Economica

Economica (2016) **83**, 704–740
doi:10.1111/ecca.12180

Role-dependent Social Preferences

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Final version received 27 August 2015.

Bargaining results emerge from the interplay of strategic options and social preferences. For every bargaining game, however, the advantage of a player having certain preferences in terms of negotiated equilibrium revenues might differ. We explore the hypothesis that preferences change according to the players' strength combination. Simple 1×1 bargaining experiments from the literature are discussed, and 2×2 as well as 2×3 assignment market experiments with possible renegotiations are investigated. The assumption that players adopt preferences for two to five roles, defined by strength combinations of the two bargainers, explains the experimental results better than individually constant preferences.

Introduction

> *Es ist nicht das Bewusstsein der Menschen, das ihr Sein, sondern umgekehrt ihr gesellschaftliches Sein, das ihr Bewusstsein bestimmt*. [It is not the consciousness of men that determines their being, but, on the contrary, their social being that determines their consciousness.]
>
> (Karl Marx, 1859)

One of the central insights of experimental economics is that the results of social interaction cannot be explained by assuming egoistic players. The necessity of including social preferences has led to an abundance of proposals for modeling altruism, fairness, and reciprocity. None of these proposals can claim, however, to be capable of explaining a set of diverse experiments. No distribution of motives (or parameters of motive structures over individuals) applies to different decision situations or resists the challenge of framing. Under these circumstances, we suggest a fundamentally new view on decision-makers and their decision-making processes.

In standard microeconomic theory, an individual decision-maker is completely described by his endowment and his preferences. Here, we abandon the standard assumption of individually stable preferences. While not denying that preferences have individual components, or that preferences are 'interactive' (e.g. through the perception of other players' kindness and through reciprocity, i.e. Cox *et al*. 2007), we emphasize the systematic and fundamental change of preferences according to the roles that players adopt.[1] Such a hypothesis need not provide unlimited flexibility, and as we will show in 2×2 and 2×3 assignment games, the introduction of two or three roles, each with two parameters for an altruistic preference function, delivers a better fit than the introduction of several hundred individual altruism or inequity aversion parameters.

From an evolutionary point of view the main reason for the development of role-dependent preferences is the strategic value of social preferences. Let us illustrate this statement for the case where two egoistic players, i and k, bargain over the distribution (x_i,x_k) of a dollar. Many concepts of cooperative game theory support the whole set of possible distributions. If, however, one of the players is spiteful toward the other player or inequity-averse, then they will not accept extremely unfavourable distributions. A utility function

$$(1) \qquad U_i(x_i, x_k) = x_i + a_i x_k,$$

with $a_i < 1$ and the restriction that $x_i + x_k = 1$, means that player i would rather let the negotiation fail (with the consequence of zero income for both players) than accept incomes x_i smaller than $-a_i/(1-a_i)$. For inequity aversion, the argument is similar. As a consequence, players are protected against receiving 'unfair' bargaining results if they are (known to be) spiteful or inequity-averse. Under Nash bargaining, where two egoistic players agree on an equal split, spiteful players receive more than their egoistic counterparts.

The conditional advantage of certain social preferences has been proved in a number of theoretical papers. Bester and Güth (1998) show that altruism can be evolutionarily stable[2] if the members of a society play duopoly games or if there are other pairwise relations. A necessary condition for this result is that the games exhibit strategic complementaries because, among others, positive externalities are produced. Bolle (2000) and Possajennikov (2000) point out that with strategic substitutes, negative altruism (spite) is evolutionarily stable. Heifetz *et al.* (2007) show that for almost any game, evolution would foster a deviation from egoistic preferences—but in different directions. The profitability of adopting 'advantageous' preferences has also been proved in the literature on strategic delegation (e.g. Fershtman *et al.* 1991; Konrad *et al.* 2004). So there is a clear result from theoretical investigations: *social preferences are advantageous in terms of fitness (income) only if they can be adapted to the strategic situation (or the role) of a player*.

Many experimental observations are in line with the view that changing strategic situations (changing roles) go along with changing preferences. Results from the ultimatum game,[3] for example, can be explained by altruistic preferences in the role of the proposer or by anticipating spiteful preferences in the majority of responders. Role-dependent behaviour is also well known from everyday social exchange with friends and strangers. Everyone switches roles frequently, by interacting with different family members, colleagues at work, business partners or sports friends. An extreme example of role inducement is the infamous Stanford Prison experiment (Zimbardo 1972), where students adopted roles of prisoners *or* guards to an extreme.

The consequences of role-dependent preferences appear as instability of social preferences. Laury and Taylor (2008) report that context-free parametric measures of altruism only poorly predict which subjects will contribute to 'a naturally occurring public good'. Blanco *et al.* (2011) estimate the individual parameters of the Fehr and Schmidt (1999) inequity aversion model in dictator and ultimatum game experiments, and use the estimated parameters, in a within-subjects approach, in order to predict individual behaviour in sequential prisoner's dilemma and public good games. They conclude that the degree of individual inequity aversion in the first games has very little explanatory power for subsequent games. Furthermore, a number of papers (Kritikos and Bolle 2001; Binmore and Shaked 2010) prove that inequity aversion cannot apply generally. Further examples from the literature for the lacking universality of social preferences are provided by Blanco *et al.* (2011). Also, personality questionnaires capturing individual differences (e.g. Brandstätter and Königstein 2001; Swope *et al.* 2008) appear of rather limited capacity in explaining the variations in the results. In a similar vein, Otto and Bolle (2011b) report that the frequency of blood donation behaviour is not (and giving to charity is only weakly) correlated with altruism overall, and only correlates with a specific facet of altruism.

In Section I our principles of role definition are introduced, and in Section II 'simple' bargaining experiments from the literature are discussed under the aspect of role-dependent preferences. Section III generally describes and defines assignment games. In Section IV we introduce theoretical concepts for assignment markets—in particular, role-dependent altruism—where bilateral bargaining takes place with exogenous plus endogenous outside options. In Section V our experiments are described. Section VI compares the performance of role-dependent preferences and competing theories. Section VII discusses the results and concludes.

I. How Can Roles be Defined?

A role is basically defined here as a type of player in a specific game or subgame who meets the same or other types of co-players. The role of a player then depends on both own type and the other types. For broad applications, a class structure of games and players is needed in order to identify typical players in typical games. We assume that role-dependent preferences are determined by social learning and that there is only a limited number of roles in the 'game of life'.[4] Consequently, role-dependent social preferences cannot be optimal (in objective terms as resulting income) in every situation, but they should be more successful in the class of situations for which they have evolved. Benchmarks for relative success are the expected performance of a subject with egoistic or constant social preferences. We admit that we cannot propose a method of how to generally define roles, but we raise this problem for discussion, make proposals for bargaining games, and investigate the question of role-dependent preferences experimentally.

Hypothesis 1. In bargaining situations, players adopt preferences that make their outside options more valuable compared with possible bargaining results. The adoption of preferences is limited by the requirement that successful bargaining is, with a sufficiently high probability, not prevented by over-valuable outside options.

We call a player with valuable objective (monetary) outside options strong, and one who has only low-valued outside options weak. Although weak and strong are mostly relative, we may distinguish between more than two degrees of strength. Roles in any one-on-one bargaining situation are determined *ex ante* in the following way: if player 1 of strength A bargains with player 2 of strength B, then player 1 adopts role AB1 and player 2 adopts role AB2. If there are n levels of strength for player 1 and m levels for player 2, then we have a maximum of $2nm$ roles; we call this maximum *exhaustive role definition*. Usually, however, we have small numbers n and m, and we discriminate between fewer than $2nm$ roles.

In simple one-on-one free bargaining situations with exogenous outside options, we may discriminate between weak (W), middle (M) and strong (S) players with correspondingly low, middle and high outside options. This would result in 18 exhaustive roles. But as in unrestricted bargaining where player indications 1 and 2 are not important, roles AB1 and BA2 would be redundant, so that only 9 distinctive roles remain. If we assume it to be important only whether or not the outside option of player 1 compared with player 2 is larger, smaller or equal, then we would identify $AAi = BBk$ for all A, B and i, k, and in addition, $WMi = WSi = MSi$ and $MWi = SWi = SMi$. Then there remain only three roles: one for a weaker against a relatively stronger player, one for a stronger against a weaker player, and one for equally strong players. In a situation where player 1 is always weak and player 2 is always strong, the number of roles is even reduced to two. An alternative definition of three roles might be given by the principle that only the player's own strength defines the role or that only the bargaining partner's strength defines the role.

In assignment games, the definition of strength and the number of exhaustive roles may be different. If the numbers of players on the two market sides are different, then we have, with necessity, unmatched players. If there are more players 1 than players 2, then there are n further roles for the unmatched players 1, and the number of exhaustive roles is $2nm + n$. There are also endogenous outside options that stem from the possibility that a player may bargain with different other partners in the market, and these have to be considered when evaluating the strength of a player.

Hypothesis 2. The strength of a player i in cooperative games (including assignment markets) that are described by a characteristic function $V(C)$, with $C \subset N$ as the set of players, may be defined by two values, namely $V(\{i\})$ for staying alone (exogenous outside option) and $V(N) - V(N - \{i\})$ as the marginal value of i's participation (in assignment games a proxy for the endogenous outside option).

A more differentiated view of strength would incorporate further attributes of $V(C)$, but we assume that this simplification will often be sufficient. In 1×1 bargaining situations, we can restrict our attention to the exogenous outside options because the difference of the endogenous outside options is equal to the negative difference of exogenous outside options. In assignment games, $V(C)$ is defined as the maximum sum of profitabilities that can be reached by forming matches from players in C. In our matching experiments, the monetary value of all exogenous outside options is zero, so strength is defined only via the endogenous outside options here. This property releases us from aggregating the two values.

In addition, the question remains as to which roles apply in the various negotiations in assignment games. If players can bargain a provisional match with one partner and afterward switch to another partner, then this requires an assumption about the dynamics of role adoption. The following hypothesis is developed from the requirement that a stable state, where no alternative match is advantageous for the involved players, should be described by constant preferences for every player.

Hypothesis 3. In assignment markets, with the possibility of switching to other matches, players bargain with the roles defined by their existing match or the role of being unmatched.

In Section II we formulate more detailed hypotheses for simple bargaining situations with exogenous outside options in connection with two bargaining experiments from the literature.

II. Simple Bargaining Experiments

The majority of experimental investigations of structured bargaining employ variants of the ultimatum game, the Nash demand game, or the Rubinstein bargaining game.[5] In the standard case of unstructured bargaining, the Nash bargaining solution provides us with a unique prediction, and as an alternative, there are set predictions from cooperative game theory. All these 'simple' one-on-one bargaining games have typically one outside option, namely disagreement connected with exogenous revenues (exogenous outside options) of the players. Concentrating on linear altruistic preferences as in equation (1), what sign should we expect for the altruism parameter? In the Nash demand game, strategies are strategic substitutes, and the same is true for the Rubinstein game. If one player is known to decrease demands, then the other player will increase demands. In the case of the ultimatum game, and in unstructured bargaining, the notion of strategic substitutes loses its specific meaning, but nonetheless the consequences sustain: lower aspiration levels of the one invite higher levels of the other. According to Bester and Güth (1998), Bolle (2000) and Possajennikov (2000), we expect the following.

Hypothesis 4a. Two-person bargaining with exogenous outside options is governed by spite.

With monetary outside options v_i and v_k, and under linear altruism (1), player i accepts a distribution (x_i,1−x_i) only if she receives more than her 'psychological outside option'

$$v_i^* = \frac{v_i - a_i(1 - v_k)}{1 - a_i}. \tag{2}$$

v_i^* increases with decreasing a_i, and if higher outside options guarantee higher shares of the pie (as long as the two outside options do not add up to more than the pie), then both players are better off with as much spite as possible. Who can be more spiteful? For both players 'optimal spite', as a best reply to the average spite of their counterparts in this and similar situations, is determined by the probability of disagreement and the difference between their agreement revenue and their monetary outside option. As the stronger player with the higher outside option gets more under disagreement and can also be expected to get more under agreement, this question of who adopts more spite does not seem to have a general answer. Nevertheless, the following can be expected.

Hypothesis 4b. If the exogenous outside options are substantially different, then the two players adopt specific roles with diverging distributions of altruism parameters.

The threshold for being substantially different remains an empirical question. From the following two examples it becomes apparent that in the first experiment, the outside options of the two players can be assumed to be different, while in the second experiment, the adjacent outside option intervals of the two players raises the question of which difference is 'substantial.'

Rubinstein bargaining (*Binmore et al. 1991*)

Ståhl (1972) and Rubinstein (1982) propose an alternating offer model for bargaining about the distribution of a pie of size one. Binmore *et al*. (1991) distinguish between two variants of this game. Under 'forced breakdown', after every rejection of an offer it is randomly decided with a probability δ whether a counter-offer can be made. With probability 1−δ the game is terminated and both receive their outside options v_i. Under 'optional breakdown', after every offer by a player the other player can decide to accept the offer, terminate the game (with the consequence that both receive their outside options), or make a counter-offer. In the last case, the pie as well as the outside options are discounted by δ.

In their theoretical investigation, Binmore *et al*. (1991) show that under forced breakdown in the unique subgame-perfect equilibrium with egoist preferences, player 1 offers $[\delta(1 - v_1) + v_2]/(1 + \delta)$ (which is called STD, i.e. split the difference). Under optional breakdown, player 1 offers $\max[v_2, \delta/(1 + \delta)]$ (which is called DMO, i.e. deal me out). In both cases, player 2 accepts these offers. In their experiment, however, Binmore *et al*. (1991) observe systematic deviations from these predictions. As no model-based explanation for these deviations is offered, we propose role-dependent preferences here. Under linear altruism (as described in (1)), and with altruism parameter a_i of player i, the subgame-perfect equilibrium strategies are derived in Appendix A. For their experiments, Binmore *et al*. (1991) select $\delta = 0.9$, $v_1 = 0.04$ and $v_2 = 0.36$ (or $v_2 = 0.64$), that is, player 1 is always 'weaker' than player 2. Most of their experimental negotiations end with an agreement, and nearly all of the results for player 2 lie in the interval defined by DMO and STD. In the case of high v_2 this interval is [DMO,STD] = [0.65,0.8], and in the case of low v_2 it is [DMO,STD] = [0.5,0.64]. Compared with the theoretical predictions, the results in forced breakdown treatments have a bias toward equal splits, but in optional breakdown treatments the bias is in the opposite direction. Therefore these biases can be driven not by equality considerations but, as we assume, by spite.

