Bargaining with a Residual Claimant: An Experimental Study*

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Abstract

Most negotiations involve risks that are only revealed ex-post. Often these risks are not incurred equally by the parties involved. We experimentally investigate bargaining situations where one player is exposed to ex-post risk, whereas the other is not. We find that residual claimants extract a risk premium, which increases in risk exposure. This premium is sometimes high enough to make it advantageous to bargain over a risky rather than a risk-less pie. Standard theory captures some of our observations but important issues remain. First, comparatively less risk averse residual claimants benefit the most. Second, when given the chance, residual claimants tend to choose a riskier distribution of surpluses only when there is the possibility of an equal-split ex-post. Third, bargaining frictions increase as risk increases. Our results indicate that bargaining models require separation between the determinants of bargaining power and fair compensation for risk exposure.

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1 Introduction

In most bargaining situations the actual surplus at stake is not known when negotiations take place, and agreements need to be reached before this is revealed. Furthermore, one side is often exposed to a risk that is only resolved after an agreement has been reached. In the political arena, prominent examples include negotiations on curbing greenhouse gas emissions and the foundation of the European Financial Stability Facility. In the former exposure to the consequences of climate change is both uncertain and asymmetric across countries worldwide and in the latter the risks of external and internal economic shocks and responsibilities for covering debts are very asymmetrically distributed among countries of the Euro area.

In economics examples abound. In supply chains, two common forms of wholesale price contracts between a supplier and a retailer differ in which of the parties bears the ex-post risk of unsold inventory (Cachon, 2004).[1] In procurement projects, asymmetric exposure to risk arises when two parties transact but only one is liable for any cost overruns, damages, defects or delays. For example, Lam et al. (2007) discusses asymmetric risk exposure in the construction industry and TxDOT (2014, e.g., Items 8.6 & 9.4) highlights the risks faced by highway construction and repair contractors. In labor-firm negotiations, employees generally receive a fixed salary, while the firm faces ex-post risk due to uncertainty over factors such as future demand or costs (Riedl and van Winden, 2012).

Indeed, asymmetric exposure to risk appears to have played a prominent role in two recent high-profile labor negotiations between sports leagues and their players unions: In the National Football League (NFL), with $9.5 billion in annual revenue to be divided, "ownership wants the players to 'buy in' to the fact that running an NFL team requires an enormous allocation of risk not currently shared by the players to an appropriate level [...] at one bargaining session, NFLPA representatives responded to the 'shared risk' argument with an offer to also share in profits [...] that argument stopped the discussion in its tracks", and in the National Hockey League (NHL), "owners bear all of the risk. Players talk about desiring a partnership, but they certainly don't want to share the risk."[2] These quotes illustrate two things. First, asymmetric exposure to risk is a salient feature in real-world, high-stakes, bargaining. Second, it is not clear what effect asymmetric risk exposure has on the different sides at the bargaining table. While the NHL example suggests that exposure to risk is something that both sides would like to minimize, one may infer from the NFL example that it may have been advantageous to the owners.

Using a series of controlled laboratory experiments, we provide empirical support for the latter suggestion that the party exposed to risk can actually benefit from this exposure.

[1] Randall et al. (2006) report that between 23 and 33% of internet retailers exclusively use wholesale price contracts in which the supplier is responsible for unsold inventory. To get a sense of the money at stake in these relationships, e-commerce sales totaled $304.9 billion in 2014 (U.S. Census Bureau, 2015).

[2] The NFL revenue estimate comes from, "If the NFL were a Real Business", by Eric Chemi, *Bloomberg Business*, September 12, 2014. The NFL quote comes from, "Key To The NFL CBA: Mitigating Risk", by Andrew Brandt, *Forbes*, March 7, 2011. The NHL quote comes from, "Allen: How to solve NHL labor dispute" by Kevin Allen, *USA Today*, September 15, 2012.

Furthermore, we find notable cases where residual claimants choose to bargain over a riskier distribution, thereby increasing their risk exposure. At first this seems counterintuitive, as adding a mean-preserving risk to the agreed payoff of an agent could only improve her welfare if she were strictly risk loving. However, the asymmetric exposure to risk can shift the agreement in favour of the exposed agent. Recent theoretical work by White (2008) analyses this indirect beneficial effect and shows that it may dominate the direct adverse effect of adding risk, resulting in higher overall welfare for the exposed agent.

White's (2008) analysis highlights the role of prudence in bargaining, a higher-order risk attitude.[3] She shows that introducing a mean-preserving spread to a prudent agent's payoff has an effect analogous to that found in the precautionary savings literature (Kimball, 1990). The key insight is that for such agents the introduction of ex-post risk increases their expected marginal utility of an additional unit of surplus and thus their willingness to delay reaching an agreement.[4] That is, ex-post risk effectively makes the exposed agent more patient, which can increase her expected receipts by more than her compensating risk premium.

In addition to this theoretical mechanism there are also behavioral factors that may have a significant influence on bargaining when there is asymmetric risk exposure. In particular, it could create competing norms for what constitutes a fair allocation. For example, the fixed-payoff players might well view the 50-50 split of the expected pie as fair, whereas residual claimants may deem it fair that they are compensated for their exposure. Several studies (such as Gächter and Riedl, 2005; Bolton and Karagözoğlu, 2013; Karagözoğlu and Riedl, 2015) have shown that when there are competing norms for fairness, agreements often fall between these norms. Consistent with the theoretical prediction, this would suggest that the residual claimant will receive a risk premium. However, to the extent that fixed-payoff players can pull the agreement closer to their (self-serving) 50-50 fairness norm, this behavioral mechanism works against the theoretical mechanism, as it makes it less likely that the residual claimant will gain a sufficient premium to make risk exposure advantageous.

Given the theoretical and behavioral mechanisms that may be at work in bargaining environments with asymmetric exposure to risk, we seek to address a number of empirical

[3]The effect of higher-order risk attitudes on economic decisions has received renewed attention, including a few prominent experimental studies investigating the prevalence of higher-order risk attitudes, such as prudence and temperance (see, in particular, Deck and Schlesinger, 2010, 2014; Noussair et al., 2014). For our purposes, we note that these studies generally find that a majority of subjects exhibit choices consistent with both risk aversion and prudence, in student populations as well as a large representative sample. A recent paper by Kocher et al. (2015) investigates precautionary bidding in auctions with ex-post risk. They confirm the theoretical prediction that subjects with decreasing absolute risk aversion reduce their bids by more than the risk premium.

[4]Risk attitudes are important in bargaining as they partly determine an agent's willingness to delay making an agreement. Consider alternating-offers bargaining, where the current proposer offers the responder just enough to make them indifferent between accepting now and rejecting to make their optimal counter-offer. Ceteris paribus, the more risk averse the responder, the less they require to accept a proposal, since their marginal utility for the additional surplus in the next stage is reduced. A player's marginal utility is also pivotal in the optimization that characterises the Nash bargaining solution.

questions in actual bargaining situations.[5] First, is the residual claimant able to extract a risk premium for her exposure to risk, as both the theoretical and behavioral mechanisms suggest? Second, if residual claimants do extract a risk premium, is it sufficiently large to make them better off when being exposed to risk? The theoretical analysis suggests that this result should hold, at least under certain conditions which we discuss later, but the aforementioned behavioral factor works in the opposite direction. Finally, if given the choice between distributions, would a residual claimant choose into the one with more ex-post risk? That is, do residual claimants judge for themselves that they are likely to be better off when being exposed to risk?

We address these questions through two experiments. In the baseline study, the distribution of the surplus being bargained over is exogenously determined. Subjects are assigned either the role of the residual claimant or the fixed-payoff player. They negotiate over a payment to the latter, with the residual claimant receiving the difference between the realized pie and the agreed payment. Subjects negotiate in this way ten times experiencing five distributions for the pie, which are ranked according to second-order stochastic dominance.

In answer to our first question, we find that residual claimants are able to extract a risk premium. On average, fixed-payoff players receive less than half of the expected pie and their payment is decreasing in the riskiness of the distribution. Consistent with a large body of bargaining literature (see Murnighan et al., 1987, and the references cited therein), the payment to the fixed-payoff player is decreasing in own risk aversion and increasing in the risk aversion of the residual claimant. Regarding our second question, with an exogenous distribution, we find that specific residual claimants do better in expected utility terms through their exposure to risk. However, in contrast to the theoretical benchmark predictions, it is the comparatively less risk averse residual claimants that benefit the most.

To address our third question about whether residual claimants would choose to bargain over a riskier distribution, we use an endogenous distribution implementation: After having experienced different exogenously imposed distributions, the residual claimant must choose one of two distributions before bargaining begins. In this environment, choosing the riskier distribution might be perceived as an unfair act (see, e.g., Cappelen et al., 2013; Cettolin and Tausch, 2013), and thus alter subsequent bargaining behavior. We, therefore, conducted two treatments. In the first, the choice of the residual claimant is implemented for sure (transparent choice); in the second, the choice is implemented with only probability 0.7 (non-transparent choice). The latter treatment masks intentionality by reducing the responsibility

[5] Several experimental papers have studied bargaining with one-sided private information, where one player knows the size of the pie, while the other does not (see, e.g., Mitzkewitz and Nagel, 1993). However, this environment notably differs from the one we study, as in our case the uncertainty does not result in asymmetric information about the size of pie. Deck and Farmer (2007) study a Nash demand game between two risk neutral parties, with one a residual claimant, an environment that is somewhat close to the one we explore. They consider behavior under different arbitration rules and find that final-offer arbitration favors the residual claimant. However, the presence of arbitration increases conflict, relative to the no arbitration benchmark.

of the residual claimant in distribution choice, which should increase the frequency with which residual claimants choose the riskier distribution (Dana et al., 2007).[6]

Consistent with the results with exogenously specified distributions, we find that the relatively less risk averse residual claimants are more likely to choose into more risk. The results also indicate a general reluctance to choose the riskier distribution, regardless of the level of transparency. A likely reason for this is that bargaining over the riskier distribution is associated with a 5–8 percentage points increase in the frequency of disagreements. Interestingly, however, in the case where one alternative is riskless and the other – risky one – has the possibility of an ex-post equal split, we observe frequent choices for the riskier distribution – some 50% – both in the transparent as well as non-transparent conditions.

In addition, our analysis of the bargaining process suggests that, when the pie is risky, fixed-payoff players – mainly those who are relatively more risk averse – adopt a weaker bargaining position. Specifically, they demand less, they make larger concessions and they are more likely to agree to an offer than their residual claimant counterparts. As a result, these players earn a lower payoff to the advantage of (less risk averse) residual claimants. Finally, we find that asymmetric exposure to risk increases conflict, making disagreements more likely. This result can be attributed to competing notions of what constitutes a fair split.

The rest of the paper is organized as follows: Section 2 covers the design, predictions and results of the exogenous treatment, while Section 3 covers the endogenous treatments. In Section 4, we pool the data from all treatments and discuss important aspects of the bargaining process, with particular emphasis on trying to explain the observed deviations from the benchmark predictions. A final section concludes.

2 Exogenous Distribution

We implemented an unstructured bargaining environment in which pairs of subjects have four minutes to exchange offers and reach an agreement. One agent is the residual claimant (RC); the other the fixed-payment player (FP). At the time of bargaining, the actual pie size is unknown, and agents only know the distribution of possible pie sizes. The object of negotiation is the amount of fixed payment to be paid to the FP player that is received irrespective of the realized pie size. An agreement is reached if one player accepts the current proposal of the other player before the expiration of bargaining time, in which case the FP player receives the agreed upon fixed payment, while the residual claimant receives the realized value of the pie less the fixed payment. If the agents do not reach an agreement before bargaining time expires, then both receive zero.

[6] Indeed, responses from our post-experiment survey from the exogenous sessions support the expectation that fixed-payoff players would be unwilling to compensate residual claimants for exposing the pair to greater risk. Three quotations expressing this view are: (1) "I would not accept less since I know [the residual claimant] took on more risks knowingly." (2) "I would kind of punish him for thanking [*sic*] this extra risk." (3) "If he had chosen over the certain outcome, I would pay a lower risk premium."

The same interaction between prudence and ex-post risk, which we will discuss in the next subsection, is suggested in both the standard structured and unstructured bargaining frameworks. However, we chose the unstructured one because it provides a more natural environment in which players can better express their preferences through the more continuous back-and-forth nature of proposals and counter-proposals. Such an environment also avoids possible issues that might arise due to an exogenous bargaining protocol.[7]

To investigate the effect of differences in ex-post risk on bargaining, five different pie distributions were implemented using a within-subject design. As a benchmark, the first distribution had no risk and subjects bargained over a pie size of €20 for sure. Four mean-preserving spreads were then used, varying the extremes of the possible outcomes (low risk versus high risk) and the number of possible outcomes (binary lottery versus tertiary lottery), where each outcome was equally likely. This within-subject variation was chosen to obtain a direct comparison of how well the same residual claimant does under differing risk conditions. Figure 1 gives the support of the four risky pie-distributions that were implemented.

Figure 1: Summary of the distributions with uncertainty.

	Tertiary	Binary
Low risk	(16,20,24)	(16,24)
High risk	(12,20,28)	(12,28)

Fixing the number of possible outcomes, the distribution including the outcomes 12 and 28 is riskier than the one including 16 and 24. Fixing the extremes of the distribution, the binary distribution is riskier than the tertiary distribution. Finally, it is easy to see that the (16,24) distribution second order stochastically dominates the (12,20,28) distribution. Thus, the tertiary-high-risk condition is riskier than the binary-low-risk condition. From a behavioural perspective, a further difference between the binary and tertiary distributions is that the latter includes the 20 outcome. As a result, with the tertiary distributions, it is possible for both agents to earn ex-post the same payoff, should they agree to a 50-50 split of the expected value of the pie. With the binary distribution, the 50-50 split of the expected value of the pie necessarily leads to an ex-post unequal outcome. This difference may be salient if subjects have concerns for ex post fairness.

2.1 Theoretical Background and Hypotheses

The theoretical background to the problem of asymmetric exposure to risk is provided by White (2008). She provides mild conditions under which the expected receipts of the residual

[7]In the alternative of alternating offers bargaining first-mover advantages and/or the probability of being proposer, as well as the chosen discount factor, may interact with the effect of risk exposure. These are extra complications we wanted to avoid. Moreover, in sequential bargaining often disadvantageous counter-offers are observed, which could compromise the analysis and interpretation of results regarding our research questions.

claimant increase with her exposure to risk, and analyses when this increase is large enough to result in higher welfare. The driving force behind her results is the effect of prudence in bargaining. In both alternating-offers bargaining (Rubinstein, 1982), which she shows has a unique subgame perfect equilibrium in her setting, and cooperative Nash bargaining (Nash, 1950), an agent's willingness to delay agreement is a key determinant of the predicted distribution of the surplus. This holds irrespective of whether the aversion to delay is generated by an explicit time preference or an exogenous risk of breakdown.[8] For risk averse agents the willingness to delay depends not only on the discount rate or the probability of breakdown, but also on the curvature of the utility function.

Exposing a risk-averse agent to a mean-preserving spread results in two premia. The first is the usual compensating risk premium, which is associated with the direct effect of adding ex-post risk. It measures how much the expected receipts of the residual claimant need to increase to return her utility level to that of the risk-free agreement. The second is the compensating precautionary premium. It measures how much the expected receipts of the residual claimant need to increase to return her *marginal* utility to that of the risk-free agreement. It is the latter premium that is pivotal for the distribution of surplus, and provides the mechanism for the indirect effect of ex-post risk that we seek to investigate. Whenever the precautionary premium is larger than the risk premium, the residual claimant may benefit in welfare terms from her exposure to risk. With additive risk, a classic result from the literature on precautionary savings (Kimball, 1990) shows that this condition is equivalent to decreasing absolute risk aversion. The reason is that, even after the agreement has been adjusted to compensate her utility for the risk exposure, a prudent residual claimant is still behaving more "patiently" – her expected marginal utility of an additional unit of surplus is still higher than at the agreement without risk – and, thus, she may yet extract further surplus in the bargaining solution. Whether she ultimately benefits will also depend on the risk preferences of the fixed-payoff player since his marginal utility often increases as the agreement moves in favor of the residual claimant.

Since we implement unstructured bargaining in our experiments, we specialise to the Nash bargaining solution to provide a detailed theoretical benchmark. In what follows, we give the specific predictions for the implemented environment; the more general results can be found in White (2006). The Nash bargaining solution is found by maximising the product of the expected utilities of the FP and RC players. In our setting, given the amount to divide is a random variable, π, with support $[\pi_{min}, \pi_{max}]$, the solution is a payment to the FP player, y, that maximises the Nash product: $u_{FP}(y) \cdot \mathbb{E}_{\pi}[u_{RC}(\pi - y)]$. For a fixed distribution of π, since disagreement represents the worst outcome, the solution will have the usual comparative statics with respect to the utility functions of the FP and RC players: for either player, greater concavity in their utility function will result in a lower share of the bargaining surplus (see, for example, Roth and Rothblum, 1982).

