvable decision–making models. Cooperative bargaining theory, in particular, offers empirically manageable scenarios for n-actors games. Of these, the Nash Bargaining Solution (NBS) has found increasing support in the application to negotiation analysis, in particular for the case of the EU. In order to highlight the usefulness of this model for the scope of my study, I will now introduce the NBS, summarize how it has been used in bargaining analysis, and then describe how it can be exploited for the case of climate change negotiations.

Nash Bargaining Solution: precedents, promises and application

Cooperative bargaining theory is generally preoccupied with the welfare of a group of actors, assuming all of them are interested in the sharing of the “pie” and commitment does not affect strategy. While less used in the study of international behaviour than noncooperative games, cooperation theory is often cited in works on international negotiations, and therefore also climate change negotiations (Hovi, 2001; Osmani and Tol, 2008).

Researchers have most often concentrated on the Rubinstein type of sequential bargaining, because its dynamic strategic setting introduces non-cooperative behaviour within a cooperative setting (Binmore et al., 1986). However, this model comes with rather complex formulations and difficult empirical operationalizations, especially in the case of multiple actors and long bargaining periods (Muthoo, 1999). Less used but equally theoretically efficient is the static Nash Bargaining Solution (NBS) approach that preceded Rubinstein’s model. General academic attention to NBS modelling sparkled in the 1980s, with the “grounding” of the Nash program in classical game theory (Binmore and Dasgupta, 1987). Consequently, the analysis of international decision-making has increasingly explored this approach – see Mansfield et al. (2000) for an NBS study of international trade negotiations, and Achen (2006b) for a discussion of the NBS application to European Union legislative bargaining. Nonetheless, students of the climate change negotiations have barely made use of this game theoretic tool. By consequence, works that examine explanatory factors integrated in the NBS are still quite rare with regards to the study of the UNFCCC – an exception being Okada (2007), though the paper propose a hardly imaginable one-issue scenario. Finally, no study has yet applied the NBS logic to produce empirical forecasts of the UNFCCC outcomes.

How does the NBS approach come useful in the assessment of factors that predict outcomes at the UNFCCC? The answer lies on the nature of the NBS, as pinpointed by Binmore et al. (1986). Firstly, Nash (1950)’s solution reveals that cooperative outcomes can be approximated to a game where players are willing to search for the bargaining protocols. This means that the bargaining space can be assumed to be uniform, as no outcome is excluded from the search process. A second convenience of the model is that the NBS outcome is easy to compute for scenarios that include more than two actors (Barrett, 2001). Thirdly, the NBS simplifies equilibria computations by assuming simultaneous action. The analysis then compares point-value outcomes to the actors' minimum expectations (called 'disagreement' or 'resistance' points) with simple arithmetics (Binmore et al., 1986). This consequently eases the integration of further considerations in the multilateral negotiation analysis, such as side payments and issue-linkage mechanisms. Fourthly, by aggregating preferences to the actors' utility for one issue, the NBS can process different bargaining dimensions at the same time, hence producing outcome points for interrelated bargaining (see Roth, 1978). Lastly, as the empirical studies in the EU decision–making literature show, the NBS can be 'programmed' and computed in different ways, according to payoff definitions weighted by different explanatory variables (Schneider et al., 2010).

The use of the NBS in the EU literature is particularly promising for the study at hand, as it shows how this simple preference–based model can produce straight forward estimations for bargaining outcomes. Following Schneider et al. (2010), I base my conceptualization of the UNFCCC process as a NBS model that can vary with the introduction of different explanatory variables. Assuming that the basic form of international reciprocity at the UNFCCC is a symmetric bargaining problem that is solved by one unique Pareto-efficient equilibrium, the NBS is a weighted difference between cooperation outcome and failure, here expressed with Euclidian utility distances (1). Finding the solution to the bargaining game implies computing the extreme outcomes that make the decision-making worthwhile for all players (Binmore et al., 1986). This nuance facilitates the conception of the solution as an actual point along a spectrum of possible agreements with the the status quo as the origin (Ward et al., 2001). From here the spatial implication of the NBS: if the UNFCCC negotiations' set of possible agreements is defined as a continuous vector where movement from the status quo means an improvement approaching full cooperation, then the further away a bargaining outcome (O) is from the ideal point (x) of each player i on a certain issue j, the larger the utility loss (Bailer and Schneider, 2006).