Deviations from point predictions[6] can be explained by random components of behaviour or by variability of preferences. Assuming two roles (one for the weak player and another for the strong player) and individual variability of parameters $a_1 \in [-0.7, -1.2]$ and $a_2 \in [-0.2, -0.7]$, under forced breakdown applying equation (A3) from Appendix A, we get $x_2 \in [0.74, 0.80]$ for the high v_2, and $x_2 \in [0.54, 0.66]$ for the low v_2. Under optional breakdown, we get $x_2 \in [0.69, 0.77]$ for the high $v_2 = 0.64$, and $x_2 \in [0.46, 0.61]$ for the low $v_2 = 0.36$. The largest deviation of our forecast from the interval [DMO,STD] results in the case of forced breakdown with high v_2, and also in this case the empirical results are concentrated on a small interval below STD (see Figure 2 in Binmore *et al*. 1991).

It is impossible to describe the empirical results with one role, that is, with the same set of altruism parameters for players 1 and 2, but by defining only two roles (one for the weak player and one for the strong player) with different altruism parameters, we can describe the results of Binmore *et al*. (1991) rather well. The fit could be further improved by also differentiating between roles according to the outside options v of the strong player.

Unstructured bargaining (*Anbarci and Feltovich 2013*)

Under unstructured bargaining, the parties can freely communicate until they agree on the division of the cake, one party cancels the negotiation, or a specific time limit has been passed. In the latter cases they receive their outside options. The core predicts all possible distributions where both get at least their outside options; in the 'altruistic core' these are the psychological outside options v_i^* defined by equation (2). In the following sections about the more complex assignment markets, the altruistic core will turn out to be a rather successful explanation of the results of unstructured bargaining. To compare the predictions of our concept with the experimental results derived by Anbarci and Feltovich (2013), which are mainly given in terms of averages and regression coefficients, we assume here that on average the midpoint of the core results, that is,

$$(3) \qquad x_i^* = \frac{1 + v_i^* - v_k^*}{2}.$$

Note that in the case of egoistic players, the Nash bargaining solution coincides with the midpoint of the core. For egoistic players an increase of player i's outside option by $\mathrm{d}v_i$ should increase player i's share by $0.5\mathrm{d}v_i$, and an increase of player k's outside option should decrease the proportion of the pie by $0.5\mathrm{d}v_k$.

Anbarci and Feltovich (2013) conduct experiments where the outside options are randomly and independently selected (as a share of the pie) with a uniform distribution from two intervals, namely [0.25,0.45] for the advantaged player i and [0.05,0.25] for the disadvantaged player k. Their participants play the Nash demand game or bargain without structure under two different pie sizes. In a regression analysis they find the influence of outside options on bargaining results to be weaker than expected and the average share of the pie of the advantaged group to be smaller than the expected 0.6. They explain these results by a variant of the Fehr and Schmidt (1999) inequity aversion utility function

$$U_i(x) = x_i - \alpha_1 \times (\max[x_j - x_i, 0])^2 - \beta_i \times (\max[x_i - x_j, 0]).$$

In other words, stronger players (who receive more than half of the pie because they have the higher monetary outside option) have a linear loss function, while that of the weaker players is quadratic. Although this explanation is in the spirit of role-dependency, we can apply the same explanation as we suggested for the Rubinstein bargaining experiment by Binmore *et al.* (1991). We assume equation (3) to apply, and in a first approach assume the same intervals of a_i and a_k as in the explanation of the Binmore *et al.* (1991) results, this time additionally with uniform and independent distributions of the altruism parameters. Inserting equation (2) into equation (3) results in

$$x_i^* = \frac{1}{2} + \frac{v_i}{2}\left(\frac{1}{1-2a_i} - \frac{a_k}{1-2a_k}\right) - \frac{v_k}{2}\left(\frac{1}{1-2a_k} - \frac{a_i}{1-2a_i}\right),$$

and integrating over a_i and a_k, we get $x_i = 0.41 + 0.54v_i - 0.45v_k$ and an average bargaining result of $x_i = 0.53$ for the advantaged group. The empirical average x_i of the advantaged group in Anbarci and Feltovich (2013) is 0.575 for the smaller pie and 0.569 for the larger pie (compare their Table 2). Thus our prediction indicates the correct direction but overestimates the magnitude of the empirical deviation from the under egoism expected share of 0.6. The fit of our estimations $\mathrm{d}x_i/\mathrm{d}v_i = 0.54$ and $\mathrm{d}x_i/\mathrm{d}v_k = -0.45$, with the regression coefficients of v_i (0.280) and v_k (−0.287), is not satisfactory, however. The reason may be that while in the Rubinstein experiment the outside options of 0.04 versus 0.36 or 0.64 are strongly different, in Anbarci and Feltovich (2013) the groups have adjacent intervals of outside options. Why should players with outside options of 0.23 and 0.27 adopt different roles? Under the above assumption of different roles and more spite of the disadvantaged group, the player with the outside option of 0.27 would get, on average, only a share of 0.46 when confronted with a player with an outside option of 0.23. Assuming a third role for players with $v_i - v_k < \varepsilon$, where both players get about half of the pie, would improve the fit of the average x_i as well as the expected coefficients in the regression of x_i on v_i and v_k (because the expected x_i for small differences $v_i - v_k$ are increased).

The application of our general hypothesis of role-dependent preferences and its specification for two-person bargaining with exogenous outside options to two bargaining experiments from the literature is promising. Its advantage over the competing hypothesis of individually constant preferences is, however, even more striking in more complex bargaining situations with endogenous outside options.

III. Assignment Games

Many cooperation problems are restricted to pairs of players. A central question is always what pairs will form and how the gains of cooperation are to be distributed between the two partners. Firms that need to fill a position are specific examples here. The potential partners negotiate a price, a wage, that determines the distribution of the joint profit. In some cases, distribution is difficult to manipulate because cooperation mainly produces public goods (i.e. the marriage problem introduced by Gale and Shapley 1962). If distribution of a joint profit is possible, we follow the bulk of the literature and understand pair formation as an *assignment problem* (also discussed as an assignment market or assignment game).

In the general assignment problem, there are W_i ($i = 1,\ldots,m$) and F_k ($k = 1,\ldots,n$) players on the two sides of the market. A match of W_i and F_k results in a productivity (joint profit) of π_{ik}. If a match is formed, then $\pi_{ik} = w_i + f_k$, where w_i and f_k denote the partners' respective payoffs, which can be arbitrarily negotiated between them. As a strategic concept, the core defines the most convincing requirements for coalition games with transferable utility. Let N be the set of players, and let x_i, $i \in N$, be i's payoff. $V(C)$, where $C \subseteq N$, is the payoff of coalition C, which can be arbitrarily distributed among its members $i \in C$. Then the negotiated payoffs x_i should obey the *stability condition* that no coalition C and vector x_i' exist with $x_i' > x_i$ for all $i \in C$ and $\sum_{i \in C} x_i' \leq V(C)$. For the assignment game, this means that the system of matches and distributions of productivities is stable, if no alternative match can be formed allowing both partners to increase their earnings. The general stability condition is

$$(4) \qquad \sum_{i \in C} x_i \geq V(C) \quad \text{for all } C \subseteq N.$$

The problem with these seemingly self-explanatory requirements is that they cannot be fulfilled in every coalition game Γ defined by a value function $V(C)$. In assignment games, however, that are characterized by value functions $V(C)$ giving 'effective value' only to pairs of players, the core always exists (Koopmans and Beckmann 1957). Otto and Bolle (2011a) show that most other concepts of cooperative game theory are not applicable in assignment games. An assignment is *efficient* if the sum of productivities of matches (the social product) is maximized. The core of the assignment game consists of stable and efficient matches.

Literature on the assignment game[7] is rather limited. For the general case, Koopmans and Beckmann (1957) show that market prices (wages, rents, profit requirements) exist that support efficient and stable matches. Shapley and Shubik (1971) independently come to the same conclusion. There are theoretical papers characterizing the core of an assignment game (e.g. Sotomayor 1999; Solymosi and Raghavan 2001), and a number of papers investigating certain specifications of the core (e.g. Núñez and Rafels 2003; Núñez 2004). Becker (1974) examines the marriage market under simplifying assumptions (men and/or women are homogeneous) as an assignment market. There are also macro or intermediate approaches analysing labour market efficiency under different conditions, such as the unemployment vacancies structure or information technologies (for related literature see Otto and Bolle 2011a).

As far as we know, Tenbrunsel *et al.* (1999) and Otto and Bolle (2011a) provide the only experimental studies of assignment games—both in a 2×2 market. Tenbrunsel *et al.* (1999) fully concentrate their investigation on the influence of personal relationships on the efficiency of resulting matches. Otto and Bolle (2011a) compare the explanatory power of core, Nash bargaining (with and without implicit threats), the EDC (equal division core introduced by Selten (1972, 1991), to be discussed in more detail below), and the simplistic benchmark concept of ε-ES (equal share), where the productivity of a match is distributed equally ($\pm\varepsilon$). Surprisingly, the last concept significantly outperformed all others. Contrary to these two papers, we analyse the data from the 2×2 assignment market and an expanded 2×3 market in terms of *role-dependent preferences*, demonstrating that the core with role-dependent preferences describes the bargaining results better than cores with individual preferences, EDC or ε-ES.

IV. Assignment Markets With and Without Social Preferences

The core of an assignment market will be defined without social preferences first and only then expanded to include social preferences. Furthermore, the question of role adoptions in the 2×2 and 2×3 market cases needs to be discussed in more detail.

The core with egoistic preferences

We describe the productivities π_{ik} as in Table 1. W_i stands for worker i, F_k stands for firm k, and w_i and f_k denote their respective incomes. A complete assignment (i,k) means that W_1 matches with firm i and W_2 with firm k. If $\alpha + \delta \geq \beta + \gamma$, then the assignment (1,2) is efficient. According to the requirements of equation (4), the core of the 2×2 assignment market can then be described by

$$(5) \qquad w_1 + f_1 = \alpha, \quad w_2 + f_2 = \delta,$$

$$(6) \qquad 0 \leq w_1 \leq \alpha, \quad 0 \leq w_2 \leq \delta,$$

$$(7) \qquad w_1 + \delta - \beta \geq w_2 \geq w_1 + \gamma - \alpha.$$

If assignment (2,1) is efficient, then the core is defined respectively. For $\alpha + \delta = \beta + \gamma$, both matching structures define core assignments, where the area described by equation (7) is reduced to a line. Then only equations (5) and (6) are different. A

Table 1.
Notation of Match Productivities in 2×2 and 2×3 Assignment Markets

	Firm 1	Firm 2	Firm 3
Worker 1	α	β	σ
Worker 2	γ	δ	τ

graphical illustration of the core with egoistic preferences is provided in Figure A1 of Appendix C.

In 2×3 markets (with two workers and three firms), assignments can again be described by (i,k), this time with $i,k \in \{1,2,3\}$ and $i \neq k$. Thus one firm remains unmatched. In the core solution, this is the firm that does not belong to the efficient matches. Let us assume that this is F_3, as in Table 1. The productivities of this firm ($\pi_{13} = \sigma$ with W_1, and $\pi_{23} = \tau$ with W_2) provide additional restrictions for core solutions, namely

$$(8) \qquad w_1 \geq \sigma \quad \text{and} \quad w_2 \geq \tau.$$

The core with social preferences

Let us assume that players have social preferences $U_j(x_j,x_{-j},A)$, where $A = (i,k)$, x_j is j's income, and x_{-j} is the vector of others' incomes. Furthermore, j knows the productivity of her own possible matches and infers (if necessary) from the bargaining process the others' incomes.[8] The players know neither the complete assignment nor the distribution of the productivity of other matches. We fill these gaps (if necessary) by assuming the following: j believes that, in addition to her own match (or remaining single), the most efficient matches are formed and that productivity is equally split between the partners in a match. These beliefs are denoted as x_{-j}. For notational ease, $U_j(0)$ stands for j's utility of remaining single.[9]

Definition of stability In complete assignment structures, a distribution of the productivities (w_1,w_2,f_1,f_2,A) or (w_1,w_2,f_1,f_2,f_3,A) according to a complete assignment $A = (i,k)$, that is, $0 \leq w_j,f_k$ and $w_1 + f_i = \pi_{1i}$, $w_2 + f_k = \pi_{2k}$, is stable if (i) for those players who are in a match remaining single is not preferred to being in the match, i.e. $U_j(0) \leq U_j(x_j,x_{-j},A)$, and (ii) no alternative match can be formed in which the partners can distribute their productivity so that both enjoy higher utilities than in their former matches (or staying alone if they are alone).

Assumptions. (i) We assume that an incomplete allocation (with an unmatched worker) is not stable, that is, there is always a distribution of the productivity of the match between this worker and an unmatched firm that both prefer to remaining single. (ii) With constant A, j prefers income allocations with larger x_j.[10]

Definition of the core The core C of the 2×3 market (2×2 market correspondingly) is defined by

$$C = \bigcup_{A \in K} \{(w_1, w_2, f_1, f_2, f_3; A) : (w_1, w_2, f_1, f_2, f_3; A) \text{ is stable}\}$$

with $K = \{(1,2),(1,3),(2,1),(2,3),(3,1),(3,2)\}$. For the investigation of the stability conditions, see Appendix D. In the following we use two types of social preferences, namely linear altruism and Fehr–Schmidt inequity aversion. Different forms of role dependency are discussed and corresponding parameters estimated for both types.

To first describe the linear altruistic utility function of player W_1 under the assignment $A = (1,2)$, we assume different altruism parameters for the income of the partner in the match and for the variable number (m) of players outside the match. In the current assignment, there are $m = 2$ in a 2×2 market and $m = 3$ in a 2×3 market. If a player also considers remaining single, then $m = 3$ in a 2×2 market and $m = 4$ in a 2×3 market. We have

$$\widetilde{U}_{W_1} = w_1 + a_{W_1} \times f_1 + \frac{b_{W_1}}{m} w_2 + \frac{b_{W_1}}{m} f_2 = (1 - a_{W_1}) w_1 + a_{W_1} \alpha + \frac{b_{W_1}}{m}(w_2 + f_2)$$

or (under the restriction $a_{W_1} < 1$)

$$U_{W_1} = w_1 + r_{W_1} \alpha + \frac{s_{W_1} \delta}{m}, \quad \text{with } r_{W_1} = \frac{a_{W_1}}{1 - a_{W_1}}, s_{W_1} = \frac{b_{W_1}}{1 - a_{W_1}}. \tag{9}$$

Here, altruistic utility is determined only by a player's assignment and income, not by the distribution of the productivities of other matches. If assignment $A = (2,1)$ results, then W_1 enjoys the utilities in equation (9), where α is substituted by β, and δ by γ. In general, the utility function of a player j with income x_j in an assignment A is

$$U_j(x_j, A) = x_j + r_j p(j, A) + \frac{s_j}{m} p(-j, A), \tag{10}$$

where $p(j,A)$ denotes the productivity in j's match, and $p(-j,A)$ the productivity of the other match that j expects to be formed. In the case of complete allocations in the 2×2 market, players have necessarily rational expectations about the only other possible match; in the case of 2×3 markets, we assume players to believe that the most profitable other match is formed. In the latter case, beliefs can be counter-factual.

