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Bargaining with a Residual Claimant: An Experimental Study

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February 4, 2019

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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 it is revealed. Furthermore, exposure to this risk is often asymmetric. 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 world-wide 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).[2]

Despite its obvious relevance there is no clean evidence on how asymmetric exposure to risk affects bargaining outcomes and how these are related to negotiators' risk preferences. Using a series of controlled laboratory experiments we provide such evidence. Specifically, we show that the party exposed to risk can actually benefit from this exposure. Furthermore, under some circumstances residual claimants actively choose to bargain over a riskier distribution, thereby increasing their risk exposure. At first sight this may seem 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, there are theoretical arguments proposing that the asymmetric exposure to risk can shift the agreement in favour of the exposed agent. 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.

[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] Asymmetric exposure to risk appears to have played a prominent role in two 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 (Eric Chemi, *Bloomberg Business*, September 12, 2014), "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" (Andrew Brandt, *Forbes*, March 7, 2011), 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." (Kevin Allen, *USA Today*, September 15, 2012). These quotes illustrate that it is far from 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, the NFL example suggests that it may have been advantageous to the owners.

In addition to the theoretical argument 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 ideas of 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 risk exposure. Studies have shown that when there are competing fairness ideas in bargaining, agreements often fall between between the two fairness ideas (e.g., Gächter and Riedl, 2005; Bolton and Karagözoğlu, 2016; Karagözoğlu and Riedl, 2015). This suggests that the residual claimant will receive some risk premium. However, whether the premium is sufficient to make risk exposure beneficial will depend on how much of the difference between these fairness ideas residual claimants can secure for themselves.

We conduct a series of lab experiments to address the issues discussed. Specifically, we ask the following questions. First, is the residual claimant able to extract a risk premium for her exposure to risk? Second, if residual claimants do extract a risk premium, is it sufficiently large to make them better off when being exposed to risk? Third, when 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?[3]

We obtain systematic empirical evidence on bargaining behaviour under asymmetric exposure to risk in two different experimental environments. In both environments, subjects are matched into pairs and 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. In the *exogenous* environment, the distribution of the pie is exogenously determined. Subjects negotiate ten times in randomly rematched pairs, experiencing five distributions of the pie, which are ranked according to second-order stochastic dominance. In the *endogenous* environment, after having experienced different exogenously imposed pie-distributions, residual claimants must choose to bargain over less or more risky distributions of pies.

Our main results are as follows. 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. Additionally, the payment to the fixed-payoff player is decreasing in own risk aversion and increasing in the risk aversion of the residual claimant.[4] Further, using estimates of the certainty equivalent of agreements, we find that the relatively less risk averse residual claimants benefit in expected utility terms from their exposure to risk. Consistent with these results, when residual claimants choose in

[3]Other experimental studies have investigated bargaining with one-sided private information on the pie size (see, e.g., Mitzkewitz and Nagel, 1993), an environment notably different from the one we are studying. Somewhat related to our research, Deck and Farmer (2007) study a Nash demand game between two risk neutral parties, with one being a residual claimant. Their focus on arbitration rules differs considerably from our research questions.

[4]For previous experimental results on bargaining and risk preferences, see Murnighan et al. (1987) and the references cited therein.

the endogenous environment between a less risky or more risky pie-distribution over which to bargain, it is the relatively less risk averse residual claimants who are more likely to choose the riskier pie-distribution. Our results also indicate a general reluctance to choose the riskier pie-distribution, which may be attributed to the 5–8 percentage points increase in the frequency of disagreements associated with bargaining over the riskier pie-distribution.

In addition, our analysis of the bargaining process (opening and final offers, concessions, bargaining duration) shows that, when the pie is risky, fixed-payoff players (especially those who are relatively more risk averse) adopt a weaker bargaining strategy. That is, 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 relative to a risk-free bargaining situation asymmetric exposure to risk increases the frequency of disagreements and decreases the prevalence of 50-50 splits. This result can be attributed to competing notions of what constitutes a fair split.

2 Experimental Design

We implemented a free-form tacit bargaining environment in which pairs of subjects have four minutes to exchange offers and reach an agreement, but have no other channel to communicate beyond their offers/demands. One agent is the residual claimant (RC); the other the fixed-payoff player (FP). At the time of bargaining, agents know the distribution of possible pie sizes but the actual pie size is unknown to them. The object of negotiation is the amount to be paid to the FP player, which 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 case of agreement 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.[5]

We chose an unstructured bargaining framework because it provides a natural environment in which players can express their bargaining strategy through the continuous back-and-forth nature of proposals and counter-proposals. The unstructured bargaining environment also provides a rich set of bargaining process data, which can be used to provide further insights into the nature of bargaining.

We implemented two related environments. First, in the *exogenous* environment, the distribution of the pie is exogenously varied from round to round. This environment is used to understand how asymmetric exposure to risk affects bargaining outcomes, and whether subject behavior responds to manipulating the degree of ex-post risk. It also allows us to address the question of whether residual claimants benefit in welfare terms from their exposure to risk. Second, in the *endogenous* environment the residual claimant is asked to choose between two pie-distributions over which to bargain, after having gained some bargaining

[5]See Section C of the Supplementary Materials (SM) for a complete set of instructions.

experience in an environment with exogenously given pie-distributions. The choice is always between two pie-distributions where one is a mean-preserving spread of the other. This allows us to more directly address the welfare question because a choice of the riskier distribution reveals a preference to bargain over a riskier pie-distribution.

Five different pie-distributions were implemented using a within-subject design. As a benchmark, one distribution had no risk and subjects bargained over a pie size of €20 for sure. For the risky cases, four pie-distributions with a mean of €20 and mean-preserving spreads were used, varying the extremes of the possible outcomes (low risk versus high risk) and the number of possible outcomes (binary lottery versus ternary lottery). In each pie-distribution, every 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: Summary of Experimental Design

(a) Exogenous Environment: Pie-distributions with Risk

	Ternary	Binary
Low Risk	(16,20,24)	(16,24)
High Risk	(12,20,28)	(12,28)

(b) Endogenous Environment: Pie-distribution Choices in Rounds 6–10

Low Risk	High Risk
(20) vs (16,24)	(20) vs (12,28)
(20) vs (16,20,24)	(20) vs (12,20,28)
(16,24) vs (16,20,24)	(12,28) vs (12,20,28)
(16,24) vs (12,28)	(16,24) vs (12,28)
(16,20,24) vs (12,20,28)	(16,20,24) vs (12,20,28)

Figure 1(a) shows the four risky pie-distributions that were implemented. Fixing the number of possible outcomes (Ternary, Binary), the pie-distribution including the outcomes 12 and 28 is riskier than the one including 16 and 24. Fixing the extremes of the pie-distribution (Low Risk, High Risk), the binary distribution is riskier than the ternary distribution. Finally, it is easy to see that the (16,24) distribution second order stochastically dominates the (12,20,28) distribution. Thus, the ternary-high-risk condition is riskier than the binary-low-risk condition. A further difference between the binary and ternary pie-distributions is that the latter includes the 20 outcome. As a result, with the ternary pie-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. In contrast, with the binary pie-distribution, the 50-50 split of the expected value of the pie necessarily leads to an ex-post unequal outcome. This difference may effect bargaining behaviour and outcomes if subjects have concerns for ex-post fairness (Saito, 2013; Cettolin et al., 2017). Subjects bargained for 10 rounds experiencing each pie-distribution twice.

In the endogenous environment, subjects first bargained in 5 rounds with exogenous pie-distributions, in which they experienced each pie-distribution once. Thereafter, in rounds 6–10, residual claimants were asked to choose between two pie-distributions before bargaining. The endogenous environment was implemented in two variants. In half of the sessions, the pie-distribution chosen by the residual claimant was for sure the pie-distribution that the pair bargained over (transparent implementation); in the other half, the chosen pie-distribution was implemented with 70% chance, and the non-chosen pie-distribution was implemented with 30% chance (non-transparent implementation).[6]

Given the five pie-distributions considered, we could create 10 possible pairs of pie-distributions for the residual claimant to choose from in the endogenous environment. However, since we also wanted subjects to gain experience first with an exogenously given pie-distribution, it was not feasible to consider all 10 possible pairs in the same session. Therefore, we created two sets, called 'Low Risk' and 'High Risk' (see Figure 1(b)). In each set the RC player had the choice between distributions with the same general structure: (20) versus binary, (20) versus ternary, binary versus ternary (with the same extreme points), low risk binary versus high risk binary and low risk ternary versus high risk ternary. In the low risk set, the relatively less risky $(16, 24)$ and $(16, 20, 24)$ pie-distributions are used in the first three choices (rounds 6–8); in the high risk set, the relatively more risky $(12, 28)$ and $(12, 20, 28)$ pie-distributions are used in the first three choices (rounds 6–8). The remaining two distributions used in rounds 9–10 were the same in both the low and high risk set. In total we get data on 8 of the 10 possible binary choice sets, including all four of the more important ones: no risk versus some risk.

2.1 Theoretical Background and Hypotheses

The theoretical background is provided by White (2006, 2008). Assuming common knowledge of risk preferences, the author provides mild conditions under which the expected receipts of the residual 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) and cooperative Nash bargaining (Nash, 1950), the curvature of an agent's utility function is a key determinant of the allocation an agent will receive. All else equal, a more risk averse agent values an additional dollar less. Therefore, in the alternating-offers setting, she is less willing to hold out to make a more advantageous counteroffer. In the Nash bargaining solution, which seeks to maximize the Nash product, as risk aversion increases, the share allocated to the agent decreases because the marginal impact on the Nash product of an additional dollar gets smaller.

To illustrate that exposure to risk could be beneficial for an agent, consider adding a mean-preserving spread to a risk averse agent's payment. Under the assumption of decreas-

[6] We were initially concerned that the transparency of the RC's choice over which pie-distribution to bargain over would affect RCs willingness to choose the riskier pie-distribution, even if they otherwise perceived the additional risk as advantageous; hence the transparent and non-transparent variations of the endogenous environment. However, this dimension proved not to be a salient consideration, therefore for expositional ease we collapse this treatment variation and pool the data for our main analysis. Section D of the SM provides a detailed account of the design considerations, and the results of the transparent versus non-transparent contrast.

ing absolute risk aversion, marginal utility is a convex function. Consequently, holding the original agreement fixed, the expected marginal utility of the agent exposed to risk has increased relative to the risk-free case. Thus, the new agreement must shift away from the risk-free agreement in favor of the agent exposed to risk. Whether she ultimately benefits in utility terms from exposure to ex-post risk will also depend on the preferences of the fixed-payoff player since his marginal utility may increase as the agreement moves in favor of the residual claimant.[7]

Since we implement tacit bargaining in our experiments, we apply the Nash bargaining solution to provide a theoretical benchmark. In what follows, we give the specific predictions for the implemented environment with common knowledge of preferences. The Nash bargaining solution is found by maximising the product of the expected utilities of the FP and RC players. In our setting, given that the amount to divide is a random variable, π, 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, since disagreement represents the worst outcome, the solution will have the usual comparative statics with respect to the players' utility functions: 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).