[8] See Binmore et al. (1986) for the connection between the *static and cooperative* concept of the Nash bargaining solution and the *dynamic and non-cooperative* equilibrium of alternating-offers bargaining.

Fixing the preferences of the players, Proposition 6 of White (2006) shows that a residual claimant's share of the pie will increase (equivalently, the FP player's share will decrease) with the addition of a small additive risk, compared to the no risk case, as long as:

$$-\frac{u'''}{u''} > -\frac{u'}{u}. \tag{1}$$

However, a decreasing payment to the FP player does not always imply increasing welfare for the RC player. A necessary and sufficient condition for her welfare to improve with a small additive risk, compared to the no risk case, is (White, 2006, Proposition 7):

$$u''_{RC}(\overline{\pi}-y)/u'_{RC}(\overline{\pi}-y) - u'''_{RC}(\overline{\pi}-y)/u''_{RC}(\overline{\pi}-y) \geq u'_{FP}(y)/u_{FP}(y) - u''_{FP}(y)/u'_{FP}(y). \tag{2}$$

It is easy to see that (1) always holds under both constant relative risk aversion (CRRA; $u_i(x) = \frac{x^{1-\rho_i}}{1-\rho_i}$) and constant absolute risk aversion (CARA; $u_i(x) = 1 - e^{-\alpha_i x}$). This result, formalized as Hypothesis 1 below, says that FP player's payment should decrease when the probability distribution of the pie gets riskier.

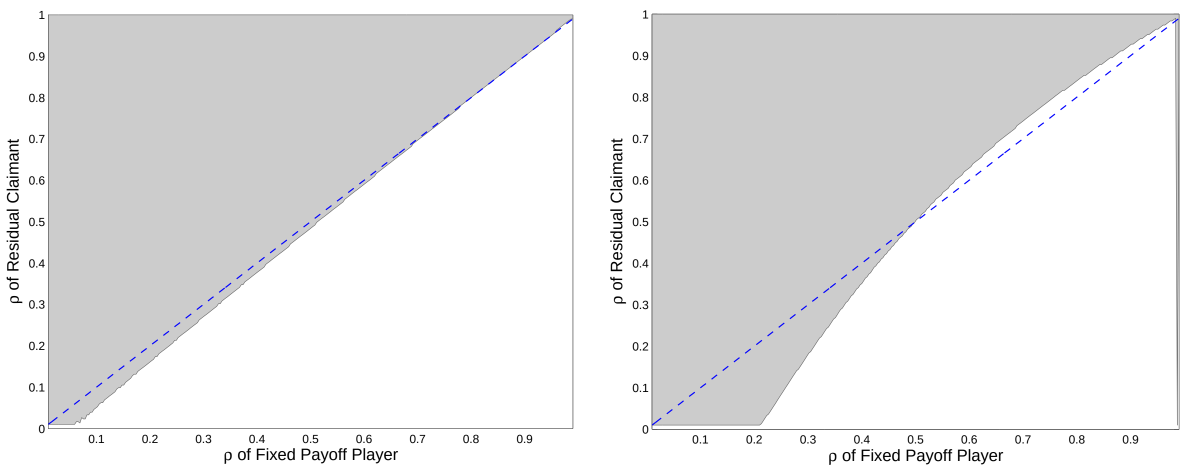
Regarding (2), simple computations show that it can never be satisfied under CARA risk preference. However, under CRRA risk preferences, (2) reduces to $y \geq \frac{\overline{\pi}}{2}$. That is, the residual claimant will do better in expected utility terms if she would, in the risk-free setting, receive less than half of the pie. Since this happens whenever $\rho_{RC} > \rho_{FP}$, her welfare should increase with the addition of a small additive risk whenever she is *more risk averse* than the FP player. In what follows, we will base our hypothesis on welfare assuming CRRA risk preferences.[9]

In our experiment, the risks that the RC is exposed to are not small, meaning this condition will not be exact. Indeed, our numerical calculations show that $\rho_{RC} > \rho_{FP}$ is neither necessary nor sufficient for the RC's welfare to improve when exposed to the risks in our experiment. In particular, as long as both players are not too risk averse, then for some distributions, the RC may do better even if she is slightly less risk averse than the FP player. On the other hand, as risk aversion increases, an RC who is slightly more risk averse than the FP player may not have a welfare improvement relative to the risk-free distribution. Despite these caveats, $\rho_{RC} > \rho_{FP}$ is a useful approximation for the RC to do better in expected utility terms from being exposed to risk. This can be seen from Figure 2, which plots the region (shaded in grey) over which RCs are predicted to do better in expected utility terms for two distributions used in the experiment: $(16, 20, 24)$, which is the least risky of the uncertain distributions, and $(12, 28)$, which is the the most risky. The broken 45 degree line indicates the locus for which the RC and FP players have identical risk preferences ($\rho_{RC} = \rho_{FP}$).

From the above analysis, we have the following predictions that we will test in our subsequent data analysis.

[9]Holt and Laury (2002) find evidence for increasing relative risk aversion but decreasing absolute risk aversion. However, both Harrison and Rutström (2008) and Wilcox (2008) highlight that the finding of increasing relative risk aversion is highly dependent on the estimation procedure. They argue that constant relative risk aversion cannot be rejected.

Figure 2: Region Over Which Exposure to Risk is Advantageous (Shaded in Gray)



Note: These figures are drawn under the assumption that players have, commonly known, CRRA utility functions.

Hypothesis 1 *As the riskiness of the bargaining distributions increases, the amount allocated to the fixed-payoff player declines.*

Hypothesis 2 *The amount allocated to the fixed-payoff player is decreasing in ρ_{FP} and increasing in ρ_{RC}, regardless of the riskiness of the distribution, provided that $\rho_{RC} > 0$.*

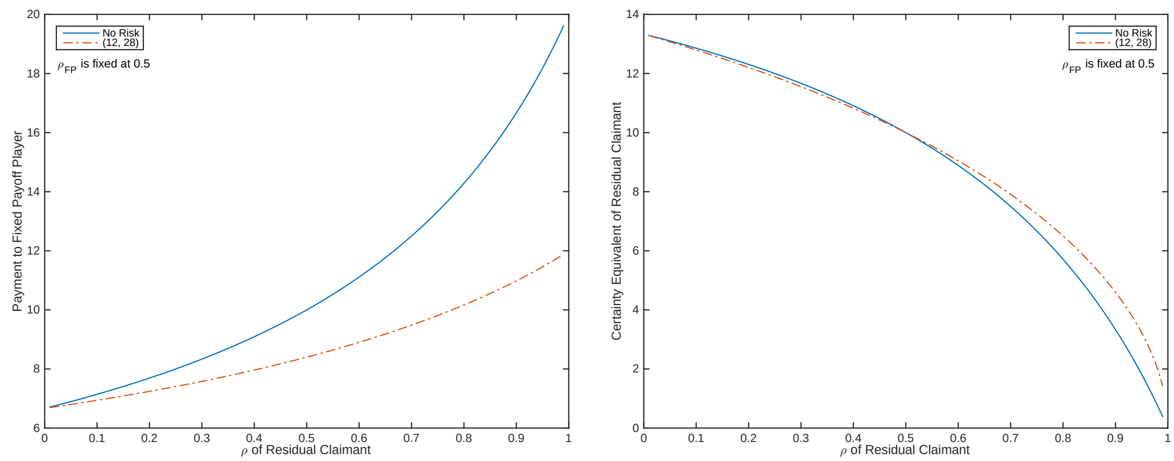
Hypothesis 3 *To a first approximation, whenever $\rho_{RC} > \rho_{FP}$, the residual claimant's welfare will be higher when faced with a risky probability distribution than a riskless distribution.*

Hypotheses 2 and 3 concern two distinct comparative statics that could be confused. Hypothesis 2 fixes the probability distribution over which players bargain and varies risk preferences, while Hypothesis 3 fixes the risk preferences of the players and varies the probability distribution. Figure 3(a) shows how the payment to the FP player, with risk parameter fixed at $\rho_{FP} = \frac{1}{2}$, varies as the risk parameter of the RC player varies. Consistent with Hypothesis 2, as the RC player's risk aversion increases, the payment to the FP player increases; however, the absolute compensation for risk is greater when the pie is risky (i.e., the curve is much flatter).

Figure 3(b) plots the certainty equivalent of the RC player as a function of her risk parameter. Again, consistent with Hypothesis 2, the certainty equivalent is decreasing as risk aversion increases. To see Hypothesis 3, one should compare the solid and dashed lines that correspond to the (20) and $(12, 28)$ distributions, respectively. As can be seen, approximately when $\rho_{RC} > \frac{1}{2} = \rho_{FP}$, the welfare of the RC player becomes larger when bargaining over the risky distribution. Importantly, however, this does not mean that, in a world in which risk preferences are private information, the residual claimant would try to pretend to be *more*

Figure 3: Example of Payment to FP Player and Certainty Equivalent for RC Player

(a) Payment to FP Player (b) Certainty Equivalent for RC Player



Note: These figures are drawn under the assumption that players have, commonly known, CRRA utility functions.

risk averse. As Figure 3 clearly demonstrates, *for a fixed probability distribution*, increased risk aversion is disadvantageous.

Hypothesis 4 (a) *Across all probability distributions, the frequency of agreements is 100%.*

Hypothesis 4(a) is a direct consequence of the Pareto optimality axiom built into the Nash bargaining solution. That agents would always take advantage of any Pareto improvements is a natural assumption for the purposes of a cooperative solution concept such as the Nash bargaining solution. However, it is not one that we would necessarily expect to hold in our experiments. In particular, recent literature suggests that under risk there may be a conflict between ex-ante and ex-post fair outcomes (Fudenberg and Levine, 2012; Brock et al., 2013), which may generate disagreements even if agents would otherwise agree in situations without risk. Furthermore, Birkeland and Tungodden (2014) is a recent paper which explicitly incorporates fairness ideals in a bargaining model. They show that disagreement may arise when players have divergent fairness ideals. Such divergence is likely in our case because each player type has a natural self-serving fairness norm. In light of this discussion (see also, Babcock et al. (1995)), we state the following alternative hypothesis regarding the frequency of agreements:

Hypothesis 4 (b) *Disagreements are more likely to occur for risky probability distributions.*

2.2 Experimental Procedures

For the exogenous pie distribution experiments, 48 subjects (25 female, 23 male) participated in two sessions with 24 subjects each. Each session was split into two matching groups of 12, to give 4 matching groups in total. The experiments took place at the BEElab of Maastricht University, and all participants were students at Maastricht University recruited using ORSEE (Greiner, 2015). Sessions took less than 1 hour and 30 minutes, and on average subjects earned between €20 and €23.

Each session consisted of two parts. At the beginning of the first part, subjects were randomly assigned either the role of the RC or the FP player, and kept the same role throughout the experiment. At the beginning of a bargaining round, subjects were randomly matched into pairs (one RC and one FP) and received information about the probability distribution of possible pie sizes over which they would bargain. During the round, subjects had four minutes to reach an agreement, which was framed as a payment to the FP player.[10] Subjects were free to make as many offers as they wished during this time, and subsequent offers were not required to improve upon one's previous offer. An agreement was reached when one of the two accepted the current offer of the other player. No communication beyond sending and accepting offers was permitted.

Subjects were randomly assigned into one of two matching groups, which were run in parallel on separate z-Tree servers (Fischbacher, 2007), and randomly rematched between bargaining rounds within their matching group.[11] During a session, the order of probability distributions was the same for all subjects in a matching group. Across matching groups the order of presentation was varied, except that in rounds 1 and 10 subjects always bargained over the risk-free pie of €20. Within a matching group, the order of presentation of the four uncertain pies was the same in bargaining rounds 2 to 5 and bargaining rounds 6 to 9. Thus, by bargaining round 6, every subject in every session had experienced each pie probability distribution exactly once. Four order combinations were used by systematically varying whether the binary lotteries or the tertiary lotteries were shown first, and whether the low risk or high risk came first.[12] After the 10 bargaining rounds were completed, one round was randomly selected to determine their payoff from this part of the experiment.

During the second part of the experiment, subjects were given a risk elicitation task. Specifically, the certainty equivalent for six different binary lotteries was elicited using an implementation similar to Cettolin and Tausch (2013) (see also Bruhin et al., 2010).[13] This

[10]See Section B.1 of the Supplementary Materials for sample instructions. Proposals were restricted to ensure that the residual claimant would never go bankrupt. That is, the most that the fixed-payoff player could claim or be offered was the lowest possible realisation of the pie (i.e., 12, 16 or 20 depending on the probability distribution). In all cases, this was greater than half of the expected pie size of 20.

[11]The re-matching scheme means that all observations within a matching group are potentially correlated. Consequently, statistical significance in the subsequent results sections is established using a regression-based approach that uses cluster-robust standard errors, allowing for arbitrary correlation between observations within a matching group. That is, the statistical approach does *not* assume that observations within a matching group are independent; only that those across matching groups are independent. Where possible, non-parametric tests on matching-group averages were run as a robustness check, without any notable affect on the conclusions, and are available upon request. For a recent exposition on "session-effects" in experimental data analysis, see Fréchette (2012).

[12]That is, the four orders were: (16,24), (12,28), (16,20,24) and (12,20,28); (12,28), (16,24), (12,20,28) and (16,20,24); (16,20,24), (12,20,28), (16,24) and (12,28); (12,20,28), (16,20,24), (12,28) and (16,24).

[13]The six lotteries were: $(15, 1/2; 0, 1/2)$, $(14, 1/2; 6, 1/2)$, $(20, 2/5; 0, 3/5)$, $(18, 1/2; 2, 1/2)$, $(10, 3/4; 0, 1/4)$

risk elicitation stage was included in all sessions of both our exogenous and endogenous distribution experiments. For each subject, the elicited certainty equivalents were used to estimate the ρ parameter assuming a CRRA functional form. The vast majority of residual claimants are estimated to be risk averse (see Figure A.1 of Appendix A).

An estimate of subjects' risk preferences is important for a number of reasons. First, the conditions provided in White (2006) for the Nash bargaining solution, as well as the standard results on outcomes without ex-post risk, are based on the risk attitudes of the bargaining parties. With these estimates, the predictions can be tested at the match level and, thus, more precisely. Furthermore, a measure of risk preferences is required to address any hypothesis concerning the welfare of residual claimants.

At the end of the experiment, subjects answered a series of survey questions, including for each of the five pie probability distributions, their judgement of a fair allocation to the FP player. Specifically, they were asked, "what would be, in your opinion, a 'fair' amount to give to the [fixed-payment player] from the vantage point of a **non-involved neutral arbitrator**" (Babcock et al., 1995; Gächter and Riedl, 2005).[14]

2.3 Results

We begin our analysis by presenting some basic summary statistics of the experimental results, and how these differ (significantly) across the different pie distributions, before turning to the explicit hypotheses. Table 1 presents a summary of the bargaining outcomes (a complete set of pairwise comparison tests for the bargaining outcomes can be found in Table A.1 of Appendix A). As can be seen, the FP players earn on average less than half of the expected pie for each probability distribution (ordered from risk-free to riskiest in the table). This average, however, includes the disagreement payment of zero when the players fail to reach an agreement. Focusing on agreements, which is the primary concern of the benchmark theory, the average agreed FP payment is decreasing in the riskiness of the probability distribution, consistent with Hypothesis 1.[15]

Overall, we see that disagreements are not infrequent – ranging from 4.2% to 18.8%. These rates are comparable to earlier studies. For example, Roth et al. (1988) and Gächter and Riedl (2005) who report disagreement rates of approximately 23% and 16% respectively. More importantly, we see that the presence of risk also increases bargaining frictions. There

and $(12, 2/3; 0, 1/3)$. Lotteries $(14, 1/2; 6, 1/2)$ and $(18, 1/2; 2, 1/2)$ were chosen to provide some gambles similar to those the RC faced in the bargaining task; these are simply the (16,24) and (12,28) pie distributions minus an FP payment of 10. The other four lotteries were chosen to aid the estimation of CRRA coefficients. Instructions were given via the computer interface after the bargaining task had been completed. One decision was chosen at random and paid. In addition to the payoff from bargaining and the risk elicitation, subjects also received a €2 show-up fee.

[14] We chose to elicit fairness judgements after the experiment because we did not want to risk anchoring subjects on these judgements, and have those anchors be the drivers of our results. The downside of this is that fairness judgements may be ex post rationalizations of behavior. However, we believe that this is unlikely because, as we show later, elicited fairness judgements are correlated with opening offers and appear to influence the concession process.

[15] See the top two panels of Table A.1 in Appendix A for the result of a complete pairwise comparison.

are more disagreements with risk than without risk, statistically rejecting Hypothesis 4(A) in the case of the riskiest probability distribution, $(12, 28)$ and failing to reject Hypothesis 4(B). Moreover, with risk if an agreement is reached, more time is required to reach it.[16] Along with the greater bargaining friction, fairness assessments diverge as the riskiness of the probability distribution increases. FP players generally view the 50-50 division as fair, while many residual claimants report a fair allocation that compensates them for their risk.[17] Moreover, for all probability distributions with risk, average agreed payments are between the (self-serving) fairness perceptions of the RC and the FP players.

