SUPPORT IN AN ASYMMETRIC SOCIAL DILEMMA: A BEHAVIORAL GAME-THEORETIC APPROACH*

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Abstract

In this paper, we study social support relations. We model these relations as a repeated social dilemma between two actors. We account for asymmetry between the actors: they can differ in benefits from receiving support, costs of providing support, or the likelihood of needing support. Thus, our study addresses two classical problems of the social sciences, namely, cooperation problems – we will show that providing social support can be conceived as a cooperation problem – and inequality problems, since differences in benefits from receiving support, costs of providing support, or the likelihood of needing support reflect inequality between actors. We address, first, who provides more often support in the beginning of a relationship and, second, the dynamics of support. Using a behavioral game-theoretic approach, we assume that each actor tries to provide support according to a specific "support ratio." Such a support ratio depends on actors' costs of providing support, benefits from receiving support, and likelihood of needing support. We propose new behavioral dynamics, assuming that actors seek to match their behavior with the support ratio. We use equity theory and bargaining theory to derive testable predictions. Data from a laboratory experiment are employed to test the predictions. Both theories are able to predict who will provide support more often in the experiment. With respect to the behavioral dynamics, predictions based on bargaining theory seem to slightly outperform predictions based on equity theory.

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1. Introduction

Ms. Neumann and Ms. Morgenstern are neighbors, both working part time. They can help each other from time to time by taking care of each other's children while the other is at work. Both women work as stand-by nurses in a hospital. Assume their relation is symmetric in the sense that each of them has a two year old child, they obtain an equal bonus from their job, and they are called in by the hospital equally often. What are conditions such that they do provide support by baby-sitting the other's child? Now assume that their relation is asymmetric. For example, Ms. Neumann has twins so that it is more costly for Ms. Morgenstern to baby-sit Ms. Neumann's children than the other way around. Twins need more attention than a single child. As a consequence, Ms. Morgenstern cannot do much housework while baby-sitting the twins. What is more, Ms. Neumann works in a department that is somewhat understaffed and so the hospital calls her in more often than they do Ms. Morgenstern. Finally, assume that Ms. Neumann, other than Ms. Morgenstern, works at intensive care, thus receiving a higher bonus. Given such asymmetries between the two women, an additional question arises naturally and in addition to the question on conditions such that support is provided at all: Does one of the two women provide support more often and, if so, who will provide support more often? For example, it may be intuitive to expect that Ms. Neumann is willing to help Ms. Morgenstern more or less every time, since the costs are relatively low for her and Ms. Morgenstern does not ask too often. Ms. Morgenstern, on the other hand, might not help Ms. Neumann every time she needs help. Moreover, Ms. Neumann understands this perfectly, since she is relatively often in need of support and it is relatively costly for Ms. Morgenstern to provide support.

This paper models and analyses asymmetric support relations focusing on who provides support more often and how support develops over time. We thus address the interplay between two core problems of social science, namely, cooperation problems and problems of inequality (see, e.g., Ultee et al. 2003). We argue that providing support can be conceived as a cooperation problem in the sense that actors are better off when mutual support is provided compared to the situation that nobody provides support, while each actor faces individual incentives to unilaterally avoid the costs of providing support. Conversely, differences between the actors in benefits from receiving support, costs of providing support, or the likelihood of needing support evidently relate to core dimensions of inequality.

Our contribution is related substantively and with respect to the research strategy to Louk Hagendoorn's work. First, his own research domain – ethnic relations – offers paradigmatic examples of cooperation problems and problems of inequality (e.g., Hagendoorn et al. 2001; Sniderman and Hagendoorn 2007). Assume that Ms. Neumann and Ms.

Morgenstern are members of different ethnic groups. We then address problems of support and cooperation between members of different ethnic groups, taking into account inequalities in the sense that members of one of the groups are often able to mobilize more resources. This can imply, for example, differences in the likelihood of needing support so that the relation is asymmetric. Also, an actor's costs of providing support and benefits from receiving support need not be conceived exclusively in terms of the actor's own time and money. Rather, these costs and benefits may likewise be affected by the social distance between the actors due to ethnic differences (see Aksoy et al. 2006 for related arguments). For example, as claimed by identity theory, supporting an in-group member may be associated with "psychic benefits" in addition to costs in terms of own time and effort. While such extensions of our theory and applications in the field of ethnic relations are in fact nontrivial and clearly beyond the scope of this paper, we would like to stress that the theoretical tools developed and used here may lend themselves for such extensions and applications (in various respects, Hardin 1995 is a study on ethnic relations that employs theoretical tools similar to ours).

Further connections to Hagendoorn's work can be seen in our general research strategy. We use theory on more fundamental psychological (cognitive etc.) processes for generating (ideally: deducing) testable hypotheses on behavior in social relations such as hypotheses on providing social support and on the interplay of inequality and cooperation. Thus, just like Hagendoorn, we prefer hypotheses based on systematic theoretical arguments rather than hypotheses that come "out of the blue." Of course, more often than not there is a trade-off between a rigorous formal theoretical model and pertinent testable hypotheses that do not only follow from the model but also apply to situations outside the laboratory and can be tested on other than experimental data. Hagendoorn most likely would agree with us that it would be best to have both the model and such hypotheses. What would be best is, however, often not feasible. When a trade-off is unavoidable, more than Hagendoorn typically does, we try to stick to formal theoretical models when coming up with arguments for our hypotheses. Also, more than Hagendoorn we are willing to accept that our hypotheses, for the time being, are less than readily applicable to situations outside the laboratory. However, different preferences with respect to such trade-offs should not obscure the common preference for analytical, problem- and theory-guided social science that aims at testable hypotheses and actually testing such hypotheses with empirical data and appropriate statistical models, freely using insights from different social science disciplines.

In the remainder of this paper, we first sketch a game-theoretic model of social support relations. After discussing a standard game-theoretic approach for deriving hypotheses on providing support and the limitations of such an approach, we develop a theoretical alternative that can be best described as a behavioral game-theoretic approach. Using this approach, we present theory and hypotheses on who provides more often support in such relations and on how support depends on what has happened in earlier encounters. Subsequently, we use data from a laboratory experiment for testing our predictions and conclude with a general discussion.

2. Modeling social support relations

We employ a game-theoretic model for social support relations (see Weesie 1988: 155-160; Hegselmann 1994, Vogt and Weesie 2004). The *Support Game* (SG) is played by two players, labeled A and B. The game starts with a random move of Nature (see, for example, Rasmusen 2001 for a careful but accessible textbook on game theory that introduces game-theoretic concepts and assumptions used in this paper). In fact, Nature decides whether player A or player B needs help. More precisely, actor A needs support with probability π_A and actor B needs help with probability π_B. We refer to the probability π_i as the neediness of actor i (i = A, B). We assume that each actor needs help with positive probability and that exactly one actor needs help: $0 < \pi_i < 1$ for i = A, B and $\pi_A + \pi_B = 1$. It would be possible to account for the possibility that neither of the actors needs support or, respectively, both need support, but here we neglect these complications. If an actor needs support, the other player decides whether or not to provide support. Providing support involves costs $c_i > 0$, but less so than the benefits $b_i > 0$ from receiving support, $b_i > c_i > 0$. Note that we make a *within*-actor comparison of the costs of providing support with the benefits from receiving support and do not compare the benefits of actor i from receiving support with the costs of providing support for actor j (j = A, B and $j \neq i$). Strictly speaking, the parameters b_i and c_i are utility differences rather than utilities in the sense that b_i is the difference between i's utility if i needs and receives support and i's utility if i needs but does not receive support. Similarly, c_i is the difference between i's utility if i does not need support and does not give support, and i's utility if i does not need but does give support. Without loss of generality, we assume that each actor receives payoff 0 if no support is provided. Figure 1 represents the extensive form of the SG. The game is symmetric if there are no differences between the actors with respect to neediness, costs, and benefits, i.e., $\pi_i = \pi$, $c_i = c$, and $b_i = b$ for i = A, B. The game is asymmetric otherwise.