Fixing the preferences of the players, Proposition 6 of White (2006) states that a residual claimant's expected share of the pie will increase with the addition of a small additive risk, compared to the no risk case. That is, the fixed payment to the FP player will decrease as risk increases.[8] However, a decreasing payment to the FP player does not always imply increasing welfare for the RC player. Proposition 7 of White (2006) provides a necessary and sufficient condition for the RC's welfare to improve with a small additive risk, compared to the no risk case. Under CRRA risk preferences, this will be true whenever the residual claimant is *more* risk averse than the FP player.[9]

In our experiment, the risks the RC player is exposed to are not small and White's Proposition 7 will not hold exactly. Indeed, numerical calculations show that the residual claimant being more risk averse than the FP player is neither necessary nor sufficient for the RC's welfare to improve when exposed to the risks in our experiment. However, it is still a useful approximation as can be seen in Figure 2, which plots in grey the region of risk preference parameter values over which RCs are predicted to do better in expected utility terms for two pie-distributions used in the experiment: $(16, 20, 24)$, which is the least risky

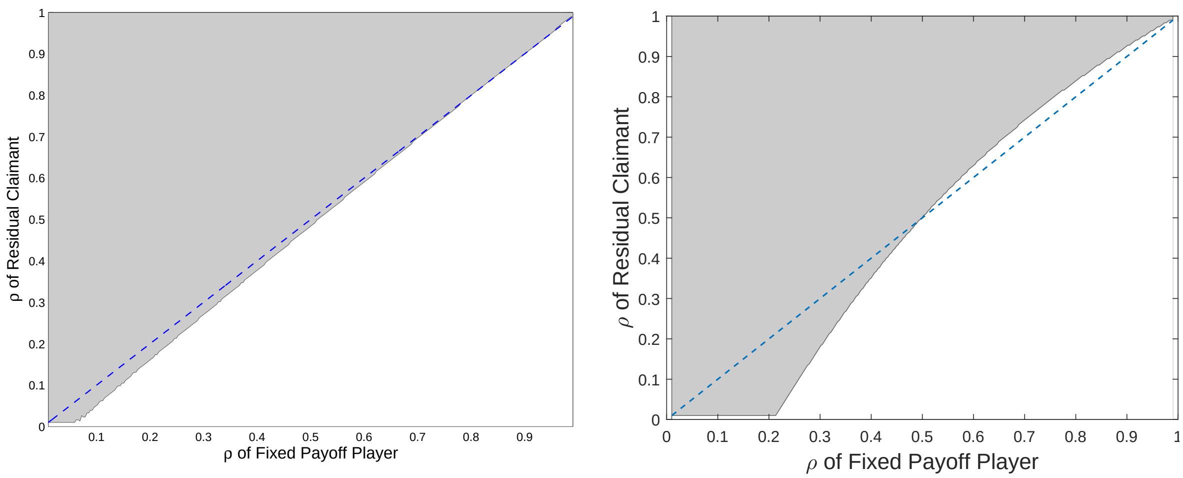
[7]The intuition is reminiscent of a result from the precautionary savings literature. Kimball (1990) showed that, with additive risk, a decision maker exhibiting decreasing absolute risk aversion (DARA) will *increase* her savings when her future income becomes risky. That is, the introduction of risk effectively makes the decision maker more patient.

[8]This holds under a mild condition that is always satisfied under both constant relative risk aversion (CRRA) and constant absolute risk aversion (CARA).

[9]Simple calculations show that this condition can never be satisfied under CARA risk preferences. 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, and argue that constant relative risk aversion cannot be rejected.

Figure 2: Region of players' risk parameters over which exposure to risk is advantageous for RC players

(a) $(16, 20, 24)$ **(b)** $(12, 28)$



Note: In the grey region RC players are predicted to do better in expected utility terms. The broken 45-degree line indicates the locus for which the RC and FP players have identical risk preferences. These figures are drawn under the assumption that players have, commonly known, CRRA utility functions. The parameter ρ represents the CRRA risk parameter, where $\rho = 0$ implies risk neutrality.

of the uncertain pie-distributions, and $(12, 28)$, which is the the most risky. The 45 degree line indicates the locus for which the RC and FP players have identical risk preferences.

An immediate implication of these welfare results is that there may be (risk-averse) residual claimants who should choose to add a mean-preserving risk to the pie-distribution because they can expect a higher welfare from the subsequent distribution of surplus. In particular, for the CRRA case, to a first order approximation, RC players should choose – when given the opportunity – a riskier distribution whenever they are more risk averse than the FP player they are matched with. In our experimental implementation, given the random matching scheme and timing of choices, the RC players do not know the risk attitude of the FP player they are matched with when making their pie-distribution choice. Nonetheless, for a given pool of FP players, the more risk averse the RC player, the more likely she is to be more risk averse than her randomly selected counter-part. Therefore, relatively more risk averse RC players should expect on average to do better when bargaining over the riskier pie-distribution.

The above discussion leads us to the following set of hypotheses:[10]

Hypothesis 1 *The amount allocated to the fixed-payoff player declines as the riskiness of the pie-distribution increases.*

Hypothesis 2 *The amount allocated to the fixed-payoff player is decreasing in own risk aversion and increasing in the residual claimant's risk aversion. This holds regardless of the riskiness of the pie-distribution, provided that the residual claimant is strictly risk averse.*

[10]See Section B.1 of the SM for a graphical illustration of Hypotheses 1–3.

Hypothesis 3 (a) *Residual claimants can benefit in welfare terms from adding a mean-preserving risk to their receipts.* (b) *To a first approximation, whenever the residual claimant is* ***more*** *risk averse than the fixed-payoff player, the residual claimant's welfare will be higher when faced with a risky pie-distribution than when faced with a riskless pie-distribution.*

Hypothesis 4 (a) *There are residual claimants who choose the riskier of two pie-distributions.* (b) *The likelihood of choosing the riskier pie-distribution is increasing in the risk aversion of the residual claimant.*

In addition to the above, the following hypothesis regarding disagreements is a direct consequence of the Pareto optimality axiom built into the Nash bargaining solution concept:

Hypothesis 5 *Across all pie-distributions, the frequency of agreements is 100%.*

2.2 Behavioral and Theoretical Extensions

As already mentioned, there may be factors at play not considered by the benchmark model. Most prominently, fairness-driven bargaining behavior or private information of risk preferences could have a significant influence on bargaining, especially with the addition of asymmetric exposure to risk. We briefly discuss how these might impact our benchmark hypotheses.

2.2.1 Fairness-Driven Bargaining Behavior

It is entirely plausible that asymmetric exposure to risk could create competing beliefs for what constitutes a fair allocation. For example, the fixed-payoff players may think that the 50-50 split of the expected pie is a fair allocation, whereas residual claimants may deem it fair that they are compensated for their exposure to risk and, thus, may feel entitled to more than half of the expected pie. Bargaining studies have indeed shown that when there are competing fairness ideas, agreements often fall between allocations reflecting these ideas (see, e.g., Gächter and Riedl, 2005; Karagözoğlu and Riedl, 2015; Bolton and Karagözoğlu, 2016).

To provide more structure to how such fairness ideas might impact our benchmark hypotheses, we follow the approach taken in Bolton and Karagözoğlu (2016), who consider a social preference modification of the Nash bargaining solution (NBS) in an environment with two competing fairness ideas, d_1 and d_2, where d_1 is advantageous to player 1 and d_2 is advantageous to player 2. The main idea is that, in the worst case, to avoid disagreement a player could always concede to the other player's perceived fair distribution. The result is a *fairness-adjusted* NBS, where each player's disagreement utility is given by the amount they would receive under the other player's perceived fair allocation.

In our setting, it is natural to think that there are two prevalent self-serving fairness ideas: The FP player may try to argue that the players should ignore risk and just divide the expected pie evenly. On the other hand, the RC player may argue that some compensation for risk is fair. Let $y^f_{RC}(\pi) \leq y^f_{FP}(\pi)$ be the prevalent fairness ideas for the residual claimant and fixed payoff players, respectively, for a given pie-distribution. Then the adjusted disagreement point for the fixed payoff player is their utility from accepting, or offering, the payment $y^f_{RC}(\pi)$. For the residual claimant, their adjusted impasse point is their expected utility from accepting, or offering, the payment $y^f_{FP}(\pi)$. Denoting these impasse utilities by $(\tilde{d}^{\pi}_{FP}, \tilde{d}^{\pi}_{RC})$, then the fairness-adjusted NBS would select the $y \in [y^f_{RC}(\pi), y^f_{FP}(\pi)]$ that maximizes the product $[u_{FP}(y) - \tilde{d}^{\pi}_{FP}] \cdot \mathbb{E}_{\pi}[u_{RC}(\pi - y) - \tilde{d}^{\pi}_{RC}]$.

Given this framework there are two main questions. First, how do the players' fairness ideas respond to the riskiness of the pie-distribution? Second, how does the presence of such fairness ideas affect bargaining? To answer the first question, first consider the risk-free pie-distribution where it is reasonable to expect that the fairness ideas are symmetric so that $y^f_{RC} = y^f_{FP} = \frac{\bar{\pi}}{2}$. Consequently, the fairness-adjusted NBS would predict a prevalence of 50-50 splits irrespective each players' risk preferences, since there is no surplus over which to negotiate beyond satisfying each other's fairness-driven bargaining positions. With the introduction of ex-post risk, $y^f_{RC}(\pi)$ must be decreasing in the riskiness of π to compensate risk averse residual claimants for their loss in utility from being exposed to the risk that the fixed payoff player is not.[11]

In answer to the second question, this divergence in associated self-serving fairness ideas opens a new channel through which exposure to risk affects bargaining outcomes, over and above the prudence mechanism identified in White (2008). Furthermore, the fixed payoff players find themselves in a more difficult bargaining position as their associated fairness idea does not change, while that of the residual claimants is moving in a way that can only reduce the FP player's likely payment. It is also now the less risk averse residual claimants that are likely to benefit from the introduction of risk, since the less risk averse they are the more they can pull the agreement towards their own fairness idea, extracting a greater proportion of the surplus that remains between the two fairness-adjusted disagreement points.

