

## The need for marriage contracts: An experimental study

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**Abstract.** A spouse who invests in relationship specific human capital enlarges the size of a couple's total surplus. Such investments typically also weaken the outside opportunities of the specializing spouse and thereby her bargaining position. Realizing this, underinvestment in relationship specific human capital may result. This reduces the couple's potential surplus. Private or public marriage contracts can stipulate conditions to solve this holdup underinvestment problem. This paper reports about an experiment that addresses the practical relevance of this problem. We find that although underinvestment in home production occurs, it is less frequent than game theory predicts. That is: players are prepared to specialize in home production when backwards induction predicts them not to do so. Furthermore, we find that the non-investing spouses are less opportunistic towards their partners when the large surplus has been created by the spouse than when the size of the surplus is determined exogenously.

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## 1. Introduction

Partners in a marriage can often earn a potential gain when they each specialize in a particular kind of activities. Specialization enhances performance. For the partners this would imply that one of them specializes in market activities and the other in home production. This division of labor within the household enlarges the surplus that is up for division between the spouses. At the same time, however, it also affects the outside opportunities or disagreement payoffs of the partners differently. The spouse who specializes in market activities will in most cases experience an improvement of his disagreement payoffs. The spouse who specializes in home production will in most cases experience no improvement or even a deterioration of her disagreement payoffs.<sup>1</sup> Improved disagreement payoffs will usually lead to a more favorable bargaining position.

In such long term and complicated relations as a marriage, contracts are necessarily incomplete. Marriage contracts do not specify what will happen in each and every possible contingency. This leaves scope for opportunistic behavior from the spouse with the improved bargaining position. This spouse can successfully claim a larger share of the available surplus. When the spouse who is *ex post* placed in the weaker bargaining position anticipates this opportunistic behavior, she may decide not to specialize in home production. This in turn implies that the joint available surplus will be below the social optimum amount. This is an application of the holdup underinvestment problem as introduced to the economics literature by Williamson (1985). The specific application discussed here, is also spelled out in Cigno (1991, pp 67–73).

Cigno (1991) and Laferrère (2001) evaluate different specifications of marriage contracts and marriage settlements in terms of their effects on underinvestment in home production. These evaluations operate on the assumption that parties behave opportunistically. The spouse with the better bargaining position exploits the other spouse to the fullest extent. Although fully exploiting one's bargaining position is instrumentally rational, it is an empirical question whether parties indeed do not care about the past when they bargain, and whether prospective investors anticipate this and refrain from making relationship-specific investments. Unfortunately, empirically it is difficult to prove that underinvestment would really occur without proper arrangements being made. Despite the existence of empirical work in the intra-household bargaining literature, a clear gap between theory and empirics still exists. The lack of good-quality, intra-household data on, e.g. individual consumption, endowments and disagreement points effectively prohibits any thorough testing of the models developed so far.<sup>2</sup>

Where there is a gap between theoretical predictions and empirical evidence, laboratory experiments can provide useful contributions. Not as substitutes for empirical evidence, but as complements which – in the absence of sufficient high-quality real-world data – allow us to examine whether the game-theoretical predictions hold in a laboratory environment constructed to give the theory a fair trial (cf. Loomes 1999). The purpose of the experiment reported in this paper is to provide such a complementary contribution.

Pairs of subjects play a bargaining game which is preceded by a stage in which one of the subjects chooses between two investment opportunities: a general investment and a specific investment. When the general investment is

chosen, the amount up for division in the bargaining stage is relatively small and the two players have the same disagreement payoffs. When the specific investment is chosen, the amount up for division is relatively large and the disagreement payoffs are more favorable for the non-investing party. This represents the choice for the female partner in a marriage in which the male partner has already chosen to specialize in market activities. If the wife also specializes in market activities the couple forgoes the potential gain from specialization in different activities. Both spouses keep the same relative disagreement payoffs. If the wife instead specializes in home production, the couple reaps the gain from specialization in different activities, but the relative disagreement payoffs shift in favor of the husband.

The experimental design considers  $3 \times 2$  different treatments. The first dimension relates to 3 different values (Low, Middle and High) of the disagreement payoffs of the husband. The exact values of these disagreement payoffs have been chosen such that they differentiate between three types of bargaining behavior. According to the 'split-the-difference' solution, the wife will only specialize in home production in the Low treatment. According to the so-called 'deal-me-out' solution, the wife specializes in home production in the Low as well as in the Middle treatments. Finally, the so-called 'equal-split' solution predicts the wife to specialize in home production in all three treatments.<sup>3</sup> The second dimension relates to the source of the amount up for division in the bargaining stage. In the experimental condition, this size is determined by the wife's choice between specializing in market activities or in home production. In the control condition, this size of the surplus is set by the experimenter rather than by the wife's choice. According to the game theoretical framework underlying the predictions, it should not matter for the bargaining stage whether the experimental or the control condition applies. This experimental design addresses two main research questions. First, under which conditions is the wife prepared to specialize in home production? Second, does it matter for the bargaining process whether the wife's choice or the experimenter's choice has determined the size of the surplus, i.e. does endogeneity matter?

Experimental studies related to the analyses presented here fall in two categories. The first are studies which deal with bargaining games with unequal disagreement points – but without an investment choice stage. Examples include Sopher (1990), Forsythe et al. (1991), Rapoport et al. (1990), and Kahn and Murnighan (1993). Secondly, there are numerous studies on the effects of norms of fairness and reciprocity. For example, in dictator games and ultimatum bargaining there is a tendency to split cakes evenly (for an overview see Roth 1995). The question is whether someone can and will rely on the fairness norms of others. This is studied in trust games. In a typical bilateral trust game player 1 can decide to play safe and stop the game, in which case both players get a payoff of  $s$ , or to continue. If the game is continued and player 1 decides to trust player 2, the second player decides between rewarding trust (both players get a payoff of  $t$ ) or exploiting player 1 (payoff 0 for player 1 and  $r$  for player 2), with  $0 < s < t < r$ . Studies by Berg et al. (1995) and Güth et al. (1997) find that subjects are inclined to invest even if they are completely dependent on their opponents' generosity to earn a positive return. In these studies, the bargaining stage takes the form of a dictator game in which player 2 has maximum possibility to exploit player 1's trust, and keep a maximum payoff for him/herself. A common finding in the experimental

economics literature is that bargaining in such simplified games is likely to produce insights different from those gained from more extensive bargaining experiments like the one presented in this paper (see e.g. Binmore et al. 1985).

