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Dynamics of International Negotiations. A Simulation of EU Intergovernmental Conferences

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Abstract

Complex negotiations seem indeterminate. In constellations with many negotiation parties, each consisting of internal factions, varying internal decision rules and more or less defined organizational boundaries, bargaining over multiple issues over more than one sequence, make outcomes unpredictable. Despite providing useful abstract representations of such processes, game theory is often limited to highly stylized set-ups. Relying on the behavioral assumptions of the Zeuthen-Harsanyi process model we propose a dynamic simulation model. We explicitly take into account of preferential and informational determinants of governments' risk attitudes. We empirically confront predicted outcomes with actual negotiation outcomes, using quantitative data for the complex multi-lateral, multi-level, multi-issue negotiation system of the EU intergovernmental conference of 1996, which resulted in the Amsterdam treaty.

Contents

1 Introduction[1]

Why do international negotiations fail or succeed? The success story of the constitutionalization of the European Union seems to be seriously challenged since december 2003 when the head of member states admittedly failed to decide on a proposal on it's future constitution. Media ventilated the reason to be the obstinate refusal of Poland and Spain to accept a new reweighting of votes. This reweighting would have abolished a compromise of the conference in Nice in 2000. Obviously, previously applied techniques of compromising during long negotiations were not successful – or even attempted.

However, the public impression of one-shot intergovernmental conference negotiations and the invoking of a single cause of failure are inconclusive. Such negotiations span months of formal meetings and informal coordination between member states. Furthermore, they are not separated from ongoing political business and events - at the international as well as at the domestic level. Therefore, an understanding of negotiation outcomes has to take account of the specific form of the underlying processes and its' connectedness to process-relevant determinants.

Unfortunately, our knowledge about processes and dynamics of negotiations is scant. Whereas the sophistication of game-theoretic models has increased enormously during the last decade, their model setup remains highly stylized. The identification of necessary assumptions for a sequential two-player game immediately ending in a unique equilibrium is ingenious and instructive. However, it does not answer our question. Even if there is a convergence of real world negotiations towards the non-cooperative result of the Rubinstein model or the cooperative Nash-bargaining solution, we would like to know the actors' microbehavior in getting these macro-results.

In the following, we use the Zeuthen-Harsanyi model of concession behavior - a predecessor to the Rubinstein model – as a framework for simulating the dynamics of a multilateral, multiple issue, multi-stage, multi-level negotiation system, the EU Intergovernmental Conference 1996 leading to the Amsterdam treaty. The objective of this analysis is to contribute to a 'comparative game dynamics' (Richards 2000: 176, see also Aoki 2001). Simulation is an appropriate tool for coping with actors' strategic choices over time and learning. In order to evaluate the appropriateness of our simulation model we compare the predicted outcome with the actual Amsterdam outcome. We use a new data set (cf. Thurner/Pappi/Stoiber 2002) including quantitative data on relevant domestic organizational structures as well as preferences of the involved governmental actors (EU member states' ministries, premiers' offices and – where existent – presidential offices).

First, we present the debate with regard to the dynamics of EU integration and it's constitutionalization. Then, we give an overview on the literature on (international) negotiation processes and it's shortcomings. Next, we introduce the Zeuthen-Harsanyi model as a behavioral negotiation model. This is followed by a chapter on the advantages of simulations social sciences. We provide the formal

[1] This work was financially supported by the MZES. We wish to thank Eric Linhart, Franz Urban Pappi, and the anonymous referees for helpful comments.

set up of our modification and translation of the Zeuthen-Harsanyi model into a dynamic simulation model with incomplete information. Finally we present our empirical results.

2 The Gradual Constitutionalization of the EU: Backgrounds of Theorizing

Which were the driving forces of European Integration? For certain historians the answer would be clear: Personalities like Jean Monet, Jacques Delors etc. More generalizing sciences are looking for structures: For the realist school in IR it is the structure of the international system, i.e. the distribution of power between nations. According to (Neo-) Functionalism (cf. Haas 1964, Sandholtz/Sweet Stone 1998) increasing regional economic interdependencies induce demands for international political coordination and cooperation. In this view, European societal integration has given rise to a supranational organization. Once established, its institutions are expected to have their normative repercussions back onto the national level. Domestic political structures are regarded merely as objects of integration.

Intergovernmentalism views European integration as a sequence of intergovernmental bargains on treaties with the governments continuing to be the 'Masters of the Treaty'. Power asymmetries between nations find their way into the choice of constitutional options. Contrary to realist approaches where domestic institutions are considered to be irrelevant, because nations are assumed to react in a similar way externally, liberal intergovernmentalism acknowledges the importance of domestic preference formation. However, it lacks an explicitly formulated suggestion how these processes could be conceived.

Multi-level approaches propose to take into account both domestic interests and institutions as well as international and supranational constellations (cf. Hooghe/Marks 2001). However, as Tsebelis/Garrett (2001) criticize, political-science proponents of this approach content themselves with descriptions. Up to now, only game-theoretic approaches exhibit analytic ambitions (Iida 1993a, 1993b, Mo 1995, Pahre 1997). Even proponents of the concept of multi-level decision-making are rather sceptical about its empirical applicability: "Although promising as a framework for analysis, this approach does not constitute a theory with testable hypotheses, as even its proponents admit." (Milner 1997: 4).

Taking stock of the huge literature on EU constitution building, there is a conspicuous asymmetry: interstate bargaining processes during European Intergovernmental Conferences are extensively investigated from legal, historical and political science views.[2] Contrary, there are only few studies investigating preference formation processes at the domestic level[3] during such conferences. This is surprising as it is common wisdom of the negotiation literature that 'real negotiations are at home' (Moravc-

[2] For a recent view, cf. Smith 2002.

sik/Nicolaidis 1999: 66, Raiffa 1982). There are several case studies focusing on intranational preference formation for single Member States. The edited volume of Laursen (2003) collects case studies for each of the member states' 'national preference formation'. Despite providing descriptive insights, these studies are neither theory-guided nor do they follow a common research framework. Therefore it is rather hard to draw generalizations. Only recently, Thurner/Pappi/Stoiber 2002 provide a theory-guided handbook including a section on comparative domestic preference formation focusing on cabinets. Taking a quantitative approach, the handbook contains all issues and the respective options as prepared by the Service Juridique of the Council's secretariat. The authors present formally as well as informally involved domestic actors, their most preferred issue options, their intragovernmental and transgovernmental network relations, and the sequence of proposal making at the interstate level[4]. We take the richness of this data set as an invitation to reconstruct real negotiation processes by simulating a specific process dynamic and by confronting predicted outcomes with actual outcomes.

3 Models of International Negotiations Processes

Recent approaches consider the design and redesign of political constitutions and institutions as the result of a continuous bargaining process. (Cooter 1999, Doron/Sened 2001). In this view, political entrepreneurs invest in the supply of collective goods, i.e. in creating and enforcing rules, anticipating rents from their political activity. The actors may be conceived as individuals (state leaders) or corporate actors (governments) and they may act at any identifiable level of an existing political system – from the local level to the international sphere. What distinguishes this positive approach from previous normative ones is that political actors are conceived as striving for their own benefit and institutions are understood as the more or less stable outcome of their bargains (Knight 1992, Sened 1997, Doron/Sened 2001). Strategic actors deciding in the international sphere are considered to take into account both domestic as well as international constraints (Bueno de Mesquita 2003). More specifically, negotiations in the international sphere are characterized by a less institutionalized context, i.e. the commitment to rules are far less credible/guaranteed. The Hobbesian state of nature permanently jeopardizes fragile international law and conventions.

Non-cooperative game theory is a natural candidate for the parsimonious representation of interdependent decisions in such contexts. Game-theoretic approaches define bargaining as follows: „Bargaining is any process through which the players on their own try to reach an agreement. This process is typically time-consuming and involves the players making offers and counteroffers to each other" (Muthoo 1999: 2). According to most of the definitions, this nature of process and sequentiality is inherent to bargaining and negotiations (cf. Bartos 1974, Zartman 1978). Informal approaches try to identify and classify distinct phases of negotiations (cf. Dupont/Faure 1991) without providing insights

[3] Notice that there is an increasing literature on the transformation and adaptation of national administrations with regard to the preparation and implementation of EU policies, cf. Laursen 2003. However, this literature does not specifically deal with the preparation of Intergovernmental Conferences.

[4] For a more detailled analysis on this aspect, cf. Thurner/Kroneberg/Stoiber 2003.

as to the driving forces. For a long time, even game theory had "[l]ittle to offer in analyzing the sequences of actions and reactions (or offers and counteroffers) through which the participants ultimately arrive at a specific bargain" (Young 1975: 37). Nash's cooperative bargaining solution as well as the equilibrium conception abstract from the dynamic process leading to the outcomes. The meanwhile classic model of alternating offers under perfect information (Rubinstein 1982) explicitly introduces sequences of moves. However, the supposed sequencing is rather spurious because of the rational players' instantaneously finding an agreement. There is no place for delay, moves, and disagreement (cf. Crawford 1985). Recent studies accentuate the fact that the Rubinstein alternating-offers set up is only one possible *procedure* of bargaining. Here, procedure is defined as "[t]he structure of moves of the bargaining process – it defines the rules of the bargaining game." (Muthoo 1999: 188) The respective definition of "[w]ho makes offers and when can have a significant impact on the bargaining outcome" (Muthoo 1999: 188). Furthermore, these approaches criticize Rubinstein's assumption that offers once they have been made can be withdrawn at will. Extensions of these models consider the credibility of declared commitments as variable and connect their gradual revocation to the respective revocation costs (for an overview cf. Muthoo 1999: 211f). One version supposes simultaneous initial offers. In case of incompatibility, the second stage consists of concessions in order to overcome the deadlock situation. The sequencing of concessions depends on the distribution of information and actor-specific incidence of revocation costs. However, like in the Rubinstein model, the equilibrium is reached instantaneously. In case of incomplete information, equilibria are no more unique or even efficient – as long as one avoids the restrictive assumption that only those actors concede who lack private information with regard to their own valuation of the issue (cf. Muthoo 1999: 293).

As a conclusion we recognize that bargaining analysis continues to lack a genuine theory about the processes of bargaining (cf. Muthoo 1999: 188). However, theoretical misspecification of the rules of actual games prevents us from understanding the real forces behind the dynamics (Brams 2000). For a reasonable assessment of outcomes it is crucial to know "who makes offers and when" (Muthoo 1999: 188). The gap of knowledge is even deeper with regard to the determinants of negotiation dynamics. Recent studies urgently demand to consider the perceptions and the expectations of decision makers in the light of their national as well as international constraints (cf. Bueno de Mesquita 2003: 343f).

We follow these suggestions and propose a simulation approach in which we represent the "…negotiating activity as a series of sequences, during which negotiators propose joint strategies, representing demands and offers, proposals and counterproposals, tending typically to converge as a result of an exchange of concessions" (Bartos 1974). For this aim we translate a game-theoretical inspired process model, the Zeuthen-Harsanyi model into a dynamic model. We enrich it with regard to determinants of risk behavior and information distribution and test the respective modifications with regard to their descriptive accuracy.

4 The Zeuthen-Harsanyi Model as a Behavioral Negotiation Model

Harsanyi (1956, 1977)[5] has elaborated a formal model, which tries to reconstruct how two rational bargainers' negotiations finally converge to the Nash equilibrium. This model is based on Zeuthen's bargaining theory (Zeuthen 1968, first 1930). Initially, the two parties are demanding outcomes at preferred points P_i and P_j, respectively. The algorithm assumes that both parties contemplate a static utility frontier in order to find some point on it that will be mutually acceptable. Only two additional variables are introduced to explain the negotiation process: The maximum probability of conflict that each player would be willing to accept in preference to acquiescing in the current offer of the other side (in short "risk of conflict"), and the size of the concession that each player will make. At each point of time, each player first compares the utility that he/she can achieve with certainty by giving in completely to the other's demand to the expected utility implied if he/she holds out for his/her own demand. Second, each player decides about making a concession, or not. A player will make a concession if the maximum subjective probability of conflict that this player can stand is below that of the other player. The maximum subjective probability of conflict of player i is obtained as the quotient of the cost of accepting the offer of the other player j (calculated from the difference of the utilities of the last offers of players i and j to player i) and the cost of stubbornness of player i (calculated from the difference of the utility of the last offer of player i to player i and the cost of conflict to player i). Both players make simultaneous concessions if their probabilities of conflict are equal. However, neither makes a complete concession to the other's current demand. Instead, each player concedes only enough to make it the other player's turn to make a concession, too.