These arguments suggest that the residual claimant will in general receive a premium for their exposure to risk, and that being more risk averse is, other things being equal, a disadvantage in bargaining, at least in the cases with risky pie-distributions. Consequently, the introduction of fairness-driven bargaining behavior does not alter Hypotheses 1 and 2. Furthermore, the opening up of a wedge between the self-serving fairness ideas for residual claimants and fixed payoff players, along with the prudence mechanism, also leads to the prediction that residual claimants can benefit in welfare terms from their exposure. However, the identity of those that are likely to benefit is quite different. Thus, while the (A) parts of Hypotheses 3 and 4 remain unchanged, we can formulate the following alternative versions of the (B) parts:

[11] Unlike Bolton and Karagözoğlu (2016), where the competing fairness ideas are clear, there is more ambiguity about the fairness idea for the residual claimant in our setting. For our purposes, we only need that $y^f_{RC}(\pi)$ decreases sufficiently in the riskiness of π, while a 50-50 split of the expected surplus remains the perceived fair outcome for fixed payoff players. For simplicity, we do not consider fairness ideas that are specific to the risk attitude of the residual claimant.

Hypothesis 3 (b alt) *It is the less risk averse RC players that are more likely to benefit in welfare terms when faced with a risky pie-distribution compared with a risk-less pie-distribution.*

Hypothesis 4 (b alt) *It is the less risk averse RC players that are more likely to choose to bargain over the riskier of two pie-distributions when given the choice.*

With regard to disagreements, that agents would always reach a Pareto-improving agreement is an accepted assumption for the Nash bargaining solution. However, it is not one that we would necessarily expect to hold in real bargaining. 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; Cettolin and Riedl, 2017), which may generate disagreements even if agents would otherwise agree in situations without risk. Birkeland and Tungodden (2014) is a recent paper which explicitly incorporates conflicting fairness ideals in a bargaining model. They show that disagreement may arise when players' fairness ideals diverge too much. In our case, such divergence is likely because each player type can easily adopt a self-serving fairness idea (see also, Babcock et al., 1995). Moreover, as the RC's desired compensation for bearing risk is predicted to increase with the riskiness of the pie-distribution, so does the tension between self-servingly biased fairness ideas. The fairness-adjusted model of Bolton and Karagözoğlu (2016) includes a small probability of a player being non-compromising; that is, they would rather disagree than accept an allocation that gives them less then *their own* perceived fair allocation. Given that the fairness ideas are compatible in the risk-free case, no disagreement is predicted irrespective of player types. However, divergent fairness ideas and the possibility that two non-compromisers meet means that bargaining with a risky pie-distribution could result in disagreement in their model.[12] This suggests the following alternative hypothesis regarding the frequency of agreements:

Hypothesis 5 (alt) *Disagreements are more likely to occur for risky pie-distributions than for the risk-less one. The frequency of disagreements increases with the riskiness of the pie-distributions.*

2.2.2 Concession Process

Zeuthen (1930) suggested a behavioral model of the bargaining process based on his concession principle, which states that the next concession must come from the player with the least willingness to face the risk of a conflict. Harsanyi (1977) extended this idea and

[12]Non-compromisers are included in Bolton and Karagözoğlu (2016) to make the fairness ideas credible. The simple formulation of a fixed probability of players being a compromiser or non-compromiser means that the probability of disagreement is the same irrespective of the degree of divergence in fairness-ideas. The authors consider the possibility of using the probability of meeting a non-compromiser as a way of modeling the credibility of a fairness-idea, something that would be needed to generate the prediction of increasing disagreement rates when the risky pie-distribution gets riskier or when comparing between two risky pie-distributions.

demonstrated its close connection to the Nash bargaining solution. More recently, Bolton and Karagözoğlu (2016) established an analogous bargaining process and equivalence result for their fairness-adjusted Nash bargaining solution. A player's willingness to face the risk of conflict is measured by their risk limit, which is defined as the ratio of their utility gain from getting their offer rather than the other's and their utility gain of getting their offer rather than disagreement. As shown in these papers, comparing players' risk limits for a given set of offers is equivalent to comparing the Nash product, or fairness-adjusted Nash product, of the offers. Based on these arguments the following benchmark and alternative hypotheses for the concession process can be formulated.[13]

Hypothesis 6 *Given open but incompatible offers from the FP and RC players, the player who has the lower risk limit will be the player more likely to make the next concession.*

Hypothesis 6 (alt) *When bargaining over risky pie-distributions, given incompatible open offers from the FP and RC players, which lie between their fairness ideas, the player who has the lower fairness-adjusted risk limit will be the player more likely to make the next concession.*

2.2.3 Incomplete Information

In the benchmark model, bargaining parties are assumed to have common knowledge of all the important parameters of the environment. The same is essentially true for the fairness-adjusted behavioral alternative discussed above. This assumption implies that bargaining parties should know each other's (risk) preferences and, for the behavioral alternative, additionally, each other's (self-servingly biased) fairness ideas. Both are clearly strong assumptions.

Extensions of the cooperative Nash bargaining solution concept to the case of incomplete information typically involve parties negotiating over more complex objects than offers and counter-offers. Since simple offers over divisions of the surplus can reveal valuable private information, in such extensions, parties bargain over whole mechanisms, which are then implemented once an agreement has been reached (see Myerson, 1991, chapter 10). It is beyond the scope of this paper to provide a full fledged formal treatment of the incomplete information case. However, Section B.4 of the Supplementary Materials provides a numerical analysis of a number of possible specifications for the extension of the Nash bargaining solution suggested by Myerson (1979).

This analysis finds that residual claimants can benefit from there exposure to risk, in line with the (A) parts of Hypotheses 3 and 4. However, whether more or less risk averse residual claimants are most likely to benefit from ex-post risk depends on the details of the type-space. Yet, our numerical analysis suggests that it is more likely to be the less risk averse type, as long as risk aversion is not too pronounced for the least risk averse type.

[13] See Section B.3 of the SM.

Finally, when risk preferences are private information, disagreement may occur as part of the solution to a generalized Nash bargaining solution. Interestingly, the numerical analysis shows that the frequency of disagreement may actually *decrease* when the riskiness of the pie-distribution increases.

2.2.4 Overall Summary

As this discussion shows, all of the models generally agree that FP players earnings should decrease as risk increases. Moreover, there is also agreement that *some* residual claimants may actually benefit in welfare terms from bargaining over a risky pie-distribution (relative to the risk-free case). However, there is less agreement on *which* residual claimants can be expected to benefit from risk exposure. In the results section we will, among other things, test those predictions about which the models agree and report insights about actual behavior where the models disagree.

2.3 Experimental Procedures

Overall 240 subjects participated in ten sessions with 24 subjects in each (48 subjects across two sessions for the exogenous pie-distribution environment; 192 subjects across eight experimental sessions for the endogenous pie-distribution environment). Each session was split into two matching groups of 12, which were run in parallel on separate z-Tree servers (Fischbacher, 2007), giving 20 matching groups in total.

Each session consisted of two parts. At the beginning of the first part, which consisted of 10 bargaining rounds, subjects were randomly assigned either the role of the RC or the FP player, and kept the same role throughout. For the exogenous pie-distribution experiments, at the beginning of a bargaining round, subjects were randomly matched within their matching groups into pairs (one RC and one FP) and were informed of the pie-distribution 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.[14] 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, and subjects received feedback on the size of the pie, their own payoff and that of their match. In case of disagreement both bargaining parties earned nothing. No communication beyond sending and accepting offers was permitted.

During a session, the order of pie-distributions was the same for all subjects in a matching group. For the exogenous environment, this order was varied across matching groups, except that in rounds 1 and 10 subjects always bargained over the risk-free pie of €20.[15] In all cases,

[14]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 pie-distribution). In all cases, this was greater than half of the expected pie size of 20.

[15]The four orders were: (16,24), (12,28), (16,20,24), (12,20,28); (12,28), (16,24), (12,20,28), (16,20,24); (16,20,24), (12,20,28), (16,24), (12,28); (12,20,28), (16,20,24), (12,28), (16,24). These systematically vary

Table 1: Details of Experimental Design

Environment	Choice Set	Transparency	Sessions	Matching Groups	Subjects
Exogenous	n/a	n/a	2	4	48
Endogenous	Low Risk	Transparent	2	4	48
		Non-Transparent	2	4	48
	High Risk	Transparent	2	4	48
		Non-Transparent	2	4	48

in the first five rounds all subjects experienced each of the five pie-distributions exactly once. The order in rounds 6 to 9 was the same as in rounds 2 to 5.

For the first five rounds, in the endogenous environment the procedures were identical to the exogenous environment: an FP player and an RC player bargained over an exogenously specified pie-distribution.[16] In rounds 6 through 10 of the endogenous environment, at the beginning of each round, the residual claimant was presented with a pair of possible pie-distributions (c.f. Figure 1) and asked to choose one which would be implemented, either with certainty in the transparent choice sessions, or with 70% chance in the non-transparent choice treatment. Details of the design are shown in Table 1.

In the second part of the experiment, subjects were given a risk preferences elicitation task. Specifically, the certainty equivalent for six different binary lotteries was elicited using an implementation similar to Cettolin and Tausch (2015) (see also Bruhin et al., 2010).[17] For each subject, the elicited certainty equivalents were used to estimate the ρ parameter assuming a CRRA functional form: $u(x) = (1/(1-\rho))x^{1-\rho}$. The vast majority of residual claimants are estimated to be risk averse (see Figure A.1 of the appendix).

We also gathered information on subjects fairness views for the different pie-distributions. Subjects were asked to give their judgement of a fair allocation to the FP player, for each of the five pie-distributions. 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). This fairness elici-

whether the binary lotteries or the ternary lotteries were shown first, and whether the low risk or high risk came first.

[16]The data from the first five rounds in the endogenous environment can be used for a robustness check of the results in the exogenous environment, with the qualifiers that the order of uncertain pie-distributions in round 2-5 was always (16,24), (12,28), (16,20,24) and (12,20,28), and subjects knew that in rounds 6-10 the RC player would make a choice before bargaining. This robustness check is not a primary concern and is relegated to the Supplementary Materials. The main results reported in Section 3 carry over to the first five rounds of the endogenous environment—see Section E of the SM for details.

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

tation was completed at the end of the experiment as part of a questionnaire that included questions on demographic and study programme characteristics.[18]

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. Subjects were paid a show-up fee of €2. They also received payment for one randomly selected bargaining round from the first part, and the risk-elicitation in part 2 was similarly incentivized. On average subjects earned between €20 and €23.