Two studies by Hackett (1993, 1994) merge the investment and bargaining stages. Following a model developed by Tirole (1988), a seller and a buyer each have to decide how much they invest. The larger the investment each party makes, the larger the expected value of the joint surplus they have to divide in the bargaining stage. The results indicate that the bargaining outcomes are influenced by the relative levels of sunk, relationship-specific investment and that this is especially the case if investment levels are observable. These findings support the view that social norms of equity are important for relational exchange. Hackett's experimental design differs in a number of important respects from ours. First, Hackett follows closely the prototypical hold-up problem which involves upfront costs that are sunk at the time of the bargaining. While this is the appropriate setting for many applications, we believe that in our setting the relevant choice involves the type of investment rather than the investment per se. In our experiment, this choice is incorporated as a choice between a large pie coupled to asymmetric disagreement payoffs, and a small pie coupled to symmetric disagreement payoffs. Second, in Hackett's papers both parties make an investment decision, while in our design only one party makes an investment choice. In the latter case it is clearer which party plays which role. Third, in Hackett's design the amount of the surplus created by the investment is uncertain. Instead of creating a surplus of a certain amount (as in our experiment), investments raise the expected value of the surplus. The disadvantage of that approach is that the effects of the subsequent bargaining stage on the investment level cannot be distinguished from the effects of risk aversion. Finally, in Hackett's experimental design the effects of the investment choice stage on the bargaining stage are identified by varying investment incentives. Although this is perfectly legitimate, we think that identification is even stronger with control treatments in which the investment choice stage is omitted altogether. Our design includes three control treatments which have the implicit aim of contrasting the bargaining-*cum*-investment outcomes to bargaining outcomes when there is no investment choice stage.

The remainder of this paper is organized as follows. Section 2 starts with a description of the experimental design. Section 3 elaborates on the research questions and formulates hypotheses. Section 4 presents and discusses the results. Section 5 concludes.

## 2. Design

A total of 120 subjects participated in a total of six sessions. The subject pool was the student population of the University of Amsterdam.<sup>4</sup> A majority of 61% of those who participated majored in economics,<sup>5</sup> 80% of the subjects were male. They earned on average  $47\frac{1}{2}$  Dutch guilders (approximately 24 US dollars) in about 2 hours.

In each session 20 subjects played 10 bargaining games against 10 different anonymous opponents. In every game a subject was teamed up with a subject whom he or she had not met before in the session. Nor had the second subject met someone with whom the first subject had bargained before.

Hence, subjects always were ‘perfect strangers’ when they interacted. This property of the rotation scheme was known to the participants. In 5 out of 10 games subjects had the role of the non-investor, i.e. the one who makes the first proposal. In the other half of the games they were investors, i.e. the one who – in the experimental treatments – determines the size of the pie. In the sequel we will refer to the non-investor as the husband and to the investor as the wife. It should be noted, however that in the experiment the role of “husband” is also played by all female subjects and the role of “wife” is also played by all male subjects. In the experiment the phrasing is neutral (1 and 2) and does not refer to any specific context. Subjects interacted with each other through a computer network, and did not know with which other participants they were connected. Subjects were placed in cubicles so that they could not observe or talk to other participants.

### *2.1. Treatments*

The design of the experiment covers 6 treatments: 3 experimental and 3 control treatments. Each treatment corresponds with one experimental session. In the first experimental treatment the wife had to choose between specializing in market activities generating a stream of 10 pies of 1000 points each coupled with disagreement payoffs (250, 250) for the husband and the wife respectively, and specializing in home production generating a stream of 10 pies of 1500 points coupled to disagreement payoffs (250, 0). The second and third experimental treatments are exactly the same except that the disagreement payoffs after specialization in home production are equal (750, 0) and (1250, 0) respectively. Thus, the three experimental treatments differ only in the amount of husband’s outside opportunity when the wife specializes in home production. We refer to these treatments as Low, Middle and High. In the 3 control treatments, the initial choice stage is omitted. Instead the size of the surplus up for division and the disagreement payoffs are set by the experimenter. Subjects were informed about the possible pie-sizes and were also told that the actual pie-sizes were determined beforehand by the experimenter. In fact, the pie-sizes in the control treatments are based upon the choices made by the subjects in the experimental treatments (e.g. subject 14 in the control Middle treatment encounters the same sequence of 10 pie sizes and corresponding disagreement payoffs as subject 14 in the experimental Middle condition). This is done to ensure that differences in bargaining behavior between experimental and control treatments cannot be caused by different histories of bargaining situations. In the remainder of this paper we refer to the 6 different treatments by the following acronyms: ExpLow (for Experimental Low treatment), ConLow (for Control Low treatment), ExpMid (for Experimental Middle treatment), ConMid (for Control Middle treatment), ExpHigh (for Experimental High treatment) and ConHigh (for Control High treatment). Table 1 summarizes the 6 treatments.

### *2.2. Procedure*

The experiment is computerized. Subjects start with on-screen instructions. All subjects have to answer a series of questions correctly before the experiment starts. For example, they have to calculate the earnings of subjects for some hypothetical bargaining outcomes. Subjects also receive a

**Table 1.** Summary of the treatments

Treatment	Possible surpluses (S) and disagreement payoffs (DP)	Who determines surplus?	Number of games
ExpLow	S = 1000, DP = (250, 250), or S = 1500, DP = (250, 0),	Wife	100
ConLow	S = 1000, DP = (250, 250), or S = 1500, DP = (250, 0),	Experimenter	100
ExpMid	S = 1000, DP = (250, 250), or S = 1500, DP = (750, 0),	Wife	100
ConMid	S = 1000, DP = (250, 250), or S = 1500, DP = (750, 0),	Experimenter	100
ExpHigh	S = 1000, DP = (250, 250), or S = 1500, DP = (1250, 0),	Wife	100
ConHigh	S = 1000, DP = (250, 250), or S = 1500, DP = (1250, 0),	Experimenter	100

summary of the instructions on paper. A translated copy of this hand-out is attached as Appendix.

At the start of a game all subjects receive a message informing them about their role in that particular game. In the control treatments the subjects are informed about the size of the surplus and the disagreement payoffs. In the experimental treatments the wife first chooses between specializing in market activities and specializing in home production. Once she has made a choice, the husband is informed about it.

The bargaining procedure is the same in all treatments. The husband starts and proposes a division of ten equally sized pies of that game. If the wife accepts this proposal, all ten pies are divided as proposed and the game ends. If the wife rejects the proposal, the first pie vanishes and both receive their disagreement payoffs. The wife then formulates a counterproposal. If the husband accepts this proposal, the remaining 9 pies are divided accordingly. If the husband rejects the proposal, the 2 pie also disappears and again both receive their disagreement payoff. This process continues until the subjects reach an agreement or until all 10 pies have disappeared due to disagreement. The costs of disagreement are the same for each round and equal to the sum of the costs the players incur, i.e. one pie minus the sum of the 2 disagreement payoffs. Thus, there are fixed joint costs of bargaining.

