Two on exchange

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Transferring Goods or Splitting a Resource Pool*

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We investigated the consequences for exchange outcomes of the violation of an assumption underlying most social psychological research on exchange. This assumption is that the negotiated direct exchange of commodities between two actors (pure exchange) can be validly represented as two actors splitting a fixed pool of resources (split pool exchange). We designed five experimental conditions to determine differences in bargaining behavior in pure exchange and split pool exchange. We conclude that the validity of research using the split pool exchange approach is questionable, since we observed much less variance in outcomes and more efficient agreements in split pool exchange than pure exchange. Moreover, although theories accurately predicted outcomes of split pool exchange, they could not accurately predict outcomes of pure exchange. We discuss possible implications of our findings for exchange and research on exchange.

A large amount of research in the social sciences has been undertaken in the field of exchange. Our goal is to investigate a major assumption underlying much of the research on negotiated direct exchange, namely that negotiated direct exchange can be validly represented as two exchange partners splitting a fixed pool of resources or "profit points."

An *exchange* is a social situation in which two actors (either individuals or corporate actors) can collaborate with each other to the benefit of both. This collaboration can take several forms, such as exchanging goods or services, but also performing favors or transmitting information (e.g., Blau 1964; Homans 1958; Lawler and Ford 1995; Molm 1997; Thibaut and Kelley 1959), rendering exchange research important for a variety of disciplines in the social sciences, such as economics, sociology and (social) psychology.

Homans' (1958) definition of social behavior as an exchange of goods implies pure exchange. In *pure exchange,* partners are endowed with bundles of commodities that they can exchange with each other, and have different preferences over these commodities (Coleman 1990; Edgeworth 1881; Emerson 1976). Consider a simple pure exchange situation with two actors, A and B, and two goods, X and Y. Assume that A holds 18 units of X, B holds 30 units of Y, A is equally interested in a unit of both goods, and B is five times more interested in a unit of good X than Y. In this pure exchange situation, A and B can make a mutually profitable exchange if the exchange rate is in the range of 1 to 5 units of Y for 1 unit of X.

Since pure exchange is a concept originated in economics, it is prudent to briefly discuss its relation to typologies of exchange known in the sociological literature. We refer to Molm (1997:11–28) for an excellent and extensive discussion on exchange typologies. Pure exchange as studied in the present paper is referred to by sociologists as negotiated direct exchange. *Direct exchange* refers to bilateral resource flows. *Negotiated exchange,* as opposed to reciprocal exchange, involves a joint decision process, such as bargaining, to determine the terms of exchange. Pure exchange, as conceptualized in economics, entails the transfer of commodities differently valued by actors, whether exchange is reciprocal or negotiated. Whenever we write "pure exchange" in the text below, we refer to nego-

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tiated direct pure exchange, unless we explicitly state otherwise.

The first empirical studies on negotiated direct exchange in sociology are Cook and Emerson (1978) and Stolte and Emerson (1977). After formulating pure exchange in their theory section, Cook and Emerson used transaction tables in their experiment to transform a pure exchange situation into a task in which no goods are transferred but in which "persons . . . have 24 units of profit to divide through negotiations" (1978: 725). In their studies subjects had only restricted information; they did not know they were jointly dividing 24 units of profit and did not know their partner's payoff after exchanging. This experimental task, which we'll call "constant-sum exchange under restricted information," has been used in many studies on exchange, for instance, in all studies on negotiated direct exchange in the power-dependence tradition (e.g., Cook et al. 1983; Cook and Yamagishi 1992), the studies of Lawler and Yoon (1993, 1996, 1998), and others (e.g., Molm, Peterson, and Takahashi 1999; Thye, Lovaglia, and Markovsky 1997).

In many other studies on negotiated direct exchange in sociology and social psychology (e.g., see the special issues of *Social Networks* from June 1992, *Rationality and Society* from January 1997, and van Assen 2003 for an extensive list of references), and in economics and behavioral economics (e.g., see Camerer 2003; Roth 1995), an abstraction of pure exchange was used in which exchange was conceptualized as the opportunity of two actors to split a resource pool. This abstraction, introduced in the eighties by Markovsky and Willer (e.g., Markovsky, Willer, and Patton 1988), is further called *split pool exchange.* In the typical split pool exchange task, utilized in dozens of studies, subjects have full information on the task and the others' payoffs. Subjects negotiate over the split of a pool of points, typically of size 24, that has the same value to both of them. If two subjects manage to agree on a division of the pool, the points are divided according to the agreement. If they fail to reach agreement, neither subject gets any points. The entire pool of points must be divided, provided agreement is reached. This typical split pool exchange task is also employed in our experiment, i.e., with full information to the subjects and all the other characteristics mentioned.

The use of split pool exchange in order to study negotiated direct pure exchange is commonly justified by stating that split pool exchange is equivalent to negotiated direct pure exchange (Markovsky 1987; Molm 1994; Willer 1992; Willer, Markovsky, and Patton, 1989). Skvoretz and Willer (1993:803) defend the split pool exchange task as follows:

> This task is formally equivalent to [pure] exchange formulated as an Edgeworth box problem (Edgeworth 1881). In Edgeworth's formulation, both actors can improve on their "initial" endowment by exchanging until some point on the "contract curve" is reached. (. . .) in the present task [split pool exchange] (. . .) any agreement that gives a larger share to one person necessarily gives a smaller share to the other, as do exchanges along the contract curve of the Edgeworth box.

The conceptualization of pure exchange as split pool exchange evokes two questions. First, are these conceptualizations equivalent with respect to payoff possibilities? Bonacich (1992: 22) has raised doubts on split pool exchange as a conceptualization of exchange, by commenting that "nothing is actually exchanged in these experiments." Indeed, van Assen (2001) proved that split pool exchange and pure exchange are not equivalent with respect to the payoff possibilities: only under some special, well-defined conditions exchanging resources (pure exchange) can be represented by splitting a pool of points (split pool exchange).

The second question is particularly compelling because of the violation of the presumed equivalence of split pool exchange and pure exchange underlying many studies on negotiated direct exchange: to what extent can results and conclusions of studies on exchange using split pool exchange be generalized to real exchange, i.e., pure exchange? To answer this fundamental question, one needs to compare bargaining outcomes in split pool exchange and pure exchange situations. If bargaining outcomes differ greatly in the two situations, then one should have doubts concerning the validity of research using split pool exchange. The aim of the present study is to investigate the consequences on exchange outcomes and research on negotiated direct exchange of the violation of this basic equivalence assumption, by experimentally comparing bargaining behavior in pure exchange and split pool exchange situations in which subjects have full information.