3 Results

We begin our analysis by focussing on outcomes in the exogenous environment, to understand how asymmetric exposure to risk affects bargaining outcomes in the residual claimant environment (Hypotheses 1 and 2). Exploiting both the exogenous and endogenous environment, we then address the questions of whether there is any evidence that residual claimants might gain, or expect to gain, in welfare terms from their exposure to risk, and if so which risk preference types of residual claimant (Hypotheses 3 and 4). Finally, we investigate the robustness of the results on bargaining outcomes using the endogenous environment. Throughout, statistical significance is established using a regression-based approach with cluster-robust standard errors that allow for arbitrary correlation between observations within a matching group. Where possible, non-parametric tests on matching-group averages were run as a robustness check. These robustness checks are reported in Section F of the Supplementary Materials.[19]

3.1 Bargaining Outcomes in the Exogenous Environment

Table 2 presents a summary of the bargaining outcomes (for pairwise comparison tests see Table A.1 in the appendix). As can be seen, the FP players earn on average less than half of the expected pie of 10 for each pie-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

[18] We chose to elicit fairness judgements after bargaining 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. Nonetheless, we believe these measures are informative, not least since elicited fairness judgements are correlated with opening offers and appear to be related to the concession process (see the discussion in Section 4.2).

[19] In order to run robustness checks for analysis that focuses on the exogenous environment data, we use data from any period with an exogenously specified pie-distribution. This includes the first five periods of the endogenous environment sessions, as well as all periods of the exogenous environment sessions. Doing so gives 20 independent averages per pairwise comparison in the robustness-check version of Table A.1 (see Section F, Table F.1 in the SM). These robustness results are comparable to those reported in the main text.

model, in all risky pie-distributions the average agreed FP payment is less than half the equal split of the expected value (10) and decreasing in the riskiness of the pie-distribution.[20]

Disagreement rates range from 4.2% to 18.8% and are comparable to other studies using free-form bargaining—see, for example, Roth et al. (1988) and Gächter and Riedl (2005) who report disagreement rates of approximately 23% and 16%, respectively. Notably, the presence of risk also increases bargaining frictions. There are more disagreements with risk than without risk and if an agreement is reached, more time is required to reach it with risk. Along with the greater bargaining friction, fairness assessments diverge as the riskiness of the pie-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.[21] Moreover, for all pie-distributions with risk, average agreed payments are between the (self-serving) fairness perceptions of the RC and the FP players.

Table 2: Bargaining Outcomes and Fairness Ideas in the Exogenous Environment

Distribution of Pie	Final FP Earnings (€)	Agreed FP Payments (€)	Disagreements (%)	Remaining Time (sec)	Fairness Ideas (€ 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)	6.3 (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. 'Final FP Earnings' averages include the disagreement payment of zero when players fail to reach an agreement; 'Agreed FP Payments' averages do not. 'Remaining time' is the average time left when an agreement was reached (and as such is conditional on an agreement). The columns 'Fairness Ideas (€ 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.

The regression results reported in Table 3 investigate Hypotheses 1 and 2 directly. The dependent variable in these random-effects regressions is the agreed payment to the FP player (that is, payments conditional on agreements). The indicator variables $\mathbf{1}[(\cdot)]$ take value 1 for the indicated pie-distribution and 0 otherwise. The first specification confirms that, in comparison to the risk-free pie-distribution, risky pie-distributions reduce the agreed payment for FP players, and significantly so for all but the least risky pie-distribution. The second specification uses the variance of the pie-distributions, normalized so that the variance of the riskiest pie-distribution is one, as a single measure of riskiness and shows that this also captures the effect of this treatment variation. This supports Hypotheses 1.

[20] The top two panels of Table A.1 show that most of the pairwise comparisons are statistically significant for both final FP earnings and agreed FP payments. The latter result is also shown in the regression analysis reported in Table 3.

[21] 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 pie-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 not possible to reject the null hypothesis that the fairness assessments of FP players is equal to the 50-50 split for all pie-distributions. For the RC players, this can be rejected for all pie-distributions with risk.

Building upon specification (2), the last two columns include estimates of the risk aversion parameter 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 pie-distribution, being more risk averse worsens a subject's bargaining position irrespective of their role. In addition, the marginal effect of risk aversion appears smaller in magnitude for the RC player than the FP player. Specification (4) indicates that this results from the interaction between ρ_{RC} and risk. For fixed risk preferences of the FP and RC, increasing the risk of the pie improves the bargaining position of the latter, but the overall effect is still disadvantageous because $1.64 - 1.48 \times \text{Var} > 0$. For a fixed pie-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 (i.e., when $p_{RC} \times$ Var. equals zero because the variance equals zero). Overall, it can be concluded that risk preferences affect the agreed FP payment in the direction predicted by the benchmark model.

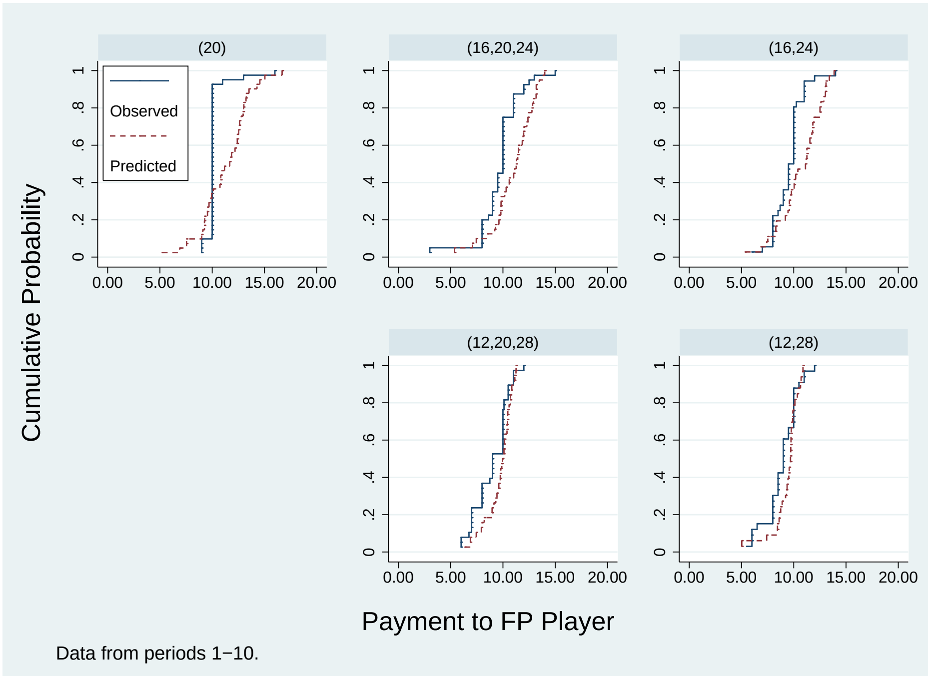
Table 3: Linear Random-Effects Regression of Agreed Payments to the FP Player

	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)
$\rho_{RC} \times$ 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

Note: Data include 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 3 show that agreed payments vary with risk preferences in the predicted manner, in line with Hypothesis 2, a stronger test 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 3 plots the cumulative distribution of agreed and predicted payments. This figure provides a number of insights. First, when there is no risk (panel (20)), nearly all agreements are a 50-50 division of the pie. That is, differences in preferences lose salience and the fairness idea of equal division dominates, which is consistent with the Bolton and Karagözoğlu (2016) model. Second, for the risky pie-distributions, there is a close correspondence between the observed and predicted division of payoffs, in particular for the high risk pie-distributions. Finally, agreed FP payments are on average smaller than predicted by the theoretical model. Indeed, for all pie-distributions,

Figure 3: Observed Versus Predicted Agreed Payments to the FP Player



this difference is significant ($p < 0.01$).[22] We summarize the above discussion in the following result.

Result 1 *Asymmetric exposure to risk affects bargaining outcomes in important aspects in a way consistent with the benchmark model: (1) average agreed payments to the fixed-payoff player decrease as the pie-distribution becomes more risky; (2) increased risk aversion reduces the average surplus share for a player, holding constant the pie-distribution and bargaining partner. There is also significant evidence for bargaining behavior consistent with a fairness-adjusted model: (3) with no pie-distribution risk, the equal split of the pie is the predominant agreement.*

3.2 Residual Claimant Welfare

Hypotheses 3 and 4 concern whether the welfare of a residual claimant could be increased by bargaining over a risky pie-distribution rather than a risk-free pie distribution. That is, is the observed reduction in FP payments when bargaining over a risky pie-distribution sufficient to compensate RC players for the disutility of bearing risk? To address this, we analyze behavior in both the exogenous and endogenous environments. First, we look at bargaining outcomes

[22]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.

in both environments and use the estimated risk attitude of the RC player to calculate the certainty equivalent of an agreement. Second, using the distribution choice data from the endogenous environment, we take a revealed preference approach and examine if RC players actually choose the more risky distribution.

To test if RC players' certainty equivalents of agreements are larger when bargaining over a risky rather than a risk-less pie-distribution we use a regression with independent variables for whether the pie-distribution has risk ($\mathbf{1}[\text{Var.} > 0]$), a control for whether the RC player is more risk averse than the FP player ($\mathbf{1}[\rho_{RC} > \rho_{FP}]$) and an associated interaction term.[23]

Column (1) of Table 4 reports the results of this analysis for the agreements from the exogenous environment. If Hypothesis 3(B) were correct—so that residual claimants benefit from exposure to risk when they are more risk averse than the FP player—then the sum of the coefficients of $\mathbf{1}[\text{Var.} > 0]$ and the interaction should be positive. As can be seen from the table, the coefficient for a risky pie-distribution is significantly positive; however, the coefficient of the interaction term is negative and larger in magnitude than the former coefficient. Therefore, while we find evidence of residual claimants benefiting in welfare terms from their exposure to risk in line with part (A) of Hypothesis 3, it is actually those residual claimants who are *less* risk averse than their fixed-payoff counterparts who are the ones benefiting, contrary to part (B) of the hypothesis. Indeed column (2) of Table 4—

Table 4: Linear Random-Effects Regression of the Certainty Equivalent of Agreements for RC Players

	Certainty Equivalent of Agreement for RC Player			
	Exogenous Environment		Endogenous Environment	
	(1)	(2)	(3)	(4)
$\mathbf{1}[\text{Var.} > 0]$	0.74^{***} (0.283)	0.63^{***} (0.022)	0.68^{***} (0.147)	0.83^{***} (0.163)
$\mathbf{1}[\rho_{RC} > \rho_{FP}]$	-0.05 (0.481)		-0.45 (0.367)	
$\mathbf{1}[\text{Var.} > 0] \times \mathbf{1}[\rho_{RC} > \rho_{FP}]$	-0.87^{***} (0.177)		-0.53^{*} (0.318)	
$\mathbf{1}[\text{Var.} > 0] \times \mathbf{1}[\rho_{RC} > 1/2]$		-1.67^{***} (0.198)		-0.72^{**} (0.301)
$\mathbf{1}[\text{Var.} = 0] \times \mathbf{1}[\rho_{RC} > 1/2]$		-0.44 (0.478)		0.63^{***} (0.188)
Constant	9.92^{***} (0.268)	10.07^{***} (0.100)	9.75^{***} (0.148)	9.38^{***} (0.195)
R^2	0.06	0.17	0.05	0.03
Observations	195	195	749	749

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.