$$NBS_j = \max_{O \in \Theta} \prod_{i=1}^{n} \left(-\sqrt{(O_j - x_{ij})^2} + \sqrt{(Q_{ij} - x_{ij})^2} \right) \tag{1}$$

In addition to the symmetric version of the NBS, Schneider et al. (2010) discuss how the axioms proposed by Nash play an important role for the empirical extensions of the bargaining solution. The first axiom, the *invariance to equivalent utility representations*, requires that the utility outcome co-varies with the representation of preferences, so that any physical outcome that corresponds to the solution of the problem also corresponds to the solution of any linear transformation of the same problem. This refers to the fact that "it is the players' preferences, and not the particular utility functions which represent them, that are basic" (Muthoo, 1999, p. 31). Therefore, one can be comfortable translating the NBS into a Downsonian space of actors' preferences. Second, the *Pareto efficiency* axiom requires that the bargaining solution for each bargaining problem be Pareto efficient. This means that no other point beyond the set of possible agreements can provide any of the players greater utility without reducing the utility received by the other. If this was observed, the empirical estimation would be invalid (Schneider et al., 2010, p. 94). Third, the *independence of irrelevant alternatives* is assumed to hold true, as the solution point among a set of players must be the same for any subset of those players.

Finally, and more importantly for the empirical implication of the NBS, the *symmetry* axiom relies on the idea that the bargaining problem is symmetrical with respect to the players, which feature an "equality of bargaining skills" (Nash, 1950, p. 159). Building on this point, Schneider et al. (2010) propose to relax the symmetry assumption, and allow for different levels of power to affect the actors' utility functions. This is a simple way to integrate information on the bargaining process that preferences by themselves leave out. Furthermore, this procedure can arguably improve the prediction of the location of the negotiation outcome.

Based on this intuition, I extend the baseline NBS model into different permutations, so to produce different predictions of the UNFCCC outcomes. Assuming the international reciprocity at the climate negotiations is founded on power asymmetry or two–level games, I can model the effect of players' relative economic endowments (a), natural resources vulnerability (b) or domestic constraints (c) as part of the NBS expression. Following Binmore et al. (1986) and Schneider et al. (2010), the solution shall be transformed so to integrate relative weights for each separate variable within the negotiators' utilities. This produces an asymmetric maximization problem where each weighted independent variable is an exponent noted as v (here, to make reference to the three separate mentioned variables, the notation is stylized as $v_{a,b,c}$) (2).

$$NBS_j = \max_{O \in \Theta} \prod_{i=1}^{n} \left(-\sqrt{(O_j - x_{ij})^2} + \sqrt{(Q_{ij} - x_{ij})^2} \right)^{v_{a,b,c}} \tag{2}$$

Alternatively, if one conceives the reciprocity at the UNFCCC as a function of salience

(s_j), this variable can be defined as a discount factor that controls whether countries are likely to be satisfied with a share proposed by themselves versus a share proposed by others (Schneider et al., 2010, p.92). I then configure an NBS model that integrates the valence of countries' ideal positions as the main predictor of the location of the negotiation outcomes. This is a maximization problem where the salience variable is an issue–specific weight multiplied to the NBS maximand (3).

$$NBS_j = \max_{O \in \Theta} \prod_{i=1}^{n} s_j \left(-\sqrt{(O_j - x_{ij})^2} + \sqrt{(Q_{ij} - x_{ij})^2} \right) \tag{3}$$

Until here I outlined the theories that help conceptualize outcomes at the climate change negotiations, and I drew the main drivers of the UNFCCC agreements as reported by various studies in the climate policy literature. In this section I also claimed that the NBS model can be useful to produce systematic predictions on the UNFCCC conventions, and I consecutively illustrated the configuration of the reported independent variables in Nash's maximization problem. In what follows I will move to the research design and describe the operationalization of the variables within the different versions of the NBS model.