If the game is played noncooperatively in the sense that the actors cannot make binding and externally enforced agreements on how to play the game (i.e., whether or not to provide support), $c_i > 0$ implies that there is only one (Nash) equilibrium (both actors maximize their own expected utility, given the other actor's strategy), namely, both actors do not provide support. Both actors are better off in the situation such that both actors provide support for sure if and only if the expected benefits of receiving support outweigh the expected costs of providing support, i.e., $\pi_i b_i - \pi_j c_i > 0$ for i = A, B and $j \neq i$. In this case, the equilibrium is Pareto inefficient and the game is a social dilemma in the sense (see Rapoport 1974) that individual rationality (equilibrium behavior) conflicts with collective rationality (Pareto efficiency). In the remainder of this paper, we only consider parameters for which this social dilemma condition is fulfilled. In that case, the strategic form of the SG (a representation using the well-known payoff matrix for a 2-player game) is a special case of a Prisoner's Dilemma (see Vogt 2007: chapter 1).

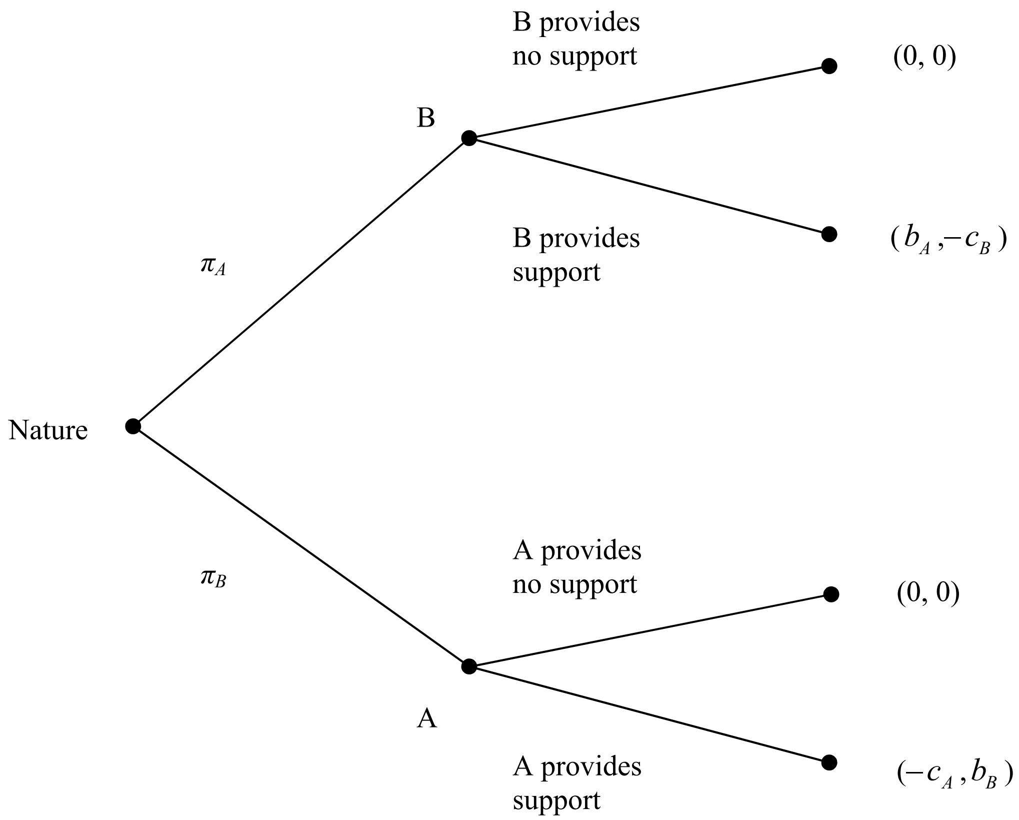

Figure 1 Extensive form of the Support Game, with $b_i > c_i > 0$.

Social support relations are typically durable relations (Blau 1964, 1968; Emerson 1976; Kollock 1998): Ms. Neumann and Ms. Morgenstern repeatedly face the problem of needing support and repeatedly have to decide on providing support. We account for this core feature of social support relations by considering a repeated version of the Support Game. Technically, the *Repeated Support Game* (RSG) is a game such that after the SG – the constituent game – has been played at time t, it is played again with probability w ($0 < w < 1$) at time $t + 1$ ($t = 1, 2,\ldots$). Thus, the RSG is the indefinitely repeated version of the SG in which the parameters are the same in each "round" t. Specifically, the parameters of the game in round t are assumed not to depend on the history (what happened in rounds $1,\ldots, t - 1$). For example, future neediness does not increase by current decisions to support others, nor does it decrease by support received now.

Remark. In terms of our example of the two women taking care of each other's children, "providing more support" could mean that Ms. Neumann provides support to Ms. Morgenstern with a higher probability than the other way around. One then studies support in terms of probabilistic choices. Also, "providing more support" could mean that, given Ms. Morgenstern needs support, Ms. Neumann provides support for the whole day while, conversely, Ms. Morgenstern would provide support only for a few hours when Ms. Neumann needs support. This leads to a study of "fractional support." Conceptualizing less-than-full support in terms of probabilistic choices is the natural approach when using the SG as a model of support relations. This is also the approach chosen in this paper. The study of fractional support requires a variant of the SG such that actor *i* cannot choose between providing or not providing support but rather chooses the amount of support provided (see Weesie 2005 for details).

3. Theory and hypotheses

For the analysis of the RSG, our model for durable support relations, we first briefly sketch an approach based on standard game theory and indicate limitations of the standard game-theoretic approach. These limitations motivate an alternative approach that relies on behavioral game theory. The behavioral game-theoretic approach yields testable hypotheses on providing support and on who provides support more often.

3.1 An approach using standard game theory

Standard game theory can be used for studying mutual support in the RSG based on *reciprocity* in the sense of *conditional cooperation* (Gouldner 1960; Taylor 1987; Axelrod 1984). The underlying idea is that actors' behavior in the RSG results from using strategies that are conditionally cooperative in the following sense. First, support received from the other actor today is rewarded by providing support oneself in the future when the other actor needs support. Second, these strategies likewise carry an (implicit) threat to punish the other actor in the future if the other actor does not provide support today. The punishment consists in refusing to provide support oneself in future situations when the other actor needs support. Using conditionally cooperative strategies in the RSG may be individually rational. After all, if actor *i* anticipates that *j* provides support conditionally in the sense just sketched, *i*'s short-term incentive not to provide support today has to be weighed against the long-term benefits of providing support (namely, receiving support from *j* in the future) and against the long-term costs of not providing support today (namely, not receiving support from *j* in the future).

An elegant and analytically tractable model focuses on the extreme case of a conditionally cooperative strategy, namely, a *trigger strategy*. An actor using such a strategy is never the first to refuse to provide support, but if the other actor refuses support even once, an actor using a trigger strategy will never provide support in the future. Evidently, if both actors use trigger strategies, they will support each other throughout the RSG. It is not necessary to claim that actors in fact use trigger strategies. Still, analyzing conditions for the individual rationality of using trigger strategies, i.e., analyzing the conditions such that trigger strategies are in equilibrium, serves an important theoretical purpose. If mutual social support throughout the RSG between actors using trigger strategies is not individually rational, then mutual support based on other strategies is not individually rational either. Intuition for this result follows from the observation that a trigger strategy carries the most severe threat of punishment for not providing support (see Abreu 1988).

