Exploring the Dynamics of International Cooperation

by

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Abstract

International cooperation normally develops through more or less complex processes, extending in some cases over several decades. Inherent in these processes are certain mechanisms that may be important in shaping trajectories and outcomes. We begin by briefly reviewing some of these mechanisms. We then outline a simple static model of multilateral negotiation and explore what might be gained by extending such a model to include one form of connectivity central to process dynamics such as momentum and cascading collapse, viz. contingency relationships. Our main conclusion is that while a static model can be a useful tool for, inter alia, distinguishing options (“solutions”) that are politically feasible from those that are not, a dynamic model will be needed to examine pathways that can lead to the adoption and implementation of one of these solutions. In the final section, we offer a simple empirical illustration focusing on the global climate change negotiations. More specifically, we ask whether and to what extent (commitment to) a mitigation measure by one of the major actors will affect the incentives of others to contribute. The preliminary results confirm that even major actors are sensitive to what other parties do, and in fact can increase their own welfare by inducing important others to undertake mitigation measures. Moreover, this first round of simulations indicates that a more refined map of the contingency web could provide useful clues in the search for pathways that can lead to a more effective international regime.

1. The Questions

In this paper we address two main questions. First, can additional insights be gained by studying cooperation as a process - more precisely, as an evolving sequence of connected events - rather than as a state? Second, how might we go about studying the dynamics of cooperation processes in a systematic and rigorous manner? This paper is an early report from work in progress, and our ambitions are limited to exploring these questions rather than providing conclusions.

We proceed as follows: In section 2 we explore the distinction between cooperation-as-state and cooperation-as-process, and identify some of the mechanisms that serve to connect a sequence of events. In section 3 we explore what might be gained by including one form of connectivity - that of contingent behaviour - in the analysis of multilateral negotiation. In section 4 we provide an empirical illustration focusing on contingency relationships in the global climate change negotiations. Finally, section 5 briefly summarizes lessons so far.
2. Cooperation as *Process*

Cooperation can be conceived of as a *state* or as a *process*. Conceptualized as a state, cooperation is described in terms of scores on dimensions such as problem scope, participation, strength, or effectiveness - as observed at one particular point in time. Change is measured by comparing snapshots taken at different time points, and explained in terms of change in a set of independent (and perhaps also intervening) variables, measured by means of comparative statics (see e.g. Breitmeier et al., 2006; Miles et al., 2002). The explanation itself is likely to focus largely on “structural” variables, including the configuration of interests, the distribution of power, and the institutional setting. Conceived of as a process, cooperation is described as an evolving sequence of connected events, in which events taking place at an early stage can affect what happens later. To the extent that events are in fact thus connected, mechanisms inherent in the process itself can influence its development and outcome. Identifying these mechanisms and understanding how they work are therefore integral elements of the study of international cooperation.

The argument to be made here is *not* that one perspective is “right” and the other “wrong”. It can make perfect sense to describe cooperation as a state (of play) and explain change in terms of comparative statics; in fact, most of our own research has adopted this perspective. Moreover, “structural” models may well be able to account for most of the variance observed in behaviour and outcomes. Yet, we know that cooperation normally develops through more or less complex processes, extending in some cases over several decades. Such an extended sequence of events will rarely if ever be the product of one single decision, informed by one grand design. Moreover, if challenged to predict what will flow from a set of initial conditions, most of us will in most cases see more than one possible trajectory or outcome, and perhaps come up with conditional answers. Further refinement of static models and more precise and reliable data may well enable us to come up with more determinate and accurate predictions. But optimism should be cautioned by a reminder that different strands of research converge in suggesting that initial conditions quite often leave a range of indeterminacy, and that mechanisms internal to the process itself can shape its course and affect its outcome. For example, several case studies offer compelling evidence that moves made or events occurring at an early stage can constrain the menu of choice or change the value of particular options for later stages, and that a certain idea sometimes gather momentum that cannot be adequately explained in terms of new information about its substantive merits (e.g. Miles, 1998; Levy 1993; Risse, Ropp, and Sikking 1996). Relying on a different set of tools including evolutionary game theory and agent-based modelling, complex systems analysis confirms that the course taken by cooperation processes can be governed in part by internal dynamics, generated by a combination of various types of feedback and critical thresholds or tipping points (see e.g. Axelrod, 1997; Jervis 1997). Adding up these and other pieces of evidence, we may conclude that there seems to be “something” about the process itself that
we need to understand in order to be able to explain well the evolution (and collapse) of cooperation. This paper is a modest contribution to moving that agenda forward.

Building on previous research, we suggest that the analysis of cooperation-as-process may proceed from three basic premises. First, as already indicated, the approach builds on the assumption that initial conditions (or “structural” features) leave a range of genuine indeterminacy.1 The word “genuine” is important here, pointing to indeterminacy that is inherent in (the state of) a certain system and therefore cannot be overcome by further refinement of static models or more complete and accurate data of the same format. By studying conflict as a state we can, for example, determine that it has the essential features of being “explosive” but not whether or when it will in fact “explode”. “Explosion” occurs if and when an “explosive” object becomes subject to a triggering event.

Second, in studying cooperation as a process we see it as an evolving sequence of connected events. The word “connected” is particularly important in this context, since it is this connectivity that provides the grid through which some events are amplified and others rendered insignificant. Connectivity is, in brief, the stuff from which evolutionary dynamics can arise and develop. A distinction can be made between connectivity in space and connectivity in time. A well-known example of the former is contingent behaviour, e.g. situations in which the willingness of an actor to contribute to a joint project depends on whether or to what extent one or more of its prospective partners also contribute.2 Connectivity in time means that the causal significance - and sometimes also the meaning - of a certain event depends on when it occurs. Quite often, initiatives taken or choices made at an early stage will set a process on a particular path that becomes harder and more costly to change the longer it has been pursued. And what would have been interpreted as a generous offer had it come early in the process may - after a prolonged period of hard bargaining - be seen as an act of yielding to pressure or admitting defeat.