3 Research design

In order to produce empirical estimates of the NBS outcomes, I rely on a novel dataset that I generated by coding official texts of the UNFCCC produced between the years 2001 and 2004. This dataset constitutes the primary source of information for ideal points, saliences, disagreement points and final outcomes on 22 issues that I identified as most controversial in the negotiations between the solidification of the Kyoto Protocol (early 2001) and its global enforcement (late 2004) (Gupta, 2010, p. 646).

The criterion for the selection of the issues was whether these topics emerge from a qualitative review of the negotiation summaries produced by the UNFCCC watchdog, the Earth Negotiation Bulletin (ENB), as well as a frequency–based assessment of the key words that I *a priori* assigned to different issue categories. The texts from where I extracted the decision–level data (disagreement points and final outcomes) are the final written agreements published on the UNFCCC website. The decision text that represents the reference point of my analysis is the Bonn agreement of June 2001, which for several special circumstances represented a true full convention (Dessai, 2001). The agreement of Buenos Aires in December 2004 instead corresponds to my final outcome. Additionally, I drew the country–level observations (ideal points and saliences) from the so–called National Communications to the UNFCCC, which are report–like documents that member countries submit to the Conference of the Parties (COP) on a regular basis in order to meet commitments under the Convention.[2] The accessible National Communications published between June 2001 and December 2004 are 89 in total.

The data was generated following three main steps: the selection of the units of text to be coded, the assignment of selected text to the 22 pre-determined issue categories, and the allocation of a numerical positional value to each categorized unit of text. The first step implied understanding the structure of the language in the decision texts and the National Communications. As both are written as short paragraphs divided by strong punctuation marks, I choose the "natural sentence" as my unit of text (Ray, 2001; Daubler et al., 2011). I then categorized the units by issue. Here I first ran a key–word dictionary through the entire body of the texts and identified the words that highlight positional language. I read the highlighted paragraphs and assigned each to either one of the 22 mutual exclusive issues.[3] Finally, I assigned a coding value to each of the categorized units of text, based on the metric that I established for each issue. This final step implies a certain understanding of the 'scale' of each issue spectrum (Lowe et al., 2011). I drew the criteria for the extreme and intermediate values of each issue from the sources used to identify the issues (i.e. the ENB reports and secondary literature). The measuring task led to the scaling of the 22 issues into 9 ordinal issues (of which five trichotomous, and the rest extending above three values), 8 continuously scaled issues (of which three are "naturally" continuous as they are numerical indicators, while the rest are continuous in that the intermediate values are distributed in short intervals), and 5 binary issues. Table 1 reports the issues and their scales.

Ideal positions, reference points and outcomes are all located along the same preference scales, and standardized so to have all values fall in a bargaining space between 0 and 1. Regarding saliences, these were produced according to the logic of the Comparative Manifesto Project, where these measures are a normalized sum of counts of position-relevant sentences that exist on a given issue in each manifesto (Lowe et al., 2011). Accordingly, I made the salience estimates a function of the proportional amount of text that each country dedicates

[2]The core elements of the NCs called for the years 2001–04 are *"information on emissions and removals of greenhouse gases (GHGs)* and [...] *"information on national circumstances, vulnerability assessment, financial resources and transfer of technology"* (UNFCCC, 2012).

[3]If the key word did not actually carry bargaining–relevant information, I judged it null and left it uncoded.