Figure 1 shows a typical computer screen. The figure shows information provided to a husband in the Experimental Middle treatment. The information given indicates that his wife has specialized in home production with disagreements (750, 0) in the first stage ('part 1'). The spouses are now in the process of bargaining over the division of 10 pies of 1500 points each. In this bargaining stage of the game, the negotiations have reached the third round (or 'period' on the screen). In the first round, the husband proposed a division of the ten pies such that 1250 points of each pie are allocated to himself, and 250 to his wife. She rejected his offer. Thus, the first pie vanished, and both received their disagreement payoffs of 750 and 0 respectively. In round 2, the wife proposed a 750–750 division for the nine remaining pies. This time, her husband rejected the offer. Thus, the second pie vanished as well again leaving both spouses with their disagreement payoffs. The screen shows the state of affairs in round 3, when the husband proposed a 1100–400 division for the eight remaining pies.

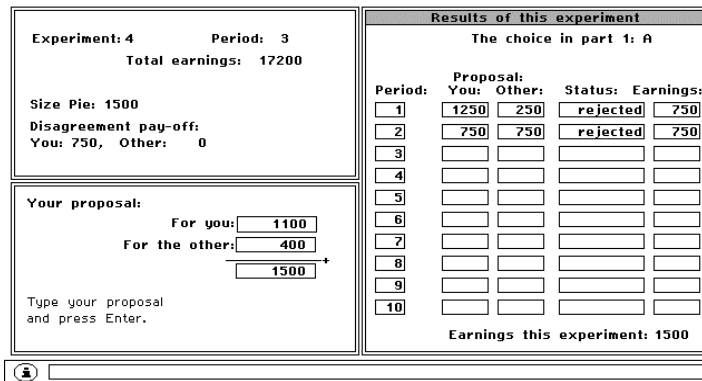


Fig. 1. Example of a computer screen during bargaining.

Note: The screen shows information shown to a husband in the ExpMid treatment. Translated from Dutch. The screen in the control condition differs slightly (e.g. instead of ‘The choice in Part 1’ in the right hand window it says ‘The situation’)

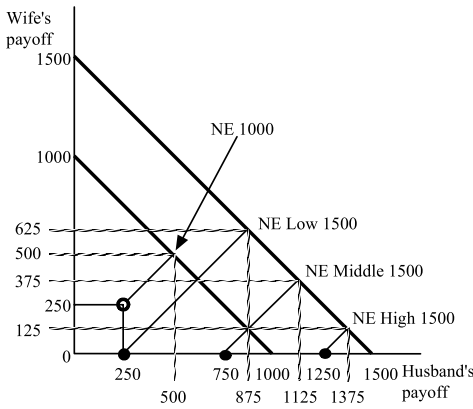
After the subjects have played ten games, they fill out a short questionnaire. At the end of the experiment the experimental points earned are exchanged for money at a rate of 1200 points = 1 Dutch guilder. Subjects are paid individually and separately from the other participants.

### 3. Hypotheses

The experiment is designed to address two issues in particular: (1) the conditions under which the wives are prepared to specialize in home production and (2) whether and how the bargaining process and outcomes depend on the inclusion of a choice stage. In this section we spell out more precisely the hypotheses that are tested in the empirical section. This section starts with a description of the game-theoretical predictions for the outcomes of the different treatments of the game. Next, we formulate competing hypotheses concerning wives’ choices between specialization in market activities and specialization in home production. Finally, hypotheses are formulated regarding the bargaining process and the bargaining outcomes.

#### 3.1. Backwards induction outcomes

The bargaining literature on alternating offer games assumes that players’ bargaining behavior is based on sequential reasoning of backwards induction and on common knowledge of rationality.<sup>6</sup> In these games, the only rational strategy for the husband is to make a first offer equal to the backwards induction outcome. The only rational strategy for the wife is to immediately accept this first offer. Figure 2 displays the equilibria for different pie sizes and different disagreement payoffs, and shows them to be equal to both spouses receiving their respective disagreement payoff and half of the remaining surplus (see also Table 2).<sup>7</sup> If the surplus equals 1000, the maximum



**Fig. 2.** Subgame-perfect Nash-equilibria.

*Note:* On the horizontal axis husband's payoff, on the vertical axis wife's payoff. The *open circle* (250, 250) indicates the disagreement payoffs in the case of a surplus of 1000, the *solid circles* are the disagreement payoffs in the case of a surplus of 1500 in the different treatments

**Table 2.** Nash equilibria of the subgames

Round number	Low				Middle		High	
	Surplus = 1000 DP = (250, 250)		Surplus = 1500 DP = (250, 0)		Surplus = 1500 DP = (750, 0)		Surplus = 1500 DP = (1250, 0)	
	husband	wife	husband	wife	husband	wife	husband	wife
	$p_H - p_W$	$p_H - p_W$	$p_H - p_W$	$p_H - p_W$	$p_H - p_W$	$p_H - p_W$	$p_H - p_W$	$p_H - p_W$
1	500–500		875–625		1125–375		1375–125	
2		473–527		806–694		1084–416		1362–138
3	500–500		875–625		1125–375		1375–125	
4		465–535		786–714		1072–428		1358–142
5	500–500		875–625		1125–375		1375–125	
6		450–550		750–750		1050–450		1350–150
7	500–500		875–625		1125–375		1375–125	
8		417–583		667–833		1000–500		1334–166
9	500–500		875–625		1125–375		1375–125	
10		251–749		251–1249		751–749		1251–249

*Note:* the  $n$ -th row displays the proposal to be made (and to be accepted by the other player) if the first  $n - 1$  proposals are rejected. The notation  $p_H - p_W$  means that the husband gets  $p_H$  and the wife gets  $p_W$ . In uneven rounds proposals are made by the husband; in even rounds by the wife.

earnings the couple can achieve are located on the lowest of the two downward sloping lines.<sup>8</sup> Both spouses then have disagreement payoffs equal to 250, indicated by the open circle. In the subgame perfect Nash equilibrium the husband proposes a division of 500–500 (indicated by NE 1000) which his wife accepts. If the pie is 1500 and disagreement payoffs equal 250 and 0 (the left solid circle on the horizontal axis), the backwards induction outcome is that the husband proposes a 875–625 split (indicated by NE Low 1500) which the wife accepts.<sup>9</sup>



The disagreement payoffs for the Middle and High treatments are indicated by the middle and right solid circles on the horizontal axis. Here the backwards induction outcomes are for the husband to propose 1125–375 (NE Middle 1500) and 1375–125 (NE High 1500) respectively, which in both cases his wife will accept. Notice that these subgame-perfect Nash equilibria are independent of the way the surplus and the disagreement payoffs have been created (by the wife's choice or by the experimenter).