If a player remains single or considers remaining single, she is again assumed to believe that the most profitable match (or matches in the case of 2×3 markets) with aggregate productivity $p(j,0)$ is (are) formed by the remaining three (four) players. Here the altruistic utility of remaining single is

$$U_j(0) = \frac{s_j}{m} p(j, 0).$$

Note that under the above assumption, utility functions should be monotone for income that restricts altruism parameters r_j to values below 1. The assumption that incomplete matches are unstable requires values s_j to be larger than -1. Fehr and Schmidt (1999) inequity aversion is specified in Appendix B. The altruistic core is depicted in Figure 1, where the effect of decreasing r_{W_1} is illustrated. 'Player in match' indicates the condition for wage w_i so that this player does not prefer to stay single. Increasing s_{W_1} would have the same effects in this allocation for W_1. In other matches or treatments there is no influence of s_{W_1} on the restriction 'W_1 in match' (but never a negative influence), and an opposite effect on the respective diagonal restriction. Figure 1 characterizes the core in terms of the wages of the two matches. That does not mean that the workers strive directly for high wages and the firms for high profits. Stability and the

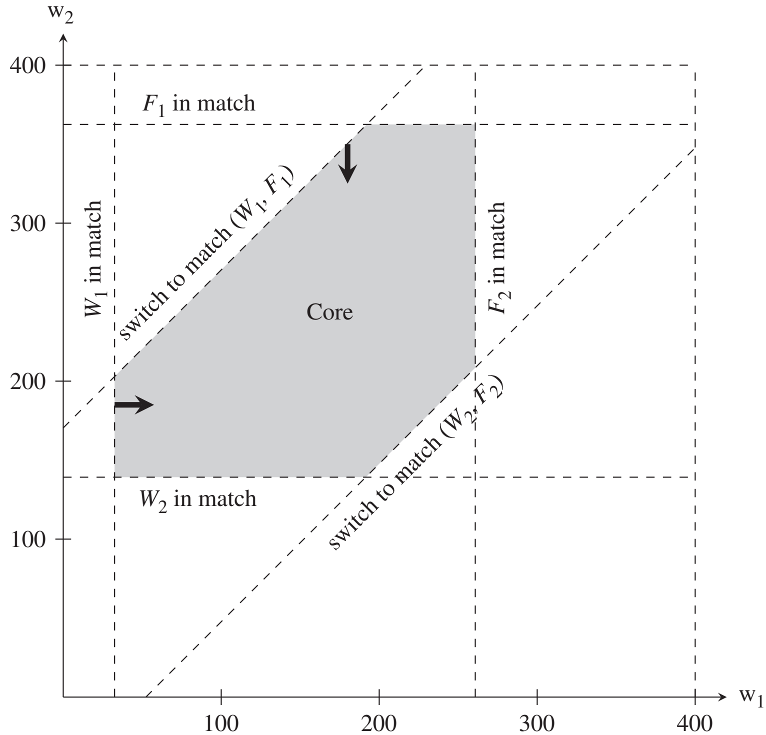

FIG. 1. Altruistic core for matches (W_1, F_2) and (W_2, F_1) in the 2×2 market with T_1 values (as shown in Table 2) and social preferences. The black arrows describe the effect on the core of decreasing r_{W_1}.

core are defined above in terms of social preferences. The implicit assumption in these definitions is that players want to maximize their social utility. If we regard the evolutionary game, then success in terms of wages and profits would guide the selection of the social utility functions.

Individually-constant and role-dependent preferences

The assignment problem has been analysed above as a one-shot game. As subjects play the game several times in different positions, we have to make additional assumptions about preferences with the option of role dependency.

(i) Under the assumption of *individually constant preferences*, the same subject always has the same utility function.
(ii) Under the assumption of *player-dependent preferences*, all subjects use the same utility function when representing a certain player in a class of comparable games. (Here: W_1, W_2, F_1, F_2 or, F_3.)
(iii) Under the assumption of *role-dependent preferences*, subjects use the same utility function when they are in similar subgames. (Here: players with certain strength combinations negotiate their incomes.)

The general idea concerning the definition of roles has already been outlined in Section I. There we mentioned that (ii) is a subcase of (iii). The assumption of player-dependent versus role-dependent preferences has particular bite if players and roles are defined for large classes of (sub)games and if the individual variability of preferences as well as the possibility of adopting different roles in the same situation is negligible. Therefore in order to isolate the influence of roles, we will fully disregard individual differences. Roles are determined solely by the strength combinations of the bargainers, which in turn depend on the values of outside options whose numerical values are provided by Hypothesis 2. The exogenous outside option of staying alone is, for every player, connected with zero income.

In the 2×2 market, W_1, W_2, F_1 and F_2 define four player positions, that is, players in the same class of games. Subjects play six games in different positions and, under (ii), they are expected to switch their social preferences according to their player positions. The number of roles in (iii) can be defined by the interaction of a certain firm and a certain worker and is eight (2×2×2). Such an exhaustive definition of roles, however, is contrary to our intention of isolating a limited number of typical roles. Thus we differentiate only between weak players W and strong players S. The relations $\alpha \leq \beta \leq \gamma < \delta$ always hold in the following experiment. This implies that W_2 and F_2 are in a stronger bargaining position than W_1 and F_2.

Applying Hypothesis 2 and computing the average endogenous outside option for all treatments ($T_1,\ldots,T_6$), the bargaining strength of the weak players W_1 and F_1 is 280, and the strengths of the strong players W_2 and F_2 are 520 and 440. In our RDA4 model (role-dependent altruism with 4 roles), the roles are WW, WS, SW and SS, with, for example, WS denoting the preferences of a weak player (W_1 or F_1) who is matched with a strong player (W_2 or F_2). The latter players' preferences in this match are determined by the role SW. With this, in (ii) with the model player-dependent altruism (PDA) as well as in (iii) with the model RDA4, parameters have to be estimated for four different players/roles. We can further reduce the number of roles by considering only the strength of one's opponent (model RDA2), which leaves us with two roles, .W and .S. Note that differentiation with respect to one's own strength is a subcase of player dependency. In addition to the egoistic core, EDC and ε-ES, the exhaustive role model and individually-constant preferences, both with altruistic as well as Fehr–Schmidt preferences, are estimated as benchmark models.

In the 2×3 market, for (ii) one further player position, F_3, is added, and only (iii) poses a new challenge. The number of exhaustive roles is 15 (see Section I: 2×2×3+3). There are three possible partners for both workers (i.e. six worker roles) and two partners for each firm (i.e. also six firm roles). One firm remains unmatched, thus defining three further roles. To reduce the number of roles to a minimum, we begin by differentiating only the strength of the opponent as defined in the 2×2 market. (The additional firm F_3 is always weak.) In the 2×3 market, however, we need to add a third role, designated 0, for the unmatched firm (model RDA3). This simplification is more severe here than in the 2×2 market, because the weakening of firm positions by the existence of an unmatched firm is not considered. Applying the definition from Section I, the bargaining strengths (again measured as the average endogenous outside option of all treatments $T_1,\ldots,T_6$) of the weak players (weak compared with players from their market side) W_1, F_1 and F_3 are 280, 40 and 0, while those of the strong players W_2 and F_2 are 520 and 237.

Thus in a first intermediate approach, we accept the simplification of role definition by the strength of the partner but, additionally, we separate between workers and firms. This approach results in five roles (model RDA5). In a second intermediate approach we differentiate between three levels of strength of the bargaining partner, namely weak players F_1 and F_3, medium players F_2 and W_1, and a strong player W_2, but no longer between workers and firms (model RDA4 with three combinations of strength and one role for the unmatched firm). Naturally, because of the complex structure of the 2×3 market, many other hypotheses on role formation are plausible, but only these three structures are investigated here. Exhaustive role definition and individually-constant preferences are again used as benchmark models that are estimated for altruistic as well as Fehr–Schmidt preferences.

In connection with Figure 1, we have discussed the impact of changes of the altruism parameters on the core. A player can secure a certain minimum income by spite toward the bargaining partner and positive altruism toward the other players (which makes the outside option of staying alone more valuable). Depending on the match, however, these coefficients have different impacts on the endogenous outside option. Nonetheless we expect the following.

Hypothesis 5a. The relation to one's partner in a match is generally governed by negative altruism (spite) and/or the relation to players outside the match by positive altruism.

Hypothesis 5b. Role-dependent preferences provide a better fit with the bargaining results than individual preferences.

V. Experimental Design

Four different market settings were implemented as a worker-to-firm allocation task. In the first three settings, each experimental session consisted of eight subjects allocated to two parallel 2×2 markets with two workers and two firms. These market settings differed in the following way: one setting was implemented with full information, while in all other settings only partial (or private) information about each player's own possible profits were provided; of the latter, one setting was implemented in a classroom (with face-to-face bargaining), while all others took place in a laboratory at Viadrina University. In the fourth setting, ten subjects were allocated to two parallel 2×3 markets with two workers and three firms (in the laboratory and with only partial information). As only one-on-one matches were possible, at least one firm remained unmatched here. The group as well as worker and firm positions were determined by a random allocation. Free negotiations between workers and firms were possible for ten minutes until new allocations to positions took place. During this time preliminary matches (with certain distributions of productivities) could be dissolved by forming new matches. This was repeated six times under different productivities for the possible worker and firm constellations. The six productivity treatments of the 2×2 and 2×3 market cases are provided in Table 2 in euro cents. The productivity treatments of the 2×3 market correspond to the 2×2 market, as only a third column is added for F_3. The productivities for F_3, which are shown in parentheses, leave the efficient matches unchanged. The orders of the productivity treatments were randomized over the sessions. Subjects were paid according to their final negotiation results one-to-one in euro cents, and no show-up fees were implemented. A detailed step-by-step description of the 2×2 matching experiment and information about resulting differences between the settings are provided in Otto and Bolle (2011a). The experimental instructions and screenshots of the negotiation phase are provided in Appendix F (online only) for the 2×3 market.

In total, 324 students took part in the study, with each subject participating only once and only under one setting. Altogether, 38 sessions were conducted (10 under each

TABLE 2.
PRODUCTIVITIES OF MATCHES IN EURO CENTS OVER THE SIX EXPERIMENTAL TREATMENTS

T_1			T_2			T_3		
280	400	(240)	280	280	(240)	160	460	(140)
400	640	(360)	520	640	(480)	460	640	(420)
T_4			T_5			T_6		
160	400	(120)	280	460	(240)	280	400	(240)
520	640	(480)	460	640	(420)	520	640	(480)

Notes
As in Table 1, rows = workers and columns = firms. If unique, the socially efficient matchings are underlined. In T_5 and T_6, both assignment possibilities are efficient. Productivities shown in brackets apply only in the 2×3 market.

setting, except the 2×2 market setting with full information, which had 8 sessions), and every session provided us with one independent observation. Each session lasted a maximum of 1.5 hours. Total average payment per person was €12.96, and payment differed between settings only with regard to the number of non-matches.[11]

The following results are differentiated only by market size (2×2 versus 2×3), as no other market setting variation produced systematic differences in aggregated results. Also, only full assignments are analysed, as we do not aim to explain the formation of incomplete assignments here, which would require explicit consideration of the dynamics of the bargaining process. Complete assignments of all workers and firms resulted in the 2×2 market 252 times (75%) and in the 2×3 market 100 times (83%).

VI. EXPERIMENTAL RESULTS

All theories considered here (the core with and without social preferences, the equal division core, and ε-equal split) are 'area theories', that is, they predict not a point but continuum of values. A proposal for evaluating such theories is the Selten score (Selten 1972), which is defined as the difference between the percentage of hits (hit rate) and the relative area of theoretical results. Relative area is the area of theoretical results divided by the area of possible results.[12] For our purpose, it is important to mention that the space of possible results as well as the space of theoretically predicted results are described by two two-dimensional areas of wage combinations (representing the two possible assignments) in the 2×2 market, and by six areas (representing the six possible assignments) in the 2×3 market. For every assignment A, there is a set of theoretical wage combinations $Theo(A)$, and a larger set of possible wage combinations $Poss(A)$, where non-negativity of wages and profits is required and with the wage plus profit in a match adding up to the productivity of the match. This description determines $|Poss(A)| = \pi_{1i} \times \pi_{2k}$ for the assignment $A = (i,k)$. The sum of $|Theo(A)|$ divided by the sum of $|Poss(A)|$ is defined as the relative area (RA). The hit rate H is the frequency of empirical results lying in $\bigcup_{A \in K} Theo(A)$, with K being the set of assignments. $H - RA$ is the Selten score. As there is more than one treatment, sums of $|Theo(A)|$ and $|Poss(A)|$ are computed over the areas of all treatments before RA is determined by dividing these sums. A pair of wages and an assignment also fully determines the profits of the firms.

