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REGULAR ARTICLE

Social support among heterogeneous partners: an experimental test

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Abstract This paper studies how dyadic social support is affected by heterogeneity of the partners. We distinguish heterogeneity with respect to three parameters: the likelihood of *needing support*; the *benefits* from receiving support; and the *costs* of providing support. Hypotheses are based on a game-theoretic analysis of an iterated support game. First, we predict that heterogeneity in one of the parameters hampers social support. Second, we predict that under heterogeneity with respect to two of the parameters, support is most likely if there is a specific heterogeneous distribution such that heterogeneity in one parameter 'compensates' for heterogeneity in the other parameter. If there is no compensation social support is even more hampered. The hypotheses have been tested by experimental data with a mixed within-subject, between-subject design. The data gives support to the hypotheses.

Keywords Dyadic social support · Iterated support game · Human subject experiments

JEL codes C91 · C92 · C72

1 Introduction

This paper seeks to study issues regarding social support between *heterogeneous* partners in *durable* relationships. We distinguish heterogeneity between actors

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with respect to *individual properties* such as *benefits* from receiving support, *costs* for providing support, and the likelihood of needing support (from now on called *neediness*). Individuals are likely to vary in these properties (see, e.g., Blau 1964, 1968). Take as an example two colleagues, Ego and Alter, who from time to time give each other advice. Ego, who has less work experience than Alter, might benefit more from this supportive relation than Alter does. At the same time, giving advice might be more costly for Ego than for Alter. Since Ego is less experienced than Alter, Ego needs advice more often than Alter does. What effects do these differences in the individual properties have on the supportive relation? Is Alter unwilling to give advice because receiving advice is of little profit for Alter? Is Alter willing to give support because it is cheap for him or her to do so? Ego benefits a lot from receiving advice, but also pays a lot for giving advice. Does that make Ego more or less willing to be supportive? Does it matter that Ego asks for advice more often than Alter does? It is not clear whether and how heterogeneity in several dimensions between persons facilitates or hampers social support. We expect that heterogeneity in one dimension (e.g., Ego has higher costs of providing support than Alter does) leads to different behavioral consequences than heterogeneity in several dimensions (e.g., Ego has higher costs of providing support and higher benefits from receiving support). We therefore want to study the effects of heterogeneity in multiple individual properties on social support simultaneously. We argue that it is the heterogeneity per se that affects the relation. The degree of heterogeneity of actors is a dyadic characteristic, and this is intricately related to the dissimilarity of actors (see for instance, Frank 1985). We are interested on whether mutual support is more likely if Ego and Alter are homogeneous or if they are heterogeneous. Thus, we are not interested on whether Ego provides more often support in a heterogeneous relation than Alter does. In the literature on similarity and social support, heterogeneity in several dimensions is seldom studied simultaneously.

In earlier work we have extensively studied supportive relations (Vogt and Weesie 2004). Using a game-theoretic model on social support, called the iterated support game (ISG), actors are characterized by their *neediness* of support, the *benefits* from receiving support, and the *costs* of providing support.[1] We introduce the ISG and the relevant predictions in more detail in the next section. We subsequently describe an experimental test.

2 The game-theoretic model

2.1 Model of support

Social support occurs in the context of *durable* relations (Blau 1968 and 1964; Homans 1961; Emerson 1976). In a durable relation, it can be individually rational to provide support because other persons may repay these services in

[1] We also analyzed effects of heterogeneity in time preferences. Since time preferences were not taken into account in the experimental test, we do not discuss them in this paper.

the future. If Alter is not helping Ego today, Ego might not help Alter either next time. In this sense, the long-term benefits of supporting each other can be higher than the short-term benefits from not supporting each other. Thus, support in durable relationships can be based on the possibility that actors threaten each other with refusing support and can promise each other rewards for being supported. This mechanism is known as conditional cooperation (Axelrod 1984). We study exclusively *durable pairwise* relationships. We model social support in an ISG. At each time, either actor A (π_A) or actor B (π_B) needs support. When A needs support, B decides whether or not to support A. Only one person needs support at one time point, $\pi_A + \pi_B = 1$. If A receives support from B, A will obtain the benefits (b_A) at costs (c_B) for B. However, next time the situation can be reversed with B needing support from A. The ISG continues after each time point with a constant continuation probability w, with $0 < w < 1$. Substantially, the continuation probability refers to the common future of persons having a supportive relation, e.g., colleagues with indefinite contracts or families that rent houses next to each other. Both actors would obviously prefer to receive support but not to provide support. However, in the long run the short-term costs can be overcome by the long-term benefits from support received as a repayment in kind. If the common future is 'long enough', actors have an incentive to offer support (see e.g., Kreps 1990; Rubinstein 1990).

We assume that $b_i > c_i > 0$, i.e., the benefits to i of support received are larger than the costs to i if he or she helps j. We are not comparing the benefits of one player to the costs of another player, thus, there is no interpersonal comparison of utilities. Mutually providing support is more beneficial for both actors than not providing support given that $\pi_A b_A - \pi_B c_A > 0$ (i.e., $\frac{b_B}{c_B} > \frac{\pi_A}{\pi_B} > \frac{c_A}{b_A}$). Both actors cannot leave the relationship, and do not know when the relationship ends. Both partners know the parameters of the support situation π_i, c_i, b_i, and w. We distinguish *heterogeneity* in the ISG in terms of likelihood of needing support ($\pi_A \neq \pi_B$), benefits from receiving support ($b_A \neq b_B$), and costs of providing support ($c_A \neq c_B$). If two actors differ in at least one of the three parameters, the iterated support game is said to be heterogeneous, otherwise the game is homogeneous.