There has been some criticism to this model: We will concentrate on four aspects, here. (1) The assumption of perfect and complete information, (2) the static nature, (3) the extreme parsimoniousness of the model, and (4) its ability to model strategic interaction.

(1) Several authors have criticized that many assumptions of the Zeuthen-Harsanyi model are ad hoc (Young 1975, Berninghaus/Ehrhart/Güth 2002). Young argues that these assumptions are made only for one reason: "Zeuthen's restrictive assumptions have the effect of giving the parties perfect information (or … the ability to arrive at confident expectations about each other's probable behavior), with the result that each can treat his decision-making environment at any given moment in time as if it were fixed" (Young 1975: 135f.) It is heroic to assume that each individual is able to attach a precise and meaningful value to the risk of conflict that the other side is willing to accept. Both sides have every incentive to manipulate each other's information on this point, as well as their most favored outcomes, and their understanding of the other's side's offer:

> "… there is nothing intrinsically necessary about the assumption that the next concession will come from the side willing to withstand the smaller risk of conflict. If this relationship were not fixed by assumption and buttressed by additional assumptions affording the parties confident knowledge of each other's willingness to accept risk, the question of priority in the making of

[5] See also the presentations of this model in Holler/Illing 2000, and Esser 2000.

> concessions would become a natural focus of strategic interaction. Finally, the same conclusion applies to the question of the size of the concession to be made at specific points in the bargaining process. There is nothing inherently necessary about the procedure of making the minimum concession necessary to push one's risk willingness above that over the other side" (Young 1975: 135).

(2) As Young has stated above, the effect of giving the parties perfect information is no means in itself. Instead, this effect is intended in order to avoid a truly dynamic modeling. At each point in time, the parties contemplate a static utility frontier. As a result, the model cannot reproduce the dynamic adjustment processes that take place during negotiation processes. However, these adjustments may be of critical importance for the final negotiation outcome.

(3) The Zeuthen-Harsanyi model is an extremely parsimonious model. Even such factors as the degree of organization of the participants, the resources of the players, and the prevailing rules of the game are neglected. A more friendly interpretation of this critique states that these concepts are subsumed in the cost functions and learning parameters of the two sides (Young 1975: 133). However, if they are not included the model lacks important empirical constraints on bargaining processes.

(4) Finally, there is a discussion of the ability of the Zeuthen-Harsanyi model to represent strategic interaction. Bishop states that the subjective probabilities of conflict, which motivate the concessions, are mechanical ones that the bargainers must arrive at in a uniquely specified way: "even though the theory is ostensibly rooted in a process of successive concessions … it really implies a fore-ordained outcome that the bargainers might just as well establish without any play-acting." (Bishop 1964:. 185 in Young 1975). This view has been criticized by Walton/McKersie (1965: 88) who argue that the alternation of concessions is not a mechanical process. Each side would be alert to the meaning of the other's concession: "not only are concessions expected, but they are deliberately analyzed for new information" (Walton/McKersie 1965: 228). E.g., through one's own concession behavior weakness is signalled to an opponent" (Walton/McKersie 1965: 89f.).

Despite this criticism, we choose the Zeuthen-Harsanyi model as a starting point for our behavioral model of negotiations. We argue that it belongs to a progressive research program in the sense of Lakatos (1978). Relaxing certain assumptions we will enrich the model with regard to important determinants of negotiation outcomes. Especially,

(ad 1) we allow for asymmetric information: both parties have private information with respect to their own firmness. However, they have incomplete information with respect to firmness of the other side. (ad 2) We reconceptualize the Zeuthen-Harsanyi model as a truly dynamic model by way of transforming it into a dynamic simulation model. As a result, the model can reproduce the dynamic adjustment processes that take place during negotiation processes. I.e., we reconceptualize bargaining as a process of convergence over time.

(ad 3) We include constraints (like the degree of domestic and international conflict, and endowments of the players determining their stubbornness (cf. Schelling 1960, Putnam 1988, Raiffa 1982).

(ad 4) As a consequence, each player will at each point in time build expectations on the risk of conflict of the opponent. Ego will try to conceive of the potential of conflict and the negotiation power of alter. At each point in time, ego will make or will not make a concession which depends on the asymmetric knowledge on and the last offer of alter and of ego's last offer. This concession (or non-concession) will (not) alter the utilities of alter who will react on ego. Even if ego has not made a concession, the evaluation of the situation by alter may change due to the imperfect knowledge on the risk of conflict which alter expects from ego. At the next point of time, the dynamic interaction begins again by the reaction of ego on alters' last action. In sum, the negotiation process is reconstructed as a process of successive concessions and strategic interaction of the players.

5 Simulation and Computational Modeling

Simulation and computational modelling are gaining momentum in Political Science and Political Economy since several years (cf. Aldrich/Alt 2003, Johnson 1999, Kollman et al 2003). Generally, in social science research, computer simulation was used as a method for the generation and for the test of hypotheses (see e.g., Schnell 1990, Jacobsen/Bronson 1995, Conte/Gilbert 1995; critical: Kreutz/Bacher 1991). Computer simulation has been described as a third symbol system besides verbal argumentation and mathematics (Ostrom 1988). Computer simulations are used if neither verbal argumentation nor mathematical modeling fulfill the requirements of representing an empirical phenomenon or a theory: whereas a verbal model may describe very complex empirical phenomena, it is only very seldom possible to derive exact and basic statements on its general behavior (solutions). Computer simulations are deductive systems like mathematical models, which allow for such deductions. Whereas mathematical analysis derives final states (equilibrium outcomes) of social dynamics, computer simulations are suited to explore the pathway to equilibrium and to explore into the dynamics of social systems if they are far from equilibrium and will never reach an equilibrium state. Are there, for example, characteristic trajectories for a social system of a certain structure? Which are the critical variables that decide on the trajectory given exogenous parameters and endogenous system dynamics? Are there phase transitions between different trajectories? How stable are temporary equilibrium states? Computer simulation models can be optimized, e.g. with respect to the fit of empirical data or the maximum or minimum of selected variables. It is important to note, that computer simulation is misinterpreted if it is only judged as bad mathematics: there might be verbal theories, which cannot be adequately expressed in mathematical models, but can be in simulation models.

These arguments are made strong again by political scientists: „rational choice models of international relations have run up against the barriers imposed by mathematical intractability. Although one can persuasively outline a rational choice theory with an indefinitely large number of actors who perform indefinitely complicated calculations, it is often difficult or impossible to analytically solve such systems" (Johnson 1999: 1518). E.g., game theorists typically respond to this difficulty by restricting their models to a handful of states (Duffy 1992: 24). However, game theory was also the theory that celebrated as first rational choice approach the success of applying simulation to rational choice theory

building (Axelrod 1984). Axelrod (1997) emphasizes the role of simulation in 'hypothesis-generating'. Simulations may be looked upon as thought experiments. Computation is becoming more important in applications of game theory" (Judd 2001).

Among the different simulation techniques (for an overview, see Gilbert/Troitzsch 1999), there are three which are especially suited to advance rational choice theorizing because they allow for the micro foundation of dynamic social phenomena: agent-based modeling, cellular automaton and multi-level modeling. All three assume agents as actors (micro level) who interact in social systems (agent societies; macro level). In computer science, the word „agent" or „intelligent agent" is a technical term without a generally agreed usage. An agent denotes a hardware or (more usually) software-based computer system. Political scientists have adopted agent definitions from diverse sides. We want to discuss some of these with respect to agency assumptions of rational choice theory. Let us assume a continuum of agency assumptions in rational choice theory, which span from parsimonious to rich. Then, the statement that agent-based models "depart substantially from the focus …. on rational, optimizing agents and equilibrium outcomes" (Kollman et al. 2003: 3) describes a parsimonious assumption on agency. A rich assumption on agency may have the following four features: "agents are diverse, agents interact with each other in a decentralized way, agents are bounded rational and adaptive, and the resulting patterns of outcomes often do not settle into equilibria" (Kollman et al. 2003: 3f.). In the words of Aldrich/Alt (2003 :313f.):

> "In 'complex adaptive systems', computation is used to simulate agents' cognitive processes and behavior in order to explore emergent macro phenomena, structural patterns that are not reducible to, or even understandable in terms of, properties of the micro-level agents. These evolutionary and agent-based models take a fundamentally different view of behavior from standard rational choice – that individuals are programmed to behave in certain ways and only change their behavior through replacement or imitation. Such models typically feature local and dispersed interaction rather than centralized control. Thus, agent-based modeling is a complement to rational-choice techniques, with potential to bridge the gap between conventional formal tools and qualitative theorizing of complex settings".

The last statement is no longer a statement on agency assumptions. Rather, it is a statement on conventional rational choice methodology. Johnson (1999: 1522) highlights the fact rational choice theories striving for equilibria, agent-based models emphasize adjustment processes. Following Simon (1957), the goal is to more fully explore the implications of a realistic theory of human information processing and decision-making (see also Johnson 1999: 1522). E.g., our agents are built on a premise of bounded rationality and limited information. They exchange information and adjust their positions in a dynamic, interactive environment.

We use agent-based theory building as a method "to close the gap between theoretical derivation and empirical test" (Aldrich/Alt 2003: 309). We accept an existing rational theory of negotiations, the Zeuthen-Harsanyi model, as our hard-core proposition (Lakatos 1978), which is treated as irrefutable. We enrich the Zeuthen-Harsanyi model by way of introducing new auxiliary hypotheses, which are derived from theory-based empirical research. This is our first step of hypothesis-generation. Then, we

test the whole model by applying it to the EU Intergovernmental Conference of 1996. This is our second step of hypothesis testing. Finally, we use the model with the best fit to the empirical data for further theory development: We vary selected assumptions of the model and check whether they improve the fit of the simulated data to the empirical data. If a selected assumption indeed improves the fit, it is looked upon as a new auxiliary hypothesis. In other words, the final step is again a step of hypothesis-generation. The newly generated hypotheses may then be empirically verified in further studies.

6 Informal Conceptualization of the IGC 1996

The multi-level approach in international relations has found a more general formal micro-foundation within the 'strategic approach' in international relations (cf. Bueno de Mesquita 2003). In this view, governments trade off expected costs and benefits, both at the national and the international level. At the international level, governments are confronted with other self-interested sovereign states – revealing more or less honestly their preferences and their own restrictions. Internally, governments have to take account of the electorate, interest groups, the bureaucracy, etc.. The approach is compatible with (multi-attributive) decision- and game-theoretic conceptions of policy-making and therefore opens to any assumptions of information endowment, organizational contexts and cost structures. Due to its focus on opportunity costs[6] it is especially appropriate to model the trade-offs actors are carrying out when assessing different strategies and their respective constraints. In order to derive operational hypotheses we provide an informal conceptualization of how to conceive the multi- level decision making character of the EU Intergovernmental Conference (IGC) 1996 leading to the Amsterdam treaty.

6.1 Sequences of the IGC 1996 negotiations

The IGC 1996 constituted another step – like Maastricht or Nice – of an institutional reform contributing to the constitutionalization of the European integration. Hitherto, EU constitution building proceeded gradually, i.e. member states consented on voluntarily incomplete contracts. The Amsterdam conference took place from April 1996 to June 16/17 1997. The IGC 1996 had the purpose of fulfilling Political Union, of (re-) balancing the division of power, but especially of preparing the institutional setting for an EU enlargement. Already the Maastricht Treaty contained provisions for the amendment of the constitutional framework of the EU. These provisions included the date of reconvening as well as particular issues to be negotiated.

During prenegotiations within the so-called Westendorp reflection group, an intergovernmental preparation of the IGC 1996 took place from June 1995 to December 1995. This group of delegates of the member states reached an agreement on the agenda, i.e. with regard to the issues to be negotiated.

[6] "Opportunity costs are not out-of-pocket expenses. Rather, they are the foregone alternative uses of valuable resources" (Bueno de Mesquita 2003: 85)

The report of the Westendorp group provided a set of roughly formulated issues, i.e. it delivered broad political goals and guidelines. The Service Juridique of the Council of the European Union processed these global issues into 30 precise issues with hard legal options. Each issue included an explicit status quo with indications on its legal status. Legal options were ordinally arrayed going from the least integrationist to the most far-reaching option. This prestructuring of issues and options demonstrates the enormous institutionalization of this negotiation system.