Table 1: Issues and scales

Issue	Scale
1. CDM mechanism engagement	Ordinal[a]
2. Emission trading	Ordinal[a]
3. Binding commitment	Ordinal[a]
4. LUCF accounting	Ordinal[a]
5. Funding approach	Ordinal[a]
6. Abatement credits	Ordinal
7. LUCF eligibility threshold	Ordinal
8. Nuclear energy mitigation	Ordinal
9. Technological transfers	Ordinal
10. Adaptation support	Continuous[b]
11. LUCF–based abatement	Continuous[b]
12. Emission abatement target	Continuous[b]
13. International accountability	Continuous
14. Level of legislative action	Continuous
15. Offset projects accreditation	Continuous
16. Regulatory approach	Continuous
17. Systematic observation	Continuous
18. Differentiated responsibility	Binary
19. ODA diversion	Binary
20. Supplementarity	Binary
21. Proportional industry impact	Binary
22. Uncertainty of policy	Binary

[a] Trichotomous

[b] Indicator

to any one issue, which by default ranges between 0 and 1. Finally, I dealt with missing values. With respect to the ideal points, I drew from the discussion started by Thomson and Stockman (2006), and imputed the estimates with the statistical software AMELIA, as I believe this procedure in the case of the UNFCCC is more theoretically valuable than imputing by median values.[4] With regards to the missing values for salience, I assigned a zero to those texts that did not express a position (or opinion) on a given issue.

The data for the independent variables integrated in the non–symmetric versions of the NBS come, with the exception of salience, from external sources. The indicator for power in the form of *capabilities* is the national gross domestic product, averaged for the

[4] A reason to rely on probabilistic imputations is the fact that the coded positional observations outnumbers the missing values, and in a cohort of 89 countries the AMELIA algorithm can be precise and more secure than in smaller samples like the EU. Moreover, the UNFCCC bargaining scenario offers no reference to the proposal of extra–parties such as the EU Commission. Therefore, there is no reason to set the value of a missing position at any theoretically justifiable median.

Table 2: Models, variables and operationalizations

NBS Models	**Variables**	**Operationalizations**
Symmetry	National preferences	UNFCCC dataset (positions)
Capabilities	National preferences; Economic capabilities	UNFCCC dataset (positions); relative GDP
Vulnerability	National preferences; Natural resources vulnerability	UNFCCC dataset (positions); EVI indicators
Two–level game	National preferences; Domestic limitations on executive	UNFCCC dataset (positions); DPI veto players power
Saliency	National preferences; Issue–specific saliences	UNFCCC dataset (positions and saliences)

years 2001–04 and expressed in constant (2005) prices. The variable is handled so that each country is assigned a fraction of the total world GDP that ranges between 0 and 1. The variable for *vulnerability* is measured using the Environmental Vulnerability Index (EVI) developed by the United Nations Environmental Programme. The EVI measures 13 specific indices regarding climate change vulnerability, which I aggregate and also standardize in order to obtain values between 0 and 1 for each country. Possible alternatives to the EVI are the Climate Risk Index developed by the Germanwatch institute or the indicators for carbon footprint produced by the World Development Indicators. However, the EVI is more refined than the other two as it relies on different indicators, and is less correlated to GDP. Finally, the *domestic constraints* indicator is drawn from the "number of veto players" variable in the 2010 Database of Political Institutions. This is an incremental variable that captures the level of competitiveness and executive limitations within a domestic political system. I divided the values into 10 categories, and standardized them so to produce a range, once again, between 0 and 1. In addition, I compared such values with the "executive involvement in legislative process" variable in Hathaway (2008): no significant difference was found using either of the two indicators. Finally, I checked the correlation coefficients across variables, to avoid computing solutions that would be too "close" and therefore redundant.[5] To summarize, Table 2 reports the parameters in each of the NBS models and their respective operationalizations.

[5]The Pearson r for the relation between GDP and EVI and GDP and domestic constraints is .1160 and -.1191 respectively. The coefficient for EVI and domestic constraints is also comfortably low, at .0691.