Third, studying cooperation as a process can, then, be described as an attempt at understanding how the logic of connectivity shapes the dynamics of evolution. This is a tall order, requiring that we are able to identify the main process-(generated) mechanisms at work and determine how they work. Previous research can provide some useful guidance. Most importantly, it has identified and explored several process mechanisms that can leave a significant imprint on trajectories and outcomes. To set a wider stage for our own more narrowly focused study, we begin by briefly reviewing five of these mechanisms: path dependence, momentum, cascading

1 The flip side of the coin is that the scope of validity of this particular approach is limited to settings where this condition is met.

2 Conditional cooperation is studied by different approaches, ranging from in-depth, ideographic process-tracing (see e.g. Miles, 1998) to experimental economics (e.g. Fishbacher, Gächter, and Fehr, 2001; Keser and van Winden, 2000).
collapse, escalation, and spill-over. The former is the more general notion, capturing the essence of connectivity in time. The other four are more specific manifestations of positive or self-reinforcing feedback that may be generated also by connectivity in space.

Path dependence generally refers to sensitivity to initial conditions and/or previous events. Where such sensitivity is high, events taking place early in a sequence - even seemingly insignificant events - may have large and enduring consequences, and in fact “lock” a process into a certain trajectory. There are several specific mechanisms that can produce such effects. In economics, attention has focused mostly on increasing returns. Seen from the perspective of the producer, increasing returns means that output (and in certain circumstances also profit) rises at a higher rate than input. For the consumer or user increasing returns occur where the pay-off stemming from the use of a particular product increases the more users there are (Arthur, 1994). Products introducing a new technology, such as the telephone or a particular operating system for personal computers, are celebrated examples. The basic logic of increasing returns has, however, a much broader scope of application. Arthur (1994) has suggested that it is likely to be operating in systems characterized by high initial set-up costs, increasing effectiveness from learning through use, increasing advantages from others adopting the same option, and adjustment of behaviour to expectations in ways that serve to make projections self-fulfilling. Arguably, these are conditions found at least as often in politics as in markets (Pierson, 2000). In our context there are, though, also other mechanisms that deserve attention. One, which may be labelled increasing costs of reversal, is a very close relative, but highlights potentially important elements that are not explicitly captured by the conventional definition of increasing returns. One such element is the political stakes generated by an actor for himself by increasing commitment to a particular policy or position. Another - and basically different - mechanism is that of internalization of norms and routines. A particular practice can take hold and gain ground as its rules or standards come to be seen as “appropriate”, or a certain routine adopted as the default option, by an increasing number of actors (March and Olsen, 1989).

In classical mechanics, momentum = mass x velocity. This definition can be adapted to the study of politics as well. If we define “mass” in terms of the number of actors weighted by some measure of their relative “weight”, the formula implies that the pressure generated by a certain cause or effort on other actors will increase the greater the aggregate weight of the parties that have already joined and the more rapidly the coalition is growing. A firm deadline can reinforce this effect. We can see the footprints of momentum in a wide range of political processes, including (election) campaigns, negotiations, and the diffusion of policies or practices.

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3 This effect is known also as “network externalities”.

4 Internalization also tends to increase the costs of reversal, so at least part of its effect can be conceptualized in rational choice terms. The basic mechanism itself does, however, involve other psychological processes.
The logic of *cascading failure* is essentially that of momentum reversed. Cascading failure occurs when the collapse of one component of a system shifts its “load” on to other components, thereby bringing one or more of these beyond their functioning capacity. As more components fail, stress on remaining parts increases, leading to additional failures which at some point break the system completely. The scope and strength of these effects depend on properties of the connectivity network (e.g. Watts, 2000). In our context, one example may be a situation where the withdrawal of one or some parties from an established international institution reduces the benefits that can be obtained from that institution for one or more of the remaining parties (or increases their costs of compliance) to the point where they also start withdrawing, thereby tipping the institution over the brink. The same mechanism seems to play an important role in a number of domestic regime shifts as well.

*Escalation* is generally defined as an increase in the intensity of a conflict. Under certain circumstances - notably strong asymmetry of power - escalation by the stronger party may compel the weaker to yield. In more symmetric relationships - particularly those already laden with animosity - an escalatory move often provokes a retaliatory response, leading the parties into a vicious circle of action and reaction. Thus, the dynamics of escalation can transform what began as a relatively benign dispute over modest stakes into a malignant conflict threatening vital interests.

Finally, as known from neo-functional integration theory, the notion of *spill-over* refers to the demand that can be generated by cooperative measures in one area for follow-up measures in some other area(s). This demand is generated by a particular configuration of functional linkages. Spill-over is therefore confined to interconnected fields of policy. Although a less prevalent and effective force in regional integration than initially believed by Ernst B. Haas (1964) and other pioneers, the mechanism is known from other cooperation processes as well (Nye, 1970:804).

To be sure, the evolution of cooperation may be shaped also by mechanisms of *negative* feedback. For example, it is well known that in certain circumstances a contribution made by one party to the provision of a collective good can weaken the incentives of one or more prospective partners to reciprocate (Olson, 1965). As we have noted above, an escalatory move by one party will sometimes compel its opponent to yield rather than retaliate. And students of (regional) integration have long recognized that progress sometimes generates negative “spill-back” rather than positive “spill-over” (Schmitter, 1970).

What these examples have in common is that they highlight mechanisms that are internal to the process of cooperation and therefore largely outside the domain of approaches explaining outcomes in terms of structural statics. In the next section we take a small step towards exploring what one form of connectivity - that of *contingent* behaviour - might add to a static model of multilateral negotiation. In section 4 we provide an
empirical illustration focusing specifically on contingency relationships among key players the global climate change negotiations.

3. Modelling Negotiation: Statics and Dynamics

Imagine the president of a UN conference on some global environmental change problem sitting in her hotel suite pondering how to design a policy programme so that it can be (a) effective, and (b) accepted and implemented by a "sufficient" number of the governments involved. She has carefully studied the conclusions of the panel of natural scientists that have examined the impact of human activities on the biophysical environment, and also the advice offered by a panel of social scientists studying the impact of environmental change on human welfare and the costs and benefits of alternative policy options. She has listened - patiently - to the statements made by a large number of delegations. By now she has a fairly clear idea about what should be done; the remaining question is how to design a solution so that it can also be adopted and implemented. If called upon to offer advice, how would we go about diagnosing the situation in those terms and exploring alternative options? Do we have a model that could help us (and her) determine the political feasibility of alternative options and the shape of the settlement range?