The resulting – at that time highly confidential – notes were faxed to the foreign ministries of the member states, where the temporarily implemented units prepared the cabinets' negotiation. As a rule such temporary project management has been installed in order to coordinate the 'distributed decision making' with regard to the proposed legal options. The project management had to strategically disseminate and aggregate information to and of the political subdivisions. Then governments sent public messages, mostly in form of declarations, to the international environment as well as to the intranational environment in order to signal their preferences on each of the issues.[7]

National delegations negotiated during 16 months in Brussels. They tried to find out each other's ranges of maneuver and their discretionary leeways in order to maximize their own governments' expected utility of a negotiation outcome taking into account the implied internal and intergovernmental transaction costs. Through bilateral and multilateral communication, negotiators tried to find out simultaneously their domestic as well as their external restrictions. This process led to a preliminary settlement of a part of the issues in the Dublin II report (December 1996). The final game reached its climax at the Amsterdam summit. The resulting Amsterdam Treaty was formally implemented through a ratification process under specific constitutional provisions in each member state. [8]

6.2 Levels of Negotiation

We conceive governments as maximizing expected utility – with the main objective of staying in office domestically. Acting both on the national as well as international level, they have to build ex-ante expectations about forthcoming international negotiations as well as about the domestic restrictions to be faced during the ratification stage. There are two reasons why we focus on the within-cabinet coordination of ministries: a) the specific chain of delegation in parliamentary governments (cf. Thurner 1998, Strøm 2000, Thurner/Stoiber 2002), and b) the quasi-monopoly of expert informations with regard to the highly abstract issues. [9]

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[7] Actually, not all governments signal a position on all issues. Hypotheses on international signalling behavior are tested in Thurner/Kroneberg/Stoiber (2002).

[8] An exhaustive identification of formal ex-post ratification requirements as well as discretionary agenda setting powers of all involved EU member states is provided by Stoiber/Thurner 2004.

[9] Due to the highly abstract issues of constitutional building during such reform conferences, ministries have a quasi-monopoly of expertise (Hayes-Renshaw/Wallace 1997).

We distinguish between the intranational game (level 2) where negotiation positions are prepared among the ministries and the cabinet's secretariats and the international game (level 1) where sovereign states are bargaining.

Level 2 Game

In parliamentary systems, the leader of a government directs a team of ministers. We conceive the task of preparing external negotiation positions as a problem of coordinating distributed, specialized decision making units, where the divisions are ministries. Relying on previous analyses (cf. Mayntz/Scharpf 1975, Thurner/Pappi/Stoiber 2002) we consider governmental policy-making in parliamentary systems as a process of interministerial coordination where information is finally aggregated to a policy-specific collective decision – in our case a national bargaining position.

Level 1 Game

We argue that after an internal coordination process (cf. Thurner/Stoiber 2002, Thurner/Pappi/Stoiber 2002, Stoiber 2003) within the ministerial bureaucracy and the cabinet, governments officially declared negotiation positions with respect to the issues on the agenda. These publicly declared 'starting positions' may have been consensual internally or they may have been contested.[10] Additionally, we assume the asymmetry of the distribution of information to run in both ways: delegations as well as ministries are able to fully control and reveal the actions and informations of the respective other. Nevertheless, we suppose informational advantages of the mandated agent representing the government externally due to the advantageous situation as a bridge between the domestic and the international level – at least at the beginning of negotiations. At that point in time, only publicly declared positions are assumed to be common knowledge for all member states' negotiation delegations, whereas the preferred positions of the governmental pivotal actors as well as the preferred ratification paths of the government are assumed to be private information of each member state. This gives the governments and/or the delegation the discretion to choose their bargaining position given their strategic assessment of its domestic and international restrictions, i.e. to understate or overstate positions.

Level 1 negotiations take place under the rule of unanimity, i.e. each member state has a formally granted right to veto modifications of the unanimously accepted status quo – implemented in previous sequences of the bargained integration process. Recent bargaining approaches assume incomplete commitments to initially declared bargaining positions.[11] In case of initial incompatibility of positions, propositions are derived with regard to the concession behavior of negotiators. The revocation of declared commitments is considered as costly, and it is expected that the higher the costs the lower the probability of conceding.

Issue-specific failure of multilateral negotiations is conceived as the maintenance of the legally defined and third party enforced (ECJ) status quo. We argue that as soon as we observe international negotia-

[10] Due to conflicting stances within coalition governments, but also due to special jurisdictional interests that may deviate from a re-election chance maximizing position of the government as whole.

[11] For an overview on this literature cf. Muthoo 1999.

tions there should be at least a non-negligible demand for a collective solution because of (expected) negative externalities or because of some parties expecting cooperation/coordination benefits. Negotiators vetoing openly a transition of a status quo that is perceived as disadvantageous by a relevant number of actors do incur costs – reputation costs.[12] The agenda of this reform conference had been jointly set up by all member states (cf. Thurner/Pappi/Stoiber 2002) during highly institutionalized pre-negotiations. Therefore it is reasonable to assume that every issue on the agenda was considered as 'negotiable' and that negotiations for a transition to a new state were accepted by negotiation parties.

7 Formal Definitions and Assumptions

We assume an international negotiation system consisting of n governments G_i (i = 1,…, 15) negotiating over m issues k = 1,…, 46, each with a finite number of options m_k. Let O_k = [0,1] be the outcome space for each issue k with $o_k \in O_k$. Define the legally defined status quo in the k-th issue $SQ_k \in O_k$ and the negotiation result in the j-th issue $AO_k \in O_k$. We assume issue-by-issue negotiations, i.e. each issue is negotiated separately. Negotiations take place during a time span of t = 16 months. Assume, that each cabinet is a collective actor composed of a varying number of actors[13] J_i = 1,..., n_i. Call the ideal point of a within-cabinet actor j of a government i on issue k $\theta_{ijl} \in O_k$. Call the announced ideal point of a government i in issue k $P_{ik^*} \in O_k$. Governmental preferences over the outcomes can be characterized by the following von-Neumann-Morgenstein utility function $U_i(o_k, P_{ik^*}) = 1-| P_{ik^*} - o_k|$.

We assume that the initially declared bargaining positions of governments are common knowledge internationally. Initial bargaining positions are (a) the declared initial bargaining position P_{ik^*} of each government i with respect to issue k as far as an initial bargaining position has been explicitly declared by government i, or (b) the position of the majority pivot D_{ik} of the cabinet of government i with respect to issue k, otherwise.

The informal adjustment processes are reconceptualized as Zeuthen-Harsanyi negotiation model for two coalitions. Per assumption, governments strive for building or joining powerful, countervailing coalitions in order to maximize benefits and to avoid bargaining costs and indefinite bargaining outcomes of n-person-games. They form two coalitions B_b (b = 2; b_1 = left, b_2 = right). Coalitions of governments take positions in the negotiation space in such a way that at the beginning of the negotiations $P_{left\ k} < P_{right\ k}$.[14] Coalitions are the actual bargaining agents.

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[12] Vice versa, there are structural incentives to use the veto only during negotiation processes. Negotiation parties may use the threat of a veto in several issues as a leverage for gaining more in other issues. Contrary, member states may take highly integrationist stances in extract at least marginal concessions by non-integrationist member states.

[13] Involved ministries, the prime minister's office and – in semi-presidential systems – the president's office.

[14] This is a modification of a model set up by Van Deemen (1997: 137) who defined a player i as a center player if the coalition of all players who are to the left of i are losing without i but winning with i and if all the players to the right of i are losing without him but winning with him.

We assume incomplete information, i.e. governments and coalitions may have some private information about their own situation that is unavailable to the respective other players. Following Harsanyi (1967, 1968a,b) we conceive them as having only probabilistic information about the private information of other players, however starting with the same prior probability distribution on this private information. [15] These priors are common knowledge.

First, nature chooses the expected value μ (in our theoretical model: the objective risk attitude of the opposed coalition; see equation 18) and variance σ^2 (in our theoretical model: y^2; equation 19), thereby determining the types of the governments. Then, governments declare bargaining positions at t1. These stated commitments are partial and may appear random to other member states. The declaration is followed by the formation of two coalitions where private information of governments is partly shared by a gradual revelation. Next, the bargaining process starts until a convergence is reached. It is important to note, that at each point of time during the simulation, nature starts again by choosing the expected value and the variance.

In the following, we first explain the process of the coalition formation.

7.1 International Coalition Formation

We assume bipolar conflicts between member states and two-center player forming coalitions (cf. Peleg 1981, van Deemen 1997). As long as the declared initial positions P_{ik^*} of the governments are distributed in a bipolar way, and as long as governments have strong preference orders, a bipartition seems to be rather straightforward. However, even in this case, members of one of these obvious bipartitions are not immune against incentives to switch to another coalition. Starting from this problem, we model coalition formation with respect to each issue as a two-stage process. In the first step, two *initial* coalitions form. The core of coalition formation are the respective border actors, i.e. those governments which have declared the highest and the lowest initial positions P_{ik^*} in the negotiation space of an issue. Obviously, these actors have no incentive to switch to another coalition. Only those actors occupying middle positions are susceptible to switch. Their assignment to one of the partition is as follows: In order to identify undecided 'middle actors' we define an 'indeterminacy interval' around the mean bargaining position with respect to each issue. In a second step, each government, which has declared an initial bargaining position P_{ik^*} in the indeterminacy interval must individually decide on the basis of a utility function to join a respective coalition.

Let $V_k = [v_{1k}, v_{2k}]$ denote the indeterminacy interval consisting of a one unit concession in each direction ($Z_{Unit\ k}$, see equation 10) around the overall mean of all declared initial bargaining positions P_{ik^*} of all governments:

[15] I.e., we assume a game of incomplete or asymmetric information in which Nature moves first and is unobserved by at least one of the players" (Rasmusen 2001: 50), cf. Bueno de Mesquita (2003: 341).

$$V_k = [v_{1k}, v_{2k}] = [1/n \sum (P_{ik^*}) - Z_{Unit\,k},\ 1/n \sum (P_{ik^*}) + Z_{Unit\,k}] \quad (1)$$

The minimum (maximum) value of the indeterminacy interval are set to values which are higher (smaller) than the smallest (highest) declared initial bargaining position in order to allow the respective border actors to form the core of coalition formation ($v_{1k} > \min p_{ik^*}$; $v_{2k} < \max P_{ik^*}$).

The decision to join a coalition is assumed to depend on utility considerations. Let h_{ik} be the affiliation of government i to an initial coalition with respect to issue k. All governments which have declared initial bargaining positions which are smaller (higher) than the minimum (maximum) value of the indeterminacy interval affiliate to initial coalition 1 (2). The governments which have declared an initial bargaining position P_{ik^*} in the indeterminacy interval affiliate to neither of both initial coalitions:

$$h_{ik} = \begin{cases} 1 & \text{if} \quad (P_{ik^*} \leq v_{1k}) \\ 2 & \text{if} \quad (P_{ik^*} \geq v_{2k}) \\ 0 & \text{else;} \end{cases} \quad (2)$$

Then, the bargaining position H_{hk} of initial coalition h with respect to issue k is derived as mean of the declared initial bargaining positions P_{ik^*} of all governments which are affiliated to initial coalition h. There are two initial coalitions:

$$H_{1k} = 1/n_{1k} \sum P_{ik^*} \quad (i \in h_1 = 1) \quad (3a)$$

$$H_{2k} = 1/n_{2k} \sum P_{ik^*} \quad (i \in h_2 = 2) \quad (3b)$$

Let M_{ik} denote the bargaining power of government i with respect to issue k. We assume that M_{ik} is a constant. In the European Union, unanimity is necessary for decisions on constitutional reforms. As a consequence, we assume that the bargaining power of n governments is distributed in a uniform way:

$$M_{ik} = 1/n \quad (4)$$

Then, the bargaining power M_{hk} of each initial coalition h with respect to issue k is conceived of as the proportion of governments, which are affiliated to initial coalition h:

$$M_{hk} = n_{hk}/n \quad (5)$$

Each government which has declared an initial bargaining position P_{ik^*} in the indeterminacy interval will be able to build expectation as to whether and how much utility a coalition will guarantee. The expected utility U_{ihk} of initial coalition h with respect to issue k for government i which is located in the indeterminacy interval is the product of two factors. The first factor is the sum of the bargaining power M_{hk} of initial coalition h and the bargaining power of government i. The second factor is the distance between the bargaining position H_{hk} of initial coalition h and the declared initial bargaining position P_{ik^*} of government i with respect to issue k.

$$U_{ihk} = \begin{cases} (M_{hk} + 1/n) * |H_{hk} - P_{ik^*}| & \text{if} \quad h_{ik} = 0 \\ 0 & \text{else} \end{cases} \qquad (6)$$