2.2 Analysis

In Vogt and Weesie (2004), we presented a game-theoretic analysis of the ISG. We derived an equilibrium condition for trigger strategies to see under which conditions rational partners provide support. Trigger strategies are a particular implementation of reciprocity. An actor using a trigger strategy never refuses support the first time around, but if support has been denied, the actor refuses support from then on. If two actors use trigger strategies, they will both always provide support. We do not claim that subjects actually use trigger strategies. However, the analytical treatment of trigger strategies serves an important theoretical purpose. If exchange of social support is not individually rational among actors using trigger strategies, then it is not individually rational among any other strategies either (see, e.g., Abreu 1988). Thus, we use the restrictiveness of the equilibrium condition for trigger strategies as an indicator of the likelihood of support. Trigger strategies are in equilibrium if the following threshold condition is fulfilled:

$$\begin{aligned} \zeta^* &= \max(\zeta_{\mathrm{A}}, \zeta_{\mathrm{B}}) \leq w, \\ &\quad \text{with} \quad \zeta_i = \frac{1}{\pi_i \eta_i + (1 - \pi_j)} \eta_i \\ &\quad \text{with} \quad \eta_i = \frac{b_i}{c_i} > 1 \quad \text{for } i = \mathrm{A}, \mathrm{B}, \; i \neq j. \end{aligned} \tag{1}$$

According to the equilibrium condition, support between rational actors requires that a certain threshold is smaller than the continuation probability w. This threshold depends on the costs (c_i), the benefits (b_i), neediness (π_i), and the continuation probability (w). Rational cooperation (mutual support) requires that no actor face strong incentives to deviate from mutual support. Thus, both individual thresholds have to be smaller or equal to the continuation probability w, i.e., the dyadic threshold ζ^* has to be smaller or equal to the continuation probability w. While it is only a necessary condition for social support that the individual thresholds are smaller or equal to the continuation probability, it is sufficient if the dyadic threshold is smaller or equal to the continuation probability. The individual threshold ζ_i increases in the benefit-cost ratios η_i (i.e., increases in the costs and decreases in the benefits), and in neediness π_i. Note that the equilibrium condition depends on the benefits b_i and costs c_i only through the benefit–cost ratio η_i. From now on we therefore study heterogeneity in two parameters: the benefit-cost ratio η_i and neediness π_i.

2.3 Hypotheses

The equilibrium condition (1) states that there will be no support between people if the dyadic threshold ζ^* is larger than the continuation probability w, and that there will be full support if the dyadic threshold ζ^* is smaller or equal than the continuation probability w. We do not expect such a sharp distinction empirically. First of all, it is not straightforward for subjects to compute the equilibrium threshold. Second, subjects presumably do not play trigger strategies. For instance, occasional refusal of support may well be forgiven. And third, there is a difference between the prediction of the existence of an equilibrium at the dyadic level as stated in (1), and the prediction of how a person behaves in the decision situations at the individual level. We do not expect that people either provide full support or no support depending merely on whether a certain threshold is larger or smaller than a given continuation probability. We use the game-theoretic results heuristically and test less strict hypotheses. We expect less support between subjects, the larger ζ^* and the smaller w. Keeping the continuation probability w fixed, ζ^* can be treated as an indicator for 'how likely social support is' between pairs of subjects.

Hypothesis 1 (dyadic threshold) The larger the dyadic threshold ζ^*, the smaller the probability of providing support.

The dyadic threshold ζ^* is a function of η_i and π_i. How does the dyadic threshold ζ^* depend on these parameters? The comparison of heterogeneous situations with homogeneous situations is not straightforward. We need a method to compare homogeneous and heterogeneous ISGs. One common method to do this is to keep the 'total amount' of the parameters for the benefit-cost ratio and for neediness constant and to study the consequences of varying the distribution of the parameters between the actors (constant sum condition). This resembles the distribution of a fixed amount of tangible resources between the actors. Similar approaches to study effects of 'inequality' can be found, for instance, in the literature on income inequality (see e.g., Atkinson 1983; Sen 1997) and on insurance and uncertainty (see e.g., Arrow 1951). Given the constant sum condition, the minimization of ζ^* is not equivalent with minimizing ζ_{A} and ζ_{B} at the same time. If ζ_{A} decreases, ζ_{B} necessarily increases. To simplify the presentation of the analysis we induce heterogeneity in the benefit-cost ratio η_i via the costs ($c_{\mathrm{B}} > c_{\mathrm{A}}$) and keep the benefits ($b_{\mathrm{A}} = b_{\mathrm{B}}$) homogeneous. We do not have a theoretical reason to vary the costs and fix the benefits. Our experimental design is merely based on the intuition that heterogeneity in the costs is more salient than heterogeneity in the benefits.

We now consider several heterogeneous and homogeneous distributions of the parameters. First, we address the situation with homogeneity in all parameters. It can be shown (see Vogt and Weesie 2004) that ζ^* is smallest under a homogeneous distribution of all parameters and equal individual thresholds ($\zeta_{\mathrm{A}} = \zeta_{\mathrm{B}}$).

Hypothesis 2 (homogeneity) A homogeneous distribution of all parameters between the actors, $\pi_{\mathrm{A}} = \pi_{\mathrm{B}}$ and $\eta_{\mathrm{A}} = \eta_{\mathrm{B}}$, leads to optimal conditions of social support.

Next, we consider heterogeneity in only one parameter, and homogeneity in the others. For example, B has higher support costs than A. Consequently, the support situation is more difficult for B than for A. It can be shown that the dyadic threshold is larger under heterogeneity in one parameter than in the situation with equal costs. Thus, if $c_{\mathrm{B}} > c_{\mathrm{A}}, \zeta_{\mathrm{B}}$ is larger than ζ_{A}, and $\zeta^* = (\zeta_{\mathrm{A}}, \zeta_{\mathrm{B}})$ is larger than under $c_{\mathrm{A}} = c_{\mathrm{B}}$. Analogously, heterogeneity in π hampers social support.