3.1 Negotiation statics

Most simply, the task of determining the settlement range can be described as one of feeding alternative policy options into a particular negotiation system and predicting what will come out of the process that is thereby generated (see figure 3.1).

*Figure 3.1: Determining political feasibility: a simple flowchart.*

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5 The settlement range includes the set of options that meet the minimal requirements of being politically feasible. This set might, of course, be empty.
A model of negotiation must, accordingly, include at least four basic elements:

- a set of **policy options**, described in terms of the properties by which they are evaluated by the actors themselves;
- a **negotiation system**, consisting of an institutional framework and a set of actors, each with certain preferences and a certain power base;
- a **negotiation process**, through which actor preferences and positions are articulated, modified, and aggregated; and
- an **outcome**, for each option most simply described in dichotomous terms (feasible vs. not feasible).

The process component is marked with dotted lines to indicate that we begin this section by modelling outcomes as a function of features of policy options and the negotiation system only. In subsection 3.2 we open the “black box” and begin exploring what might be gained by extending the analysis to include also process mechanisms. This extension is limited to one form of connectivity - contingency relationships.

**Policy options**

For our purposes, policy options must be described in terms of the properties by which they are evaluated. An in-depth study of the global climate change negotiations would almost certainly show that governments use multiple, and to some extent also different, criteria. Prominent among these criteria are, though, likely to be national economic welfare and a set of normative principles.

The impact of climate change policy on economic welfare is a function of damage costs (i.e. the welfare loss caused by environmental damage), mitigation costs (i.e. the costs of avoiding such damage), and adaptation costs (i.e. the costs of adapting to environmental change). The risk that human behaviour can inadvertently affect the global climate system also raises a number of ethical and other normative concerns. Particularly central to the international negotiations seem to be concerns about the distribution of costs and benefits. At least three distinct ideas of distributive fairness are invoked. One is the simple norm of *equal* rights and obligations. We assume that this norm serves as the default option, leaving the burden of proof with anyone who would argue that circumstances are such that it cannot legitimately be applied. Such circumstances are, though, recognized to exist in this case, and when they do the norm of equality yields (first), we assume, to the norm of *equity*. There are several more precise principles of equity, but the common denominator is the idea that the distribution of costs or benefits ought to be (at least roughly) *proportional to* some important differentiating feature of the
issue or the parties involved. In the context of global environmental change, this idea seems to translate into at least four specific principles, summarized in table 3.1 (Ringius et al., 2002).

Table 3.1: Main principles of equity in global environmental change negotiations.

<table>
<thead>
<tr>
<th>Perspective</th>
<th>Object to be distributed</th>
<th>Benefits</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause of problem</td>
<td>Contribution to problem-solving</td>
<td>Guilt in causing the problem</td>
<td></td>
</tr>
<tr>
<td>Consequence</td>
<td>Need</td>
<td>Capacity to contribute</td>
<td></td>
</tr>
</tbody>
</table>

In cases of extreme inequality, the idea that costs be distributed in proportion to responsibility or capacity seems to yield to the principle of *exemption*, saying - in essence - that countries below a certain poverty line have no obligation whatsoever to contribute, unless fully compensated for the costs involved.

These three norms of fairness seem to have different *domains* or scopes of validity, as indicated in table 3.2.

Table 3.2: Domains of different norms of distributive fairness.

<table>
<thead>
<tr>
<th>Basic norm</th>
<th>Domain (scope of validity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal obligations</td>
<td>Difference among actors &lt; x</td>
</tr>
<tr>
<td>Equity (∼ proportionality)</td>
<td>x ≤ difference ≤ y</td>
</tr>
<tr>
<td>Exemption (from any obligation whatsoever)</td>
<td>Difference &gt; y</td>
</tr>
</tbody>
</table>

The negotiation system

The negotiation system consists of an institutional setting and a set of actors. The institutional setting can be described by answering the question: *who* are to decide on *what*, *when*, and *how*? In other words, it identifies a set of participants (or specifies rules of access), formulates an official purpose and sets an agenda, and specifies “the rules of the game” (of which the decision rule - agreement - is the most important).

Actors have to be characterized in terms of at least two features: *preferences* and *power*. We have already assumed that governments evaluate policy options in terms of two main criteria: impact on national economic welfare, and correspondence with salient norms of distributive fairness. It remains, however, to determine how these criteria are combined. We know of no straightforward method for transforming such basically different criteria into one integrated measure of value. Nor do we have evidence suggesting that governments normally pursue such a “synoptic” approach in dealing with complex problems. Poliheuristic theory seems to hit closer to the mark, arguing that decision-makers typically proceed in two steps - relying first on
cognitive heuristics to narrow the menu for choice, then on rational calculation of costs and benefits to choose among remaining options (Mintz, 2004; see also Below, 2008). Building on this proposition, we propose to use one of the criteria as a **filter** determining the range within which the other is permitted to rule. Since economic welfare seems more conducible to calculation in cost-benefit terms, we use norms as a filter blocking policy options that are “unfair”. Options that pass this filter are then evaluated in terms of impact on national economic welfare only.

Consider, next, how we might conceptualize and measure **power**. For the purpose of determining the settlement range it is sufficient to identify **pivotal** actors and coalitions of actors. Where the decision rule is agreement, only options that satisfy the minimal requirements of all pivotal parties and coalitions of parties are politically feasible. There are, however, at least two reasons why we may want to go beyond the confines of this simple recipe. One is that once we introduce the notion of pivotal **combinations** of actors, we need to assign weights to parties who – although not pivotal in their own right – are plausible members of such combinations. The other is that a first screening will often leave us with two or more options that satisfy the minimal requirements. In such cases we may want to determine which of these options is most likely to be adopted. For that purpose we need a more refined measure of power.