Each government which has declared an initial bargaining position in the indeterminacy interval decides on base of this utility function on her affiliation to an initial coalition with respect to each issue. We assume that the coalition membership b_{ik} of each government i with respect to each issue remains fixed.[16] A government i decides to join coalition b_1 = left (b_2 = right) with respect to issue k if her declared initial bargaining position P_{ik^*} is smaller or equal to (higher or equal to) the minimum (maximum) value of the indeterminacy interval, or – in case that she has declared an initial bargaining position in the indeterminacy interval – if her utility from initial coalition h_1 is higher (smaller) than her utility from initial coalition h_2. If both utilities should be equal for a government, which has declared an initial bargaining position in the indeterminacy interval, we assume a random process. Then, government i will join either coalition with the same probability p_ω.

$$b_{ik} = \begin{cases} 1 & \text{if} \quad (P_{ik^*} \leq v_{1k}) \,||\, ((v_{1k} < P_{ik^*} < v_{2k}) \,\&\&\, (U_{i1k} > U_{i2k})) \\ 2 & \text{if} \quad (P_{ik^*} \geq v_{2k}) \,||\, ((v_{1k} < P_{ik^*} < v_{2k}) \,\&\&\, (U_{i1k} < U_{i2k})) \\ \Omega = \{1,2\},\ p_\omega = 0{,}5 & \text{else} \end{cases} \qquad (7)$$

The final bargaining power M_{bk} of each coalition b with respect to issue k is conceived of as the proportion of governments, which are affiliated to coalition b:

$$M_{bk} = n_{bk} / n \qquad (8)$$

7.2 The Bargaining Process

After the formation stage, immediately following after the declaration of initial positions at t=1, coalitions enter the bargaining process. We reconceptualize the bargaining process as a Zeuthen-Harsanyi-model under incomplete information. Whereas risk attitude in the original concession model is conceived rather mechanistically as the quotient of differences between known declared positions and points-of-no-agreement, we elaborate more extensively on risk-taking in international politics[17] and we will differentiate between several sources of uncertainty in the following. First, we will translate the original model set up to our specific context.

Let $P_{left\ k^*}$ denote the declared bargaining position of coalition *left* with respect to issue k at time t=1. $P_{left\ k^*}$ is derived as mean of the declared initial bargaining positions P_{ik^*} of all governments which are affiliated to coalition *left*.

$$P_{left\ k^*} = 1/n_{left\ k} \sum P_{ik^*} \qquad (i \in b_1 = \text{left}) \qquad (9)$$

[16] This assumption is realistic, because switching governments incur reputation costs.
[17] Cf. McDermott 1998.

The declared bargaining position $P_{left\ kt}$ of coalition *left* with respect to issue k at any other point of time is:

$$P_{left\ kt} = \begin{cases} P_{left\ k^*} & \text{if} \quad t = 1 \\ P_{left\ kt-1} + Z_{left\ kt} & \text{if} \quad (R_{left\ kt} < R'_{right\ kt}) \;\&\&\; (C = 0) \\ P_{left\ kt-1} & \text{else} \end{cases} \tag{10a}$$

As outlined above, we introduce incomplete information into the Zeuthen-Harsanyi-model. Governments, and to a lesser degree a coalition may have complete knowledge on her own risk attitude due to private information. With regard to the risk attitude of the respective opponent we assume, that each coalition only has an expectation on the risk attitude of its opponent (for more details, see equation 18). As a consequence, coalition *left* makes a concession $Z_{left\ kt}$ with respect to issue k at time t if she estimates that her own risk attitude $R_{left\ kt}$ with respect to issue k at time t is smaller that the risk attitude $R'_{right\ kt}$ which coalition *left* expects from coalition *right* with respect to issue k at time t. Under certain circumstances, both coalitions could conceed during the same time step and switch their positions. This happens if the risk attitudes of both coalitions are quite close to each other, if both perceive their own risk attitude to be smaller than that of the opposing coalition, and if both positions are already close to each other. In order to avoid switching, we introduce an auxiliary variable that indicates whether both coalitions would switch (C = 0) or not (C = 1). Then, and in all other situations, coalition *left* will make no concession, but will repeat to declare the same bargaining position as at the time step before ($P_{left\ kt-1}$).

Coalition right is modelled analogous, however, the concession goes into the other direction:

$$P_{right\ kt} = \begin{cases} P_{right\ k^*} & \text{if} \quad t = 1 \\ P_{right\ kt-1} - Z_{right\ kt} & \text{if} \quad (R_{right\ kt} < R'_{left\ kt}) \;\&\&\; (C = 0) \\ P_{right\ kt-1} & \text{else} \end{cases} \tag{10b}$$

The size of a concession depends on the declared bargaining positions of both coalitions at the previous point of time. As a rule, a concession goes up to the next bargaining position in the negotiation space into the direction of the opposing coalition. However, as the initial positions of both coalitions may be located between two neighbour options, three concepts are needed to define the size of a concession: the initial concession,[18] the unit concession, and the final concession[19] (for technical details on the initial and final concession, see equations 13a-d in the appendix):

[18] According to equation (9) the declared bargaining position of each coalition with respect to an issue is derived as mean of the declared initial bargaining positions of all governments which are affiliated to that coalition. As a consequence, the declared bargaining position of each coalition with respect to an issue at time t=1 may be located between two neighbour options in the negotiation space of that issue. In this case, a concession just goes to the next option in direction of the bargaining position of the opposing coalition.

[19] If the opposing coalition is still located between two neighbour options, the final concession of the other coalition just goes up to that option.

$$Z_{left\ kt} = \begin{cases} Z_{left\ init\ k} & \text{if} \quad (P_{left\ kt-1} = P_{left\ k^*}) \,\&\&\, (P_{left\ kt-1} \neq P_{right\ kt-1}) \\ Z_{left\ Unit\ k} & \text{if} \quad (P_{left\ kt-1} \neq P_{left\ k^*}) \,\&\&\, (P_{right\ kt-1} \neq P_{right\ k^*}) \,\&\&\, (P_{left\ kt-1} \neq P_{right\ kt-1}) \\ Z_{left\ final\ k} & \text{if} \quad (P_{left\ kt-1} \neq P_{left\ k^*}) \,\&\&\, (P_{right\ kt-1} = P_{right\ k^*}) \,\&\&\, (P_{left\ kt-1} \neq P_{right\ kt-1}) \\ 0 & \text{else} \end{cases} \quad (11)$$

If the positions of both coalitions have converged (i.e., if $P_{left\ kt-1} = P_{right\ kt-1}$) the size of the concession becomes zero (0 else). Please note, that the equation for the size of the concession of coalition right $Z_{right\ kt}$ is symmetric (in the following, we omit all symmetric equations for reasons of space; the only exception will be equations 16).

We define a unit concession $Z_{Unit\ k}$ with respect to each issue. We assume that coalitions can only move from one to another bargaining position, which is available as option with respect to that issue. The concept of unit concession allows for treating all the 46 issues with the same algorithm although the number of discrete positions in the negotiation space varies from issue to issue. The unit concession $Z_{Unit\ k}$ with respect to each issue k is the distance between two neighbor options in the negotiation space of that issue. All options with respect to each issue have the same distance on the unit interval:

$$Z_{Unit\ k} = 1/(m_k - 1) \qquad (Z_{Unit\ k} \leq 1) \quad (12)$$

The following assumptions on the implications of different distributions of information determine the risk attitude:

- implications of the degree of international heterogeneity of a coalition,
- implications of the degree of domestic heterogeneity of a coalition,
- implications of the cumulated bargaining power of a coalition
- implications of the mutual perceptions of each others risk attitude

Following the original Zeuthen-Harsanyi-model, the unweighted perfect information risk attitude $UR_{left\ kt}$ of coalition *left* with respect to issue k at time t is the quotient of the cost of accepting the bargaining position $P_{right\ kt-1}$ which coalition *right* had declared at the previous point of time and the cost of stubbornness of coalition *left*:

$$UR_{left\ kt} = \begin{cases} |U_{left\ (P\ left\ k^*)} - U_{left\ (P\ right\ kt-1)}| \,/\, |U_{left\ (P\ left\ k^*)} - U_{left\ (SQ\ k)}| & \text{if} \quad U_{left\ (P\ left\ k^*)} \neq U_{left\ (SQ\ k)} \\ |U_{left\ (P\ left\ k^*)} - U_{left\ (P\ right\ kt-1)}| \,/\, 0.001 & \text{else} \end{cases} \quad (14)$$

The cost of accepting the bargaining position which coalition *right* had declared at the previous point of time always amount to $(|U_{left\ (P\ left\ k^*)} - U_{left\ (P\ right\ kt-1)}|)$. It is important to note that the utilities for a coalition always depend on her initial bargaining position; i.e. they do not adapt to changes in the actual bargaining position of that coalition; they only adapt to changes in the bargaining position of the opposed coalition. The cost of stubbornness amount to $(|U_{left\ (P\ left\ k^*)} - U_{left\ (SQ\ k)}|)$ if the utility $U_{left\ (P\ left\ k^*)}$

from the initial bargaining position of coalition *left* for coalition *left* is unequal to the utility $U_{left\ (SQ\ k)}$ from the status quo for coalition *left*.[20]

The utility $U_{b\ (P\ b\ kt)} = [0,1]$ from the bargaining position P of coalition b with respect to issue k at time t for coalition b always depends on the declared initial bargaining position P_{bk*} of coalition b. This utility amounts to 1 if the declared bargaining position P_{bkt-1} of coalition b at time t-1 is equal to the declared initial bargaining position P_{bk*} of coalition b. It amounts to zero if the declared bargaining position P_{bkt-1} of coalition b at time t-1 is of maximum distance to the declared initial bargaining position P_{bk*} of coalition b.

$$U_{b\ (P\ b\ kt)} = 1 - |P_{bk*} - P_{bkt-1}| \qquad (15)$$

However, the declared bargaining position of a coalition depends on the risk attitude, which is the product of the unweighted risk attitude and three weights. These weights are:

(1) The degree of heterogeneity of governments and/or coalitions. We assume that a high degree of heterogeneity of bargaining positions makes a government or coalition immovable. Transaction costs would become very high if governments or coalitions had to come to an agreement under that condition. Therefore, heterogeneity increases the risk attitude. (1a) Let $kp_{nat\ ik}$ denote the degree of domestic heterogeneity within government i with respect to issue k which is given as a constant. Then, the degree of domestic heterogeneity $kp_{nat\ bk}$ within coalition b with respect to issue k is the mean of all degrees of heterogeneity of those governments which are affiliated to coalition b. (1b) Let $kp_{int\ bk}$ denote the degree of international heterogeneity of each coalition b with respect to issue k. The degree of international heterogeneity can be obtained as the standard deviation of the declared initial bargaining positions P_{ik*} of all governments which are affiliated to coalition b.

The decisive variable with respect to risk attitude is not the absolute size of these heterogeneities, but the relation between the degrees of heterogeneity of both coalitions, e.g., the relation $(kp_{nat\ left\ k} + kp_{int\ left\ k})/(kp_{nat\ right\ k} + kp_{int\ right\ k})$ with respect to coalition *left*. The question is which coalition is more immovable. If ego's coalition heterogeneity is higher (smaller), then ego's weighting parameter GKP_{bk} increases (decreases). The unweighted risk attitude is weighted by this relation (see equations 16). Additionally, the relation of the heterogeneities is weighted by the square root in order to avoid huge differences in the coalitions' risk attitudes.

(2) The bargaining power M_{bk} of coalition b with respect to issue k. We assume that the risk attitude increases with the bargaining power of a coalition: Governments know that their coalition has many or only few members. A coalition of many members assumes that it can better determine the negotiation result.

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[20] In order to avoid that the risk attitude of coalition *left* is not defined because of zero division the cost of stubbornness is set to a small positive number (0.001) if the utility $U_{left\ (P\ left\ k*)}$ from the initial bargaining position of coalition *left* for coalition *left* is equal to the utility $U_{left\ (SQ\ k)}$ from the status quo for coalition *left,* i.e. if the declared bargaining position of coalition *left* has been the status quo.