4 Predicting outcomes at the UNFCCC negotiations

In this section I first report and discuss the predictions produced from the different NBS models, and then I assess the forecasting errors. The algorithm that I used for the predictions is the one developed by Schneider et al. (2010), which relies on the GAUSS 'Constrained Optimisation' library that solves problems under both linear and non-linear (i.e. zero–equalized) constraints. The results are consequentially bound to the bargaining space between 0 and 1.00.[6] In addition to the theoretically derived models, I also ran predictions for a null model based on the median voter. This allows me to additionally assess the forecasting accuracy of theory *vis à vis* atheoretical predictions. As voting at the UNFCCC is ruled by unanimity, there is no reason to estimate a "mean vote" model as it is usually done in the study of the EU.

Forecast of the Buenos Aires 2004 agreements: prediction accuracy

The first criterion to evaluate the prediction of my NBS models is the mean absolute error (MAE). This is the "simplest, easiest to understand, and perhaps the best overall" standard to judge the performance of prediction models (Achen, 2006a, p. 275). This measure is not perfect: the MAE can be downward biased in cases where the actual outcomes is inside the issue continuum (Schneider et al., 2010). At the same time, it can be inflated by instances of outliers. Nonetheless, the MAE has the advantage of being completely reliant on the scale of the original data, hence easy to interpret, and unconditional of when or how issues are raised in the course of the negotiations. I therefore estimated the by–issue error values and the MAEs for the different models, which are presented in Table 3.[7]

The first remarkable note from the prediction results is that the error range across the issues does not vary highly. In fact, each separate row shows that, with the exception of issue 15 ("accreditation criterion for offset projects"), the models fail with no more than a 10 percent distance from each other. The algorithms do not produce such strikingly different predictions across models as Schneider et al. (2010) found in their analysis of EU legislative bargaining. This is most likely because the observation structure in Schneider et al. (2010) is different from mine: while for the EU study the authors use a long data matrix (they account for 15 national preference points on 162 issues), my analysis concentrates on a wide dataset

[6]It is worth pointing out that the same models were run through an analogous NBS algorithm recently written in R. However, given that as of 2012 the R script is not published and yet to be improved, I rely my inferences only on the GAUSS results. This said, the direction of the predictions is to some extent similar.

[7]I here transformed the values to a scale between 0 to 100 for readability.

Table 3: Models predictions and error comparison

Issues	Median	Symmetry	Capabilities	Vulnerability	Two–level	Salience
1.	16.7	14.35	14.13	14.32	14.34	10.43
2.	16.7	3.58	3.33	3.51	3.52	4.77
3.	0	28.83	28.28	28.84	28.85	12.27
4.	0	22.01	21.98	21.85	21.87	11.35
5.	0	4.62	4.22	4.60	4.60	5.83
6.	25.0	12.53	12.11	12.49	12.46	16.35
7.	16.7	2.33	1.75	2.21	2.30	2.19
8.	21.4	21.51	20.96	21.48	21.53	16.02
9.	25.0	5.69	5.44	5.64	13.72	13.62
10.	46.0	34.69	34.69	34.71	34.73	37.93
11.	20.0	7.45	7.77	7.49	7.45	14.10
12.	45.0	1.48	1.48	1.48	1.53	1.83
13.	12.5	26.90	26.65	26.92	26.93	22.69
14.	0	9.02	9.38	9.07	9.12	9.57
15.	37.5	23.90	24.0	23.93	23.97	40.59
16.	0	9.63	9.28	9.61	19.29	9.36
17.	50.0	6.17	5.26	6.05	6.03	10.80
18.	50	0	0	0	0	0
19.	50	0	0	0	0	0
20.	50	100	100	100	100	100
21.	0	50	50	50	50	50
22.	50	100	100	100	100	100
MAE 1	19.55	13.80	13.57	13.78	14.83	14.09
MAE 2	24.20	22.01	21.48	21.67	22.84	22.25

Note: underlined are the "best" (i.e. lowest) issue–specific errors produced by the NBS models.

(for 89 countries on 22 issues). Since the MAE is measured at the issue unit of analysis, the more issues are available, the more material to produce predictions on, and therefore the more discriminant the MAE can be.