Table 1: Bargaining Outcomes and Fairness Perceptions in the Exogenous Environment

Distribution of Pie	Final FP Earnings (€)	Agreed FP Payments (€)	Disagreements (%)	Remaining Time (sec)	Fair Payment to FP	
					FP (€)	RC (€)
(20)	9.71 (2.29)	10.13 (1.05)	4.2 (20)	153 (93)	9.96 (0.20)	9.92 (0.40)
(16,20,24)	9.04 (3.07)	9.64 (2.03)	6.2 (24)	70 (88)	10.33 (1.42)	9.44 (0.87)
(16,24)	8.17 (3.65)	9.56 (1.40)	14.6 (36)	39 (63)	10.29 (1.74)	9.44 (0.87)
(12,20,28)	8.10 (3.15)	9.04 (1.54)	10.4 (31)	38 (66)	9.88 (1.21)	8.42 (1.54)
(12,28)	7.14 (3.73)	8.79 (1.52)	18.8 (39)	54 (85)	9.58 (1.40)	8.06 (1.44)

Notes: Standard deviations are reported in parentheses. The columns "Fair payment to FP" report the judgements of a fair allocation to the FP player. The first of these is the average allocation reported by those assigned the FP role; the second, the average reported by those assigned the RC role.

Table 2 investigates Hypotheses 1 and 2 directly. Since the predictions of the benchmark theory primarily concern the nature of agreements, the dependent variable in these random-effects regressions is the agreed payment to the FP player. The indicator variables $\mathbf{1}[(\cdot)]$ take value 1 for the indicated probability distribution and 0 otherwise. The first specification confirms that risk reduces the agreed payment for FP players, and significantly so for all but the least risky distribution. The second specification uses the variance of the distributions, normalized so that the variance of the riskiest distribution is one, as a single measure and shows that this also captures the effect of this treatment variation.

With this simplified specification for the treatment variation, the last two columns include estimates of the risk attitude of the FP (ρ_{FP}) and RC (ρ_{RC}) players as explanatory variables. These specifications test Hypothesis 2. Consistent with this hypothesis, the coefficient on ρ_{FP} is significantly negative, while the coefficient on ρ_{RC} is significantly positive. That is, fixing the probability distribution, being more risk averse worsens a subject's bargaining position irrespective of their role. Notably, the marginal effect of risk aversion appears smaller in magnitude for the RC player than the FP player. As specification 4 illustrates, this results

[16] See the the bottom two panels of Table A.1 in Appendix A for the result of a complete pairwise comparison that establish the significance of the comparisons for disagreement and time remaining.

[17] Overall, the fairness assessments of the RC players are significantly below those of the FP players when there is risk. This result is primarily driven by the two high-risk distributions. The null hypothesis that the assessments are the same is tested using a regression-based approach with standard errors clustered at the matching-group level. Starting with the deterministic pie and going in order of increasing riskiness, the p-values are 0.721, 0.081, 0.206, 0.004 and 0.003, respectively. It is also not possible to reject the null hypothesis that the fairness assessments of FP players is equal to the 50-50 split for all probability distributions. For the RC players, this can be rejected for all probability distributions with risk.

from the interaction between ρ_{RC} and risk. For fixed FP and RC preferences, increasing the risk of the pie improves the bargaining position of the latter, but the overall effect is still negative. For a fixed probability distribution, the ρ coefficients for the FP and RC players have the opposite effect on agreed FP payments, with a comparable magnitude in the risk-free case. That is, the elicited risk preferences affect the agreed FP payment in the direction predicted by theory; recall Figure 3 for an illustration of this.[18]

Table 2: Linear Random-Effects Regression of Agreed Payments to the FP Player

	Agreed FP Payments			
	(1)	(2)	(3)	(4)
$\mathbf{1}[(16,20,24)]$	-0.41 (0.439)			
$\mathbf{1}[(16,24)]$	-0.48^{**} (0.202)			
$\mathbf{1}[(12,20,28)]$	-1.11^{**} (0.467)			
$\mathbf{1}[(12,28)]$	-1.32^{***} (0.324)			
Variance		-1.31^{***} (0.263)	-1.32^{***} (0.275)	-0.68^{**} (0.340)
ρ_{FP}			-1.99^{***} (0.651)	-1.95^{***} (0.667)
ρ_{RC}			1.05^{***} (0.388)	1.64^{***} (0.456)
ρ_{RC} × Var.				-1.48^{***} (0.443)
Constant	10.12^{***} (0.098)	10.00^{***} (0.101)	10.07^{***} (0.195)	9.81^{***} (0.191)
R^2	0.09	0.08	0.17	0.17
Observations	195	195	195	195

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

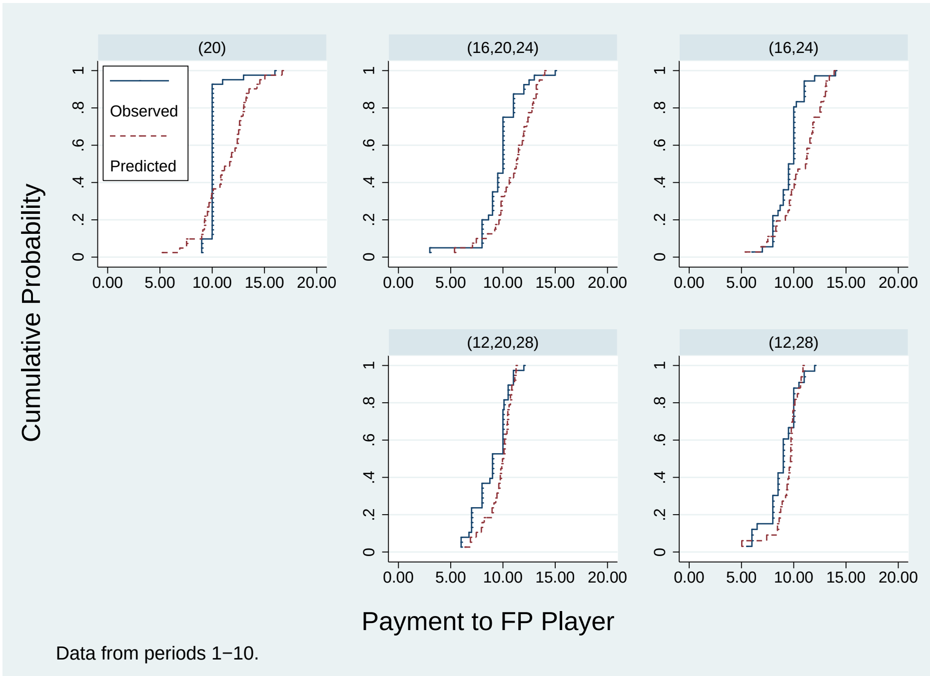
While the regressions reported in Table 2 show that agreed payments vary with risk preferences in the predicted manner, a stronger test of the theory would be to examine the relationship between the agreed payment predicted by the Nash bargaining solution, given the elicited risk preferences of the bargaining pair. Figure 4 plots the observed cumulative distribution of agreed and predicted payments. This figure provides a number of insights. First, when there is no risk, nearly all agreements are a 50-50 division of the pie. That is, differences in preferences lose salience and the norm to divide the pie equally dominates. Second, for the risky distributions, there is a close correspondence between the observed and predicted division of payoffs, in particular for the high risk distributions. Finally, agreed FP payments are less on average than would be predicted by the theory; indeed, for all probability distributions, the difference is significant ($p < 0.01$).[19]

We turn next to Hypothesis 3, which predicts that exposure to risk is advantageous for the RC player (in expected utility terms) approximately when she is more risk averse than the FP player. To measure the RC player's welfare, the estimated risk attitude is used to calculate the certainty equivalent of an agreement. The certainty equivalent gives a measure that is comparable across subjects since it measures welfare on a common scale, allowing

[18]Our result is consistent with some early papers (e.g. Murnighan et al., 1988; Harrison, 1986) that studied the effects of risk aversion on bargaining outcomes.

[19]Regression-based test of the difference between actual and predicted agreed FP payment on a constant, using standard errors clustered at the matching group level. The reported p-value is the significance of the (negative) constant term.

Figure 4: Observed Versus Predicted Agreed Payments to the FP Player



observations to be pooled across subjects for the regression analysis. Since subjects are randomly re-matched between bargaining rounds, comparing the agreed payments in rounds with risk to those without risk misses the exact counter-factual of the hypothesis as a given RC player is likely to be bargaining with different FP players in each round.

The regressions reported in Table 3 address this missing counter-factual by including an indicator variable for whether the RC player is more risk averse than the FP player ($\mathbf{1}[\rho_{RC} > \rho_{FP}]$), as well as an indicator variable for a risky distribution ($\mathbf{1}[\text{Var.} > 0]$) and an interaction term. If Hypothesis 3 is correct then the sum of the coefficients of $\mathbf{1}[\text{Var.} > 0]$ and the interaction should be positive. The results of this regression can be seen in the first column.[20] While the coefficient on risk is significantly positive, the coefficient on the interaction term is negative and larger in magnitude than the coefficient on risk. Therefore, contrary to the theoretical prediction, it is actually the *less risk averse* residual claimants who

[20]It should be noted that the elicited risk parameter, ρ_{RC}, appears on both sides of the regression equation: it is used to calculate the certainty equivalent for the dependent variable and it is used to determine the value of the independent variables $\mathbf{1}[\rho_{RC} > \rho_{FP}]$ and $\mathbf{1}[\text{Var.} > 0] \times \mathbf{1}[\rho_{RC} > \rho_{FP}]$. Error in the measurement of ρ_{RC} would result in correlation between the independent variables and the error term, resulting in biased coefficient estimates. Under the hypothesis of the benchmark theory, this bias can be signed. To see this, suppose that, due to measurement error, the ρ estimate for an RC is over estimated. The over estimate would result in both *under* estimating the certainty equivalent of an agreement made under risk and *over* estimating whether the RC should benefit from bargaining under risk – since $\mathbf{1}[\rho_{RC} > \rho_{FP}]$ is more likely to be one. Thus, the estimated coefficients would be an *under*-estimate of the impact of variables $\mathbf{1}[\rho_{RC} > \rho_{FP}]$ and $\mathbf{1}[\text{Var.} > 0] \times \mathbf{1}[\rho_{RC} > \rho_{FP}]$.

gain in welfare terms when bargaining over a risky distribution. To illustrate this further, the second and third columns of Table 3 estimate the aggregate effect of bargaining over risk, versus no risk, for two subsamples of RC players. The second column, where $\rho_{RC} \leq 0.5$, represents the sample of less risk averse RC players; the third column, where $\rho_{RC} > 0.5$, is the sample of more risk averse RC players.[21] As can be seen, bargaining over risk significantly increases the estimated welfare of the less risk averse group, but does not have a significant impact on the more risk averse group.

Table 3: Linear Random-Effects Regression of the Certainty Equivalent of Agreements for RC Players

	Certainty Equivalent of Agreement for RC Player		
	(1)	(2)	(3)
$\mathbf{1}[\text{Var.} > 0]$	0.74*** (0.283)	0.63*** (0.222)	−0.60 (0.556)
$\mathbf{1}[\rho_{RC} > \rho_{FP}]$	−0.05 (0.481)		
$\mathbf{1}[\text{Var.} > 0] \times \mathbf{1}[\rho_{RC} > \rho_{FP}]$	−0.87*** (0.177)		
Constant	9.92*** (0.268)	10.08*** (0.102)	9.61*** (0.409)
R^2	0.06	0.02	0.03
Observations	195	111	84
RC sub-sample	—	$\rho_{RC} \leq 0.5$	$\rho_{RC} > 0.5$

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

To summarize the results thus far, there is strong support for Hypotheses 1 and 2: agreed payments to FP players are decreasing in riskiness and, for a given probability distribution, the payment is increasing in the risk aversion of the RC player and decreasing in the FP's own risk aversion. We do not find support for Hypothesis 3, that predicts it should be the more risk averse RCs who benefit from exposure to risk. While we identify RCs that seem to gain from the exposure to risk, it is rather the relatively less risk averse that benefit. Finally, Hypothesis 4 is rejected: as the risk increases, the frequency of disagreements increases and significantly so for the riskiest distribution.

3 Endogenously Chosen Distribution

The welfare result of White (2006) predicts that some RC players achieve a higher welfare when bargaining over more risky distributions. An immediate corollary to this result is that such an RC player should, if given the choice, choose to bargain over a riskier distribution. This observation suggests an alternative way of testing the welfare predictions by asking the RC player to choose between probability distributions. This approach avoids the need to calculate the certainty equivalent of observed agreements, since the observed choice reveals the RC player's preferred environment. Furthermore, giving the RC player a choice between

[21] The exact cut-off is not important. Note that in the sample of RC players with $|\rho| < 1$, none have an estimated ρ below zero; the average ρ estimate is 0.44, and for every match with an RC player with a $\rho > 0.5$, the RC player had a higher ρ than the FP player they were matched with.

probability distributions avoids the missing counterfactual from comparing behaviour across bargaining rounds.

While the welfare results from the exogenous-distribution experiment identified RCs that benefit from risk, they were contrary to our hypothesis in that the wrong group seemed to benefit — namely, the relatively less rather than more risk averse. To test the robustness of this result and to further understand the relation between RC players' welfare and risk exposure, we conducted a set of endogenous-distribution treatments. Specifically, we ask under what conditions would the RC player choose the riskier distribution? The benchmark theory suggests that it should be the relatively more risk averse RC players, while our previous empirical results suggest it should be the relatively less risk averse.

There are, however, two notable factors that might make an RC player reluctant to choose a riskier probability distribution, even though she might otherwise expect a higher welfare. First, the previous welfare result was for agreed payments, yet disagreements were also more likely with riskier distributions. Factoring in the increased likelihood of disagreement, it is less clear that, even for the less risk averse RC players, it is better to bargain over a riskier distribution. It was also the case that the probability of disagreement depends on whether the probability distribution is binary or tertiary (see, for example, Table 1). Consequently, the endogenous-distribution design systematically varies within-subjects the alternative probability distributions available to the RC player. It exposes the RC players to a wide variety of comparisons: certainty versus a binary distribution, certainty versus a tertiary distribution, binary versus tertiary and high versus low risk, for both the binary and tertiary distributions.

Second, a large literature in behavioral economics emphasizes the role of bargaining norms, often based around fairness considerations and the role of intentions; that is, how "kindly" other players' actions are perceived to be. As a result, FP players may refuse to compensate the RC for the risk they are exposed to if they knew that the risky distribution was deliberately chosen. If so, the RC player may be concerned that the other player may not perceive her position as credible, resulting in her choosing the safer probability distribution. If this behavioral reasoning turns out to be important, then the literature on accountability and fairness suggests a role for how accountable the RC player is for the choice of probability distribution (Konow, 1996; Cettolin and Tausch, 2013). If there is some randomness about which pie the players bargain over, then the FP player cannot conclude with certainty that the riskier distribution was actually chosen by the RC, making him (perhaps) more willing to compensate her for the extra risk. If this is the case, this lack of transparency could restore the RC player's willingness to choose the riskier probability distribution.

These considerations led to a 2×2 design, summarised in Figure 5. The first dimension varies the riskiness of the distributions that the RC player must choose between. As there are many possible binary combinations between the five distributions, two sets were used, called 'low risk' and 'high risk'. In each set the RC player had the choice between distributions with the same general structure: certainty versus binary, certainty versus tertiary, binary versus tertiary, low risk binary versus high risk binary and low risk tertiary versus high risk tertiary.

In the low risk set, the low risk distributions are used in the first three choices; in the high risk set, the high risk distributions are used.

Figure 5: Summary of the Treatment Variations for the Endogenous Environment

	Transparent	Non-transparent
Low risk	(20) vs (16,24) (20) vs (16,20,24) (16,24) vs (16,20,24) (16,24) vs (12,28) (16,20,24) vs (12,20,28) Probability choice implemented =1	(20) vs (16,24) (20) vs (16,20,24) (16,24) vs (16,20,24) (16,24) vs (12,28) (16,20,24) vs (12,20,28) Probability choice implemented =0.7
High risk	(20) vs (12,28) (20) vs (12,20,28) (12,28) vs (12,20,28) (16,24) vs (12,28) (16,20,24) vs (12,20,28) Probability choice implemented =1	(20) vs (12,28) (20) vs (12,20,28) (12,28) vs (12,20,28) (16,24) vs (12,28) (16,20,24) vs (12,20,28) Probability choice implemented =0.7

The second dimension varies the transparency of RC's choice of the distribution. In the *transparent choice* setting, the RC's chosen distribution is always implemented, and the FP player is aware of this fact, as well as the choice faced by the RC. In the *non-transparent choice* setting, the RC's chosen distribution is implemented 70% of the time and the non-chosen distribution 30% of the time. The FP player knows the choice problem faced by the residual claimant, but not the actual choice made by the residual claimant. The contrast between the transparent and non-transparent treatments can be used to establish whether being accountable for the choice of bargaining distribution is a salient consideration for RC players (cf. Konow, 2000).