Hypothesis 3 (heterogeneity in one parameter) The probability of providing social support is smaller under a heterogeneous distribution in one parameter than under a homogeneous distribution in all parameters. The more heterogeneous the distribution of one parameter, the less likely is social support.

Now we allow heterogeneity in the benefit-costs parameter and neediness (η_i and π_i). We then have to differentiate between two feasible situations. The first situation is characterized by $(\pi_{\mathrm{A}} - \pi_{\mathrm{B}})(c_{\mathrm{A}} - c_{\mathrm{B}}) < 0$. Given heterogeneity in one parameter, adding heterogeneity in another parameter makes social support even less likely than in a situation with heterogeneity in only one parameter. Assume again that providing support is more costly for B than it is for A. This already makes support more difficult for B. Now assume that at the same time, A needs support more often than B does. Thus, B is asked to provide support more often than A is, although it is more costly for B than for A to give support. Thus, B has two 'problems', namely high support costs and a very needy partner. The heterogeneous distribution of one parameter ($c_{\mathrm{B}} > c_{\mathrm{A}}$) 'compounds' with the heterogeneous distribution of another parameter ($\pi_{\mathrm{B}} < \pi_{\mathrm{A}}$). Such a heterogeneous distribution of two parameters leads to more heterogeneity in the individual thresholds ($\zeta_{\mathrm{A}} > \zeta_{\mathrm{B}}$) than a heterogeneous distribution of only one parameter, and consequently to a larger dyadic threshold ζ^*.

Hypothesis 4 (compounded heterogeneity) The probability of providing social support is smaller under a heterogeneous distribution of two parameters, such that the heterogeneity of one parameter compounds with the heterogeneity of the other parameter, than under a heterogeneous distribution of one parameter. The more the heterogeneity of the two parameters compounds, the less likely is social support.

In a second class of situations, characterized by $(\pi_{\mathrm{A}} - \pi_{\mathrm{B}})(c_{\mathrm{A}} - c_{\mathrm{B}}) > 0$, we consider heterogeneity in two parameters in which 'each actor has a problem'. For instance, B has higher support costs, but A needs support less often than B does. In this sense, the problems are 'divided' between B and A; B's problem are the high support costs, A's problem is that B is needier in comparison to him or herself. In other words, the heterogeneous distribution of the costs ($c_{\mathrm{B}} > c_{\mathrm{A}}$) 'compensates' for the heterogeneous distribution of neediness ($\pi_{\mathrm{B}} > \pi_{\mathrm{A}}$). If the heterogeneous distributions of the two parameters compensate each other optimally, this leads to an equalization of the individual thresholds ($\zeta_{\mathrm{A}} = \zeta_{\mathrm{B}}$). Consequently, under optimal compensation ($\zeta^* = \zeta_{\mathrm{A}} = \zeta_{\mathrm{B}}$) $\zeta^*$is less restrictive than under heterogeneity in one parameter ($\zeta^* = \max(\zeta_{\mathrm{B}} > \zeta_{\mathrm{A}})$). Thus, we predict more support under optimal compensation than under heterogeneity in one parameter.

Hypothesis 5 (compensated heterogeneity) The probability of providing social support is larger under a heterogeneous distribution of two parameters, such that the heterogeneity of one parameter optimally compensates for the heterogeneity of the other parameter, than under a heterogeneous distribution of one parameter.

We want to stress that there exists an 'optimal degree of compensation'. Up to this level, the larger the compensation of the heterogeneity of the two parameters, the more social support there is above this level of heterogeneity, the compensation becomes less effective and consequently support starts to decrease again.

Figure 1 combines hypotheses 4 and 5. The figure shows that the negative effect of heterogeneity in one parameter can either be compensated by the

		Heterogeneity in π_i	
		$\pi_A > \pi_B$	$\pi_A < \pi_B$
Heterogeneity in c_i	$c_A > c_B$	Compensated heterogeneity: Facilitates support	Compounded heterogeneity: Hampers support

Fig. 1 Heterogeneity in two dimensions (compounded vs. compensated heterogeneity)

negative effect of heterogeneity in another parameter or compounded by the negative effect of heterogeneity in another parameter. In the first case, heterogeneity in individual properties encourages mutual dependence relationships. This happens, for instance, when the actor with the high costs of providing support has a supportive relation with a less needy actor with low costs of providing support. In the second case, heterogeneity in individual properties hampers mutual dependence relationships. Now, the actor with the high costs of providing support has a supportive relation with a needier actor with low costs of providing support.

For a formal proof of the hypotheses see Vogt and Weesie (2004). In Sect. 3.2, we derive testable implications of the hypotheses. We use the experimental design (Sect. 3.1) to present these implications. The experimental conditions reflect the hypotheses and the testable implications.

3 Experiment

To test our hypotheses, we use data from a laboratory experiment, in which subjects played series of ISGs. We first introduce the experimental set-up in more detail. Subsequently, we discuss the statistical model and the empirical findings.

3.1 Design

General set-up of the experiment: A laboratory experiment with 148 subjects was carried out at Utrecht University, the Netherlands, in May 2004. Subjects played homogeneous and heterogeneous ISGs.[2]

Subjects: Subjects participated in reaction to an advertisement inviting them to participate in a ‘decision-making experiment’. The advertisement promised them between 9 and 18 euros for participation. The number of subjects in one experimental session ranged from 14 up to 18 subjects. Sixty-eight percent of the participants were female. Most of the participants were students, coming from a variety of disciplines. Subjects were on average 22 years old (std. 3.6).

