Efficient Self-Coordination in Policy Networks. A Simulation Study

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Abstract

The paper begins with a reexamination of claims regarding the welfare-theoretical efficiency of various modes of non-hierarchical policy coordination which Charles Lindblom (1965) had subsumed under the label of "Partisan Mutual Adjustment". It is argued that these claims are implausible if Lindblom's mechanisms of horizontal self-coordination are examined one at a time. They either will not assure significant welfare gains in the general case, or the attempt to raise the level of general welfare through self-coordination will encounter rapidly escalating transaction costs. As Lindblom had pointed out, however, several coordination methods will often be combined in real-world policy processes. The intuition that this might significantly increase the welfare efficiency of self-coordination is explored in a computer simulation study based on the game-theoretical reformulation of five simple coordination mechanisms. We can show that, in a given population of interdependent actors, "Positive Coordination" within relatively small coalitions who are required to obtain the agreement of outside actors through "Negative Coordination" and "Bargaining", are able to achieve relatively high welfare gains while economizing on transaction costs. This pattern is by no means unusual in real-world policy processes.

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Der Aufsatz untersucht die Plausibilität von Behauptungen über die wohlfahrtstheoretische Effizienz von Methoden der nicht-hierarchischen Koordination politisch-administrativer Akteure, die Charles Lindblom (1965) unter dem Sammelbegriff des "Partisan Mutual Adjustment" zusammengefaßt hatte. Für jede einzelne dieser Methoden, so kann gezeigt werden, ist dieser Anspruch nicht generell zu begründen. Entweder können unter allgemeinen Bedingungen nur geringe Wohlfahrtsgewinne erzielt werden, oder die Koordination scheitert an eskalierenden Transaktionskosten. Allerdings hatte schon Lindblom darauf hingewiesen, daß in realen Politikprozessen typischerweise mehrere Koordinationsmethoden zugleich zum Zuge kommen. Die Vermutung, daß gerade dadurch die Wohlfahrts-Effizienz der horizontalen Selbstkoordination gesteigert werden könnte, wird hier in einer Computer-Simulationsstudie überprüft. Ausgehend von einer spieltheoretischen Rekonstruktion von fünf einfachen Koordinationsmechanismen kann gezeigt werden, daß insbesondere die Kombination von "Positiver Koordination" mit "Negativer Koordination" und mit "Bargaining" eine hohe Wohlfahrtseffizienz erreicht. Wenn die Mitglieder relativ kleiner Koalitionen sich intern positiv koordinieren, aber die Zustimmung der übrigen Mitglieder einer Population von interdependenten Akteuren durch Negativkoordination und Bargaining gewinnen müssen, dann können relativ hohe Wohlfahrtsgewinne bei moderaten Transaktionskosten erwartet werden. Eben dieses Muster läßt sich auch in realen Prozessen der Politikformulierung und Implementation wiederfinden.

Contents*

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1 The Promise of Self-Coordination

Normative theories of representative democracy generally presuppose hierarchical governance. Democratic accountability seems to require that policy choices should originate from a unitary government (or a presidency) that is legitimated through competitive general elections, that they should be ratified by majority decisions in parliament, and that they should then be implemented by a disciplined bureaucracy relying on the superior force of the state and using resources collected through general taxation. By holding the governing hierarchy accountable to the *general* electorate, and by minimizing the direct influence of special interests on any phase of the policy process, the democratic process is supposed to produce policy outcomes that will maximize the *general welfare* of the polity.

In the real world of Western democracies, of course, actual policy choices are often worked out through negotiations among the representatives of partial interests in a great variety of arenas - among ministerial departments, among coalition parties, among specialized legislative committees, between the federal government and the states, in transnational agreements, in neocorporatist concertation between the government and peak associations of capital and labor, or other representatives of sectoral self-organization, and in issue-specific policy networks involving interest organizations together with specialized subunits within the executive and legislative branches of government. Typically, parties to these negotiations not only represent particular interests, but they also are likely to control specific action resources - jurisdictional competencies, or the loyalty of certain segments of the population - whose use may be essential for the achievement of policy goals.

All of these forms of negotiated policy making present challenges to conventional democratic theory that are not yet well understood. During the 1970s and 1980s, the attention of political scientists was mainly focused on the implications of neo-corporatist concertation (Schmitter/ Lehmbruch 1979; Lehmbruch/ Schmitter 1982; Goldthorpe 1984). After the apparent decline of this mode of governance, there now seems to be a renewed interest in pluralist policy networks involving a larger number of governmental and nongovernmental corporate actors in more loosely-coupled interactions (Laumann/ Knoke 1987; Schneider 1988; Marin 1990; Marin/ Mayntz 1991).

Much of this recent work is empirical and explanatory, drawing on the powerful tools of social network analysis (cluster analysis, block models, graph theory, etc.) for more accurate descriptions of highly complex structures of interaction. In general (but see Mayntz 1992; 1993b), less systematic attention is now paid to the normative, or evaluative, questions that were a central concern of the theorists of pluralist democracy in the 1950s and 1960s (e.g., Truman 1951; Dahl 1967), as well as of their critics (McConnell 1966; Lowi 1969). In the present paper, we will address these concerns in an analytical effort that takes as its point of departure the intellectually most ambitious attempt to justify pluralist policy making in welfare-theoretical terms.

Charles Lindblom (1959) described governance in pluralist democracies as a "Science of Muddling Through" that relies on *Disjointed Incrementalism* as its "Strategy of Decision" (Braybrooke / Lindblom 1963) and whose "Intelligence" is produced through *Partisan Mutual Adjustment* (Lindblom 1965). Both of these practices are primarily justified ex negativo - by comparison, that is, to the counterfactual ideal of hierarchical governance based on "synoptic" analyses of all pertinent issues and affected interests. While the synoptic ideal is said to overtax the bounded rationality of real-world decision makers, the incrementalist strategy will disaggregate large and complex issues into series of small steps that reduce the risks of misinformation and miscalculation, and that can use rapid feedback to correct any errors. Similarly, instead of relying on the benevolence and omniscience of central decision makers, Partisan Mutual Adjustment will directly involve representatives of affected groups and specialized office holders that are able to utilize local information, and to fend for their own interests in pluralist bargaining processes. In short, compared to an impossible ideal, muddling through is not only feasible but likely to increase overall welfare by producing policy choices that are, at the same time, better informed and more sensitive to the affected interests.

It is fair to say that Lindblom's critique of the synoptic and centralized ideal found a much more sympathetic audience than his welfare-theoretic defense of incrementalism and pluralist bargaining. Incrementalism was equated with the "tyranny of small decisions" (Kahn 1966) that must systematically preclude large-scale policy changes. Its conservative implications were thus in conflict with the planning optimism and the reformist spirit of the period (Dror 1964; Etzioni 1968). On the pluralist front, the egalitarian assumption that all societal interest were in fact effectively organized, had been attacked on empirical grounds by "elite theorists" in American sociology and political science (Hunter 1953; Mills 1956; Schattschneider 1960). An even more fundamental challenge was raised by Mancur Olson's analytical demonstration that, under rational-actor assumptions, the most widely shared interests would be least capable of organization, or at least systematically disadvantaged in collective action (Olson 1965). Finally, the rise of public choice theory with its emphasis on rent-seeking in the public sector has dampened any remaining enthusiasm for the welfare potential of pluralist bargaining - in fact, Mancur Olson has since placed the blame for the economic "decline of nations" precisely on the effectiveness of "distributive coalitions" in pluralist democracies (Olson 1982).

In his later work, Lindblom himself has conceded some of these points. That is particularly true of the egalitarian issue - where he now describes the "market as prison" (Lindblom 1982) to characterize the superior influence of capitalist interests in market economies. Since policy makers depend on profit-oriented private investment for economic growth and employment, capital interests must be respected through "deferential adaptation" and need not even be actively pursued through pluralist lobbying (Lindblom 1977). At the same time, Lindblom also had second thoughts on the virtues of incrementalism and mutual adjustment, suggesting that these practices might be most useful for a subclass of "secondary issues" while "grand issues" would benefit from "broad-ranging, often highly speculative, and sometimes utopian thinking about directions and possible futures, near and far in time" (Lindblom 1979: 522). In that regard, however, he may well have gone too far in his self-criticism. Some recent work suggests that the incrementalist strategy of decision may have greater reformist potential than it was given credit for by Lindblom's critics (Gregory 1989; Weiss / Woodhouse 1992). In our opinion, the same can also be demonstrated for "Partisan Mutual Adjustment". In order to do so, we will first reconstruct and systematize the variety of coordinating mechanisms that can be subsumed under the common label of PMA, and we will then present the results of computer simulation experiments that were designed to explore the welfare effects, as well as the transaction costs, of these coordination mechanisms used separately and in combination.

2 Varieties of Partisan Mutual Adjustment

When the decisions of one actor have an impact on matters that are also the object of the decisions of another actor, welfare gains may be obtained through the coordination of these decisions. While coordination is generally considered desirable, it is also a poorly understood concept. Lindblom (1965: 154) provides at least a rudimentary definition:

> A set of decisions is coordinated if adjustments have been made in it such that the adverse consequences of any one decision for other decisions in the set are to a degree and in some frequency avoided, reduced, counterbalanced, or outweighed.

Thus, negative externalities should be avoided or compensated and, of course, positive externalities should be identified and exploited. Optimal coordination, in other words, is defined not merely by the Pareto criterion but by the utilitarian Kaldor criterion according to which public policy measures should be undertaken whenever their negative consequences are outweighed by their expected aggregate benefits (Kaldor 1939). But Lindblom is less concerned with definitions of welfare-theoretic optimality than with the demonstration that the welfare gains of coordination can be realized in the absence of a central, hierarchical coordinator and even in the absence of common goals and world views among the actors involved. In everyday life, "people can coordinate with each other without anyone's coordinating them, without a dominant common purpose, and without rules that fully prescribe their relations to each other" (1965: 3) - and the same is supposedly true of the multiple participants in pluralist policy processes. They should be able to achieve coordination through one of several methods of "Partisan Mutual Adjustment".

Lindblom provides an "exhaustive list" of altogether twelve such methods, subdivided into two classes of "Adaptive Adjustment" and "Manipulated Adjustment" (1965: 33-4). While the latter class describes variants of negotiations whose definitions are neither particularly original nor very systematic (and which we will try to redefine in the later part of this section), the former includes two forms of non-negotiated coordination, "Parametric Adjustment" and "Deferential Adjustment", whose existence is not generally recognized in the literature. They are important enough to merit a more thorough explication and discussion of their welfare-theoretic characteristics.

2.1 Parametric Adjustment

We begin our examination with "Parametric Adjustment" which Lindblom defined as follows (1965: 37):

> In a decision situation, a decision maker X adjusts his decision to Y's decisions already made and to Y's expected decisions; but he does not seek, as a recognized condition of making his own decision effective, to induce a response from Y; nor does he allow the choice of his decision to be influenced by any consideration of the consequences of his decision for Y.

It is clear from this definition and the accompanying descriptive examples that Lindblom has in mind a form of interaction which, in game-theoretic terminology (which he never uses, however), could be described as a peculiar type of noncooperative sequential game. What makes it peculiar - in contrast to the superhuman assumptions of classical game theory - are the much more modest demands on the information available to, and the computational capacities possessed by, the players. In Parametric Adjustment, players depend on only two sets of information: the first describing the status quo, as it was brought about by the past moves of players, and the second describing their own potential moves and the outcomes these will, ceteris paribus, be able to produce. In addition, players must, of course, be able to compare these outcomes to the status quo in the light of their own self-interest. But they are explicitly not required to have ex-ante information on the payoffs and potential moves of other players, and they are not expected to be able to anticipate the future responses of other players to the moves which they, themselves, are considering. It is only when another player makes a move, or proposes a certain move, that they must be able to identify its impact on their own interest position. In other words, the need for omniscience and the infinite regress of conditional expectations, which are likely to overtax the capacities of real actors in the simultaneous, or fully anticipated sequential, games of noncooperative game theory (Scharpf 1990), are cut short by these assumptions of bounded rationality.

By itself, that is not remarkable. Bounded rationality is a flexible concept that can be defined to mean various things. The point which Lindblom needs to make is that the assumed constraints on rationality will not necessarily have negative effects, in welfare-theoretic terms, on the outcomes obtained. He achieves this purpose through a peculiar interpretation of the sequential nature of moves in Parametric Adjustment. In effect, the functions which classical game theory ascribes to mutual anticipation, based on the common knowledge of strategies and payoffs, are here supposed to be performed by hindsight in ongoing processes of interaction. In these processes, ex-ante information and forward-planning are replaced by sequences of responses, "creating in the ‘present’ a rapid succession of ‘pasts’ to which each rapidly succeeding decision can be adapted" (Lindblom 1965: 39).

But while it is surely true that, in ongoing processes of interdependent choices, each move of a self-interested and myopic player may impose externalities on others, or create new opportunities for others, to which these will again respond, and so on - that does not assure the equivalence of outcomes to those that would be achieved under conditions of complete information and perfect foresight. If there is an equivalence, it must be owed to the concept of a noncooperative "Nash" equilibrium which - regardless of how it was reached - cannot be unilaterally left again by perfectly or boundedly rational players. It is this possibility of a Nash equilibrium which justifies Lindblom’s optimism that, in Parametric Adjustment, "chaos is not the only possible consequence. What may ensue is a kind of process of successive approximation" (1965: 40).

So far, so good. We know from historical case studies that myopic actors, in noncooperative games played sequentially, may "lock in" on a path-dependent equilibrium where none of the players is left with an option that could still improve her own situation (David 1985; Arthur 1990); and we have it from the best game-theoretic authority that a game of incomplete information, in which players are ignorant of each others' preferences, may be the equivalent of a (much more complicated) game of complete information (Brams/ Doherty 1993).

But as Lindblom recognizes, equilibrium is not the most likely outcome. While mathematical game theory assures us that every noncooperative simultaneous game has at least one Nash equilibrium in mixed strategies, players in Lindblom's version of a sequential game are constrained to use only pure strategies, and the path dependent nature of the process may also place some existing pure-strategy equilibria beyond the reach of players who must start from a particular status-quo position. As a consequence, the probability of reaching any equilibrium outcome at all diminishes rapidly as the number of players and the number of their available options increases. Interaction may then deteriorate into an unending sequence of meandering moves - with presumably negative welfare consequences.