Despite our prior belief that the transparency of the choice of distribution would affect the RC players' choice to bargain over the riskier distribution, our initial analysis found no difference in behavior between the transparent and non-transparent choice treatments.[22] For example, residual claimants are equally likely to choose the risky distribution; nor do agreements or disagreements appear to be affected by this treatment variation. For this reason our subsequent data analysis will pool data from the transparent and non-transparent sessions.

3.1 Theoretical Predictions and Hypotheses

Following the analysis from Section 2.1, the benchmark theory (White, 2006) predicts, to a first order approximation, that the RC player would choose the riskier distribution whenever they are more risk averse than the FP player. However, the random matching scheme and timing of the probability distribution choice means that the RC player does not know the risk attitude of the FP player when making the choice. Nonetheless, for a given pool of FP players, the more risk averse the RC player is the more likely she is to be more risk averse than

[22]See Appendix C for details of the transparent versus non-transparent contrast.

her randomly selected counter-part. These considerations lead to the following theory-driven hypothesis:

HYPOTHESIS 5 *The likelihood of choosing the risky probability distribution is increasing in the risk aversion of the RC player.*

Note, however, that the results from the exogenous-distribution sessions, in which the relatively less risk averse RC players were the main beneficiaries of risk, would suggest the opposite prediction. Therefore, an alternative hypothesis is that the likelihood of choosing the risky distribution is decreasing in the risk aversion of the RC player.

3.2 Experimental procedures

In this experiment only subjects who did not participate in the exogenous-distribution experiment were allowed to participate. 192 subjects participated across 8 experimental sessions. For each of the four treatments, we conducted two sessions. Each session consisted of 24 subjects, who were then separated into two matching groups of 12 running on separate servers.

For the first five rounds, the procedures were identical to our original experiment: an FP player and an RC player bargained over an exogenously specified probability distribution.[23] In rounds 6 through 10, at the beginning of each round, the residual claimant was given two possible probability distributions of pies and asked to choose one of them which would be implemented, either with certainty in the transparent choice treatment, or with 70% chance in the non-transparent choice treatment (cf. Figure 5). All other procedures remained identical. As before, after the tenth bargaining round, subjects completed a risk elicitation task (see Figure A.1 of Appendix A) and a series of survey questions, which included their judgements on fair allocations to the FP player.

3.3 Results

Table 4 gives an overview of the choices made by RC players during the last five periods, when they were asked to decide between two probability distributions over which to bargain. As can be seen from the table, subjects were generally reluctant to take the riskier of the two distributions, with overall only one-third of choices being for the riskier of the two. The Certain versus Tertiary alternative is the notable exception, with just over 50% of RC players choosing the riskier tertiary distribution. The significance of this result is established in specification (1) of the regression analysis reported in Table 5. The Certain versus Tertiary alternative is the baseline of this regression and the variables $\mathbf{1}[\cdot]$ are indicator variables assuming value 1 for the respective alternative and 0 otherwise. As can be seen from the table, for any alternative other than Certain versus Tertiary there is a significantly lower rate

[23]The data from the first five rounds can be used to conduct robustness check of the results from the exogenous-distribution sessions. As with the transparency contrast, this robustness check is not a primary concern and so is relegated to the supplementary materials. All the main results from Section 2.3 carry over to the data from the first five rounds of the endogenous-distribution treatments — see Appendix D for details.

of riskier-distribution choice. Moreover, the effect is fairly uniform across the four indicator variables: it is not possible to reject the null hypothesis that all of the coefficients are all equal ($p = 0.604$).[24] Specification (2) of Table 5 illustrates that this effect is not a result of the difference in risk. Taking all distributions except Certain vs Tertiary as the baseline it shows a significantly positive effect for choosing the riskier distribution in Certain vs Tertiary even after controlling for the difference in variances of the probability distribution.[25] Consequently, subjects appear most likely to prefer to bargain over a risky distribution, rather than the expected value for sure, when there is the possibility of an ex-post equal split. This may be due to concerns for ex post fairness.

Table 4: Percent of RCs Choosing Riskier Distribution (Periods 6-10)

Alternatives	Low Risk Treatment	High Risk Treatment	Combined
Certain versus Tertiary	52.1	52.1	52.1
Certain versus Binary	31.3	39.6	35.4
Tertiary versus Binary	31.3	25.0	28.1
(16,20,24) versus (12,20,28)	27.1	25.0	26.0
(16,24) versus (12,28)	37.5	12.5	25.0
Pooled	35.8	30.8	33.3

The final regression of Table 5 addresses Hypothesis 5, which stated that the likelihood of choosing the risky distribution should increase in risk aversion of the RC player. Contrary to that prediction, the likelihood of choosing the riskier distribution is decreasing in the risk aversion of the RC player. While in contradiction to the theory-based hypothesis, it is entirely consistent with the results from the exogenous-distribution experiment, where it was the relatively less risk averse RC players that appeared to benefit from risk.

A summary of the bargaining outcomes and fairness assessments can be found in Table 6. For the most part, the observations from the exogenous-distribution environment carry over to the endogenous one:[26] final FP earnings and agreed FP payments are generally decreasing in the riskiness of the probability distribution; bargaining over a risky probability distribution results in more disagreements and longer bargaining duration; and agreed FP payments for

[24]A linear regression model is used to keep the regression analysis simple and consistent across tables, and for the ease of interpretation of coefficients. For specifications that only include a complete set of indicators as independent variables, such as specification (1) of Table 5, this simplification is not important. This is not necessarily the case for specifications with independent variables that are not of this form. However, using a logit or probit model does not change the conclusions for specifications (2) and (3) of Table 5; the same is also true for the disagreements regression of Table 10. These additional robustness checks are included in the data-analysis scripts of the supplementary materials.

[25]The Difference in Variance variable is normalised, so that the largest difference (certain versus (12,28)) is set to one. The tertiary-rather-than-risk-difference result can also be seen by comparing the proportion choosing $(12, 20, 28)$ over (20) with the proportion choosing $(16, 24)$ over (20), since the former is riskier than the latter. In the sample included in the regression analysis, the difference is significant at the 5% level ($p = 0.031$; including observations involving subjects with $|\rho| \geq 1$ it is significant at the 10% level ($p = 0.077$).

[26]See Table A.2 of Appendix A for a complete set of pairwise comparisons across distributions.

Table 5: Linear Random-Effects Regression of Choice of Distribution (Periods 6-10)

	Riskier Distribution Chosen		
	(1)	(2)	(3)
1[Certain versus Binary]	-0.20^{***} (0.068)		
1[Tertiary versus Binary]	-0.26^{***} (0.050)		
1[(16,20,24) versus (12,20,28)]	-0.29^{***} (0.050)		
1[(16,24) versus (12,28)]	-0.29^{***} (0.058)		
Difference in Variance		0.05 (0.075)	
1[Certain versus Tertiary]		0.26^{***} (0.039)	0.26^{***} (0.039)
ρ_{RC}			-0.21^{***} (0.076)
Constant	0.54^{***} (0.041)	0.25^{***} (0.036)	0.34^{***} (0.035)
R^2	0.05	0.05	0.06
Observations	455	455	455

Notes: Data includes only observations for which $|\rho_{RC}| < 1$. ***1%, **5%, *10% significance using standard errors clustered at the matching group level. In (1), Certain versus Tertiary is the baseline category. Difference in Variance variable normalized so that the largest difference (Certain versus (12,28)) is 1.

risky probability distributions tend to lie between the (self-serving) fairness assessments of the FP and RC players.

Regression analyses corroborate this impression. In the first regression of Table 7 it can be seen that agreed FP payments are, in accordance with Hypothesis 1, (weakly) decreasing as risk increases. An analogous linear regression, specification (1), for disagreements establishes the significance of the increase in the frequency of disagreements for most risky distributions, contrary to Hypothesis 4. The second specifications show that the riskier of the two probability distributions being implemented does not have a significant bearing on agreed payments to the FP player, but does increase the likelihood of disagreement.[27] This suggests that choosing the riskier probability distribution may have a cost that is not captured by the theory, which assumes no disagreements. Finally, specification (3) establishes that the majority of the comparative statics from Hypothesis 2 carry over to the endogenous-distribution environment. For a given probability distribution, the direct effect of more risk averse is to reduce bargaining power (negative effect on payments for FP players; positive for RC players). For RCs, the interaction between variance and risk aversion improves their bargaining position. However, the direct effect is smaller and the interaction effect larger than in the exogenous-distribution environment, resulting an overall effect for ρ_{RC} that is negative for risky distributions; i.e. more risk aversion improves the RC player's bargaining position, contrary to Hypothesis 2.

Finally, Table 8 provides further evidence for the consistency with which the estimates of risk preferences organise the results of bargaining outcomes, although these are not always in line with the benchmark theory. The first regression replicates the certainty equivalent

[27] The linear functional form slightly over-states the disagreement effect in this case. With either a logit or probit form the marginal effect is around 5.5%, and the significance between 5-7%.

Table 6: Bargaining Outcomes and Fairness Perceptions in the Endogenous Environment (Periods 6-10)

Distribution of Pie	Final FP Earnings (€)	Agreed FP Payments (€)	Disagreements (%)	Remaining Time (sec)	Fair Payment to FP: FP (€)	Fair Payment to FP: RC (€)
(20)	9.76 (2.53)	10.14 (1.67)	3.7 (19)	123 (101)	10.00 (0.00)	10.15 (1.40)
(16,20,24)	8.39 (3.92)	9.81 (1.99)	14.4 (35)	62 (80)	10.50 (1.48)	9.80 (1.73)
(16,24)	8.71 (3.58)	9.84 (1.81)	11.4 (32)	60 (82)	10.29 (1.28)	9.28 (1.35)
(12,20,28)	8.51 (2.91)	9.17 (1.75)	7.1 (26)	52 (77)	9.57 (1.53)	8.86 (1.83)
(12,28)	7.42 (3.23)	8.44 (1.77)	12.1 (33)	22 (51)	9.30 (1.54)	8.45 (1.97)

Notes: Standard deviations are reported in parentheses. The columns "Fair payment to FP" report the judgements of a fair allocation to the FP player. The first of these is the average allocation reported by those assigned the FP role; the second, the average reported by those assigned the RC role.

Table 7: Linear Random-Effects Regressions of Bargaining Outcomes in the Endogenous Environment (Periods 6-10)

	Agreed FP Payments (1)	Agreed FP Payments (2)	Agreed FP Payments (3)	Disagreements (1)	Disagreements (2)
$\mathbf{1}[(16,20,24)]$	-0.39^{**} (0.153)			0.12^{**} (0.048)	0.11^{**} (0.050)
$\mathbf{1}[(16,24)]$	-0.39^{**} (0.197)			0.07^{**} (0.033)	0.04 (0.034)
$\mathbf{1}[(12,20,28)]$	-0.90^{***} (0.319)			0.04 (0.039)	-0.02 (0.043)
$\mathbf{1}[(12,28)]$	-1.47^{***} (0.337)			0.10^{**} (0.047)	0.03 (0.070)
Variance		-1.47^{***} (0.447)	-0.96^{*} (0.529)		
$\mathbf{1}$[Riskier Dist.]		0.09 (0.255)	0.04 (0.246)		0.08^{**} (0.040)
ρ_{FP}			-1.35^{**} (0.562)		
ρ_{RC}			0.28 (0.361)		
ρ_{RC} × Var.			-1.73^{**} (0.731)		
Constant	10.22^{***} (0.163)	10.17^{***} (0.119)	10.59^{***} (0.341)	0.03^{**} (0.017)	0.03^{*} (0.017)
R^2	0.07	0.07	0.11	0.02	0.04
Observations	371	371	371	412	412

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

analysis of Table 3. As in the exogenous-distribution sessions, but contrary to Hypothesis 3, the estimated certainty equivalent for RC players is decreasing in the estimated ρ (see specification (1)).[28] Specifications (2) and (3) look at periods 1-5 where players could not choose the distribution. The results of specification (2) show that the relatively less risk averse RC players do significantly better with risk, and specification (3) shows that the relatively more risk averse do worse. Consistent with these results, one can see from the last column of Table 3 that in periods 6-10 it is the less risk averse RC players who are more likely to choose the riskier probability distribution.

[28] Although neither $\mathbf{1}[\rho_{RC} > \rho_{FP}]$) nor $\mathbf{1}[\text{Var.} > 0] \times \mathbf{1}[\rho_{RC} > \rho_{FP}]$ are significant (at 5% level) in isolation, the overall effect of the RC player being more risk averse than the FP player when there is risk is significant.

Table 8: Linear Random-Effects Regression of the Certainty Equivalent of Agreements for RC Players and Riskier Distribution Choice in the Endogenous Environment

	Certainty Equivalent of Agreement for RC Player			Riskier Chosen
	(1)	(2)	(3)	(1)
$\mathbf{1}[\text{Var.} > 0]$	0.68*** (0.147)	1.29*** (0.317)	−1.00** (0.457)	
$\mathbf{1}[\rho_{RC} > \rho_{FP}]$	−0.45 (0.367)			
$\mathbf{1}[\text{Var.} > 0] \times \mathbf{1}[\rho_{RC} > \rho_{FP}]$	−0.53* (0.318)			
$\mathbf{1}[\rho_{RC} \leq .5]$				0.13** (0.052)
Constant	9.75*** (0.148)	8.89*** (0.327)	10.29*** (0.251)	0.22*** (0.047)
R^2	0.05	0.05	0.03	0.02
Observations	749	281	97	412
Periods	1-10	1-5	1-5	6-10
RC sub-sample	—	$\rho_{RC} \leq 0.5$	$\rho_{RC} > 0.5$	—

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

4 Bargaining Process

Our analysis thus far has focussed on bargaining outcomes, primarily because these are objects over which our benchmark theory provides predictions. Next we turn our attention to the bargaining process data on which the theory is silent. The unstructured design provides a rich data set on offers, and the timing and the sequence of these offers. These data can provide further insights into the nature of bargaining conflicts, how these conflicts are resolved, and the possible explanations for the deviations we observe from the benchmark theory. For this analysis, we pool the data from the exogenous and endogenous distribution sessions, and investigate in turn offers, concessions and duration.

The overall picture, which is consistent with our analysis of outcomes, is one in which the presence of risk increases conflict, in a large part because of differences in perceptions of what constitutes a fair division. Further, the presence of risk seems to lead to notably different bargaining postures by the FP and RC players. For example, when there is risk, FP players generally make larger concessions, while RC players make smaller concessions. Finally, risk attitudes — particularly for FP players — play an important role. Specifically, more risk averse FP players are less aggressive from the start of bargaining, make larger concessions and are more likely to accept the RC's offer than are less risk averse FP players. These observations go a long way to explain why it is actually the comparatively less risk averse residual claimants who seem to benefit from bargaining over a risky pie. The reason is that such residual claimants are more likely to be paired with a comparatively more risk averse fixed-payoff player, and that such players appear to be in a "weak" bargaining position.

4.1 Offers

Despite not being fully credible, as they can always be revised, it is still informative to compare the opening offers of the two types of players with their fairness assessments and final offers (offers outstanding either at the time of agreement or the expiry of bargaining time). These data are summarized in Table 9. It should be of little surprise to see that the opening offers of the RC players are always significantly lower than those of the FP player. Consistent with Bolton and Karagözoğlu (2013), opening offers are also more extreme than subjects' reported fair allocation. Moreover, RC players always demand a risk premium whenever they are exposed to risk, and this premium is increasing in the riskiness of the probability distribution. While FP players also tended to demand less as risk increases, their opening offers are consistently above half the expected pie size.

The two middle columns of Table 9 show a similar pattern for final offers. Both the RC and FP players concede ground from their opening positions; although, RC players still demand a statistically significant risk premium, relative to the certain distribution, for all the risky distributions. While the final offer of RCs is still significantly lower than that of the FP players, the average difference is now only €1.74, as compared to €3.71 for opening offers. Note, however, that final offers by RC players would still give less to the FP player than their own fair assessment. The final offers of FP players concede a statistically significant risk premium, relative to the certain distribution, to the RC player for all the risky distributions, unlike with opening offers where this was only the case for the two riskiest probability distributions. Indeed, for these two probability distributions, their final offers are actually slightly *less* than their perceived fair allocation. Therefore, it seems that there is broad agreement that the residual claimant should be compensated for her exposure to risk, but that the tension in bargaining is to determine precisely the magnitude of compensation.