[23]It should also be noted that the elicited risk parameter, ρ_{RC}, appears on both sides of the regression equation as it is used to calculate the certainty equivalent for the dependent variable as well as 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 model, 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 $\mathbf{1}[\text{Var.} > 0] \times \mathbf{1}[\rho_{RC} > \rho_{FP}]$.

which replaces the indicator variable for the RC player being more risk averse than the FP player with an indicator for whether the RC player has an estimated ρ_{RC} greater than $1/2$— suggests that it is the less risk averse RC players more generally that benefit, in line with Hypothesis 3(B ALT), the behavioral alternative of Hypothesis 3(B).

Specifications (3) and (4) replicate this analysis using the first five periods of the endogenous environment (during which the pie-distribution was exogenously specified). As for the exogenous environment, the results are contrary to Hypothesis 3(B). Specifically, specification (3) shows that risk exposure is beneficial but only for residual claimants who are less risk averse than their fixed-payoff player partner. Specification (4) shows that it is indeed the relatively more risk averse residual claimants who do not benefit from risk exposure.[24]

An alternative approach to the use of estimated certainty equivalents of agreements is to exploit RC players' pie-distribution choices in the endogenous environment, thus appealing to a revealed preference argument. That is, exploring whether RC players judge for themselves that they may benefit from bargaining over a pie with additional risk. This analysis addresses Hypothesis 4 and focuses on the choice of pie-distribution made by RC players during the last five rounds of the endogenous environment. Table 5 gives an overview of these choices. As can be seen, subjects were generally reluctant to take the riskier of the two pie-distributions, with overall only one-third of choices being for the riskier of the two. The Certain versus Ternary alternative is the notable exception, with just over 50% of RC players choosing the riskier ternary pie-distribution.

Table 5: Percent of RCs Choosing Riskier Pie-Distribution (Periods 6-10)

Alternatives	Low Risk Treatment	High Risk Treatment	Combined
Certain versus Ternary	52.1	52.1	52.1
Certain versus Binary	31.3	39.6	35.4
Ternary 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 statistical significance of this result is established in specification (1) of the regression analysis reported in Table 6, where the Certain versus Ternary alternative is the baseline. Variables $\mathbf{1}[\cdot]$ are indicator variables assuming value 1 for the respective alternative and 0 otherwise. The regression shows that, in comparison to Certain versus Ternary, there is a significantly lower rate of riskier pie-distribution choice for any other alternative. The effect appears fairly uniform across the four indicator variables and it is not possible to reject the null hypothesis that all the coefficients are equal ($p = 0.604$).[25]

[24] In specification (3), 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 ($p \ll 0.01$).

[25] A linear regression model is used to keep the regression analysis simple and consistent across tables, and

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

	Riskier Pie-Distribution Chosen		
	(1)	(2)	(3)
1[Certain versus Binary]	-0.20^{***} (0.068)		
1[Ternary 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 Ternary]		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 Ternary is the baseline category. Difference in Variance variable normalized so that the largest difference (Certain versus (12,28)) is equal to one.

Specification (2) of Table 6 illustrates that this effect is not a result of the difference in risk. Taking all pie-distributions except Certain vs Ternary as the baseline it shows a significantly positive effect for choosing the riskier pie-distribution in Certain vs Ternary even after controlling for the difference in variances of the pie-distributions. Recall that of the risky pie-distributions only the ternary distribution contains the possible realization of 20, which is also the pie-size in Certain. It thus appears that subjects most likely prefer to bargain over a risky pie-distribution, rather than the expected value for sure, only when there is the possibility of an ex-post equal split.

Finally, specification (3) of Table 6 addresses the second part of Hypothesis 4(B), concerning the relationship between the willingness to choose the riskier pie-distribution and risk preferences. The likelihood of choosing the riskier pie-distribution is decreasing in the risk aversion of the RC player, which goes against the prediction of the benchmark model, but is entirely consistent with the results from our indirect, regression-based inference reported in Table 4, where it was the relatively less risk averse RC players that appeared to benefit from bargaining over a risky pie-distribution. We summarize the discussion in our second result.

Result 2 *In line with Hypotheses* 3(A) *we find evidence that residual claimants can benefit in welfare terms from their exposure to risk. However, only a minority of residual claimants act in line with Hypotheses* 4(A) *and choose to bargain over the riskier distribution when given the choice. Moreover, contrary to Hypotheses* 3(B) *and* 4(B)*, but consistent with Hypotheses* 3(B alt) *and* 4(B alt)*, it is the relatively less risk averse residual claimants that are likely to be the ones to benefit from risk exposure and to choose the riskier pie-distribution.*

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 6, this simplification is unproblematic. 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 6. These additional robustness checks are included in the data-analysis scripts of the Supplementary Materials.

3.3 Bargaining Frictions in the Exogenous Environment

In Table 2 we saw that, disagreements were more prevalent when the pie was risky and when an agreement was reached, it took longer to do so when the pie-distribution was risky. Table 7 reports the results of linear random-effects regressions testing for significant differences across pie-distributions in disagreements and bargaining duration. As can be seen in specification (1) disagreements are significantly more frequent when bargaining over the riskiest pie-distribution than when bargaining over a riskless pie-distribution.

Table 7: Linear Random-Effects Regression of Disagreement and Time Remaining on Pie-Distribution

	Disagreement		Time Remaining (sec)	
	(1)		(2)	
$\mathbf{1}[(16,20,24)]$	0.02	(0.040)	-82.74^{***}	(27.626)
$\mathbf{1}[(16,24)]$	0.10	(0.071)	-114.05^{***}	(18.247)
$\mathbf{1}[(12,20,28)]$	0.06	(0.053)	-114.86^{***}	(14.320)
$\mathbf{1}[(12,28)]$	0.15^{***}	(0.053)	-101.63^{***}	(32.525)
Observations	480		428	
R^2	0.03		0.23	

Notes: ***1%, **5%, *10% significance using standard errors clustered at the matching group level.

Result 3 *Contrary to Hypothesis 5, but consistent with Hypothesis 5(*ALT*), disagreements are (significantly) more frequent when the pie-distribution is risky than when it is not.*

In addition, specification (2) shows that, when an agreement is reached, it occurs with significantly less time remaining until the deadline when the pie-distribution is risky than when it is not.

3.4 Robustness of Bargaining Outcomes in the Endogenous Environment

While the main focus of the endogenous environment is on the pie-distribution choices made by residual claimants, the bargaining outcome data can be used to see if bargaining behavior is substantially affected by this choice. For the most part, the observations from the exogenous environment carry over to the endogenous one. The most interesting *new* finding is that choosing the riskier of the two distributions is associated with an increased likelihood of disagreement. The next result summarized the main findings.[26]

Result 4 *The main bargaining outcomes seen under the exogenous environment are also observed in the endogenous environment. Residual claimants extract a risk premium for their exposure to risk and, all else equal, being more risk averse—at least for FP players—reduces a player's share of the surplus in an agreement. While choosing the riskier of two distributions does not appear to affect agreed payments to the FP player, it is associated with an increase in the likelihood of disagreement.*

[26] The details of this analysis can be found in Appendix A.3.

4 Bargaining Process

4.1 Harsanyi-Zeuthen Concessions

Thus far our analysis has focused on bargaining outcomes, for which both the benchmark and alternative models make predictions. Next we turn our attention to exploring other aspects of the bargaining process data on which these models are mostly silent. For this analysis, we pool the data from the exogenous and endogenous environments.

Using the concept of players' risk limit of the Harsanyi-Zeuthen behavioral model (Zeuthen, 1930; Harsanyi, 1977) of the concession process, we could derive process predictions for the benchmark and fairness-adjusted NBS predictions (Hypotheses 6 and 6 (ALT)). To test these hypotheses, Table 8 presents a simple regression analysis of the extent to which a comparison of the players' risk limit is associated with the identity of the player making the next concession.[27] The dependent variable is a simple indicator of whether the residual claimant was the one to concede. The prediction is that the RC player concedes if their risk limit (RL_{RC}) is lower than the risk limit of the FP player (RL_{FP}). In the table, the first two columns use the standard NBS concept, and its associated risk limit, to build an indicator for when the residual claimant is predicted to concede; the third and fourth columns use the fairness-adjusted NBS, and its adjusted risk limit, to build this variable.[28]

As can be seen in columns (1)–(4), both the benchmark NBS and fairness-adjusted NBS models result in risk limit comparisons that are significantly associated with the identity of the party making the next concession. In all cases, an RC player is more likely to be the one to concede when their risk limit is less than the FP player's, while the opposite holds if the risk limit is larger. This is consistent with both Hypotheses 6 and 6 (ALT).

The last two columns consider a horse-race specification that includes both the benchmark and fairness adjusted predictions. Both models are informative with neither model strictly dominating the other. Notably, however, the fairness-adjusted model has a larger estimated contribution. More detailed analysis of the role of the pie-distribution risk shows that, while the benchmark model is equally informative across the pie-distributions, the fairness-adjusted model makes better predictions in the risk-less and less risky distributions (see Table G.5 of the Supplementary Materials). Indeed, one of the important elements that the fairness-adjusted model brings over and above the benchmark model is the prediction that, when just one player makes an offer inconsistent with the fairness ideas it is this player that is likely to concede; this happens less often in the riskier pie-distributions (see Figure G.1 of the Supplementary Materials).

[27] See Section G of the Supplementary Materials for details of this analysis. The Harsanyi-Zeuthen concession principle makes predictions about the identity of the player making a subsequent concession, rather than whether there is a standoff and whether the subsequent standoff ends with a concession. Consequently, the analysis focuses on episodes where there are open and incompatible offers from both parties (i.e., a standoff) and one party subsequently concedes to the other (See Tables G.1 and G.2 for a breakdown of the category of observations across pie-distributions). A concession can take the form of an acceptance of the other's offer or a new offer with terms more favourable to the other player but still incompatible with their current demand.

[28] The standard NBS and the fairness-adjusted risk limits differ due to differing disagreement utilities.