[2] Information about the full documentation of the experiment can be found at http://www.fss.uu.nl/soc/iscore/.

Procedure: Upon entering the laboratory, subjects received a random number and were asked to take a seat behind the PC with the corresponding number. The subjects were at all times able to see each other to some extent. The experiment was to be partly completed by pen and paper, and partly by computer. The instructions were given on paper. The interactive part of the experiment and the questionnaires were done by computer. All subjects were given the same instructions. As a first task the subjects were asked to read the instructions. The experiment was conducted with the software program z-Tree (Fischbacher 1999). The introduction to the instructions ended with three questions intended for testing the subjects' understanding. The instructions emphasized that the payment at the end of the experiment would be in accordance with the number of decisions that subjects had made. For each point the subjects earned, they would receive one eurocent. It was explicitly mentioned that there were no 'right' or 'wrong' decisions. All references to heterogeneity were avoided. Subjects were told that they could interrupt any task at any time to ask the experimenter for assistance.

The subjects played series of ISGs with other subjects. In each ISG one subject was assigned the role of person A and the other subject obtained the role of person B. Subjects could not identify who the other person was with whom they were playing. Roles A and B can be homogeneous with respect to the benefit–cost ratio and neediness, or they can be heterogeneous. We present the experimental conditions in terms of the individual parameters of role A and role B in the next section. Which subject got which role was determined at random by the computer. For a period of 15 min, i.e., one part of the experiment, subjects played ISGs under one specific set of values for costs, benefits, and neediness (one experimental condition). Subjects were linked with a randomly selected other at the beginning of each ISG. Subjects may by accident have been assigned to the same role and partner in subsequent ISGs. However, they could not recognize their partner. The parameters remained the same within each separate part of the game, but they varied between the different parts. One single session was comprised of three different parts. Each subject participated in one session. The entire experiment contained nine sessions.

In each decision situation the subjects got certain amounts of points (endowments). All subjects run the risk of loosing all points with a certain probability (likelihood of needing support). Half of the subjects were actually confronted with the possibility of losing all their endowments. The subjects not in such a situation had to make the decision whether to let their partners fold or else bail him out at some cost to themselves. The benefits from receiving support, b_i, were the same as the endowment, since the benefits have been defined as the difference between the situation of receiving help (keeping all endowments), and not receiving help (losing all endowments). An actor, who did not run the risk of losing points had to decide whether to help, or not to help his or her partner. Helping was operationalized as giving away some own costly endowments. Subjects could not choose the number of points they gave up, neither the costs nor the benefits or probabilities of being under risk to lose points. These parameters were fixed within one part of a session (see section 'conditions' below).

The computer determined the duration of an ISG, i.e., how long two subjects were matched together. A number from one to five was chosen, each with equal probability. If five turned up the ISG ended. During the entire experiment, the same continuation probability of $\frac{4}{5}$ was used in all ISGs. We wanted to use the dyadic threshold as a 'measure' of how likely social support is given different heterogeneous distributions of the individual parameters. Keeping w fixed allows us to focus exclusively on the effects of increasing or decreasing heterogeneity (i.e., increasing or decreasing ζ^*). Moreover, we feared that varying w would make the experiment unnecessarily more complicated for the subjects. Changing partners was a necessity, but changing roles was not. Since an ISG only ended when a certain probability had been reached after each decision, no part lasted exactly 15 min.

A session started with four practice decision situations (for a discussion on the effects of experience with the decision situation, see e.g., Camerer and Weigelt 1988). Subjects were informed during the practice rounds that they were playing against the computer and that they could not earn money.[3]

Questionnaire: After playing the games, subjects filled in a questionnaire on a number of 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. In total the experiment took between 70 and 90 min.

Conditions: The experiment varied the costs of providing support (c_A, c_B) and the probabilities of needing support (π_A, π_B) between two subjects playing an ISG and between the conditions. The benefits did not vary between subjects ($b_A = b_B$), but the benefits varied between conditions. This was done in order to obtain appropriate numbers for the benefit–cost ratio. It suffices to test the hypotheses by varying these two parameters between subjects. In each part of the experiment, subjects played support games with the parameters as they are used in one of the nine conditions displayed in the design table below (Table 1).

The rows specify the nine conditions of the experiment, the individual thresholds ζ_i, and the equilibrium threshold ζ^* as derived from our game-theoretic model (assuming 'own points match utility'). Consider, for instance, C_9. Subjects in role A need support with probability $\pi_A = 0.3$. The costs for providing support in role A are $c_A = 8$ points, and the benefits of 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 for providing support are $c_B = 24$ points for role B. This is 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. In accordance with the equilibrium condition (Sect. 2.2), these parameters lead to the individual

[3] The practice rounds were designed in such a way that both the computer and the subjects run the risk of losing all points twice. In the cases where the subjects run the risk to lose points, the computer 'provided support' once, and did 'not provide support' once. The practice round was a game under heterogeneity in probabilities and costs.