But even when an equilibrium can be reached, there is no reason to think - as Lindblom seems to do - that it must be a good solution. In fact, any speculation about the welfare-theoretical qualities of non-cooperative equilibria is meaningless unless the original game constellation is well defined. When that constellation resembles an N-person Prisoner's Dilemma, the outcome of a sequential non-cooperative game - even when players are non-myopic and fully rational - will be the "tragedy of the commons" (Hardin 1967) in which all parties end up worse-off than in the status quo from which they started. That this is by no means an unlikely outcome is demonstrated by the inflationary spirals produced by partisan mutual adjustment among fragmented and competing labor unions (Scharpf 1992a). And even when constellations are more benign, mutual adjustment may well "lock in" on a local optimum that is inferior to better solutions which, however, cannot be reached through path-dependent sequential moves. A pertinent example is provided by Paul David's famous study of the evolution of the QWERTY typewriter keyboard (David 1985).

However, while there surely is no general reason to consider Parametric Adjustment or sequential noncooperative games as a promising method for achieving welfare-increasing coordination, there are certain specific types of game constellations where precisely this method is superior to all others in achieving coordination at the lowest transaction costs. One obvious example are games of pure coordination where interests coincide, and where even the problem of converging upon one among several, and equally acceptable, coordination points (Schelling 1960) is eliminated by the sequential character of Lindblom's game. Once one party has moved, the other one has no problem in making an optimal choice. Of course, under such benign circumstances, all other methods of coordination would also work equally well.

But Parametric Adjustment also turns out to be the optimal approach to certain types of mixed-motive game constellations in which other coordination mechanisms would run into difficulties. The prime example are constellations resembling the Battle of the Sexes game, in which all parties prefer a coordinated outcome over the consequences of non-coordination, but where there is conflict over the choice among several coordinated solutions which differ in their distributive consequences. Under such conditions, coordination may not be achieved at all in noncooperative games with simultaneous moves, and even when binding agreements are possible, they may fail to be reached because of high transaction costs. By contrast, coordination is quite easily achieved in a noncooperative game that is being played sequentially. Here, whichever player moves first is able to select her most preferred solution, while later players (assuming perfect information on others' past moves) will find it in their interest to converge on the coordinated solution so defined, even though it is by no means their most preferred outcome.[1] Given the fact that they still prefer coordination to non-coordination, they have no rational alternative. Similar conditions are likely to prevail in constellations resembling the Chicken game.

2.2 Deferential Adjustment

Nevertheless, these are narrowly circumscribed constellations which will not justify a positive evaluation of the welfare consequences of "Parametric Adjustment" in the general case. To a somewhat lesser degree, that verdict also applies to "Deferential Adjustment", Lindblom's second type of non-cooperative coordination mechanism which he defined as follows:

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1 This form of coordination was identified by Philipp Genschel (1993) in an empirical study of coordination within and among specialized standard-setting committees in international telecommunications. Even though there is a high degree of overlap between the jurisdictional domains of these committees, and even though their membership is also overlapping (so that all actors are fully aware of the interdependence among separate standardization processes), there is no attempt to achieve overall coordination either through merging adjacent committees or through establishing liaison committees that would work out common solutions. Instead, whichever committee is further advanced in its own work will define its own standard, while the other committees will take that standard into account in their own subsequent work. As a result, the overall patchwork of standards tends to be highly coordinated and, in that sense, efficient.

> In a decision situation, a decision maker X does not seek, as a condition of making his own decision, to induce a response from another decision maker Y. He either deliberately avoids impinging adversely on Y's values or he takes care not knowingly to impinge adversely, except trivially, on Y's values as Y perceives them at the time of X's decision; nor does he tailor his decision to create a gain for Y (1965: 45).

In other words, Deferential Adjustment requires that decision-makers unilaterally avoid negative externalities for other actors or their jurisdictional domains. This resembles the "Negative Coordination" which Mayntz and Scharpf had found to prevail in the German federal bureaucracy, where departmental policy initiatives must, as a rule, be designed so as to avoid potential objections from other departments since the Cabinet is generally unwilling to act in the face of unresolved interdepartmental conflict (Mayntz / Scharpf 1975: 145-150). More generally, the pattern is likely to arise in all constellations where jurisdictional domains, property rights or vested interests are protected by substantive law, by procedural veto positions, by the anticipation of retaliation, or by mutual sympathy (Scharpf 1993). While the existence of these conditions surely cannot be universally assumed, Deferential Adjustment or Negative Coordination still occurs frequently enough to merit systematic attention.

In their study of interdepartmental policy making, Mayntz and Scharpf emphasized the dangers of political immobilism when innovative options were blocked by interdepartmental vetoes. Lindblom, on the other hand, had focused on the welfare-theoretic advantages of "Deferential" over "Parametric Adjustment": By excluding moves that would violate another party's interests, it would prevent players from locking into Nash equilibria that are inferior to the status quo. Moreover, since the status quo cannot be left at all[2] if anybody has reason to object, the danger of endlessly meandering moves and counter moves in situations without a Nash equilibrium is also eliminated. Unlike Parametric Adjustment in non-cooperative games, therefore, Negative Coordination will only permit policy changes that are pareto-superior to the status quo.

At the same time, however, this form of coordination can hardly exploit the potential welfare gains inherent in a particular constellation of interests. Lindblom, it is true, hopes that the self-blocking tendencies of veto systems will also stimulate the search for innovative solutions that are acceptable all around (1965: 47-51). But when all is considered, it still is analytically true that the

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2 That is only true if changes must be brought about by new decision initiatives. If the status quo should deteriorate as a consequence of external changes, a pure system of negative coordination would prevent the adjustment of standing decisions as long as there are still parties who are better off without the adjustment.

space for innovative solutions must rapidly shrink as the number and variety of veto-positions increases.[3] Deferential Adjustment is able to avoid disturbances and losses, but it is not, by itself, able to approximate the welfare optimum.

2.3 Varieties of Negotiated Coordination

Thus, Lindblom's welfare theoretic claims appear questionable for both[4] of the "adaptive" variants of Partisan Mutual Adjustment. But that may not be equally true of "Manipulative Adjustment", or at least not of those variants which, in one way or another, involve negotiations and binding agreements. Lindblom distinguishes between "Negotiation", "Bargaining", "Partisan Discussion", "Compensation" and "Reciprocity".[5] All of these modes provide for coordination through voluntary agreement, which can only be expected when all parties can expect to be better off than they would be without the agreement. Under such conditions, coordination is indeed likely to produce positive welfare effects for participants - and according to the "Coase Theorem" (which Lindblom does not mention) outcomes may systematically approximate the utilitarian welfare optimum (Coase 1960), provided that they are divisible and transferrable, or that side payments or package deals are possible (Scharpf 1992b). Depending

3 With two actors, orthogonal preference vectors, and policy options randomly distributed in Euclidian space, the probability that a proposal that is attractive to one side will be rejected by the other side, is p = 1/2. With three actors, the probability of agreement is reduced to p = 1/4, and with n actors it shrinks to $p = 1/2^{(n-1)}$.

4 We do not discuss here the theoretically less interesting mixed form of "Calculated Adaptive Adjustment".

5 In addition, the rubric of "Manipulated Adjustment" is to include "Authoritarian Prescription" and "Unconditional Manipulation" (i.e. direct and indirect forms of hierarchical control), as well as "Prior Decision" (i.e. exploiting the advantage of the first move in a sequential, noncooperative game) and "Indirect Manipulation" (i.e. prevailing on a third party to use its influence on the target actors).

Analytically, this is an extremely heterogeneous list whose diverse welfare implications cannot be fully explored here. If he had thought that hierarchical coordination were generally efficient, Lindblom would have written a different book (Miller 1992). "Prior Decision" seems to be a less myopic variant of "Parametric Adjustment" discussed above. Its implications are highly contingent on the nature of the game, however. Having the first move in a sequential game is an advantage if the game has multiple Nash equilibria, it is irrelevant if the game has precisely one Nash equilibrium in pure strategies, and it is a disadvantage in mixed-motive games without a Nash equilibrium or in zero-sum games without a saddle point. "Indirect Manipulation", finally, does not seem to have any specific consequences of welfare-theoretic interest.

on the allocation of property rights, either winners could compensate losers if aggregate gains are higher than aggregate costs; or potential victims could pay for the avoidance of initiatives whose aggregate costs exceed aggregate benefits. Of course, distributional consequences would differ - but in both cases all initiatives, and only those initiatives, which increase net aggregate welfare, would be realized through negotiated coordination.

However, the Coase Theorem is not only insensitive to distributional issues, but it also presupposes complete information and negligible transaction costs - and its welfare-theoretic conclusions are highly sensitive to real-world departures from these idealized conditions.[6] Moreover, the different variants of negotiated coordination seem to be affected in different ways and to different degrees by the obstacles to agreement encountered in real-world decision processes. In order to discuss these differences, however, Lindblom's phenomenological categories appear to be less useful than a theoretically derived classification which is based on the two crucial dimensions of the negotiation problem: Negotiated coordination enables actors to create value (or to avoid losses), either through cooperating on the production of new goods or through the (utility-increasing) exchange of existing goods (the dimension of *"value creation"*). At the same time, parties must also agree on how to divide the value so created, and how to allocate the costs of joint action among themselves - either by choosing among several coordinated solutions available or by defining appropriate side payments (the dimension of *"distribution"*).

Logically, all negotiations can be characterized in both of these dimensions (Walton/ McKersie 1965; Lax/ Sebenius 1986). But both dimensions will not be equally salient in all negotiations - which also means that different types of disagreement will have to be overcome in the individual case. This will, in turn, determine the procedures that must, at a minimum, be employed to reach successful coordination through negotiations.[7] When value-creation is at issue,

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6 In the absence of transaction costs, for instance, there would be no reason to consider external effects as a problem, since all parties affected could participate in negotiations leading to an agreed decision. By contrast, if transaction costs matter, the inevitable non-identity between those who are able to participate in a decision, and those who are affected by it, must become the core problem of normative political theory. By the same token, the problems associated with the "logic of collective action" (Olson 1965) and empirical differences in the capacity of interests to achieve collective organization, derive their political salience entirely from the real-world importance of transaction costs.

7 There is, of course, no suggestion here that negotiations should be the only means available for achieving coordination in the face of distribution and value-creation problems. Hierarchical fiat, majority vote, or noncooperative games may

new solutions must be invented and comparatively evaluated in terms of their effectiveness and costs; when distribution is in dispute, the justification of competing claims must be discussed in the light of accepted standards of distributive justice. It thus seems promising to use the salience of potential disagreement over value-creation and over distribution for a systematic classification of types of negotiations. They will here be labeled "Negative Coordination", "Bargaining", "Problem Solving" and "Positive Coordination" (Diagram 1).

		Salience of Distribution	
		low	high
Salience of Value Creation	low	(1) Negative Coordination	(2) Bargaining
	high	(3) Problem Solving	(4) Positive Coordination

Diagram 1: Ideal Types of Negotiations

2.3.1 Negative Coordination

The first field is meant to describe minimal negotiations in which neither issues of joint production nor issues of distribution are of high salience, but where agreement is nevertheless necessary. This is true in market exchanges when a well-defined product is offered at a fixed price, leaving the buyer only the choice of accepting or rejecting it with a view to her own interests. It is also true, however, in a form of "Deferential Adjustment", discussed above, where the occupant of a veto position must explicitly agree to let a policy initiative pass. As in market exchanges, negotiations may be quite rudimentary, since they will be about a well-defined object (e.g., a policy initiative pursued by one of the parties, in which others are not expected to take an intrinsic interest). Since the exercise of a veto will simply end this particular transaction, there is also no incentive to dissimulate circumstances or motives. As a consequence, the transaction costs of pure Negative Coordination may be minimal - all that is needed is to check for agreement or vetoes which, in either case, will bring the interaction to an end. But, for the reasons discussed above, if transaction

do as well or even better in some situations.

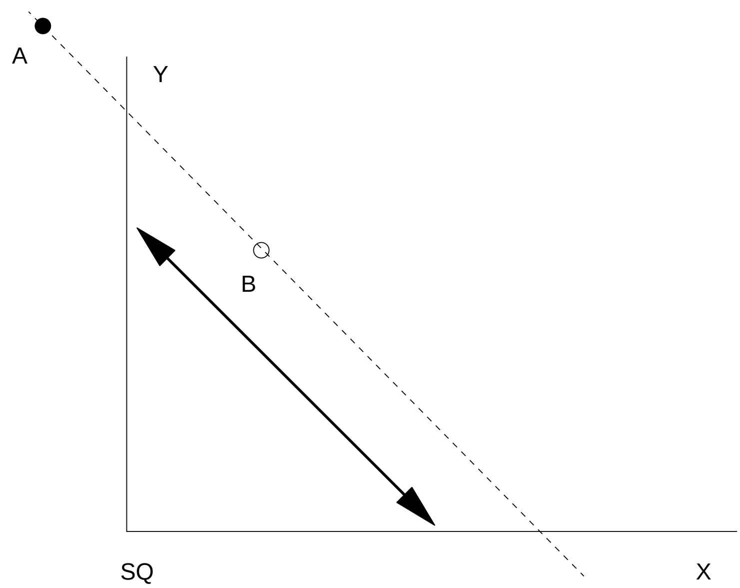
costs are minimal, so are the welfare gains that can be expected if this form of coordination is practiced exclusively.

2.3.2. Bargaining[8]

The second field is the location of negotiations dominated by distributional issues, in which problems of value creation play little or no role. In market exchanges, this would apply to the purchase of an existing object - a house or a work of art - which is unique, so that its price must be determined through bargaining among the parties. Other examples may be collective bargaining over wages, but also many political compromises in which it is expected that the outcome will be an "intermediate" solution between the extreme positions championed by the parties. Similarly, the Nash bargaining solution and its variants (Nash 1953; Kalai/ Smorodinsky 1975; Rubinstein 1982) presuppose the existence of a given production possibility frontier which is not itself the object of negotiations. In any case, Bargaining is focused entirely on the distributional issue (Diagram 2).