2×2 market

Table 3 reports the Selten scores in the 2×2 market of the different models proposed in Section IV.The equal division core (EDC) of Selten (1972) is defined as the core, but where alternative matches are evaluated under the assumption of an equal productivity split. That is, in the 2×2 market with $A = (1,2)$, in addition to equations (5) and (6), w_1 and f_2 cannot both be larger than $\beta/2$, and w_2 and f_1 cannot both be larger than $\delta/2$. ε-ES as the weakened form of equal split assumes that W_1 (W_2) as well as F_i (F_k) requires at least half of the productivity π_{1i} (π_{2k}) minus ε, that is, $w_1 \in [\pi_{1i}/2 - \varepsilon, \pi_{1i}/2 + \varepsilon]$, and w_2 respectively.[13] Epsilon and the parameters for the social preference models are optimized by their Selten scores.[14]

We see from Table 3 that ε-ES delivers a relatively high Selten score, with only the RDA models performing better. This difference is significant ($p < 0.05$) even for RDA2 when comparing the Selten scores of all 28 sessions of the 2×2 market in a two-sided

TABLE 3.
HIT RATES, AREA SIZES AND SELTEN SCORES (ALL IN PERCENTAGE POINTS) IN THE 2×2 MARKET

Model	Concept	No. of parameters	Hit rate	Relative area	Selten score
Core	Egoism	0	18.7	6.1	12.6**
EDC	Behavioural	0	71.2	41.1	30.1**
ε-ES	Behavioural	1	80.5	23.1	57.4*
FSind	Individual inequity aversion	448	39.0	6.6	32.4**
FSexh (8 roles)	Role-dependent inequity aversion	16	75.8	32.4	43.4**
RDAexh (8 roles)	Altruism	16	85.7	16.8	68.8
Individual	Altruism	448	75.1	15.5	59.6
PDA	Altruism	8	66.7	21.8	44.8**
RDA4 (4 roles)	Altruism	8	85.7	17.8	67.9§
RDA2 (2 roles)	Altruism	4	82.9	17.6	65.3§§

Notes
Investigated models include the core, equal division core (EDC), equal split with error (ε-ES), Fehr–Schmidt inequity aversion (FS), player-dependent altruism (PDA), and role-dependent altruism (RDA). For the definition of the role-dependent altruism models, two levels of strength have been considered: W(eak) and S(trong). WS is the role of a player who is weak and confronted with a strong bargaining partner. Roles that are defined only by the strength of the partner are designated .W or .S. If roles are differentiated between workers and firms (in the exhaustive role definition), then they are indicated by $f_{W_1F_2}$ for the strong firm F_2 that is confronted with the weak worker W_1.
The roles of the investigated models are as follows.
FSexh and RDAexh: $w_{W_1F_1}, w_{W_1F_2}, w_{W_2F_1}, w_{W_2F_2}, f_{W_1F_1}, f_{W_1F_2}, f_{W_2F_1}, f_{W_2F_2}$
PDA: W_1, W_2, F_1, F_2
RDA4: WW, WS, SW, SS
RDA2: .W, .S
* indicates significantly lower than RDA2 (2 roles) with $p < 0.05$, and RDA4 as well as RDAexh with $p < 0.01$ in a two-sided Wilcoxon matched-pairs signed-rank test for the 28 sessions.
** indicates significantly lower than RDA2, RDA4 and RDAexh with $p < 0.01$.
§ indicates significantly lower than RDAexh with $p < 0.01$.
§§ indicates significantly lower than RDA4 with $p < 0.05$.

Wilcoxon matched-pairs signed-rank test. The comparison between ε-ES and RDA2, however, suffers from the fact that four free parameters are determined for role-dependent altruism, while ε-ES needs only one. (We have to keep in mind that integrating further parameters into this purely descriptive model is arbitrary, as long as there is no theory limiting the choice area.) All other theories except individual altruism perform worse than ε-ES and significantly worse than the role-dependent altruism models. In every session, eight subjects produced between three and twelve combinations of complete assignments and (w_1,w_2)-values. Nonetheless, the 16 individual parameters for every session (altogether 448 individual parameters) deliver a worse—though not significantly worse—description of the results than role-dependency.

We assume that in our 2×2 market with its relatively strong symmetry between the worker and the firm positions, the definition of two roles is sufficient. When bargaining with a weak player, altruism is highly negative in the match and zero or positive outside the match. Both parameter signs are connected with increasing value of the option to remain alone, thus improving the bargaining position. When bargaining with a strong player, such high demands are dangerous because they may prevent a match, which is less severe for the stronger player who has a better alternative.

2×3 market

When comparing the 2×2 with the 2×3 market, one difference becomes obvious. While in the 2×2 market the results are seeminglydominated by equality considerations (as in ε-ES), in the 2×3 market with one additional firm, strategic considerations have a stronger impact. Also, it turns out that efficiency is a valid predictor for the resulting assignments. Table 4 shows that more efficient assignments are preferred to less efficient ones. In the 2×2 market, in cases where inefficiencies were possible, there are 108 efficient and 57 inefficient complete matches. In the 2×3 market (with eight out of thirty-six allocations in these treatments being efficient), the proportion of inefficient (n = 56) in comparison to efficient (n = 44) complete assignments is higher, but the assignments observed (Table 4) also show a strongly significant correlation ($r = 0.74$, $p < 0.0001$) for the 36 cases (possible assignments differentiated by treatments) between relative efficiency (realized divided by the maximal possibly sum of productivities) and frequency of choice.

Table 5 reports the average profits of W_1 and W_2 in the treatments for the two markets. While in the 2×2 market average worker and firm incomes do not differ, in the 2×3 market they do. Here the worker's income is always higher than in the 2×2 market.

TABLE 4.
NUMBER OF TOTAL CASES, EFFICIENT CASES AND AVERAGE JOINT PRODUCTIVITIES FOR POSSIBLE ASSIGNMENTS

Assignment	n	No. efficient	euro cents
A_0 (only partially formed)	20	0	—
A_1 = (1,2)	27	23	880
A_2 = (2,1)	27	21	880
A_3 = (3,2)	17	0	843.3
A_4 = (2,3)	15	0	840
A_5 = (3,1)	10	0	683.3
A_6 = (1,3)	4	0	680

This difference between the markets is significant according to a t-test for both w_1 ($p < 0.01$) and w_2 ($p < 0.0001$). There is also a strong difference between workers' and firms' incomes within the 2×3 market. When part of a match, average wages (262 euro cents) are significantly higher with $p < 0.0001$ than profits (172 euro cents). The significance of this difference holds for all treatments separately (maximal $p = 0.018$ in T_3) and expresses the strategic advantage of the additional outside option (a match with the third firm).

The core solution, however, overemphasizes this strategic advantage (compare Figure A1 in Appendix C). Its performance is even worse than in the case of the 2×2 market, as no single bargaining result is in the core (compare Table 6). Also, the benchmark theory ε-ES as well as individually constant social preferences perform badly. In the 2×3 markets, the superiority of role-dependency against these concepts is even stronger. Each role-dependent altruism version outperforms all other theories. All in all, it seems as if RDA5 delivers a good behavioural description. The reason for its superiority over RDA3 is that in the 2×3 market we have a second dimension of strength. The unmatched firm is an important competitor for the firms in a match, so a strong firm is no longer as strong as in the 2×2 market and a weak firm is even weaker. The Selten score of RDA4, which distinguishes three levels of strength but does not differentiate between the market sides, is between that of RDA3 and RDA5. Defining roles only by workers and firms, that is, taking into account only that there are more firms than workers, is necessarily less successful than PDA.

Results overall

All role-dependent altruism models that take into account the strength of one's bargaining partner perform better than all the competing concepts; linear altruism allows a better role description than Fehr–Schmidt inequity aversion; and both regularities are more pronounced in the more asymmetric 2×3 market. The parameters of RDA2 for the 2×2 market and RDA5 for the 2×3 market are provided in Table 7. For these models the data fit is illustrated in Appendix E. The structure of parameters confirms the expectation that bargaining strengths have changed from the 2×2 to the 2×3 market. From the r parameters, we see in the 2×3 markets that firms are altruistic while workers are spiteful concerning the income of their matching partners. This 'disadvantage of firms' is somewhat counterbalanced, however, by their highly positive s parameters, which make staying alone more attractive. The unmatched firms are characterized as rather demanding, which not only prevents them from matching, but also weakens their function as an outside option for the workers. This function strongly influences the 2×3 market, but it is far less important than predicted by core theory with egoistic players.

TABLE 5.
AVERAGE WAGES (W_1,W_2) IN THE TREATMENTS OF THE TWO MARKETS

	T_1	T_2	T_3	T_4	T_5	T_6
2×2	(158,299)	(144,318)	(140,290)	(139,331)	(169,308)	(152,334)
2×3	(182,336)	(170,359)	(171,328)	(135,383)	(184,335)	(184,376)

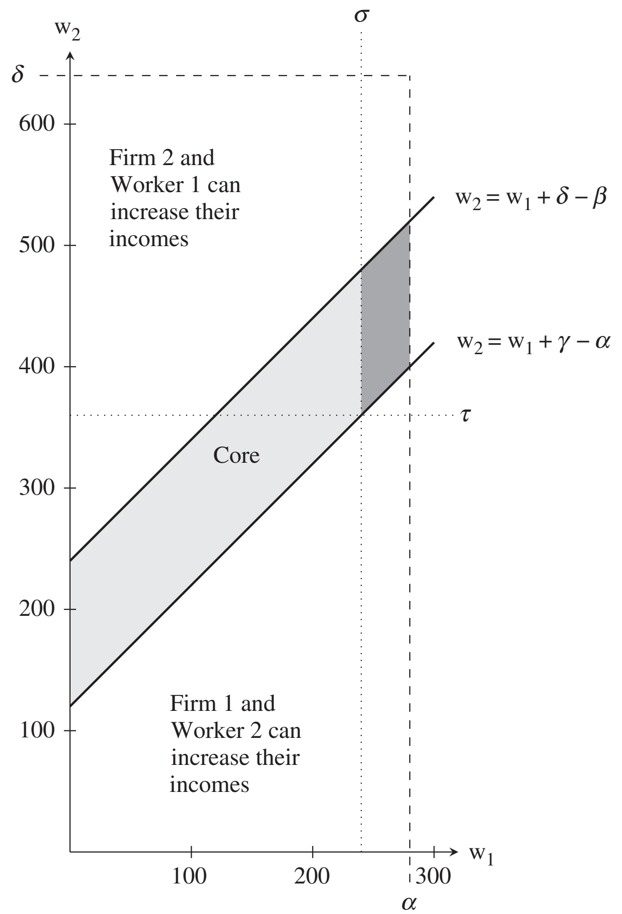

FIG. A1. The core is a 45° lattice, illustrated here for $A = (1,2)$ and T_1 values. The light-shaded area depicts the 2×2 core, and the darker-shaded area is for the 2×3 core.

Hypothesis 5a is supported by the estimated role-dependent altruism parameters (see Table 7) more often, however, in its 'or' version (r parameter negative or s parameter positive) than in its 'and' version. This estimate is plausible from their ambiguous effects on the endogenous outside option and from the necessity to prevent a too-demanding exogenous outside option, which might cause an empty altruistic core. Hypothesis 5b is also supported (see Tables 3 and 6), although significantly only in the 2×3 market.

VII. CONCLUSION AND DISCUSSION

Traditional decision theory rests on individual preferences and strategy spaces. These two elements of decisions are assumed to be independent. Preferences may be 'social', for example depending on others' income, but they should not be influenced by strategic options or by frames (which keep the strategic options constant). Experiments show, however, that preferences are neither independent from strategy spaces nor frames without effect.

TABLE 6.
HIT RATES, AREA SIZES AND SELTEN SCORES (ALL IN PERCENTAGE POINTS) IN THE 2×3 MARKET

Model	Concept	No. of parameters	Hit rate	Relative area	Selten score
Core	Egoism	0	0	0.1	−0.1**
EDC	Behavioural	0	61	18	43*
ε-ES	Behavioural	1	70	37	33**
FSind	Individual inequity aversion	200	0	0	0**
FSexh (15 roles)	Role-dependent inequity aversion	30	23	8.8	14.2**
RDAexh (15 roles)	Altruism	30	90	22.8	67.2
Individual	Altruism	200	25.1	0.9	24.7**
PDA (5 roles)	Altruism	10	33	7.9	25.1**
RDA5 (5 roles)	Altruism	10	84	21.5	62.5§
RDA4 (4 roles)	Altruism	8	78	19.1	58.9§
RDA3 (3 roles)	Altruism	6	66	12.7	53.3§

Notes
For the definition of role-dependent altruism, two or three levels of strength have been considered: W(eak), S(trong) and in addition M(edium). Roles that are defined only by the strength of the partner are designated .W, .M or .S. If roles are differentiated between workers and firms, then they are indicated by *f*.S for a firm that is confronted with a strong worker. The roles of the investigated models are as follows.
FSexh and RDAexh: $w_{W_1F_1}, w_{W_1F_2}, w_{W_1F_3}, \ldots, f_{W_1F_1}, \ldots, f_{W_2F_3}, 0_{F_1}, 0_{F_2}, 0_{F_3}$
PDA: W_1, W_2, F_1, F_2, F_3
RDA5: *w*.W, *w*.S, *f*.W, *f*.S, 0
RDA4: .W, .M, .S, 0
RDA3: .W, .S, 0
* indicates significantly lower than RDA4 and RDA5 with $p < 0.05$, and RDAexh with $p < 0.01$ in a two-sided Wilcoxon matched-pairs signed-rank test for the 10 sessions.
** indicates significantly lower than RDA3 with $p < 0.05$, RDA4 with $p < 0.01$, and RDAexh with $p < 0.001$.
§ indicates significantly lower than RDAexh with $p < 0.05$.

Interaction in our bargaining model is described by the core concept in connection with social preferences. What we have shown here is that the results obtained in small-number bargaining situations could best be explained by role-dependency of preferences. Negotiations with two parties can be successfully described by the introduction of role-dependent preferences, and the superiority of the approach becomes obvious in more complicated situations. Behaviour in the 2×2 assignment market can be better (though not significantly better) explained by the introduction of four parameters for two

TABLE 7.
PARAMETER ESTIMATES OF RDA WITH TWO AND FIVE ROLES

	2×2 market (2 roles)		2×3 market (5 roles)				
	.W	.S	*w*.W	*w*.S	*f*.W	*f*.S	0
r	−0.466	−0.126	−0.294	−0.254	0.300	0.728	−1.073
s	0.482	−0.090	−0.057	−0.362	0.694	0.389	0.795

Notes
The effective value of the *s*-parameters is s/m ($s/2$ in the 2×2 market and $s/4$ in the 2×3 market).

roles than by 448 individual parameters for the 224 subjects. In the 2×3 assignment market, six parameters for three roles deliver a significantly superior result than 200 individual parameters for the 100 subjects. The achieved fit is even better with five roles. Roles are defined by the combination of bargaining strengths of the players, which are derived from a person's income when staying alone as well as their social contributions. These results are even clearer in the 2×3 assignment market. While the 2×2 market is only mildly asymmetric, the 2×3 market is highly so, and the conditions of the core are more restrictive. This prevents concepts with individual preferences from gaining better fits.