It is interesting also to look at the Nash equilibria of the subgames. Table 2 shows the backwards induction proposals if a certain round of the game is reached. With fixed disagreement payoffs and an even number of maximum proposals (10), the backwards induction proposals of the husband are independent of the bargaining round reached. This is an attractive feature of the design, as we are especially interested in the husband responses to the wife's choice in the first stage.

### 3.2. *The wife's specialization choice*

The first issue is to what extent the wife's specialization choice is related to the location of the disagreement points. This depends on her expectations about her husband's bargaining behavior. We consider three possibilities.

First, assume the wife expects that the subsequent bargaining game will result in the subgame-perfect Nash equilibrium. If she specializes in market activities she expects to earn 500 points. Specializing in home production results in a payoff of 625 points in the Low treatment, 375 in the Middle treatment and 75 in the High treatment. Consequently, a wife who expects to end up with the split-the-difference payoff, will only specialize in home production in the Low treatment.

A second possibility is known as deal-me-out. In this case, parties split the surplus equally unless this gives one party less than his or her disagreement payoffs. Experimental support for this bargaining approach is reported in Binmore et al. (1989). Deal-me-out predicts a bargaining outcome of 500 points for both players when the surplus equals 1000. With a surplus of 1500, both players end up with 750 points in the Low and Middle treatments. In case of a large pie in the High treatment, deal-me-out predicts a division of 1250 for the husband (his disagreement payoff) and 250 for the wife (surplus minus husband's disagreement payoff). Hence, a wife who expects that the bargaining outcome will result in deal-me-out payoffs will specialize in home production in the Low and Middle treatments and in market activities in the High treatment.

A third possibility is that the parties divide the surplus equally independent of the disagreement payoffs. With this equal-split, a large surplus gives both players a payoff equal to 750 points, while the small surplus results for both players in payoffs of 500 points. Clearly, a wife who expects to end up with an equal-split will always prefer to specialize in home production.

To summarize, we have 3 alternative hypotheses concerning the wife's specialization choice:

**H1A** (Split-the-difference): she specializes in home production only in the Low treatment;

- H1B** (Deal-me-out): she specializes in home production in the Low and Middle treatment;
- H1C** (Equal-split): she always specializes in home production.

### 3.3. *The bargaining process*

The wife's specialization choice is conditional on her beliefs about her husband's bargaining behavior. His first proposal provides an indication of his intention in the bargaining stage. With the surplus of 1000, both players' disagreement payoffs equal 250. The split-the-difference result is for the husband to propose a (500, 500)-division in the first round, which she accepts. But equal-split and deal-me-out also predict that the first proposal equals (500, 500), which is then accepted. Consequently any deviation from a (500, 500) proposal by the husband in the first round is hard to interpret from the point of view of the three types of bargaining behavior.

With the surplus of 1500, the split-the-difference predictions for the husband's first proposal are (875, 625), (1125, 375) and (1375, 125) for the Low, Middle and High treatments respectively. Equal-split predicts the first proposal to be (750, 750) irrespective of the treatment. Deal-me-out predicts first proposals equal to (750, 750) in the Low and Middle treatments, and to (1250, 250) in the High treatments. This translates into three hypotheses regarding the husband's first proposal when the surplus is large:

- H2A** (Split-the-difference): in the first round the husband proposes a division equal to backwards induction outcome of (875, 625) in the Low treatments, (1125, 375) in the Middle treatments and (1375, 125) in the High treatments;
- H2B** (Deal-me-out): in the first round the husband proposes (750, 750) in the Low and Middle treatments and (1250, 250) in the High treatments;
- H2C** (Equal-split): in the first round the husband proposes (750, 750) in all treatments.

From a backwards induction point of view, it is irrelevant for the bargaining process whether the size of the surplus is determined by the wife's choice or by the experimenter. The same bargaining behavior is expected in the experimental and control treatments as 'bygones are bygones'. However, there is ample experimental evidence that considerations of fairness can play an important role. The wife's choice to specialize in home production can be seen as a choice that increases the husband's potential payoffs. Whatever the predicted outcome (deal-me-out; equal-split; split-the-difference), the husband is better off with a large surplus than with a small surplus. Hence, if the wife specializes in home production the husband's position improves. Reciprocity then predicts that the husband will exploit his bargaining position to a lesser extent than would have been the case if the experimenter and not his wife's choice had created the large surplus.

Furthermore, the wife is only likely to specialize in home production if she expects to benefit from it. Proposals that give her 500 points or 750 points may therefore be relevant focal points when bargaining about the division of the large surplus in experimental treatments, that is, they may be outcomes that can claim salience in the minds of the spouses. The former is focal from

an absolute point of view in that wives are likely to demand at least the *same number* of points (500) from the large surplus as they would have obtained from the small surplus. The proposal of a (750, 750)-division is focal from a relative point of view in that wives are likely to demand at least the *same share* (50%) of the large surplus as they would have received from the small surplus. In the control treatments no such focal points exist simply because bargaining about the division of a small surplus never was an option. Therefore in case of specialization in home production wives may be less inclined to accept proposals that give them less than 500 or 750 and more inclined to come up with counter-proposals that give them at least 500 or 750 in the experimental treatments than in the control treatments. This discussion is captured in the following hypotheses about bargaining behavior in case a surplus of 1500 is to be divided:

- H3A** (endogeneity does not matter): there will be no differences in bargaining behavior between experimental and control treatments;
- H3B** (endogeneity does matter): bargaining behavior differs between experimental and control treatments in the following directions:
- i (reciprocity): the first proposal of the husband will be more generous towards his wife;
  - ii (focal point): the wife is less likely to accept first proposals which give her less than the payoffs from the relevant focal point and more likely to demand at least the payoffs associated with the relevant focal point in the experimental treatments than in the control treatments.

The two items of H3B point to potential conflicts that can arise during the bargaining stage in the experimental treatments. It is possible that H3B (i) is not true, but that H3B (ii) is. In that case, the husband's proposal is not more generous in experimental treatments than in control treatments, but the wife is likely only to accept proposals that give at least the payoffs associated with the relevant focal points. It is also possible for the husband to make a proposal that gives his wife more than the backwards induction outcome (implying that the husband is reciprocal), but that this proposal still gives the wife less than the focal point payoff. In both cases, if both spouses only show scant willingness to overcome the resulting 'gap', agreement will not be reached soon. Efficiency losses are then likely to be larger in the experimental treatments than in the control treatments.

## 4. Results

### 4.1. Wives' specialization choices, part I

In each of the 3 experimental treatments we observe 100 specialization choices.<sup>10</sup> In the Low treatment specialization in home production occurs 96 times, in the Middle treatment this happens 54 times, and in the High treatment only 7 times. These choice patterns are very persistent over the ten games subjects played. In the last two games of the Low treatment this choice is made 19 out of 20 times, in the last two games of the Middle treatment this happens 9 times, and in the last two games of the High treatment only once.