Table 8: Linear Regression of RC Concession: Benchmark versus Fairness Adjusted Predictions

	Benchmark Model		Fairness-Adjusted Model		Horse Race	
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$	0.12***	0.24***			0.08**	0.17***
	(0.000)	(0.000)			(0.012)	(0.000)
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}]$			0.27***	0.35***	0.24***	0.28***
			(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.46***	0.22***	0.35***	0.25***	0.33***	0.13***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	4980	4980	2538	2538	2538	2538
Clusters	20	20	20	20	20	20
R^2	0.02	0.11	0.06	0.20	0.07	0.21
Average predicted probability of concession by the RC when:						
$\mathbf{1}[RL_{RC} > RL_{FP}]$	0.46	0.39			0.49	0.44
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$	0.58	0.64			0.57	0.61
$\mathbf{1}[RL_{RC}^{adj} > RL_{FP}^{adj}]$			0.35	0.29	0.37	0.35
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}]$			0.62	0.65	0.61	0.62

Notes: RL^{adj} denotes the fairness-adjusted calculation of risk limit. Data includes only observations with $|\rho_i| < 1$ for both RC and FP players. ***1%, **5%, *10% significance using standard errors clustered at the matching group level. Models (1) and (3) are simple linear regressions; models (2) and (4) include subject level fixed effects (see Table G.3 of the SM for details on modelling unobserved heterogeneity); in all cases, adding controls for unobserved heterogeneity at the subject or group level increases size and significance of the risk limit variables.

4.2 Further analysis of bargaining process data

The Harsanyi-Zeuthen concession principle does not make predictions for the content of offers, in particular opening offers, the size of concession or the duration of bargaining. Therefore, in what follows, we analyse these aspects of the bargaining process in more detail.

In a nutshell, the overall picture that emerges from this analysis is one that is consistent with our analysis of outcomes. Specifically, 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. Finally, risk attitudes play an important role, particularly for FP players. These observations go a long way to explain why it is actually the comparatively less risk averse residual claimants who benefit from bargaining over a risky pie: such residual claimants are more likely to be paired with a comparatively more risk averse fixed-payoff player, which appear to be in a "weak" bargaining position.

First and Final Offers

We start with comparing 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. Unsurprisingly, opening offers of the RC players are always significantly lower than those of the FP player (Wilcoxon signed-rank tests; $p < 0.01$). Consistent with Bolton and Karagözoğlu (2016), 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 pie-distribution. Interestingly, FP players also tend to demand less as risk increases, however their opening offers are consistently above half the expected pie size.

Table 9: Opening and Final Offers to FP Players by Player Type

Distribution of Pie	Opening Offers FP	Opening Offers RC	Final Offers FP	Final Offers RC	Fairness Ideas (€ to FP) FP	Fairness Ideas (€ to FP) RC
(20)	12.77	8.25***	11.31	9.59***	9.91	10.16
(16,20,24)	12.80	6.77***	10.77	8.55***	10.39	9.70
(16,24)	12.48	6.99***	10.62	8.76***	10.21	9.27
(12,20,28)	11.13	5.74***	9.73	7.71***	9.82	8.64
(12,28)	10.92	5.79***	9.45	7.59***	9.54	8.40

Notes: The lightly shaded cells are significantly different from offers in (20) at the 1% level. *** indicates that the offers between RCs and FPs are significantly different at the 1% level. For both sets of tests we use Wilcoxon signed rank tests using the matching group average (for the particular type or pie-distribution) as the unit of independent observation. We use data from all treatments and have 20 matching groups overall.

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. Notably, relative to the certain pie-distribution, RC players still demand a statistically significant risk premium for all the risky pie-distributions. While the final offer of RCs is still significantly lower than that of the FP players, the average difference is now only €2.05, as compared to €5.65 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 to the RC player for all the risky pie-distributions, except for the $(16, 20, 24)$ pie-distribution where the difference is only significant at $p = 0.052$. This is in contrast to opening offers where this was only the case for the two riskiest pie-distributions. Indeed, for these two pie-distributions, their final offers are actually slightly *less* than their perceived fair allocation. Therefore, it seems that there is an implicit 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.

A regression analysis reveals that, controlling for the riskiness of the pie-distribution, opening offers for FP players are significantly positively correlated with fairness ideas (coefficient = 0.16, $p < 0.01$), while this is not the case for RC players (coefficient = 0.02, $p > 0.7$). These results extend to final offers. For FP players fairness ideas are significantly related (coefficient = 0.15, $p < 0.01$). For RC players, this is not the case ($p = 0.13$), although compared to opening offers the coefficient has increased (0.13) in magnitude. Thus, at least for FP players, own fairness ideas are positively related to the offers made.

Table 10 reports results of more detailed regression analyses of offers. The first two columns show that opening offers are strongly influenced by agents' risk preferences. The more risk averse the FP player is, the lower the demand—i.e., the opening offer to himself—

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 1^{st} offer FP)/100					0.35	(0.227)	0.01	(0.030)
(Time 1^{st} offer RC)/100					0.03	(0.166)	0.06	(0.072)
Δ(Time $1^{\text{st}} - 2^{\text{nd}}$ offer FP)/100					0.16	(0.155)	0.05	(0.039)
Δ(Time $1^{\text{st}} - 2^{\text{nd}}$ 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. These specifications do not include fairness ideas as an explanatory variable; however, when adding it there is no qualitative difference in the results.

while the more risk averse the RC player is, the smaller is her opening offer to the FP player. Thus, in contrast to FP players, more risk averse RC players become more aggressive in their opening offers; that is they demand greater compensation for their exposure to risk.

Of course, if opening offers were merely cheap talk, then the above results would be of little importance. However, it has been suggested that opening offers may *anchor* negotiations and influence final outcomes (see, e.g., Galinsky and Mussweiler, 2001; Bolton and Karagözoğlu, 2016). The results reported in the third column of Table 10 support this notion. 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 initially demands more, or an RC player who initially offers less likely end up with a more favorable outcome, assuming an agreement can be reached. Thus, making a weak opening offer—which is more likely to be done by more risk averse FP players—leads to a lower payment.

This result appears to be due to the persistence of anchoring throughout the bargaining process, as we will show when discussing concessions. 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*, they also increase the chance of disagreement. This is evident from 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.[29]

Finally, the third and fourth columns of Table 10 also control for the time at which players made their first offer and the amount of time that they waited between making their first

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

and second offer. 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 the table shows the coefficients of these variables are insignificant.

Proposals During Bargaining

Table 11 reports analysis of the proposals during bargaining in Panel (a) and on whether the residual claimant accepts or not in Panel (b). Consider first the proposals models. The dependent variable is the player's current proposal (i.e., the amount proposed to the FP player). As explanatory variables, we include the player's elicited risk parameter and either the time the offer was made (specifications (1) and (3)) or the proposal number (specifications (2) and (4)), as well as an interaction between the risk parameter and, respectively, proposal number and proposal time. Lastly, we also include indicator variables for the pie-distribution. Consistent with Table 10, which looked at first offers, we see that RC players offer less and FP players claim less as the riskiness of the pie-distribution increases. Also consistent with Table 10, more risk averse residual claimants offer less and more risk averse FP players claim less. Moreover, as would be expected from a gradual concession process, FP players' claims are decreasing over time and proposal number, while RC players' offers are increasing with these variables. Interestingly, looking at specification (2) for FP players, it appears that more risk averse FP players make larger concessions as evidenced by the significantly negative coefficient on (Own) $\rho \times$ Offer Num. In contrast, the concession process for residual claimants does not appear to be significantly affected by risk preferences.

The main message from Table 10 and Table 11(a) is that FP players take weaker initial positions as the riskiness of the pie-distribution increases. Furthermore, the more risk averse are FP players, the weaker is their initial position and the more they appear to concede during bargaining. On the other hand, as risk increases, residual claimants take stronger initial positions, and their concession process is not moderated by risk preferences.

In Table 11(b), the dependent variable is an indicator that takes value 1 if the RC player was the one who accepted. The main point to note is the negative, and marginally significant, coefficient on the risk coefficient of the FP player. That is, the more risk averse the FP player, the more likely they are to be the one ultimately accepting, again suggesting that more risk averse FP players are in a relatively weaker bargaining position than less risk averse ones. Finally, there is also the intuitive result that RC players are less likely to accept when the final offers on the table—i.e., the offer at the end of the bargaining period—by both players, are more advantageous to the FP player.

Bargaining Duration

To complete the picture of the bargaining process, we lastly look at the determinants of bargaining duration. Table 12 reports the results of a Weibull regression, where a player

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

(a) Proposals

	FP Player		RC Player	
	(1)	(2)	(3)	(4)
(Own) ρ	-1.316^{***} (0.495)	-0.487 (0.482)	-1.157^{***} (0.331)	-1.060^{***} (0.350)
Time	-0.787^{***} (0.105)		0.736^{***} (0.136)	
(Own) $\rho \times$ Time	0.040 (0.249)		0.286 (0.286)	
Offer Number		-0.107^{***} (0.020)		0.122^{***} (0.043)
(Own) $\rho \times$ Offer Num.		-0.189^{***} (0.061)		0.075 (0.096)
$\mathbf{1}[(16, 20, 24)]$	-0.545^{***} (0.179)	-0.600^{***} (0.189)	-0.871^{***} (0.183)	-0.789^{***} (0.154)
$\mathbf{1}[(16, 24)]$	-0.702^{***} (0.168)	-0.810^{***} (0.181)	-0.988^{***} (0.204)	-0.964^{***} (0.173)
$\mathbf{1}[(12, 20, 28)]$	-1.917^{***} (0.208)	-2.081^{***} (0.226)	-1.965^{***} (0.230)	-1.850^{***} (0.191)
$\mathbf{1}[(12, 28)]$	-2.124^{***} (0.173)	-2.320^{***} (0.198)	-1.901^{***} (0.259)	-1.750^{***} (0.209)
Constant	13.045^{***} (0.221)	12.473^{***} (0.249)	8.817^{***} (0.215)	9.233^{***} (0.188)
R^2	0.270	0.235	0.111	0.047
Observations	4635	4635	5057	5057

(b) Residual Claimant Accepts

	RC Accepts
$\mathbf{1}[\text{Var.} > 0]$	-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. In panel (b), "Final Offer x" is the last proposal made by player type x before the end of bargaining for that period. 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.

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. In addition, the strength of bargaining conflict, measured as the difference between the standing offers of the FP and RC players at any point in time, is included. This 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 both estimated models, the amount of conflict has a strongly significant effect on duration. In particular, the stronger the conflict, the longer bargaining takes. Consistent with our descriptive results, bargaining also takes longer when the pie is risky. Interestingly, as can be seen from the second model, when the conflict variable is interacted with an indicator for risky pie-distributions, the primary effect of risk on duration is through

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".

bargaining conflict. That is, for a given amount of conflict in offers, it takes longer to bridge the gap if the pie is risky.

Finally, more support for the interpretation that FP players—particularly the more risk averse ones—adopt weak bargaining positions, comes from the fact that bargaining duration decreases in the risk aversion of the FP player. This observation is consistent with that more risk averse FP players are more likely to accept an offer (cf. Table 11(b)). The duration analysis shows that they also do so more quickly, intuitively because they fear disagreement.