The second observation from Table 3 is the fact that all theoretical models predict the same exact outcomes regarding the binary issues. This is because in these cases the NBS assumption that all parties will look out for cooperation cannot hold. Therefore, the predicted outcomes halt at the zero values in one fourth of the issue cases. This inevitably inflates the MAE measures. For this reason I computed two kinds of MAE, namely one that reports the average error for the 17 non–binary issues (MAE 1), and one that reports the average error for all issues, including those that are binary (MAE 2).

A further look at the results provides the substantial inferences of the analysis. Both

MAE measures reported in the last two rows of Table 3 reveal that all theoretical models perform better (i.e. with smaller errors) than the median model. This is a relieving finding in favour of theoretical modelling: MAE 1 in particular shows that the atheoretical predictions fail by an average of 5 percent points compared to the NBS models.

Comparing MAEs across the theoretical models, the results indicate that the capabilities NBS fares best at predicting the outcomes of the negotiation agreements at COP 2004. According to the models accuracy captured by the MAE, this means that on average in Buenos Aires resourceful countries forged final outcomes more than poorer ones. However, it should be noted that the capabilities model only marginally outperforms the symmetric one (or the close vulnerability model). This confirms that "the inclusion of information on the intensity of the actors' preference especially improves the predictive accuracy of the models" (Schneider et al., 2010, p. 96).

The salience model that scores best in several EU–based bargaining predictions (Achen, 2006a) is here worse than the symmetric model. This finding contradicts the assumption that the more salient an issue is for a country, the more powerful she is at the negotiations. However, the errors reported on the issue rows in Table 3 reveal that the salience NBS is a volatile rather than a systematically mistaken source of prediction. In fact, the model scores best in five different issues. This is a significantly better rate than, for instance, the vulnerability NBS, which only fares best on one issue. Salience then seems to be a bargaining advantage over certain topics. Nonetheless, it cannot be considered a consistent predictor of the 2004 agreements overall based on the MAEs – something that is worth exploring with further error analysis. Finally, just like in the EU decision–making studies, the two–level NBS is revealed as the worst predictor of outcomes at the UNFCCC. Accordingly, domestic hurdles do not appear as a particularly important bargaining resource in climate change decision–making.

The second approach that I use to explore the predictive accuracy of my models is the number of accurate point predictions. Schneider et al. (2010) make use of this idea to show that the median model loses predictive relevance if a slightly higher margin of error is allowed. In this paper, the same criterion can be used to investigate the true fitness of the capabilities model as well as the ambiguous performance of the salience variable. Table 4 illustrates the evaluation of the models when the error is measured at two different levels of tolerance (0.1 and 10 percent respectively). The results – cumulative for all 22 issues – show that the predictive capacity of the median model weakens once the predictions are allowed to diverge by up to 10 percent. Economic resources remain the best predictor of the UNFCCC outcomes, scoring the highest point accuracy at the lower tolerance level of 0.1 percent. With regards to salience, in the lower margin of error this performs just like the vulnerability model. However, at the higher threshold salience dramatically improves its ranking: at the 10 percent level, the number of accurate predictions of the salience model is 3 percent points larger than the asymmetric NBS. This further supports the argument that, while resource wealth remains a strong predictor of bargaining outcomes, salience is not an irrelevant source of bargaining power. Finally, the point predictions of the symmetric and the two–level NBS result as the most unreliable of the tested models.

Table 4: Accurate point predictions

NBS Models	**0.1% Tolerance**	**10% Tolerance**
Median	24.71%	29.41%
Symmetry	22.94%	46.47%
Capabilities	28.82%	49.41%
Vulnerability	25.88%	49.41%
Two–level game	22.94%	46.47%
Saliency	25.88%	52.35%

Error explanations

In the analysis above I showed the use of NBS models in explaining outcomes at the UNFCCC. I claimed that the capabilities model fares consistently well in predicting the spatial location of actual agreements, while others, namely the two–level NBS, are less reliable. I also argued that salience, while a volatile predictor, enhances the forecasting capacity of the preference–based model, especially if a certain error tolerance is allowed. My inferences were however based on simple arithmetic comparisons. In order to fully pin down the importance of the independent variables singularly as well as aggregately, I now explore to what extent the predictions are similar to each other, and what features of the bargaining space explain the size of the prediction error.