One can show (see Vogt and Weesie 2004 for details) that trigger strategies are in equilibrium if and only if the continuation probability w exceeds (the maximum of) two thresholds, one for each of the two actors. These thresholds depend on the costs c_i and benefits b_i of providing and receiving support as well as on the actor's neediness π_i. What is more, one can derive testable hypotheses from a comparative statics analysis of the equilibrium condition, i.e., the two thresholds. More precisely, one can study how the equilibrium condition becomes more or less restrictive when the parameters of the game change. Assume now that support will be more likely when the equilibrium condition for triggers strategies is less restrictive. One can then derive hypotheses that, for example, support will be more likely when the continuation probability increases, when the costs of providing support decrease, when the benefits of receiving support increase, and when neediness decreases. It is also possible to derive considerably more complex and less intuitively obvious hypotheses, for example, on the effects of asymmetry on the likelihood of support. In fact, such hypotheses have been tested in empirical research (Vogt and Weesie 2006; Vogt et al. 2006).

While such a standard game-theoretic model is not only elegant and analytically tractable but also allows for deriving testable hypotheses, the model likewise has limitations. First, note that a trigger strategy equilibrium implies that support is provided in each round of the RSG. A trigger strategy equilibrium of the type sketched does not account for support that is provided sometimes but not always and does not account for differences between the actors with respect to how often they provide support. Moreover, assume that the game is asymmetric as defined above, i.e., actors differ in at least one of the parameters of the game. It is then less than intuitive that the actors use the same strategy, as required by a trigger strategy equilibrium. The equilibrium condition mentioned does reflect the asymmetry since the condition involves two individual thresholds. Each threshold depends on the individual parameters of the actors. Thus, asymmetry implies different individual thresholds. Since the existence of the trigger strategy equilibrium depends on the maximum of the two individual thresholds, the equilibrium condition reflects asymmetry between the actors. Nevertheless, in the equilibrium the actors are restricted to using the same strategies. However, it may seem theoretically unreasonable that in a situation such that, for instance, actor A needs support twice as often as actor B, both actors provide full support. Instead, while actor A provides full support, actor B might provide support only every now and then. Also, experimental data (Vogt and Weesie 2006; Vogt et al. 2006) indicate that actors indeed make different choices in an asymmetric support relation, i.e., they do not provide support equally often.

It is possible to study a standard game-theoretic model assuming that actors use more complex trigger strategies (Weesie 2005). More precisely, consider a trigger strategy that requires to provide support with probability α_i, given that the other actors needs support, as long as the other actor has always provided support at least with probability α_j in the past, given that i needed support. Again, after any deviation of j from this rule, i provides no more support in the future. It is feasible to derive conditions for equilibria of such more complex trigger strategies. One thus arrives at a standard game-theoretic model that does account for less-than-full support as well as for differences between the actors in providing support, since we may have $0 < \alpha_i < 1$ and $\alpha_i \neq \alpha_j$ for i = A, B. However, such a model involves the problematic assumption that actors can observe not only the other actor's support *behavior* but can also observe the other actor's *probability* of providing support. There are, again, approaches to circumvent the problematic assumption of the observability of probabilities for behavior rather than only behavior itself. However, these approaches involve very strong rationality assumptions (Fudenberg and Maskin 1986) or they involve changes in the basic structure of the Support Game that allow for studying fractional rather than probabilistic support (see the Remark at the end of Section 2 and Weesie 2005). Moreover, basic difficulties remain. First, there are many different trigger strategy equilibria such that one actor provides support with probability α_i, while the other provides support with probability α_j. Thus, the problem arises to provide arguments for selecting one of those equilibria as the "solution" of the game (this is a variant of the equilibrium selection problem due to the famous "folk theorem" for repeated games). Second, the model still relies on the assumption of a complete breakdown of support after any deviation from the rules for providing support according to the trigger strategies. This can be seen as theoretically unsatisfactory and is typically not observed in experiments either (Kagel and Roth 1995). We thus conclude that a standard game-theoretic model may be useful for predicting behavior in the first round of a repeated support game, exploiting a comparative statics analysis of the equilibrium condition as sketched above. However, such a model has difficulties in providing predictions on differences between actors with respect to providing support and is ill-suited for deriving predictions on the dynamics of support after the initial round of the repeated support game.

3.2 A behavioral game-theoretic approach

Behavioral game theory can be roughly characterized as an approach extending standard game theory by using insights from (social) psychology. Camerer (2003: 465) aptly put it as "a formal modification of rational game theory aided by experimental evidence and psychological intuition." Of course, and similar to criticism of other multidisciplinary research (in the sense of Hagendoorn 1994), rather than characterizing the approach as "extending standard game theory," game theorists might prefer to characterize it as "watering down standard game theory," while (social) psychologists (Louk Hagendoorn possibly not excluded) might doubt that "insights from (social) psychology are used" and might suspect the use of "layman psychology." In the following, we sketch a model of adaptive behavior that predicts who provides support more often and that can be used for the study of the dynamics of support. The model assumes adaptive behavior according to a matching mechanism (Herrnstein 1997). Moreover, we consider two variants of the model, one using insights from equity theory as developed in social psychology and sociology, the other based on bargaining theory, a branch of standard game theory.

The basic idea is as follows. We assume that each actor tends to provide support according to a *support ratio* that specifies how often the actor will provide support, given the other actor is in need. The question is, however, what specific support ratio an actor strives for. We call the support ratio that an actor strives for the *target support ratio*. We derive target support ratios from *equity* theory and from *bargaining* theory. In each round of playing the RSG, actors are assumed to compare their target support ratio with the *experienced support ratio* based on the history of what happened in previous rounds of the RSG. Predictions on the *behavioral dynamics of support* throughout the RSG can then be derived from assuming that actors try to match the experienced support ratio with the target support ratio: Actors are more likely to provide support if providing support leads to a more even match of the experienced support ratio with the target support ratio than if providing support leads to a less even match with the target support ratio.

The target support ratio depends on the actors' individual parameters such as the costs of providing support, the benefits from receiving support, and the likelihood of needing support. Thus, target support ratios can reflect asymmetry between the actors with respect to one or more of these parameters. Therefore, we can use our model to answer the question on *who provides support more often*. It is important to note that we exclusively focus on the support *ratio*. We do not study how often actors provide support in *absolute* terms, we only study how often actors provide support, *relative* to each other.

3.2.1 Two behavioral assumptions

Our first behavioral assumption is that each actor provides support in accordance with a target support ratio that defines how often each actor provides support, given the other actor needs support. Thus, a target support ratio specifies how often A and B should provide support relative to each other. Knowing that it is more costly for Ms. Morgenstern to baby-sit Ms. Neumann's twins and knowing that Ms. Neumann needs support more often, it is likely that out of all times Ms. Neumann needs support, Ms. Morgenstern will support Ms. Neumann less often than Ms. Neumann will support Ms. Morgenstern out of all the times Ms. Morgenstern needs support. We define the *target support ratio* for A and B as the ratio of A's *conditional probability* α_A of providing support, given B needs support, and B's *conditional probability* α_B of providing support, given A needs support:

$$s_{AB} = \frac{\alpha_A}{\alpha_B} \ .$$

If $s_{AB} > 1$, this does not necessarily mean that actor A provides support more often than actor B, since actor B *needs* support less often than A if $\pi_B < \pi_A$. However, $s_{AB} > 1$ does imply that A provides support *relatively* more often than B does. Thus, α_A is A's *conditional* probability of providing support, given B needs support, whereas $\alpha_A \pi_B$ is A's *marginal* probability of providing support. Therefore, who is providing support more often throughout the RSG is determined by $\frac{\alpha_A \pi_B}{\alpha_B \pi_A} = s_{AB} \frac{\pi_B}{\pi_A}$. In this paper, we describe and analyze social support by means of the *conditional* probability of providing support. Consequently, $s_{AB} > 1$ or $s_{AB} < 1$ specifies who has to provide support more often, *given the other actor needs support*. In the following, "how often actor *i* provides support" refers to "how often *i* provides support out of all times *j* needs support."