The inequality of split pool exchange and pure exchange is visualized by comparing Figure 1a to Figure 1d. Figure 1 depicts the payoff space or payoff possibilities in four distinct bilateral pure exchange situations. The payoffs of actors A and B are registered on the horizontal and vertical axes, respectively. The lines drawn in the figures show the sets of Pareto efficient agreements available to the pair of actors. A Pareto efficient agreement is

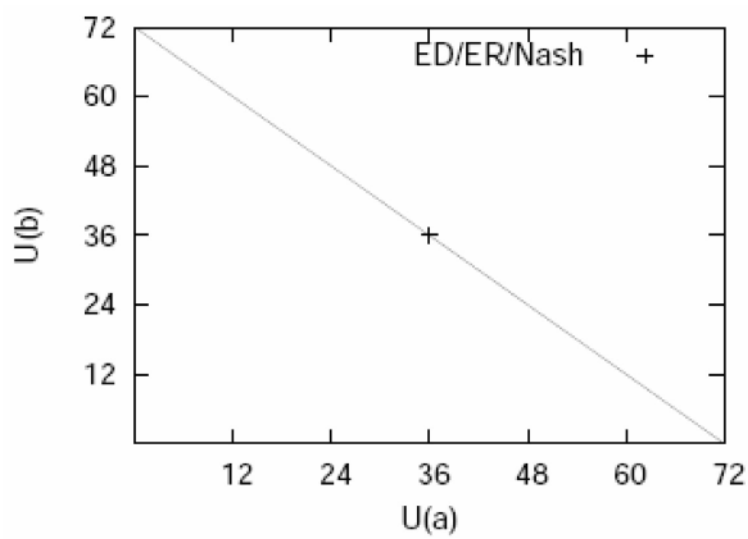

Figure 1a: Payoff space of conditions 1 (split pool exchange) and 2; ED and ER indicate equidependence and equiresistance, respectively

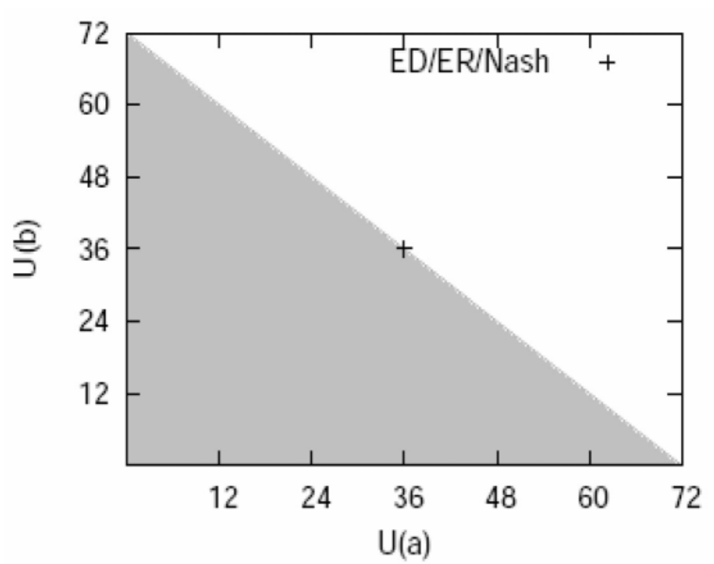

Figure 1b: Payoff space of condition 3; ED and ER indicate equidependence and equiresistance, respectively

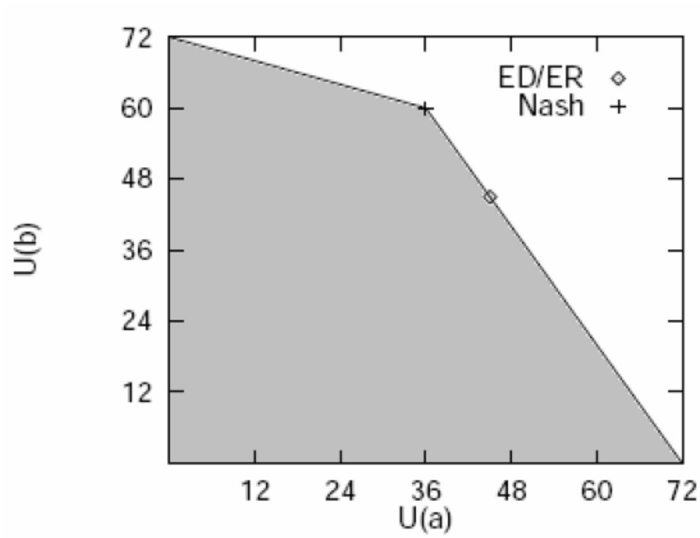

Figure 1c: Payoff space of condition 4; ED and ER indicate equidependence and equiresistance, respectively

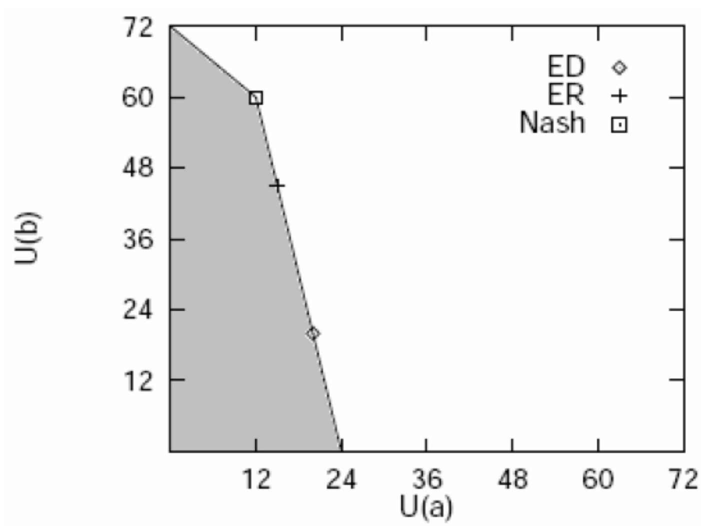

Figure 1d: Payoff space of conditions 5 (typical pure exchange); ED and ER indicate equidependence and equiresistance, respectively

an agreement such that no actor can improve his payoff without decreasing the payoff of the other actor. The area to the upper right of this Pareto frontier is the set of unfeasible agreements. The area to the lower left of the frontier depicts feasible agreements if and only if this area is shaded in the figure. The shaded area depicts the agreements that are not Pareto efficient. The numbers at the intersections of the Pareto frontier and the axes indicate the actors' maximum gains in the set of feasible agreements. If an actor earns his maximum, his partner gains nothing.

Figure 1a depicts a pure exchange situation that can be represented by an split pool exchange of 72 points. Note that all feasible agreements are Pareto efficient, both actors' maxima are 72, and the sum of the actors' payoffs is 72 for all agreements. If the actors do not agree, neither obtains any points. Figure 1d depicts the payoff possibilities that arise in a typical pure exchange situation. Four differences exist between the pure exchange situa-

Table 1. Summary of the Five Experiment Conditions and their Characteristics

	Characteristics			
Condition	(i) Splitting a fixed pool of points	(ii) Pareto efficiency enforced	(iii) Constant sum across Pareto efficient agreements	(iv) Identical maxima
1 (split pool exchange; Fig.1a)	Yes	Yes	Yes	Yes
2 (Fig.1a)	No	Yes	Yes	Yes
3 (Fig.1b)	No	No	Yes	Yes
4 (Fig.1c)	No	No	No	Yes
5 (typical pure exchange; Fig.1d)	No	No	No	No

tion depicted in Figure 1d and the split pool exchange situation. These differences are:

(i) The *task:* in pure exchange actors exchange resources, whereas in split pool exchange actors split a fixed pool of points.

(ii) *Pareto efficiency:* in split pool exchange Pareto efficiency is enforced by the requirement that the entire pool of points be divided, whereas Pareto efficiency is not guaranteed in pure exchange, as indicated by the shaded area in Figure 1d.

(iii) *Constant-sum:* the sum of points that actors earn is constant in split pool exchange, which is not generally true in pure exchange. If the Pareto frontier is kinked, such as in Figure 1d, this sum of points cannot be constant.

(iv) *Equal maximum:* in split pool exchange the maximum number of points actors can earn is always equal for both subjects, which is not generally true in pure exchange, as indicated in Figure 1d.