To explain the individual importance of the independent variables analyzed in this study, I considered whether the models' predictions are more similar than the preceding error analysis demonstrated. In order to assess whether the model–specific errors are inde-

Table 5: Difference of means across models

	Symmetry	**Capabilities**	**Vulnerability**	**Two–level**
Capabilities	2.663**			
Vulnerability	1.686	-2.684**		
Two–level	-1.439	-1.723*	1.468	
Salience	0.882	0.154	0.094	-0.239

Paired t–tests (t values reported); ** significant at 5%; * significant at 10%.

pendent of one another, I ran 'paired' t-tests across the models. The results are shown in Table 5. According to the statistics, only the capabilities model produces p–values that are lower that the alpha level of .05 when contrasted with the other models. For the two–level, vulnerability and symmetric models I fail to reject the hypothesis that the measurements have different means. Curiously, also the capabilities–salience pair indicates no difference. This insignificance is puzzling. However, it may be caused by the fact that these two models have very few "ties" in their respective predictions, as the analysis of Table 3 already suggested.

A simple way to explore the relation between capabilities and salience is to correlate the predictions of the models (Schneider et al., 2010). The Pearson (r) coefficients demonstrate a strong correlation between the predictions of the capabilities model with the vulnerability and two–level models. By contrast, they reveal no strong correlation between capabilities and salience, where the coefficient is at $-.05$. This means that, while the different domestic constraints and vulnerability levels dissolve with regard to the collective outcome when capabilities are controlled for, capabilities and salience do not cancel out. In other words, the coefficients prove the intuition that these two variables capture different important information regarding the bargaining process of the UNFCCC.

In light of the variance in the models' predictive accuracy and the explanatory capacity of the independent variables, the final task is to assess whether or not the predictions are systematically 'drifted' by the characteristics of the bargaining space. I therefore conducted a regression analysis of the size of the prediction error on different features of the bargaining spectrum. I suspect that errors correlate positively with the *polarization of preferences*, and therefore negatively with the refinement of the distribution of positions over a given issue. The reason is that instances where mediation has little hope trigger extreme positions among conservatives and supporters of cooperation (Thomson and Stockman, 2006). Analogously and relatedly, I presume that the *scale of an issue* has an impact on error. In other words, I expect that issues that are formulated with the possibility for a range of "middle–ground" proposals are less likely to produce prediction mistakes than issues that enforce sharper positions (Arregui et al., 2006). Finally, I regard at the *underlying dimensions* of the bargaining space as a possible driver of prediction error. A factor analysis performed in advance on my dataset showed that two main dimension cross the UNFCCC issue space for the years 2001-04, where the strongest (i.e. most loaded) of these two is a rather ideology–based dimension. Assuming that conflict may be more vicious on this first dimension than on the second one, I expect this loading to be a possible trigger of forecasting error.

I perform a linear regression where the unit of analysis is the issue–level error. To operationalize the drivers of the bargaining space, I constructed the following indicators: A nominal variable accounts for the concentration of the UNFCCC negotiating countries – i.e. the *polarization* – across the bargaining spectrum. Here the lowest value (1) indicates that the empirical distribution is skewed to the status quo and the highest value (5) indicates that most countries are located to the right of the mean, close to the Pareto frontier. The middle values capture whether the countries have mixed distributions with a maxim on the left (2) or on the right (4), or if they are normally distributed (3). As for the *issue scale*, I constructed an ordinal variable where the value 1 stands for dichotomous issue, 2 for trichotomous, 3 for ordinal, and 4 for continuous. I used a dummy variable (*factor loading*) to account for whether the issues are loaded on the first latent conflict dimension or not. Finally, I generate an interaction term (*scale*polarization*) to account for the simultaneous relationship between the two variables.