Interestingly, regressing opening offers on fairness perceptions, while controlling for the riskiness of the distribution, reveals that opening offers are significantly positively correlated with fairness perceptions for FP players (coefficient = 0.16, $p < 0.01$). However, for RC players there is no such relationship between fairness perceptions and opening offers (coefficient = 0.02, $p > 0.7$). For final offers, the results are nearly identical for FP player (coefficient = 0.15, $p < 0.01$), while for RC players, the relationship is still not significant ($p = 0.13$), but

Table 9: Opening and Final Offers by Player Type

Distribution	Opening Offers		Final Offers		Fair Payoff to FP	
of Pie	FP	RC	FP	RC	FP	RC
(20)	12.67	8.23***	11.25	9.59***	9.91	10.16
(16,20,24)	12.74	6.86***	10.69	8.67***	10.39	9.70
(16,24)	12.48	7.03***	10.64	8.80***	10.21	9.27
(12,20,28)	11.16	5.78***	9.81	7.79***	9.82	8.64
(12,28)	10.97	5.84***	9.43	7.63***	9.54	8.40

Notes: The lightly shaded cells are significantly different from (20) at the 1% level. *** indicates that the offers between RCs and FPs are significantly different at the 1% level.

the coefficient has increased (0.13) in magnitude. Thus, at least for FP players, own fairness perceptions are positively related to the offers made.

With these summary statistics in mind, Table 10 investigates offers in more detail. The first two columns show that opening offers are strongly influenced by one's risk preferences.[29] As can be seen, the more risk averse is the FP player, the lower is his opening demand, while the more risk averse the RC player is, the less is her opening offer to the FP player. Thus, one piece of the picture emerges: the more risk averse are FP players, the less they demand from the start of bargaining. The table also shows that more risk averse RC players actually demand greater compensation for their exposure to risk; that is, in contrast to FP players, they become more aggressive in their opening offers.[30]

Of course, if opening offers are merely cheap talk, then the above results would be of little importance. However, it has been suggested by Galinsky and Mussweiler (2001) that opening offers may *anchor* negotiations and influence the final outcome. As can be seen, in the third column of Table 10, there is a significantly positive relationship between the opening offer of both the FP and RC players and the final agreed upon payment to the FP player. Therefore, an FP player who demands more, or an RC player who offers less, as an initial offer is likely to end up with a more favorable outcome, assuming an agreement can be reached. This finding represents another important piece of the picture: making a weak opening offer — which is more likely to be done by more risk averse FP players — leads to a lower payment.

When we look at concessions, we will show that this result appears to be due to the persistence of anchoring throughout the bargaining process. However, before proceeding, a word of caution is in order. While strong opening offers increase the payoff to the player making the offer, *conditional on an agreement being reached*, the more extreme is the opening offer, the greater the chance of disagreement. This is evidenced in the right-most column of Table 10 where there is a significantly positive coefficient on the opening offer of the FP player and a significantly negative coefficient on the opening offer of the RC player.[31]

Finally, the third and fourth columns of Table 10 also show that neither the time at which players made their first offer, nor the amount of time that they waited between making their first and second offer appeared to influence either the outcome, conditional on an agreement, or the likelihood of disagreement. These two variables are meant to capture aspects of a player's bargaining posture. For example, someone who makes an opening offer but then never amends it may be trying to "stick to his guns". However, as can be seen, there is no apparent effect for these variables.

[29]The table does not include fairness perceptions as an explanatory variable; however, when adding it there is no qualitative difference in the results.

[30]As we saw in Table 3, this does not lead to higher welfare compared to the risk free case. One reason is that such risk averse RC players are likely to be paired with a relatively less risk averse FP player who, as we will show, is relatively more aggressive in bargaining. Also, our welfare results were conditional on an agreement being reached. We will also see that disagreements are more likely with more risk averse RC players. Therefore, they may be under-sampled in that analysis. Finally, the additional amount that they get from their relatively aggressive opening offer may be insufficient to compensate for the risk.

[31]Recall that, for the RC player, making a higher offer is more generous to the FP player.

Table 10: Linear Random-Effects Regressions of the Role of Risk Preferences and Offers

	Opening Offer FP		Opening Offer RC		Agreed FP Payments		Disagreements	
$\mathbf{1}[(16,20,24)]$	−0.03	(0.216)	-1.34^{***}	(0.245)	-0.52^{***}	(0.176)	0.06^{*}	(0.032)
$\mathbf{1}[(16,24)]$	−0.23	(0.236)	-1.21^{***}	(0.216)	-0.50^{***}	(0.174)	0.06^{**}	(0.029)
$\mathbf{1}[(12,20,28)]$	-1.50^{***}	(0.241)	-2.43^{***}	(0.223)	-0.64^{***}	(0.179)	0.02	(0.035)
$\mathbf{1}[(12,28)]$	-1.68^{***}	(0.258)	-2.34^{***}	(0.230)	-0.92^{***}	(0.179)	0.09^{***}	(0.031)
ρ_{FP}	-1.24^{**}	(0.573)			-1.18^{***}	(0.352)	-0.18^{***}	(0.049)
ρ_{RC}			-1.51^{***}	(0.273)	−0.19	(0.219)	-0.07^{**}	(0.031)
Opening offer FP					0.22^{***}	(0.040)	0.02^{***}	(0.005)
Opening offer RC					0.16^{***}	(0.039)	-0.01^{**}	(0.005)
(Time 1st offer FP)/100					0.35	(0.227)	0.01	(0.030)
(Time 1st offer RC)/100					0.03	(0.166)	0.06	(0.072)
Δ(Time 1st − 2nd offer FP)/100					0.16	(0.155)	0.05	(0.039)
Δ(Time 1st − 2nd offer RC)/100					−0.20	(0.184)	0.04	(0.030)
Constant	13.11^{***}	(0.296)	8.70^{***}	(0.214)	6.79^{***}	(0.728)	−0.07	(0.073)
R^2	0.13		0.12		0.24		0.08	
Observations	1046		1080		1536		1736	

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

4.2 Concessions

Table 11 looks at the process of concessions during bargaining (Panel (a)) and on whether the residual claimant accepts or not (Panel (b)). Consider first the concessions models. The dependent variable is the size of the concession from the current to the previous offer. The explanatory variables are the opponent's most recent concession, the current offer of the opponent, one's own previous offer, fairness perceptions, bargaining time, whether the pie is risky and the risk preferences of the players. As can be seen by the coefficient on the indicator for the presence of risk, FP players make larger concessions when the pie is risky, while RC players make smaller concessions. Thus, consistent with the explanation so far, FP players appear to adopt more concessionary bargaining positions when risk is present. This is further reinforced by the finding that more risk averse FP players also make greater concessions.

As can be seen by the positive coefficient on the variable "other's concession" for both player types, concessions appear to be reciprocal. That is, the larger my match's most recent concession, the larger is my own concession. The coefficient on the other's current offer shows that anchoring is important throughout bargaining. Specifically, for FP players, the more the RC player is offering, the less he is willing to concede. Similarly, for RC player, the more the FP player is demanding, the more she is willing to concede. Consistent with our earlier result, fairness perceptions seem more salient for FP players. The higher is his own perceived fair allocation, the less he is willing to concede. For RC players, the effect has the same direction, but is not significant.

In Table 11(b), the dependent variable is an indicator that takes value 1 if the RC player was the one that accepted. The main point to note is the negative, and weakly significant,

Table 11: Linear Random-Effects Regression on Concessions Behaviour and Acceptances

(a) Concessions

	FP Player	RC Player
Other's Concession	0.11*** (0.039)	0.18*** (0.058)
Other's Current Offer	−0.06*** (0.017)	0.04** (0.019)
Own Previous Offer	0.35*** (0.036)	−0.54*** (0.053)
Fairness Perception	−0.10** (0.041)	0.08 (0.051)
Time/100	0.09** (0.041)	0.35*** (0.058)
1[Var. > 0]	0.51*** (0.159)	−0.47*** (0.114)
ρ_{FP}	0.79** (0.324)	
ρ_{RC}		−0.17 (0.310)
Constant	−2.99*** (0.697)	3.00*** (0.608)
R^2	0.20	0.22
Observations	3128	3482

(b) Residual Claimant Accepts

	RC Accepts
1[Var. > 0]	−0.02 (0.034)
ρ_{FP}	−0.16* (0.083)
ρ_{RC}	0.07 (0.067)
Final Offer RC	−0.05*** (0.010)
Final Offer FP	−0.03** (0.011)
Constant	1.25*** (0.177)
R^2	0.07
Observations	844

Notes: FP = Fixed-payoff player; RC = Residual claimant. Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

coefficient on the risk coefficient of the FP player. Thus, the more risk averse the FP player, the more likely it is that the FP player is the one that ultimately accepts, again suggesting that such FP players are in a weak bargaining position. Finally, there is also the intuitive result that RC players are less likely to accept when the final offers on the table, by both players, are more advantageous to the FP player.

4.3 Duration

To complete the overall picture of the bargaining process, we now look at the determinants of bargaining duration. Table 12 reports the results of a Weibull regression, where a player accepting an offer counts as a "failure" in the language of duration models. The regression includes a set of time-invariant explanatory variables, namely, the risk preferences of the FP and RC players, and an indicator variable for whether the pie is risky. The amount of bargaining conflict (the difference between the current offers of the FP and RC players) is also included, which is a time-varying coefficient. Note that a negative coefficient estimate means that the particular variable *increases* duration (i.e., bargaining takes longer), while positive coefficients mean that the variable decreases duration (i.e., bargaining ends sooner).

As can be seen from the first column, the amount of conflict has a strongly significant effect on duration. In particular, the greater the conflict, the longer that bargaining takes. Also consistent with our descriptive results, bargaining takes longer when the pie is risky. Interestingly, when the conflict variable is interacted with an indicator for risk, we see that the primary effect of risk on duration is through conflict. That is, when the pie is risky, for the same conflict, it simply takes longer for players to bridge their differences and come to an agreement, if they agree at all.

Finally, as further support for our claim that FP players — particularly the more risk averse ones — adopt weak bargaining positions, the duration decreases in the risk aversion of the FP player. This observation is consistent with that from Table 11(b), which showed that more risk averse FP players are more likely to accept the offer. The duration analysis shows that, in addition, they do so more quickly, perhaps because they fear disagreement.

Table 12: Weibull Regression on Bargaining Duration

	Duration	
Conflict	-0.27^{***} (0.031)	-0.17^{***} (0.043)
$\mathbf{1}$[Var. > 0]	-0.34^{***} (0.091)	-0.08 (0.136)
$\mathbf{1}$[Var. > 0] × Conflict		-0.16^{***} (0.056)
ρ_{FP}	0.46^{***} (0.170)	0.44^{**} (0.176)
ρ_{RC}	-0.07 (0.138)	-0.07 (0.139)
Constant	-11.61^{***} (1.577)	11.62^{***} (1.526)
Log-Likelihood	-618.85	-609.63
Observations	8532	8532

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching-group level. In the Weibull regression, an acceptance is a "hit".

5 Conclusion

This paper reports the results of an experimental study on the effect of asymmetric exposure to risk in bargaining. Our results confirm important aspects of the theoretical benchmark model (White, 2008). Risk-exposed residual claimants are generally able to extract a risk premium from the fixed-payoff player and the premium is increasing in the riskiness of the distribution. Furthermore, in some circumstances this premium is large enough to make it advantageous (in expected utility terms) for residual claimants to bargain with some ex-post risk. That is, we find empirical support for the, at first sight counter-intuitive, prediction from theory that the strategic benefit of ex-post risk can outweigh the direct cost.

We also identify several behavioral aspects that go, in part, against the benchmark theory. First, it is the less risk averse residual claimants who benefit the most from exposure to risk. Second, consistent with this result, when given the choice, it is again the relative less risk averse residual claimants that are more likely to choose into more risk. Generally, we observe a reluctance to choose the riskier distribution, regardless of the level of transparency. A likely reason for this is that bargaining over the riskier distribution is associated with a 5–8 percentage point increase in the frequency of disagreements. On the other hand, in the special cases where one distribution is riskless and the other has the possibility of an ex-post equal split, we observe frequent choices for the riskier distribution – some 50%. Our results show not only that the relatively less risk averse agents are more willing to make such choices, but also that this same group is more likely to gain from it in bargaining.

Risk preferences are private information and fixed-payoff players may be willing to compensate an average residual claimant for her exposure to risk, thus over compensating the relatively less risk averse ones (recall Figure 3(a)). In addition, fixed-payoff players, in particular the more risk averse ones, adopt weak bargaining strategies in risky environments: they demand less from the start, make larger concessions, and are more likely to accept. These factors, likely working in conjunction, can explain why the relatively less risk averse residual claimants benefit the most from risk exposure.

This suggests that explicitly modeling the incomplete information could reconcile the benchmark theory with our experimental evidence. However, simply adding incomplete information over the residual claimant's risk attitude is unlikely to be sufficient. In the benchmark model, while increased risk aversion implies greater compensation for risk, it also implies less bargaining power. We know that a residual claimant should not pretend to be more risk averse than she actually is (recall Figure 3(b)). In fact, it would be advantageous to be thought of as being risk neutral. Another important aspect of our results is that bargaining frictions increase with riskiness of the distribution and that this is — at least in part — the result of diverging fairness ideals between the fixed-payoff player and the residual claimant. Consequently, a satisfactory extension of the theory would require some separation between the determinants of bargaining power and the determinants of fair compensation for risk exposure.[32]

Finally, we also observe disagreement to be significantly more likely when bargaining is over a risky distribution than when it is over a risk-free distribution — with disagreements occurring only 5% of the time under the risk-free distribution but nearly 20% of the time with the riskiest distribution. This observation is consistent with the idea that risk introduces competing (self-serving) norms for fairness that increase bargaining conflict. With no risk, the 50-50 norm is the most salient and most agreements specify this division. However, as risk increases, differences in fairness perceptions emerge and grow.Deleted last paragraph on dynamic bargaining.

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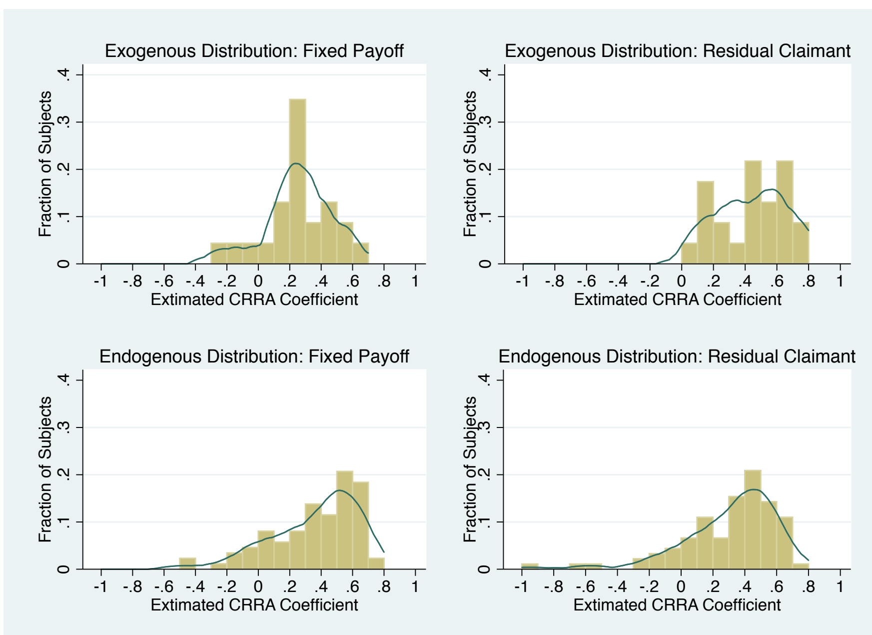
A Additional Material

A.1 Figures

Figure A.1 provides histograms of the estimated CRRA coefficients broken apart by exogenous versus endogenous distribution and player type. While it appears that the distributions look different between FP and RC players for the exogenous distribution treatments, we consider it unlikely that this is because the bargaining treatment influenced the subsequent elicitation of risk preferences. First, the difference in the FP and RC distributions is only marginally statistically significant for the exogenous treatments – the p-value of a Kolmogorov-Smirnov test is 0.089 using each subject as an independent observation. Second, the distributions are virtually identical for the endogenous distribution treatments, which is generated by a much larger sample – the p-value of the Kolmogorov-Smirnov test for the endogenous treatments is 0.151 using each subject as an independent observation. The p-value for the test using the combined data is 0.755, suggesting that the differences in the exogenous distribution treatments is more likely due to random sampling of subjects.

Figure A.1: Histogram: estimated CRRA risk aversion coefficients



Note: 16 (out of 240) subjects were dropped from this histogram for having estimated CRRA coefficients above 2 or below -1 (1 RC and 1 FP from the exogenous sessions; 5 RCs and 9FPs from the endogenous sessions).