From a welfare theoretical point of view, the great advantage that Bargaining has over Negative Coordination arises from the possibility of compensation. Solutions are not automatically ruled out when they seem to violate the status-quo interests of one of the parties. Thus, in Diagram 2, if actor Y proposes solution A (which, by itself, would be completely unacceptable to actor X), an agreement can still be reached through side payments from Y to B, which will in effect transform solution A into solution B, to which X would have no reason to object. As a consequence, bargaining processes can potentially reach any solution that lies on the utility isoquant of a given proposal - provided that the parties are able to reach agreement on the distributional issue. This may be difficult, since both sides will have incentives to dissimulate factors affecting their valuation of the outcome - but when it is simply a case of buying off a potential veto through the compensation of expected damages, transaction costs may nevertheless remain within manageable bounds.

8 In the terminology of Walton and McKersie (1965), this would be "distributive bargaining".



Bargaining over Divisible Outcomes (SQ = Status Quo)

Diagram 2: Bargaining

2.3.3 Problem Solving[9]

The third field of Diagram 1 represents "cooperation" in its pure form. Here, actors are somehow able to concentrate on issues of joint production, and to put distributive issues aside at least temporarily. If the focus is on the comparative evaluation of available solutions, the criterion is their contribution to the common or aggregate interest of all participants; but even more important will be the common search for new solutions that will extend the possibility frontier - without regard for their distributional consequences. In Diagram 3, therefore, both parties would join in the search for the welfare-maximizing solution B, even though its realization would leave X worse off than solution A.

These may appear to be highly idealistic stipulations - which is why the possibility of Problem Solving is often dismissed as practically irrelevant by social scientists committed to a rational-actor perspective. But that conclusion appears

9 "Integrative Bargaining" is the term used by Walton and McKersie (1965) while Lindblom (1965: 28) describes this mode as "Cooperative Discussion" - whose practical relevance he considers to be marginal at best.

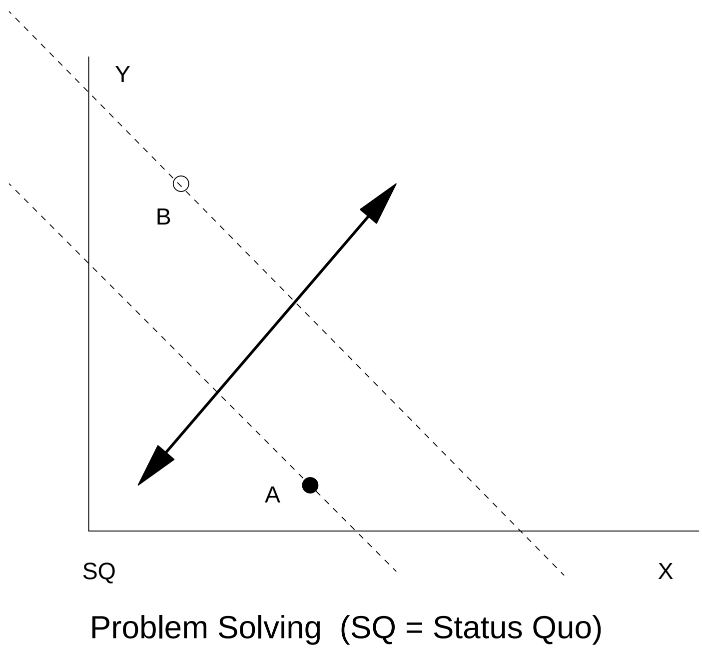


Diagram 3: Problem Solving

too simple-minded. Actors are in fact often involved in negotiations in which distributional issues are quite irrelevant. Sometimes, they are effectively neutralized by prior agreement on explicit rules for the allocation of costs and benefits. This is the typical case in joint ventures, which are based on elaborate contracts settling all sorts of distributive issues in advance just in order to facilitate uninhibited cooperation within the common undertaking. Similarly, in the Swiss federal government a fixed allocation of ministerial positions to a set of political parties tends to immunize "consociational" cooperation even against the distributional conflicts arising from electoral competition (Lehmbruch 1967; Bogdanor 1988). Examples in other areas are easy to find.

Another condition facilitating Problem Solving is the "veil of ignorance". It is well illustrated in a case study of successful research collaboration among firms which became feasible only after it had become clear that all of the competitors were as yet very far from the point where they might have marketable products to introduce (Lütz 1993; Häusler/ Hohn/ Lütz 1993). Similarly, technical standardization by committees in telecommunication is relatively easy to achieve for technologies which have not yet been introduced, but extremely difficult when competing solutions are already on the market, so that their producers would benefit or suffer when one or the other were adopted as a common standard (Schmidt/ Werle 1992).

Problem Solving also occurs within organizations, where the personal self-interest of staff members is largely neutralized when the actions required occur within the "area of acceptance" or "zone of indifference" specified by the employment relation (Simon 1957; 1991; March / Simon 1958). Similarly, corporate actors involved in policy networks may also engage in processes of Problem Solving governed by notions of public interest or "systemic rationality" as long as their own institutional self-interest is not challenged in the process. As Renate Mayntz has shown, this was true of the role of the large West German research organizations in the transformation of the East German Academy of Sciences (Mayntz 1994).

In short, therefore, Problem Solving is by no means a rare and exotic mode of coordination that could be safely dismissed in realistic analyses of real-world negotiations. True, its practice does depend on specific preconditions which are neither ubiquitous nor easily created where they do not exist. But they do occur quite frequently, and where they do exist, the search for welfare-maximizing solutions can be immensely facilitated by negotiations in which distributive conflict is not a major obstacle to agreement.[10]

2.3.4 Positive Coordination

The fourth field in Diagram 1, finally, describes negotiations in which participants must simultaneously solve production problems and resolve conflicts over distribution. Mayntz and Scharpf identified this mode in their study of interdepartmental task forces in the German federal bureaucracy, whose members were supposed to develop innovative policy solutions for problems cutting across several ministerial portfolios, but were at the same time expected to protect the domain interests of their respective home departments (Mayntz and Scharpf 1975). In their view, this was the most desirable and, at the same time, the most difficult form of coordination actually practiced in policy processes.

The difficulties result from the contradictory nature of the functions which must be simultaneously performed. In Diagram 4, they are represented by moves in orthogonal directions. If attention is focused on distributional issues, parties concentrating on their most preferred solutions A or B may not even perceive of the overall superior solution C. It will not come into view unless it is realized

10 None of this should imply, however, that Problem Solving will necessarily be harmonious. Cognitive disagreement over cause-and-effect hypotheses or normative disagreement over the appropriate definition of organizational goals or the public interest may be as severe, or more severe, than distributional conflict over personal or institutional self-interest could be.

that the pursuit of maximal advantage is ultimately pointless, since an equitable division will be the precondition of agreement in any case. Once this is accepted, it will be obvious that solution C may be better even from a self-interested point of view than the inevitable compromise between A and B.

What stands in the way of agreement is, however, not only a cognitive problem. As long as negotiations are dominated by attention to distributive issues, success will in fact be facilitated by "playing one's cards close to one's chest", by understating one's own interest in an agreed-on solution, and by manipulating information about the likely consequences of different solutions. Such stratagems, however, are objectively incompatible with the joint search for superior solutions, which can only succeed if communication is open and information freely exchanged. Worse yet, parties who are actively engaged in the search for common advantage are most likely to be exploited by partners who are primarily trying to maximize their own shares. This is the core of the "negotiation dilemma" (Lax/ Sebenius 1986) which often leads to the failure of Positive Coordination. If it is to be overcome, parties not only must develop mutual trust in the face of ubiquitous opportunities for deception, but they must also agree on fair rules of distribution and their application to the case at hand (Scharpf 1992b).

Thus it may seem that we have finally discovered a general mechanism which would permit pluralist polities to maximize their common welfare even when all parties involved are pursuing their own, self-interested goals, rather than the public interest. Unfortunately, however, the welfare-theoretic argument holds only for those corporate actors who in fact participate in policy negotiations, and for the interests represented by them. Because of the difficulties of reaching agreement in the first place, external effects are even more likely to be ignored by negotiating groups of self-interested actors than by self-interested individual actors. Thus, unless all affected interests are in fact represented, there is again no assurance that Positive Coordination by itself will increase, rather than reduce, general welfare. And even if we restrict attention to only those interests which are in fact represented in pluralist policy networks, relegating those who are excluded to other representational mechanisms,[11] the welfare-theoretical attractiveness of the solution is undercut by the escalating transactions costs as the number of participants increases.

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11 Regardless of all normative advantages of pluralist and corporatist interest intermediation, universal suffrage remains the only truly egalitarian representational mechanism - and the political process will approximate egalitarian outcomes only to the extent that the relative weight of general elections remains high in comparison to other forms of political influence (Scharpf 1970).

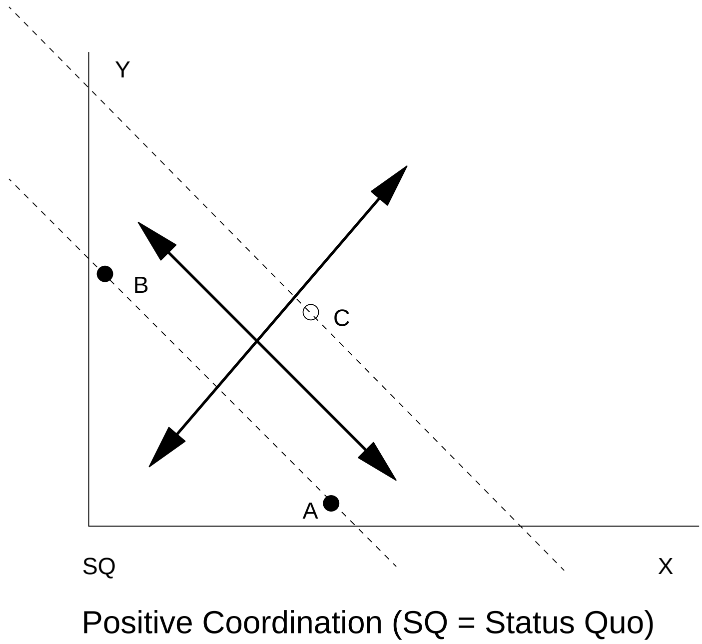

Diagram 4: Positive Coordination

Positive Coordination depends on trust, and mutual trust among rational egoists requires costly investments in trustworthiness; it takes time to develop, and it is easily destroyed (Sabel 1993; Scharpf 1993). And even if all parties should refrain from deception, they will find it difficult to achieve simultaneous agreement on the solution which is best for all, and on the fair distribution of benefits and costs. Moreover, these transaction costs will increase exponentially, not proportionately, with the number of parties participating in negotiations. If each of N participants has S options to choose from, search for the overall optimal solution requires the comparison of S^N outcomes, and agreement on a fair distribution involves the examination of N(N-1)/2 bilateral relationships. By comparison, the transaction costs of Negative Coordination are much lower: Each party needs to be concerned only with its own options and with its own benefits and costs, and whoever takes the initiative to change the status quo needs only to check with (N-1) other parties to see whether a veto will be exercised. The implication is that Negative Coordination may indeed be practical among relatively large numbers of participants, while Positive Coordination is not feasible beyond limits which, though hard to define with any precision, are bound to be very narrow.[12]

12 The problem of prohibitive transaction costs seems to be acknowledged by Lindblom when he points out that the number of participants in negotiations must necessarily be very limited. In his view, therefore, the main burden of coordina-

Thus we seem to have not come very far in our search for the welfare potential of pluralist policy networks. Parametric Adjustment in sequential noncooperative games is likely to lead to unstable constellations, and may end in social traps (but see, above, footnote 1). And Negative Coordination, while protecting status quo interests, is hostile to welfare gains that can only be realized through policy innovation. Bargaining has a somewhat greater welfare potential when negotiations are merely about the costs and benefits of predefined solutions. Problem Solving, on the other hand, is highly effective in defining innovative welfare maximizing solutions, but it depends crucially on the neutralization of distributive issues. Finally, both of these constraints are relaxed in Positive Coordination which, like Problem Solving, would allow participants to pursue their common interest to the fullest degree. However, the number of possible participants is constrained by escalating transaction costs. Hence Positive Coordination is likely to be practiced among small numbers of active participants. As a consequence, there may be significant external effects, and welfare gains obtained by participants may under certain conditions be more than offset by the damage done to the interests of outsiders.

In reaching these skeptical conclusions, we have considered each of these coordination mechanisms separately. In doing so, however, we may not have done justice to the spirit of Lindblom's work, in which the welfare effects of "Partisan Mutual Adjustment" are discussed without actually distinguishing among its different variants. That may be criticized as a lack of analytical precision, but it may also be interpreted as an implicit[13] suggestion that, in combination, the several coordinating mechanisms might have more attractive welfare consequences than each of them has when applied in isolation. In the remainder of this paper we will pursue this suggestion for constellations in which Positive Coordination, Negative Coordination, and Bargaining are jointly applied to solve a given coordination problem. In order to do so, one of us has developed a computer simulation program which allows us to determine the welfare effects (defined by the influence on the *joint payoffs* of all participants) of different types of negotiation procedures. In the following section, we will provide a brief description of the characteristic features and results of the simulation.

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tion has to be borne by "Parametric Adjustment" and "Deferential Adjustment" (1965: 68). But that throws us back to the welfare deficits discussed above.

13 In his discussion of "parametric adjustment" Lindblom explicitly suggests that, when one form of coordination fails, actors might switch to another: "The coordinating potential of the various mutual adjustment processes may be greater than is at first supposed, since in these processes themselves are opportunities for participants to choose one or another of quit different methods, as circumstances require" (1965: 41). This seems plausible, but is different from the combination effects discussed here.

3 The Simulation Program

We use computer simulation not in order to model particular processes of interdependent policy choices under conditions approaching real-world constellations, but in order to clarify the general characteristics of the methods of coordination discussed above, and of their combinations. Conceivably, this clarification could also be achieved more elegantly by analytical means, and we certainly hope that some of our results will eventually be confirmed analytically. But we know of no analytical procedures that would permit us, at this stage of our work, to vary assumptions as flexibly, and to explore such a variety of stipulated conditions, as is possible with simulation methods. Thus, without further excuses, we proceeed to present our basic simulation model.[14]

In one sense, our model is deliberately unrealistic: it represents the horror world of total interdependence - a world which Herbert Simon (1962) had promised we would never have to face. Each of N actors is able to choose among S policy options[15], and each choice will affect the payoffs of all actors at the same time. If a method of coordination succeeds here, it will succeed more easily under the more benign conditions of selective interdependence. Moreover, the interdependence among policy choices is unstructered, since our model uses random payoff matrices of size S^N rather than matrices representing certain types of well-known game constellations[16]. Payoffs are assumed to be interpersonally comparable, measurable in a general medium of exchange, such as money, and transferrable if required[17]. Games are played sequentially,[18] and players are assumed to be myopic in the sense defined above in the exposition of Lindblom's Parametric Adjustment. They will respond to other

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14 A more complete description, and a copy of the program, written in Turbo Pascal and running on IBM compatible 386 PCs, can be obtained from Matthias Mohr.