Such a concept has been developed by Coleman (1973; see also Bacharach & Lawler, 1981). Coleman conceived of one actor's direct power over another as a function of its relative control over events (goods) important to the latter. In the context of a bilateral relationship, we can thus express A's direct power over B with regard to a particular event or issue \((i)\) in the simple formula

\[
K^{i,a} \cdot U^{b,i}
\]

where \(K^{i,a}\) is A's share of control over issue \(i\) \((0 \leq K^{i,a} \leq 1)\), and \(U^{b,i}\) is the relative interest of actor B in the outcome of the same issue \((0 \leq U^{b,i} \leq 1)\).

To be able to use this formula in empirical research, we must transform it into an operational tool. A first step would be to determine what constitute the critical “events” over which we want to measure control. In the global climate change case, the obvious categories are greenhouse gas emissions and sequestration. Everything else the same, the larger a country's emissions, the more important becomes its participation in an agreement to reduce emissions. Large emissions are, then, a major source of power to block mitigation measures. Similarly, the more a country contributes or can contribute to sequestration, the more important it becomes to any policy for the preservation or build-up of sinks. A measure of power should include also other “positive” capabilities, such as
the size of a country's R&D establishment. A second step would be to determine how to measure “control”. The most simple solution would be to say that a government controls what falls under its formal jurisdiction.6

Determining feasibility - the basic operations

Now that we have defined the main elements, time has come to summarize the main tasks involved in constructing the type of model sketched above. Table 3.3 describes the main steps involved in determining each of three main components: interests, norms, and power. Table 3.4 provides a summary description of how the three components may be combined – within the parameters of a given institutional setting – to determine which policy options are feasible, and which stands the best chance of being selected as “the solution”.

6 In an earlier paper, Underdal (1998) suggested a very crude formula combining “negative” and “positive” aspects of power as follows:

\[ M_i = \left[ e_i + (\text{gdp}_i \cdot \text{w}_i) \right]/2, \]

where \( M_i \) is the relative power of country \( i \), \( e_i \) is \( i \)'s share of global emissions (present and projected), \( \text{gdp}_i \) is its GDP in per cent of total world product, and \( \text{w}_i \) is its relative wealth (measured as gdp/capita in per cent of gdp/capita for the richest country in the world). The power vectors calculated according to this formula range from a figure slightly higher than zero to .22 (for the US, adjusted as described in table 2.3).
Table 3.3: Mapping interests, norms, and power: the main steps.

<table>
<thead>
<tr>
<th>Path 1: Interests</th>
<th>Path 2: Norms</th>
<th>Path 3: Power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1:</strong> Identify a (limited) set of policy options to be examined</td>
<td><strong>Step 2:</strong> Estimate damage and mitigation costs for each of these options for each country</td>
<td><strong>Step 1:</strong> Compute power vectors for each state or coalition of states, and adjust so that the sum of vectors for all states = 1.00.</td>
</tr>
<tr>
<td><strong>Step 2:</strong> Calculate the relative attractiveness of each policy option for each actor:</td>
<td></td>
<td><strong>Step 2:</strong> For each option: identify states and coalitions of states that are pivotal - directly or indirectly.(^7)</td>
</tr>
<tr>
<td>(a) Identify the best solution within the set. The relative attractiveness of this option = 1.00.</td>
<td></td>
<td><strong>Step 3:</strong> Specify the relationship between or among these norms, in terms of domains or relative weight</td>
</tr>
<tr>
<td>(b) Determine the value of the non-cooperative outcome (relative attractiveness = 0).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Calculate the relative attractiveness of all other options as a fraction of the difference between a and b (0\leq U_j\leq 1).(^8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3:</strong> If used as filter:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) specify minimal requirements, and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) determine which policy options “pass”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^7\) Note that for this purpose we will need a map of contingencies.

\(^8\) Options with relative attractiveness scores < 0 are eliminated at this stage.
Table 3.4: Combining interests, norms, and power to derive outcomes.

Step 1:
Combining interests and norms to determine preferences:
Eliminate options that do not satisfy normative filter values (minimum requirements)
Evaluate remaining options in terms of impact on national welfare

Step 2:
Combining preferences and power:
In determining the political feasibility of a particular option, \( O_j \),
(a) determine the critical minimum of participants or contributions required to accomplish that solution \( (kO_j) \);
(b) eliminate any actor(s) for whom that option is inferior to the non-cooperative outcome; and
(c) determine whether the remaining set of participants or contributions \( \geq kO_j \)

Step 3:
In determining the settlement range, eliminate options that are inferior to the non-cooperative outcome for any actor that is directly or indirectly pivotal.

Step 4:
Eliminate Pareto-inferior options from the settlement range.
Remaining options make up the contract zone.

Step 5:
To determine the outcome:
calculate the relative strength of each option in the contract zone, and derive the outcome by weighting these options for their relative strength. The steps involved may be specified as follows:

The strength of an option, \( j \) (\( SO_j \)) is a function of the extent to which it satisfies the interests and values of powerful actors:

\[
(1) \quad SO_j = \sum_{i=1}^{\infty} [U(O_j)V_i],
\]

where \( U(O_j) \) = the relative value of option \( j \) for actor \( i \), and
\( V_i = \) the relative power ('weight') of actor \( i \)

Compute, next, the relative strength of option \( j \) (\( WO_j \)) as a fraction of the aggregate strength of all options:

\[
(2) \quad WO_j = \frac{SO_j}{\sum SO_i},
\]

With continuous options, we may now compute the outcome of a negotiation process \( (R_n) \) as a weighted aggregate of all options in the contract zone:

\[
(3) \quad R_n = \sum O_i WO_i
\]

\footnote{To be sure, there are also other approaches to be considered, see e.g. Bueno de Mesquita (2000).}
With non-continuous (discrete) options, the outcome may be derived as follows:

(a) Any option which is ‘stronger’ than all competitors taken together (measured as $W>.50$) wins, unless it is an extreme position;

(b) In all other circumstances, the option closest to the result derived for continuous options ($R_i$) wins.