Considerations about the individual advantages of role-dependent preferences (in terms of fitness or income) guided the formulation of our hypotheses. Our general hypotheses 1, 2 and 3 are mainly supported by the overall success of our approach; the specific hypotheses, in particular 5a and 5b, are supported by the estimated parameters and the superior fit of the role-dependent altruism models. The exact nature and number of roles could not be determined in our experiments, which may be due also to a certain degree of variability in role adoption. Still, we emphasize that a small number of simple roles is sufficient to outperform the competing theories. One surprising regularity is the higher importance of the bargaining partner's strength compared to one's own strength, which is implied by the comparison of RDA2 and RDA4 in the 2×2 market as well as RDA3, RDA4 and RDA5 in the 2×3 market with the respective PDA models. Another unanticipated result is the considerably better fit of our model with linear altruism than with Fehr–Schmidt inequity aversion. Nonetheless, we do not claim that roles are always best described by parameters of linear altruism, or that roles are exclusively determined by the strategic situation of a player.

We agree that a more general definition of roles needs to be developed. A basic assumption made here is that role-dependent preferences have evolved to exploit own while counteracting others' strategic advantages. With such an interpretation of individual and social wellbeing, we can think of roles as socially determined by behavioural norms in line with, for example, Cappelen *et al.* (2013) or Krupka and Weber (2013). Social norms can be strongly influenced by, for example, entitlements, group assignments or labelling. When players have created the income by their own labour, and bargain over its distribution, they are far less willing to share these fruits than in situations where they are provided with effortless income by the experimenter (Ruffle 1998). In the assignment market experiments presented here, players bargain over income that they fictitiously create by cooperation. Further sources of role adoption could be dichotomous categories such as insider/outsider, rich/poor, leader/follower, and so on.[15]

The successful introduction of role-dependent preferences should encourage further explorations in this direction. Note, however, that role-dependency does not necessarily deny individual differences in preferences. Symmetric games where roles are identical (i.e. public good games) prove the existence of individual differences, which might be partly—but certainly not completely—due to differences in role perception. Thus the hypothesis here is that besides influences from random factors, decisions are based on (i) role-dependent preferences and (ii) individual deviations. In situations with different and well-defined roles, the first component (i) should dominate. In symmetric situations, the second component (ii) should prevail. While classical economic theory has been based mainly on egoistic preferences, and behavioural economists have assumed a continuum of social preferences, we suggest that there is a limited number of archetypal structures (i.e. roles) around which individual preferences gather. The evolutionary advantage of having adequate social preferences for different types of social interactions might have led to homogeneity with regard to natural social roles.

APPENDIX A: RUBINSTEIN BARGAINING STRATEGIES UNDER FORCED AND OPTIONAL BREAKDOWN

Psychological outside options v_1^* have been defined in equation (3). If $v_1^* + v_2^* > 1$, then conflict is inevitable. Otherwise, both can make an offer to the other so that acceptance is at least as good as rejection (with counter-offer). Player 1 offers x_2 with $U_2(accept) = U_2(reject)$ or, in the case of forced breakdown,

$$x_2 + a_2(1 - x_2) = \delta(1 - x_1 + a_2 x_1) + (1 - \delta)(v_2 + a_2 v_1),$$

thus

$$\text{(A1)} \qquad x_2 = \frac{-a_2 + (1 - \delta(v_1 + a_2 v_1))}{1 - a_2} - \delta x_1,$$

$$\text{(A2)} \qquad x_1 = \frac{-a_1 + (1 - \delta)(v_2 + a_1 v_2)}{1 - a_1} - \delta x_2,$$

where x_1 is player 2's counter-offer, which is determined as x_2. From equations (A1) and (A2), we get x_1 and x_2. The latter is

$$x_2 = \frac{-a_2 + (1 - \delta)(v_1 + a_2 v_1)}{(1 - a_2)(1 - \delta^2)} - \delta \frac{-a_1 + (1 - \delta)(v_2 + a_1 v_2)}{(1 - a_1)(1 - \delta^2)}.$$

x_2 is not effective if it is smaller than v_2^*, that is, player 1 has to offer $\max[x_2, v_2^*]$ for the offer to be successful. This is profitable, however, only if this leaves at least v_1^* for oneself. Therefore player 1's equilibrium offer (called STD) is

$$\text{(A3)} \qquad y_1 = \min[1 - v_1^*, \max[x_2, v_2^*]].$$

With a similar argument, we can determine the equilibrium offer of player 1 under optional breakdown (DMO). For sufficiently small v_1 (i.e. in Binmore *et al.* (1991) v_1 is 0.04) we get

$$x_2 = \min\left[\frac{1 - \delta v_1 - \delta a_1 v_2}{1 - a_1}, \max\left[\frac{v_2 + a_2 v_1 - a_2}{1 - a_2}, \frac{\delta - a_2}{1 - a_2} - \frac{\delta(\delta - a_1)}{1 - a_1}\right]\right],$$

and player 2 accepts it if the offer is at least $(v_2 + a_2 v_1 - a_2)/(1 - a_2)$. Otherwise player 2 terminates the game.

APPENDIX B: FEHR–SCHMIDT INEQUITY AVERSION PREFERENCES IN ASSIGNMENT MARKETS

Fehr–Schmidt inequity aversion for j being in a match is defined by the utility function

$$U_j(x_j, A) = x_j - \frac{a_j}{m}\left(\max\{0, p(j,A) - 2x_j\} + 2 \times \max\{0, p(-j,A)/2 - x_j\}\right)$$
$$-\frac{b_j}{m}\left(\max\{0, 2x_j - p(j,A)\} + 2 \times \max\{0, x_j - p(-j,A)/2\}\right),$$

with $0 < b_j < a_j$. If players are single or only consider staying alone, then their utility is

$$U_j(0) = \frac{-a_j}{m} p(j,0),$$

with $m = 3$ in a 2×2 market and $m = 4$ in a 2×3 market. Parameters a_j describe 'envy' when others have a higher income than j, and parameters b_j describe 'guilt' if j is better off than others. While altruism is a personal concept that justifies differentiation between closer (within a match) and more distant (outside the match) people, inequity aversion is a social concept of fairness where no such differentiation is made.

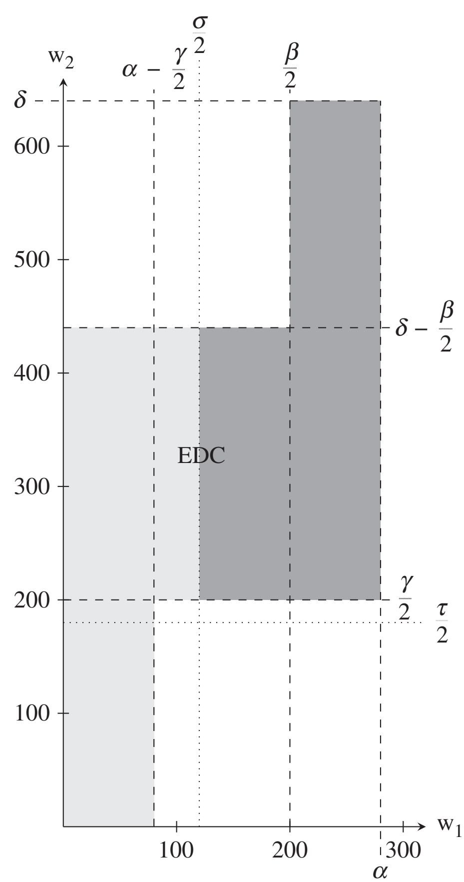

FIG. A2. EDC for A = (1,2) and T_1 values.

The assumption made previously that utility increases with a player's income requires $4b_j/m < 1$. The assumption that incomplete matches are unstable is always fulfilled under Fehr–Schmidt preferences, because two unmatched partners both increase their utility if they split the productivity of their match equally.

APPENDIX C: THE EGOISTIC CORE AND OTHER BENCHMARK CONCEPTS

CORE

Figure A1 provides a graphic representation of the core area. The shaded area between the lines describes the core for the 2×2 market case. Above this area, F_2 can increase total income with W_1, and below it F_1 can increase total income with W_2. In the 2×3 market, the additional restrictions $w_1 \geq \sigma$ and $w_2 \geq \tau$ have to be fulfilled, leading to a shrinking of the core area, as depicted by the darker-shaded area. Here the same holds as for the 2×2 market case, but in addition W_1 could earn the (or close to the) amount σ and W_2 up to the amount τ by forming a match with F_3, who is not in a match under $A = (1,2)$. However, the latter has no bite in the illustrated case T_1, where $w_1 = \sigma$ and $w_2 = \tau$ happen to intersect on the lower boundary of the 2×2 core. Similarly, small core areas result in all treatments of the 2×3 market.

EDC

For all six possible matches, EDC requirements can simply be specified for the workers only (who are always part of a match with the respective joint profits α, β, γ, δ, σ and τ) within the 2×3 market. In the following, we concentrate on the assignment (1,2). EDC for all other assignments only needs a substitution of the respective productivities:

$$A_{(1,2)} : (w_1, w_2) \in \left[\frac{\sigma}{2}, \alpha\right] \times \left[\frac{\tau}{2}, \delta\right] - \left\{ \left[\frac{\sigma}{2}, \frac{\beta}{2}\right] \times \left[\delta - \frac{\beta}{2}, \delta\right] \cup \left[\alpha - \frac{\gamma}{2}, \alpha\right] \times \left[\frac{\tau}{2}, \frac{\gamma}{2}\right] \right\}.$$

For the 2×2 market, $A_{(1,2)}$ applies respectively, with $\sigma/2$ and $\tau/2$ being zero.

Figure A2 provides a graphic representation of the EDC area. All the shaded areas together describe the equal division core for the 2×2 market case. For $w_2 < \gamma/2$ and $w_1 > \alpha - \gamma/2$ (i.e. $f_1 < \gamma/2$), F_1 and W_2 would form a match. This excludes the white square at the bottom right of Figure 3A2 from the feasible bargaining results. The white square at the top left is excluded by the requirement that F_2 and W_1 should not be able to match profitably with an equal split of β. In the 2×3 market case, this area is further restricted by the equal splits, with the firm not being in a match (F_3 in this case of $A = (1,2)$). w_1 always needs to be above $\sigma/2$, and w_2 always needs to be above $\tau/2$ (no restriction here) for the assignment to be stable under the threat of equal splits.

APPENDIX D: CHARACTERIZATION OF THE CORE WITH ALTRUISTIC PREFERENCES

When investigating the stability condition more closely, it is sufficient to concentrate on the assignment $A = (1,2)$. Then the worker matched with F_1 is always labelled W_1, and in the case of the 2×3 market, the unmatched firm is labeled F_3. Stability means that it is not better to remain single and that no $(w'_1, w'_2, f'_1, f'_2) \geq (0,0,0,0)$ exist with $w'_1 + f'_2 = \beta$, $f'_1 + w'_2 = \gamma$, and

(A4) $$U_{W_1}(w'_1, (2,1)) > U_{W_1}(w_1, (1,2)),$$

(A5) $$U_{F_2}(f'_2, (2,1)) > U_{F_2}(f_2, (1,2)),$$

or

(A6) $$U_{W_2}(w'_2, (2,1)) > U_{W_2}(w_2, (1,2)),$$

(A7) $$U_{F_1}(f'_1, (2,1)) > U_{F_1}(f_1, (1,2)).$$

Note that $U_{W_1}(w'_1, (2,1))$ and $U_{W_1}(w_1, (1,2))$ describe the same preferences—only the assignment and therefore the matches and their productivities have changed. Roles are defined separately, and as we have assumed in Hypothesis 2, they are always determined by the existing match, in this case by (W_1, F_1). For a 2×3 market, two additional conditions (corresponding to equation (8)) have to be fulfilled: W_1 and W_2 cannot profitably match with F_3, that is, there is no $(w'_1, f'_3) \geq (0,0)$ with $w'_1 + f'_3 = \sigma$ or $(w'_2, f'_3) \geq (0,0)$ with $w'_2 + f'_3 = \tau$, and

(A8) $$U_{W_1}(w'_1, (3,2)) > U_{W_1}(w_1, (1,2)),$$

(A9) $$U_{F_3}(f'_3, (2,1)) > U_{F_2}(0),$$

or

(A10) $$U_{W_2}(w'_2, (1,3)) > U_{W_2}(w_2, (1,2)),$$

(A11) $$U_{F_3}(f'_3, (2,3)) > U_{F_1}(0).$$

How can we check the stability conditions of the core with social preferences? Equation (9) implies that the utility of a player in a match increases with her share of productivity. Let us define $w_1 = w_1^*$, which makes W_1 indifferent between a match with F_1 or F_2, that is, for which the inequality in equation (A4) is an equality. As W_1's utility is increasing in w'_1, there is at most one solution in $[0,\beta]$. If this inequality applies for all $w'_1 \in [0, \beta]$, then $w_1^* = 0$, and if the opposite relation is always fulfilled, then $w_1^* = +\infty$. If $w_1^* > \beta$, then W_1 cannot receive a high enough wage in the match with F_2, and inequality equation (A4) is without bite. If $w_1^* \leq \beta$, then the inequality in equation (A5) must not apply for w_1^*. In the same way, w_1 and w_2 exist for which inequalities (A6)–(A11) do not apply. The exogenous outside options (staying alone) supply lower and upper bounds on w_i, expressed in relations (A12) and (A13) below.

The altruistic core of the 2×2 market is described by

$$C = \bigcup_{A \in \{(1,2),(2,1)\}} \{(w_1, w_2, f_1, f_2; A) : (w_1, w_2, f_1, f_2) \text{ is stable}\} = X_{(1,2)} \cup X_{(2,1)}.$$

Necessary and sufficient conditions for $(w_1, w_2, f_1, f_2) \in X_{(1,2)}$ are equations (5) and (6) as well as

$$\text{(A12)} \qquad \alpha(1 + r_{F_1}) > w_1 > -r_{W_1}\alpha,$$

$$\text{(A13)} \qquad \delta(1 + r_{F_2}) + s_{F_2}(\alpha - \gamma) > w_2 > -r_{W_2}\delta + s_{W_2}(\beta - \alpha).$$

Also, if $\widetilde{w}_1 \leq \beta$, then

$$\text{(A14)} \qquad \begin{aligned} w_2 &\leq \widetilde{w}_1 + (1 + r_{F_2})(\delta - \beta) - s_{F_2}(\gamma - \alpha) \\ \text{with } \widetilde{w}_1 &= \max\{0, w_1 - r_{W_1}(\beta - \alpha) + s_{W_1}(\delta - \gamma)\}, \end{aligned}$$

and if $\widetilde{w}_2 \leq \gamma$, then

$$\text{(A15)} \qquad \begin{aligned} w_1 &\leq \widetilde{w}_2 + (1 + r_{F_1})(\gamma - \alpha) - s_{F_1}(\delta - \beta) \\ \text{with } \widetilde{w}_2 &= \max\{0, w_2 - r_{W_2}(\gamma - \delta) + s_{W_2}(\alpha - \beta)\}. \end{aligned}$$

The altruistic core of the 2×3 market is described by

$$C = X_{(1,2)} \cup X_{(1,3)} \cup X_{(2,1)} \cup X_{(3,1)} \cup X_{(3,2)},$$

where $X_{(i,k)}$ are described as in the 2×2 market, with the additional restrictions that a match with the unmatched firm is no feasible option for W_1 and W_2.