A.2 Tables

Table A.1: Pairwise Comparison of Bargaining Outcomes in the Exogenous Environment (Periods 1-10)

	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)
	Final Earnings					*Agreed FP Payments*				
(20)	9.71	$>$	$>^{**}$	$>^{***}$	$>^{***}$	10.13	$>$	$>^{**}$	$>^{**}$	$>^{***}$
(16,20,24)		9.04	$>^{**}$	$>^{**}$	$>^{***}$		9.64	$>$	$>^{*}$	$>^{***}$
(16,24)			8.17	$>$	$>^{*}$			9.56	$>^{*}$	$>^{***}$
(12,20,28)				8.10	$>^{***}$				9.04	$>$
(12,28)					7.14					8.79
	Disagreements					*Time Remaining*				
(20)	4.2	$<$	$<$	$<$	$<^{***}$	153	$>^{***}$	$>^{***}$	$>^{***}$	$>^{***}$
(16,20,24)		6.2	$<$	$<^{*}$	$<^{***}$		70	$>^{***}$	$>^{*}$	$>$
(16,24)			14.6	$>$	$<$			39	$>$	$<$
(12,20,28)				10.4	$<^{**}$				38	$<$
(12,28)					18.8					54

Notes: The symbol indicates how the outcome measure of the row distribution compares (statistically) to the column distribution. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

Table A.2: Pairwise Comparison of Bargaining Outcomes in the Endogenous Environment (Periods 6-10)

	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)
	Final Earnings					*Agreed FP Payments*				
(20)	9.76	$>^{***}$	$>^{**}$	$>^{***}$	$>^{***}$	10.14	$>^{**}$	$>^{**}$	$>^{***}$	$>^{***}$
(16,20,24)		8.39	$<$	$<$	$>$		9.81	$<$	$>^{**}$	$>^{***}$
(16,24)			8.71	$>$	$>^{**}$			9.84	$>^{**}$	$>^{***}$
(12,20,28)				8.51	$>^{**}$				9.17	$>^{**}$
(12,28)					7.42					8.44
	Disagreements					*Time Remaining*				
(20)	3.7	$<^{**}$	$<^{**}$	$<$	$<^{**}$	123	$>^{***}$	$>^{***}$	$>^{***}$	$>^{***}$
(16,20,24)		14.4	$>$	$>$	$>$		62	$>$	$>$	$>^{**}$
(16,24)			11.4	$>$	$<$			60	$>$	$>^{***}$
(12,20,28)				7.1	$<$				52	$>^{***}$
(12,28)					12.1					22

Notes: The symbol indicates how the outcome measure of the row distribution compares (statistically) to the column distribution. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

SUPPLEMENTARY MATERIALS: FOR ONLINE PUBLICATION ONLY

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B.1 Exogenous Distribution

General Instructions

Welcome

You are about to participate in a session on interactive decision-making. Thank you for agreeing to take part. The session should last about 90 minutes.

You should have already turned off all mobile phones, smart phones, mp3 players and all such devices by now. If not, please do so immediately. These devices must remain switched off throughout the session. Place them in your bag or on the floor besides you. Do not have them in your pocket or on the table in front of you.

The entire session, including all interaction between you and other participants, will take place through the computer. You are not allowed to talk or to communicate with other participants in any other way during the session. You are asked to follow these rules throughout the session. Should you fail to do so, we will have to exclude you from this (and future) session(s) and you will not receive any compensation for this session. We will start with a brief instruction period. Please read these instructions carefully. They are identical for all participants in this session with whom you will interact. If you have any questions about these instructions or at any other time during the experiment, then please raise your hand. One of the experimenters will come to answer your question.

Structure of the session

There are two parts to this session. Instructions for the part 1 are detailed below. Part 2 consists of survey and individual choice questions. Instructions for part 2 will be given once part 1 has been completed. Parts 1 and 2 are independent.

Compensation for participation in this session

You will be able to earn money for your decisions in both parts of this session. What you will earn from part 1 will depend on your decisions, the decisions of others and chance. Further details are given below. What you will earn from part 2 will only depend on your decisions and chance. Further details will be given after part 1 has been completed. In the instructions, and all decision tasks that follow, payoffs are reported in Euros (EUR). Your final payment will be 2 EUR plus the sum of your earnings from the two parts. Final payment takes place in cash at the end of the session. Your decisions and earnings in the session will remain anonymous.

Instructions for Part I

Structure of part 1

Part 1 is structured as follows:

1. At the beginning of part 1, you will be randomly assigned as either a type A or a type B participant. Your type will remain the same for the duration of part 1.

2. Part 1 consists of 10 periods.

3. At the beginning of a period, you will be randomly paired with another participant of a different type. That is, if you were assigned as type A, you will be randomly paired with a participant that was assigned as type B; if you were assigned as type B, you will be randomly paired with a participant assigned as type A.

4. This random pairing procedure is repeated at the beginning of every period.

5. During the period, you will interact only with the participant you have been paired with for that period. We refer to this participant as *your match*.

Description of a period

6. During a period you and your match will negotiate over how to divide between you an amount of money. We call the amount of money that you have to divide *the pie*. However, you will not always know size of the pie for sure. In some periods, there will be only one value that the pie could be (i.e. it is certain), in others there will be two values it could be – with each amount equally likely – and in others there will be three values it could be – again, with each amount equally likely.

7. At the beginning of the period, you and your match will be informed of the list of possible amounts for the pie. This list will vary from period to period. Neither you nor your match will know the actual size of the pie until end of the period. Only at this point will the size of the pie be determined: it will be randomly selected from the list of possible amounts.

8. You will decide on how to divide the pie by negotiating over the value (in Euros) of a fixed payment to the type A participant. These negotiations will take place through the computer interface. You will have 4 minutes in which to negotiate. The time limit is binding: if you and your match do not reach an agreement during this time limit you will both receive zero for the period.

9. During the negotiation time, you may make offers at any time. An offer is a suggested value for the fixed payment to the type A participant. *Note: If you are a type B participant, this will not be your payoff if the offer is accepted.*

10. The only restrictions on the offers you can make are: 1) the offer must be larger than zero, and 2) the offer must be less than the smallest possible value for the size of the pie. The computer interface will ensure these restrictions are met. Finally, only the *current offer*, that is the most recent offer made by a participant, can be accepted by the other participant.

11. An agreement is reached when either you or your match accept the other's current offer. Once an offer has been accepted, negotiations for the period end.

12. If you do agree on a value for the fixed payment, then the payoff in this period for the type A participant will be the agreed payment. The type B participant will receive whatever is left from the pie once the agreed payment has been subtracted. Consequently, if you reach an agreement, type A's payoff will always be certain, whereas type B's payoff will depend on the realised size of the pie.

13. A period is ended either by an agreement or by the elapse of the negotiating time limit.

At the end of a period

14. At the end of a period, the random pie size, your payoff for the period and that of your match will be determined and displayed.

The end of part 1

15. After a period is finished, you will be randomly paired for a new period. Part 1 consists of 10 such periods.

16. At the end of part 1 – that is, after the tenth period – one period will be selected at random. The payoff you gained during the selected period will be used to as your final payoff for part 1.

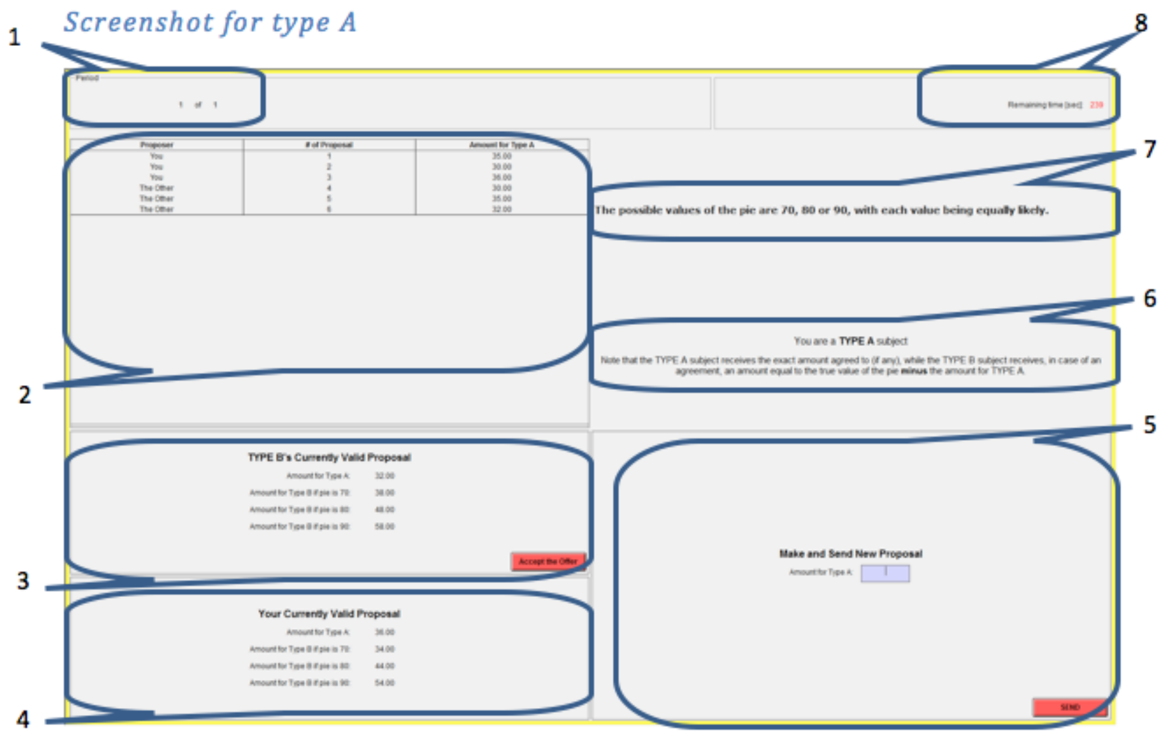
17. After your final payoff for part 1 has been calculated, the session will move on to part 2. Instructions for part 2 will be displayed on your computer terminal. Please read them carefully and proceed through part 2 at your own pace.

Making and Accepting Offers

An example

The following screen shot is used as an example to illustrate how you use the computer interface to make and accept offers. The screenshot shows the situation for a type A participant. The layout for a type B participant is analogous. For completeness, the associated screen for the type B participant is shown below.

Please note that the possible sizes of the pie, and the offers shown on the screen, are not values that you will see during the session itself. They have been selected for illustrative purposes only.



Key

1. *Period number box:* The number of the current period.

2. *Proposal history box:* This shows the history of offers you and your match have made.

3. *Your match's current offer box:* Details of the current offer made by your match. To accept their offer, click on the "Accept the Offer" button.

4. *Your current offer box:* Details of your current offer.

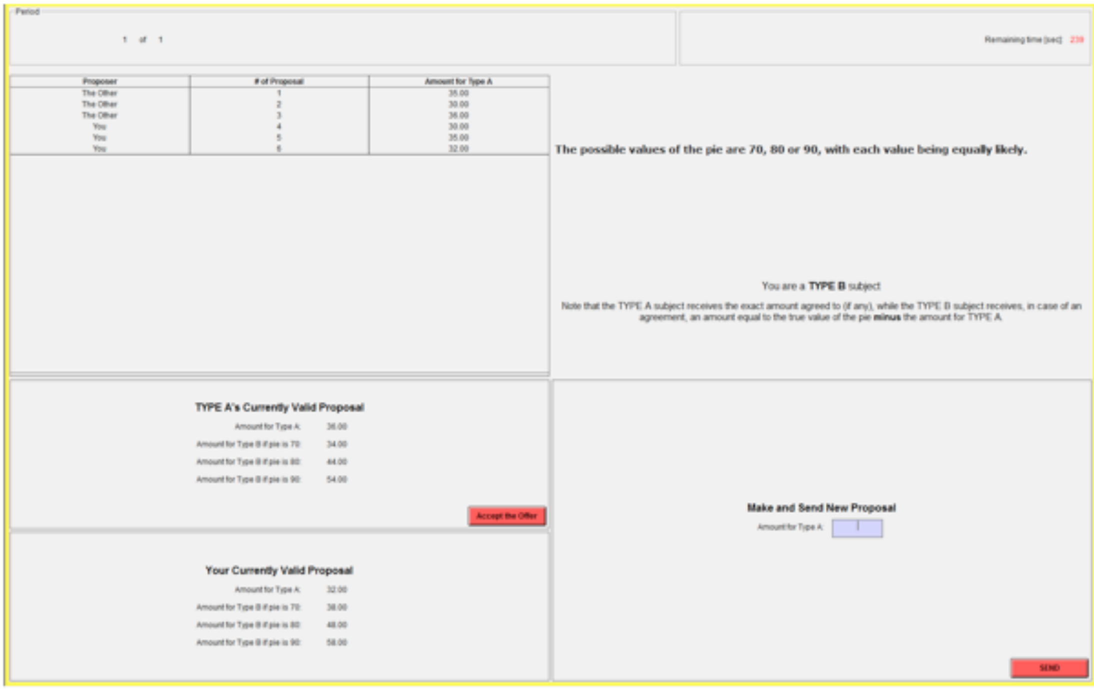
5. *New offer box:* To make a new offer enter a value for the fixed payment and click the "SEND" button.

6. *Type reminder box:* A reminder of your type and how your payoff for the period is calculated should you reach an agreement.

7. *Pie size reminder box:* A reminder of the possible sizes of the pie. Each amount is equally likely.

8. *Timer box:* The amount of time remaining.

Screenshot for type B



B.2 Endogenous Distribution – Transparent Choice

General Instructions

Welcome

You are about to participate in a session on interactive decision-making. Thank you for agreeing to take part. The session should last about 90 minutes.

You should have already turned off all mobile phones, smart phones, mp3 players and all such devices by now. If not, please do so immediately. These devices must remain switched off throughout the session. Place them in your bag or on the floor besides you. Do not have them in your pocket or on the table in front of you.

The entire session, including all interaction between you and other participants, will take place through the computer. You are not allowed to talk or to communicate with other participants in any other way during the session. You are asked to follow these rules throughout the session. Should you fail to do so, we will have to exclude you from this (and future) session(s) and you will not receive any compensation for this session. We will start with a brief instruction period. Please read these instructions carefully. They are identical for all participants in this session with whom you will interact. If you have any questions about these instructions or at any other time during the experiment, then please raise your hand. One of the experimenters will come to answer your question.

Structure of the session

There are two parts to this session. Instructions for the part 1 are detailed below. Part 2 consists of survey and individual choice questions. Instructions for part 2 will be given once part 1 has been completed. Parts 1 and 2 are independent.

Compensation for participation in this session

You will be able to earn money for your decisions in both parts of this session. What you will earn from part 1 will depend on your decisions, the decisions of others and chance. Further details are given below. What you will earn from part 2 will only depend on your decisions and chance. Further details will be given after part 1 has been completed. In the instructions, and all decision tasks that follow, payoffs are reported in Euros (EUR). Your final payment will be 2 EUR plus the sum of your earnings from the two parts. Final payment takes place in cash at the end of the session. Your decisions and earnings in the session will remain anonymous.

Instructions for Part I

Structure of part 1

Part 1 is structured as follows:

1. At the beginning of part 1, you will be randomly assigned as either a type A or a type B participant. Your type will remain the same for the duration of part 1.

2. Part 1 consists of 10 periods.

3. At the beginning of a period, you will be randomly paired with another participant of a different type. That is, if you were assigned as type A, you will be randomly paired with a participant that was assigned as type B; if you were assigned as type B, you will be randomly paired with a participant assigned as type A.

4. This random pairing procedure is repeated at the beginning of every period.

5. During the period, you will interact only with the participant you have been paired with for that period. We refer to this participant as *your match.*

Description of periods 1 to 5

6. During a period you and your match will negotiate over how to divide between you an amount of money. We call the amount of money that you have to divide *the pie.* However, you will not always know size of the pie for sure. In some periods, there will be only one value that the pie could be (i.e. it is certain), in others there will be two values it could be – with each amount equally likely – and in others there will be three values it could be – again, with each amount equally likely.

7. At the beginning of the period, you and your match will be informed of the list of possible amounts for the pie. This list will vary from period to period. Neither you nor your match will know the actual size of the pie until end of the period. Only at this point will the size of the pie be determined: it will be randomly selected from the list of possible amounts.

8. You will decide on how to divide the pie by negotiating over the value (in Euros) of a fixed payment to the type A participant. These negotiations will take place through the computer interface. You will have 4 minutes in which to negotiate. The time limit is binding: if you and your match do not reach an agreement during this time limit you will both receive zero for the period.

9. During the negotiation time, you may make offers at any time. An offer is a suggested value for the fixed payment to the type A participant. *Note: If you are a type B participant, this will not be your payoff if the offer is accepted.*

10. The only restrictions on the offers you can make are: 1) the offer must be larger than zero, and 2) the offer must be less than the smallest possible value for the size of the pie. The computer interface will ensure these restrictions are met. Finally, only the *current offer*, that is the most recent offer made by a participant, can be accepted by the other participant.

11. An agreement is reached when either you or your match accept the other's current offer. Once an offer has been accepted, negotiations for the period end.

12. If you do agree on a value for the fixed payment, then the payoff in this period for the type A participant will be the agreed payment. The type B participant will receive whatever is left from the pie once the agreed payment has been subtracted. Consequently, if you reach an agreement, type A's payoff will always be certain, whereas type B's payoff will depend on the realised size of the pie.

13. A period is ended either by an agreement or by the elapse of the negotiating time limit.

At the end of a period

14. At the end of a period, the random pie size, your payoff for the period and that of your match will be determined and displayed.