The effects of each of these four differences on the bargaining outcomes of pure exchange compared to split pool exchange will be investigated by pair-wise comparisons of five experimental conditions. These comparisons allow us to determine which characteristic of the typical pure exchange of Figure 1d, embodied in condition 5 below, is responsible for the differences in bargaining outcomes between split pool exchange and pure exchange, if such differences exist. The five experimental conditions and their characteristics are presented in Table 1. Condition 1, which is the standard split pool exchange, has all characteristics (i) to (iv) and corresponds to Figure 1a, while condition 5, embodying the typical pure exchange situation and corresponding to Figure 1d, has none of them. Compared to condition 1 (split pool exchange), condition 2 only differs in (i) *task,* pure exchange vs. split pool exchange, and thus also corresponds to Figure 1a. Condition 3 in addition also differs in (ii) *Pareto efficiency,* corresponding to Figure 1b, that has a shaded area indicating Pareto inefficient agreements are feasible. Condition 4 additionally differs in (iii) *constant-sum,* because of the kinked Pareto frontier, as depicted in the corresponding Figure 1c.

Only if some special well-defined requirements are met, pure exchange can be represented by split pool exchange. Condition 2 satisfies all these requirements: (a) one actor can only transfer one unit of an indivisible good, implying Pareto efficiency; (b) the Pareto frontier is a straight line; and (c) both actors have the same maximum possible gain.[1] Note that b and c are very restrictive assumptions on the actors' preferences, implying that pure exchange situations that can be represented as a split pool exchange situation hardly occur in real life. Requirement a is violated in conditions 3, 4, and 5 (typical pure exchange), requirements a and b are violated in condition 4 and all three requirements are violated in condition 5 (typical pure exchange).

[1] Requirements (b) and (c) hold if $U_{AY}U_{BX}/U_{BY}-U_{AX} = U_{BX}-U_{AX}U_{BY}/U_{AY}$ and $E_{BY} \geq U_{BX}/U_{BY}$, respectively, where E_{ij} and U_{ij} denote respectively actor i's endowment and actor i's utility of good j.

Several dimensions of outcomes of bargaining situations can be distinguished that might be affected by the differences between pure exchange and split pool exchange. The five experimental conditions are analyzed and compared with respect to the following five bargaining outcomes:

1. The average payoffs of the actors
2. The probability of subjects reaching agreement
3. The conditional probability that agreements are Pareto efficient given that agreements are reached
4. The conditional probability that actors' payoffs are equal given that agreements are reached
5. The variance in the actors' payoffs.

With respect to the average payoffs, we make use of three formal bargaining theories that make exact predictions concerning actors' payoffs. These theories are the Nash bargaining solution (Nash 1950), the Raiffa-Kalai-Smorodinsky (RKS) solution (Kalai and Smorodinsky 1975) and the Kernel solution (Friedman 1986; Shubik 1982). An important implication of split pool exchange in condition 1 is that these three theories all make the same prediction: they all predict actors A and B to split the pool evenly (see Figure 1a). In typical pure exchange however, predictions of the three theories generally differ (see Figure 1d, corresponding to condition 5), indicating that different bargaining behavior can be expected in split pool exchange and pure exchange. Consequently, from the perspective of bargaining theories, split pool exchange obscures interesting aspects of pure exchange that cause the theories' predictions to be different, and thus yields uninteresting bargaining situations.

In the next section we will discuss the bargaining theories and formulate hypotheses concerning the comparisons of the different experimental conditions on the five bargaining outcomes. The subsequent section discusses the methods employed in our experiment.

THEORY AND HYPOTHESES

The following subsections discuss the hypotheses concerning each dependent variable. Most of these hypotheses are derived from three prominent bargaining theories, which are therefore briefly discussed in the first subsection. In the second subsection the theories' predictions for our experimental conditions are presented as hypotheses about the average payoffs of the actors. Hypotheses concerning the four other dependent variables, probability of reaching agreement, the conditional probability of Pareto efficiency, the conditional probability that actors' payoffs are equal, and the variance in actors' payoffs are derived mainly by comparing the predictions of the bargaining theories. Throughout, the hypothesized differences between the two extremes, conditions 1 (split pool exchange) and 5 (typical pure exchange), are discussed first.

Bargaining Theories

The three theories discussed in this subsection stem from cooperative game theory. Bienenstock and Bonacich (1993) explicitly argue for the use of solutions from cooperative game theory for the development of predictions for negotiated direct exchange. In addition, two of the three theories have prominent counterparts in sociological negotiated direct exchange theory.

The Nash bargaining solution is arguably the best-known solution to the bilateral bargaining problem. Its most famous rival in cooperative game theory is the RKS solution (Kalai and Smorodinsky 1975; Raiffa 1953). Moreover, a basic principle of one of the most well-known and often used theories of negotiated direct exchange in sociology, called Network Exchange Theory, is based on the RKS solution (Willer 1999). This principle, called *equiresistance,* yields predictions of bilateral negotiated direct exchange that are identical to predictions of the RKS solution (Heckathorn 1983a; Patton and Willer 1990). Finally, a natural and obvious other prediction of bilateral negotiated direct exchange is that both exchange partners share their gains of exchange equally. This prediction also results from a solution from cooperative game theory, called the Kernel (cf. Friedman 1986; Shubik 1982). Moreover, it also follows from a principle of the oldest theory of negotiated direct exchange in sociology, called Power-Dependence Theory (e.g., Cook and Emerson 1978). This principle is called *equidependence.*

All three solutions from cooperative game theory are axiomatized solutions. These solution concepts, and hence implicitly also their counterparts in sociology, prescribe certain requirements that the outcome of the bargaining situation should meet. Pareto efficiency is an outcome requirement in all three solutions. Moreover, the solutions assume agreement always occurs.

The Nash solution is that Pareto efficient agreement between the two players, for which the product of their utility gains is at a maximum. The equiresistance solution is given by a Pareto efficient agreement between the two players, such that the players' utility gains are proportional to their maximally attainable utilities. The equidependence solution is given by a Pareto efficient agreement where the utility gains of the players are equal. All solutions are indicated in figures 1a through 1d.

Payoff Predictions and Hypotheses

The three solutions predict the following payoffs of A and B (denoted π_A and π_B, respectively), formulated as hypotheses:

> *Hypothesis 1a:* In conditions 1 (split pool exchange), 2, and 3 $\pi_A = \pi_B = 36$ Nash/equiresistance/equidependence).
>
> *Hypothesis 1b:* In condition 5 (typical pure exchange) i), $\pi_A = 12$ and $\pi_B = 60$ (Nash), ii) $\pi_A = 15$ and $\pi_B = 45$ (equiresistance), iii) $\pi_A = 20$ and $\pi_B = 20$ (equidependence).
>
> *Hypothesis 1c:* In condition 4 i) $\pi_A = 36$, $\pi_B = 60$ (Nash), ii) $\pi_A = 45$, $\pi_B = 45$ (equiresistance/equidependence).

All three bargaining solutions are based upon reasonable characteristics that an outcome should have (maximum product of gains, equal relative gain, equal absolute gain). Hypotheses 1a and 1b reveal that these three solutions, and thus their underlying principles, yield identical predictions in split pool exchange situations such as condition 1, but yield different predictions in typical pure exchange situations such as condition 5.

Since the Pareto frontiers of conditions 1 (split pool exchange), 2 and 3 are identical (see figures 1a and 1b), and all three theories assume exchange is Pareto efficient, the theories make the same prediction concerning the average payoffs for the three conditions. Thus, Hypothesis 1a not only pertains to condition 1 (split pool exchange), but also to conditions 2 and 3.