The second behavioral assumption is that actors seek to implement the support ratio in their relation. In our theoretical analysis we use an experienced support ratio reflecting actors' experienced behavior. We define actor A's experienced support ratio as the "real proportion of provided support" of A, i.e., p_A = (number of times A supported B)/(number of times A *could have* supported B) and p_B analogous. Thus, the *experienced support ratio* of actor A is simply

$$a_{AB} = \frac{p_A}{p_B} \ .$$

The behavioral dynamics we want to study is a simple *matching mechanism* such that actors seek to match the experienced support ratio a_{AB} with the target support ratio s_{AB}. An actor provides support if it improves the match between the experienced support ratio and the target support ratio. Otherwise, the actor does not provide support.

Obviously, we could use other mechanisms for behavioral dynamics, for example, based on reinforcement learning or imitation mechanisms (e.g., Camerer 2003; Vega-Redondo 2003). Experiences with a partner might influence behavior through "learning." People who were more supportive in the past may be expected to be more supportive in the future. However, it is not straightforward to apply reinforcement learning theories to the RSG. Usually, learning mechanisms are used for analyzing games where actors move simultaneously but are uncertain about the outcome of behavior. In the RSG, actors choose sequentially whether or not to provide support. Thus, there is no uncertainty about the direct outcome of a choice. We therefore think that simple reinforcement mechanisms are less appropriate for studying behavioral dynamics in the RSG. Another behavioral dynamics could be "imitation." Actors learn from each other what constitutes "appropriate" behavior and then imitate it (e.g., Schlag 1998; Hedström 1998; Barrera and Buskens 2007). With respect to an asymmetric RSG, dyadic imitation does not seem to be a reasonable approach since it is not convincing in our context to assume that an actor blindly imitates someone who has different incentives.

3.2.2 Models of target support ratios

It is important to realize that there are no clear a priori reasons to fix the conditional probabilities of providing support, α_i, and consequently s_{AB}, across all parameter values in one or the other way. Therefore, we need theoretical assumptions to derive target support ratios. We include an element of theoretical pluralism in our model and consider assumptions for deriving target support ratios from two rather different theoretical traditions. One is equity theory as developed in social psychology and sociology, the other is bargaining theory, a branch of standard game theory.

A target support ratio based on equity theory

Equity theory offers a number of different principles to specify the target support ratio (Adams 1965; Deutsch 1975, 1985; Walster et al. 1978; see Desmarais and Lerner 1994 for a review). Equity principles usually focus on "equal" distributions of "outputs" and "inputs," i.e., of rewards and contributions. In the context of social support, we think of outputs as the benefits from received support and of inputs as the costs of provided support. Intuitively, the most convincing principle states that "outputs should be *proportional* to inputs" ("distributive justice," see, e.g., Van den Bos et al. 1997). For an actor *i*, the expected benefits are $b_i\pi_i\alpha_j$ per round *t* of the RSG and the expected costs are $c_i\pi_j\alpha_i$. The advantage of this principle over related equity principles is that it takes into account asymmetry in the costs, the benefits, and the neediness of both actors. Outputs and inputs are proportional for both actors if

$$\frac{b_A\pi_A\alpha_B}{c_A\pi_B\alpha_A} = \frac{b_B\pi_B\alpha_A}{c_B\pi_A\alpha_B}.$$

Assuming that actors behave as if they have a target support ratio based on equity theory and using straightforward computation, the *equity support ratio* is then

$$e_{AB} = \frac{\alpha_A}{\alpha_B} = \frac{\pi_A}{\pi_B}\sqrt{\frac{b_A c_B}{b_B c_A}}.$$

The ratio e_{AB} is a function of the costs, benefits, and neediness parameters b_i, c_i, π_i. The ratio e_{AB} increases in b_A, c_B, and π_A and decreases in c_A, b_B, and π_B. Thus, actor A provides support relatively more often than actor B if A's benefits are higher and costs are smaller, and if A is more often in need.

Obviously, under symmetry ($c_A = c_B$, $\pi_A = \pi_B$, $b_A = b_B$) equity theory predicts that actors provide support equally often, $e_{AB} = 1$. As a more interesting example, if the costs of actor A ($c_A = 8$) are smaller than the costs of actor B ($c_B = 16$), while benefits ($b_A = b_B = 32$) and neediness ($\pi_A = \pi_B = 0.5$) are symmetric, we obtain $e_{AB} > 1$, namely

$$e_{AB} = \frac{0.5}{0.5}\sqrt{\frac{32\cdot 16}{32\cdot 8}} = \sqrt{2}\,.$$

Consequently, out of all times B needs support, actor A has to provide support $\sqrt{2}$ times more often than actor B provides support out of all the times A needs support. It is thus clear that using equity theory for specifying the target support ratio allows for predictions on who provides support more often.

A target support ratio based on bargaining theory

Now we assume that actors behave as if their target support ratio follows from applying bargaining theory. Our target support ratio based on bargaining theory is derived from a paradigmatic approach in this branch of standard game theory, the Kalai-Smorodinsky bargaining solution (Kalai and Smorodinsky 1975; see Roth 1979 for a textbook treatment and Weesie 2005 for technical details of our application). Bargaining theories à la Kalai-Smorodinsky consider the following problem (again, we leave out quite some technical details). Two actors can come to an agreement. In our case, this would be an agreement on each actor's probability to provide support, given the other actor needs support. An agreement would thus imply a target support ratio. If they fail to reach an agreement, the disagreement outcome (sometimes labeled as "status quo") obtains. In our case, the disagreement outcome would be the unique equilibrium of the SG, namely the actors do not provide support. The theories start by introducing a small number of (hopefully) intuitively plausible assumptions ("axioms") on properties that an agreement between rational actors should satisfy. From these assumptions one then derives the solution, i.e., the agreement that will be reached. The theoretically appealing feature of such bargaining theories is that, first, the predicted agreement does not come "out of the blue" but follows from more basic theoretical assumptions. Moreover, second, important bargaining theories have the surprising property that few and more or less plausible assumptions suffice to derive a *unique* solution. Different bargaining theories employ different sets of assumptions and thus typically imply different solutions. Some of the assumptions used by Kalai and Smorodinsky are likewise used in Nash's (1950) classic bargaining theory (readers not well versed in game theory should note that the Nash bargaining solution is something completely different from the Nash equilibrium concept for noncooperative games). For convenience, we use the Kalai-Smorodinsky bargaining solution, noting that predictions we will derive from that solution are highly correlated with those one would obtain using the Nash bargaining solution.

Roughly, the assumptions used for deriving the Kalai-Smorodinsky bargaining solution are, first, that the solution is individually rational in the sense that no actor will be worse off than under the disagreement outcome. The second assumption is that the solution is Pareto efficient: the agreement is such that no other possible agreement would be better for both actors (after all, why would actors agree "to leave money on the table"?). The third assumption is that the solution should be invariant to admissible transformations of the utility functions of the actors. A fourth assumption requires, in a nutshell, that both actors get the same in a symmetric bargaining problem. The final assumption, and in fact the only one that differs from the assumptions used by Nash (1950), is a more technical one on how the solution is affected by deleting some of the agreements from the set of possible agreements.