15 These "options" are not "strategies" in the game-theoretic sense of a complete specification of moves in a sequential game. Instead, they are meant to represent specific policy stances among which a particular actor in a policy network may choose - such as between cutting the budget, raising taxes, or increased borrowing.

16 We have also experimented with matrices structured so as to represent specific types of game constellations, but have chosen to present here only the general case.

17 For all examples presented here, the random payoffs are distributed identically in the interval [0...100].

18 Since switching back to an earlier option in later stages of the game is not precluded, it is necessary, for each method of coordination, to define the point at which a particular sequence of moves will come to an end. Choices of options become final only at this point.

players' moves, but cannot anticipate them; and in selecting their own moves, they will always pick the one that would give them the highest payoff, if no other player should move again.[19]

Table 1 illustrates these assumptions in a form of presentation that allows the direct inspection and analysis of fairly large n-person games in normal form. It represents a game with four players, each of whom has two options, labeled 1 or 2. Each row stands for a cell of the payoff matrix, which is defined by a combination of options producing an outcome consisting of a set of individual payoffs (varying between 0 and 100). Players' choices are driven by the (myopic) maximization of individual payoffs, but since we are exploring *welfare effects* of various types of negotiations, our attention is focused on the aggregate or *joint payoffs* represented in the last column. Thus, the relative success of a coordination method is judged by the location of the outcome in the solution space between the joint payoff minimum (cell 8) and the joint payoff maximum (cell 4). In order to achieve comparability, joint payoffs are normalized to a range between 0 and 1 in all later presentations.

Another characteristic that departs from the usual game-theoretic conventions is the fact that all our simulation runs must start from a specific "status quo" cell, and that outcomes must be reached through sequential moves from this point of departure. In the present article, simulations will either start from the cell representing the joint payoff minimum or from a cell selected at random.

3.1 Parametric Adjustment

In order to simulate Lindblom's version of a noncooperative sequential game, the first move is assigned to the player who could achieve the largest individual gain through a unilateral switch from her status-quo policy position on the assumption that all other players would meanwhile stick to their own status-quo positions. This move then defines a new point of departure to which other players will now respond. Again, the player who can now expect the greatest individual gain will move, and again other players will respond to the new situation, and so on. The sequential noncooperative game will stop under one of two conditions: On the one hand, it is possible that a cell will be reached

19 Maximax, rather than Minimax, makes sense as a rule for myopic players who must choose one move at a time (rather than complete strategies) and who are ignorant of the options as well as of the preferences of other players. The risks are minimized in a sequential game in which a player may respond again to other players' responses to her own move.

Cell	Option of Player A B C D	Payoff for Player A B C D	Joint Payoffs	Normalized Joint Payoffs
1	1 1 1 1	20 69 46 18	153	0.20
2	2 1 1 1	97 29 52 00	178	0.35
3	1 2 1 1	73 25 37 00	135	0.10
4	2 2 1 1	73 76 99 38	286	1.00
5	1 1 2 1	48 23 79 98	248	0.77
6	2 1 2 1	42 60 60 31	193	0.44
7	1 2 2 1	97 69 33 26	225	0.63
8	2 2 2 1	22 10 50 37	119	0.00
9	1 1 1 2	94 08 05 37	144	0.15
10	2 1 1 2	24 71 31 34	160	0.25
11	1 2 1 2	94 99 03 05	201	0.49
12	2 2 1 2	51 81 11 20	163	0.26
13	1 1 2 2	18 25 29 60	132	0.08
14	2 1 2 2	88 87 07 16	198	0.47
15	1 2 2 2	35 26 63 12	136	0.10
16	2 2 2 2	96 80 47 04	227	0.65

Table 1: Random Payoffs, 4 Players, 2 Options

which represents a *Nash equilibrium*, i.e. an outcome in which no player could still improve her own payoff by a unilateral change of policy. On the other hand, if no equilibrium is reached, moves will continue until a cell is reached that was touched before with the same player being in the position to move - at which point the game moves into an infinite cycle and the simulation breaks off. In this case, we arbitrarily assign status quo payoffs to the outcome.[20]

In our example, player A would initially move the game from cell 1 to cell 2. Thereafter, player B would have most to gain by moving the game to cell 4 - which would also benefit players C and D, but would reduce the payoff of player A. However, neither A nor any other player could still improve her payoff by *unilaterally* changing her own option. Thus, a Nash equilibrium is reached which, incidentally, also represents the welfare maximum. But, of course, this is a not a representative example.

20 Alternatively, players with perfect recall might then backtrack to a non-equilibrium but pareto-superior cell touched earlier during the sequence of moves. This is a possibility that we have not modelled.

3.2 Negative Coordination

Negative Coordination (or "Deferential Adjustment" in Lindblom's terminology) also begins with a first move by the player who has most to gain. But that move can only be completed if it is not vetoed by another player who would be made worse off in comparison to the status quo. In other words, whoever has the right of initiative cannot impose negative externalities on others. If no veto is exercised, the game moves to the new cell and continues from there. Otherwise, the leading player will try her next best move, and so on, until the game comes to a stop. Thus, in Table 1, player A would have most to gain by moving the game from cell 1 to cell 2. But this move would be blocked by players B and D, whose status quo interests would be violated.

Again, however, our example is not representative. When there are relatively few players with relatively many options, chances are good that the leading player will find ways to improve her own situation without damaging the status-quo interests of any other player. This would be even more likely if the initiative is not restricted to a single player but will shift to others when the first one cannot succeed. If the number of options per player stays constant or is reduced, however, while the number of players (and thus the number of veto positions) increases, there is a much greater possibility that all initiatives will be blocked and that the status quo cannot be left under conditions of Negative Coordination. In any case, however, Negative Coordination will not produce payoffs that are worse than the status quo, and any initiative that is not blocked will lead to welfare improvements.

3.3 Bargaining

The Bargaining process begins like Negative Coordination: the player with the most to gain makes the first move. But if she encounters one or more vetoes, the move is not immediately withdrawn. Instead, the player determines whether her expected gain would be sufficient to (just barely) compensate those players who are objecting, so that their status quo payoffs ("reservation payoffs") would be maintained while she herself would still make a profit. When that is true, the move is carried out, and the game continues from the new cell - whose payoffs are adjusted according to the outcome of the bargain. In Table 1, for instance, if the game starts in cell 1, player A would gain 77 points from a move to cell 2. This would also improve the payoff of player C, but player B would lose 40 points and player D would lose 18. Since the gains of player A are sufficient to compensate these losses, the move can be completed. The new reservation payoffs in cell 2 would now be 39, 69, 52, and 18 for players

A, B, C, and D, respectively. Next, player D could gain 16 points by moving to cell 10 - but that would not be enough to compensate player A for a loss of 15 points and player C for a loss of 21 points. Player C could move to cell 6 for a gain of 8 points - which would not be enough to pay for player B's loss of 9 points. Finally, player B would gain only seven points from a move to cell 4, but since this move would entail large windfall profits for all others, it would be carried out. Beyond that, no player could make a profit by moving away from cell 4 which, incidentally, is also the welfare optimum.

3.4 Problem Solving and Positive Coordination

Both Problem Solving and Positive Coordination are here defined as methods for maximizing the collective payoff of coalitions of self-interested players.[21] They differ only in the distributive dimension - which is treated as being irrelevant for Problem Solving, and highly relevant for Positive Coordination. In the simulation program, coalitions are formed incrementally. The nucleus is again the individual player who has most to gain. She will then join forces with a second player who, when options are pooled, will allow the pair to achieve the largest additional gain,[22] and so on.

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21 Renate Mayntz (1993a; 1994) equates Problem Solving with "system rationality". Translated into our simulation model, this would mean that the members of a coalition are always aspiring to maximize the *joint payoffs of the whole population of players*, regardless of payoffs achieved by themselves (or, alternatively, provided that their own status-quo interests are not violated). In doing so, they could still use only the moves available to coalition members - and they might need to play a non-cooperative game against players not included in the coalition. In the present paper, we have not explored this variant of coordination mechanisms.

22 It should be clear that these are *assumptions*, rather than deductions from a rational-choice theory of coalition formation. According to these assumptions, coalition partners will be selected by the criterion of maximally convergent or harmonious interests (i.e. coalitions should coopt their closest friends, which corresponds to Fritz Heider's theory of "structural balance" - Cartwright/ Harary 1956). This is not the only plausible assumption, however. When outsiders can interfere with its strategies (or have a veto), a given coalition might do better by coopting potential opponents, rather than close friends.

In a well-researched historical example, that was the logic of Bismarck's system of criss-crossing alliances. But since it was a very difficult system to manage, his successors in the 1890s regressed to the more harmonious "Triple Alliance" of Germany, Austria and Italy - whose confrontation with the "Triple Entente" of England, France and Russia then defined the lineup of World War I (McDonald/ Rosecrance 1985).

Two points are important to note. First, by pooling their policy options,[23] the members of a coalition can significantly increase the action space available to themselves. Thus, starting from cell 1 in Table 1, player C would only have the option of moving to cell 5, and player D could only reach cell 9. A coalition of players C and D, however, could use these options of their individual members and, in addition, could also reach cell 13 by combining both these moves. More generally, from any given status quo, a coalition of N members with S policy options each can reach a set of S^N-1 different outcomes while a population of uncoordinated indidividual actors of the same size could only reach (S−1)N outcomes.

Second, in Problem Solving, the coalition's only criterion of choice is the aggregate net gain of the group. Individual losses are not compensated. Thus, in Table 1, the coalition of players 3 and 4 could obtain the maximum total gain of 113 points by moving to cell 5. Player C would collect 33 points, while 80 points would fall to player D. In Positive Coordination, by contrast, additional distributive negotiations are needed to allocate gains and losses among the members of the coalition. These are more demanding than the distributive negotiations involved in the Bargaining simulation. There, the player who proposes a solution is also the "residual claimant" who will keep the remaining profit after having paid minimal compensation to those other players who would otherwise suffer losses compared to their reservation payoffs. Within the coalition, however, a "fair" distribution is required for which a number of factors will be relevant. Of course, no actor will join a coalition if it will not at least allow her maintain her reservation payoff. Beyond this, the Nash Bargaining solution would distribute profits in proportion to the status-quo payoffs of the players involved. This is also the rule applied in our simulation model.[24]

In our simulations, the cooptation of opponents would increase the welfare effectiveness of combinations of Positive and Negative Coordination. But in the interest of comparability, the cooptation of friends was used as coalition building rule in all examples presented below.

23 Coalitions are modeled here as a set of actors with distributed, rather than centralized, action resources - which is generally true in policy processes among corporate actors controlling certain policy instruments.

24 Alternatively, and perhaps more plausibly, distribution could be proportional to the highest potential gain a coalition member could have achieved (Kalai/ Smorodinsky 1975). However, if utility functions are linear as in our case or if they are identical, both concepts lead to the same solution. We have chosen the Nash solution for pragmatic reasons since the Zeuthen-Harsanyi bargaining procedure, which easily lends itself to simulation, produces Nash distributions (Harsanyi 1977: 149-162, 198-203).

However, our definitions of Problem Solving and Positive Coordination do not yet specify a complete coordination mechanism for all cases where the coalition is smaller than the total population of players (i.e. is not a grand coalition). What is needed in addition is a specification of the rules governing the interaction between the coalition and players outside. This relationship could be *dictatorial* in the sense that the coalition is able to prevent all other players from responding to the coalition's preferred move, or it could be defined by one of the coordination mechanism discussed so far - Parametric Adjustment, Negative Coordination and Bargaining. It is here that Lindblom's and our hunch, according to which combinations of coordination methods might produce particularly attractive welfare effects, would have to be tested.

4 Comparative Welfare Effects

We have already discussed the potential welfare effects of simple coordination mechanisms - Parametric Adjustment, Negative Coordination, and Bargaining - and we will here merely add some more precise observations derived from our simulation experiments. We will then present simulation results of the welfare effects of partial coalitions, and will then proceed to the main theme of this section, the examination of combination effects of partial coalitions and simple coordination methods. The section will conclude with an examination of the rise of transaction costs associated with coalitions of increasing size.

4.1 Simple Coordination Methods

As discussed above, *Parametric Adjustment* may in fact be the most efficient coordination method available for certain constellations resembling games of pure coordination or the Battle of the Sexes. In the general case, however, the

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However, both rules are likely to underestimate the difficulties of agreeing on the relevance of criteria for distribution. In Table 1, for instance, players C and D may agree to move to cell 5 which provides them with a common surplus of 113 points. But player C, who must produce this outcome through a change of her own strategy (while player D remains inactive), is unlikely to forget that she could have done even better by sitting still and letting the game move to its noncooperative equilibrium in cell 4 - a prediction which player D might challenge by pointing to her own threat potential, whose credibility might again be disputed, and so on.

probability that a Nash equilibrium can be reached at all through sequential moves is greatly reduced as the number of options and/or the number of players increases. In order to test this intuition,[25] we have conducted series[26] of 100 simulation runs for games in which the number of players varied between 2 and 12, while the number of options available to each player was held constant at 2. The outcome is presented in Table 2. Similarly, when we held the number of players constant at six while varying the number of options available to each between two and five, an equilibrium was reached in 24/100 plays when the players had two options, but only in 4/100 cases when the number of options was increased to five.

Number of Players	Number of Nash Equilibria Reached
2	90/100
3	70/100
4	55/100
5	34/100
6	30/100
7	22/100
8	11/100
9	10/100
10	8/100
11	4/100
12	6/100

Table 2: Nash Equilibria in Sequential Games

25 A mathematical proof is difficult because of the path-dependent character of our sequential games.

26 These series of simulation runs are *not* to be mistaken for "iterated games". We do not assume that players anticipate future interactions or react to past experiences. Thus, each run is a one-shot game, and the number of runs is increased simply to average out the variance of individual outcomes resulting from our use of random payoff matrices.