These results clearly reject H1C (equal-split), which predicts that the wife will always specialize in home production independent of the disagreement payoffs because these play no role. The other two hypotheses also have to be rejected in their pure forms. H1A (split-the-difference) predicts specialization in home production only in the Low treatment, while H1B (deal-me-out) predicts this to happen in the Low and Middle treatments. Neither one of the two hypotheses explains why specialization in home production occurs in the Middle treatment in about 50 percent of the cases. We will return to this after we have presented the results of the bargaining process.

The results indicate that in the Middle and High treatments, the fear of wives that husbands will hold them up and will engage in opportunistic bargaining causes very substantial efficiency losses. In the ExpHigh treatment, 93 out of 100 choices are inefficient. This leads to a social loss of 465,000 points, which is 31 percent of the maximum feasible sum of earnings. In the ExpMid treatment, the loss equals 230,000 points, which equals 15 percent of the maximum feasible sum of earnings.<sup>11</sup>

4.2. The bargaining process

Next we turn to the results from the bargaining stage to see how realistic the different expectations about the outcomes of the bargaining process actually are. Since we only observe 7 choices for the large surplus in ExpHigh, and because the outcomes of bargaining over small surpluses are only of interest to us in relation to the outcomes of bargaining over large pies, this section will sometimes ignore the results from the ExpHigh and ConHigh treatments.

*Earnings.* Relevant information about the earnings is summarized in Fig. 3. For each combination of treatment and size of the surplus this figure contains one bar. The size of a bar equals the total surplus (of 10 rounds). Each bar is divided into 5 parts:

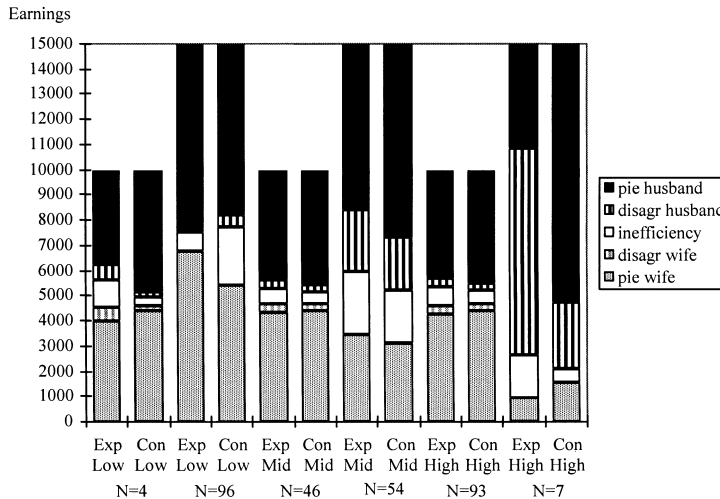


Fig. 3. Mean earnings of husbands and wives and inefficiency costs, by treatment and size of pie

1. Pie husband: a part earned by the husband after the parties reached agreement. The size of this part is determined by the amount the husband receives in the agreement times the number of rounds to which this agreement applies.
2. Pie wife: a similarly defined part for the wife;
3. Disagreement husband: a part earned by the husband before the parties reached agreement. The size of this part is determined by the husband's disagreement payoff times the number of rounds before agreement is reached;
4. Disagreement wife: a similarly defined part for the wife;
5. Inefficiency: the amount that has been wasted because the couple did not reach agreement immediately. The size of this part is determined by the difference between the (round) surplus and the sum of the disagreement payoffs times the number of rounds before agreement is reached.

The division of the bars into five parts is based on the average division of the relevant pies in the different treatments. This figure illustrates the following results.

Firstly, in the Low treatments, mean earnings for wives are higher with a large surplus than with a small surplus, while in the Middle and High treatments the reverse holds. This explains why in so few instances in the ExpHigh treatment wives specialize in home production. It does not explain why specialization in home production occurs so frequently in the ExpMid treatment. Apparently, wives expect their husbands will not use their bargaining power, or not to the full, while they on average do so. The design of the experiment is such that each subject has the wife's role five times. In ExpMid many wives specialize in home production more than once. The question then arises why wives continue to make this choice when they can expect higher earnings from specializing in market activities. We return to this at the end of this section.

A second thing to be observed from Fig. 3 is that, in case of a large surplus, wives earn on average more in ExpLow and ExpMid treatments than in the ConLow and ConMid treatments. The difference between ExpLow and ConLow is significant at the 1 percent-level by a Mann-Whitney test; the difference between ExpMid and ConMid is, however, not significant at conventional levels.<sup>12</sup> Hence, the results suggest that eventual outcomes of the bargaining process are more favorable for wives when they have created the large surplus than if the large surplus has been determined by the experimenter. This indicates that it matters for the course of the bargaining process whether or not the surplus and disagreement points are determined endogenously. This is not in accordance with H3A (endogeneity does not matter) and supports H3B (endogeneity does matter). We explore differences in the different stages of the bargaining process in more detail below.

A third observation to be derived from Fig. 3 relates to inefficiency. Inefficiency can be measured by the share of maximum feasible earnings wasted during the bargaining stage. With the small surplus these shares are all fairly close to each other; inefficiency levels are similar in these cases. The only deviating case is in the ExpLow treatment, but the number of observations is small here. Expressed relative to the maximum feasible sum of earnings, inefficiency levels with the small surplus are between 4% and 7% (except in the ExpLow treatment where it is 11%). With the large surplus, inefficiency

**Table 3.** First proposal in Low-treatments with surplus = 1500, by type of session (In percentages of the total number of first proposals with surplus = 1500, N = 96)

Amount first proposal leaves		Type of session	
Husband	Wife	ExpLow	ConLow
>1000	<500	0	20
=1000	=500	1	5
$875 < p_H < 1000$	$500 < p_W < 625$	7	25
=875	=625	1	3
$750 < p_H < 875$	$625 < p_W < 750$	60	35
=750	=750	29	10
<750	>750	1	1
Mean value		802	934
Median value		800	882

*Note:* ExpLow is the experimental treatment with low disagreement payoffs of 250 to the husband and zero to the wife, the wife's choice determines the surplus. ConLow is the control treatment which only differs from the experimental treatment in that the experimenter and not the wife, determines the surplus.

is lower in ExpLow than in ConLow, whereas it is higher in ExpMid than in ConMid. It is also higher in ExpHigh than in ConHigh, but there are only very few observations for the large surplus in the High treatments. Below we relate these results to the two parts of hypothesis H3B.

*First proposals.* The results of the bargaining stage are determined by players' bargaining behavior. In the previous section we presented three hypotheses concerning husbands' first proposal when the surplus equals 1500. For reasons given earlier, we focus on the results of the Low and Middle treatments when the surplus is large. Tables 3 and 4 give frequencies for different relevant values of first proposals.