These assumptions suffice to derive a unique solution that is known as the proportionality rule. Applied to our case, the Kalai-Smorodinsky bargaining solution is such that the gains from support are distributed relative to the gain that actors could maximally obtain in all possible distributions that satisfy the individual rationality constraint. If actor A *could* gain a lot from individually rational support, while actor B *could* gain only a little, actor A is predicted to obtain a lot in the Kalai-Smorodinsky bargaining solution. Whereas the derivation of the support ratio from equity theory is simple and straightforward, the derivation of the support ratio from the Kalai-Smorodinsky bargaining solution is rather elaborated and not very intuitive (see Weesie 2005). For the parameters we consider in this paper, the Kalai-Smorodinsky bargaining solution implies that support should satisfy the *bargaining support ratio*

$$k_{AB} = \frac{\alpha_A}{\alpha_B} = \frac{\pi_A}{\pi_B} \cdot \frac{b_A c_B \pi_A + b_A b_B \pi_B}{b_B c_A \pi_B + b_A b_B \pi_A}.$$

The ratio k_{AB} is a function of b_i, c_i, and π_i. The ratio k_{AB} increases in b_A, c_B, and π_A and decreases in c_A, b_B, and π_B, as is the case for the equity support ratio e_{AB}. In the symmetric case ($c_A = c_B$, $\pi_A = \pi_B$, $b_A = b_B$), the Kalai-Smorodinsky bargaining solution implies that actors should have the same conditional probability of giving support, $k_{AB} = 1$. In our more interesting example with costs of actor A ($c_A = 8$) smaller than the costs of actor B ($c_B = 16$) and symmetry in benefits ($b_A = b_B = 32$) and neediness ($\pi_A = \pi_B = 0.5$), we obtain

$$k_{AB} = \frac{0.5}{0.5} \cdot \left(\frac{32 \cdot 16 \cdot 0.5 + 32 \cdot 32 \cdot 0.5}{32 \cdot 8 \cdot 0.5 + 32 \cdot 32 \cdot 0.5} \right) = \frac{6}{5}.$$

Thus, A has to provide support 1.2 times more often than B, given B needs support. Again, we see that predictions are feasible on who provides support more often. Additional numerical examples can be found in Section 4 on the experimental design.

We briefly compare the target support ratios derived from equity theory and bargaining theory. We have already seen that both target support ratios, e_{AB} and k_{AB}, increase in b_A, c_B, π_A and decrease in c_A, b_B, π_B. Given the different substantive assumptions underlying these theories, it is surprising that the equity support ratio and the bargaining support ratio always agree on who has to provide support more often. Obviously, this makes it difficult to distinguish these theories empirically. It can also be shown that equity theory predicts more extreme ratios than bargaining theory, i.e., $e_{AB} \geq k_{AB} \geq 1$ or $e_{AB} \leq k_{AB} \leq 1$ (see for a more detailed discussion Weesie 2005).

3.2.3 Hypotheses

We now turn to deriving testable hypotheses, proceeding from the assumption that each actor tends to provide support in accordance with the target support ratio (either the equity support ratio or the bargaining support ratio) the actor strives for. The equity support ratio and the bargaining support ratio always agree on who provides support more often. If $s_{AB} > 1$, i.e., $\alpha_A > \alpha_B$, then A has to provide support with a higher conditional probability than B. We label the actor who is more likely to provide support as the "weak" actor, and the other actor as the "strong" one. In other words, we label the actor with the larger α_i the weak actor, and the other actor with the smaller α_j the strong actor. A is the weak actor and B is the strong actor, if either $\pi_A > \pi_B$ or $b_A > b_B$ or $c_A < c_B$, assuming no difference in the other two parameters. Thus, the weak actor is the actor who is either more often in need, or fears the higher loss from not receiving support, or has the lower costs of providing support.

Once again, note that we have specified support ratios. Thus, we have specified how the conditional probability α_A relates to the conditional probability α_B rather than having specified α_A and, respectively, α_B itself. In the remainder of the paper, though, we will sometimes need assumptions on α_A and, respectively, α_B itself. In those cases, we wish to be consistent with other assumptions we employ and thus assume that α_A and α_B are consistent with a Pareto efficiency constraint. This implies (see Weesie 2005) that $\alpha_i = 1$ for the larger of the two conditional probabilities for providing support.

In the beginning of an interaction, i.e., the first round of the RSG, actors cannot compare the experienced support ratio with the target support ratio. Each actor is assumed to provide support with the conditional probability that is in accordance with the actor's target support ratio and fulfills the Pareto efficiency constraint. Thus s_{AB} predicts actors' behavior in the first round of an interaction. Since the conditional probability of the weak actor is larger than the conditional probability of the strong actor according to the equity support ratio as well as the bargaining support ratio, we hypothesize that the weak actor is more likely to provide support in the first round than the strong actor.

Hypothesis 1 (initial support) *The weak actor is more likely to provide support in the first round of a series of interactions than the strong actor.*

Turning to behavioral dynamics, we assume that actors seek to implement s_{AB} in their interaction. To do so, actors compare their experienced behavior with the behavior they strive for according to the equity support ratio or the bargaining support ratio. Actors are thus assumed to compare the experienced support ratio a_{AB} with the target support ratio s_{AB}. If $a_{AB} > s_{AB}$, we say that "A provided support relatively more often than B" with respect to s_{AB}. Thus, B is predicted to provide support more often to match the support ratio – independent of the behavior of actor A – to avoid at least the *discrepancy* of s_{AB} and a_{AB} becoming even larger. The situation is opposite for A. To match s_{AB}, A does not provide support to avoid the discrepancy between s_{AB} and a_{AB} becoming even larger. If $s_{AB} = a_{AB}$ the matching rule is not well defined. Just as in the first round, we then expect the weak actor to be more likely to provide support than the strong actor. Thus, in this case experience does not matter, rather the individual parameters that define the support ratio s_{AB} matter.

The discrepancy of the experienced support ratio and the target support ratio is a continuous quantity. Assuming that an actor's decision whether to provide support or not depends on this discrepancy, we hypothesize that the larger the discrepancy, the larger the probability that the actor "who provided support relatively less often" will provide support and the smaller the probability that the actor "who provided support relatively more often" will provide support.

Hypothesis 2 (dynamics of support) *The larger the discrepancy between the experienced support ratio and the target support ratio, the larger/smaller the probability to provide support in a decision situation of the actor who provided support relatively less/more often than according to the target support ratio.*

With respect to the first hypothesis, our applications of equity theory and bargaining theory always agree on who provides support more often, i.e., they agree on who is the strong and, respectively, the weak actor. However, equity theory and bargaining theory do not yield the same target support ratios. Even though the target support ratios agree on the weak and strong actor, equity theory always predicts more extreme target support ratios than bargaining theory. Thus, the two theories do not coincide with respect to the predictions based on the second hypothesis.

4. Method

Predictions have been tested with data from an experiment with 148 subjects, carried out at Utrecht University, the Netherlands, in May 2004 (see Vogt and Weesie 2006 for a more detailed description). Subjects played symmetric as well as asymmetric RSGs. Subjects participated in reaction to an advertisement inviting them to participate in a "decision experiment." Most of the participants (68%) were female. Most participants were students, coming from a variety of disciplines. On average, subjects were 22 years old (SD = 3.6). The experiment was partly completed by pen and paper, partly by computer using z-Tree software (Fischbacher 1999). Instructions emphasized that the payment at the end of the experiment would be in accordance with the decisions subjects had made. For each point gained, subjects earned one eurocent. Additionally, subjects received a €5 show-up fee to guarantee reasonable earnings for participation. It was explicitly mentioned that there were no "right" or "wrong" decisions. Subjects were told that they could interrupt any task at any time to ask the experimenter for assistance. In the beginning of each interaction, subjects were assigned to role A or role B, representing actor A and actor B of the experimental design.