When a Nash equilibrium is in fact reached, however, the outcome usually constitutes a welfare improvement over the status quo[27] - but not invariably so. In a series of 60 simulation runs of a 3-players-by-3-options game, Nash equilibria were reached in 28 cases. Of these, 23 could be classified as welfare improvements, but in five cases, aggregate payoffs were in fact lower than in the status quo. This is a reminder that even in nonstructured (randomized) game constellations, players may encounter situations resembling a social trap - and that sequential, noncooperative games among three or more players do not provide protection against the "lock in" on inferior solutions.

Our simulations have also confirmed the expectation that the welfare efficiency of *Negative Coordination* will decline as the number of independent players in veto positions increases. Table 3 summarizes the normalized joint-payoff gains of thirty simulation runs in which Negative Coordination is applied among 4, 8, and 12 players respectively, each of whom is provided with a choice among two options.

	Number of Players		
Status Quo is	4	8	12
Joint Payoff Minimum	0.51	0.35	0.02
Random Selection	0.13	0.02	0.00

Table 3: Average Joint-Payoff Gains Through Negative Coordination

The table also shows that gains are higher if the simulation departs from a status-quo situation in which joint payoffs are at a minimum than if the status quo is selected by random choice. In the first case, when most players will also start from low individual payoffs, moves that will improve the outcome for the leading player are less likely to be blocked by vetoes. When the initial status quo is selected at random however, it is more likely that any move that would improve one player's payoff will violate the vested interests of others.

27 That is so because we use a random payoff matrix. While players moves will improve their own payoffs, the external effects on the outcomes of other players may be positive or negative.

Since *Bargaining* is in all respects similar to Negative Coordination, except that vetoes may be bought off, the outcomes show a similar tendency (Table 4). However, the level of gains that can be achieved is generally higher, since some profitable moves can be carried out here, while they would have been blocked under Negative Coordination.

	Number of Players		
Status Quo is	4	8	12
Joint Payoff Minimum	0.68	0.53	0.03
Random Selection	0.28	0.07	0.00

Table 4: Average Joint-Payoff Gains Through Bargaining

4.2 Partial (Dictatorial) Coalitions

When a coalition that is practicing Positive Coordination (or Problem Solving, for that matter) internally, can impose its preferred outcome on all other players, there is, of course, no question that the collective welfare of coalition members will be maximized. And there is also no question that a grand coalition that includes all affected parties would maximize aggregate welfare. But, as will be shown below, transaction costs of coalitions rise steeply as the number of members increases. As a consequence, coalitions are likely to be quite small, and the welfare consequences of small coalitions may be quite problematic. This is illustrated in Diagram 5.

The Diagram shows the normalized joint payoffs of three individual simulation runs of a game with eight players and three options. The status quo cells were selected at random for each run. The lines represent the joint payoffs (aggregated over all players) achieved by self-interested coalitions of varying sizes (K1 to K8). Players who are not members of the coalition are here assumed to make no moves of their own - in other words, the coalition is "dictatorial" in the sense that it alone can exercise policy options.

Even under these unrealistic conditions, the unrestricted pursuit of self-interest by a dictatorial individual (K1) will often *reduce* general welfare in comparison

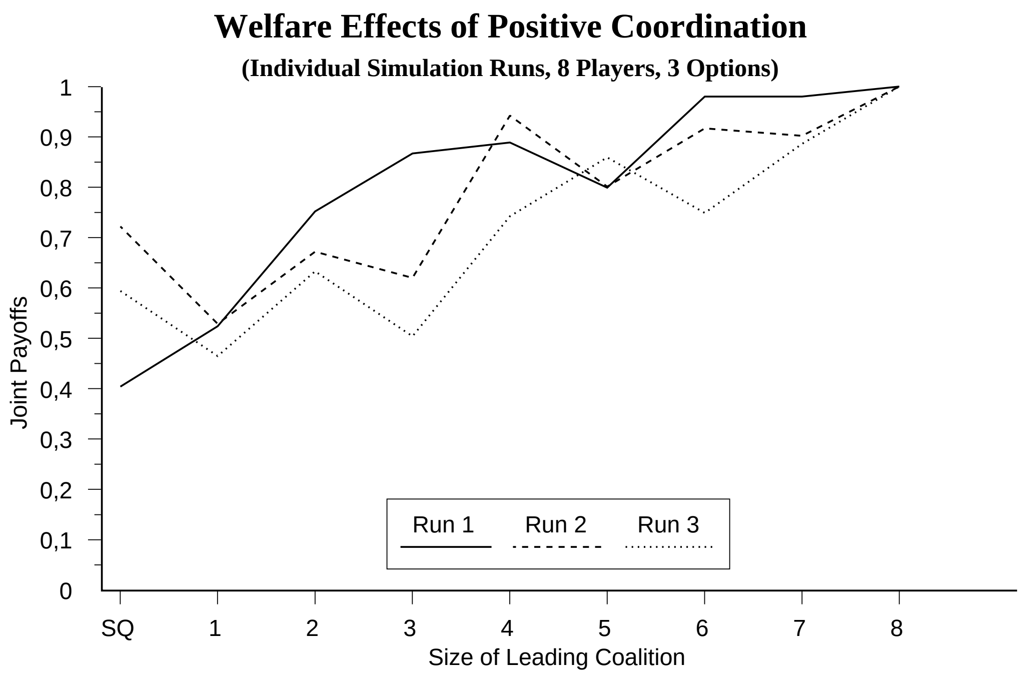

Diagram 5: Welfare Effects of Dictatorial Coalitions

to the status quo. It is also interesting to note that, in the individual case, *general welfare* will not necessarily increase if the size of the coalition increases. Thus, in two of the three runs shown here, the move from a two-member to a three-member coalition, and from a four-member coalition to a majority coalition including five out of eight players, would in fact have reduced *general* welfare. Since the members of the coalition are, of course, increasing their per-capita payoff at each step, these reversals are an indication of negative externalities which are imposed on players outside of the coalition.

The selected results of individual simulation are of course not representative. In our randomized payoff matrices, positive and negative externalities will cancel out on the average, so that the aggregate result of large numbers of simulation runs will show a steady increase of average joint payoffs (Diagram 6). It is interesting to note that the choice of the status quo from which the simulation starts (from the joint payoff minimum or from a randomized point of departure) does not seem to make much of a difference. Even when starting from the minimum, the first move of the leading player brings the welfare level *of the whole population* up to a medium range, from where on progress tends to be quite slow.

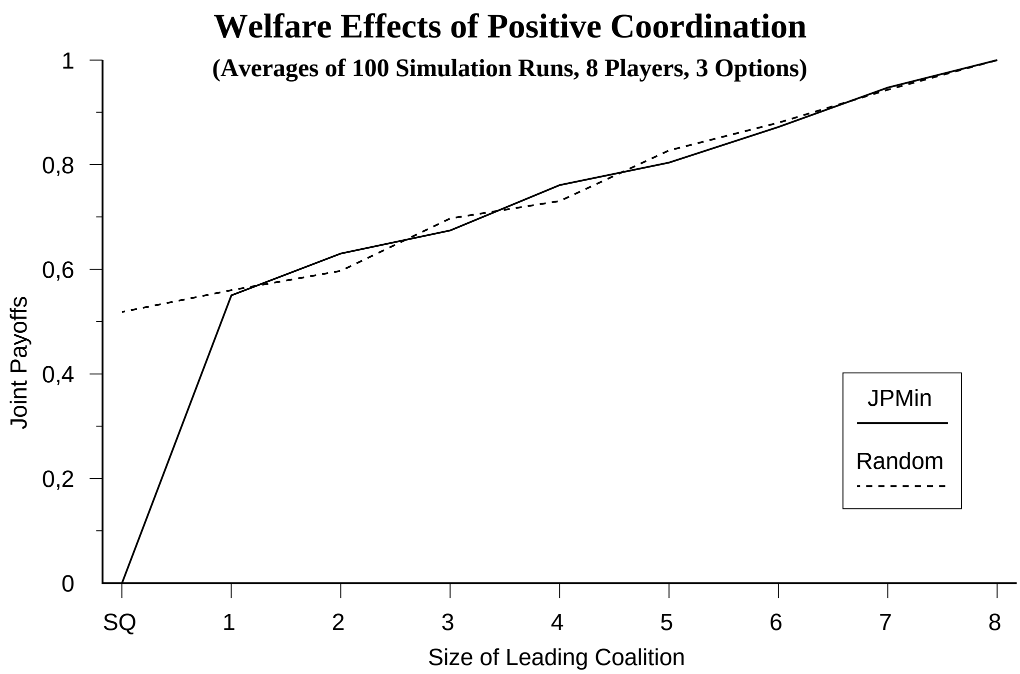

Diagram 6: Joint Payoffs from Positive Coordination

4.3 Positive Coordination plus Parametric Adjustment

When policy options are evenly distributed, as we have assumed, dictatorial coalitions are, of course, not a realistic proposition. We have included them for purposes of exposition, but will in the remainder of the paper explore constellations where the players outside of the coalition also have a role. At a minimum, they should be able to exercise their own individual policy options in response to the new situation created by the initial move of the coalition. When that is so, we have in fact a noncooperative sequential game played between the coalition and all other players. In our simulations, the coalition has the first move and will choose its most preferred cell. Starting from there, the outside player who has most to gain will have the next move, to which the coalition or another player may again respond, and so on. Given its greater range of options, the coalition will be at an advantage, but it will not be able to determine the outcome unilaterally.

In comparison to the pure model of Parametic Adjustment discussed above, the number of players is reduced when some of them combine to form a coalition. Thus, in a constant population of players, the probability that a Nash equilibrium can be reached will increase as the size of the coalition increases. When it is reached, the welfare effect is likely to be positive. But as long as the number of independent players is larger than four or five, a Nash equilibrium will not be reached in the majority of simulation runs. The probability that an equilibrium will be reached decreases further when players can choose among more than two policy options, as is true in the example presented here. Since in the absence of an equilibrium outcome the status quo will be maintained by definition in our simulations, the *average* welfare gains achieved by a combination of Positive Coordination and Deferential Adjustment will be quite modest unless relatively large coalitions (implying very high transaction costs) are formed (Diagram 7).

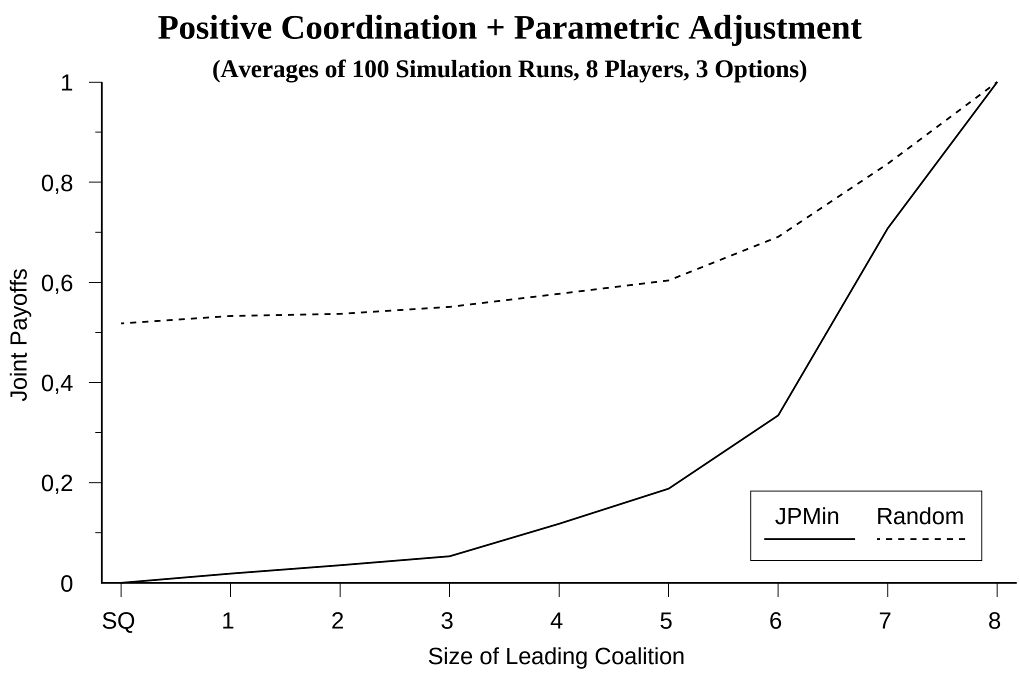

Diagram 7: Positive Coordination plus Parametric Adjustment

4.4 Positive plus Negative Coordination

In the next variant we explore the combination of Positive Coordination and Negative Coordination. As before, there is a coalition building process which begins with the player who has most to gain. But now the status-quo payoffs of all players who are not members of the leading coalition are protected (say, by institutionalized property rights). Thus, the coalition is only able to complete its most preferred move if it leaves no other player worse off than in the status quo. If its initiative is blocked, the coalition will try its second-best move. When it is successful, or when its options are exhausted, the coalition is enlarged by coopting the outside player whose addition promises the greatest joint gain for the larger coalition, and so on.