The kink in the Pareto frontier of condition 4, depicted in Figure 1c, causes the prediction of Nash to differ from the predictions of equiresistance and equidependence, yielding Hypothesis 1c. The inequality of the actors' maxima in condition 5 (typical pure exchange) causes the equiresistance and equidependence solutions to be different. The two predictions are different in condition 5 (typical pure exchange) because the equiresistance solution is not affected by linear transformations of payoffs, but the equidependence solution is.[2]

Overview of Other Hypotheses

Table 2 summarizes the hypotheses pertaining to the dependent variables other than the average payoffs. Shown are the predicted orderings of the conditions according to the hypotheses. Also shown are the orderings observed in the experiment. Our hypotheses pertain to pair-wise comparisons of subsequent conditions.

As an example, consider the conditional probability of equal payoffs. It follows from the second column of Table 2 that this probability is expected to be lower in condition 5

[2] Condition 5 (typical pure exchange) is obtained from condition 4 by dividing the payoff scale of actor A by 3. This has the effect of lowering the maximum of A from 72 to 24 (Figure 1d). Such linear transformations of payoffs do not affect the predictions of the Nash and equiresistance solutions: the prediction for condition 5 (typical pure exchange) is the same as the one for condition 4, with the payoff of A divided by 3. However, the payoffs predicted by the equidependence solution are affected by this change in scale. It is said that the Nash and equiresistance solution assume that interpersonal utility comparisons are invalid, while equidependence does not. See also Heckathorn (1983b) and Emerson et al. (1983) for a discussion of this point.

Table 2. Summary of Hypotheses other than on Payoff Predictions

Dependent Variables	Predicted Order of Conditions	Observed Order of Conditions
Probability of agreement	1 > 5 (H2a)	1 = 5
	1 > 2 (H2b),	1 = 2
	4 > 5 (H2c)	4 > 5
Conditional probability of Pareto efficiency	1 > 5 (H3a)	1 > 5
	2 > 3 (H3b)	2 > 3
Conditional probability of equal payoffs	1 > 5 (H4a)	1 = 5
	1 > 2 (H4b)	1 > 2
	3 > 4 > 5 (H4c and H4d)	3 = 4 = 5
Variance in payoffs	1 < 5 (H5a)	1 < 5
	1 < 2 (H5b)	1 < 2
	3 < 4 < 5 (H5c and H5c)	3 > 4, 4 < 5

Note: Conditions are designated by their arabical numerals. The ">," "<," and "=" signs indicate the relevant variable has a higher, lower, or equal value respectively, in the subsequent condition. Hypothesis numbers are indicated in brackets next to each comparison.

(typical pure exchange) than in condition 1 (split pool exchange), lower in condition 2 than in condition 1 (split pool exchange), lower in condition 4 than in condition 3, and lower in condition 5 (typical pure exchange) than in condition 4. The third column of Table 2 shows that only the hypothesized difference between conditions 1 and 2 was actually observed.

Hypotheses Concerning the Probability of Reaching Agreement

The reasoning underlying Hypthesis 2 is as follows. Firstly, moving from condition 1 (split pool exchange) to condition 2 increases the complexity of the experimental task, since in condition 2 it involves the processing of more diverse types of information: how many units of what resource do I give up, how many units of which do I receive, how much is each resource worth to me and to the other subject, how much do I gain, etc? The task in condition 1 (split pool exchange) is easier in this respect, since the size of the pool is known to the subjects, and no calculations with units of different resources have to be performed to determine one's own gain from the (prospective) agreement. We expect that subjects will fail to reach agreement more often in the case of the more complex task.

Secondly, moving from condition 4 to condition 5 (typical pure exchange) introduces a conflict between relative and absolute payoffs, or between the equiresistance and equidependence solutions. This means that a conflict results between a subject wanting relative payoffs to be equal and a subject who feels absolute payoffs should be equal. We expect this conflict to result in even fewer agreements in condition 5 (typical pure exchange) than in condition 4.

Hypotheses Concerning the Conditional Probability of Pareto Efficiency Given Agreement

In condition 1 (split pool exchange) and condition 2 Pareto inefficient agreements are not possible, contrary to the other three conditions. Although Pareto inefficient exchanges are possible in these three conditions, the three bargaining solutions presume that Pareto inefficient transactions do not occur. However, because of the task complexity or other reasons concerning the cognitive capacities of the subjects, some inefficient agreements in these conditions can be expected. Note that this expectation of inefficient agreements reflects our belief that subjects' rationality is bounded.

Hypotheses Concerning the Conditional Probability of Equal Payoffs Given Agreement

The reasoning underlying Hypothesis 4 is as follows. First, in condition 1 (split pool exchange) equally dividing the pool of points is a focal solution to the bargaining problem (Schelling 1960). In condition 2 this focal point is blurred, since there is no pool of points to be divided, even though the set of feasible agreements is identical.

Second, we expect the conditional probability of equal payoffs to be lower in condition 4 than in condition 3. All three solutions point to equal gain for both actors in condition 3, but in condition 4 Nash points to an unequal gain (see figures 1b and 1c). If some subject's or pair of subjects' behavior is accurately described by the Nash solution, then fewer equal gain agreements will be observed in condition 4 than in condition 3. Finally, following a similar reasoning, even fewer equal gain agreements are expected to be observed in condition 5 (typical pure exchange): if some subjects' behavior is accurately described by equiresistance, then fewer equal gain agreements will be observed in condition 5 (typical pure exchange) than in condition 4.

Hypotheses Concerning the Variance in Actors' Payoffs

The reasoning underlying Hypothesis 5 on the variance of payoffs reflects the reasoning underlying Hypothesis 4. The variance is expected to be larger in condition 2 than in condition 1 (split pool exchange) because the focal point is less prominent in the former than in the latter. And the variance is expected to be larger in condition 5 (typical pure exchange) than in condition 4, in which it is in turn expected to be larger than in condition 3, because moving from condition 3 to condition 5 (typical pure exchange), more solutions are conflicting in the subsequent condition.

METHOD

Participants

Subjects were students from several departments at the University of Groningen. We recruited 124 subjects by sending an email to all students at the university, advertising participation in our exchange experiment. The email explicitly stated that subjects in the experiment would be paid according to their earnings in the exchanges they completed, and that the maximally feasibly monetary reward was 12.96 euros.

Materials

Experiments were conducted using the computer program ExNet 3.0, developed by Willer and his coworkers at the University of South Carolina. The computer screen displayed the letters A and B, indicating the two subjects in the pair. In condition 1 (split pool exchange), the computer screen showed the pool of 72 profit points to be divided. In conditions 2 through 5 (typical pure exchange), the screen showed a subject's own and their partner's resources, and their own and their partner's points for each unit of resource. In all conditions, the computer screen showed the offers and counteroffers subjects and their partners made. For each offer, the computer screen showed both subjects the number of points this would yield each of them.

Procedure

Subjects were paired randomly to form 62 pairs. The pairs were randomly assigned to one of the five conditions. Thirteen, fourteen, nine, thirteen, and thirteen pairs played conditions 1 (split pool exchange) through 5 (typical pure exchange), respectively. In each pair, one subject was assigned the letter A and the other the letter B.

Upon arrival in the experimental room, subjects were seated behind computer terminals. Subjects could see each other, but because of the presence of multiple pairs in each session, could not infer which other subject was their particular exchange partner. Communication between subjects, other than making offers and counteroffers via the computer program, was not allowed. Computers were arranged such that subjects could not read each other's screens.

Subjects first read an explanation of the general purpose of the experiment which also reiterated the fact that points scored in the experiment were converted linearly to monetary payment. The researcher then explained the experiment by reading aloud the instructions necessary to make an offer to one's partner, to receive and read an offer made by one's partner, to make a counteroffer, to accept an offer, and to confirm an acceptation and thereby complete an exchange.