Conditions: Next to a symmetric game, we employed games with asymmetry in the costs of providing support (c_A, c_B) and the probabilities of needing support (π_A, π_B). These parameters varied between two subjects playing an RSG and between conditions. The benefits did not vary between subjects playing an RSG ($b_A = b_B$), but varied between conditions. Details of the design can be found in Table 1.

Table 1 Design and predictions for the experiment.

Condition Description	π_A	π_B	c_A	c_B	$b_A = b_B$	Equity e_{AB}	Bargaining k_{AB}
C_1: *Symmetry c, π, b*	0.5	0.5	8	8	24	1.00	1.00
C_2: *Small asymmetry c*	0.5	0.5	8	16	32	1.41	1.20
C_3: *Large symmetry c*	0.5	0.5	8	24	36	1.73	1.36
C_4: *Small asymmetry π*	0.6	0.4	8	8	24	1.50	1.23
C_5: *Large asymmetry π*	0.7	0.3	8	8	24	2.12	1.50
C_6: *Accumulation c & π*	0.6	0.4	8	16	32	2.60	1.74
C_7: *Accumulation c & π*	0.6	0.4	8	24	36	2.33	1.56
C_8: *Compensation c & π*	0.3	0.7	8	16	32	0.61	0.77
C_9: *Compensation c & π*	0.3	0.7	8	24	36	0.74	0.85

The rows describe the nine conditions of the experiment. Consider, for instance, C_9. Subjects in role A need support with probability $\pi_A = 0.3$. The costs of providing support in role A are $c_A = 8$ points, and the benefits in role A are $b_A = 36$ points. Subjects in role B need support with probability $\pi_B = 0.7$, thus much higher than the probability of role A. The costs of providing support are $c_B = 24$ points for role B, three times more than the costs for role A. The benefits are the same for roles A and B, namely $b_A = b_B = 36$ points. The last two columns of the table indicate the target support ratios e_{AB}, and k_{AB}. Unsurprisingly, we see that target support ratios are identical under symmetry $e_{AB} = k_{AB} = 1$. The label "accumulation" for conditions C_6 and C_7 is meant to indicate asymmetry in the sense that one of the actors (B) has two problems due to asymmetry, namely high costs of support as well as a very needy partner. The label "compensation" is meant to indicate that one of the actors (B) has the problem of high costs of support, while the other actor (A) has the problem of a very needy partner.[1] We employ the conventional, though far from unproblematic, assumption that "utility = own points = own money." We thus neglect the possibility that utility, perhaps due to social distance (see the discussion in the introduction), may depend not only on own

[1] Accumulation versus compensation with respect to asymmetry between actors matters for predictions based on a theoretical model using trigger strategy equilibria (see Vogt and Weesie 2004, 2006 for details). Note also that originally the experimental conditions have not been designed specifically with the aim of testing the hypotheses presented in this paper. We return to some shortcomings of our design due to this feature in our concluding discussion.

outcomes but also on the identity of the other actor or the other actor's outcomes. However, because subjects are matched to anonymous others, the identity of the other subject cannot play a role in the experiment.

Repeated Support Game (RSG): For 15 minutes, i.e. one *part*, subjects played several RSGs with randomly selected others under *one* experimental condition. Three different parts made up one session. The entire experiment contained nine sessions. In an RSG, one subject had the role of person A and the other subject had the role of person B. The roles represent the different values of the different parameters. The roles were determined at random in each RSG. Subjects could not identify the other person they were playing with. The continuation probability w was set at $w = 0.8$.

Operationalization: In the beginning of each *decision situation*, all subjects received certain numbers of points, i.e., endowments (benefit = b_i). All subjects were threatened to lose their endowment with a certain probability (neediness π_i). At one decision situation, either i or j was threatened to lose the endowment. If i was threatened to lose the endowment, j could overcome this threat by giving away a part of his or her own endowment. If j gave away a part of his or her own endowment at the costs of c_j, i overcame the threat and did not lose anything ("actor j provides and actor i receives support"). Finally, i lost the entire endowment if j did not give away a part of his or her own endowment ("actor j does not provide and actor i does not receive support").

Questionnaire: After playing the games, subjects filled in a questionnaire on some basic demographics and they were asked to evaluate a number of statements on trust, reciprocity, support, giving and receiving compliments, empathy, giving and denying help, etc. This information is not used here. In total the experiment took between 70 and 90 minutes.

5. Results

We analyze, first, whether subjects initiate support relations in accordance with the target support ratios based on equity theory and bargaining theory. Second, we analyze whether actors follow the proposed behavioral dynamics, namely, matching of the experienced support ratio and the target support ratio.

5.1 Initial support

Table 2 reports the experienced support ratio a_{AB} in the first round of the RSG. Considering only the first round allows us to exclude how people adjust their behavior to experience. We test whether the weak actor is indeed more likely to provide support in the first round of an interaction. The first column of Table 2 specifies the experimental conditions. The following two columns present observed percentages of support provided in the first round for subjects in roles A and B. The next column shows the experienced support ratio, i.e., the percentage of support provided by role A in the first round divided by the percentage of support provided by role B, $a_{AB} = \frac{\text{\% provided support A}}{\text{\% provided support B}}$. If $a_{AB} > 1$, then A provided support more often than B, given the other actor needed support in the first round. The next two columns report predictions (e_{AB}, k_{AB}) of target support ratios. If e_{AB}, $k_{AB} > 1$, A is the weak actor and is more likely to provide support than B. As mentioned, equity theory and bargaining theory provide the same predictions on whether A or B is more likely to provide support in the first round, while the predictions using equity theory are more extreme. The following four columns report the results of the tests described in the following paragraph.

The test on whether experienced support ratios correspond with predicted target support ratios, a nonlinear Wald test, is used on the parameter estimates of a logistic regression with random subject effects and fixed effects for conditions times role. With two exceptions (C_8, C_9), the actor who actually provides support more often is the weak actor, i.e., the actor who, according to our predictions, indeed has to provide support more often. This holds true for predictions based on bargaining and for predictions based on equity theory. The nonlinear Wald tests find significant differences between some of the theoretical point predictions and the data. For equity theory, a significant difference is found between the experienced and the target support ratios for three conditions, (C_4, C_7, C_8). For bargaining theory, a difference between the predicted and the experienced ratios is found in only one condition, C_4. Note that in C_8 and C_9 the observed weak role is different from the expected weak role, but the difference is significant only for C_8.

Table 2 Nonlinear Wald tests for point predictions, percentage of support by A and B and (in parentheses) the number of decisions in round 1.