In treatments ExpLow and ExpMid the means (and medians) of the first proposals give husbands less, and wives more, than predicted by the split-the-difference divisions of (875, 625) and (1125, 375) respectively. In ConLow and ConMid, on the other hand, the means (and medians) of the first proposals are more favorable for husbands, and less favorable for wives, than these predictions. Apparently, if wives have created the large surplus, there is a tendency for husbands to claim less than is the case if there is no preceding choice stage.<sup>13</sup> This is also reflected in the frequencies of proposals that give husbands less than the backwards induction solution. In ExpMid, in 70% of the cases husbands claim less than 1125, in ConMid this is only 26%. In ExpLow 90% of the first proposals is more favorable for wives than the split-the-difference solution. In ConMid this is true only in 47% of the cases. Mann-Whitney tests reveal that differences are significant at the 1%-level. These results provide strong support in favor of reciprocity (H3Bi) and against hypothesis H3A (endogeneity does not matter).

Further inspection of Tables 3 and 4 shows that in only a few instances actual first proposals are exactly equal one of the divisions predicted by hypotheses H2A, H2B or H2C. In the Low treatments only 2% of the first proposals equal the backwards induction division of (875, 625). In the Middle treatments (1125, 375) is proposed only once. The only case in which

**Table 4.** First proposal in Middle-treatments with surplus = 1500, by type of session (In percentages of the total number of first proposals with surplus = 1500, N = 54)

Amount first proposal leaves		Type of session	
Husband	Wife	ExpMid	ConMid
>1125	<375	30	72
=1125	=375	0	2
$1000 < p_H < 1125$	$375 < p_W < 500$	24	13
=1000	=500	26	2
$750 < p_H < 1000$	$500 < p_W < 750$	19	11
=750	=750	0	0
<750	>750	2	0
Mean value		1071	1197
Median value		1075	1225

*Note:* ExpLow is the experimental treatment with low disagreement payoffs of 250 to the husband and zero to the wife, the wife's choice determines the surplus. ConLow is the control treatment which only differs from the experimental treatment in that the experimenter and not the wife, determines the surplus.

relatively many first proposals seems to coincide with one of the divisions predicted is that of the (750, 750) proposals in ExpLow. Table 3 shows that for ExpLow there is a clear peak in the frequency distribution at this equal-split annex deal-me-out proposal. In ConLow, the percentage of these (750, 750) proposals is substantially lower, i.e. 10% instead of 29%. In the ExpMid treatment many first proposals (26%) concentrate at the (1000, 500)-division. Such a division is not predicted by one of the 3 bargaining possibilities, but is certainly an intuitive division. This proposal leaves the wife 500 points, which is exactly the amount she was predicted to receive had she chosen the small pie. If this predicted outcome for the wife in case of a small surplus, is used as a constraint on the range of feasible first proposals, a proposal of (1000, 500) is optimal for the husband. Such a no-exploitation proposal, if accepted, gives the husband the maximum amount of points he can get without making his wife worse off for specializing in home production rather than in market activities. That it is the wife's predicted payoff from specializing in market activities which serves as a focal point in the ExpMid treatment is hinted at by the fact that in the ConMid treatment (where the wife makes no decision), (1000, 500) is proposed in only 2% of the cases.

We conclude that the frequent occurrence of proposals of a (750, 750)-division in the ExpLow treatment and of a (1000, 500)-division in the ExpMid treatment relative to the occurrence of these proposals in the ConLow and ConMid treatments provides support in favor of focal points (H3Bii) and against hypothesis H3A (endogeneity does not matter). This suggests that husbands in the experimental sessions anticipate that their wives may be less inclined to accept proposals that give them less than 750 or 500.

*Responses to first proposals.* The notion that in the experimental treatments the wife needs to be compensated for specializing in home production is not only relevant for understanding the first proposal of her husband, but also for understanding her subsequent responses. Further analysis of the acceptance rate of first proposals and the type of counter-proposals in the second round of the

bargaining stage reveals the following. In ExpLow 32% of the first proposals are rejected by the wives; in ConLow this happens in 51% of the cases. The mean values of the rejected first proposed divisions is (840, 660) in ExpLow and (1038, 462) in ConLow. Hence wives in ExpLow reject higher earnings for themselves than wives in ConLow. Wives who did not accept their husbands' first proposal, claim in the next bargaining round on average a larger share in ExpLow than in ConLow. And in spite of the fact that this leaves less for the husband, more second proposals are accepted in ExpLow than in ConLow. In contrast to this, 72% of the first proposals in ExpMid are rejected, against 78% in ConMid. The mean values of the rejected proposed divisions by the wife equal (1125, 375) in ExpMid and (1259, 241) in ConMid. Again, wives reject higher own earnings in the experimental treatment than in the control treatment. And also, wives who rejected their husbands' first proposal demand in the next bargaining round a larger share in ExpMid than in ConMid (on average 614 points vs. 486 points). However, in this case husbands do not accept these higher demands more easily; in ExpMid only 3 percent of the second round proposals are accepted as opposed to 25% in ConMid. These differences in acceptance behavior by husbands between ExpLow and ExpMid suggest that the more costly it is to them to delay agreement, the more likely husbands are to accept a fair division. This explains why agreement is reached sooner in ExpLow than in ConLow, but later in ExpMid than in ConMid (see below). A similar conclusion is reached by Zwick and Chen (1997).

We also analyzed the percentages of accepted first proposals and counter-proposals in round 2 that are below or at the two focal points formulated in hypothesis H3Bii. Are wives less inclined to accept proposals that give them less than some relevant focal point in the experimental treatments than in the control treatments? In the ExpLow treatment, we observe a total of 53% of the accepted first proposals and counter-proposals which give wives at least 750 points. In the ConLow treatment, this percentage drops to 39%. When we analyze similar figures for the Middle-treatment groups, we find that in this group the focal point of a (1000, 500)-division enables us to clearly distinguish between the experimental and the control group. In the ExpMid group, 96% of the accepted first proposals and of the counter-proposals give the wife at least 500. In the ConMid group, this percentage drops to 48%. We conclude that these results clearly provide support in favor of focal points (H3Bii) and against hypothesis H3A (endogeneity does not matter).

*Duration of the bargaining process.* While the share of earnings wasted during the bargaining stage can be used to compare efficiency between experimental treatments and control treatments, it is not a sensible measure to compare inefficiency levels across Low, Middle, and High treatments. This is because the joint costs of bargaining are 5 (3) times as expensive in the Low treatment than in the High (Middle) treatment. This brings us to the issue of the speed at which agreement is reached in the different treatments. Table 5 shows the average numbers of rounds required to reach agreement.