In condition 1 (split pool exchange), subjects were told the size of the pool of points to be divided. In conditions 2 through 5 (typical pure exchange), subjects were told how many resources they had and how many points each unit of a resource was worth to them. During this explanation, subjects could follow the instructions, since each subject had a copy of the spoken text. Subjects could refer to these written instructions at any time during the experiments.

Before starting the experiment, two practice rounds were played in which the experiment leader led the subjects through the entire bargaining procedure by indicating the actions each type of subject (either A or B) should take. Then each pair of subjects played a number of rounds in the actual experiment. A round ended whenever agreement was reached or time was up. When no agreement was reached, no points were scored.

In condition 1 (split pool exchange), subjects earned 1 point for each unit of the resource pool they received. In conditions 2 through 5 (typical pure exchange), the value of the initial endowments was subtracted from subjects' points, to ensure that no points were earned when no exchange had taken place. Only points earned in exchange were counted, as was the case in condition 1 (split pool exchange). After each round, the resource pool was filled again (in condition 1) or the initial endowments were replenished (in conditions 2 through 5). After all rounds had been played, subjects were paid according to the number of points they had scored. In all the conditions, points scored in exchange were converted to money at a rate of 3 eurocents per point, yielding an average of 5.80 euros per subject across all conditions.

Design

We used a between-subjects design, so each individual subject bargained in only one of the five conditions. Each pair of subjects played a maximum of 6 rounds of 120 seconds each.[3] Overall, 78, 78, 54, 75, and 60 rounds were played for each of the conditions respectively. We used a full information design, implying subjects knew each other's points in the experiment as well as gains in money. In 24 rounds of the first four conditions and in 12 rounds of condition 5 (typical PE), subjects were able to observe the ongoing negotiations of other pairs on their computer screens. Subjects were not told that they could observe other pairs. In the analyses reported in the results section, we control for the fact that some subjects had the possibility to observe other pairs while others did not.

In condition 1 (split pool exchange), corresponding to Figure 1a, subjects A and B negotiated over the division of 72 points. They could divide these points in any way they wished, as long as they both agreed to the division.[4] If they failed to reach agreement, neither got any points. Provided subjects reached agreement, they had to divide all of the 72 points, implying any exchange was Pareto efficient.

In conditions 2 through 5 both subjects were given an endowment (E) of units of resources X and Y which they could exchange with each other, and for which they got points (U) in the experiment. Endowments and utilities in the four pure exchange conditions are presented in Table 3. For instance, the first E-row in Table 3 shows that in condition 2, subject A had 1 unit of X and no units of Y, whereas subject B had no units of X and 90 units of Y. The first U-row indicates that in condition 2, a unit of X was 18 times more valuable to subject A than a unit of Y. The same row shows that in condition 2, a unit of X was 90 times more valuable to subject B than a unit of Y.

Since in condition 2, corresponding to Figure 1a, subject A had only 1 unit of X to transmit, any exchange that occurred was Pareto efficient. For all exchanges the points

[3] Since the computer program used for the experiment ran over the internet, and connection problems sometimes caused the clock in the program to run slower, not all 6 rounds were always played.

[4] Subjects had to agree to a division in integer numbers.

Table 3. Endowments (E) and Utilities (U) of Goods X and Y for the Pure Exchange Conditions

	Actors	A		B	
Condition	Goods	X	Y	X	Y
2 (Fig.1a)	E	1	0	0	90
	U	18	1	90	1
3 (Fig.1b)	E	18	0	0	90
	U	1	1	5	1
4 (Fig.1c)	E	18	0	0	30
	U	3	3	5	1
5 (typical pure exchange; Fig.1d	E	18	0	0	30
	U	1	1	5	1

scored by the two exchange partners summed to 72.[5]

In condition 3, corresponding to Figure 1b, subject A had 18 units of X. Subject A was free to transmit any number of units of X in his possession. This way, Pareto inefficient exchanges were feasible, i.e., exchanges in which subject A transmitted fewer than 18 units of X.

In conditions 2 and 3, subject A always transferred all his units of X to B, in the set of Pareto efficient exchanges. Condition 4, corresponding to Figure 1c, was different in this respect, since for an agreement to be Pareto efficient either the A subject had to transfer all of his units of X to B, or the B subject had to transfers all his units of Y to A, or both. The upper portion of the Pareto frontier in Figure 1c corresponds to exchanges in which subject A transferred all of his units of X. The lower portion corresponds to exchanges in which B transferred all of his units of Y.[6] At the point where these portions intersect, i.e., at the 'kink' in Figure 1c, A and B both transferred all of their resources.

In condition 5 (typical pure exchange) the maximum for B was 72 and the maximum for A was 24, as is shown in Figure 1d. This is achieved by dividing the points of subject A by 3, relative to condition 4.[7]

RESULTS

Table 4 shows the descriptives for all dependent variables across the five conditions. The second column shows the average payoffs, only considering the rounds in which agreement was reached. No average payoff of A and B could be meaningfully calculated for condition 1 (split pool exchange) because the individual actors of a pair cannot be distinguished. The variance for condition 1 (split pool exchange) was calculated as the average sum of squared deviations from 36 of one actor of each pair across all exchanges per condition.[8] The variance of payoffs in the other conditions was calculated as the variance of B's payoffs across all exchanges per condition.

Since pairs of subjects played a maximum of 6 rounds of bilateral negotiated direct exchange in one condition, the data were structured in a multilevel fashion (with pairs of subjects at the second level and individual rounds at the first), introducing dependencies in the data (cf. Snijders and Bosker 1999). These were dealt with in three ways. For testing the payoff predictions (Hypothesis 1), random intercept models with subject pairs as the second level were estimated, subsequently called mixed models. For testing hypotheses concerning probabilities (Hypotheses 2 through 4), multilevel logistic regression was used, again with subject pairs as the second level. For testing differences in variance (Hypothesis 5), we analyzed both the vari-

[5] Since to A a unit of X is 18 times more valuable than a unit of Y, A will want *at least* 18 units of Y in return for it. In that case B will receive his maximum possible payoff gain equal to 72, and A will gain 0. Since to B, 1 unit of X is 90 times more valuable than a unit of Y, B is willing to *maximally* give up 90 units of Y in return for the unit of X. In that case A will receive his maximum possible payoff gain equal to 72, and B will gain 0.

[6] The upper and lower portions of the Pareto frontier can be written mathematically as

$\pi_B = -\frac{1}{3}\pi_A + 72$ for $0 \le \pi_A \le 36$ and $\pi_B = -\frac{10}{6}\pi_A + 120$ for $36 \le \pi_A \le 72$, respectively.

[7] The upper part of this frontier can be written as $\pi_B = -\pi_A + 72$ for $0 \le \pi_A \le 12$, whereas the lower part is written as $\pi_B = -5\pi_A + 120$ for $12 \le \pi_A \le 24$.

[8] Note that for calculating the variance, as opposed to the average, it is immaterial which actor's payoff of the pair is selected for the computation.

Table 4. Descriptives of Dependent Variables

	Dependent Variables				
Conditions	Payoffs (A first)	Probability of agreement	Conditional probability of Pareto efficiency	Conditional probability of equal payoffs	Variance payoff B
1 (split pool exchange; Fig. 1a)		0.73	1	0.54	4.12
2 (Fig.1a)	33.17 (1.90) 38.83 (1.90)	0.87	1	0.37	81.16
3 (Fig.1b)	32.85 (2.75) 33.69 (2.50)	0.89	0.73	0.67	157.74
4 (Fig.1c)	41.28 (1.22) 41.05 (1.73)	0.92	0.63	0.57	93.33
5 (typical pure exchange; Fig.1d)	14.79 (1.09) 28.33 (4.51)	0.82	0.39	0.41	218.54

Note: Robust standard errors for payoffs accounting for multilevel structure in brackets.

ances at the level of individual exchanges and at the level of pairs of subjects.