When comparing the altruistic core with the egoistic core in Figure 1, there are the following differences. The borderlines of the 45° lattice are shifted according to equation (A14), which substitutes the first inequality of (7), and equation (A15), which substitutes the second inequality of (7). Then inefficient matches are also possible. Under egoism, the upper borderline of inefficient matches lies below the lower borderline. Conditions (A12) and (A13) restrict the core (in the case of spite of all players) by limiting the wages from below and from above. The corresponding areas and the experimental allocation results are as shown in Appendix E for the 2×2 and 2×3 markets.

APPENDIX E: ROLE-DEPENDENT ALTRUISM MODELS WITH EXPERIMENTAL MATCHING MARKET DATA

Figures A3 and A4 describe the prediction area of RDA2 with the observed data in the 2×2 market. Figures A5–A10 describe the performance for RDA5 in the 2×3 market.

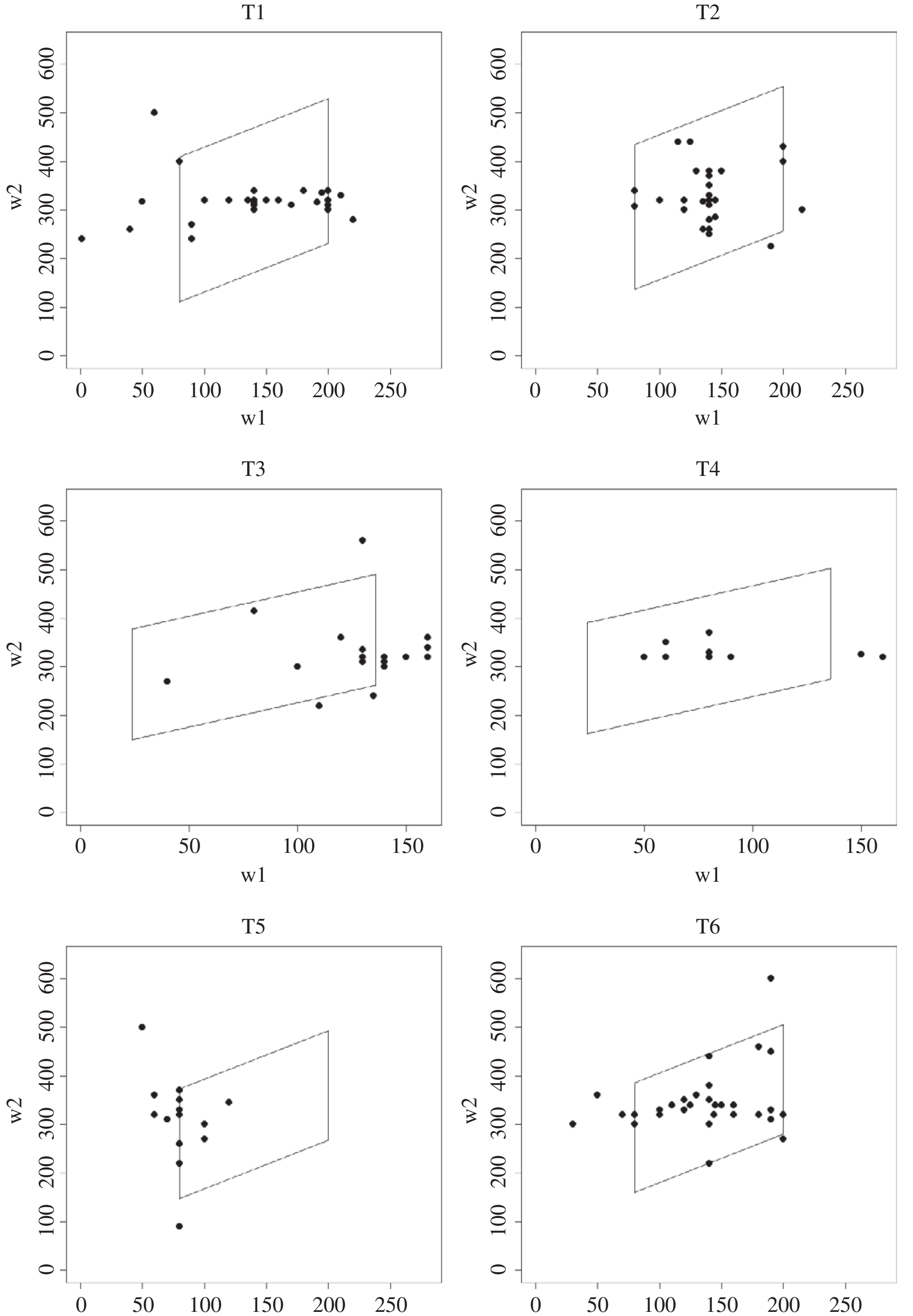

FIG. A3. Role-dependent altruism core and data points for the 2×2 market and A = (1,2).

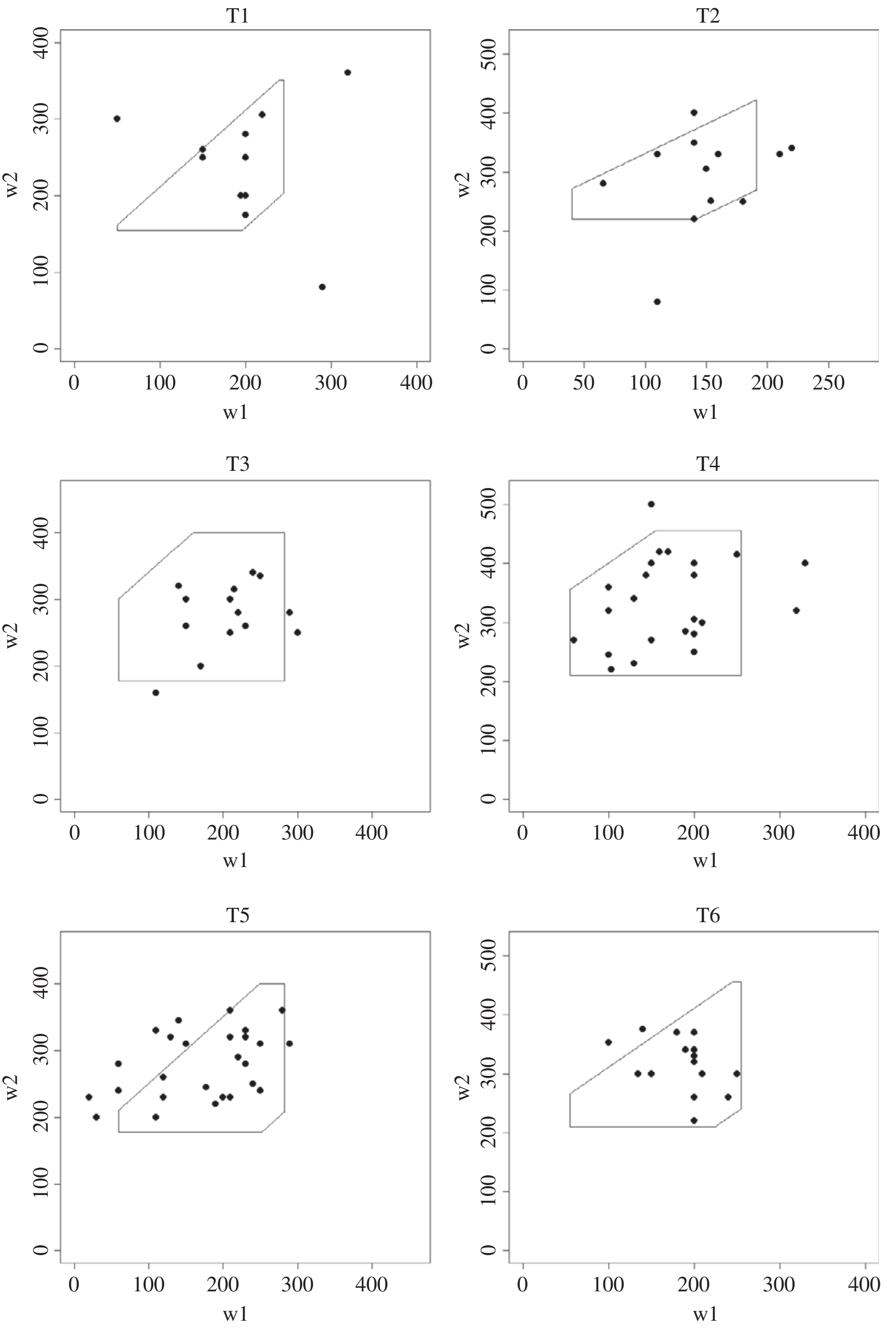

FIG. A4. Role-dependent altruism core and data points for the 2×2 market and $A = (2,1)$.

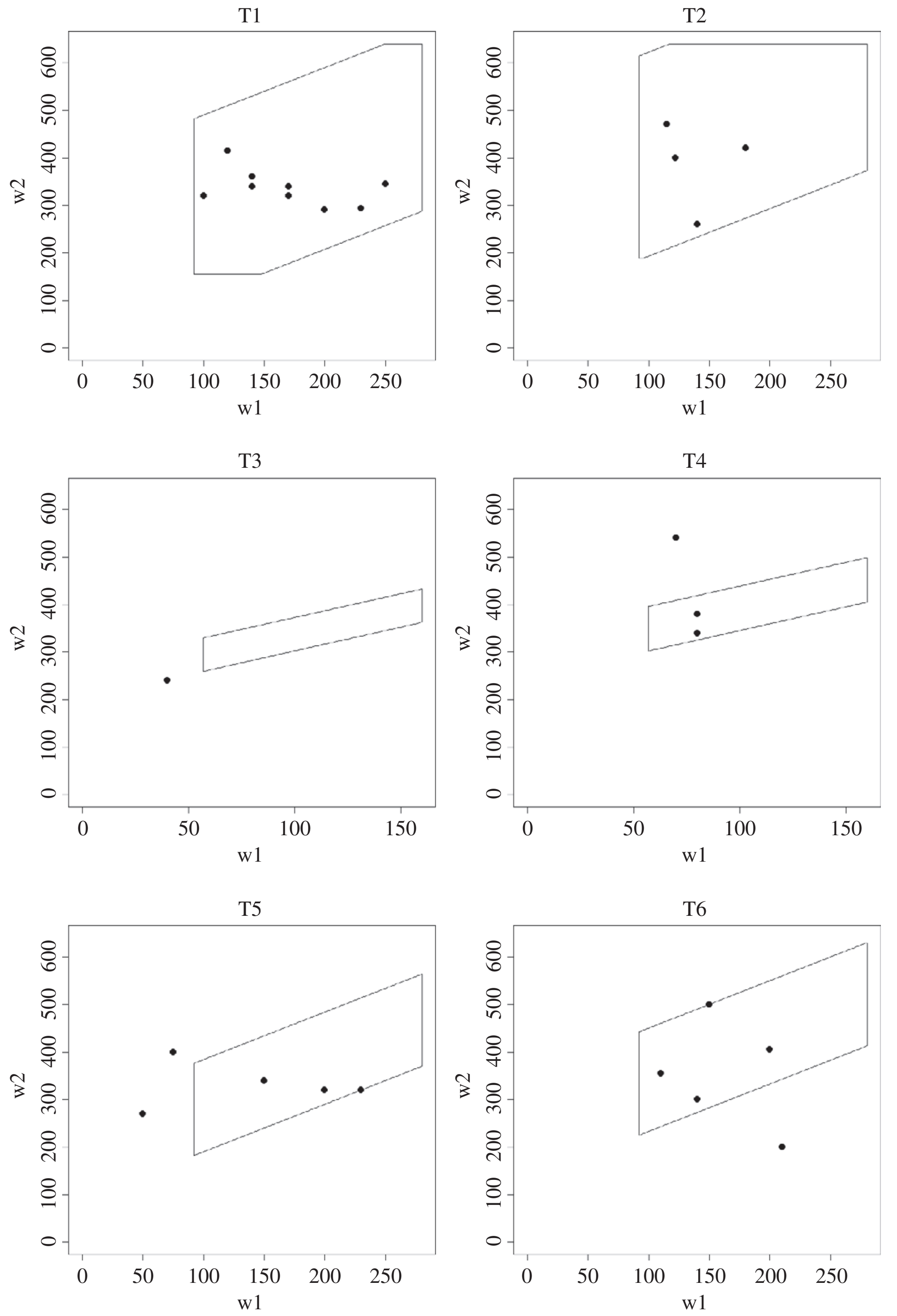

FIG. A5. Role-dependent altruism core and data points for the 2×3 market and A = (1,2).