With the small surplus, averages in all treatments are not significantly different. In about 50% of the cases agreement is reached in the first round, and in a vast majority of cases agreement is reached before the fourth round. (This cannot be read from the table, but is based on calculations not shown here.) The only exception is for the Low treatments but these relate to 4 observations only. With the surplus equal to 1500, substantial differences are



**Table 5.** Average number of rounds required to reach agreement, by treatment and size of pie

	Surplus = 1000			Surplus = 1500		
	Low (N = 4)	Middle (N = 46)	High (N = 93)	Low (N = 96)	Middle (N = 54)	High (N = 7)
Exp	3.25	2.26	2.44	1.58	4.31	7.57
Con	1.75	1.96	2.06	2.88	3.80	3.14

*Note:* a value of 11 was assigned when no agreement was reached at all; with a surplus of 1000 this happened twice, with a surplus of 1500 this happened 12 times (3 in ExpMid, 4 in ConMid, 2 in ExpHigh and 3 in ConLow).

found across treatments. Agreement is reached fastest in the Low treatments, followed by the Middle treatments. It is slowest in ExpHigh (Kruskal-Wallis test<sup>14</sup> for the experimental groups  $p = 0.00$ ; for the control groups  $p = 0.05$ ). Evidently, the fact that in the Low treatments husbands stand to lose more from disagreement than those in the Middle and High treatments speeds things up considerably. A similar result is reported by Sopher (1990) who interprets rounds of disagreement as strike activity.

Focusing on the large surplus and comparing across rows between ExpLow and ConLow and between ExpMid and ConMid again draws attention to the fact that in the Low treatments agreement is reached sooner in the experimental session (Mann-Whitney U  $p = 0.00$ ), while in the Middle treatments this happens sooner in the control session (but this latter difference is not significant).<sup>15</sup> In terms of Sopher's (1990) analysis, this suggests that if the joint costs of disagreement are large – as in the case of relatively low disagreement payoffs –, 'strike durations' are shorter or the number of rounds necessary to reach agreement smaller when one of the parties has made a relationship-specific investment.

#### 4.3. Wives' specialization choices, part II

An important finding in the experimental treatments is that in ExpLow almost all wives specialize in home production, in ExpHigh almost all wives specialize in market activities and in ExpMid about half of the times wives choose one specialisation and the other in the remaining cases. This last result is not in line with any of the hypotheses formulated in Sect. 3.3. Moreover, on average wives who specialized in home production in ExpMid earn less than wives who specialized in market activities. One interpretation of these results is that wives initially overestimate the extent to which their husbands are prepared not to exploit their bargaining position. The problem with this interpretation is that subjects in the experiment play the wife's role five times. On average each subject chooses 2.7 times to specialize in home production<sup>16</sup>, and the frequency of making this choice remains around 50% even in the last two rounds. The question then arises why subjects stick to this choice even if they experienced in previous games that they earned less than they could have earned had they specialized in market activities.

A first observation that may help to explain this phenomenon is that wives who specialize in home production the first and second time the game is played in the ExpMid session, earn on average 5067 points. This is more than they could reasonably expect to have earned had they specialized in market activities. This explains why 7 of the 12 subjects who specialize in home production the first time they have to make the choice, make the same choice the second time. If they then have low earnings the second time, it is not obvious why they should change their choice the third time. After all, one good and one bad experience makes the odds even. A second observation is that those subjects who specialized in home production after a bad experience with that choice may be a little disappointed with their earnings from specializing in market activities. All three bargaining approaches predict earnings for the wife equal to 5000 when she specializes in market activities. Yet, on average subjects in the ExpMid session who makes this choice earn 4679 points.

Subjects make the specialization choice only 5 times. Given the favorable first experience subjects may have had, and given possible lower than expected earnings from specialization in market activities, five games may simply be too few for subjects to figure out that actual earnings with the large surplus are below actual earnings with the small surplus. One might argue then that with enough games for subjects to gain experience, specialization in home production in the ExpMid treatment may disappear in later games. Such an argument has some merit, but is not especially relevant given the real-life situation we have in mind in which partners have to make their specialization choices only once or twice, and thus have limited scope to gain experience (cf. Loewenstein 1999).

## 5. Summary and conclusion

Partners in a marriage can often earn a potential gain when one of them specializes in market activities (say the husband) and the other in home production (say the wife). The downside of such specialization is that it affects the outside opportunities of the partners differently thereby weakening the relative bargaining position of the wife. When her husband exploits his advantageous bargaining position, the wife may be worse off than would have been the case if no specialization had taken place. Anticipating this, the wife will be less inclined to specialize in home production thereby reducing the total surplus available for the household.

Marriage contracts and marriage settlements can be interpreted as solutions to the resulting underinvestment in home production (cf. Cigno 1991; and Laferrère 2001). But since such arrangements are already put into place it is difficult to assess the seriousness of the underinvestment problem with field data. The experiment in this paper captures the strategic elements of the situation partners would encounter in a world without arrangements to protect the partner who specializes in home production. A bilateral bargaining game is preceded by a stage in which one of the players chooses between two options. The first option results in a surplus of 1000 points and symmetric disagreement payoffs. The second option results in a larger surplus of 1500 points and disagreement payoffs which are less

favorable for the player who chooses between the options. Different treatments vary the differences in disagreement payoffs when the surplus is large, and the endogeneity of the size of the surplus. With this design we addressed two main questions.

The first question is under which conditions wives are prepared to specialize in home production. We find that when the disagreement payoffs remain fairly equal almost all wives specialize in home production, whereas with very unequal disagreement payoffs almost no wife does so. For intermediate inequality of disagreement payoffs about half of the wives specializes in home production. This suggests that somewhere between the extremes of fairly equal to very unequal disagreement payoffs, wives switch from specialization in home production to specialization in market activities. Subgame-perfection predicts this to happen abruptly where the backwards induction payoff from the two options are exactly equal. A key finding of our experiment is that this is not the case. We conclude that holdup does occur – without specific arrangements wives do not specialize enough in home production – but not to the degree subgame-perfection predicts this to happen.

The second question is whether partners care about the past when they bargain about the division of a surplus. We conclude that bargainers do care: endogeneity matters. Husbands are less inclined to fully exploit their bargaining power when their wives specialized in home production. In addition, subjects with a relatively weak bargaining position are less inclined to be exploited if this bargaining position is a result of their own choices. These findings are compatible with the first finding because they help to explain why specialization in home production is chosen more often than economic theory predicts. They are also more than just a confirmation of earlier studies in the experimental bargaining literature which reveal a systematic deviation from the split-the-difference division towards more equal divisions. Our findings add to this the finding that such deviations increase if the surplus and the disagreement payoffs are determined endogenously.