To test our hypotheses concerning the dependent variables we controlled for the effects of round and the fact that subjects in some sessions were able to observe the negotiations in other pairs (indicated by the variable comparison). The variable round was computed by centering the rank number of the original 6 rounds that each pair played. Thus, round ranges from –2.5 to +2.5. The variable comparison had value 1 if subjects were able to observe the negotiations in other pairs and 0 otherwise. Hence the intercept in regression analyses was interpreted as the average payoff of B in the average round where pairs cannot observe each other.

Comparing Conditions 1 (Split Pool Exchange) and 5 (Typical Pure Exchange)

Hypothesis 1 concerns the average payoffs and presents no comparison between the conditions. For condition 1 (split pool exchange) all three bargaining theories expected an equal split, i.e., an average payoff of 36 for both subjects in the pair. The average payoffs of all subjects in this condition were indeed very close to 36 (ranging from 33.20 to 38.80) and the variance of individual exchange was small (4.12), corroborating the predictions of the three bargaining theories as formulated in Hypothesis 1a.

The estimates of A's and B's payoffs for condition 5 (typical pure exchange) are shown in Table 5. Two models were estimated: one with all exchanges included (third column)

Table 5. Estimated Payoffs for A and B in Condition 5 (Typical Pure Exchange); Mixed Models with Subject Pairs as Level 2

Dependent Variable		All agreements		Pareto efficient agreements only
Payoff B	Intercept	30.55	(4.85)	30.27 (4.65)
	Round	1.16	(0.65)	–1.32 (1.01)
	Comparison	–11.58	(12.23)	–8.50 (9.73)
Payoff A	Intercept	14.68	(1.06)	
	Round	1.14 **	(0.32)	
	Comparison	2.45	(2.55)	

Note: Standard errors in parentheses.
* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed tests)

Table 6. Multilevel Logistic Regression Estimates Comparing Condition 1 (Split Pool Exchange) and Condition 5 (Typical Pure Exchange); Subject Pairs as Level 2

	Dependent Variable		
	H2: Probability of agreement	H3: Conditional probability of Pareto efficiency	H4: Conditional probability of equal payoffs
Intercept	1.04*** (0.30)	0.76 (0.40)	0.26 (0.47)
Round	0.14 (0.12)	0.23 (0.14)	–0.07 (0.12)
Comparison	–0.09 (0.46)	0.85 (0.86)	–0.51 (0.71)
Condition	0.55 (0.43)		–0.53 (0.61)

Note: Standard error in parentheses.
* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed tests)

and one with only Pareto efficient exchanges included (last column). Only when inefficient exchanges are included is it sensible to estimate the payoffs of A and B separately.

Comparison had no effect on the payoffs. Round had a significant positive effect on the payoffs of A. The corresponding coefficient in the model for B's payoffs was also positive and marginally significant ($p = 0.084$). These results are evidence that the efficiency of the exchange increased as more rounds were played in condition 5 (typical pure exchange).

To test Hypothesis 1b, 95% confidence intervals (CI) were constructed for the average payoffs of A and B using the intercept estimates reported in Table 5. These were [12.60, 16.76] and [21.04, 40.06] for the payoffs of A and B, respectively. This means we could reject all bargaining theories' predictions concerning B's average payoff, and all but the equiresistance prediction concerning A's average payoff. Since all three theories assume Pareto efficiency, we also constructed the 95% CI with only efficient exchanges. This yielded [21.16, 39.38] for B's average payoff, rejecting all three theories.[9]

A more direct test of each of the bargaining theories is to count the number of times that an exchange rate was exactly equal to a theory's prediction, because each theory is assumed to operate on the level of individual exchanges. Of the 49 exchanges in condition 5 (typical pure exchange), the proportions of exchanges conforming to the Nash, equiresistance and equidependence predictions were 0.04 (0.04), 0.02 (0.02), 0.25 (0.33), respectively, where proportions based on exchanges within an absolute payoff distance of 2 are given in parentheses. These data revealed that equidependence was correct for many pairs, while Nash and equiresistance were almost never correct.

To test Hypotheses 2 through 4 on the probability of agreement, and conditional probabilities of Pareto efficiency and payoff equality, respectively, multilevel logistic regressions were run (see Table 6). The variable condition is a dummy with values 0 and 1, indicating conditions 1 (split pool exchange) and 5 (typical pure exchange), respectively. The effects of the variables round and comparison were not significant in any of the models.

Contrary to Hypothesis 2a, the probability of subjects reaching agreement was not lower in condition 5 (typical pure exchange) than in condition 1 (split pool exchange) ($p > 0.5$). Since Pareto inefficient exchanges were observed in condition 5 (typical pure exchange), Hypothesis 3a is confirmed. As expected, the conditional probability of equal payoffs given agreement was lower in condition 5 (typical pure) than in condition 1 (split pool exchange), although not significantly so (Wald $Z = -0.87$, $p = 0.19$, one-tailed). Hence we do not accept Hypothesis 4a.

Hypothesis 5a, stating that the variance in the payoffs of B is larger in condition 5 (typical pure exchange) than in condition 1 (split pool exchange) is accepted. Both at the level of individual exchanges (variances of 4.12 and

[9] This implies that the fact that the equiresistance prediction couldn't be rejected with respect to the payoffs of A is due to the inclusion of Pareto inefficient exchanges, which are, according to the equiresistance solution, not to appear in the first place.

Table 7. Estimated Payoffs for A and B in Conditions 2, 3 and 4; Mixed Models with Subject Pairs as Level 2

Dependent Variable		Condition 2	Condition 3	Condition 3 Pareto efficient only	Condition 4	Condition 4 Pareto efficient only
Payoff B	Intercept	36.94*** (2.08)	32.02*** (3.34)	35.96*** (3.95)	40.83*** (1.94)	44.13*** (1.18)
	Round	–0.28 (0.40)	1.61 (1.09)	1.85 (1.41)	2.38** (0.66)	0.39 (0.63)
	Comparison	6.27 (3.88)	3.23 (4.84)	–0.31 (5.07)	1.30 (3.41)	0.88 (1.96)
Payoff A	Intercept		30.83*** (3.67)		40.79*** (1.48)	
	Round		0.40 (1.08)		2.29*** (0.51)	
	Comparison		4.26 (5.35)		2.07 (2.61)	

Note: Standard errors in parentheses.
* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed tests)

218.54 for conditions 1 and 5, respectively; $F_{48, 56} = 53.01$, $p < 0.001$) and the level of subject pairs (1.37 and 296.59 for conditions 1 and 5, respectively; $F_{12, 12} = 215.93$, $p < 0.001$) the difference in variance was significant.

Results Concerning Subsequent Experimental Conditions

To test Hypothesis 1c, 95% confidence intervals (CIs) were constructed for A's and B's average payoffs in condition 4, based on the intercepts from Table 7. Including the Pareto inefficient exchanges (penultimate column of Table 7), we got 95% CIs around the intercepts for the payoffs of A and B of [37.89, 43.69] and [37.03, 44.63], respectively. These CIs imply all the predictions of Hypothesis 1c must be rejected. Analyzing Pareto efficient exchanges only (last column of Table 7) yielded a 95% CI for the payoff of B of [41.82, 46.44], including the value of 45 predicted by equiresistance and equidependence, corroborating Hypothesis 1c(ii).