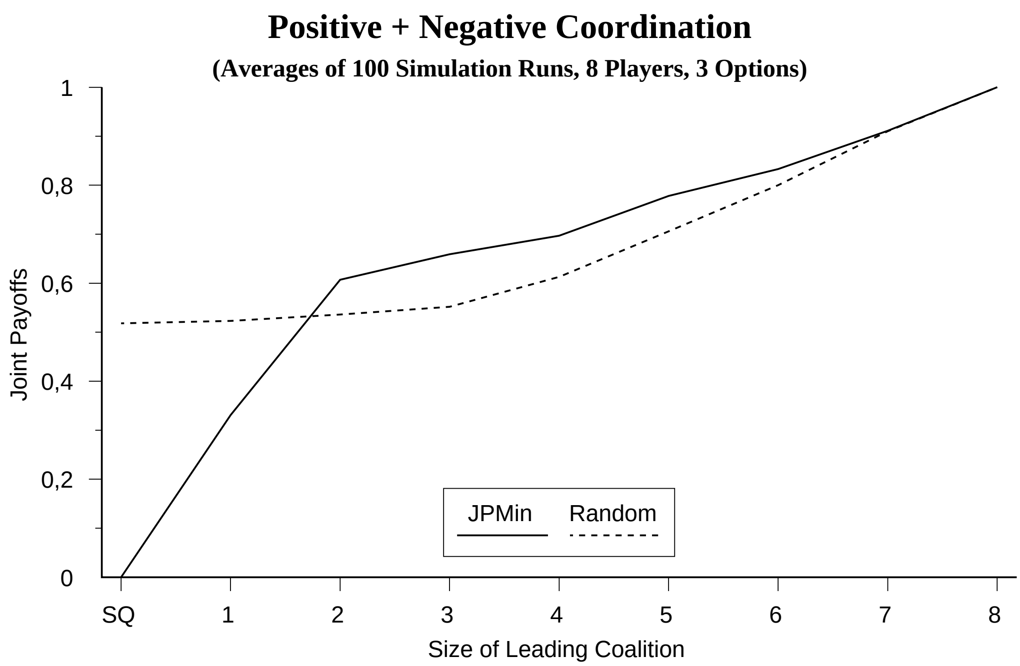

Diagram 8: Positive plus negative Coordination

As is to be expected, single actors are not doing well against a large number of veto players. But here, having larger numbers of options is an advantage for the leading coalition. Thus, if the game starts from the joint payoff minimum, and if all players can choose among three policy options, it takes only a two or three member coalition to bring joint payoffs up to a medium level. However, the outcome is much less encouraging when the game starts from a random (in the average: medium) status quo position. Here, it takes a five or six member coalition before overall welfare increases noticeably. This suggests that veto systems are least constraining when things are really bad for everybody, while under more average conditions most proposals for change will have negative effects on some vested interests, and thus are likely to be blocked.

4.5 Positive plus Negative Coordination plus Bargaining

The last coordination method to be looked at builds upon the previous one by adding a Bargaining element to the combination of Positive Coordination and Negative Coordination. Again, the leading coalition cannot impose negative externalities on outsiders. But when an initiative encounters one or more vetoes, the simulation program determines whether the potential net gains of the coalition exceed the loss that would be suffered by the veto players. If not, the move must be withdrawn as would be true under Negative Coordination. If the gain is large enough, however, the proposed move is carried out, the reservation payoffs of the veto players are maintained through transfer payments, and an equal amount is deducted from the aggregate payoff of the coalition members.

As a result, coalition initiatives are more frequently successful, and joint payoffs will rise more rapidly than they would under the combination of Positive and Negative Coordination alone. The impact on joint payoffs is quite dramatic (Diagram 9).

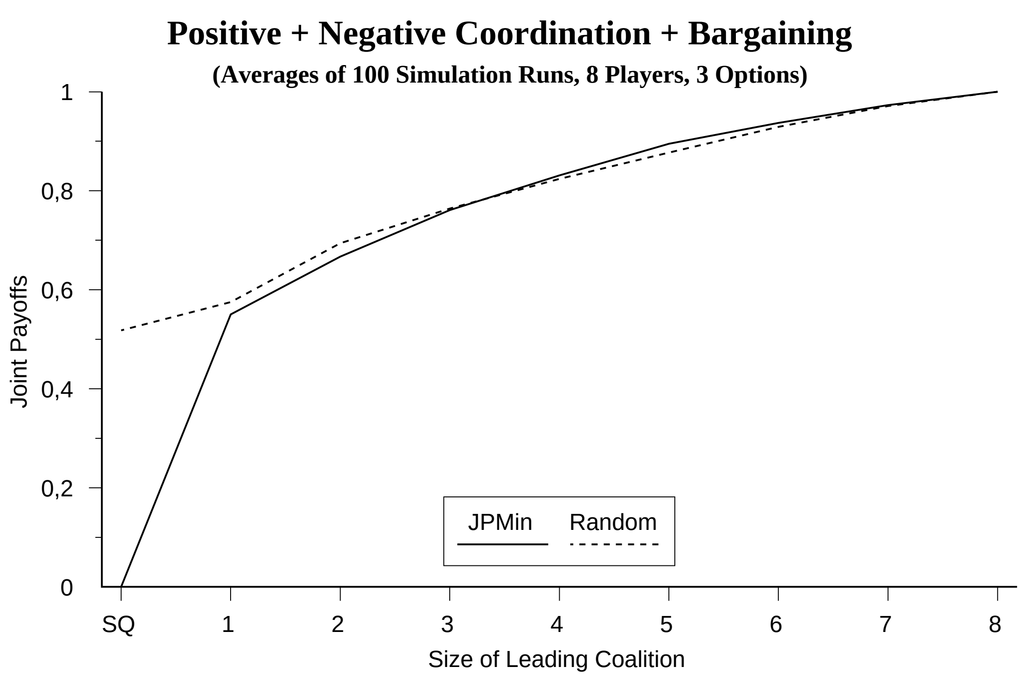

Diagram 9: Positive plus Negative Coordination plus Bargaining

Starting from the joint payoff minimum, even a single actor can raise aggregate welfare to a medium level when she is willing to engage in Bargaining. Beyond that, both curves are close enough to be practically indistinguishable, and as the size of the leading coalition increases, joint payoffs approach fairly rapidly toward the welfare maximum. Since vetos can be bought off, the location of the status quo (minimum or random) looses its determining power.

4.6 Comparative Discussion

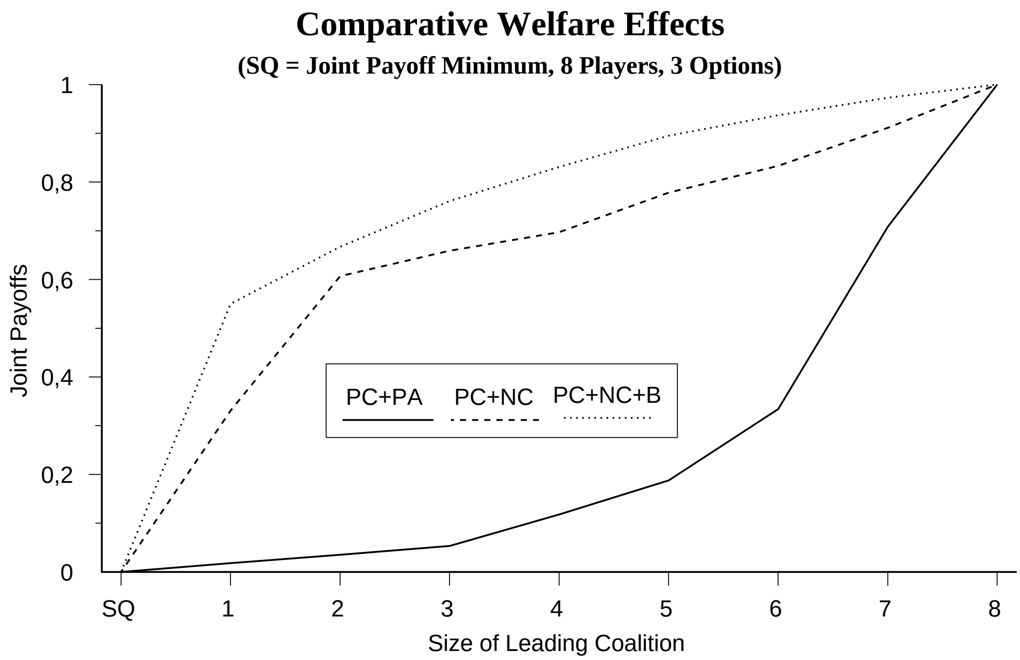

Diagram 10: Comparison of Welfare Effects when the Status Quo is at the Joint Payoff Minimum

When we now compare the welfare effects of combinations of coordination mechanism, our previous interpretations are confirmed. Leaving aside pure (dictatorial) Positive Coordination as being unrealistic under most circumstances, it appears that the most complex combination of Positive Coordination with Negative Coordination and Bargaining is generally the most welfare efficient method. It produces consistently superior welfare effects for all sizes of leading coalitions short of the grand coalition. This is true not only for constellations where the actors start from the worst possible situation, the joint payoff minimum (Diagram 10), but also when the process of bargaining starts from a randomly selected point of departure (Diagram 11). In both cases, even two or three member coalitions will be able to reach two thirds or three quarters of the maximum welfare level that can be obtained by the grand coalition.

For Positive Coordination plus Negative Coordination, however, the point of departure does make an important difference. When the actors start from a worst-case position, this method is almost as welfare-efficient as is the combination that includes Bargaining. But when everybody is reasonably well-off on the average, the veto system of Negative Coordination prevents improvements beyond the status quo. Even under those conditions, however, Positive Coordination plus Negative Coordination is more effective than the "laissez-faire" combination of Positive Coordination and Parametric Adjustment, in which small coalitions can pursue their own interests without exogenous constraints, but cannot prevent the unilateral readjustment of excluded players.

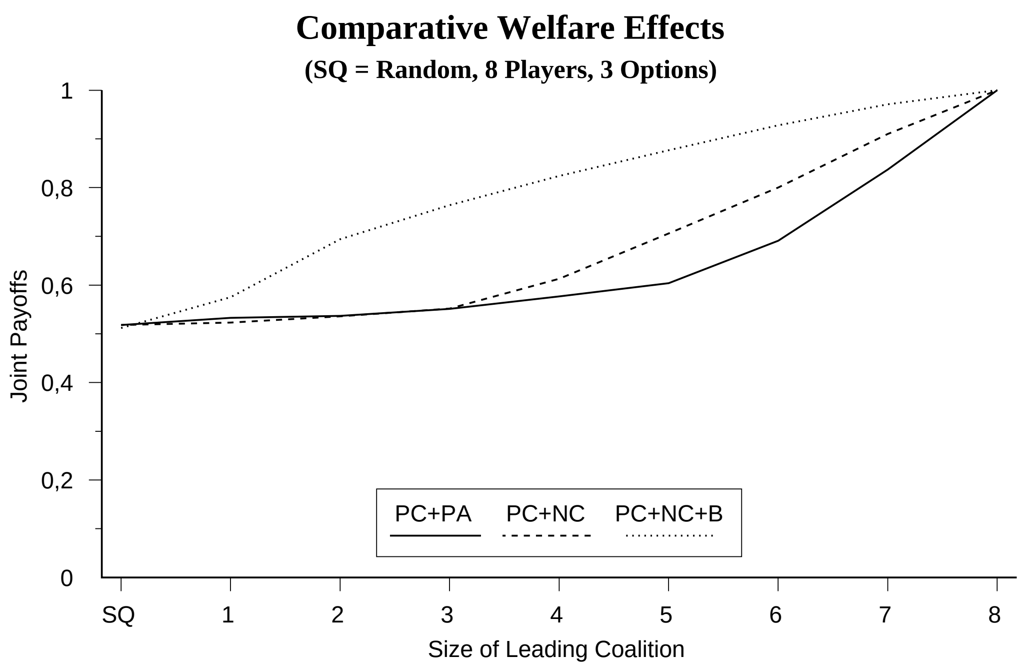

Diagram 11: Welfare Effects with Random Status Quo

These comparative results will also hold for simulation runs with larger numbers of options and larger numbers of players, while the combination of Positive Coordination and Parametric Adjustment will do relatively better if the number of players and options is reduced. What is less clear is how much these conclusions will actually mean in practice. In order to approach this question, we must now turn to the problem of transaction costs.

4.7 Transaction Costs

Transaction costs arise when actors must search for an optimal outcome and when the members of the leading coalition must agree on the distribution of their net gains. We begin with a discussion of search costs. Given the conditions of bounded rationality introduced above, players are assumed to have ex-ante information of their own status-quo payoffs and of their own options. They are also able to identify and compare the payoffs they receive, or would receive, if other players or they themselves makes, or proposes, a move away from the status quo - but they must do so at a cost. In addition, they must bargain over the allocation of aggregate gains within a coalition.

More specifically, when a leading coalition is enlarged, it is first necessary to identify and evaluate all outcomes that can be reached by combining the options of the members of the previous coalition with those of potential candidates for cooptation. The best of these outcomes determines both, the membership of the new leading coalition and its most preferred move. If Parametric Adjustment is combined with Positive Coordination, all players outside of the coalition must then respond to this move by examining their own options to see if it is profitable for them to change their position; other players, including the leading coalition, must then again evaluate their new options, and so on. In combinations of Positive Coordination, Negative Coordination and Bargaining, on the other hand, the best outcome obtainable by the leading coalition must be compared to the reservation payoffs of all outsiders in order to determine whether one or more of them will have reason to veto the proposal. If it is vetoed, the leading coalition will have to determine whether its aggregate gains are sufficient to compensate all losers. If not, the same procedure must be repeated for the second-best outcome obtainable by the leading coalition (provided that it exceeds the aggregate reservation payoffs of its members), and so on. If a profitable proposal is not blocked by a veto, the coalition must then distribute its net gains (i.e. the gains remaining after all reservation payoffs have been maintained through side payments) among its members through processes of converging offers and counter offers.

The simulation program includes an algorithm which keeps track of each step in this series of operations (see Appendix). On the heroic assumption that each of these steps represents the same degree of difficulty, or the same time delay, the number of transactions is aggregated over the whole history of a coalition-building and coordination process. In other words, the search costs associated with Positive-plus-Negative Coordination for a leading coalition of three members represent the cumulative costs incurred in a process that started with a single player who then coopted a second one, etc. These costs are significantly higher than they would have been if the process had started with a given three-member coalition. As a consequence, for larger leading coalitions the costs so defined will exceed those that would be incurred by negotiations in a grand coalition. Since we have generally characterized the transaction costs of (relatively large) grand coalitions as being "prohibitive", we have set these to unity and used them as an upper limit in Diagram 12 which also represents the welfare effects of the relatively most efficient combination of Positive Coordination, Negative Coordinaion and Bargaining.

When this Diagram is interpreted, two things must be kept in mind: First, transaction costs are interpreted as opportunity costs of the time that must be spent in negotiations. Since we can make no assumptions on the opportunities that are foregone, it is even problematic to assume (as we do) that costs should somehow be a linear function of time. Second, even though the maximum is set to unity for both curves, it should be clear that the scale of transaction costs is not comparable to the scale of joint payoffs. We also cannot tell at which point the relative differences in the transaction costs of different combinations of coordination methods will make a substantial difference in practice. All that we can say is that the number of operations required for arriving at a coordinated solution increases exponentially as the size of leading coalitions increases, but that it stays well below the level associated with the grand coalition when leading coalitions remain relatively small.