The main observations discussed in this subsection are summarized in the following result.

Result 5 *When there is risk, FP players generally make larger concessions, while RC players make smaller concessions. 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.*

5 Discussion and Concluding Remarks

This paper reports the results of an experimental study on the effect of asymmetric exposure to risk in bargaining. Our results show that 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 pie-distribution. Furthermore, this premium can be large enough to make it beneficial (in expected utility terms) for residual claimants to bargain with some ex-post risk. That is, we find empirical support for the prediction from a theoretical benchmark model (White, 2006, 2008) that risk exposure can be beneficial in bargaining.

While this benchmark model predicts that it should be the relatively more risk averse residual claimants who benefit from risk exposure, our results show that the opposite is generally true. That is, the residual claimants who are most likely to benefit are the relatively less risk averse ones. We confirmed this in two ways: first, indirectly via a regression analysis of bargaining outcomes and, second, more directly by showing, in an endogenous pie-distribution environment, that the likelihood of choosing to bargain over the riskier pie-distribution is decreasing in the residual claimant's risk aversion.

There are several reasons why the benchmark model prediction about which types benefit from risk exposure are not borne out in the data. First, our results show that risk leads to a divergence in what players consider to be fair: residual claimants believe that fairness demands compensation for risk, while FP players believe fairness means an equal split of the expected value of the pie. Second, disagreement rates were higher with risk and when residual claimants chose the riskier pie-distribution. Third, initial and final proposals by FP players are positively correlated with their ideas about what constitutes a fair division. Thus, fairness ideas matter in bargaining, and the addition of risk appears to place a wedge between the FP and RC players' fairness ideas. We showed that our observation that the relatively less risk averse residual claimants benefit from risk exposure is consistent with predictions of the fairness-adjusted Nash bargaining solution (Bolton and Karagözoğlu, 2016).

It is also possible that private information of risk preferences plays some role since it also predicts that the less risk averse residual claimants are most likely to benefit from risk. However, it is unlikely that this alone is sufficient. Not least, a simulation study of various specifications of private information of risk preferences predicts that disagreements should decline as risk increases, in contrast to both intuition and observed disagreement rates. Thus, while private information may be part of the story, an interaction between fairness ideas and risk, as described above, seems to be more compelling.

Another key driver of our results is the behavior of fixed-payoff players. They adopt weak bargaining strategies in risky environments, especially the more risk averse ones: they demand less from the start, make larger concessions, and are more likely to accept. Interestingly, this too could be driven by fairness considerations since fairness ideas for the FP players are *decreasing* in their own risk aversion. Together, these factors go a long way in explaining why the relatively less risk averse residual claimants benefit the most from risk exposure.

Circling back to our introduction, where we provided suggestive evidence that asymmetric exposure to risk is an important factor—at least as a negotiating tactic—in bargaining situations in the field, we now have controlled laboratory evidence of its importance. Asymmetric exposure to risk creates a wedge between the fairness ideas of both parties and shifts the agreement towards residual claimants, sometimes, so much that they benefit from risk exposure. This appears to be consistent with the anecdotal evidence from the NFL labor contract negotiations. We find that the asymmetry in risk exposure allowed the residual claimants to *credibly* demand compensation and, indeed, when the pie was sufficiently risky, even fixed-payoff players recognized that *some* compensation was fair. In many field situations, residual claimants may be faced with many independent risks (e.g., negotiating many labor contracts or with many suppliers). Therefore, when thought of as a whole, the overall risk to the residual claimant is much lower than for any single negotiation. One wonders whether this reduces the credibility of the residual claimant's argument for the necessity of compensation for risk. This is but one of several avenues worth pursuing in future work.

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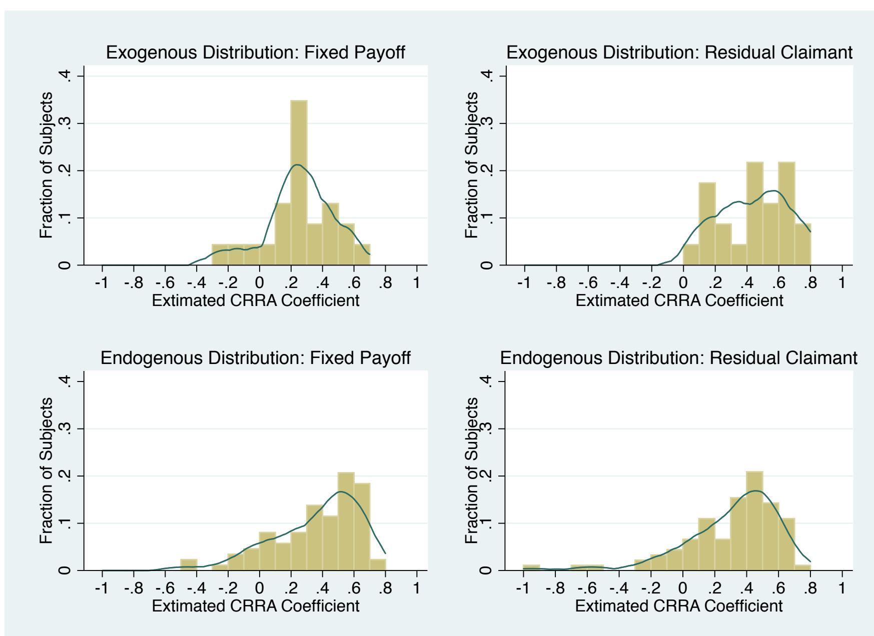
Appendix

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.

A.3 Endogenous Environment: Bargaining Outcomes in the Last Five Periods

This section focuses on Periods 6-10 of the endogenous environment when the residual claimant could choose between a relatively less risky and a relatively more risky pie-distribution over which to bargain. A summary of the bargaining outcomes and fairness assessments can be found in Table A.3. For the most part, the observations from the exogenous-distribution environment carry over to the endogenous one:[30] final FP earnings and agreed FP payments are generally decreasing in the riskiness of the pie-distribution; bargaining over a risky pie-distribution results in more disagreements and longer bargaining duration; and agreed FP payments for risky pie-distributions tend to lie between the (self-serving) fairness assessments of the FP and RC players.

Table A.3: Bargaining Outcomes and Fairness Ideas in the Endogenous Environment (Periods 6-10)

Distribution of Pie	Final FP Earnings (€)	Agreed FP Payments (€)	Disagreements (%)	Remaining Time (sec)	Fairness Ideas (€ to FP) 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.

Regression analyses corroborate this impression. The first regression of Table A.4 shows 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 pie-distributions, contrary to Hypothesis 5, but in line with Hypothesis 5 (Alt). The second specifications show that the riskier of the two pie-distributions being implemented does not have a significant bearing on agreed payments to the FP player, but does increase the likelihood of disagreement.[31] This suggests that choosing the riskier pie-distribution may have a cost that is not captured by the theoretical benchmark model, 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 pie-distribution, the direct effect of being more risk averse is a decrease in 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, different from the exogenous environment, the direct effect is smaller and the interaction effect larger, resulting in an overall effect for ρ_{RC} that is negative for risky pie-distributions. That is, more risk aversion improves the RC player's bargaining position, contrary to Hypothesis 2.

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

[31]In this case, the linear functional form gives a slightly larger disagreement effect: with either a logit or probit form the marginal effect is around 5.5%, and the significance between 5-7%.

Table A.4: Linear Random-Effects Regressions of Bargaining Outcomes in the Endogenous Environment (Periods 6-10)

	Agreed FP Payments						Disagreements			
	(1)		(2)		(3)		(1)		(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.

SUPPLEMENTARY MATERIALS: FOR ONLINE PUBLICATION ONLY

Contents

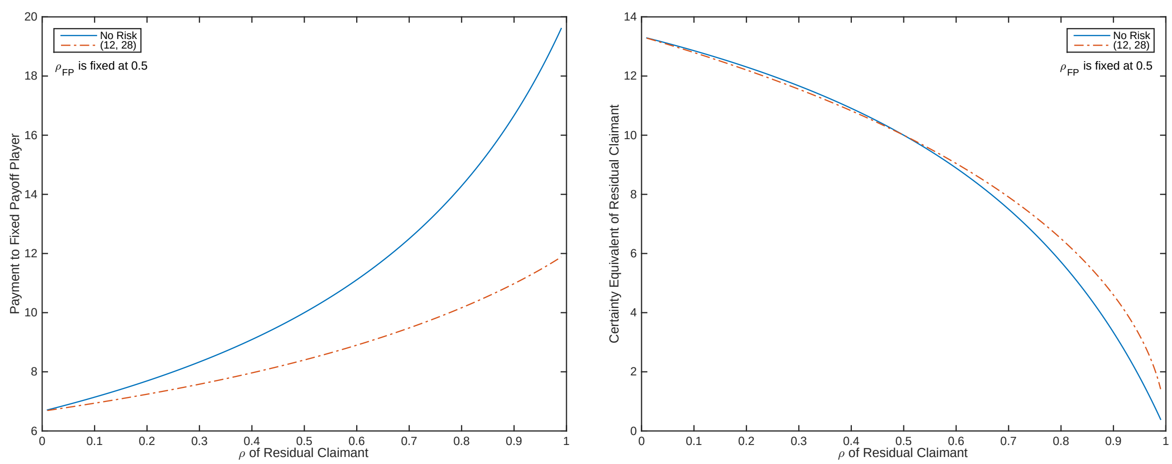
B More Theoretical Background

B.1 Illustrating the Benchmark Mechanism

Figure B.1 provides an illustration of the benchmark Hypotheses 1–3. It considers the case where both players have, commonly known, CRRA preferences, with the FP player's risk aversion parameter fixed to $1/2$. The left-hand panel graphs the predicted payment for the FP player, and the right-hand panel the certainty equivalent of this agreement for the residual claimant, as a function of the risk aversion parameter for the residual claimant (ρ_{RC}). The graphs show this for two pie-distributions: no risk (solid blue line) and $(12, 28)$ (red broken line). In Figure B.1(a), the payment to the fixed-payoff player when there is no risk is higher than the payment when there is risk for all values of ρ_{RC}, which demonstrates Hypothesis 1. Furthermore, both lines are increasing in ρ_{RC}, which is the comparative static of Hypothesis 2 for the residual claimant's degree of risk aversion.

Figure B.1: 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.

Hypothesis 3 can be seen in Figure B.1(b), in particular for the identity of the residual claimants predicted to benefit from their exposure to risk. For **fixed** risk preferences of the players, if the dashed red line is above the solid blue line then the residual claimant has a higher expected utility at the predicted agreement under the risky pie-distribution than under the riskless pie-distribution. As can be seen, this is the case for, approximately, $\rho_{RC} > 1/2 = \rho_{FP}$.