Of the 67 exchanges in condition 4, the proportions of exchanges conforming to the Nash and equiresistance/equidependence predictions were 0.06 and 0.37, respectively. Proportions based on exchanges within an absolute payoff distance of 2 from the prediction were identical. Hence, Nash predictions were almost always incorrect.

Two additional observations can be made from Table 7. Firstly, the 95% CI for conditions 2 and 3 contained 36, confirming Hypothesis 1a derived from the three bargaining theories. Secondly, there was a positive effect of Round on the payoffs earned by A and B in condition 4, revealing that exchanges became more efficient as more rounds were played.

To test Hypotheses 2 to 4 concerning subsequent conditions multilevel logistic regression analyses were run on the probability of subjects reaching agreement, the conditional probability of Pareto efficiency given agreement and the conditional probability of equal payoffs given agreement. Table 8 shows the Wald *Z*-scores for the parameters estimated for the dummy variable condition, that in each comparison had value 0 for the first condition and value 1 for the second condition mentioned. Each Wald *Z*-score shown corresponds to a hypothesis.

Contrary to what we expected, the probability of agreement was higher in condition 2 than in condition 1 (split pool exchange), refuting Hypothesis 2b. The probability of agreement was lower in condition 5 (typical pure exchange) than in 4, corroborating Hypothesis 2c. In line with our expectations (Hypotheses 3a and 3b) we found many Pareto inefficient exchanges in conditions 3 through 5. Additionally, we found that the proportion of Pareto efficient agreements in condition 5 (typical pure exchange) was smaller than in condition 4 (Wald $Z = -2.42$, $p = 0.008$). In accordance with Hypothesis 4, the probability of equal payoffs given agreement decreased from conditions 1 (split pool exchange) to 2, from conditions 3 to 4, and from conditions 4 to 5 (typical pure exchange), but only the difference between conditions 1 (split pool exchange) and 2 was significant, corroborating Hypothesis 4b.

Table 8. Wald *Z*-scores for Pairwise Comparisons between Subsequent Conditions, based on Multilevel Logistic Regressions with Subject Pairs as Level 2; Round and Comparison were included as Covariates; *p*-values in Parentheses

	Dependent Variable [1]		
Conditions Compared	Probability of agreement	Conditional probability of Pareto efficiency	Conditional probability of equal payoffs
1 (split pool exchange)–2	1.83 (0.97)		–3.49 (< 0.001)
2–3		[2]	
3–4			–0.48 (0.31)
4–5 (typical pure exchange)	–1.27 (0.1)	–2.42 (0.008)	–0.96 (0.17)

[1] All tests are one-tailed

[2] H3a is accepted on logical, instead of on statistical grounds. A statistical test could not be performed because the standard error of the conditional probability of Pareto efficiency is equal to 0 for condition 2

Each comparison in Table 8 contains round and comparison as covariates.[10] The most important effect of Round was to increase the probability of Pareto efficient exchange in the comparison between conditions 3 and 4 (Wald $Z = 3.79$, $p < 0.001$, 2-tailed), and conditions 4 and 5 (typical pure exchange) (Wald $Z = 4.25$, $p < 0.001$, 2-tailed). As with the results concerning the payoffs, this indicates subjects learned to exchange Pareto efficiently as more rounds were played.

The variance in the payoff of B was higher in condition 2 than in condition 1 (split pool exchange), both at the exchange level and at the level of the subject pairs ($F_{67, 56} = 19.69$, $p < 0.001$, and $F_{13, 12} = 44.36$, $p < 0.001$, respectively), corroborating Hypothesis 5b. Also, the variance in condition 5 (typical pure exchange) was larger than in condition 4, both at the level of exchanges and pairs ($F_{48, 66} = 2.34$, $p < 0.001$, and $F_{12, 12} = 17.44$, $p < 0.001$, respectively), corroborating Hypothesis 5d. Hypothesis 5c must be rejected, since the variance in condition 4 was lower than in condition 3 (Table 4).

[10] Comparison had a significant effect twice: i) when comparing conditions 3 and 4 with respect to the conditional probability of Pareto efficiency (Wald $Z = 1.96$, $p = 0.05$, 2-tailed), and ii) when comparing conditions 1 (split pool exchange) and 2 with respect to the conditional probability of equal payoffs (Wald $Z = -1.99$, $p = 0.05$, 2-tailed). The effect of Round was significant in all but two comparisons: i) the comparison of conditions 1 (split pool exchange) and 2, and ii) the comparison of conditions 3 and 4, with respect to conditional probability of equal payoffs.

CONCLUSIONS AND DISCUSSION

Exchange situations are typically referred to as situations of pure exchange, i.e., situations in which actors are endowed with bundles of commodities that they can exchange with each other, and in which actors have different preferences over these commodities. The present study focuses on negotiated direct pure exchange. More particularly, it focuses on the validity of a dominant paradigm to study negotiated direct exchange. This paradigm is split pool exchange, an abstract representation of negotiated direct exchange. Van Assen (2001) has proved that split pool exchange can only correctly represent pure exchange in some very restrictive well-defined conditions concerning endowments and actors' preferences, which are unlikely to be satisfied in real-life exchange situations. The question is then what the validity is of research using split pool exchange, i.e., to what extent results and conclusions of studies on negotiated direct exchange using split pool exchange can be generalized to negotiated direct pure exchange. To answer this fundamental question, we compared bargaining outcomes in split pool exchange and pure exchange situations in the simplest exchange situation, bilateral exchange.

Typical pure exchange, as operationalized in condition 5 of our experiment, is different from split pool exchange as operationalized in condition 1, in four elements: (i) task, (ii) enforced Pareto efficiency, (iii) constant-sum, and (iv) equal maximum. The last three elements are present in split pool exchange but not in typical pure exchange. To identify the causes of possible differences in bargaining behavior between split pool exchange and typical pure exchange, four pure exchange conditions were created that differed in the number of elements in common with split pool exchange. Applying well-known theories of cooperative bargaining or principles of exchange (Nash, RKS, or equiresistance, Kernel or equidependence) we expected more variance of payoffs and fewer equal payoff agreements in condition 5 (typical pure exchange) than in condition 1 (split pool exchange). Considering the higher task complexity and demands of condition 5 (typical pure exchange) than of condition 1 (split pool exchange), we expected fewer exchanges and more Pareto inefficient exchanges in condition 5 (typical pure exchange) than in condition 1 (split pool exchange).

An experiment was run with the 5 conditions as described above in a full information design corresponding to the design of split pool exchange as used in many experiments on network exchange. On the basis of our results, we conclude that the validity of research using split pool exchange is questionable, since bargaining outcomes obtained when using split pool exchange are different from those obtained using pure exchange. Three main conclusions can be drawn from our results concerning differences in bargaining outcomes between condition 5 (typical pure exchange) and condition 1 (split pool exchange). First, the bargaining theories and exchange principles Nash, equiresistance and equidependence, all accurately predict the average payoff in condition 1 (split pool exchange) but none of them does so in condition 5 (typical pure exchange). More specifically, our results suggest that as long as pure exchange is constant-sum (as in conditions 2 and 3) the three theories predict well, but if it is not constant-sum (as in conditions 4 and 5) they do not. Let us speculate on the possible implications of the first conclusion.

The lack of validity of split pool exchange as a representation of typical pure exchange as in condition 5 does not imply that split pool exchange isn't a valid representation of something. Split pool exchange is an appropriate method when investigating allocation problems in which a fixed sum must be divided. This links to a productive exchange in which, "*both* actors in the relation must contribute in order for either to obtain benefits. Neither can produce benefit for self or other through his own actions" (Molm 1997: 21–22). After the surplus has been successfully produced, it must be divided. Such a division problem occurs for instance in organizations with a profit-sharing regime: given that all members of the organization (including employees, management, and shareholders) have collaborated to produce the firm's profit, (part of) the profit is divided among the organization members. The pure exchange approach is more appropriate than split pool exchange whenever there is an (direct, generalized, reciprocal, negotiated) exchange of commodities, such as the exchange of labor effort for wages or (chances to get) promotion, between an employee and management, or the exchange of advice for status between two employees (Blau 1964).