Table 1 Experimental design

Condition description	Parameters					Thresholds		
	π_A	π_B	c_A	c_B	$b_A = b_B$	ζ_A	ζ_B	ζ^*
Symmetry in all parameters								
C_1: $\pi_A = \pi_B, c_A = c_B$	0.5	0.5	8	8	24	0.50	0.50	0.50
Heterogeneity in one parameter								
C_2: $\pi_A = \pi_B, c_A < c_B$,	0.5	0.5	8	16	32	0.40	0.67	0.67
C_3: $\pi_A = \pi_B, c_A << c_B$	0.5	0.5	8	24	36	0.36	0.80	0.80
C_4: $\pi_A > \pi_B, c_A = c_B$	0.6	0.4	8	8	24	0.42	0.63	0.63
C_5: $\pi_A >> \pi_B, c_A = c_B$	0.7	0.3	8	8	24	0.36	0.83	0.83
Heterogeneity in two parameters								
Compounded heterogeneity								
C_6: $\pi_A > \pi_B, c_A < c_B$	0.6	0.4	8	16	32	0.33	0.83	0.83
C_7: $\pi_A > \pi_B, c_A << c_B$	0.6	0.4	8	24	36	0.30	1	1.00
Compensated heterogeneity								
C_8: $\pi_A << \pi_B, c_A < c_B$	0.3	0.7	8	16	32	0.67	0.48	0.67
C_9: $\pi_A << \pi_B, c_A << c_B$	0.3	0.7	8	24	36	0.61	0.57	0.61

thresholds $\zeta_A = 0.61$ and $\zeta_B = 0.57$, and to the dyadic threshold $\zeta^* = \max(\zeta_A, \zeta_B) = 0.61$. The nine conditions satisfy the constant sum condition $\pi_A + \pi_B = 1$ and $\frac{b_A}{c_A} + \frac{b_B}{c_B} = 6$. One aim of the design was to obtain maximal variation in the dyadic thresholds. However, we did not want to vary neediness too much, since we wanted to avoid situations in which one actor almost permanently needs support.

The nine experimental conditions can be grouped in the following way. The first condition, C_1, uses a homogeneous distribution of the costs and neediness. The four conditions (C_2, C_3, C_4, C_5) specify ‘small’ and ‘large’ heterogeneity in one parameter, i.e., either in the costs or in neediness. The last four conditions specify heterogeneity in the costs and in neediness, first compounded heterogeneity (C_6, C_7) and then compensated heterogeneity (C_8, C_9).

The experiment contained the following sessions: (1) $C_1 - C_6 - C_9$, (2) $C_7 - C_5 - C_2$, and (3) $C_8 - C_3 - C_4$. The design of the experiment was a within and between subjects design. Due to computer network problems, and consequently time problems, we could not complete the third part in two sessions, which means we have less data on the conditions C_9 and C_2.

3.2 A comparison of the experimental conditions

We now consider the nine conditions in more detail, and discuss the implications of the hypotheses 2–5; we compare the percentages of support ($P_1 - P_9$) under the experimental conditions ($C_1 - C_9$). The first condition C_1 specifies a fully homogeneous situation in c and π. A totally homogeneous distribution of the individual parameters between actors leads to the smallest threshold (hypothesis ‘homogeneity’). Based on hypothesis 3 we consequently predict more support under C_1 than under any other condition (C_2 through C_9):

$$\text{Comparison 1: } P_1 > P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_9.$$

Conditions $C_2 - C_5$ involve heterogeneity in either the costs or neediness parameters and homogeneity in the other parameters. The two conditions C_2 and C_3 specify heterogeneity in the costs (c). The heterogeneity in the costs is larger in C_3 than in C_2. Similarly, the conditions C_4 and C_5 specify heterogeneity in neediness (π) with larger heterogeneity under C_4 than under C_5. We predict that heterogeneity in either costs or neediness hampers social support and that a larger heterogeneity hampers support even more (hypothesis 'heterogeneity in one parameter'):

$$\text{Comparison 2: } P_2 > P_3, \quad P_4 > P_5.$$

In the remaining four conditions ($C_6 - C_9$), we induce heterogeneity in both the costs (c) *and* neediness (π). First, we induce heterogeneity in such a way that the heterogeneity in both parameters compounds. Under C_6 actor A needs support more often than actor B ($0.6 > 0.4$), while actor B has the higher support costs ($16 > 8$). Thus, A is in a great deal of trouble, and we expect a very low support rate. The same holds for C_7. In hypothesis 4 we predict that a situation with two problems for one actor leads to less support than a situation with one problem for one actor ('compounded heterogeneity'). Comparing situations with heterogeneity in one parameter with situations with compounded heterogeneity, we predict more support in situations with heterogeneity in either costs or neediness (C_2, C_3, C_4) than in situations with compounded heterogeneity in costs and neediness (C_7, C_8):

$$\text{Comparison 3: } P_2 > P_6, \quad P_4 > P_6, \quad P_3 > P_7, \quad P_4 > P_7.$$

Under C_7 we have a higher degree of heterogeneity in the costs ($24 > 8$) than under C_6 ($16 > 8$), while the heterogeneity in neediness is the same, i.e., the compounded heterogeneity in costs and neediness is larger in C_7 than in C_6. Consequently, we predict more support under C_6 than under C_7:

$$\text{Comparison 4: } P_6 > P_7.$$

Under the last two conditions (C_8 and C_9) the heterogeneous distribution of one parameter (c) is compensated by the heterogeneous distribution of another parameter (π); role B has higher support costs than role A, but role A needs support less often than role B. Now the two problems caused by heterogeneity are divided between the two actors. Under condition C_9 the heterogeneous distribution of the costs is even more extreme than under condition C_8. It is interesting that larger heterogeneous costs compensate for the heterogeneity in neediness even 'better' than smaller heterogeneity in the costs do. This is reflected in the dyadic thresholds of the conditions C_8 and C_9 ($0.67 > 0.61$). Based on the compensation hypothesis, we predict more support under the 'better' problem division of C_9 than under C_8:

$$\text{Comparison 5: } P_9 > P_8.$$

The experimental design does not include optimal compensation. Consequently, we cannot compare optimal compensation of heterogeneity in two parameters with heterogeneity in one parameter. Compensation that is not optimal does not necessarily lead to a smaller ζ^*, and thus to a higher support rate than heterogeneity in one dimension. As numerical example, compare C_2 and C_8; in both conditions the dyadic threshold is $\zeta^* = 0.67$.