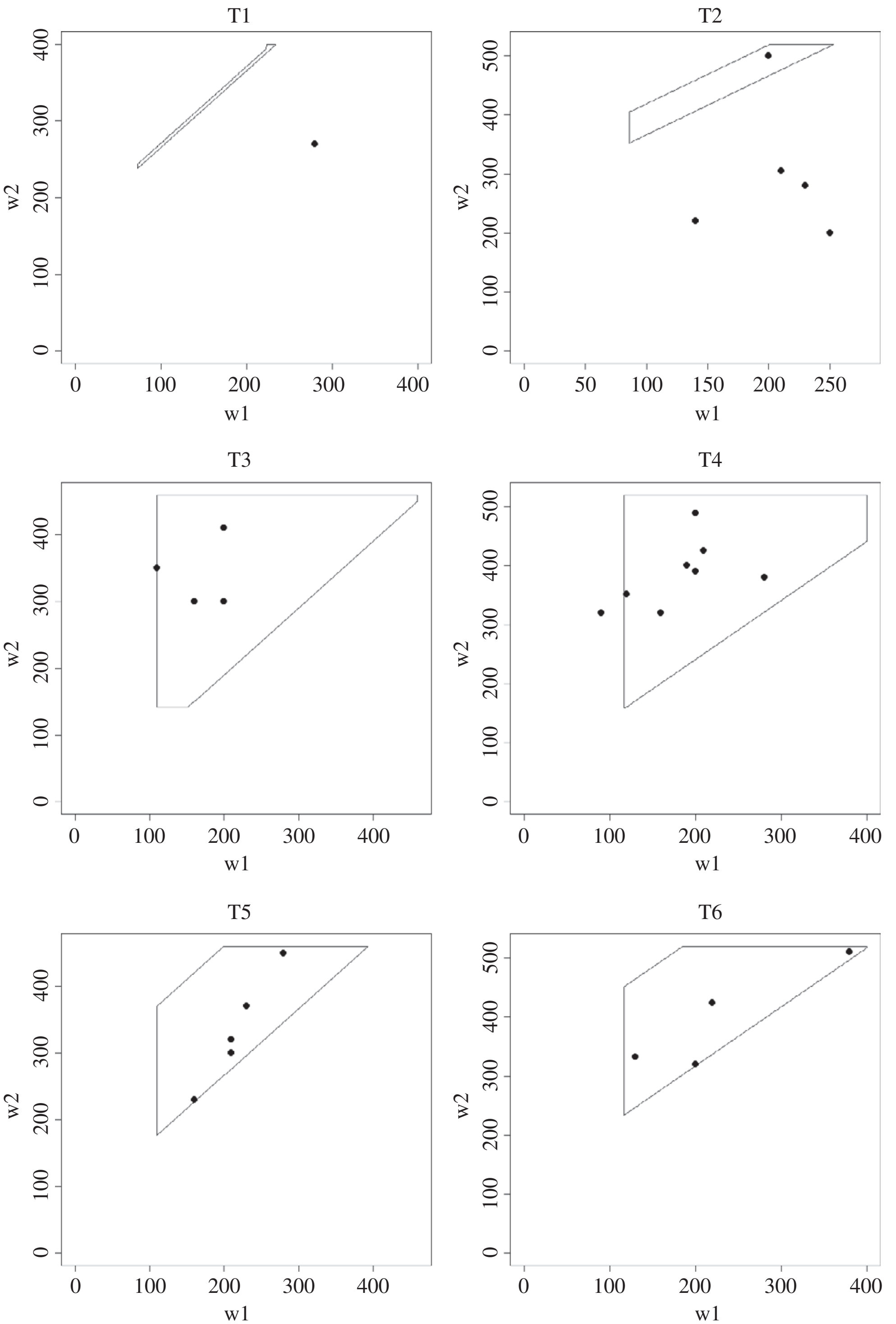

FIG. A6. Role-dependent altruism core and data points for the 2×3 market and $A = (2,1)$.

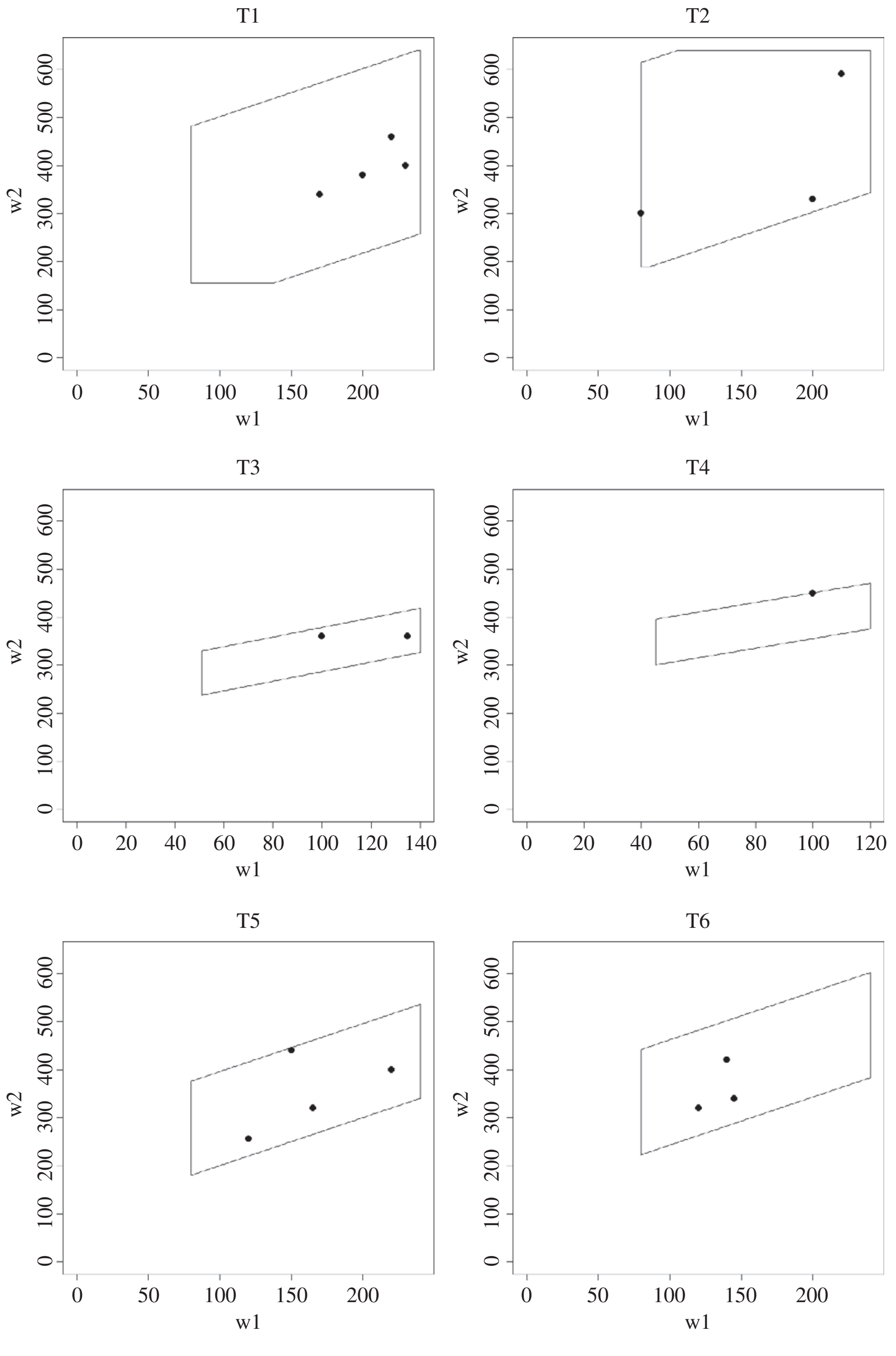

FIG. A7. Role-dependent altruism core and data points for the 2×3 market and A = (3,2).

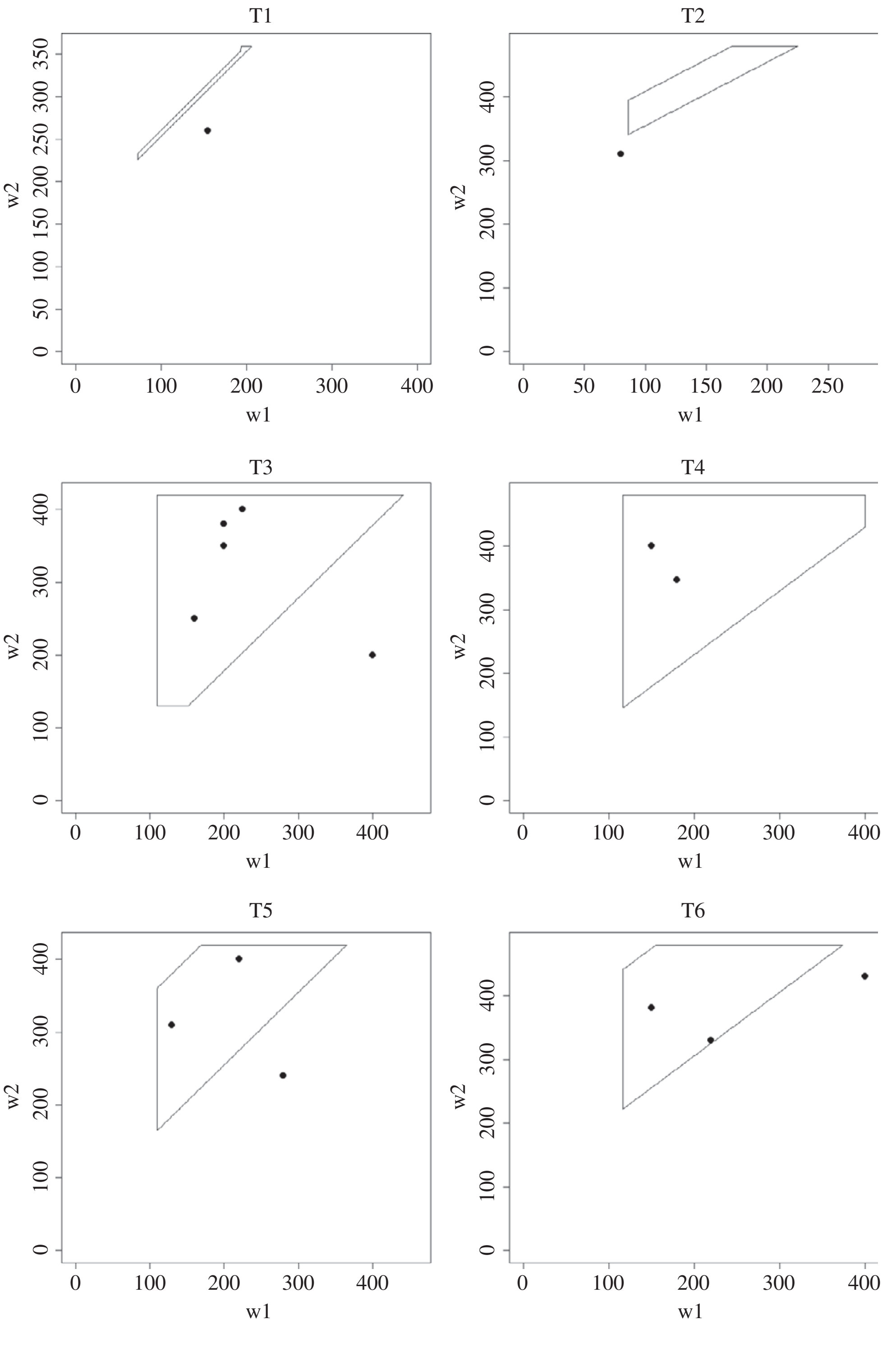

FIG. A8. Role-dependent altruism core and data points for the 2×3 market and $A = (2,3)$.

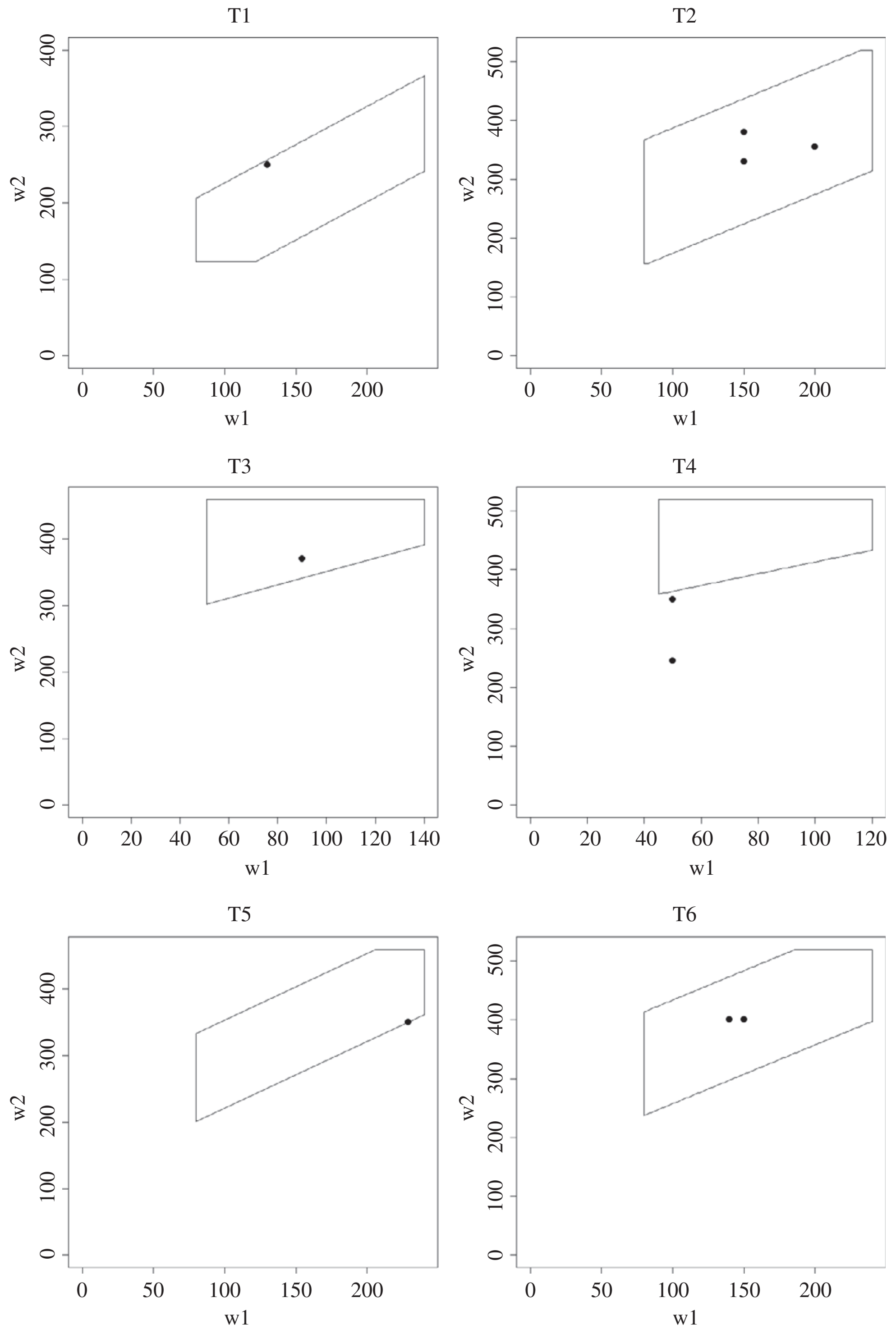

FIG. A9. Role-dependent altruism core and data points for the 2×3 market and $A = (3,1)$.