3.2 From statics to dynamics

In the preceding section we have seen the fate of policy options as being determined by the configuration of preferences, the distribution of power, and the decision rule.\(^\text{10}\) We have left no role for the negotiation process to make an impact on its own. We now open that black box and take a first small step towards exploring the role of process dynamics. As indicated in section 2, multiple process mechanisms are likely to be at work, but in this section we limit the analysis to connectivity in the form of contingency relationships.

In the static version, each actor ascribes a certain value to each policy option. These options differ not merely in terms of an actor’s own contribution but also in terms of contributions to be made by one or more of the other parties. In ascribing value to a particular option, most actors are likely to consider both of these aspects, and their own willingness to contribute may well be contingent on what others do.\(^\text{11}\) In such a setting, a map of contingency relationships could help us distinguish solutions that are politically feasible from those that are not. Perhaps more importantly, it could help us find behavioural strategies and pathways that can lead to the adoption and implementation of one of these solutions.

Moreover, as defined above the essence of power is the capacity to change the availability and value of particular options for other parties. A powerful actor may control resources that are necessary to accomplish a particular project. More often, however, an actor exerts power by changing incentives; more precisely, the value of one or more of the options available to other parties. Thus, power gives an actor the capability of influencing the terms of cooperation. If agreement is reached, we would expect the “exchange rate” for contributions to reflect the distribution of power.\(^\text{12}\)

\(^{10}\) More precisely, the distribution of power over the configuration of preferences, and the decision rule.

\(^{11}\) In the case of climate change, the main benefits of mitigation measures are determined by the sum total of contributions. The costs of mitigation measures for a particular country may, however, depend also on who contributes what. For example, in an open economy a country may have sound reasons for being particularly sensitive to contributions - and even more to the lack of contributions - from its main competitors.

\(^{12}\) Agreement may be defined as an exchange of conditional promises (see Iklé, 1964:7).
If all actors had identical and perfectly accurate maps of the contingency web, the fact that at least some of them pursue strategies of conditional cooperation would not pose an insurmountable problem to the modelling of negotiations in a static framework. In complex multilateral negotiations, however, we may safely assume that the “maps” drawn up by the participating delegations are neither perfectly accurate nor fully identical. In trying to map contingency relationships an actor faces several problems. One is that at least some governments are likely to see tactical reasons for not (immediately) revealing their true preferences. Contingencies will therefore to some extent be private information. Another problem stems from the complexity of multilateral negotiations. In a conference with 165 participating states, there are more than 27,000 bilateral relationships and an even larger number of multilateral constellations. Most governments will, of course, take a direct interest in only a tiny subset. Yet, even for a government concerned about contributions from only a handful of important others, the analysis may become quite complex as a number of different scenarios - including indirect as well as direct effects - would have to be considered. Given this complexity, most governments are likely to enter negotiations with predefined positions on only a subset of possible solutions involving contributions from important others. If required as the negotiations develop, a government will take positions on other salient option(s) as well, but until it does those positions may well be unknown not merely to other parties but also to itself! Third, even if accurate and reliable information on relevant contingency relationships were available, the behavioural implications may not at all be straightforward and clear. A contingency web may well be inconclusive, leaving several actors with a genuine dilemma as to - for example - when to move and how much to offer. The larger the number of actors and the more complex the problem, the wider is likely to be this range of indeterminacy.

Last, but perhaps even more important: as the Conference President perfectly well understands, her task is not merely one of designing a substantive solution that meets the minimal requirements of all (pivotal) parties and describing this solution to the conference plenary. It is as much a matter of working with key players to find a path that can lead to the adoption and subsequent implementation of that programme. This path consists of a connected set - perhaps a particular sequence - of moves by various governments. Finding such a path is likely to require not merely an accurate contingency map but also a good understanding of how different process mechanisms can interact in shaping trajectories and outcomes. And walking that path with, say, a hundred governments falling in line requires careful orchestration. A static model of negotiation cannot alone provide the kind of insight required for these tasks. “Process engineering” requires that we can identify important process mechanisms and understand how they work. Moreover, it requires systematic and transparent analysis

In particular, indirect links may require extension and perhaps multiple iterations. Assume that party A’s willingness to contribute is contingent on a certain contribution from party B, and vice versa. Assume, furthermore, that the willingness of B to contribute depends also on contributions from parties C and D, and that C requires contributions not merely from B but also from A, E, and F. What seemed at first to be a simple and symmetrical bilateral relationship now leads into a complex web of (asymmetrical) linkages.
of alternative scenarios. We have a long way to go before we can claim to be able to meet these requirements well. Yet, some progress is being made in improving our understanding of some of the mechanisms at work. Moreover, the methodological repertoire of social science provides tools that can be used for rigorous analysis of process dynamics (see e.g. Axelrod, 1997).

We now move on to demonstrate how a particular set of tools may be used to study contingency relationships in the global climate change negotiations. More specifically, we ask whether and to what extent (commitment to) mitigation measures by one of the key players affect the incentives of others to contribute. To determine the political significance of such contingency effects we apply a crude three-level scale. At the bottom level are moves that change the value ascribed to one or more options by other parties so that the distance between options decreases or increases. At this level there is, however, no change in the settlement range nor in the ranking of alternatives. At level 2 are moves that affect the shape of the settlement range but leave the ranking intact. Here, our interest pertains particularly to moves that bring one or more cooperative measures into the settlement range. At level 3 the ranking is also changed. Particularly significant is change in the most preferred outcome, and in the ranking of cooperative solutions relative to non-cooperative options.