3.3 Statistical model

The following section discusses statistical tests of our hypotheses and testable implications. The data is analyzed from the perspective of the actor faced with the choice of providing support to the other actor (we call this actor Ego), thus the binary dependent variable is whether or not Ego provides support. The theoretical analysis assumes complete information and is not appropriate for deriving realistic hypotheses about behavioral dynamics. To exclude common history effects we restrict our analysis to the first decision in the ISGs.

A subject's decision to either provide or not to provide support is the outcome of a discrete choice. To make an estimation of the first decisions in a single ISG, one would normally use an ordinary logit or probit regression model. But this is not appropriate, since the ISGs are repeated within subjects. Therefore, we use an extension of the logistic regression model that incorporates random or fixed subject effects, the Linear Logistic Test Model (LLTM, see Fischer 1997: 226–227). The starting point in formulating the statistical model is the simple Rasch model of item response theory. The Rasch model involves 'difficulties' of the items (decision situations) and individual abilities. With the LLTM we model the choices of subjects in a similar way. Subject i's decision whether to provide support ($y_i = 1$) or not to provide support ($y_i = 0$) is assumed to depend on the difference between i' s personal parameter θ_i, representing a person's 'general willingness' to provide support, and a parameter ϑ_r, representing the situation in which the person made his or her decision:

$$\pi_{irh} = \Pr(y_{irh} = 1 \mid \theta_i, \vartheta_r) = \frac{e^{\theta_i - \vartheta_r}}{1 + e^{\theta_i - \vartheta_r}}, \tag{2}$$

where r indexes conditions and h indexes repetition, i.e., playing ISGs with different partners, within each condition r. Our hypotheses are formulated as assertions about differences in support behavior between certain homogeneous and heterogeneous conditions. The item parameter ϑ_r is decomposed as:

$$\vartheta_r = \sum_{k=1}^{m} \beta_k z_{kr}, \tag{3}$$

z_{kr} are characteristics of experimental conditions and β_k are the parameters to be estimated. We use a random effects specification for the subject parameter, and estimate the model with marginal maximum likelihood. We present two models. The first model 'explains' differences in the support rates of conditions C_1 to C_9 with the dyadic threshold ζ^* as hypothesized in hypotheses 1 and 2. In the second model, we estimate the simple Rasch model in which each condition is represented by a dummy. This specification allows us to test the ranking of the nine conditions as hypothesized in sections 2.3 (hypotheses 3–5) and 3.2 without the strong assumption that the support rates are a smooth function of ζ^*.

4 Results

First we present a number of descriptive results of the experiment. Subjects played on average 4.8 ISGs per part (std. 3.0). Per ISG 4.5 decisions were made on average (std. 3.6). Table 2 displays the percentages of support provided in the first round of each ISG. Our theoretic model does not predict a difference in behavior between roles A and B, since the same ζ^* holds for both. We will review this expectation at the end of this section. The percentages of support provided under each condition are not in strict accordance with our hypothesis that the support rate is higher, the smaller the threshold condition; the largest percentage of support is not found under a homogeneous distribution of all parameters as predicted by the threshold model. To give another example, there is more support under C_7 (ζ^*=1.00) than under C_9 ($\zeta^* = 0.61$).

Table 2 Percentage of support in the first round of ISGs

Condition description	A and B: support in round 1	N	ζ^*	A: support in round 1	N	ζ_A	B: support in round 1	N	ζ_B
C_1: Homogeneity	72	145	0.50						
C_2: Small heterogeneity in costs	54	58	0.67	64	28	0.40	43	30	0.67
C_3: Big heterogeneity in costs	58	144	0.80	76	75	0.36	39	60	0.80
C_4: Small heterogeneity in neediness	79	121	0.63	79	43	0.42	78	78	0.63
C_5: Big heterogeneity in neediness	65	159	0.83	86	70	0.36	49	89	0.83
C_6: Small compounded heterogeneity	40	117	0.83	59	51	0.33	26	66	0.83
C_7: Big compounded heterogeneity	61	170	1.00	77	48	0.30	55	122	1.00
C_8: Small compensated heterogeneity	77	66	0.67	79	42	0.67	75	24	0.48
C_9: Big compensated heterogeneity	56	45	0.61	74	27	0.61	28	18	0.57

We now focus on hypothesis 1 based on the ISG (see Sect. 2.2). We hypothesize that supportive behavior decreases monotonically with the dyadic threshold ζ^*. We fitted a linear and a quadratic model in ζ^*; the simpler linear model fits equally well (LR $\chi^2 = 1.48$, p-two-sided$= 0.2241$). As predicted, the effect of ζ^* on the probability of support is negative. In this sense, our hypothesis is not rejected. To evaluate whether the threshold model really fits the data, we also fitted a model in which dummy variables represent the experimental conditions, i.e., a model saturated with respect to all experimental conditions. We had hoped that the threshold model fits as well as the model which is saturated with respect to conditions. This turns out not to be the case (LR $\chi^2(7) = 21.35, p = 0.0033$). We conclude that we need to be cautious in our interpretation of the positive support for the hypothesis that support decreases in the dyadic threshold. Note that we do not control for experiences subjects have from previously played ISGs.

Based on the hypotheses 2–5, we derived a series of testable implications about the ranking of the support rates of the nine experimental conditions (see Sects. 2.2 and 3.1; Table 3). Table 4 reports Wald tests of the predictions, based on a simple random effects Rasch model.