	Data			Predictions		Wald test equity		Wald test bargaining	
Condition	A	B	a_{AB}	e_{AB}	k_{AB}	$\chi^2(1)$	*p*-value	$\chi^2(1)$	*p*-value
C_1: *Symmetry c, π, b*	70 (69)	74 (76)	0.95	1	1				
C_2: *Asymmetry c*	64 (28)	43 (30)	1.49	1.41	1.20	0.38	0.5397	0.92	0.3362
C_3: *Large asymmetry c*	76 (75)	39 (69)	1.95	1.73	1.36	1.95	0.1631	3.77	0.0521
C_4: *Small asymmetry π*	79 (43)	78 (78)	1.01	1.50	1.23	27.47	0.0000	6.34	0.0118
C_5: *Large asymmetry π*	86 (70)	49 (89)	1.76	2.12	1.50	2.87	0.0903	0.63	0.4291
C_6: *Accumulation c & π*	59 (51)	26 (66)	2.26	2.60	1.74	0.01	0.9101	1.17	0.2802
C_7: *Accumulation c & π*	77 (48)	55 (122)	1.40	2.33	1.56	12.11	0.0005	0.00	0.9937
C_8: *Compensation c & π*	78 (42)	75 (24)	1.04	0.61	0.77	6.14	0.0132	2.55	0.1100
C_9: *Compensation c & π*	74 (27)	28 (18)	2.64	0.74	0.85	2.09	0.1485	1.93	0.1644

The joint nonlinear Wald test for the point predictions is significant for equity theory ($\chi^2(8)$ = 54.30, $p < 0.001$) and barely significant for bargaining theory ($\chi^2(8)$ = 16.75, p = 0.033). This means that the data are not completely in accordance with the numerical point predictions from either equity theory or bargaining theory. One needs to realize that it is very uncommon in the social sciences to have numerical predictions for social phenomena. Even if we do have numerical predictions from formal theories we mostly interpret them in a loser way, namely in terms of group orderings or effect signs to indicate in which setting something is more or less likely. This is reasonable because formal theories in the social sciences are extremely stylized simplifications of reality. Interpreting the findings above in this more relaxed way, the fit statistics of the tests reveal that bargaining theory fits the data reasonably well and indeed better than equity theory. Generally, in most cases both theories correctly predict the weak actor indeed to be more likely to provide support. Furthermore, k_{AB} is closer to the experienced support ratio than e_{AB}. Equity theory predicts more extreme target support ratios than bargaining theory. These more extreme target support ratios seem to exaggerate the differences due to asymmetry

5.2 Dynamics of support

We now address the behavioral dynamics and tests of the hypothesis that the larger the discrepancy between the experienced support ratio a_{AB} and the target support ratio s_{AB}, the more/less likely the actor who provided support relatively less/more will also provide support in the next decision situation, given the other actor needs support. We use a logistic regression analysis with random subject effects (see Fischer 1997 and Vogt and Weesie 2006 for a detailed discussion with respect to the RSG). The discrepancy between the experienced and the target support ratio will be modeled as:

$$\textit{Logit (Prob that i provides support in condition h, at time t)} = c_l + \beta D_{iht} + controls + u_i .$$

With c_h we specify the conditions (h runs over conditions (9) times role (2) with symmetry as the reference category), and with u_i we specify the random subject effect. As control variables, we added dummies for whether the data are in the second or third experimental treatments within an experimental session (the first treatment is the reference category) as well as a counter for the number of RSGs that has already been finished within the treatment. D_{iht} denotes the discrepancy of the experienced support ratio $a_{AB} = \frac{p_A}{p_B}$ and the target support ratio $s_{AB} = \frac{\alpha_A}{\alpha_B}$. Note that p_i = (number of times i supported j)/(number of times *i could have* supported j) is not well defined if the number of times *i could have* provided support is zero. We therefore assume that in case the number of times *i could have* provided support is zero, the entire term is zero, i.e., $p_i = 0$. We furthermore modify the ratio $\frac{p_A}{p_B}$ to avoid undefined cases in situations where actor B not yet has provided support or has not yet had the opportunity to provide support. To avoid such undefined cases, we add actor A and B's conditional probability of providing support (α_A, α_B). Note that here we do use the assumption that α_A and α_B fulfill the Pareto efficiency constraint. Thus, we model the discrepancy as

$$D_{iht} = \frac{p_A + \alpha_A}{p_B + \alpha_B} - \frac{\alpha_A}{\alpha_B}.$$

This discrepancy measure ensures that if p_A, $p_B > 0$, then $D_{iht} = 0$ is equivalent to an even match $p_A / p_B = \alpha_A / \alpha_B$.

In Table 3, we present the random effect logistic regression models for equity theory and bargaining theory in two different models, Model 1 (EQUITY) and Model 2 (BARGAINING). The effect of the discrepancy of the experienced and the target support ratios is highly significant and positive just as we predicted. This holds true for equity and for bargaining theory. Thus, the larger the discrepancy between the experienced and the target support ratio, the larger the support probability will be in the next decision situation of the actor who provided support relatively less often out of all times the actor could have provided support.

We furthermore studied, but do not show in detail, whether nonlinear effects of discrepancy can be found, but the quadratic models with respect to equity and bargaining theory do not yield better fitting models. The same holds true for the interaction between conditions by role and the discrepancy. In addition to the hypotheses we derived from the theory, we studied whether the effect of the discrepancy is the same for the strong and the weak actor. Model 3 (EQUITY) and Model 4 (BARGAINING) report the results. We find a highly significant negative effect of the interaction of the discrepancy in the role of strong actor, whereas the effect of the interaction between the discrepancy in the role of weak actor is positive and nonsignificant. This applies to equity theory and to bargaining theory. Thus, the effect of the discrepancy is systematically less for the strong actor than predicted. Or, in other words, the weak actor is more concerned about the discrepancy than the strong actor.

Using Akaike's information criterion (AIC), we see that the model without the interaction of discrepancy, with weak and strong actors, and based on bargaining theory fit the data better than the ones based on equity theory. However, comparing equity and bargaining with the available data is difficult. Recall that both theories always predict the same weak actor and the same strong actor: the differences are quantitative rather than qualitative. Furthermore, the model fits are generally very similar, which is due to the high correlation (0.9855) between equity support ratio and bargaining support ratio. Still, the fact that the effect of the discrepancy on the strong actor is somewhat weaker under bargaining than under equity theory, in combination with the better fit, suggests that bargaining theory predicts slightly better. Furthermore, considering also a null model in which both actors provide support with equal proportions, $s_{AB} = 1$, the AIC of the model using the bargaining support ratio (5571.8) is smaller than the AIC of the model using the equity support ratio (5599.6) and the null model (5591.6). Again, it seems that the target support ratio of equity theory is too extreme in comparison to the experienced support ratios, while assuming the proportions of times actors provide support are equal also fits the data less than the bargaining support ratio.

Table 3 Logistic regression with random subject effects, saturated with respect to conditions and roles, fitted by maximum likelihood.