In equations (16), we multiply the heterogeneity and the bargaining power weights to obtain the weighing parameter GKP_{bk} of the risk attitude of coalition b with respect to issue k: A "coalition" of only one government has no international heterogeneity ($kp_{int\ bk} = 0$). It has the domestic heterogeneity of that single government that belongs to this "coalition". This leads to a small heterogeneity value of that "coalition". However, small values of the degree of heterogeneity generate extreme values after they have been weighted by the square root. In order to avoid extreme values, we multiply the heterogeneity and the bargaining power weight. As a consequence, distortions due to coalition size are reduced.

$$GKP_{left\ k} = \sqrt{(kp_{nat\ left\ k} + kp_{int\ \ left\ k}) / (kp_{nat\ right\ k} + kp_{int\ right\ k})} \ * M_{left\ k} \qquad (16a)$$

$$GKP_{right\ k} = \sqrt{(kp_{nat\ \ right\ k} + kp_{int\ \ right\ k}) / (kp_{nat\ left\ k} + kp_{int\ left\ k})} \ * M_{right\ k} \qquad (16b)$$

Then, the risk attitude R_{bkt} of coalition b with respect to issue k at time t is the product of the unweighted risk attitude UR_{bkt} and parameter GKP_{bkt}. The unweighted risk attitude $UR_{bkt} = [0, \infty]$ is squeezed to the interval [0, 1] by help of the tangens hyperbolicus to avoid extreme values of the parameter UR_{bkt}.

$$R_{bkt} = \tanh(UR_{bkt}) * GKP_{bkt} \qquad (17)$$

Finally, we assume, that coalitions generate expectations on the risk attitudes of opposing coalitions. All governments that belong to a coalition will contribute their incomplete perceptions on the features of the opponent. These perceptions may be more or less fallible due to misperception. All information on the opponent is processed by the coalition. The result of information processing is of stochastic, not of deterministic nature: we assume that the result of information processing is an expected risk attitude of the opponent which is normally-distributed with expected value objective risk attitude of the opponent. I.e., the approximation to the objective risk attitude of the opponent is quite good. Let $R'_{right\ kt}$ denote the risk attitude which coalition *left* expects from coalition *right* with respect to issue k at time t. We assume that $R'_{right\ kt}$ is normally distributed with expected value objective risk attitude of coalition *right* and standard deviation y.

$$E(R'_{right\ kt}) = R_{right\ kt} \qquad (18)$$

y can be interpreted as a fallacy rate. Four components determine the fallacy rate: The higher the incompleteness of information on the opponent, the higher is the *probability* to misinterpret signals, which have been received. The higher the domestic and international heterogeneity of coalitions, the higher is the *probability* to misperceive selective signals from the opponent. Single signals may be misinterpreted. The higher the capacity of information processing with respect to the opponent, the smaller is the *probability* of misinterpreting signals from the opponent.

Then, standard deviation y_{bk} of the expected value of the risk attitude of the opposing coalition with respect to issue k is the sum of three factors, weighted by a fourth factor: (1.) the general incompleteness of information on the opponent x - which has been set to 0,2 by the help of calibration -, (2.) the

degree of domestic heterogeneity $kp_{nat\ bk}$ of each coalition, (3.) the degree of international heterogeneity $kp_{int\ bk}$ of each coalition, and (4.) the parameter "a" that signifies the capacity of information processing with respect to the opponent - which has been set to 0,1 by means of calibration (high quality of information is represented as a low value for "a"; the sensitivity of our simulation results with respect to this assumption is verified by sensitivity analysis; see section 9.4) .

$$y_{bk} = a\,(x + kp_{nat\,bk} + kp_{int\,bk}) \tag{19}$$

Now, the negotiation outcome $P_{k\,16}$ in issue k at time t=16 is conceived[21]:

$$P_{k\,16} = \begin{cases} P_{left\,k\,16} & \text{if } (P_{left\,k\,16} = P_{right\,k\,16}) \\ \min\limits_{b}\,(P_{b\,k\,16}) & \text{else} \end{cases} \tag{20}$$

I.e., the result of the negotiations is almost the smallest common denominator, which is the status quo in the absolute minimum case. The reason for this is that negotiations on constitutional reforms take place under the rule of unanimity, i.e. each member state has a formally granted right to veto modifications of the unanimously accepted status quo.

Finally, the utility $U_{b\,P\,k\,16} = [0,1]$ from the negotiation outcome $P_{k\,16}$ for coalition b with respect to issue k at time t=16 can be derived. This utility amounts to 1 if the negotiation outcome $P_{k\,16}$ is equal to the declared initial bargaining position P_{bk^*} of coalition b. It amounts to zero if the negotiation outcome $P_{k\,16}$ is of maximum distance to the declared initial bargaining position P_{bk^*} of coalition b.

$$U_{b\,P\,k\,16} = 1 - |P_{bk^*} - P_{k\,16}| \tag{21}$$

For an overview on all variables and parameters of the model see table 1 (in the appendix).

8 Data Collection and Operationalization[22]

Data collection combines analysis of documents and standardized interviews of top-level bureaucrats[23] in EU member states. The survey is centered around 30 documents, so called fiches, (CONF 3801/96 to CONF 3830/96) as prepared by top lawyers of the Council's *Service Juridique*. The explicit objective of the Council's secretariat was to prestructure the issues at the table in a Harvard decision-

[21] Note that this is an operational prescription, because theoretically one could imagine situations where smallest common denominator solutions that provide a pareto-superior outcome are not chosen.

[22] A synopsis of formal definitions of the variables used in the statistical analysis can be found in appendix 2.

[23] For a comprehensive introduction to this data set, cf. Thurner/Pappi/Stoiber (2002). For preceding studies on bureaucratic elites focusing rather on the socio-economic and ideological backgrounds, cf. Aberbach/Putnam/Rockman (1981) and Page (1999). Contrary to these studies, we rely mainly on standardized questionnaires, and we focus on negotiation preferences, organizational resource endowments and strategic coalition building - within the cabinet as well as transgovernmentally.

making style (Keeney/Raiffa 1976).[24] We conceive the resulting documents as constituting the actual multi-dimensional issue space. Conclusions of the prenegotiations of the Westendorp group were translated into precise, ordinally arrayed options – including the status quo and its legal implications -, which were compatible with EU law.[25] Therefore it was rather easy to construct a standardized questionnaire, since we avoided the enormous problems of validly coding so many European Law options by ourselves. The questionnaire consists of 46 negotiation issues as listed in appendix 1.[26] Each of these issues is considered to constitute a one-dimensional negotiation space with ordinally arrayed options. As a rule, we kept the order of options as proposed by the *Service Juridique*.

For the identification of the initially announced negotiation positions several exhaustive synopses[27] of official declarations were used and mapped onto the standardized questionnaires. This enables us to reconstruct the spatial conflict constellations of this Intergovernmental Conference 1996. Next, member states' formal organization structures of European policy-making and of the preparation of the IGC 1996 were reconstructed in order to identify issue-relevant top-level bureaucrats. Based on the Council's secretariat official list of delegation, heads of all 15 delegations were contacted and asked to name those ministries and respective staff actively involved[28] in the preparation of IGC 1996 negotiation positions. Interviews with responsible bureaucrats inside involved ministries were arranged in the European capitals as well as in Brussels. Interviewed bureaucrats had to render – among other information – the most preferred option of their ministry for each single issue.

9 Experiments and Results

In this section, we describe our main outcome variables, and the results, especially negotiation dynamics and the fitness of our simulated negotiation outcomes in comparison to the empirical Amsterdam outcomes as well as to alternative statistical models' outcomes.

9.1 Negotiation dynamics

Negotiation dynamics varies from issue to issue. Negotiations may take shorter or longer depending on the size of concessions, the time of concessions, the coalition, which concedes, and the negotiation outcome varies. In the following, we present the negotiation path of three issues (figures 1 to 3). The time steps of negotiation (1-16; indicating the negotiation month) are represented on the x-axis. All the different bargaining positions, which have been declared initially with respect to one issue, are

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[24] Personal communication of the administrative head of the Council's cabinet at that time.

[25] And, as we argue in our analyses, are also compatible with the concept of Euclidean preferences of spatial theory of voting.

[26] Several notes consisted of more than one issue. Contrary, issues of minor importance, e.g. the organizational reform of the ECJ, that have not been discussed at all, where discarded.

[27] Cf. Piepenschneider (1996), Griller et al. (1996) as well as the report of the European Parliament and the CD-documented synopsis of Weidenfeld (1998).

[28] Note that 'actively involved' was defined as 'delivering written proposals'.

represented on the y-axis. Dashed lines are used to mark all these different bargaining positions throughout the negotiation process. The bargaining position of coalition *left* is indicated as a grey line, the bargaining position of coalition *right* as a black line. The negotiation outcome is reached if both lines unite. In principle, the simulation could be stopped at that point of time.

Figure 1: Simulated negotiation dynamic of issue 4.3 (Status Quo = 0; Amsterdam Outcome = 0,6; a = 1; *startseed = 162379)*

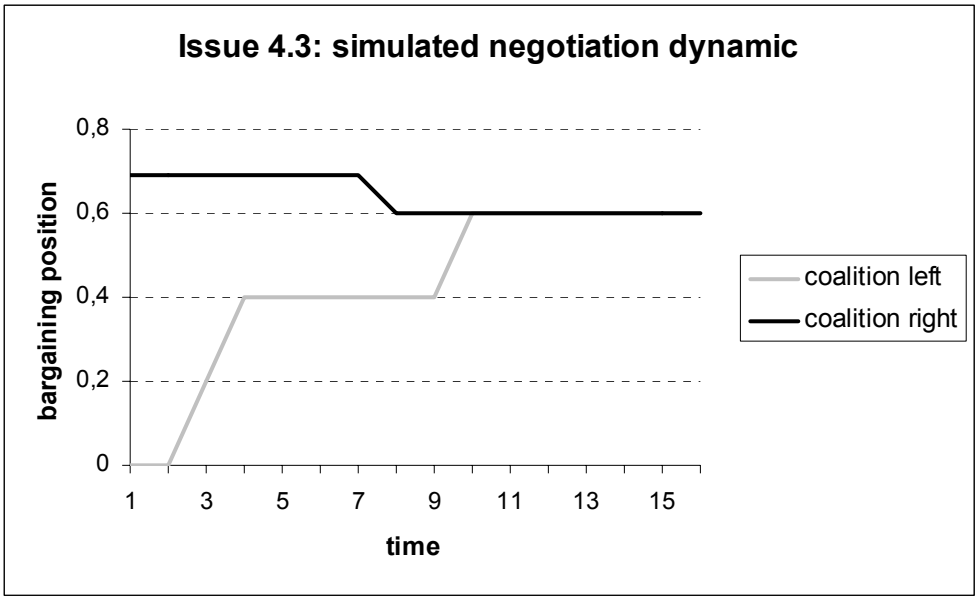


Figure 1 represents a very interesting kind of negotiation dynamic: During the second and third time step, coalition *left* makes two consecutive concessions into the direction of coalition *right* which does not at all react. After that, both coalitions keep their bargaining positions for several time steps. However, after this period of passivity, coalition *right* concedes. Then, coalition *left* makes a final concession into the direction of coalition *right*.

Periods of passivity can be explained on base of equation 10: a concession is made if a coalition assesses her own risk attitude at that point of time to be smaller than the risk attitude which she expects from the opposing coalition. Passivity may have two reasons: Either, the risk attitude of both coalitions is the same, or the risk attitude of the opposing coalition is misperceived. The latter is probable if the risk attitude of both coalitions is not much different. In case that the risk attitudes are very different, misperception is too small to influence concession behavior.

Figures 2 and 3 represent negotiation dynamics with respect to the same issue. However, as our model is a stochastic one, negotiation dynamics with respect to the same issue may vary depending on the startseed of the random number generator. The coalitions converge to the final negotiation outcome. However, the size of concessions, the time of concessions, the coalition, which concedes, and the negotiation outcome vary. I.e., contrary to the deterministic mechanism of the original Zeuthen-Harsanyi-model, the results of our proposed version take a probability distribution.