The hypothesis ‘heterogeneity in one parameter’ states that support is less likely under heterogeneity in one parameter than under full homogeneity. Thus, in comparison 1 we compare the percentages of support under full homogeneity (C_1) with the percentages of support under conditions of heterogeneity either in the costs (C_2 and C_3) or in neediness (C_4 and C_5). We find a significant difference in the predicted direction in behavior between homogeneity (C_1) on the one hand, and heterogeneity in costs (C_2, C_3), as well as large

Table 3 Random effect logistic regression for first choices in ISGs

	Threshold model		Model including all conditions	
	b	SE	*b*	SE
ζ^*	−2.452	0.606		
Constant	2.549	0.480		
C_1: Homogeneity			1.425	0.293
C_2: Small heterogeneity in costs			0.066	0.372
C_3: Big heterogeneity in costs			0.483	0.263
C_4: Small heterogeneity in neediness			1.548	0.338
C_5: Big heterogeneity in neediness			0.502	0.286
C_6: Small compounded heterogeneity			1.018	0.276
C_7: Big compounded heterogeneity			−0.450	0.301
C_8: Small compensated heterogeneity			1.302	0.401
C_9: Big compensated heterogeneity			0.349	0.435
Standard deviation of random effect	1.350		1.351	
Standard deviation of decision	$\sqrt{\pi^2/3}$		$\sqrt{\pi^2/3}$	
Log-likelihood	−601.863		−591.189	
Number of choices	1,025		1,025	
Number of subjects	148		148	

heterogeneity in neediness (C_5) on the other hand. We do not find a significant difference between the percentages of support under homogeneity (C_1) and small heterogeneity in neediness (C_4).

In comparison 2, we predict that the more heterogeneous the distribution of costs or neediness, the less likely is social support. Thus, we compare small heterogeneity in neediness with large heterogeneity in neediness, and small heterogeneity in the costs with large heterogeneity in the costs. As expected, a small heterogeneity in neediness (C_4) leads to a higher support rate than a large heterogeneity (C_5). For costs, the difference between small heterogeneity (C_2) and large heterogeneity (C_3) are not found.

The hypothesis 'compounded heterogeneity' states that heterogeneity in two parameters leads to less support if the heterogeneity compounds. In comparison 3 we compare the percentages of support under heterogeneity in one parameter (C_2, C_3, C_4) with the percentages of support under compounded heterogeneity in two parameters (C_6, C_7). The implications are partly supported. We find significant differences in supportive behavior in three cases. First, people become less supportive if they differ largely in the costs (C_3) and a small difference in neediness (C_7) is added. Second, the percentage of support is significantly less if, in addition to a small heterogeneity in neediness (C_4), a large heterogeneity in the costs (C_7) is added, such that the less needy person has higher support costs. We do not find a significant effect on supportive behavior if a small heterogeneity in the costs (C_6) compounds with a small heterogeneity in neediness (C_4). We predict less support if a small heterogeneity in neediness (C_6) compounds with a small heterogeneity in the costs (C_2). This prediction is rejected by the data. Additionally, we predicted that support is less likely the larger the compounded heterogeneity in the costs and neediness (comparison 4). We find that people tend to provide less support if they already differ with regard to costs and neediness (C_6) and the heterogeneity in the costs increases (C_7).

Based on the hypothesis 'compensated heterogeneity', we expect more support the 'better' the problems are divided between the actors, i.e., the better the heterogeneity is compensated. Since the heterogeneity is 'better' compensated under C_9 than under C_8, we expect $P_9 > P_8$. This is rejected by the data (comparison 5). Our experimental design does not allow for a comparison of compensation with heterogeneity in one dimension. Therefore, we cannot test the entire hypothesis.

According to the hypothesis on 'homogeneity', social support is most likely if all parameters are homogeneous (comparison 1). This is largely supported, though in some cases the difference in supportive behavior is not significant. The latter case consists of the situations with small heterogeneous distributions such as small heterogeneity in neediness (P_4), small compound of heterogeneity in neediness and the costs (P_6), and small compensation of heterogeneity in the costs and neediness (P_8)—except for small heterogeneity in the costs (P_2).

Generally speaking, behavior does not seem to be influenced if a small problem is added to an actor already facing a small problem, or to an actor who does not have a problem. However, if a large problem is added, there is a significant difference in the behavior of the subjects in the expected direction. This suggests that the ‘small effects’ are not found to be mostly due to a lack of power. Unfortunately, our design does not allow to compare the situations where two individual parameters are distributed heterogeneous in such a way that support is either facilitated (i.e., heterogeneity in one parameter ‘compounds’ the negative effect of heterogeneity in another parameter) or hampered (i.e., heterogeneity in one parameter ‘compensates’ the negative effect of heterogeneity in another parameter), see Fig. 1.

Before we conclude, we would like to address one more issue. According to the dyadic threshold model we did not expect a difference in the behavior of role A and role B. Based on the logic of trigger strategies in ISGs, we argue that both players provide support if and only if it is mutually rational to do so (based on the dyadic threshold condition ζ^*). If it is not in B’s interest to offer support, A will recognize this and will offer no support either. Consequently, both actors either provide support or do not provide support. However, under certain conditions one partner faces problems such as high support costs, whereas the other person faces no problems at all, or ‘small’ problems only. Intuitively, one might expect different behavior from these two persons, namely that the person with the higher support costs provides support less often than the person with the lower support costs. That is, individual behavior may well depend on the individual threshold directly. This can be related to bargaining solutions and to other equilibria in the theory of repeated games. Based on Table 2 we expect that the behavior of subjects in roles A and B indeed differ, namely such that the lower the individual threshold, the more an actor provides support. To test this, we