The first conclusion has implications for research on negotiated direct exchange in networks. From previous research that uses split pool exchange to study negotiated direct exchange in networks it can be concluded that the different theories of exchange more or less agree on their predictions for many networks and predict the exchange outcome reasonably accurately (e.g., Braun and Gautschi 2006; Burke 1997; Skvoretz and Willer 1993). Since we demonstrate that two of the most well-known principles of exchange, equiresistance and equidependence, do not provide accurate predictions on the most simple exchange situation, bilateral exchange, we also suspect that they do not provide accurate predictions of outcomes of pure exchange in the more complex networks. However, based on the current study, we cannot say anything conclusive on this matter, since we have not studied exchange networks. The effect of network structure on outcomes of pure exchange compared to split pool exchange is an important question to be answered in future research.

A final possible implication of the first conclusion concerns other research on negotiated direct exchange that does not use split pool exchange. As described in the introduction, many studies use constant-sum exchange in restricted information conditions to study negotiated direct exchange, mostly in the context of networks. The main difference with split pool exchange is the use of restricted information. However, constant-sum exchange shares many characteristics with the pure exchange of condition 2, that is, exchange is Pareto efficient, the sum of gains is a constant, and both actors have the same maximum possible gain. Our first conclusion is that theories of exchange predict well if pure exchange is constant-sum, but not if it is not constant-sum. Hence it might be that these theories also do not provide accurate predictions in typical bilateral negotiated direct pure exchange (as in condition 5), or in the more complex networks, whenever information is restricted. However, again we cannot say anything conclusive on this matter. First, we did not study negotiated direct exchange under restricted information, and second, restricted versus full information is known to affect bargaining and outcomes of exchange in networks (e.g., Skvoretz and Burkett 1994).

Our second main conclusion is that, although none of the theories accurately predicted average payoffs, the equidependence principle has considerable explanatory power. In all pure exchange conditions, a moderate to large proportion (0.41 to 0.67) of equal payoff agreements were obtained. Because only very few outcomes conformed to the Nash or equiresistance predictions, the proportion of equal payoff agreements was only slightly (and not significantly) smaller in condition 5 (typical pure exchange), where the three solutions were different, than in other pure exchange conditions where the equidependence solution coincided with either one (equiresistance) or two other solutions (Nash and equiresistance). Our findings in favor of equidependence are in agreement with findings of previous studies on bargaining. Roth and Malouf (1979) cite severable studies reporting a strong tendency of outcomes to equal payoffs in bargaining games where the Nash prediction is different from it. Examining bargaining, Schellenberg (1988) compared equidependence to equiresistance and Nash and also found that the most frequent response was that of simple equality (equidependence).

The implication of the second main conclusion could be that theories of exchange other than Power-Dependence Theory, based on equidependence, provide accurate predictions in split pool exchange situations because their predictions are close to those of Power-Dependence Theory. That is, it might be that in condition 5 (typical pure exchange) embedded in networks, other theories like Network Exchange Theory using equiresistance, provide a poorer fit than Power-Dependence Theory. In any case, our results provide considerable support for the equidependence principle and hence Power-Dependence Theory, and evidence against the equiresistance principle and hence Network Exchange Theory. Note that this evidence could not have been obtained using the split pool exchange approach, because the split pool exchange obscures interesting aspects of pure exchange that cause the theories' predictions to differ.

The oversimplification of pure exchange by using split pool exchange to represent it was also demonstrated by comparing the variances of payoffs across conditions. If only the task was different (comparing conditions 1 (split pool exchange) and 2), the variance of payoffs already increased. The variance of payoffs in condition 5 (typical pure exchange) was more than 50 times larger than in condition 1 (split pool exchange). To conclude, by abstracting away features of pure exchange, subjects in condition 1 (split pool exchange) 'knew what to do' and their behavior consequently showed little variance, and was accurately predicted by all three solutions (predicting the same). However, in condition 5 (typical pure exchange) their behavior varied to a large extent and on average none of theories predicted accurately, although many agreements corresponded to the equidependence principle.

The third main conclusion is that the basic Pareto efficiency assumption of the split pool exchange approach is violated, supporting the view of bounded rational subjects. In condition 5 (typical pure exchange) more than 60% of the agreements were Pareto inefficient. Our results revealed that the inequality of actors' maxima is the main cause of this inefficiency, because efficiency was considerably larger in the pure exchange conditions 3 and 4, which had equal maxima. It must be noted that efficiency of exchange increased as more rounds were played. Our findings concerning inefficient agreements are also in line with previous research on bargaining (see again Roth and Malouf 1979: 581). The implication of the third conclusion is that the split pool exchange approach does not recognize that actors have a hard time agreeing upon an efficient exchange. Since inefficiency of exchange is so common and undesirable, we argue that more research should be conducted on the conditions of exchange situations that affect the efficiency of exchange, and on ways to help actors achieve efficiency. To conduct this research, split pool exchange has to be abandoned.

We also hypothesized that the probability to reach an agreement was smaller in the pure exchange conditions 2 through 5 (typical pure exchange) than in condition 1 (split pool exchange), because of the complexity of pure exchange compared to split pool exchange and more conflicts between different solution principles. However, we observed *larger* sample proportions of agreements in the pure exchange conditions than in condition 1 (split pool exchange). A possible explanation is that our pure exchange conditions were not that complex after all, since essential calculations needed for exchange were performed by the ExNet program used in the experiment, the results of which were displayed on the screen. On the other hand, the many violations of Pareto efficiency in the pure exchange conditions suggest that pure exchange is a complex task. Apparently actors do not want to forgo a possible gain more in pure exchange than in split pool exchange in spite of the larger conflict and uncertainty in pure exchange.

Our study unequivocally demonstrates that bargaining behavior in typical bilateral pure exchange is different from behavior in split pool exchange, but to what extent does our study have implications for research on exchange networks using split pool exchange? Theorists of networks exchange might grant that split pool exchange is fundamentally different from typical pure exchange, but argue that they are mainly interested in the effect of (network) structure on outcomes. By abstracting pure exchange to the simpler split pool exchange one can focus on the effect of structure on outcomes with more statistical power. The argument is convincing and legitimate only if results on exchange networks using split pool exchange are not structurally different (i.e., biased) from exchange networks using pure exchange. This still remains to be shown. Our study suggests that the rather accurate predictions of outcomes in exchange networks using split pool exchange might at least be an artifact, and that the equidependence principle might outperform other theories.

Another observation on negotiated direct exchange network research using split pool exchange can be made after analyzing networks of typical pure exchange relations. It can easily be demonstrated that only under very restrictive conditions on endowments and utilities exchange relations can be represented by split pool exchanges of equal size. However, with a few exceptions (Bonacich and Friedkin 1998; Cook and Emerson 1978; Molm, Peterson, and Takahashi 2001; Stolte and Emerson 1977), almost all network exchange research has dealt with sets of exchange relations of equal size. Bonacich and Friedkin (1998) tested several theories, including Power-Dependence Theory, on networks with unequally valued split pool exchanges and observed that these theories did not accurately predict exchange outcomes, contrary to their performance in networks with equally valued relations. In our opinion these results support the statement that much remains to be learned on exchange in networks.

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