4. An Empirical Illustration: Contingencies in the Global Climate Change Negotiations

In this section we present a series of simulations exploring contingencies within a small group of important actors: the European Union, the United States, China, and India. Our main question is whether and to what extent the commitments made by the EU to cut greenhouse gas emissions can induce the US to reciprocate by agreeing to reduce its own emissions below the business-as-usual (BAU) trajectory for the period after 2012. We also examine other contingency relationships within this group. The simulations were carried out using a multi-sector and multi-region, inter-temporal, computable general equilibrium model, known under the acronym of DEEP. Further details are provided in the appendix, but it is important to note that the model measures contingencies only in terms of mitigation costs. Damage costs avoided through mitigation measures are not included.14

4.1 EU commitments and US responses

14 For the purposes of this paper, the model was set up with the following “regions”: The United States (17.3 %), China (10.4 %), EU (11.1 %), Russia (4.9 %), India (3.5 %), Japan (2.8 %), Rest of Annex I (4.8 %) and Rest of World (45.2 %). The numbers in parentheses are the regions’ share of global emissions of fossil fuel CO₂ in 2007, as estimated in the model. The sectoral aggregation in the model is coal, refined oil, oil, gas, electricity, capital good and “other”. The scenarios have used economic growth technological improvement rates from SRES A1B (IMAGE). Note that the scenarios include CO₂ emissions only.
We first ran simulations for six scenarios defined by a two-dimensional matrix (see table 4.1):

- The first dimension is emission reductions by the EU and other Annex I countries that have ratified the Kyoto Protocol. These countries are assumed to cut emissions by either 20% or 30% from 2000 levels by 2020. These two options correspond roughly to the EU goals set in March 2007, when the EU committed itself to reducing greenhouse gas emissions by at least 20% from 1990 levels by 2020, and offered a 30% reduction if other developed countries (the United States in particular) agree to join in. The difference is (1) that we use the year 2000 rather than 1990 as baseline, and (2) that our estimates assume that the EU will be followed by all other Annex I countries except the US.

- The second dimension is emissions reductions undertaken by the United States. The options we consider for the US are (1) business as usual (BAU), (2) stabilization of emissions at the 2000 level by 2020, and (3) a 10% reduction from the 2000 level by 2020.

<table>
<thead>
<tr>
<th></th>
<th>EU -20%</th>
<th>EU -30%</th>
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</thead>
<tbody>
<tr>
<td>US BAU</td>
<td></td>
<td></td>
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<tr>
<td>US stabilization</td>
<td></td>
<td></td>
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<tr>
<td>US -10%</td>
<td></td>
<td></td>
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</tbody>
</table>

*Table 4.1: The six scenarios.*

We assume that the emission targets for 2020 are reached through two four-year agreements (for 2013-2016 and 2017-2020 respectively). Also, we assume that each “party’s” emissions target for the 2013-2016 period will be the average of its Kyoto target and its target for 2020.

The results of these simulations are presented in tables 4.2 - 4.4. Table 4.2 shows permit prices per ton \( \text{CO}_2 \) in US$1997 for each of the six scenarios, and table 4.3 shows global emissions reductions.

<table>
<thead>
<tr>
<th></th>
<th>EU -20%</th>
<th>EU -30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>US BAU</td>
<td>35.7</td>
<td>51.1</td>
</tr>
<tr>
<td>US stabilization</td>
<td>18.4</td>
<td>23.5</td>
</tr>
<tr>
<td>US -10%</td>
<td>22.1</td>
<td>28.0</td>
</tr>
</tbody>
</table>

*Table 4.2: Permit prices (assumes emissions trading among all parties).*
Table 4.3: Global emissions reductions for 2013-2020 when carbon leakage - i.e., increase above BAU in non-participating countries - is accounted for.

<table>
<thead>
<tr>
<th></th>
<th>EU -20%</th>
<th>EU -30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>US BAU</td>
<td>0.301 %</td>
<td>0.367 %</td>
</tr>
<tr>
<td>US stabilization</td>
<td>-0.029 %</td>
<td>-0.019 %</td>
</tr>
<tr>
<td>US -10%</td>
<td>-0.081 %</td>
<td>-0.081 %</td>
</tr>
</tbody>
</table>

Table 4.4: Welfare changes for the US (equivalent variation)

Now, if the US were to cut by 10% and the EU (with followers) by 30%, global emissions would be 10.3% lower than baseline (which is no commitments beyond 2012). If the US continues along its BAU path and the EU cuts by 20%, global emissions will be only 4.8% below that baseline. This is a non-trivial difference. If the EU can credibly make its commitment to reduce by 30% contingent on US cooperation, the US will have to consider the costs and benefits of reducing its own emissions by 10% (~32% below BAU) in exchange for emission cuts elsewhere that will reduce global emissions by an additional 5.5 percentage points. We may safely assume that this link will reduce the distance between BAU and the cooperative option, but the model used here does not enable us to determine the size of this effect.

4.2 Commitments by China and India

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15 Equivalent variation is calculated for the full model horizon (1997-2020).
One of President Bush’s reasons for repudiating the Kyoto protocol was that it leaves developing countries free to increase their emissions. What difference would it make for the US if China and India were to take on binding emission reduction commitments? We premise our answer to this question on the assumption that if the EU (and followers) reduce emissions by 20% by 2020, China and India will restrict themselves to doubling their emissions from the 2000 level.\textsuperscript{16} If the EU cuts emissions by 30% by 2020, we assume that China and India restrict themselves to an increase of only 75% from the 2000 level. With these assumptions, we get the results shown in tables 4.2B through 4.4B.

<table>
<thead>
<tr>
<th></th>
<th>EU -20%, China &amp; India +100%</th>
<th>EU -30%, China &amp; India +75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA BAU</td>
<td>9.3</td>
<td>15.7</td>
</tr>
<tr>
<td>USA stabilization</td>
<td>7.8</td>
<td>11.9</td>
</tr>
<tr>
<td>USA -10%</td>
<td>9.0</td>
<td>13.6</td>
</tr>
</tbody>
</table>

*Table 4.2B: Permit prices (assumes emissions trading among all parties)*

Comparing tables 4.2 and 4.2B we can see that permit prices are much lower when China and India both join. This is partly because (marginal) abatement costs are lower in these countries, and partly because their commitments are less stringent than those of the rich countries. Comparing tables 4.3 and 4.3B we see that including China and India entails a relatively modest increase in global mitigation. The explanation is simply that the reductions stipulated by China and India are quite moderate (about -18% compared to BAU). However, our simulations suggest that including China and India would lead to a significant reduction in carbon leakage (not reported here). The flip side of the coin is that in the first set of scenarios much of the carbon leakage goes to these two countries.