Figure 2: Simulated negotiation dynamic of issue 3.3 (Status Quo = 0; Amsterdam Outcome = 0,75; a = 1; *Startseed = 563500)*

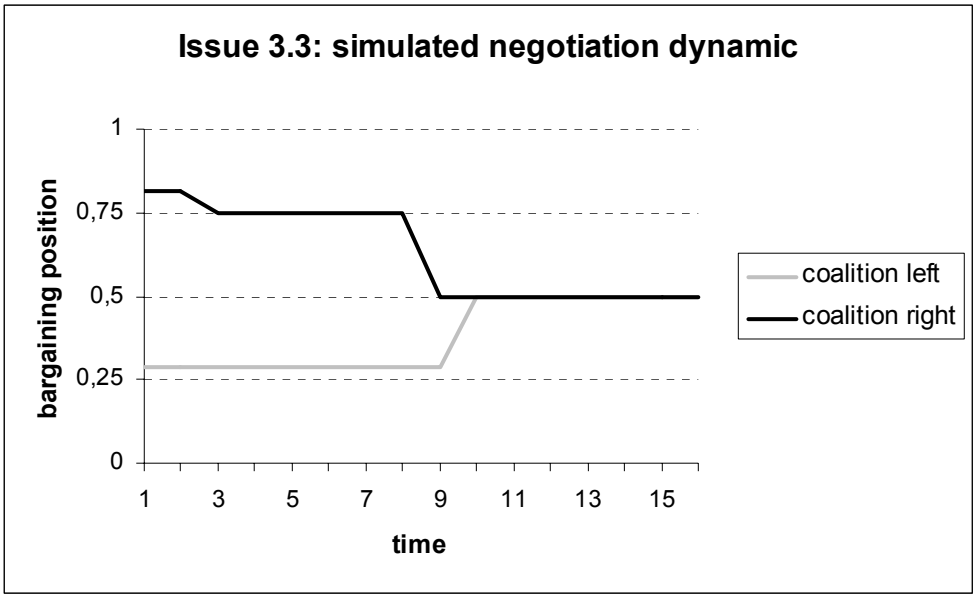
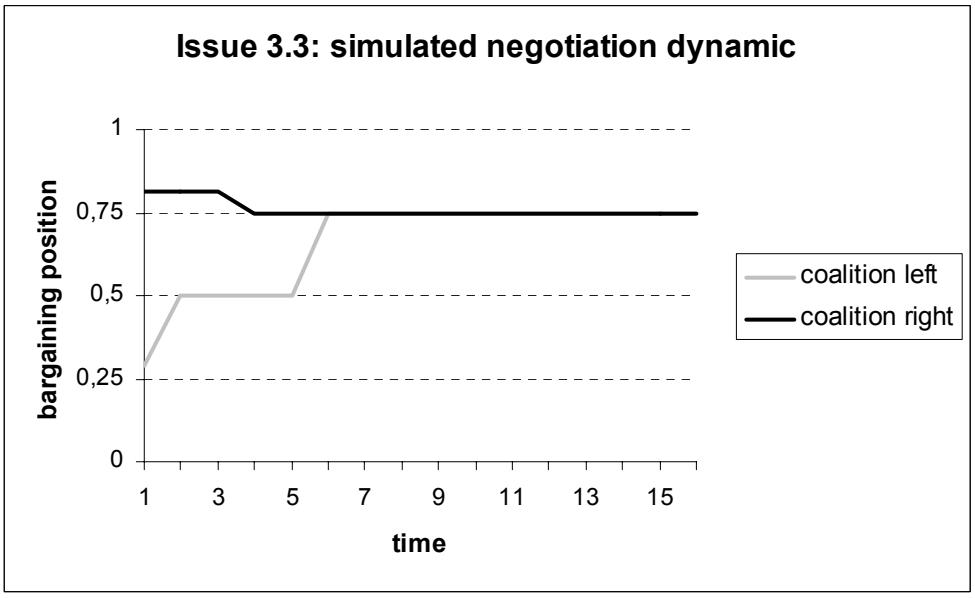


Figure 3: Simulated negotiation dynamic of issue 3.3 (Status Quo = 0; Amsterdam Outcome = 0,75; a = 1; *Startseed = 87321)*



9.2 Negotiation game

Twenty issues were chosen randomly from the pool of 46 issues, ten being 'normal' issues, the other ten being final issues. From these twenty issues, three had to be excluded due to triviality[29], ambiguous empirical outcome or a new bargaining position, which was created throughout the negotiations. The results, which are presented below, are based on simulation outcomes for seventeen randomly chosen issues.

In the following, we concentrate on the negotiation outcome. We compare the prediction that of our model (ZHM) with the actual Amsterdam outcome (AO) and to predictions of alternative solution concepts, as there are: the mean voter model (MeanV), the median voter model (MedainV), the exchange model (or Henning-model, Exchange), and the Nash bargaining solution (NBS; for a description and comparative application (Linhart/Thurner 2004). Table 2 presents empirical and predicted negotiation outcomes on the 17 randomly chosen issues, as well as a column on the unit concession with respect to each issue. Final game issues are marked by two asterisks.

Table 2: Predictions of alternative theoretical models and empirical data on Amsterdam negotiation outcome (a = 1)[30]

Issue No.	AO	ZHM	MeanV	MedianV	Exchange	NBS	Z Unit
Issue 1.7	0,75	0,72	0,72	0,69	0,76	0,73	0,25
Issue 1.8	0,67	0,94	0,96	1,00	0,96	0,93	0,33
Issue 2.1	0,33	0,47	0,54	0,50	0,52	0,45	0,33
Issue 2.5	0,25	0,50	0,54	0,75	0,44	0,34	0,25
Issue 3.3**	0,75	0,50	0,59	0,75	0,55	0,48	0,25
Issue 3.6	0,91	0,55	0,87	0,87	0,87	0,87	*
Issue 4.3**	0,60	0,60	0,65	0,60	0,64	0,49	0,20
Issue 4.5**	0,00	0,08	0,44	0,25	0,61	0,63	0,50
Issue 4.7**	0,00	0,55	0,48	0,27	0,46	0,45	*
Issue 4.8**	0,89	0,67	0,58	0,67	0,60	0,56	*
Issue 5.3**	0,50	0,55	0,55	0,63	0,57	0,40	0,25
Issue 5.5	0,00	0,00	0,56	0,67	0,61	0,18	0,33
Issue 5.7	1,00	0,75	0,80	1,00	0,83	0,63	0,25
Issue 5.10	0,67	0,50	0,54	0,59	0,00	0,00	0,17
Issue 6.1a**	1,00	0,92	0,75	1,00	0,83	0,64	0,50
Issue 6.5	0,00	0,06	0,30	0,17	0,57	0,26	0,33
Issue 6.6**	0,00	0,50	0,60	0,91	0,53	0,52	0,25

[29] Homogeneous declared initial bargaining positions of all governments

[30] * Note that in some issues a decision option (represented by the capital letters A, B, C etc.) is divided into a set of different sub-options(represented by e.g., B1, B2, B3) which are more similar to each other than to the original decision options. For all issues, the unit concession is the distance between the positions A, B, C etc. For those issues that are characterized by sub-options, we define two different unit concessions to get an adequate representation of the negotiation space. The first unit concession represents the distance between the options, the second unit concession the distance between the sub-options. The asterisk indicates issues with two unit concessions.
** Final game issue

How does the simulated outcome fit to the empirical (Amsterdam) outcome? We use two coefficients as goodness of fit parameters: Both coefficients consider that our model is stochastic. Both coefficients are based on the results of 10 simulation runs, which deviated only in the startseed of the random number generator.

Our first goodness of fit parameter, P1 = [0, 1], is based on the mode of the simulated outcome of ten simulation runs which deviate only in the startseed of the random number generator:

$$P1 = 1/k \sum | AO_k - mode(P_{k\,16}) |$$

With respect to each issue k, this parameter determines the mode of the negotiation outcome at time t=16 ($mode(P_{k\,16})$). Then, the distance to the Amsterdam outcome ($| AO_k - mode(P_{k\,16}) |$). Finally, we take the mean of all distances between empirical and simulated negotiation outcome with respect to all issues. P1 can be interpreted as the mean deviation of the simulated to the empirical negotiation outcome in the one-dimensional negotiation space $P_k = [0, 1]$. The value of P1 = 0 would indicate an absolute fit of the simulated and the empirical negotiation outcome. P1 = 1 indicates maximum misfit.

Our second goodness of fit parameter, $P3 = [0, 1/k \sum w_k]$[31], is based on the mode of the simulated outcome of ten simulation runs, too:

$$P3 = 1/k \sum |AO_k - mode(P_{k\,16})|/Z_{Unit\,k}$$

However, it considers the number of different declared positions w with respect to issue k, and calculates the mean number of unit concessions $Z_{Unit\,k}$ that the simulated outcome deviates from the empirical negotiation outcome. The distance to the Amsterdam outcome ($| AO_k - mode(P_{k\,16}) |$) is divided by the issue-specific concession distance ($Z_{Unit\,k}$). Finally, we take the mean with respect to all issues. P3 can be interpreted as the mean number of unit concessions, which our simulated outcome deviates from the empirical outcome. The value of P3 = 0 would indicate an absolute fit of the simulated and the empirical negotiation outcome. The value of P3 = 1 (2) would indicate that on average, our simulated outcome deviates one (two) unit concession from the empirical outcome. The maximum misfit is indicated by the average of the number of different declared positions w with respect to all issues ($1/k \sum w_k$).

The goodness of fit parameters as well as rank order of goodness of fit parameters of five alternative theoretical models which predict the negotiation outcome are presented in table 3. Our modified version of the Zeuthen-Harsanyi-model outperforms all other solution concepts. On average, it deviates 18,8 % form the Amsterdam outcome, whereas the Median voter model deviates 23,3 %. From the point of view of unit concessions, our model deviates on average 0,813 unit concessions from the Am-

[31] For Issues 3.6, 4.7 and 4.8, the algorithm has been adapted to the different unit concessions.

sterdam Outcome, whereas the median voter on average deviates 0,849 unit concessions from the Amsterdam Outcome.

Table 3: Overall goodness of fit parameters as well as rank order of goodness of fit parameters of five alternative theoretical models

	P1	rank order (P1)	P3	rank order (P3)
ZHM*	0,188	1	0,813	1
MeanV	0,267	3	0,987	3
MedianV	0,233	2	0,849	2
Exchange	0,308	5	1,192	5
NBS	0,279	4	1,101	4

* ZHM with a = 1

The Zeuthen-Harsanyi-model and the median voter model differ in their ability to predict normal and final game issues (table 4). Whereas the Zeuthen-Harsanyi-model is best at predicting the normal issue games, both models share rank orders 1 respectively 2 with respect to the final game issues.

Table 4: Goodness of fit parameters as well as rank order of goodness of fit parameters of five alternative theoretical models with respect to normal and final game issues

	normal game issues				final game issues			
	P1	rank order (P1)	P3	rank order (P3)	P1	rank order (P1)	P3	rank order (P3)
ZHM*	0,170	1	0,724	1	0,209	1	0,915	2
MeanV	0,228	4	0,814	3	0,310	3	1,182	4
MedianV	0,225	3	0,797	2	0,241	2	0,907	1
Exchange	0,304	5	1,205	5	0,314	4	1,177	3
NBS	0,224	2	0,979	4	0,341	5	1,237	5

* ZHM with a = 1

In sum, the Zeuthen-Harsanyi-model produces extraordinary good predictions of the Amsterdam outcome. How can these results be explained? Could the goodness of fit be further improved?

9.3 Strength and weakness of the Zeuthen-Harsanyi-model

To analyze the strength and weakness of the Zeuthen-Harsanyi-model we define “good” and “bad” predictions of the negotiation outcome. A “bad” prediction shall be a predicted outcome, which deviates more than one unit concession from the empirical Amsterdam outcome (P3 > 1; or P1 > 0,25 as 0,25 represents the unit concession for most issues; see table 2).

Table 5a: "Bad" predictions, operationalized as P3 >1 (a = 0.1)

	AO*	SimO	SQ	P1	P3	final game issue
Issue 2.5	0,25	0,75	0	0,5	2	no
Issue 3.3	0,75	0,29	0	0,46	1,85	yes
Issue 3.6	0,91	0,55	0	0,36	2	no
Issue 6.6	0	0,75	0	0,75	3	yes

* AO = Amsterdam Outcome; SimO = Simulated Outcome; SQ = Status Quo

Table 5b: "Bad" predictions, operationalized as P3 >1 (a = 1)

	AO*	SimO	SQ	P1	P3	final game issue
Issue 3.6	0,91	0,55	0	0,36	2	no
Issue 4.7	0	0,55	0	0,55	2	yes
Issue 4.8	0,89	0,67	0	0,55	2	yes
Issue 6.6	0	0,5	0	0,5	2	yes

* AO = Amsterdam Outcome; SimO = Simulated Outcome; SQ = Status Quo

Table 6a: "Bad" predictions, operationalized as P1 > 0,25 (a = 0.1)

	AO*	SimO	SQ	P1	P3	final game issue
Issue 1.8	0,67	0,94	0	0,27	0,82	no
Issue 2.5	0,25	0,75	0	0,75	2	no
Issue 3.3	0,75	0,29	0	0,29	1,85	yes
Issue 3.6	0,91	0,55	0	0,55	2	no
Issue 4.7	0	0,27	0	0,27	1	yes
Issue 6.6	0	0,75	0	0,75	3	yes

* AO = Amsterdam Outcome; SimO = Simulated Outcome; SQ = Status Quo

Table 6b: "Bad" predictions, operationalized as P1 > 0,25 (a = 1)

	AO*	SimO	SQ	P1	P3	final game issue
Issue 1.8	0,67	0,94	0	0,27	0,82	no
Issue 3.6	0,91	0,55	0	0,36	2	no
Issue 4.7	0	0,55	0	0,55	2	yes
Issue 4.8	0,89	0,67	0	0,55	2	yes
Issue 6.6	0	0,5	0	0,5	2	yes

* AO = Amsterdam Outcome; SimO = Simulated Outcome; SQ = Status Quo

As can be seen from tables 5a, b and 6a, b, there is no simple logic that explains "bad" predictions. However, "bad" predictions seem to result if the Amsterdam outcome tends to the extremes of the negotiation space. With respect to these issues, the Zeuthen-Harsanyi-model predicts bargaining outcomes, which are located in the middle of the negotiation space. This interpretation is even more obvious from the simulations with a = 1. What are the reasons for "bad" predictions?