In conclusion, we need to ask to what extent these experimental results have implications for our understanding and modelling of specialization within the household and arrangements to protect the partner who specializes in home production. In this respect it is important to note that, in contrast to the wider world, subjects in the laboratory environment are completely anonymous. Hence, effects of personal affection, interdependent utility functions or reputation are suppressed or much more limited than in real-life situations. Our experimental results show that even under such conditions, we find reciprocity and trust to operate. In real-life situations, with affection, interdependence and reputation doing their work, it is likely that such mechanisms are even more powerful and the underinvestment in relationship-specific assets because of holdup even more reduced. If anything therefore, these results suggest that the theoretical models constructed to model household behavior and to evaluate marriage contracts and marriage settlements should be modified to take these effects into account.

### **Appendix: Translation of the summary of the instructions**

The following summary of the instructions is a translated copy of the summary handed out to participants in session ExpMid. The instructions for

the other two experimental sessions are the same, except for the size of the disagreement payoffs ('ground payments'). The instructions for the control sessions differ slightly because of the absence of a choice stage.

## Summary of the instructions

### *Assignment pairs*

During this session you participate in the same experiment ten times. Each time you are paired with a different participant. Assignment in pairs is already determined before the beginning of this session. The design is such that you meet another participant at most once. You cannot meet someone who has already encountered someone with whom you were paired before.

### *Part 1: The choice between A and B*

Each experiment consists of two parts. In the first part one participant per pair is asked to make a choice between two alternatives, alternative A and alternative B. In 5 out of the 10 experiments, you will be the one making the choice between A and B. If this is the case, in the second part the other participant is the first to propose a division. The remaining 5 times the other participant chooses between A and B and you are the one who is the first to propose a division in the second part.

The choice between A and B determines both the size of the round amounts as well as the size of the ground payments in part 2 in accordance with the following table:

Alternative	Round amount	Ground payment	
		Self	Other
A	1500	0	750
B	1000	250	250

The one that has to make a choice between A and B does so without consulting the other participant. As soon as the choice is made, however, the other participant gets to see this choice. For both of you the resulting round amounts and ground payments are also shown.

### *Part two: The division of the round amount*

In the second part you and the participant with whom you are paired are asked to divide 10 round amounts between the two of you. All 10 of these round amounts are of equal size. The size of the round amounts is determined in the first stage.

You and the other person alternately propose a division – once per round – until someone accepts a proposal. If a proposal for a division is not accepted, the round amount of that round disappears. In that case both of you receive a ground payment. The size of the ground payments is determined in the first stage. The counter-proposal proposed in the next round only concerns the division of the round amounts from that round onwards. As soon as you reach an agreement, the division agreed on also applies to the round amounts of the remaining rounds.

### *Payment and exchange rate*

Your earnings will be paid to you individually and separately from the other participants. The amount to be paid out to you eventually is determined by the number of points you earned during the experiments. When you are paid you receive 1 guilder for every 1200 points.

### **Endnotes**

- <sup>1</sup> From now on we will assume that the spouses are of opposite sexes and that the male spouse specializes in market activities and the female spouse in home production.
- <sup>2</sup> On the theory-data problem in the economics of household behavior, see e.g. Kooreman and Kapteyn (1990), McElroy (1990), Behrman (1997), Bergstrom (1997).
- <sup>3</sup> The three bargaining types are described in detail in Sect. 3.
- <sup>4</sup> The experiments took place in the laboratory of the CREED research center in Amsterdam, the Netherlands.
- <sup>5</sup> We tested whether differences between economics students and students in other disciplines affected our findings, and concluded that this was not the case.
- <sup>6</sup> Common knowledge of rationality, loosely formulated, means that each person is assumed to be instrumentally rational and that each person is assumed to know that each person is instrumentally rational.
- <sup>7</sup> Note that these outcomes are equal to Nash's axiomatic solutions to the bargaining problem (1950, 1953). Rubinstein (1982) shows how in the limit these non-cooperative bargaining solutions are equivalent to Nash's solutions.
- <sup>8</sup> Remember that in each game the players can divide at most ten pies; with a pie size equal to 1000, this gives them a maximum joint payoff equal to 10,000.
- <sup>9</sup> To understand this outcome and the others presented, consider what will happen in round 10 if the negotiations reach that round (also see Table 2). Then, the wife proposes a division of the pie. It is rational to offer the husband 251 points and to keep 1249 points. A rational husband accepts this offer as it is 1 point more than he would receive in case of disagreement. Now, go back to round 9. Then, the husband proposes a division of the pie. This time, it is rational to offer the wife 625 points and to keep 875. A rational wife accepts this offer because 625 points in round 9 and 625 in round 10 is 1 point more than the 1249 she would receive in case of disagreement in round 9 and agreement only in round 10. This leaves the husband with a total of 1750 points for round 9 and 10 combined (2 times 875). Finally, consider what happens if round 8 of the game is reached and wife makes an offer. It is rational to offer him a total of 2001 points (1750 plus 251) for rounds 8 to 10, that is, to offer 667 points and to keep 833. Further backwards induction unfolding back to round 1 of the game results in an offer of 875 points for him and 625 points for her. A rational wife immediately accepts this offer. Thus, an outcome of (875, 625) is the subgame-perfect Nash equilibrium.
- <sup>10</sup> Remember that in each of the 3 experimental treatments (Low, Middle, and High) 20 subjects are asked to make the wife's choice between a small and a large pie 5 times.
- <sup>11</sup> These social losses are calculated multiplying (15,000–10,000 points) by 93 and 46 respectively.

- <sup>12</sup> A Mann-Whitney test is a non-parametric test of the equality of means of two distributions (independent samples). While a parametric test like the  $t$ -test is based on the assumption that the errors subjects make are distributed normally, nonparametric tests make no assumptions about the underlying distributions (or the error generating process). Because it is generally unknown what exactly causes differences in behavior (type errors, personality characteristics of subjects, differences in experiences in earlier rounds, etc) nonparametric statistics are widely used in experimental economics.
- <sup>13</sup> Again results are very stable over the ten games subjects played. For instance, the mean value of the first proposals in the last two games of ExpLow equals 799, in the last two games of ConLow 923, in the last two games of ExpMid 1089 and in the last two rounds of ConMid 1228. These are all quite close to the figures presented in Tables 3 and 4.
- <sup>14</sup> The Kruskal-Wallis test is a non-parametric test of the equality of means of  $n$  independent samples (comparable to the parametric  $F$ -test which assumes normal distributions). See also footnote 13.
- <sup>15</sup> Again, the results are very persistent during the ten games subjects played. For instance, during the last two games and with the large surplus agreement is reached on average in 1.16 rounds in ExpLow, 2.68 rounds in ConLow, 5.11 rounds in ExpMid, and 1.89 rounds in ConMid.
- <sup>16</sup> The exact distribution is as follows. 3 subjects never chose a large surplus, 3 subjects did this once, 4 twice, 2 three times, and 3 four times. 5 subjects chose the large pie on all five occasions.

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