The results in Table 6 show that countries' polarization and issue scales are strong explanations for the size of the prediction error. According to the regression analysis, the size of the error is likely to be large if issues are more polarizing, or in other words if countries are skewed towards the status quo (therefore the negative sign). In addition, there where the natural scaling of the issue forces the status quo inside the core, countries are little interested in cooperation. This induces larger forecasting error, such as for the case of supporting an adaptation fund (issue 10). While the latent dimensionality does not reach statistical significance, the conditional effect of polarization and scaling is significant and positive. This indicates that if both the intensification of polarization and scale tightening occur (i.e. if both variables move towards lower values), the chances of error increase.

The regression results also make sense in light of the predictive importance of the capabilities and salience models. The economic power ranging across the 89 countries in my sample arguably diffuses the distances across preferences, therefore uniforming in a quasi-normal distribution that is less prone to error (Ray and Singer, 1990). As for salience, the issues where the variable unleashes predictive insightfulness are those where mediation was possible, and therefore where countries are less polarized to begin with (Schneider et al., 2010). These interpretations provide an interesting picture of the COP in Buenos Aires: in 2004 rich countries may have felt comfortably reliable and accountable for climate change, while poor countries might have highly prioritized on climate change as a foreign affair. By consequence the agreements could have well been driven by the distribution of interests across economic capabilities and saliences, given the location of the international status quo. These, however, may not be the traits of climate change bargaining in more recent years. Looking at a closer negotiation round may strengthen the predictive trustworthiness of capabilities and saliences revealed in this first study.

Table 6: OLS regression analysis of error

	Issue–specific error
Polarization	-0.183***
	(0.0396)
Issue scale	-0.115**
	(0.028)
Factor loading	0.0271
	(0.032)
Scale*Polarization	0.0667***
	(0.015)
Constant	0.436***
	(0.076)
N	85
R^2	0.333

Standard errors in parentheses.
*** significant at 1% level; ** significant at 5% level.

5 Conclusion

The purpose of this paper was to explore whether power affects climate change bargaining processes, and if so to what extent it can help predicting the Conference of the Parties' outcomes. I first delineated the need to link theoretical evaluations of agreements at these negotiations with empirical justifications of cooperation at the UNFCCC. In so doing, I reviewed the definition of 'outcomes' in the contractual theories of international bargaining, and tied it to explanatory variables identified in the climate negotiation literature. I then proposed to demonstrate the relevance of these variables with the use of different permutations of the famous Nash Bargaining Solution, which I adapted to the analysis of the UNFCCC. The results showed that models that account for the capabilities of the negotiating countries are on average the most accurate theoretical frameworks. In parallel, the model that integrates the weight of actors' issue–specific salience offers the largest number of correct point predictions, though only when the error tolerance is relaxed.

The findings in this paper ultimately point to two important considerations regarding the study of decision making at the UN–sponsored climate negotiations. Firstly, and very differently from the prescriptive literature on these negotiations, the results show the relevance of taking strategic preferences into account. While the analyses must be further explored by comparisons with other rounds at the UNFCCC, in this paper I was able to show that resource–based models that build on preference distributions are a crucial predictive asset, and deserve more attention from students of climate negotiations.

Secondly, my results shed light on the interdependency of different sources of power at the UNFCCC. As both capabilities and salience are found important in the predictions of decision–making in 2001–04, my analysis dismisses the argument that the driver of climate change agreements is what is decided ahead back home. In fact, based on the estimations run with my data, domestic hurdles seem not to rise to the bargaining arena of the UNFCCC. Additionally and perhaps more importantly, the findings dismiss the claim that there may be only a certain group of successful countries at these negotiations, whose success is grounded either in economic power (e.g. rich countries) or in the intensity of salience (e.g. low income countries and islands). Ultimately, the results in this paper point to the interaction between power resources, in particular capabilities and salience, for further exploration and understanding of outcomes at the UNFCCC.

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