Table 4 Test of qualitative predictions on supportive behavior per condition

	Wald z	One sided p value	
Hypothesis ‘heterogeneity in one parameter’			
Homogeneity versus heterogeneity in one parameter			
$P_1 > P_2$	2.87	0.002	*
$P_1 > P_3$	2.55	0.011	*
$P_1 > P_4$	−0.28	0.612	NC
$P_1 > P_5$	2.26	0.024	*
Small versus large heterogeneity in one parameter			
$P_2 > P_3$	−0.91	0.820	NC
$P_4 > P_5$	2.37	0.009	*
Heterogeneity in one versus heterogeneity in two parameters (‘compounded heterogeneity’)			
$P_3 > P_7$	2.33	0.010	*
$P_4 > P_7$	4.41	0.000	*
$P_4 > P_6$	1.26	0.105	NC
$P_2 > P_6$	−2.05	0.980	**
Hypothesis ‘compounded heterogeneity’			
$P_6 > P_7$	3.59	0.000	*
Hypothesis ‘compensated heterogeneity’			
$P_9 > P_8$	−1.62	0.948	**

* confirmed, ** rejected,
NC not confirmed

fitted an additional model which is saturated with respect to conditions and to role.[4] A test against model 2 of Table 2 demonstrates that behavior does indeed vary with role (LR $\chi^2(8) = 96.91$, $P < 0.000$). This implies that our theoretical model could be improved by relaxing certain assumptions, such that a common threshold for both actors does not follow. This is elaborated in the discussion.

5 Conclusion

We conjectured that supportive behavior depends monotonically on the dyadic threshold ζ^*. Tests have shown that the model which is saturated with respect to conditions fitted the data considerably better than the linear model of ζ^*. We are, therefore, reluctant in concluding that social support is more likely the smaller the dyadic threshold. The tests on the qualitative predictions are more satisfactory. We found that small heterogeneity does not seem to matter; only large heterogeneity leads to different behavioral consequences. Supportive behavior in homogeneous situations differs significantly from supportive behavior in situations with large heterogeneity in one parameter. In line with this, we also found that if heterogeneity increases, social support is less likely. The only two exceptions are the comparison of small heterogeneity in the costs with small compounded heterogeneity, as well as large and small compensation, which turned out to be non-significant.

Finally, we wish to discuss one additional point with respect to the ISG. Our analysis has shown that the assumption that both actors provide support only if it is individually rational for both of them (the dyadic threshold condition) is not appropriate; subjects in role A behave different from actors in role B. This allows us to study heterogeneity in terms of roles. Intuitively, one could expect an actor facing one or two ‘problems’ to behave differently from an actor who is not facing any ‘problems’. The data indicate that subjects in the advantageous role generally provide support more often than subjects in the disadvantageous role. One explanation might be that subjects follow certain fairness principles; the advantageous actors may be willing to provide support more often so that both actors receive the same outcome. If fairness matters, actors compare their own outcome and the outcome of their partner with a ‘fair share’. Incorporating fairness would allow for an analysis of the full history of ISGs under the assumption that actors ‘maximize fairness’. Fairness principles can be derived, for instance, from equity or bargaining theory.

In a future experiment, it would be interesting to run additional conditions where we keep ζ^* fixed and vary the continuation probability. For the predictions it is only relevant whether w is larger or smaller than ζ^*. Varying the continuation probability instead of the dyadic threshold should not have different effects on actors’ behavior. Furthermore, it would be interesting to induce heterogeneity in the benefit-cost ratio via the benefits rather than the costs. Intuitively, we expected heterogeneity in the costs to be more salient than

[4] Obviously, under homogeneous roles, A and B do not differ. Therefore, the test has 8 *df*.

in the benefits. However, theoretically there is no difference between inducing heterogeneity via costs or benefits.

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References

Abreu D (1988) On the theory of infinitely repeated games with discounting. Econometrica 56:383–896

Arrow KJ (1951) Social choice and individual values. Harvard University Press, New York

Atkinson AB (1983) On the measurement of inequality. In: Atkinson AB (ed) Social justice and public policy. MIT Press, Cambridge

Axelrod R (1984) The evolution of cooperation. Basic Books, New York

Blau P (1968) Social exchange. In: Sills DL (ed) International encyclopedia of the social sciences, vol. 7, pp 452–457

Blau P (1964) Exchange and power in social life. Wiley, New York

Camerer C, Weigelt K (1988) Experimental tests of a sequential equilibrium reputation model. Econometrica 56:1–36

Emerson R (1976) Social exchange theory. Annu Rev Sociol 2:335–362

Fischbacher U (1999) z-tree—Zurich toolbox for readymade economic experiments—experimenter's manual. Working paper 21, Institute for Empirical Research in Economics, University of Zurich

Fischer GH (1997) Unidimensional linear logistic rasch models. In: van der Linden WJ, Hambleton RK (eds) Handbook of modern item response theory. Springer, Berlin Heidelberg New York, pp 225–243

Frank RH (1985) Choosing the right pond. Human behavior and the quest for status. Oxford University Press, Oxford

Homans GC (1961) Social behavior: It's elementary forms. Harcourt, Brace & World, New York

Kahneman D, Tversky A (1979) Prospect theory: An analysis of decision under risk. Econometrica 47:263–291

Kreps DM (1990) A Course in microeconomic theory. Harvester Wheatsheaf, New York

Rubinstein A (1990) Game theory in economics. E. Elgar Pub, Brookfield

Sen A (1997) On economic inequality. Clarendon Press, Oxford

Vogt S, Weesie J (2004) Social support among heterogeneous partners. Anal Kritik 2:398–422