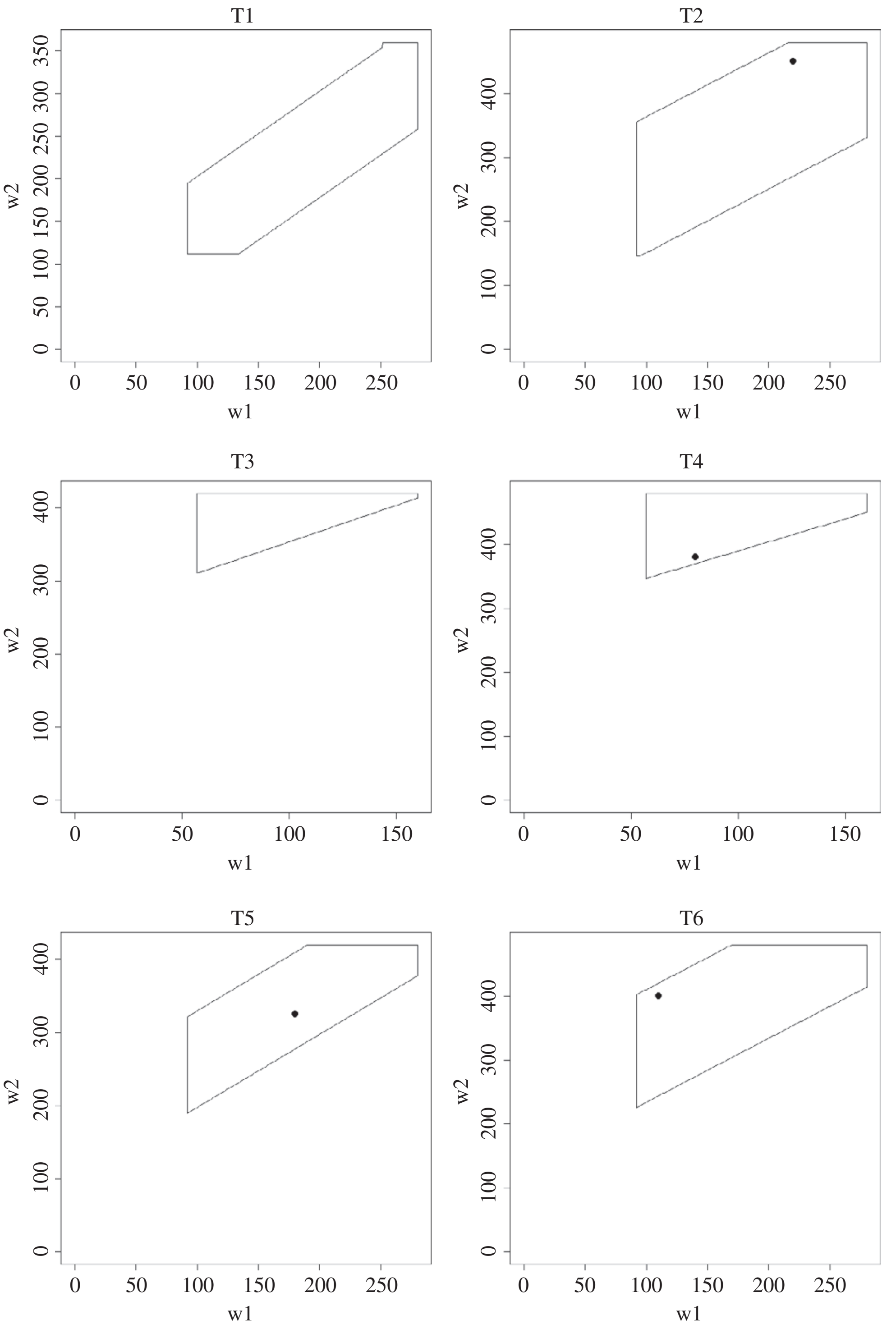

FIG. A10. Role-dependent altruism core and data points for the 2×3 market and $A = (1,3)$.

ACKNOWLEDGMENTS

We are grateful to Yves Breitmoser, who strongly influenced the content of this paper through extremely useful conceptual comments and advice with regard to the extensive numerical analysis. Financial support by the German Science Foundation (DFG#BO747/11) is acknowledged.

NOTES

1. For economists such a point of view might appear arbitrary. Other disciplines, like psychology, never accepted the notion of constant preferences and even tried to systematically influence the role of a person, for example by the technique of priming (e.g. Rudman and Phelan 2010).
2. If an *evolutionarily stable strategy* is adopted by a population, then it cannot be invaded by any alternative strategy. Güth and Yaari (1992) apply this concept to (parameters of) preferences; that is, if a population has adopted an evolutionary stable parameter a_i of equation (1), then a deviating individual with another parameter would earn less income. While individuals act according to their preferences, 'survival' in the population is determined by their income. The evolutionary stable a_i fully depends on the environment or the game.
3. A player called proposer suggests the division of a certain sum S into x for himself and $S - x$ for a second player, the responder. The responder can accept or reject the division. In the first case the players receive the proposed income shares, while in the second case both players get nothing.
4. This limitation might be seen analogously to the 'Commedia dell'arte' with its restricted number of typical characters and typical conflicts.
5. In the Rubinstein game, rejection of a proposal is followed by a counter-proposal of player 2 that player 1 may or may not accept. In the latter, player 1 makes another proposal, etc. In the Nash demand game, both players independently and simultaneously require a share of the pie. They receive their required share if the sum of shares does not exceed the total pie size (otherwise both get nothing).
6. In the assignment markets below, the core concept delivers area predictions, and there we will concentrate on point estimates of preferences.
7. The marriage problem and similar frames have received far more attention than the assignment game. The main questions in this research area (which is not the topic here) concern how the stability and efficiency of matches can be improved by appropriate market institutions.
8. Experimental results with complete information about all productivities are not significantly different from those with information only about the productivity of a player's own possible matches (see Otto and Bolle 2011a).
9. Note that $U_j(0)$ is different from $U_j(0, x_{-j}, A)$ when j is in a match.
10. These assumptions imply only weak restrictions on the parameters of linear altruism functions. See the transition from equation (9) to equation (10) and Appendix B for Fehr–Schmidt preferences.
11. We had €13.41 in the 2×2 market classroom setting, where full matches were nearly always achieved (except in two cases), possibly due to its direct face-to-face negotiation characteristic. The smaller amount to be earned under the 2×3 market setting, due to a higher percentage of people not being in a match, was balanced by a Raven intelligence test at the end of the experiment, where participants could earn up to an additional € 6. Thus the average earning of €14.51 here includes €4.87 as an incentive for the test. Earnings in the test correlated only weakly ($r = 0.19$) with earnings from the assignment game.
12. Theoretical considerations about the adequacy of this measure can be found in Selten (1991) and Bhattacharya (2004), while Hey (1998) discusses some critical points.
13. ε-ES formalizes the hypothesis that bargaining takes place without strategic considerations and is governed only by equality norms. The ε in equal split solutions can be interpreted as a measure of generosity, inertia or an insurance premium for not being left alone. For our experimental results, the estimation $\varepsilon = 120$ seems to exclude its interpretation as random error or 'just noticeable difference' (Georgescu-Roegen 1958).
14. For the more complex models—except in the case of ε-ES's data fitting—the Nelder-Mead and Newton algorithms (optimization methods from the *R* library) have been applied for each parameter with more than 100 different starting values.
15. In other words, Klumpp and Mialon (2013) define strength in an asymmetric two-player contest model by the costs of effort. They show that under the viewpoint of material payoff, the stronger player should have more hateful (altruism-opposing) preferences than the weaker player.

REFERENCES

Anbarci, N. and Feltovich, N. (2013). How sensitive are bargaining outcomes to changes in disagreement payoffs? *Experimental Economics*, **16**(2), 560–96.

Becker, G. S. (1974). A theory of marriage. In T. W. Schulz (ed.), *Economics of the Family: Marriage, Children, and Human Capital*. Chicago, IL: University of Chicago Press, pp. 299–351.

BESTER, H. and GÜTH, W. (1998). Is altruism evolutionarily stable? *Journal of Economic Behavior & Organization*, **34**(2), 193–209.

BHATTACHARYA, A. (2004). On the equal division core. *Social Choice and Welfare*, **22**(2), 391–9.

BINMORE, K. and SHAKED, A. (2010). Experimental economics: where next? *Journal of Economic Behavior & Organization*, **73**(1), 87–100.

——— MORGAN, P., SHAKED, A. and SUTTON, J. (1991). Do people exploit their bargaining power? An experimental study. *Games and Economic Behavior*, **3**(3), 295–322.

BLANCO, M., ENGELMANN, D. and NORMANN, H. T. (2011). A within-subject analysis of other-regarding preferences. *Games and Economic Behavior*, **72**(2), 321–38.

BOLLE, F. (2000). Is altruism evolutionarily stable? And envy and malevolence? Remarks on Bester and Güth. *Journal of Economic Behavior & Organization*, **42**(1), 131–3.

BRANDSTÄTTER, H. and KÖNIGSTEIN, M. (2001). Personality influences on ultimatum bargaining decisions. *European Journal of Personality*, **15**(1), 53–70.

CAPPELEN, A. W., KONOW, J., SORENSEN, E. O. and TUNGODDEN, B. (2013). Just luck: an experimental study of risk taking and fairness. *American Economic Review*, **103**(4), 1398–413.

COX, J. C., FRIEDMAN, D. and GJERSTAD, S. (2007). A tractable model of reciprocity and fairness. *Games and Economic Behavior*, **59**(1), 17–45.

FEHR, E. and SCHMIDT, K. M. (1999). A theory of fairness, competition, and cooperation. *Quarterly Journal of Economics*, **114**(3), 817–68.

FERSHTMAN, C., JUDD, K. L. and KALAI, E. (1991). Observable contracts: strategic delegation and cooperation. *International Economic Review*, **32**(3), 551–9.

GALE, D. and SHAPLEY, L. S. (1962). College admissions and the stability of marriage. *American Mathematical Monthly*, **69**(1), 9–15.

GEORGESCU-ROEGEN, N. (1958). Threshold in choice and the theory of demand. *Econometrica*, **26**(1), 157–68.

GÜTH, W. and YAARI, M. (1992). An evolutionary approach to explain reciprocal behavior in a simple strategic game. In U. WITT (ed.), *Explaining Process and Change: Approaches to Evolutionary Economics*. Ann Arbor, MI: University of Michigan Press, pp. 23–34.

HEIFETZ, A., SHANNON, C. and SPIEGEL, Y. (2007). What to maximize if you must. *Journal of Economic Theory*, **133**(1), 31–57.

HEY, J. D. (1998). An application of Selten's measure of predictive success. *Mathematical Social Sciences*, **35**(1), 1–15.

KLUMPP, T. and MIALON, H. M. (2013). On hatred. *American Law and Economics Review*, **15**(1), 39–72.

KONRAD, K. A., PETERS, W. and WÄRNERYD, K. (2004). Delegation in first-price all-pay auctions. *Managerial and Decision Economics*, **25**(5), 283–90.

KOOPMANS, T. C. and BECKMANN, M. (1957). Assignment problems and the location of economic activities. *Econometrica*, **25**(1), 53–76.

KRITIKOS, A. and BOLLE, F. (2001). Distributional concerns: equity- or efficiency-oriented? *Economics Letters*, **73**(3), 333–8.

KRUPKA, E. L. and WEBER, R. A. (2013). Identifying social norms using coordination games: why does dictator game sharing vary? *Journal of the European Economic Association*, **11**(3), 495–524.

LAURY, S. K. and TAYLOR, L. O. (2008). Altruism spillovers: are behaviors in context-free experiments predictive of altruism toward a naturally occurring public good? *Journal of Economic Behavior & Organization*, **65**(1), 9–29.

NÚÑEZ, M. (2004). A note on the nucleolus and the kernel of the assignment game. *International Journal of Game Theory*, **33**, 55–65.

——— and RAFELS, C. (2003). The assignment game: the *t*-value. *International Journal of Game Theory*, **31**, 411–22.

OTTO, P. E. and BOLLE, F. (2011a). Matching markets with price bargaining. *Experimental Economics*, **14**(3), 322–48.

——— and ——— (2011b). Multiple facets of altruism and their influence on blood donation. *Journal of Socio-Economics*, **40**(5), 558–63.

POSSAJENNIKOV, A. (2000). On the evolutionary stability of altruistic and spiteful preferences. *Journal of Economic Behavior & Organization*, **42**(1), 125–9.

RUBINSTEIN, A. (1982). Perfect equilibrium in a bargaining model. *Econometrica*, **50**(1), 97–109.

RUDMAN, L. A. and PHELAN, J. E. (2010). The effect of priming gender roles on women's implicit gender beliefs and career aspirations. *Social Psychology*, **41**(3), 192–202.

RUFFLE, B. J. (1998). More is better, but fair is fair: tipping in dictator and ultimatum games. *Games and Economic Behavior*, **23**(2), 247–65.

SELTEN, R. (1972). Equal share analysis of characteristic function experiments. In H. Sauermann (ed.), *Beiträge zur experimentellen Wirtschaftsforschung (Contributions to Experimental Economics)*, Vol. **111**.Tübingen: Mohr, pp. 130–65.

——— (1991). Properties of a measure of predictive success. *Mathematical Social Sciences*, **21**(2), 153–67.

SHAPLEY, L. S. and SHUBIK, M. (1971). The assignment game I: The core. *International Journal of Game Theory*, **1**, 111–30.

SOLYMOSI, T. and RAGHAVAN, T. E. (2001). Assignment games with stable core. *International Journal of Game Theory*, **30**(2), 177–85.

SOTOMAYOR, M. (1999). The lattice structure of the set of stable outcomes of the multiple partners assignment game. *International Journal of Game Theory*, **28**, 567–83.

STÅHL, I. (1972). Bargaining theory. PhD thesis, Stockholm School of Economics.

SWOPE, K. J., CADIGAN, J., SCHMITT, P. M. and SHUPP, R. (2008). Personality preferences in laboratory economics experiments. *Journal of Socio-Economics*, **37**(3), 998–1009.

TENBRUNSEL, A. E., WADE-BENZONI, K. A., MOAG, J. and BAZERMAN, M. H. (1999). The negotiation matching process: relationships and partner selection. *Organizational Behavior and Human Decision Processes*, **80**(3), 252–83.

ZIMBARDO, P. G. (1972). The Stanford prison experiment: a simulation study of the psychology of imprisonment. Technical Report, Stanford University.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix F contains experimental instructions and examples of screenshots (see Figures A11–A15) for the negotiation phase of one group in the 2×3 market, with two workers (W_1 and W_2) and three firms (F_1, F_2 and F_3).