Description of periods 6 to 10

15. During periods 6 to 10, you and your match will face a similar situation as in periods 1 to 5. The only difference is at the beginning of the period, before negotiations begin: the type B participant will be shown two lists of possible amounts for the pie and be asked to choose one of the two lists.

16. As before, neither you nor your match will know the actual size of the pie until the end of the period. Only at this point will the size of the pie be determined: it will be randomly selected from the list of possible amounts.

17. While the type B participant is choosing between the two lists, the type A participant will be informed of the two options the type B participant has. The choice that the type B participant has will vary from period to period.

18. Once the type B participant has made their choice, and before negotiations begin, both participants will be informed of the chosen list of possible amounts for the pie for the current period.

19. The period then proceeds exactly as before, as described in points 8 to 13 above.

At the end of a period

20. At the end of a period, the random pie size, your payoff for the period and that of your match will be determined and displayed.

The end of part 1

21. After a period is finished, you will be randomly paired for a new period. Part 1 consists of 10 such periods.

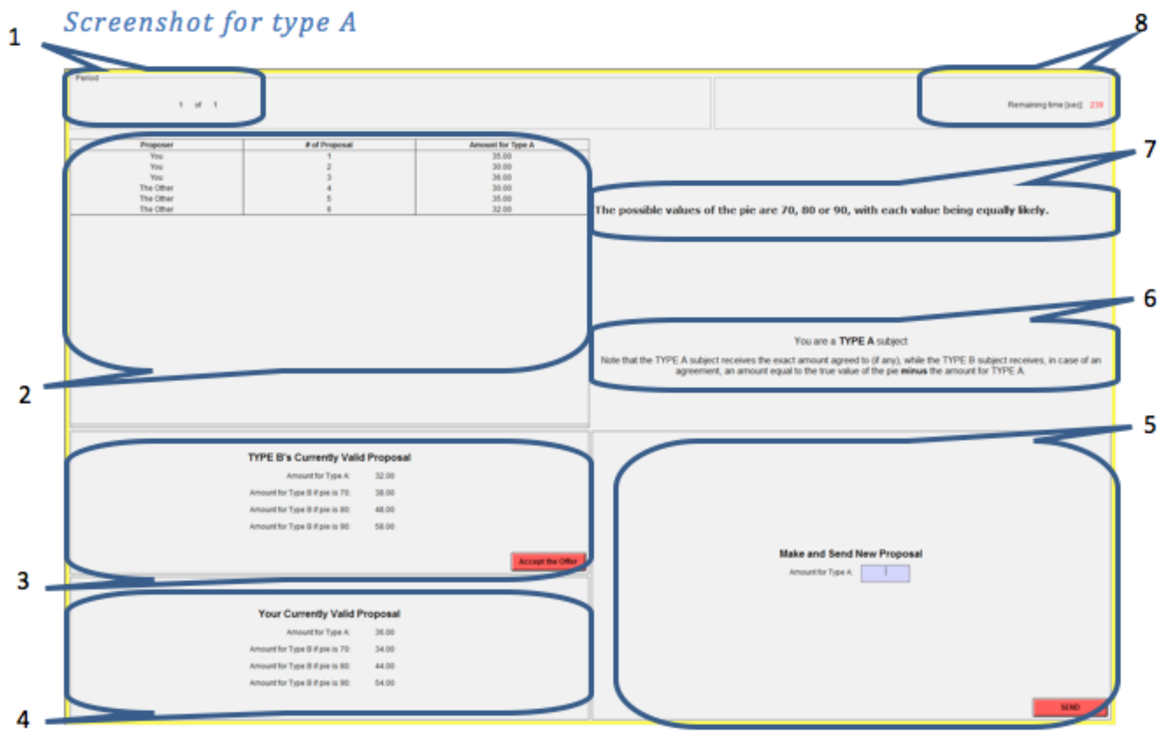
22. At the end of part 1 – that is, after the tenth period – one period will be selected at random. The payoff you gained during the selected period will be used to as your final payoff for part 1.

23. After your final payoff for part 1 has been calculated, the session will move on to part 2. Instructions for part 2 will be displayed on your computer terminal. Please read them carefully and proceed through part 2 at your own pace.

Making and Accepting Offers

An example

The following screen shot is used as an example to illustrate how you use the computer interface to make and accept offers. The screenshot shows the situation for a type A participant. The layout for a type B participant is analogous. For completeness, the associated screen for the type B participant is shown below.
Please note that the possible sizes of the pie, and the offers shown on the screen, are not values that you will see during the session itself. They have been selected for illustrative purposes only.



Key

1. *Period number box:* The number of the current period.

2. *Proposal history box:* This shows the history of offers you and your match have made.

3. *Your match's current offer box:* Details of the current offer made by your match. To accept their offer, click on the "Accept the Offer" button.

4. *Your current offer box:* Details of your current offer.

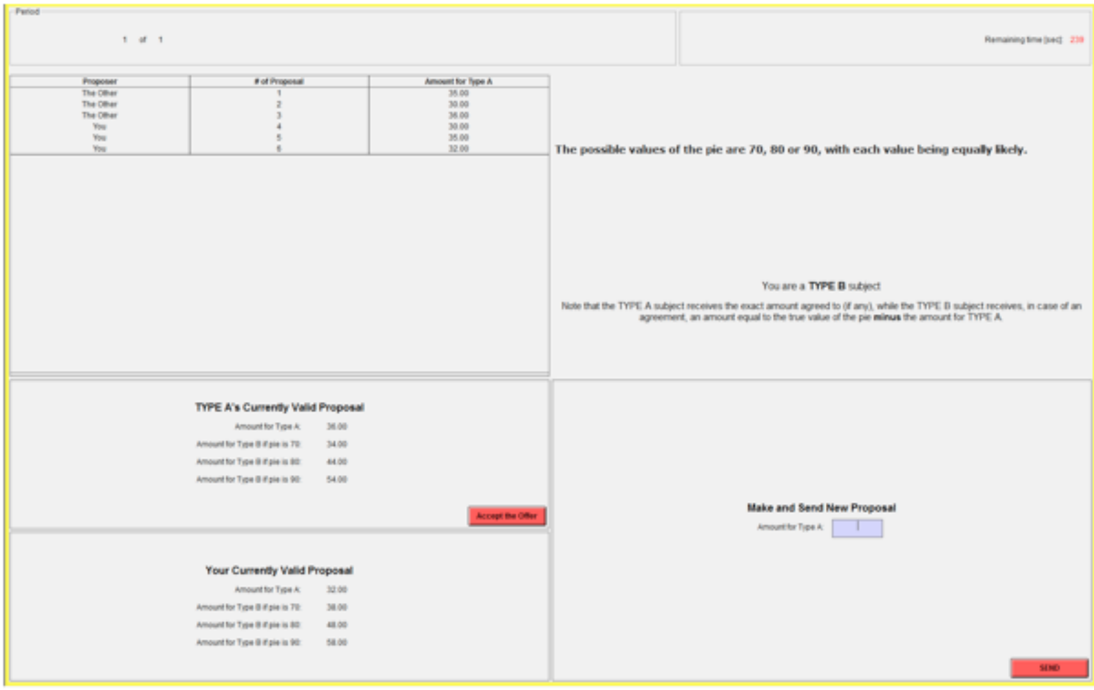
5. *New offer box:* To make a new offer enter a value for the fixed payment and click the "SEND" button.

6. *Type reminder box:* A reminder of your type and how your payoff for the period is calculated should you reach an agreement.

7. *Pie size reminder box:* A reminder of the possible sizes of the pie. Each amount is equally likely.

8. *Timer box:* The amount of time remaining.

Screenshot for type B



B.3 Endogenous Distribution – Non-Transparent Choice

General Instructions

Welcome

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Structure of the session

There are two parts to this session. Instructions for the part 1 are detailed below. Part 2 consists of survey and individual choice questions. Instructions for part 2 will be given once part 1 has been completed. Parts 1 and 2 are independent.

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Instructions for Part I

Structure of part 1

Part 1 is structured as follows:

1. At the beginning of part 1, you will be randomly assigned as either a type A or a type B participant. Your type will remain the same for the duration of part 1.

2. Part 1 consists of 10 periods.

3. At the beginning of a period, you will be randomly paired with another participant of a different type. That is, if you were assigned as type A, you will be randomly paired with a participant that was assigned as type B; if you were assigned as type B, you will be randomly paired with a participant assigned as type A.

4. This random pairing procedure is repeated at the beginning of every period.

5. During the period, you will interact only with the participant you have been paired with for that period. We refer to this participant as *your match.*

Description of periods 1 to 5

6. During a period you and your match will negotiate over how to divide between you an amount of money. We call the amount of money that you have to divide *the pie.* However, you will not always know size of the pie for sure. In some periods, there will be only one value that the pie could be (i.e. it is certain), in others there will be two values it could be – with each amount equally likely – and in others there will be three values it could be – again, with each amount equally likely.

7. At the beginning of the period, you and your match will be informed of the list of possible amounts for the pie. This list will vary from period to period. Neither you nor your match will know the actual size of the pie until end of the period. Only at this point will the size of the pie be determined: it will be randomly selected from the list of possible amounts.

8. You will decide on how to divide the pie by negotiating over the value (in Euros) of a fixed payment to the type A participant. These negotiations will take place through the computer interface. You will have 4 minutes in which to negotiate. The time limit is binding: if you and your match do not reach an agreement during this time limit you will both receive zero for the period.

9. During the negotiation time, you may make offers at any time. An offer is a suggested value for the fixed payment to the type A participant. *Note: If you are a type B participant, this will not be your payoff if the offer is accepted.*

10. The only restrictions on the offers you can make are: 1) the offer must be larger than zero, and 2) the offer must be less than the smallest possible value for the size of the pie. The computer interface will ensure these restrictions are met. Finally, only the *current offer*, that is the most recent offer made by a participant, can be accepted by the other participant.

11. An agreement is reached when either you or your match accept the other's current offer. Once an offer has been accepted, negotiations for the period end.

12. If you do agree on a value for the fixed payment, then the payoff in this period for the type A participant will be the agreed payment. The type B participant will receive whatever is left from the pie once the agreed payment has been subtracted. Consequently, if you reach an agreement, type A's payoff will always be certain, whereas type B's payoff will depend on the realised size of the pie.

13. A period is ended either by an agreement or by the elapse of the negotiating time limit.

At the end of a period

14. At the end of a period, the random pie size, your payoff for the period and that of your match will be determined and displayed.

Description of periods 6 to 10

15. During periods 6 to 10, you and your match will face a similar situation as in periods 1 to 5. The only difference is at the beginning of the period, before negotiations begin: the type B participant will be shown two lists of possible amounts for the pie and be asked to choose one of the two lists.

16. This choice will partially determine the list of possible amounts for the pie for the current period: which of the two options is implemented will be randomly determined, but the option chosen by the type B participant will have a greater chance of being chosen.

17. Specifically, the option chosen by the type B participant has a 70% chance of being implemented, whereas the non-chosen option has a 30% chance of being implemented. That is, if you were to roll a 10-sided die, the option chosen by the type B participant would be implemented if the numbers 1 through 7 came up, and the other option would be implemented if the numbers 8, 9 or 10 came up.

18. While the type B participant is choosing between the two lists, the type A participant will be informed of the two options the type B participant has. The choice that the type B participant has will vary from period to period.

19. Once the type B participant has made their choice, and before negotiations begin, the computer will randomly determine which of the two options will be implemented – remember, the option chosen by the type B participant has a 70% chance of being implemented, whereas the option not chosen by the type B participant has a 30% chance of being implemented.

20. Both participants will then be informed which of the options is implemented for the current period – remember the type A participant will not know whether the type B participant chose this option or not.

21. As before, neither you nor your match will know the actual size of the pie until the end of the period. Only at this point will the size of the pie be determined: it will be randomly selected from the list of possible amounts.

22. The period then proceeds exactly as before, as described in points 8 to 13 above.

At the end of a period

23. At the end of a period, the random pie size, your payoff for the period and that of your match will be determined and displayed.

The end of part 1

24. After a period is finished, you will be randomly paired for a new period. Part 1 consists of 10 such periods.

25. At the end of part 1 – that is, after the tenth period – one period will be selected at random. The payoff you gained during the selected period will be used to as your final payoff for part 1.

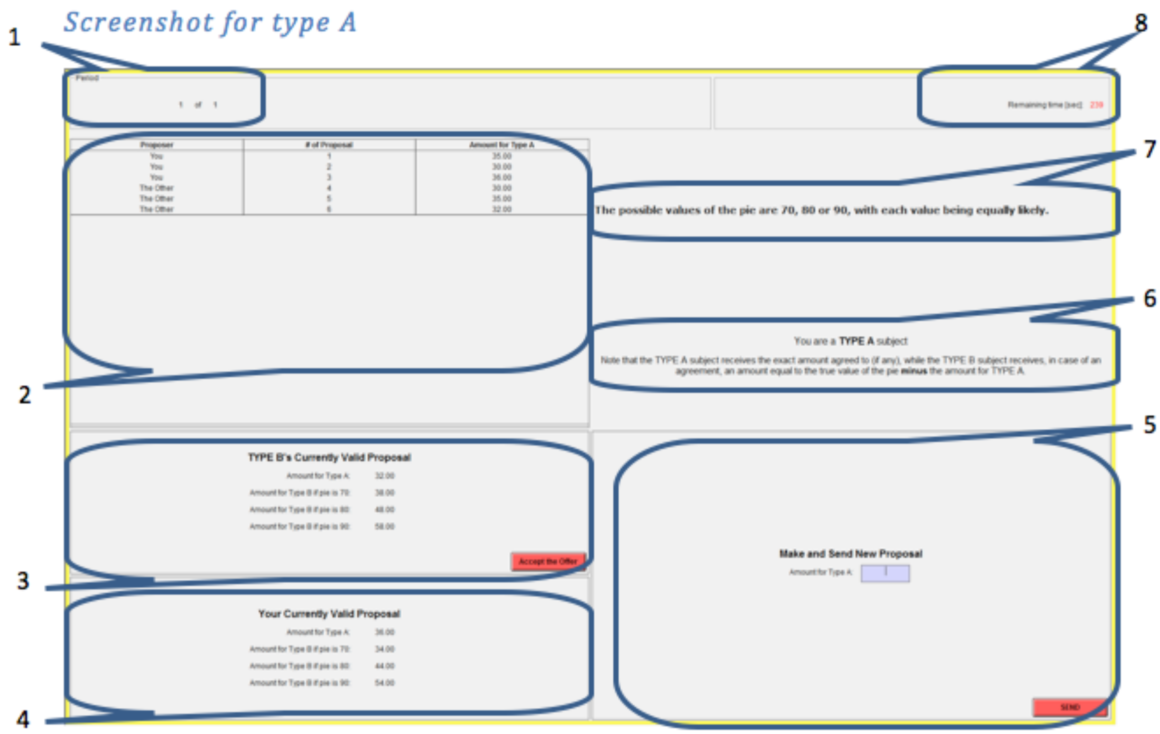
26. After your final payoff for part 1 has been calculated, the session will move on to part 2. Instructions for part 2 will be displayed on your computer terminal. Please read them carefully and proceed through part 2 at your own pace.

Making and Accepting Offers

An example

The following screen shot is used as an example to illustrate how you use the computer interface to make and accept offers. The screenshot shows the situation for a type A participant. The layout for a type B participant is analogous. For completeness, the associated screen for the type B participant is shown below.

Please note that the possible sizes of the pie, and the offers shown on the screen, are not values that you will see during the session itself. They have been selected for illustrative purposes only.