We have analyzed the following possible reasons for "bad" predictions for simulations with either a = 0,1 or a = 1: the Zeuthen-Harsanyi-model might make "bad" predictions if

(i) we lack empirical data on the declared initial bargaining position of governments. In that case, we relied on the median position of the involved ministries of that government. If we lacked even data on

the median, too, we assumed that the status quo represents the declared initial bargaining position of that government;

(ii) an issue has been a final game issue, i.e. an issue that has not been settled until the first 'single negotiation text' as proposed by the Irish presidency;

(iii) coalition formation is a problem, e.g. if there is no bipolar structure of declared initial bargaining positions, if governments are split in sub-groups within a coalition, or if governments are distributed in an asymmetric way on both coalitions;

(iv) coalitions differ with respect to their degree of international or domestic heterogeneity;

(v) governments differ with respect to their bargaining power;

(vi) issues are regarded as less or more important by governments as measured by the elicited relative weight they allocated to an issue;

(vii) the declared initial bargaining position of a government covered a range of positions rather than an exact position; in that case, we used the mean of the two most extreme positions that were accepted as options by that government.

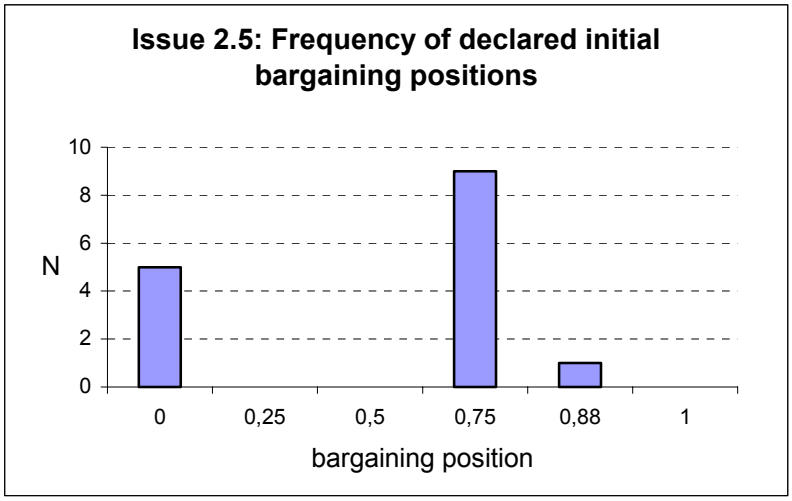
In these analyses, we found no evidence for (i), (iv), (v), (vi) and (vii): Ad (i) and (iv): Missing initial bargaining positions of governments as well as the degree of international or domestic heterogeneity are distributed randomly on the issues which the Zeuthen-Harsanyi-model predicts in a "bad" or "good" way; ad (v): the assignment of differential power weights to the member states – we distinguished between the 'big five': France, Germany, Italy, Spain and the United Kingdom – are distributed in an unsystematic way on coalitions *left* and *right*. On average, they belong in 8,6 of 17 issues to coalition *left*, and in 8,4 of 17 issues to coalition *right*. The "big five" do not concentrate in either of the coalitions which would indicate that our assumption that bargaining power is distributed in a uniform way on the governments should be modified; ad (vi) and (vii): There are no systematic differences in the goodness of fit of the Zeuthen-Harsanyi-model predictions with respect to issues which are regarded as less or more important by governments or which include more or less range positions. However, we obtained interesting results for the other conditions.

ad (ii): *The Zeuthen-Harsanyi-model makes a better prediction for 'normal' game issues.* The goodness of fit parameter P1 is 0,17 for normal game issues and 0,25 for final game issues (for both a = 0,1; a = 1). It is our hypotheses that both kinds of issues differ qualitatively with respect to the underlying negotiation processes. Normal game issues are negotiated in an issue-by-issue, step-by-step, dynamic interaction process as specified by the Zeuthen-Harsanyi-model. Final game issues are highly controversial and are conceived of being important. The final agreement on these issues does not result from issue-by-issue, step-by-step, dynamic interaction, but from a final, "single-step", issue-crossing bargaining process (c.f. Linhart/Thurner 2004). This kind of negotiation may be better reconstructed by applying exchange models (c.f. Thurner/Linhart 2004).

ad (iii): *The Zeuthen-Harsanyi-model makes a better prediction if coalitions are not internally subdivided and if they are asymmetric in size*. There is no simple relation between an obvious bipolar structure of declared initial bargaining positions and "good" predictions of our model. Rather, it is the internal structure of a coalition, e.g. the split of governments in sub-groups within a coalition, and the symmetry of coalitions that makes prediction problematic.

As figure 2 demonstrates, an issue may have an obvious bipolar structure and may nevertheless be predicted "badly" by our model (Amsterdam outcome = 0,25; simulated outcome = 0,75 for a = 0.1 and a = 1).

Figure 2: Frequency of declared initial bargaining positions with respect to Issue 2.5



Coalition formation may be problematic because of the structure of initial bargaining positions of the governments: First, there may be empty potential bargaining positions, which are located between the governments that belong to a coalition. As a result, this coalition is split into sub-groups. In that case, it is empirically possible that one sub-group changes her coalition membership throughout the negotiation process. However, this is not considered in the present version of the Zeuthen-Harsanyi-model, and this may be a reason for a "bad" prediction of the negotiation outcome. Second, there may or may not be an empty potential bargaining position between the coalitions themselves. If there is no empty position between them, single governments may change their coalition membership throughout the negotiation process.

We introduce an auxiliary variable to indicate characteristics of coalition structure. A coalition structure is defined to be

- *not problematic* if there are no empty potential bargaining positions which are located between the governments that belong to the coalitions;

- *problematic* if at least one coalition is split into sub-groups by empty potential bargaining positions, or if there is no empty position between both coalitions;

- *very problematic* if at least one coalition is split into sub-groups by empty potential bargaining positions, and if there is no empty position between both coalitions.

The results are reprinted in table 7. It is obvious that the simulated outcome becomes worse if the coalition structure becomes more problematic. A further optimization of the coalition formation algorithm with respect to the very problematic coalition structure should increase the goodness of fit of the Zeuthen-Harsanyi-model significantly. The theoretical option is to allow for changes in coalition membership throughout the negotiations.

Table 7: Mean values for goodness of fit parameters P1 and P3 for different coalition structures

	coalition structure	P1	P3	N
a = 0,1	not problematic	0,13	0,49	8
	problematic	0,16	0,61	6
	very problematic	0,47	2,0	3
a = 1	not problematic	0,15	0,58	8
	problematic	0,18	0,67	6
	very problematic	0,41	2,0	3

In a similar way, we introduced an auxiliary variable to test whether a higher range of initial bargaining positions of a coalition is worsening the simulated outcome. The “range of initial positions”-auxiliary variable is defined to be *high* if at least for one coalition the range of initial bargaining positions of governments is higher than 0,25. Else, it is *low*. As can be seen from table 8, a further optimization of the coalition formation algorithm with respect to high ranges of positions should increase the goodness of fit of the Zeuthen-Harsanyi-model.

Table 8: Mean values for goodness of fit parameters P1 and P3 for different ranges of initial positions

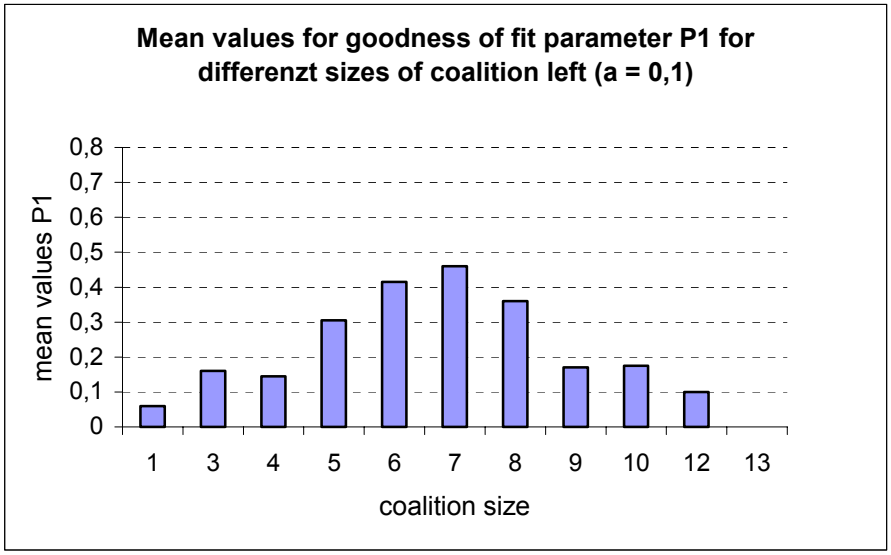
	range of initial positions	P1	P3
a = 0,1	low	0,14	0,49
	high	0,31	1,42
a = 1	low	0,11	0,37
	high	0,34	1,44

The Zeuthen-Harsanyi-model makes a better prediction if coalitions are asymmetric with respect to the bargaining power. As can be seen from table 9 and figure 4, the prediction of the simulation model is better if the distribution of governments on the coalitions is skew. The distribution of the mean values for the goodness of fit parameter P1 for different sizes of coalition *left* approaches the normal distribution. We conclude that in negotiations between coalitions of approximately equal size other or additional factors determine the negotiation outcome.

Table 9: Mean values for goodness of fit parameters P1 and P3 for different distributions of governments on coalitions *left* and *right*

Number of governments in coalition *left* (n_{left})	N	a = 0,1		a = 1	
		P1	P3	P1	P3
$n_{left} < 5$	5	0,11	0,42	0,11	0,38
$5 \leq n_{left} < 11$	9	0,31	1,35	0,31	1,26
$n_{left} \geq 11$	3	0,07	0,20	0,07	0,20
all	15	0,21	0,87	0,21	0,81

Figure 4: Mean values for goodness of fit parameter P1 for different sizes of coalition *left* (a = 0,1)



In sum, there are two reasons for “bad” predictions. In both cases, the negotiation process seems to differ qualitatively from the assumptions of our Zeuthen-Harsanyi model. In case of the final game issues, final agreement on these issues does not result from issue-by-issue, step-by-step, dynamic interaction, but from a final, “single-step”, issue-crossing bargaining process. In case that bipolar coalition formation is a problem, other patterns of coalition formation may prevail. It is quite easily possible to further elaborate our Zeuthen-Harsanyi model and to include other patterns of coalition formation. The first step would be to allow governments or sub-groups of governments to change coalitions throughout coalitions. However, it is quite difficult to further elaborate the Zeuthen-Harsanyi model with respect to the modeling of final game issues.

9.4 Sensitivity analysis

We tested the robustness of our results by the means of a sensitivity analysis.[32] Note, that there are only two parameters in our model, which we have not operationalized. These are the general incompleteness of information on the opponent x - which has been set to 0,2 by the help of calibration -, and the parameter "a" that signifies the capacity of information processing with respect to the opponent - which has been set to 0,1 by means of calibration (high capacity of information is represented as a low value for "a").

Due to the interesting implications, we have chosen to test the robustness of our results with respect to the capacity of information processing vis-à-vis the opponent.[33] As can be seen form table 9, on average, the Zeuthen-Harsanyi-model predictions perform better if the capacity of information processing with respect to the opponent decreases (i.e., parameter "a" increases). This quite counterintuitive result is explained by a further analysis, which differentiates between final and normal game issues. As can be seen from table 9 and figure 5, the goodness of fit parameters of both types of issues develop in an antagonistic way. The Zeuthen-Harsanyi-model always makes a better prediction for the normal game issues, irrespective of the capacity of information processing with respect to the opponent. However, the more miserable the capacity of information processing is the more converge the predictions for both types of issues, because the predictions of the final game issues become better and better. Obviously, the information that is processed on the opponent is not so much relevant in the final issue games. As a consequence, the prediction for the final game issues becomes better if this information is disturbed in a stochastic way.