In addition to search costs, the members of the leading coalition also incur distribution costs when they must divide the net gains obtained at a particular stage of the game. In our model, fair distributions are achieved through the Zeuthen-Harsanyi process of "multilateral bargaining based on restricted bilateral bargaining" (Harsanyi 1977: 201). This means that each pair of coalition members will, through converging offers and counter offers, move toward a (preliminary) Nash distribution, and that the overall Nash solution is obtained when all bilateral distributions are in balance. Again, the program will record the number of offers needed, and compute an aggregate measure representing the transaction costs of distribution. These costs also increase exponentially with the size of the leading coalition. Examples are presented in the Appendix. Unfortunately, however, search costs and distribution costs are not directly comparable and hence cannot be aggregated to a single overall measure of transaction costs.

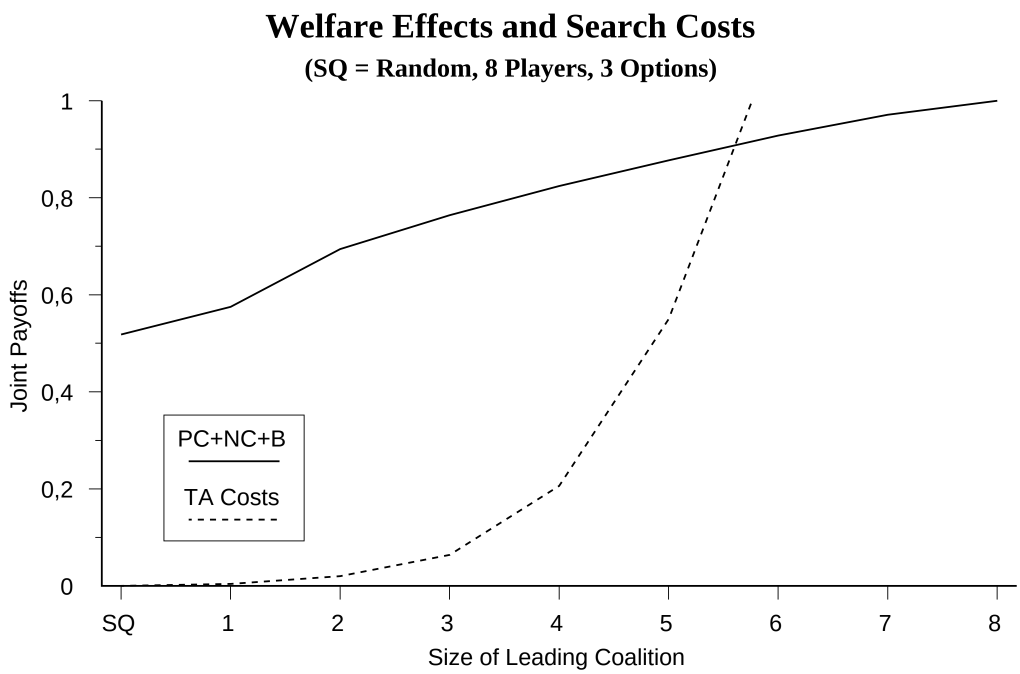

Diagram 12: Search Costs and Welfare Effects

5 Conclusions

If we now return to the questions from which we departed, it is clear that computer simulations of games defined by randomized payoff matrices are far removed from the actual practices of real-world policy networks. For this we make no excuses, since it has been our aim to clarify analytically some underlying tendencies, opportunities and difficulties, rather than to develop a realistic model of a specific negotiation situation. Within these limitations, however, our simulation analyses have confirmed the intuition that combinations of simple coordination mechanisms may have more attractive welfare effects than each of these mechanisms does when applied alone.[28] More specifically, we can now make the following assertions with greater confidence than before:

28 It may be useful to point out the difference between this proposition and the claim of Farrell and Saloner (1988) that technical standardization may be best achieved by a combination of coordination through committees and coordination through the market. In our terminology, the "committee" would be a grand coalition, and the "market" would be the equivalent of Parametric Adjustment. Thus, Farrell and Saloner suggest that members of a potential grand coalition might exit the coalition and play a noncooperative game against the remaining members - and they expect that this threat may facilitate agreement within the grand coalition. This is a constellation that we have not modelled.

(1) The Coase Theorem shows that, in the absence of transaction costs, negotiations (i.e., Positive Coordination) within a grand coalition that includes all members of a given population would reach the same welfare maximum as a benevolent and omniscient dictator could. But if, as Coase has pointed out, grand coalitions must, beyond a relatively small group size, run into prohibitive transaction costs, there is a premium on coordination mechanisms that will achieve relatively high welfare gains without coalitions or with partial coalitions of relatively small size.

(2) On the other hand, we have shown that two simple coordination mechanisms which altogether avoid coalitions, and on which Lindblom had placed high hopes - namely Parametric Adjustment and Negative Coordination (Deferential Adjustment) - will not, by themselves, be able to attain high welfare levels for the population as a whole in the general case. Coalitions thus seem to be a necessary element, under most conditions, of efficient solutions to the coordination problem.

(3) However, when relatively small leading coalitions are interacting with the rest of the population in a noncooperative game (i.e., Positive Coordination plus Parametric Adjustment), the welfare consequences are also unattractive. Welfare gains that could be achieved by Positive Coordination within the coalition are partly wiped out through the countermoves of outsiders except when the leading coalition is fairly large relative to the total population (implying high transaction costs). Thus, the most laissez-faire form of coordination, in which both small coalitions and individual actors are pursuing self-interested goals in the absence of formal constraints, is also not an efficient solution.

(4) It seems therefore that the need to achieve agreement with outsiders, through Negative Coordination and Bargaining, is an essential element of any efficient solution. When individual actors and coalitions are constrained to avoid negative externalities on outsiders, their search for self-interest maximizing solutions will necessarily increase general welfare at the same time - and the same is true to an even greater extent when transfer payments permit welfare-improving solutions to be realized even when negative externalities (which are smaller than the potential gains) are present.

The conclusion is, therefore, that even though the welfare maximum could only be obtained by the all-inclusive grand coalition, the combination of Positive Coordination, practiced within relatively small leading coalitions, and Negative Coordination or Bargaining with the remaining members of the population, is able to achieve intermediate levels of general welfare relatively efficiently.

In that sense, therefore, our simulation study supports Lindblom's optimistic expectation that, in the absence of a well-informed and public-spirited central coordinator, and even in the absence of individual and corporate actors who are primarily motivated by the public interest or by considerations of "system rationality", negotiated self-coordination in policy networks may improve the level of general welfare.

It is necessary, however, to emphasize two structural preconditions on which this optimistic expectation depends: First, we have modeled constellations in which action resources are not collectivized or centralized, but distributed among individual actors. Second, unless the total population of actors is very small, successful self-coordination presupposes a division between a leading coalition whose members are willing and able to practice Positive Coordination internally, and the remaining population of interdependent actors. Third, there must be an exogenous[29] rule according to which the status-quo interests of any actor cannot be invaded without her consent. These institutional preconditions are by no means ubiquitous (thus we are far from asserting the benevolence of an institution-free "invisible hand"), but they are not infrequently approximated, not only in the private-law world of contracts and torts, but in public-sector policy processes as well.

One example is provided by the institutional circumstances in which Mayntz and Scharpf (1975) first discovered the coexistence of Positive and Negative Coordination: bureaucratic policy making in a government where policy responsibilities are distributed among ministries, and where the Cabinet will not ratify policy initiatives in the face of unresolved interdepartmental conflict. Another example is the present system of policy-making within the European Union, where the Commission is free to develop its policy initiatives in intense negotiations with a small set of interested member states, but must ultimately respect the veto positions of practically all other member states when ratification in the Council is required (Héritier 1993; Tsebelis 1992). Structurally similar conditions exist within the committee system of the United States Congress which Lindblom had in mind when he discussed the virtues of "Partisan Mutual Adjustment". Many similar examples can easily be found.

However, one further caveat is in order. Our analysis throughout was based on the assumption that all actors are maximizing their own self-interest. This seems like a pessimistic assumption when contrasted to postulates of solidaristic

29 The rule may emerge endogenously in a history of interactions among interdependent and self-interested actors (Scharpf 1993), but it is exogenous to the specific interaction at hand.

or public-spirited action orientations. But it is also an extremely optimistic assumption when the real possibility of competitive ("relative-gains") or even hostile orientations is considered (Scharpf 1989; 1990; Grieco et al. 1993; Keck 1993). That such orientations can prevent negotiated self-coordination is illustrated not only by the conflicts in Northern Ireland or in the former Yugoslavia, but also in the German political system under conditions of divided control, where one of the two major parties is in control of the Bundestag while the other one controls a majority of Laender votes in the Bundesrat. When that is the case, the relative-gains logic of party-political competition interferes with the self-interested give-and-take that ordinarily characterizes federal-state and state-state Bargaining (Scharpf 1994). Under such conditions the welfare benefits of negotiated self-coordination are hard to realize.

Finally, we should also point out that our simulation only provides a model of coordination in situations where welfare *improvements* over the status quo are possible. We cannot draw any conclusions for constellations in which inevitable welfare *losses* must be accommodated (which may increasingly be the situation facing highly industrialized western democracies). Our hunch is that in these situations veto systems, regardless of whether vetoes can be bought off or not, will be less able to minimize the overall loss than systems in which unilateral action is unconstrained (Positive Coordination plus Parametric Adjustment). But since we have not yet modeled such constellations, we are unable to test this hunch.

6 Appendix: Transaction Costs

In some stages of the simulation, the program uses a "transaction cost counter". Costs emerge when

- players must identify and evaluate the effect of a potential or actual move on their own payoffs; (evaluation costs);

- players, or a coalition of players, must find the best option or combination of options out of the set of all available options (optimization costs); and when

- the members of a leading coalition must divide their net gains (distribution costs).

For evaluation and optimization, the cost of primitive events, which are then aggregated into transaction costs are defined by two constants:

TEval: the cost of identifying the effect of a single move for the payoff of a single player;

TOpt: the cost of comparing a pair of outcomes.

Both of these constants can be interpreted as opportunity costs of time; hence it is possible to aggregate them into a single measure. In the program, they are arbitrarily set at

TEval = TOpt = 0.01.

The costs emerging when members of the leading coalition must divide their net gain are conceptually different from costs of evaluation and optimization; they cannot be added to the costs of evaluation and optimization, and hence will be treated separately below.

In addition, we use the following abbreviations:

n: number of players;

s: number of options that a player can exercise;

k: size of the leading coalition.

6.1 Evaluation and Optimization Costs

Players are assumed to have costless information of their own payoffs in the status quo situation. They incur evaluation costs in identifying their own payoffs in all other outcomes. In addition, players, or coalitions of players, incur optimization costs in choosing the best one in a set of feasible outcomes. The optimization procedure is based on pairwise comparisons among the outcomes available.

Beyond this, we assume costless information transmission and information processing. Thus, members of a coalition are able to communicate their own payoffs to each other, and to aggregate these payoffs, at no additional cost. Similarly, players outside of the coalition are assumed to be able to transmit true information about their reservation payoffs and the payoffs expected from a proposed move of the coalition, and the coalition will be able to calculate the aggregate side payments and compare them to its own expected gains, all without incurring additional transaction costs.

6.1.1 Positive and Negative Coordination

We assume that a leading coalition of size k-1 is first to be enlarged to k members, and that it will then have to clear its proposed move with n-k potential veto players outside of the coalition. Thus, total transaction costs will consist of evaluation costs of the coalition, optimization costs of the coalition, and evaluation costs of veto players.

(a) Evaluation Costs of Coalition

When the leading coalition is examining the first candidate for cooptation, the available combinations of all options will yield a total of s^k feasible outcomes which amount to $s^k \cdot k$ payoffs for individual players. The k-1 players already in the coalition know their own payoffs for all their options. They had to calculate these $(k-1) \cdot s^{(k-1)}$ payoffs when the coalition of k-1 emerged from the one with k-2 members by coopting the [k-1]th player. The kth player also knows her payoff in the actual status quo. Hence, the total number of payoffs which need to be evaluated is reduced by $[(k-1) \cdot s^{(k-1)} + 1]$, so that evaluation costs will amount to

$$TEval \cdot [k \cdot s^k - (k-1) \cdot s^{(k-1)} - 1].$$

The same evaluation must also be carried out for all of the n-(k-1) candidates for cooptation. The evaluation of all opportunities for coopting an outside player to enlarge the leading coalition thus produces total evaluation costs amounting to

$$TEval\cdot(n-k+1)\cdot[k\cdot s^{k} - (k-1)\cdot s^{(k-1)} - 1].$$

(b) Optimization Costs of Coalition

In order to decide which player to coopt, the leading coalition must first determine the best outcome obtainable with each candidate, and then choose the candidate whose cooptation could achieve the highest aggregate gain over the reservation payoffs of all coalition members. Since s^k outcomes can be realized with each candidate, the determination of individual optima requires s^k-1 pairwise comparisons for each of n-(k-1) candidates; and the determination of the overall optimum is then achieved by n-k pairwise comparisons among individual optima. Thus, the overall optimization cost amounts to

$$TOpt\cdot[(s^{k}-1)\cdot(n-k+1) + (n-k)].$$

In order to propose its best move, therefore, the enlarged coalition incurs evaluation costs and optimization costs amounting to

$$TOpt\cdot[(s^{k}-1)\cdot(n-k+1) + (n-k)] +$$
$$TEval\cdot(n-k+1)\cdot[k\cdot s^{k} - (k-1)\cdot s^{(k-1)} - 1].$$

(c) Evaluation Costs of Veto Players

Each of (n-k) players outside of the coalition must then determine her own payoffs in the outcome proposed, and compare these to her reservation payoffs, in order to decide whether to exercise her veto power. The total cost will be

$$TEval\cdot(n-k).$$

(d) Further Proposals

If the first outcome proposed by the coalition is blocked by a veto, the coalition will then propose its second-best outcome, and so on, until a proposal is accepted or until the coalition has no more profitable proposals to make - at which point the next round of cooptation will begin. Since the coalition now knows all its options, it will incur no further evaluation costs. And since the membership of the coalition will remain constant, there is also no need to compare solutions that could be obtained with different candidates for cooptation. Moreover, since one solution was used up in the previous trial, finding the second proposal will require only (s^k-2) pairwise comparisons. More generally, making its i^{th} proposal, the coalition will incur optimization costs amounting to

$$TOpt \cdot (s^k - i).$$

Since players outside of the coalition will have to evaluate each proposal in order to decide whether they should exercise their veto power, each further proposal will also generate evaluation costs amounting to

$$TEval \cdot (n-k).$$

6.1.2 Positive plus Negative Coordination plus Bargaining

In order to arrive at its first proposal, the coalition incurs exactly the same evaluation and optimization costs as discussed above. The same is true of the evaluation costs incurred by players outside of the coalition. However, if the proposal is vetoed, the coalition must now determine whether its aggregate gains are sufficiently large to restore the reservation payoffs of the veto players. Under our assumptions, these additional evaluations will not generate additional costs: All payoffs have been evaluated before, while the truthful communication of payoffs and reservation payoffs, and the correct calculation of minimal compensation are treated as being costless.