Key

1. *Period number box:* The number of the current period.
2. *Proposal history box:* This shows the history of offers you and your match have made.
3. *Your match's current offer box:* Details of the current offer made by your match. To accept their offer, click on the "Accept the Offer" button.
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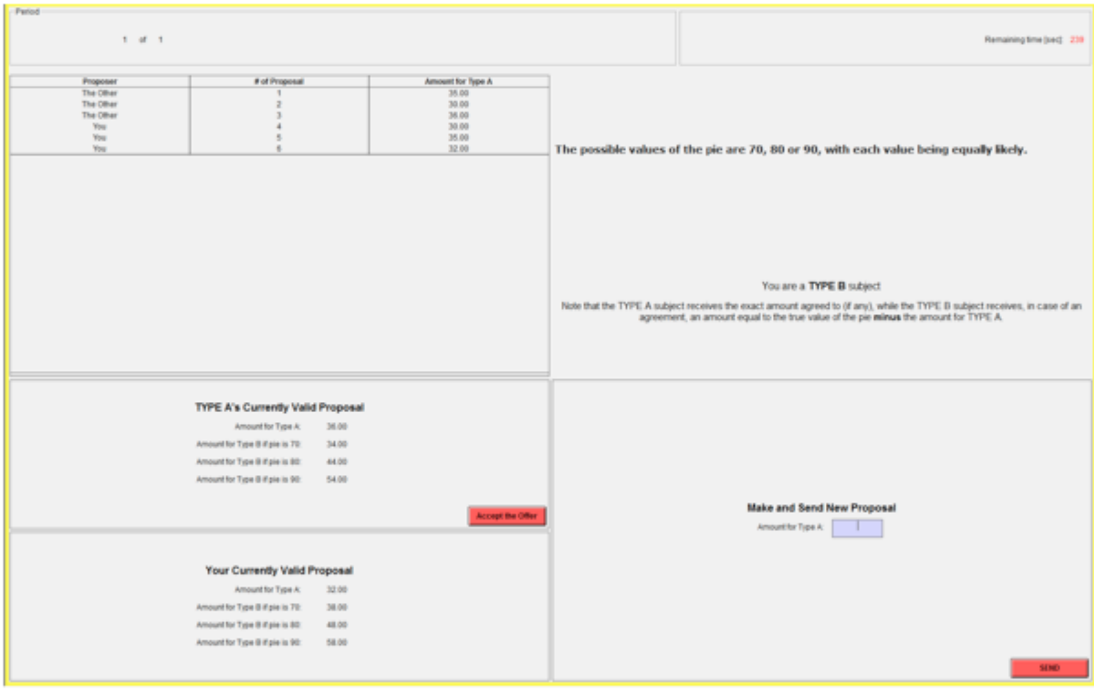
5. *New offer box:* To make a new offer enter a value for the fixed payment and click the "SEND" button.
6. *Type reminder box:* A reminder of your type and how your payoff for the period is calculated should you reach an agreement.
7. *Pie size reminder box:* A reminder of the possible sizes of the pie. Each amount is equally likely.
8. *Timer box:* The amount of time remaining.

Screenshot for type B



C Endogenous Distribution Results: Transparent versus Non-Transparent Choice

Table C.1 shows the proportion of RC players choosing the riskier distribution separately for the transparent-choice and non-transparent-choice conditions. Overall, transparency does not appear to be a salient concern. In particular, it is not the case that RC players under the non-transparent condition consistently choose the riskier distribution more often.

Table C.1: Percent of RCs Choosing Riskier Distribution by Transparency Condition (Periods 6-10) Including the TC versus NTC Contrast

	Transparent Choice			Non-Transparent Choice		
Alternatives	Low Risk	High Risk	Combined	Low Risk	High Risk	Combined
Certain versus Tertiary	58.3	41.7	50.0	45.8	62.5	54.2
Certain versus Binary	29.2	33.3	31.2	33.3	45.8	39.6
Tertiary versus Binary	37.5	20.8	29.2	25.0	29.2	27.1
(16,20,24) versus (12,20,28)	25.0	29.2	27.1	29.2	20.8	25.0
(16,24) versus (12,28)	37.5	8.3	22.9	37.5	16.7	27.1

This fact can be seen most easily by comparing specifications (1) and (2) of Table C.2, which runs a linear random-effect regression on a complete set of alternative dummies (the certain versus tertiary alternative is the baseline of these regressions) separately for the transparent and non-transparent conditions. For either condition the main observations with respect to distribution choice from Section 3.3 hold: there is a general reluctance to choose the riskier of the two distributions with the certain versus tertiary alternative being the notable exception, where around 50% of RCs choose the tertiary alternative. The only effect of non-transparency appears to be a marginally significant increase in the proportion of RCs choosing the binary distributions over the certain distribution; there is no direct effect or interaction-with-ρ_{RC} effect – see specification (3).

Tables C.3 and C.4 investigate the bargaining outcomes after the distribution choice has been made. Again there is no overall consistent effect from making the distribution choice non-transparent. For agreed FP payments — Table C.3 — the effect of risk and the role of the FP player's attitude towards risk show up more strongly in the non-transparent setting than the transparent one. However, the opposite is true for the role of the RC player's attitude towards risk.

For disagreements – Table C.4 – there is a significant increase for both tertiary distributions in the non-transparent setting; something that is not seen in the transparent setting and runs counter to the behavioural prediction that the non-transparent setting should mask intentions. However, much of the significant increases in disagreement rates in the non-transparent setting disappear once a dummy variable for whether the riskier of the two distributions was implemented is included, leaving just a large increase for the $(16, 20, 24)$.

Table C.2: Linear Random-Effects Regression of Choice of Distribution (Periods 6-10) Including the TC versus NTC Contrast

	Riskier Distribution Chosen					
	(1)		(2)		(3)	
1[Certain versus Binary]	-0.25^{**}	(0.105)	-0.07	(0.082)		
1[Tertiary versus Binary]	-0.20^{**}	(0.094)	-0.24^{***}	(0.089)		
1[(16,20,24) versus (12,20,28)]	-0.23^{***}	(0.086)	-0.29^{***}	(0.081)		
1[(16,24) versus (12,28)]	-0.28^{***}	(0.095)	-0.27^{***}	(0.085)		
1[Certain versus Tertiary]					0.25^{***}	(0.049)
1[Certain verus Binary] × **1**[Non-Transparent]					0.19^{*}	(0.105)
1[Non-Transparent]					-0.06	(0.076)
ρ_{RC}					-0.29^{***}	(0.078)
ρ_{RC} × **1**[Non-Transparent]					0.13	(0.161)
Constant	0.51^{***}	(0.055)	0.49^{***}	(0.065)	0.34^{***}	(0.049)
R^2	0.04		0.06		0.08	
Observations	206		206		412	
Transparency Condition	TC		NTC		—	

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

Table C.3: Linear Random-Effects Regressions of Agreed FP Payments in the Endogenous Environment (Periods 6-10) Including the TC versus NTC Contrast

	Agreed FP Payments							
	(1)		(2)		(3)		(4)	
Variance	-1.03	(0.677)	-1.90^{***}	(0.593)	-0.66	(0.676)	-2.22^{**}	(0.958)
1[Riskier Dist.]	0.02	(0.364)	0.23	(0.414)	-0.05	(0.351)	0.28	(0.403)
ρ_{FP}					-0.47	(1.033)	-2.15^{***}	(0.638)
ρ_{RC}					0.54^{*}	(0.297)	-0.48	(0.957)
ρ_{RC} × Var.					-2.22^{***}	(0.633)	0.82	(1.599)
R^2	0.04		0.10		0.06		0.20	
Observations	189		182		189		182	
Transparency Condition	TC		NTC		TC		NTC	

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

D Endogenous Distribution Results: First Five Periods

Table D.1 presents summary statistics, and Table D.2 complete pairwise comparisons across distributions, of the bargaining outcomes and fairness perceptions for the first five periods, when the distribution was exogenously specified. As can be seen these results reflect those for the exogenous-distribution sessions presented in Section 2.3. In particular, agreed payments to FP players are significantly lower with risk, confirming Hypothesis 1. Furthermore, Hypothesis 4 is rejected: as the risk increases, the frequency of disagreements increases and significantly so for the two low-risk distributions.

Table D.3 replicates the analysis of Table 2. With respect to Hypothesis 2, for a given

Table C.4: Linear Random-Effects Regressions of Disagreements in the Endogenous Environment (Periods 6-10) Including the TC versus NTC Contrast

	Disagreements							
	(1)		(2)		(3)		(4)	
$\mathbf{1}[(16,20,24)]$	0.07	(0.060)	0.19^{**}	(0.074)	0.05	(0.061)	0.17^{**}	(0.078)
$\mathbf{1}[(16,24)]$	0.06	(0.055)	0.09^{**}	(0.037)	0.04	(0.051)	0.06	(0.042)
$\mathbf{1}[(12,20,28)]$	-0.04^{*}	(0.025)	0.13^{***}	(0.048)	-0.08^{*}	(0.045)	0.07	(0.046)
$\mathbf{1}[(12,28)]$	0.17^{***}	(0.065)	0.07	(0.068)	0.10	(0.094)	-0.00	(0.089)
$\mathbf{1}$[Riskier Dist.]					0.07	(0.062)	0.08^{*}	(0.041)
Constant	0.04^{*}	(0.025)	0.02	(0.024)	0.04^{*}	(0.025)	0.02	(0.024)
R^2	0.05		0.04		0.06		0.05	
Observations	206		206		206		206	
Transparency Condition	TC		NTC		TC		NTC	

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

Table D.1: Bargaining Outcomes and Fairness Perceptions in the Endogenous Environment (Periods 1-5)

Distribution of Pie	Final FP Earnings (€)	Agreed FP Payments (€)	Disagreements (%)	Remaining Time (sec)	Fair Payment to FP FP (€)	Fair Payment to FP RC (€)
(20)	10.17 (3.24)	10.61 (2.50)	4.2 (20)	135 (88)	10.02 (0.25)	10.10 (1.07)
(16,20,24)	8.73 (3.44)	9.74 (1.79)	10.4 (31)	73 (86)	10.45 (1.62)	9.78 (1.76)
(16,24)	8.69 (3.84)	9.82 (2.34)	11.5 (32)	95 (80)	10.19 (1.27)	9.20 (1.28)
(12,20,28)	8.47 (2.79)	9.13 (1.50)	7.3 (26)	57 (79)	9.85 (1.45)	8.66 (1.94)
(12,28)	8.20 (3.03)	8.94 (1.81)	8.3 (28)	66 (77)	9.58 (1.61)	8.56 (1.91)

Notes: Standard deviations are reported in parentheses. The columns "Fair payment to FP" report the judgements of a fair allocation to the FP player. The first of these is the average allocation reported by those assigned the FP role; the second, the average reported by those assigned the RC role.

distribution, agreed payments to FP players are decreasing in the FP's own risk aversion, consistent with the results from the exogenous-distribution session. The coefficients for the RC player's risk aversion and its interaction with risk, however, are insignificant and of the wrong sign, although by the second half of the experiment these terms have the expected sign, even if the overall effect is still negative – see Table 7 of the main text. With respect to Hypothesis 3, consistent with the exogenous-distribution sessions, it is the relatively less risk averse RC players that benefit from risk – see Table 8 of the main text.

Table D.2: Pairwise Comparison of Bargaining Outcomes in the Endogenous Environment (Periods 1-5)

	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)
	Final Earnings					*Agreed FP Payments*				
(20)	10.17	$>^{***}$	$>^{***}$	$>^{***}$	$>^{***}$	10.61	$>^{**}$	$>^{***}$	$>^{***}$	$>^{***}$
(16,20,24)		8.73	$>$	$>$	$>$		9.74	$<$	$>^{***}$	$>^{***}$
(16,24)			8.69	$>$	$>$			9.82	$>^{***}$	$>^{***}$
(12,20,28)				8.47	$>$				9.13	$>$
(12,28)					8.20					8.94
	Disagreements					*Time Remaining*				
(20)	4.2	$<^{**}$	$<^{**}$	$<$	$<$	135	$>^{***}$	$>^{***}$	$>^{***}$	$>^{***}$
(16,20,24)		10.4	$<$	$>$	$>$		73	$<^{**}$	$>$	$>$
(16,24)			11.5	$>$	$>$			95	$>^{***}$	$>^{**}$
(12,20,28)				7.3	$<$				57	$<$
(12,28)					8.3					66

Notes: The symbol indicates how the outcome measure of the row distribution compares (statistically) to the column distribution. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

Table D.3: Linear Random-Effects Regression of Agreed Payments to the FP Player in the Endogenous Environment (Periods 1-5)

	Agreed FP Payments			
	(1)	(2)	(3)	(4)
$\mathbf{1}[(16,20,24)]$	-1.10^{***} (0.335)			
$\mathbf{1}[(16,24)]$	-0.85^{***} (0.285)			
$\mathbf{1}[(12,20,28)]$	-1.60^{***} (0.322)			
$\mathbf{1}[(12,28)]$	-1.64^{***} (0.347)			
Variance		-1.42^{***} (0.299)	-1.43^{***} (0.298)	-1.63^{***} (0.488)
ρ_{FP}			-1.12^{**} (0.520)	-1.14^{**} (0.538)
ρ_{RC}			-0.95^{**} (0.379)	-1.24 (0.811)
$\rho_{RC} \times$ Var.				0.64 (1.067)
Constant	10.78^{***} (0.301)	10.34^{***} (0.217)	11.05^{***} (0.323)	11.14^{***} (0.424)
R^2	0.09	0.06	0.10	0.11
Observations	378	378	378	378

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

E Robustness Checks using Matching-Group Averages

Table E.1: Pairwise Comparison of Bargaining Outcomes in any Period with an Exogenously Specified Distribution (Periods 1-10 of Exogenous Treatment and Periods 1–5 of Endogenous Treatment) – Robustness Check using Matching Group Averages

	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)
	Final Earnings					*Agreed FP Payments*				
(20)	10.02	$>^{***}$	$>^{***}$	$>^{***}$	$>^{***}$	10.45	$>^{***}$	$>^{***}$	$>^{***}$	$>^{***}$
(16,20,24)		8.83	$>$	$>$	$>^{*}$		9.71	$<$	$>^{***}$	$>^{***}$
(16,24)			8.52	$>$	$>$			9.73	$>^{***}$	$>^{***}$
(12,20,28)				8.34	$>^{*}$				9.10	$>^{**}$
(12,28)					7.85					8.90
	Disagreements					*Time Remaining*				
(20)	4.2	$<^{**}$	$<^{**}$	$<$	$<$	141	$>^{***}$	$>^{***}$	$>^{***}$	$>^{***}$
(16,20,24)		9.0	$<$	$>$	$<$		72	$<$	$>^{*}$	$>$
(16,24)			12.5	$>$	$>$			77	$>^{**}$	$>^{*}$
(12,20,28)				8.3	$<$				51	$<$
(12,28)					11.8					62

Notes: The symbol indicates how the outcome measure of the row distribution compares (statistically) to the column distribution. ***1%, **5%, *10% significance using signed rank test on matching-group level averages. Note that period 1-10 of the exogenous environment provides 4 independent observations per comparison, while periods 1-5 of the endogenous environment provides 16 independent observations per comparison.

Table E.2: Pairwise Comparison of Bargaining Outcomes in the Endogenous Treatment (Periods 6-10) – Robustness Check using Matching Group Averages

	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)	(20)	(16,20,24)	(16,24)	(12,20,28)	(12,28)
	Final Earnings					*Agreed FP Payments*				
(20)	9.76	$>^{***}$	$>^{**}$	$>^{***}$	$>^{***}$	10.14	$>^{**}$	$>$	$>^{***}$	$>^{***}$
(16,20,24)		8.39	$<$	$<$	$>$		9.81	$<$	$>^{*}$	$>^{**}$
(16,24)			8.71	$>$	$>^{*}$			9.84	$>^{*}$	$>^{*}$
(12,20,28)				8.51	$>^{**}$				9.17	$>^{*}$
(12,28)					7.42					8.44
	Disagreements					*Time Remaining*				
(20)	3.7	$<^{**}$	$<^{**}$	$<$	$<^{**}$	123	$>^{***}$	$>^{***}$	$>^{***}$	$>^{***}$
(16,20,24)		14.4	$>$	$>^{*}$	$>$		62	$>$	$>$	$>$
(16,24)			11.4	$>$	$<$			60	$>$	$>^{*}$
(12,20,28)				7.1	$<$				52	$>^{**}$
(12,28)					12.1					22

Notes: The symbol indicates how the outcome measure of the row distribution compares (statistically) to the column distribution. ***1%, **5%, *10% significance using signed rank test on matching-group level averages (based on 16 matching group averages).

Table E.3: Pairwise Comparison of RCs Choosing Riskier Distribution in the Endogenous Treatment (Periods 6-10) – Robustness Check using Matching Group Averages

	Certain versus Tertiary	Certain versus Binary	Tertiary versus Binary	(16,20,24) versus (12,20,28)	(16,24) versus (12,28)
	Low Risk				
Certain versus Tertiary	52.1	$>^{*}$	$>^{**}$	$>^{**}$	$>^{**}$
Certain versus Binary		31.3	$>$	$>$	$<$
Tertiary versus Binary			31.3	$>$	$<$
(16,20,24) versus (12,20,28)				27.1	$<^{**}$
(16,24) versus (12,28)					37.5
	High Risk				
Certain versus Tertiary	52.1	$>$	$>^{**}$	$>^{*}$	$>^{**}$
Certain versus Binary		39.6	$>$	$>^{*}$	$>^{**}$
Tertiary versus Binary			25.0	$>$	$>^{*}$
(16,20,24) versus (12,20,28)				25.0	$>^{*}$
(16,24) versus (12,28)					12.5
	Combined				
Certain versus Tertiary	52.1	$>^{**}$	$>^{***}$	$>^{***}$	$>^{***}$
Certain versus Binary		35.4	$>$	$>$	$>^{*}$
Tertiary versus Binary			28.1	$>$	$>$
(16,20,24) versus (12,20,28)				26.0	$>$
(16,24) versus (12,28)					25.0

Notes: The symbol indicates how the outcome measure of the row distribution compares (statistically) to the column distribution. ***1%, **5%, *10% significance using signed rank test on matching-group level averages (the low risk and high risk blocks are based on 8 matching group averages; the combined, on 16).