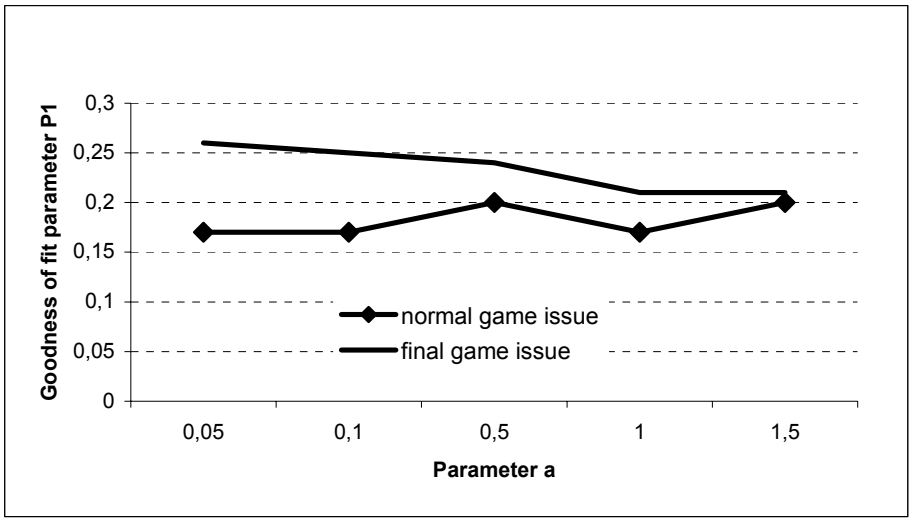
Table 9: Mean values for goodness of fit parameters P1 and P3 for different degrees of capacity of information processing vis-à-vis the opponent (a)

		a				
Goodness of fit parameter	**Issue type**	**0,05**	**0,1**	**0,5**	**1,0**	**1,5**
P1	all issues	0,22	0,21	0,22	0,19	0,20
	normal game issues	0,17	0,17	0,20	0,17	0,20
	final game issues	0,26	0,25	0,24	0,21	0,21
P3	all issues	0,93	0,87	0,94	0,81	0,86
	normal game issues	0,73	0,73	0,83	0,72	0,80
	final game issues	1,16	1,03	1,05	0,91	0,91

[32] For an overview of the general problems experienced in the application of sensitivity analysis to social simulation see Chattoe/Saam/Möhring (2000).

[33] Further studies could also test the robustness with respect to the variation of the incompleteness fo information on the opponent x.

Figure 5: Mean values for goodness of fit parameter P1 for different degrees of capacity of information processing vis-à-vis the opponent



In sum, the Zeuthen-Harsanyi-model's predictions are quite robust with respect to the capacity of information processing with respect to the opponent. This result has an intuitive practical implication: Governments and coalitions profit from increasing their capacity of information processing with respect to the opponent as far as normal game issues are concerned. They need not invest in increasing their capacity of information processing as far as final game issues are concerned.

10 Conclusion

The objective of this paper was to contribute to a 'comparative game dynamics'. We used the Zeuthen-Harsanyi model of concession behavior as a framework for simulating the dynamics of a multilateral, multiple issue, multi-stage, multi-level negotiation system, the EU Intergovernmental Conference 1996 leading to the Amsterdam treaty. We transformed the original model by introducing incomplete information, coalition formation, and concession dynamics. In order to evaluate the appropriateness of our assumptions we confronted the model predictions with the actual Amsterdam outcome.

The main result of our analyses is that our modified version of the Zeuthen-Harsanyi-model outperforms a series of other solution concepts, like the mean voter model, the median voter model, the exchange model, and the Nash bargaining solution in explaining the outcome of intergovernmental negotiations. This is not a self-evident result because the original Zeuthen-Harsanyi-model had been criticized for its assumption of perfect and complete information, for its static nature, for its extreme parsimoniousness with respect to constraints, and for its inability to model strategic interaction. This explains the fact that this model fell into oblivion in favour of the Rubinstein model with its many descendants. However, these limitations came rather from barriers imposed by mathematical tractability than by a lack of intuitive appeal. We removed these barriers by turning from mathematical analysis to computer simulation. Relaxing assumptions of the traditional Zeuthen-Harsanyi-model, we enriched

the model with regard to important determinants of negotiation outcomes. Especially, we translated the Zeuthen-Harsanyi model into a dynamic simulation model with incomplete information, we included constraints (like the degree of domestic and international conflict, and endowments of the players determining their stubbornness), and we reconstructed the negotiation process as a process of successive concessions and strategic interaction of the players. Reconceptualized in this way, the Zeuthen-Harsanyi-model demonstrates its explanatory strength with respect to real world negotiations.

Do our results imply the need for a renewed assessment of the now classic Rubinstein model?[34] This is clearly not the case: We do not test the Zeuthen-Harsanyi model against the Rubinstein model. And as subgame perfectness and backwards induction are concerned, we know already from experimental economics that human beings are not able to apply these concepts. (cf. Berninghaus/Ehrhart/Güth 2002: 114 f). Do our modelling approach and the results contribute to the rehabilitation of the Zeuthen-Harsanyi model? We hope so! Due to its simple dynamic algorithm, it is a candidate for validly representing boundedly rational human behavior.

Our simulation exercise was both a 'thought-experient' as well as ‚hypothesis-generating' (cf. Axelrod 1997). We used agent-based theory building as a method "to close the gap between theoretical derivation and empirical test" (Aldrich/Alt 2003: 309). We continously had to work anew on understanding deviations of predictions from our expectations during the development of the numerous model versions. Finally, the following theoretical assumptions proved to be very robust:

- *Coalition formation*. Governments strive for building or joining powerful, countervailing coalitions in order to maximize benefits and to avoid bargaining costs and indefinite bargaining outcomes of n-person-games.

- *Risk attitude.* Government and coalitions with a high degree of heterogeneity of bargaining positions are getting stubborn, i.e. heterogeneity increases the risk attitude of a coalition of governments. Risk attitude increases with the bargaining power of a coalition.

- *Misperception of the opposing coalition*. The higher the incompleteness of information with regard to the opponent, the higher is the probability to misinterpret signals which have been received. The higher the domestic and international heterogeneity of coalitions, the higher is the probability to misperceive selective signals from the opponent. The higher the capacity of information processing with respect to the opponent, the smaller is the probability of misinterpreting signals from the opponent.

Nevertheless, we want to highlight also limitations of the present model set up. The analysis of the strength and weakness of our modified version of the Zeuthen-Harsanyi-model has shown that the predictions of the negotiation outcome could be further improved: In cases where the assumption of bipolar coalition formation is a problem, other patterns of coalition formation may prevail. It would be

[34] We owe this suggestion to an anonymous referee.

quite easy to further elaborate our model and to include other patterns of coalition formation. The first step would be to allow governments or even sub-groups of governments to change coalitions or to build informal transgovernmental coalitions. At the same time, this would imply a network modelling approach instead of a multi-level model. Then, the organizational as well as informal ressource endowment of linked actors become important determinants. As final game issues are concerned, we learnt that agreement on these issues differs significantly from normal game issues. Due to our previous research (Linhart/Thurner 2004, Thurner/Linhart 2004) we suspect that the additional consideration of a “single-step”, issue-crossing bargaining process could further improve the prediction of final issue games – within our model set up. Therefore, in order to further elaborate the Zeuthen-Harsanyi model with respect to the modelling of final game issues, two additional processes have to be modelled: The explicit failure of negotiations, and issue-crossing bargaining processes (exchange processes). Computer simulation is an appropriate tool to cope with these theoretical challenges.

11 Literature

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12 Appendix

12.1 Formal Appendix

Equations 13 a-d define the initial concession as well as the final concession with respect to each coalition. We explain equation 13a (equation 13b is symmetric to 13a): In order to determine the initial concession of coalition *left*, we choose the minimum of the product of the unit concession and an integer number z (min ($Z_{Unit\ k}$ * z); z $\in$IN; z = 1, ... m_k) which is higher than the declared bargaining position $P_{left\ k^*}$ of coalition *left* at time t=1. From this expression, we subtract the initial bargaining position $P_{left\ k^*}$ of coalition *left*. As a result, the initial concession just goes to the next option in direction of the opposing coalition.

$$Z_{left\ init\ k} = (\min (Z_{Unit\ k} * z) > P_{left\ k^*}) - P_{left\ k^*} \quad (13a)$$

$$Z_{right\ init\ k} = (\max (Z_{Unit\ k} * z) < P_{right\ k^*}) - P_{right\ k^*} \quad (13b)$$

$$Z_{left\ final\ k} = P_{right\ k^*} - P_{left\ kt-1} \quad (13c)$$

$$Z_{right\ final\ k} = P_{right\ k-1} - P_{left\ k^*} \quad (13d)$$

12.2 Table 1: Variables and parameters of the formal model

variable	meaning	initialization at time t = 1
$P_{left\ kt}$	**Declared bargaining position of coalition** *left* with respect to issue k at t (t > 1)	-
R_{bkt}	**Risk attitude of coalition** b with respect to issue k at time t	-
$UR_{left\ kt}$	**Unweighted risk attitude** of coalition *left* with respect to issue k at time t	-
$E(R'_{right\ kt})$	**Risk attitude of coalition *right* as expected/perceived by coalition *left* with respect to issue** k at time t	-
$U_{P\ b\ kt}$	**Expected utility from declared bargaining position** P of coalition b with respect to issue k at time t; U = [0,1]	-
$U_{b\ P\ k\ 16}$	**Utility from negotiation outcome** P for coalition b with respect to issue k at time t=16	-
$P_{k\ 16}$	**Negotiation outcome in issue** k at time t=16; P_k = [0,1]	-
$Z_{left\ kt}$	**Concession** of coalition *left* with respect to issue k at time t (t > 1)	-
parameters	**interpretation**	
a	**Capacity of information processing** with respect to the opponent (a = 0,1)	
B_b	**Coalitions** (b = 2; b_1 = left, b_2 = right)	-
b_{ik}	**Coalition membership of** government i with respect to issue k	-
G_I	**National government**/cabinet (i = 1 to n)	empirical data: n =

		15
GKP_{bk}	**Parameter of the risk attitude of coalition** b with respect to issue k	-
H_{hk}	**(Derived) bargaining position of initial coalition** h with respect to issue k	-
h_{ik}	**Affiliation of government i to initial coalition with respect to** issue k ($h = 3$; $h_1 = 1$, $h_2 = 2$, $h_3 = 0$)	-
K_k	**Issues** (k = 1 to 46)	empirical data: k = 46
$kp_{int\ bk}$	**Degree of international heterogeneity of coalition** b with respect to issue k	empirical data
$kp_{nat\ bk}$	**Degree of domestic heterogeneity** of coalition b with respect to issue k	empirical data
$kp_{nat\ ik}$	**Degree of domestic heterogeneity within government** i with respect to issue k	empirical data
m_k	**Number of different declared positions** with respect to issue k	empirical data
M_{bk}	**Bargaining power/ressource endowment of c**oalition b with respect to issue k	-
M_{hk}	**Bargaining power/ressource endowment of** initial coalition h with respect to issue k	-
M_{ik}	**Bargaining power/ressource endowment of** government i with respect to issue k	$M_{ik} = 1/n$
P_{bk^*}	**Declared initial bargaining position of c**oalition b with respect to issue k	-
P_{ik^*}	**Declared initial bargaining position of** government i with respect to issue k	empirical data
U_{ihk}	**Utility of initial coalition h** for government i which has declared an initial bargaining position which is located in the indeterminacy interval with respect to issue k	-
$U_{SQ\ k}$	**Utility from status quo with respect to issue k**	-
V_k	**Indeterminacy interval of coalition accession** with respect to issue k; $V_k = [v_{1k}, v_{2k}]$	-
x	**General incompleteness of information** with respect to the risk attitude of the opposing coalition	x = 0,2
y_{bk}	**Fallacy rate** of expected value of coalition b with respect to risk attitude of the opposing coalition with respect to issue k	-
$Z_{left\ k1}$	**Initial concession** of coalition *left* with respect to issue k at time t=1	-
$Z_{Unit\ k}$	**Unit concession with respect to issue** k	empirical data