In this regard, our model is obviously not realistic. In the real world, the compensation of negative externalities will involve negotiations in which parties will have an interest in dissimulating their true preferences, and in which veto players will not necessarily be content with minimum compensation. Thus, in comparison to Positive plus Negative Coordination, the transaction costs of Positive plus Negative Coordination plus Bargaining are underestimated in our model. We leave it at that, for the time being. The reason is that we could not use an aggregate measure since we have no plausible criteria for defining the relative weights of evaluation and optimization costs on the one hand, and of bargaining costs on the other hand.

6.1.3 Positive Coordination plus Parametric Adjustment

Again, the process of coalition formation involves the same evaluation and optimization costs that were defined above for Positive plus Negative Coordination. Thus, when a leading coalition is enlarged from (k-1) to k members, these costs also amount to

$$TOpt\cdot[(s^k-1)\cdot(n-k+1) + (n-k)] +$$
$$TEval\cdot(n-k+1)\cdot[k\cdot s^k - (k-1)\cdot s^{(k-1)} - 1].$$

Since there are no veto positions this time, the coalition is able to carry out its most preferred move. In the ensuing sequential game between the coalition and all other players, the accumulation of costs depends crucially on the number of moves required until either a Nash equilibrium is reached, or until the players are caught in a cycle. In the course of this game, the situation is constantly changing, so that players need to evaluate and optimize their choices whenever they are in a position to move. In every case, the right to move goes to the actor - an individual player or the leading coalition - with the highest expected per-capita gain. Thus, when an individual player is about to move, she will incur evaluation costs amounting to

$$TEval\cdot(s-1)$$

plus optimization costs of

$$TOpt\cdot(s-1).$$

Similarly, when the coalition is about to move, the evaluation costs will amount to

$$TEval\cdot(s^k-1)\cdot k$$

while the search for the optimal move incurs optimization costs of

$$TOpt\cdot(s^k-1).$$

These costs are accumulated until the sequential game comes to an end, either in a Nash equilibrium or when a cell is reached for the second time, and with the same actor in the position to move, so that game would move into a cycle.

6.2 Distribution Costs

An outcome that is profitable for the coalition as a whole may have very different effects on the payoffs of individual coalition members. Some may obtain large gains, while others may even suffer losses in comparison to their reservation payoffs. Since disadvantaged members may threaten to break up the coalition, a fair distribution must be negotiated. For our purposes, the criterion of fairness is defined by the Nash bargaining solution. In order to determine the transaction costs of reaching this solution, our simulation model approximates the Zeuthen-Harsanyi process of "multilateral bargaining based on restricted bilateral bargaining" (Harsanyi 1977: 141-166; 196-201). It implies that the overall Nash solution can be reached if each pair of players is bargaining toward a bilateral Nash solution, given the payoffs of all other players. The process is illustrated in the following example.

Assume a leading coalition consisting of three players, x, y and z, all of whom enter the game with a reservation payoff of 2. Assume further that the best outcome that the coalition can obtain would initially provide payoffs of (3 11 0) to x, y and z respectively. The coalition as a whole would achieve a net gain of 8 units, but player z would suffer a loss of 2 units. She would be better off leaving the coalition - in which case nobody would gain anything. As a consequence, the reservation payoffs of all losers must be restored before bargaining over the fair distribution of net gains can even begin. In order to keep our model simple, however, this initial compensation of losers is also handled through the Zeuthen-Harsanyi bargaining procedure.

In our example, player z will initially challenge player y for a compensation of 2 units. Since her threat of breaking up the coalition is entirely credible, y will have to yield to this demand. Thus, bargaining over the fair distribution of net gains will begin from a new outcome in which x, y and z will initially have payoffs of (3 9 2) units, respectively. Bargaining is modeled as a sequence of bilateral challenges in which one player demands a transfer from another player. The demand is successful if the challenged player has more reason to avoid the risk of breakup than the challenger. This notion is operationalized in Harsanyi's concept of "risk limit" as a ratio of the concession a player is asked to make and of the loss she would suffer if negotiations fail (Harsanyi 1977: 151). The player with the lower risk limit will yield.

In our model, we assume that the worse-off player will always challenge the better-off player to transfer a single unit of utility while the better-off player will demand maintenance of the status quo. In our example, therefore, player z would begin by demanding 1 unit from y - which would reduce y's payoff to 8, and increase z's own payoff to 3. If agreement is not reached, all would end up with their reservation payoffs of 2. Thus, y must compare the cost of concession [(9-8) = 1 unit] to the cost of disagreement [(9-2) = 7 units], to arrive at a risk limit of 1/7. By contrast, for z the cost of concession and the cost of disagreement would both be (3-2), amounting to a risk limit of 1. Thus, y would yield, and the new payoff distribution would be (3 8 3) for x, y and z respectively.

In the next round, y's risk limit would rise to (8-7)/(8-2) = 1/6, but z's limit, while reduced to (4-3)/(4-2) = 1/2, would still be larger, so that Y would again pay the transfer, and so on. Payoffs would thus change, step by step, from

(3 9 2) to (3 8 3) to (3 7 4) to (3 6 5) as y is forced to transfer one unit after another to z.

In the next round, y's risk limit would be (6-5)/(6-2) = 1/4 while z's limit would also have fallen to (6-5)/(6-2) = 1/4. Thus, there is now no reason why y should make further concessions to z; instead, z would have to withdraw her challenge in order to avoid a breakup. But now the next most disadvantaged player x will enter into bilateral negotiations with y. Her first challenge will also be successful, leading to a payoff distribution of (4 5 5). Beyond this point, no player will be able to successfully challenge any other player, and the outcome so obtained will be the best approximation of the Nash distribution that can be achieved.

In order to compute the transaction costs of distribution, the program counts the number of bilateral bargaining steps that are necessary in order to reach the Nash solution. Since players will not be directly informed of this event, however, there will be final sequence of unsuccessful challenges involving all pairs of players, adding $k \cdot (k-1)/2$ steps to the previous total. The overall measure of distribution costs will, of course, vary exponentially with the size of the coalition. However, under the assumptions which we have introduced the aggregate size of transaction costs depends also on the size of the net gains that a coalition must distribute, and on the inequality of the initial distribution. Moreover, the number of negotiations that are required in order to reach a Nash distribution is also affected by the size of the units, relative to total gains, which are the object of demands in each challenge. As a consequence, distribution costs can be compared only within payoff matrices of a given dimension, and they cannot be aggregated with evaluation and optimization costs (search costs) into a single measure of overall transaction costs.

6.3 Comparison

We therefore use separate diagrams to show that both types of transaction costs generally increase exponentially with the size of the leading coalition (Diagram 13 and Diagram 14). The diagrams also show that the costs incurred when leading coalitions are enlarged incrementally, will eventually exceed the transaction costs of a grand coalition that is formed directly.[30] When the size of leading coalitions is limited to less than half of the total population, however, trans-

30 All values in Digram 13 and Diagram 14 are standardized by the transaction costs the grand coalition would incur. These are fixed at 1.

action costs remain well below those that would be incurred by a grand coalition.

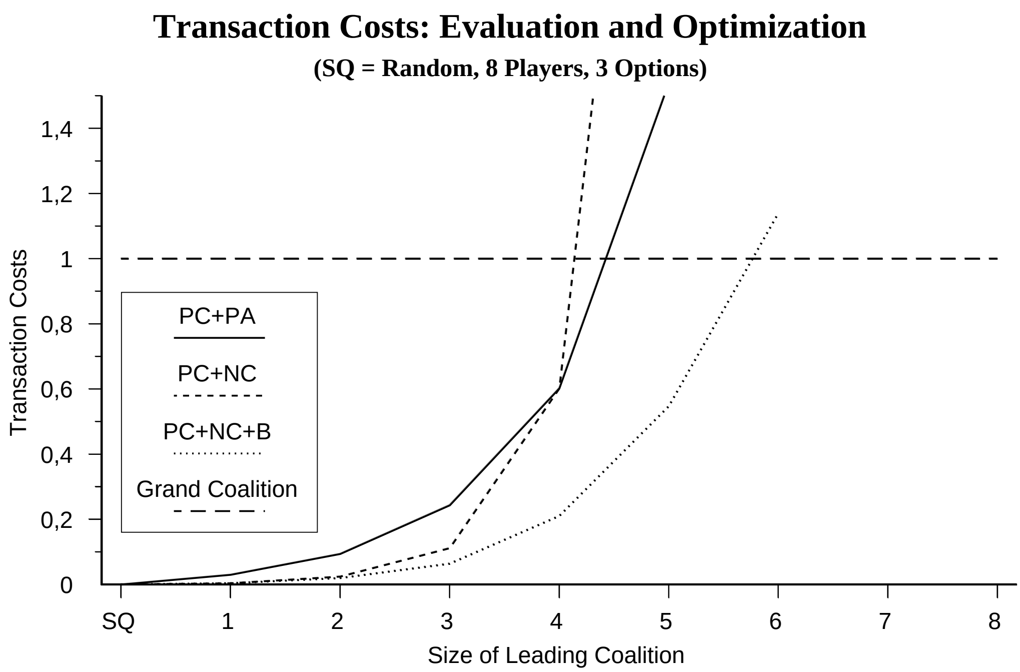

Diagram 13: Costs of Evaluation and Optimization

As Diagram 13 shows, search costs are lowest for combinations of Positive plus Negative Coordination plus Bargaining (PC+NC+B). This is explained by the fact that Bargaining reduces the number of instances in which the leading coalition must recalculate its own options. In the absence of Bargaining (i.e., in PC+NC), the leading coalition must find its next-best move whenever it encounters a veto,[31] while in PC+NC+B this veto can often be bought off by the offer of compensation (which, under our assumptions, will not entail additional transaction costs). The relatively high costs associated with the combination of Positive Coordination and Parametric Adjustment (PC + PA) reflects the large number of moves and counter-moves (each requiring evaluation and optimization) which may be needed before the noncooperative game will come to rest in an equilibrium or enter into a cycle.

31 For similar reasons, transaction costs are initially lower if the game starts from a status quo position in which joint payoffs are at a minimum. When the reservation payoffs of most players are very low, new initiatives will encounter fewer vetoes than if the game starts from a status quo situation selected at random. It can also be shown that the effect of the selection of the first status quo is stronger in PC+NC than in PC+NC+B.

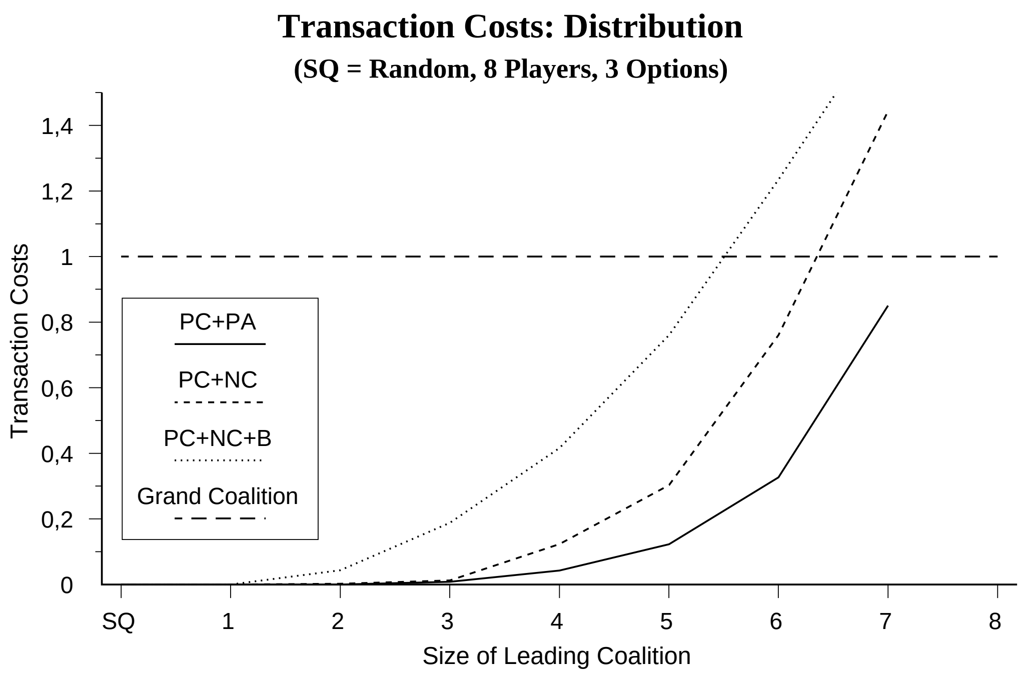

Diagram 14: Costs of Distribution

The variation in the transaction costs of distribution (Diagram 14) is explained by the fact that, ceteris paribus, the number of offers and counteroffers required to reach a Nash distribution depends not only (exponentially) on the size of the leading coalition, but also on the size of the net gain which the coalition must distribute among its members. Thus the combination of Positive plus Negative Coordination plus Bargaining (PC+NC+B), which produces the largest gains for the coalition, is also associated with the highest transaction costs of distribution. Conversely, the combination of Positive Coordination and Parametric Adjustment (PC+PA) which is least attractive from the coalition's point of view, because potential gains are often wiped out by countermoves of players outside of the coalition, also incurs the lowest costs of distribution. Distribution costs are also relatively low for (PC+NC) where the gains which the coalition can achieve are limited by the exercise of vetoes.

Unfortunately, for our purposes, this also means that the procedure associated with the lowest search costs (PC+NC+B) is also the procedure with the highest distribution costs. Moreover, as was pointed out above, the magnitudes of these different types of cost cannot be directly compared or aggregated into a single measure. Thus we are unable to present conclusions about the relative cost intensity of different coordination procedures. All we can say is that all are associated with transaction costs that increase exponentially with the size of the leading coalition.

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