<table>
<thead>
<tr>
<th></th>
<th>EU -20%, China &amp; India +100%</th>
<th>EU -30%, China &amp; India +75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>US BAU</td>
<td>8.5 %</td>
<td>10.4 %</td>
</tr>
<tr>
<td>US stabilization</td>
<td>11.3 %</td>
<td>13.5 %</td>
</tr>
<tr>
<td>US -10%</td>
<td>12.0 %</td>
<td>14.2 %</td>
</tr>
</tbody>
</table>

*Table 4.3B: Global emissions reductions when carbon leakage is accounted for (increase above BAU in non-participating countries divided by reductions in participating countries)*

\textsuperscript{16} By comparison, the business as usual scenarios lead to emission levels 243% above 2000 levels for both China and India.
The results reported in table 4.4B show (unsurprisingly) that the United States is better off when also China and India accept binding commitments. While US national welfare would still be best served by sticking to the BAU option, all the cooperative options included now yield positive outcomes. This suggests that if other countries could credibly threaten to do nothing unless the US contributes, the US would gain by cooperating. This holds true even for the most stringent emission control options examined in these scenarios.

<table>
<thead>
<tr>
<th></th>
<th>EU -20%, China &amp; India +100%</th>
<th>EU -30%, China &amp; India +75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>US BAU</td>
<td>0.204 %</td>
<td>0.292 %</td>
</tr>
<tr>
<td>US stabilization</td>
<td>0.045 %</td>
<td>0.062 %</td>
</tr>
<tr>
<td>US -10%</td>
<td>0.027 %</td>
<td>0.035 %</td>
</tr>
</tbody>
</table>

*Table 4.4B: Welfare changes for the US (equivalent variation)*

4.3 Incentives for the EU

What are the welfare effects for the EU itself of its current climate policy? Tables 4.5 and 4.5B show EU welfare changes compared to BAU in the six scenarios, with (table 4.5) and without (table 4.5B) commitments by China and India.

<table>
<thead>
<tr>
<th></th>
<th>EU -20%</th>
<th>EU -30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>US BAU</td>
<td>-0.678 %</td>
<td>-0.944 %</td>
</tr>
<tr>
<td>US stabilization</td>
<td>-0.163 %</td>
<td>-0.237 %</td>
</tr>
<tr>
<td>US -10%</td>
<td>-0.186 %</td>
<td>-0.273 %</td>
</tr>
</tbody>
</table>

*Table 4.5: Welfare changes for the EU (equivalent variation) when China and India do not participate.*

Table 4.5 shows that the EU suffers a welfare loss from implementing its own policy program. However, given that the EU is willing to make significant cuts, it would make sense to increase its target from -20% to -30% provided that doing so will induce the US to participate (and assuming that other Annex I countries follow the EU).

17 Recall, though, that benefits in the form of damage avoided through mitigation are not included in the calculations.

18 It might seem surprising that the welfare loss for the EU is larger when the US cuts its emissions by 10% than when it adopts the less ambitious target of stabilization. The explanation is that a more ambitious US target will increase the permit price, which leads to higher mitigation costs also for the EU. The ranking of these options may well have been different had...
EU -20%, China & India +100%  EU -30%, China & India +75%

<table>
<thead>
<tr>
<th></th>
<th>EU -20%, USA BAU</th>
<th>EU -30%, USA -10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>US BAU</td>
<td>-0.095 %</td>
<td>-0.168 %</td>
</tr>
<tr>
<td>US stabilization</td>
<td>0.053 %</td>
<td>0.055 %</td>
</tr>
<tr>
<td>US -10%</td>
<td>0.061 %</td>
<td>0.057 %</td>
</tr>
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</table>

Table 4.5B: Welfare changes for the EU (equivalent variation) when China and India participate.

Table 4.5B shows that commitments by China and India would affect the EU ranking of options only in case the US cuts its emissions by 10%. It would, however, reduce the welfare loss in adopting the more ambitious target of 30%, and yield positive outcomes for all options in which the US cooperates.

4.4 Incentives for China and India

Finally, we consider the incentives faced by China and India. Table 4.6 shows welfare changes (equivalent variation) for China in six scenarios. These scenarios include three options for China and India: 1) sticking to BAU, 2) restricting emissions growth to 100% from the 2000 level, and 3) restricting emissions growth to 75% from the 2000 level. Furthermore, we now assume that the EU (and followers) cut emissions by 20% by 2020 if the US continues BAU, and by 30% if the United States cuts its emissions by 10%. We already have the scenarios required for four of these combinations, so the only new scenarios are (1) China and India restricting emissions growth to +75% while the EU cuts by 20% and the US sticks to BAU, and (2) China and India restricting emissions growth to +100% while the EU cuts by 30% and the US by 10%.

Table 4.6: Welfare changes for China (equivalent variation)

Table 4.6 shows that China obtains significant economic benefits from sticking to its BAU option while the EU and followers reduce their emissions. China’s benefits are particularly significant if also the US joins in.

we been able to include damage costs avoided in the equation.
Moreover, both of the emission control options included in the table yield sizable welfare costs for China. These costs are, though, lower when rich countries reduce more rather than less.\textsuperscript{19}

<table>
<thead>
<tr>
<th></th>
<th>EU -20%, US BAU</th>
<th>EU -30%, US -10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>India BAU</td>
<td>0,721 %</td>
<td>0,954 %</td>
</tr>
<tr>
<td>India +100%</td>
<td>-0,239 %</td>
<td>-0,046 %</td>
</tr>
<tr>
<td>India +75%</td>
<td>-0,453 %</td>
<td>-0,237 %</td>
</tr>
</tbody>
</table>

\textit{Table 4.7:} Welfare changes for India (equivalent variation).

Table 4.7 shows that the welfare changes for India are similar to those reported for China. The benefits of continuing BAU are, though, larger while the costs of emission control measures are lower. Interestingly, if India and China were to restrict emissions growth to 100%, India would benefit (slightly) from an agreement in which the two countries adopt the more ambitious target of +75\% \textit{in return for} the EU (with followers) and the US both accepting their most stringent options.