Social Support	M1: EQUITY coefficient (se)	M2: BARGAINING coefficient (se)	M3: EQUITY coefficient (se)	M4: BARGAINING coefficient (se)
Discrepancy	0.415 (0.057)	0.694 (0.078)	1.368 (0.293)	1.373 (0.294)
Discrepancy - weak actor			0.404 (0.361)	0.227 (0.354)
Discrepancy - strong actor			-1.124 (0.299)	-0.942 (0.306)
Conditions				
(symmetry reference)				
Role A				
C_{2A}: A = weak, B = strong	-0.845 (0.341)	-0.843 (0.344)	-0.892 (0.345)	-0.850 (0.346)
C_{3A}: A = weak, B = strong	-1.033 (0.254)	-1.028 (0.255)	-1.048 (0.256)	-1.008 (0.257)
C_{4A}: A = weak, B = strong	-0.851 (0.318)	-0.882 (0.321)	-0.991 (0.323)	-0.948 (0.323)
C_{5A}: A = weak, B = strong	0.524 (0.191)	0.539 (0.192)	0.468 (0.195)	0.535 (0.194)
C_{6A}: A = weak, B = strong	-0.884 (0.355)	-0.880 (0.357)	-0.900 (0.357)	-0.871 (0.358)
C_{7A}: A = weak, B = strong	-0.875 (0.317)	-0.899 (0.320)	-1.105(0.323)	-1.026 (0.323)
C_{8A}: B = weak, A = strong	-0.853 (0.304)	-0.869 (0.306)	-0.876 (0.306)	-0.895 (0.307)
C_{9A}: B = weak, A = strong	-0.452 (0.257)	-0.424 (0.258)	-0.480 (0.258)	-0.460 (0.259)
Role B				
C_{2B}: A = weak, B = strong	-1.374 (0.342)	-1.418 (0.345)	-1.357 (0.345)	-1.390 (0.346)
C_{3B}: A = weak, B = strong	-1.757 (0.260)	-1.815 (0.262)	-1.707 (0.262)	-1.755 (0.264)
C_{4B}: A = weak, B = strong	-0.838 (0.301)	-0.853 (0.303)	-0.827 (0.303)	-0.848 (0.305)
C_{5B}: A = weak, B = strong	-0.765 (0.162)	-0.803 (0.162)	-0.749 (0.162)	-0.780 (0.163)
C_{6B}: A = weak, B = strong	-2.595 (0.367)	-2.635 (0.370)	-2.526 (0.368)	-2.560 (0.370)
C_{7B}: A = weak, B = strong	-1.208 (0.298)	-1.261 (0.301)	-1.209 (0.300)	-1.256 (0.302)
C_{8B}: B = weak, A = strong	-0.810 (0.338)	-0.857 (0.340)	-1.106 (0.345)	-1.025 (0.345)
C_{9B}: B = weak, A = strong	-1.097 (0.324)	-1.157 (0.326)	-1.445 (0.340)	-1.384 (0.337)
Treatment 2	0.151 (0.116)	0.149 (0.117)	0.136 (0.118)	0.141 (0.118)
Treatment 3	0.293 (0.119)	0.294 (0.119)	0.296 (0.120)	0.295 (0.120)
RSG within treatment	-0.006 (0.015)	-0.007 (0.015)	-0.010 (0.015)	-0.010 (0.015)
constant	0.691 (0.215)	0.694 (0.217)	0.680 (0.217)	0.686 (0.218)
Statistics				
AIC	5599.6	5571.8	5537.7	5538.7
Number of observations	4683	4683	4683	4683
Degrees of freedom	20	20	22	22
Model χ^2	211.4	233.3	253.2	254.0
Log-likelihood	-2777.8	-2763.9	-2744.9	-2745.3

6. Discussion

In this paper we question who provides support more often in a possibly asymmetric support relation and how support depends on experiences partners have had with each other. We argue that standard game theory is ill-suited to provide an answer. We study these two questions using a behavioral game-theoretic approach that builds on two core assumptions. First, we assume that actors tend to provide support in accordance with a specific target support ratio they strive for. Second, we assume that actors try to match the experienced support ratio in a durable relation with the target support ratio they aim at. Using equity theory and bargaining theory we derive two target support ratios. The target support ratio derived from equity theory reflects that actors' inputs are in proportion to their outputs. The target support ratio derived from bargaining theory reflects that gains from support are distributed proportionally to the utility that actors could maximally obtain in all feasible outcomes. Both target support ratios are functions of the individual parameters such as the benefits from receiving support, the costs of providing support, and neediness. We hypothesize that the "weak" actor, i.e., the actor who has to provide support more often, is more likely to provide support in the beginning of a series of interactions (first round). Surprisingly, both theories predict the same actor to be more supportive. Thus, indeed, Ms. Neumann is predicted to be willing to help Ms. Morgenstern more or less every time when Ms. Morgenstern needs help, but not the other way around. We furthermore hypothesize that the larger the *experienced* support ratio in comparison to the *target* support ratio, the more/less likely the actor who provided support relatively less/more often according to the target support ratio is to provide support in the next decision situation.

The hypotheses are tested with experimental data. Both the equity support ratio and the bargaining support ratio predict reasonably well the actor who is more likely to support at the beginning of a series of interactions. The numerical prediction of the bargaining support ratio is closer to the actual support ratio in the initial interactions than the equity support ratio. The discrepancy between the target and the experienced support ratio is a good predictor for the likelihood that an actor does support the other actor throughout the game. Again, the bargaining support ratio fits the data slightly better for predicting the development of support throughout the RSG. Interestingly, the effect of the discrepancy between the experienced and the target support ratio is stronger for the weak actors than for the strong actors, i.e., the weak actor is more concerned about the target support ratio than the strong actor. The reason for this can be that the strong actor more easily deviates from the target support ratio, since the strong actor has to provide support relatively less often.

The model based on bargaining theory has a somewhat better model fit than the one based on equity theory. When controlling for the interaction of discrepancy with the weak/strong actor, the difference in the model fit decreases and the model fit of both models becomes more similar. Bargaining theory leads to slightly better predictions than equity theory. Since the support ratio based on bargaining theory is generally less extreme than the support ratio based on equity theory, an interpretation can be that subjects do not strive for support ratios that are "too extreme." However, since the target support ratios of both theories are pretty similar under our experimental conditions, we are hesitant to conclude that bargaining theory is really the better theory.

It would have been better to test the hypotheses with experimental conditions that lead to larger differences in the target support ratios of bargaining and equity theories than the experimental conditions in the data set we use. Using data based on experimental conditions that were actually not designed specifically for testing the hypotheses presented in this paper, we do not have this option. A design that includes more extreme equity support ratios in comparison to bargaining support ratios might have led to an even sharper drop of the model fit of the model based on equity theory. Furthermore, it would be interesting to come up with reasonable alternative theories on target support ratios that do not necessarily agree with equity and bargaining theory on who provides more often support.

We assume that actors, in the first place, seek to implement their own target support ratio. However, it may well be that actors adjust their own target to their support partner's target. In this case, actors need to learn about each other's target support ratio. We would then expect actors in the beginning of an interaction to behave in line with their own target support ratio, but throughout the RSG we expect them to "update" their target support ratio by "learning" about the partner's target support ratio. Thus, next to adjusting the target support ratios we could replace the matching rule by a more advanced learning mechanism.

A final point relates to prospects for integrating the standard game-theoretic approach and the behavioral game-theoretic approach. One of the limitations of the standard game-theoretic approach focusing on trigger strategy equilibria is the equilibrium selection problem. Many applications of standard game theory assume that only those Nash equilibria are "solution candidates" that are not Pareto inefficient compared to other Nash equilibria. This reduces the equilibrium selection problem somewhat, but still there are typically many Pareto efficient trigger strategy equilibria in indefinitely repeated games and also in the RSG. Conversely, our behavioral game-theoretic approach does not consider Pareto efficiency at all. We only focus on the *distributional* aspect of social support. Some mutual support is Pareto superior to no support at all, and full Pareto efficiency implies that one of the actors always provides support. Considering s_{AB}, it becomes clear that we do not study efficiency in actors' behavior, since we only study support in relative terms, not in absolute terms. We only focus on the ratio of the conditional probabilities of both actors. However, if the conditional probabilities are both smaller than 1, both actors would be better off providing support more often, and this can be accomplished without changing the target support ratio. It would be interesting to test whether, in addition to the distributional aspect, subjects take "efficiency" into consideration in a support relation. Also, considering the set of Pareto efficient trigger strategy equilibria of the RSG as the set of "solution candidates," one could then use, for example, bargaining theory à la Kalai-Smorodinsky to select one of the equilibria as the solution of the RSG (see Weesie 2005 for some work in this direction). Obviously, this does not overcome the problem that trigger strategies involve the intuitively less-than-plausible threat of a complete breakdown of support after the first deviation from providing support as required by the trigger strategy.

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