4.5 Concluding observations

Four observations stand out from this first series of simulations. First, even the largest parties are sensitive to what others do. Contributions from other parties often change the difference in welfare between cooperative and non-cooperative options, and sometimes move cooperative options into the settlement range. More rarely, at least in our simulations, do they change a party’s \textit{ranking} of options. Second, all parties included stand to gain from (more stringent) emission control measures taken by other actors. This is basically good news, implying - inter alia - that the US can increase its national welfare by paying at least a small price to ensure more stringent control measures from the EU (and from other important actors such as China and India as well).\textsuperscript{20} There must exist also other scenarios than those explored above in which the US would enhance its economic welfare by responding positively to the EU contingency. We will be able to say more about these scenarios as we extend the analysis to include also damage costs avoided through mitigation. Third, the contingency component of current

\textsuperscript{19} Note that in this simulation we have assumed aggregate \textit{national} targets with international emissions trading. Alternative types of targets, such as a per-capita-convergence target, may well reduce China’s costs of joining substantially.

\textsuperscript{20} In fact, this applies to \textit{all} actors in this group. Also China and India stand to benefit from mitigation measures taken by, inter alia, the EU and the US, and could - by the same logic - benefit from making contributions that could \textit{trigger} such measures. More in-depth analysis of contingency relationships is required to determine whether such “trigger” options are in fact available (and, if so, what exactly would be required).
EU climate change policy makes good sense from an economic point of view. Given that reducing emissions by 30% would induce the United States to adopt a target of -10%, the EU stands to gain by moving its own target from -20% to -30%. Fourth, the latter observation holds only if the EU contingency is fully credible. If the US expects the EU to cut emissions by 30% regardless of whether the US itself contributes, then the US would expect to be better off by continuing business as usual. Well-intentioned environmental activists urging the EU to make an unconditional commitment to a more ambitious target might - inadvertently - undermine a linkage that may provide an important tool for breaking the current stalemate. In dealing with global collective goods, contingencies are not merely part of the problem but also an important ingredient of effective and feasible solutions.

5. The Questions Revisited

Pointing out that this is an early report from work in progress - exploring questions rather than providing conclusions - we began this paper by raising two main questions. First, can additional insights be gained by studying cooperation as a process rather than as a state? Second, how might we go about studying the dynamics of cooperation processes in a systematic and rigorous manner? What can be said with confidence at this stage is that the answer to our first question is positive. In particular, the study of cooperation as an evolving sequence of events may help in charting pathways that can lead to the adoption and implementation of cooperative solutions. With regard to the second question, we may safely conclude that the study of cooperation-as-process offers distinct roles to different modes of research - ranging from empirical process-tracing to computer-based simulations (including simulations employing tools that we have not used here, such as evolutionary game theory or agent-based modelling). We are currently planning future work to develop both the general framework and our computer simulations of contingency webs in international environmental governance, and we do so in the context of a more comprehensive project involving several European colleagues.
Appendix: The DEEP model

The DEEP model consists of five main elements: Production sectors, emissions trading, an Armington aggregation of domestic and imported goods, a capital and an investment sector, and a representative agent.

The structure of production and demand has been adopted - with some modifications - from the GTAP-EG model by Rutherford and Paltsev (2000). Production is described using two different production functions, one for fossil fuel production, and one for non-fossil fuel production.

Fossil fuel production is a CES-function that includes crude oil, gas and coal. Fossil fuels are produced as an aggregate of a resource and a non-resource input. Non-fossil fuel goods are produced with fixed-coefficient (Leontief) inputs of intermediate non-energy goods and an energy-primary factor composite.

Emissions trading is assumed to be comprehensive (i.e. all sectors take part in emissions trading) and fully competitive. Emissions are modelled as a fixed share input of permits in both production and final demand (more technically, it is implemented as a Leontief technology composite of fossil fuel inputs and permits).

The regions are linked through bilateral trade flows. All goods, except the primary factors (labour and capital) and the investment good, can be traded among the regions. The model assumes that goods produced in different countries are not identical (the ‘Armington assumption’). The importing of goods takes place in a separate ‘Armington’ sector. The elasticity of substitution between domestic and imported goods is 4, while the elasticity of substitution among imports from different regions is 8. Each bilateral trade flow requires its own transportation service (with the exception of emission permits). This is modelled as a Leontief technology between the imported good and the transportation good. The transportation margins are proportional to quantities traded.

The representative agent, which is both consumer and government, demands only the consumption good. This good is a constant elasticity aggregate of non-energy goods and energy goods. To pay for this good, the agent is endowed with labour and capital. The labour endowment grows for each year, at the same rate as the growth parameter, while capital is given as an initial capital stock. The representative agent collects all taxes and tariffs specified in the model. The agent is also endowed with emission permits – if the region is assumed to be taking part in a climate agreement. The agent uses the tax revenue and income from endowments to purchase the consumption good or pay for investment. While the agent gets utility
only from the consumption good, investment is driven by the returns to capital generated in the next period, and a terminal capital constraint.

The structures of the capital and investment sectors are straightforward. The capital sector converts the initial capital stock into returns to capital, and next-period capital stock. The return to capital is determined by the interest rate, while the next-period capital stock is equal to the initial capital stock less depreciation. Investment takes place through the production of an investment good (with the same production structure as other non-fossil fuel goods). The output from the investment is next-period capital stock.

The model is an intertemporal model with a utility maximising representative agent. Investment (growth) is endogenous, but investment is not determined, as in many other models, through a time preference rate or savings rate. Instead the time preference rate is implied through an equilibrium growth parameter that defines a growth rate that is optimal for the original equilibrium (baseline). Investment (and thus growth) will vary between the scenarios as the representative agent seeks to maximise utility under the new conditions (the intertemporal elasticity of substitution is 0.5). The equilibrium growth parameter is differentiated between regions and time periods.

The economic data used is the GTAP (v5.4) data base - which provides input-output data for each region, bilateral trade data, and information on taxes and tariffs. These taxes and tariffs are used in the DEEP model. The emissions data are taken from the GTAP/EPA Project “Towards an Integrated Data Base for Assessing the Potential for Greenhouse Gas Mitigation”.

Further details can be found in Kallbekken (2004).

References