B.2 Adapting the Bolton and Karagözoğlu (2016) Fairness-Adjusted NBS to the Residual Claimant Setting

Bolton and Karagözoğlu (2016) consider a social preference modification of the Nash bargaining solution in an environment with two clear competing fairness ideas. The majority of players are modeled as compromising types, which would prefer more surplus to less, so long as they receive as least as much as they would receive from the fairness idea that the other player prefers; otherwise, they prefer disagreement. There is also a small chance of meeting a non-compromising type that would prefer disagreement to any allocation that does not give them at least as much as their preferred fairness idea.

When two compromising types meet, the predicted outcome is determined via the standard Nash bargaining calculus—that is, it depends on the preferences of the two players and is found by balancing their boldness—except with the disagreement points adjusted to exclude agreements that do not lie between the competing bargaining fairness ideas.[32] Thus, compromising players negotiate as if, in the face of impasse, they could always offer the other player's self-serving fairness idea to avoid outright disagreement. Using the notation from the main text, the fairness-adjusted NBS would select the $y \in [y^f_{RC}(\pi), y^f_{FP}(\pi)]$ that maximizes the fairness-adjusted Nash product:

$$\left[u_{FP}(y) - \tilde{d}^{\pi}_{FP}\right] \cdot \mathbb{E}_{\pi}\left[u_{RC}(\pi - y) - \tilde{d}^{\pi}_{RC}\right].$$

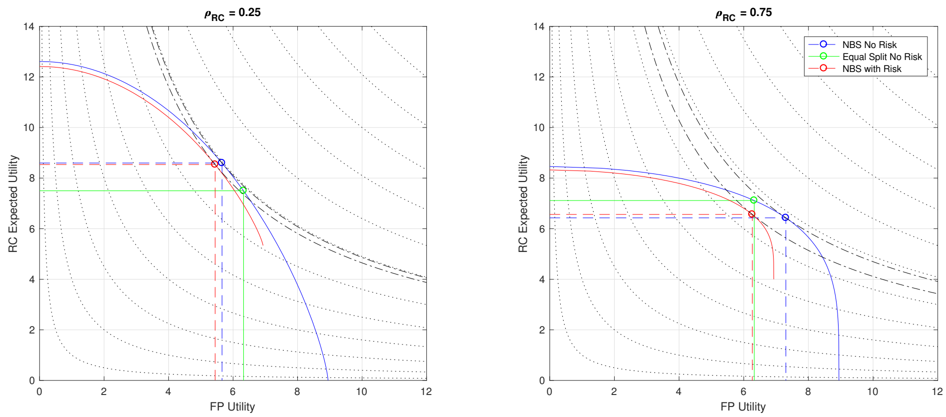
In the case of risk—and in contrast to the environment implemented in Bolton and Karagözoğlu (2016)—the fairness idea for the one player, the residual claimant, is less transparent than it is for the other, the fixed payoff player. While it is clear it would involve some compensation for their exposure to risk, it is not clear what would be a sufficient compensation to guarantee agreement with a non-compromising type. We consider two possible empirical strategies for determining this fairness idea. The first uses the fairness assessments by residual claimants, and takes the fairness idea to be the minimum fairness assessment for the associated pie-distribution. This approach leads y^f_{RC} to be 8, 8, 6, and 6 for the (16,20,24), (16,24), (12,20,28) and (12,28) pie-distributions, respectively. These values imply a very strong bargaining position for the residual claimants, to the extent that, for example, all residual claimants with a CRRA coefficient in $[0, 1)$ would be predicted to do better in expected utility terms bargaining over the (16,20,24) pie distribution rather than the (20) pie-distribution. Given that the observed riskier choice rate is much lower than this, a second approach estimates the associated fairness idea by matching the predicted riskier choice rate with that actually observed in the endogenous sessions.[33] This approach leads y^f_{RC} to be

[32] Boldness, or tolerance for risking impasse, is defined here as $\frac{u'(x)}{u(x)-u(d)}$. See Roth (1989) for an exposition of the important role played by boldness in the predictions of standard bargaining models. Indeed, the welfare result of White (2008) for the case of Nash bargaining is found by ensuring that the residual claimant's boldness is still as least as large as that of the fixed payoff player after the division has been adjusted to just compensate the residual claimant for their risk exposure.

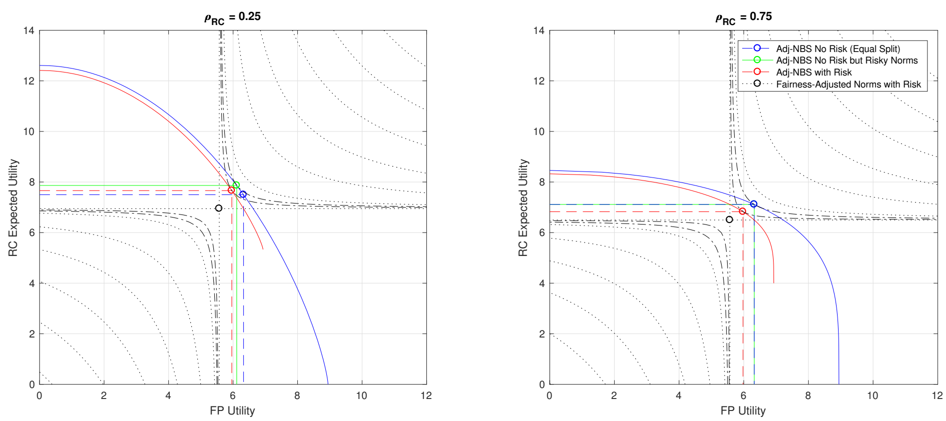
[33] Note that some of this discrepancy could be explained by the increased disagreement rate observed both in the more risky pie-distributions, as well as after the more risky distribution has been chosen.

Figure B.2: A Comparison of the Standard and Fairness-Adjusted Nash Bargaining Solutions:
Certain Pie-Distribution (20) versus the Riskiest Pie-Distribution (12, 28).

(a) Benchmark Nash Bargaining Solution



(b) Fairness-Adjusted Nash Bargaining Solution



Note: These figures are drawn under the assumption that players have, commonly known, CRRA utility functions. In all cases, the FP player has a CRRA risk aversion coefficient of $1/2$. In the left-hand figures, the residual claimant is less risk averse, with a CRRA risk parameter of $1/4$; in the right-hand figures, the residual claimant is more risk averse, with a CRRA risk parameter of $3/4$. The blue curve shows the Pareto frontier of possible agreed FP payments, and corresponding solution, for the certain pie-distribution; the red curve shows it for the risky pie-distribution. In the top figures, the green point indicates the $50-50$ split for the certain pie-distribution. In the bottom figures, the green point shows the solution for the counterfactual case where the disagreement point is moved from the binding $50-50$ allocation to the fairness ideas associated to the risky pie-distribution, but the Pareto frontier is kept the same as in the certain pie-distribution. For the fairness-adjusted cases, the ideas are the $50-50$ demand by the FP player for both pie-distributions, and the $50-50$ demand by the RC player for the certain pie-distribution and the empirically fitted fairness idea for residual claimants for risky pie-distributions. This latter fairness idea is found by matching the predicted and actual rates of riskier choice in the endogenous environment when the RC is presented with a choice between the certain pie-distribution and the risky pie-distribution.

9.52, 9.49, 8.26, and 7.76 for the (16,20,24), (16,24), (12,20,28) and (12,28) pie-distributions, respectively. We use these latter estimates in the following illustrations.

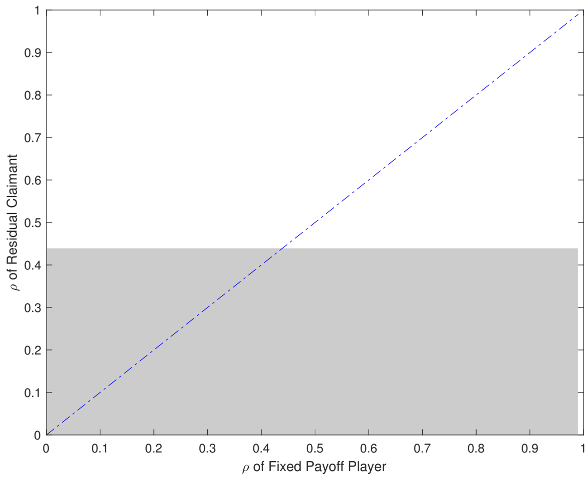
Figure B.2 illustrates the NBS for the benchmark (top) and fairness-adjusted models (bottom). As in Figure B.1 the FP player has CRRA preferences with risk parameter $1/2$ in all cases. In the left-hand figures, the residual claimant is less risk averse, with a CRRA risk parameter of 1/4; in the right-hand figures, the residual claimant is more risk averse, with a CRRA risk parameter of 3/4. The top two graphs illustrate the benchmark mechanism. In the left-hand of the two, the residual claimant is less risk averse than the fixed payoff player they are matched with. Without risk, the residual claimant does better than the 50-50 split, and the reduction in the FP payment that comes with the addition of risk is not enough to make the residual claimant's expected utility higher under risk compared to the certain pie-distribution. In the right-hand graph, the residual claimant is more risk averse then the FP player, and does worse than the 50-50 split in the case without risk. Consequently, there is more room to secure a larger reduction in the agreed payment when risk is added to the pie-distribution, and the subsequent agreement gives the RC player a greater expected utility under the risky pie-distribution than under the certain pie-distribution.

The bottom two graphs illustrate the fairness-adjusted mechanism. This has two components: the change in effective disagreement points brought about by the change in fairness ideas between the certain and risky pie-distribution, and the prudence effect from the benchmark model. The former can be seen by comparing the blue solution point—which is the binding 50-50 solution—to the green solution point. The latter is a counter-factual bargaining solution where the Pareto frontier is unchanged, as if there were no risk added, but the fairness ideas are moved to those effective under risk. The change in fairness ideas opens up a region of the Pareto frontier over which the parties now bargain, and the less risk averse the residual claimant is, against a given FP player, the greater the share of the bargaining surplus they will be able to extract. This effect can be seen as the RC on the left-hand graph moves further away from the 50-50 solution than in the right-hand graph; indeed, the solution on the right-had side happens to approximately coincide with the 50-50 solution. The second, standard, effect is seen by comparing the green solution to the risky pie-distribution solution, the red line. Since both RCs in the green line are doing at least as well as the 50-50 split, it is no surprise to see that the benchmark, prudence-based, effect reduces the RCs welfare. The overall effect is the sum of these two, and in the case of the less risk averse residual claimant results in a greater welfare under risk, while for the more risk averse residual claimant their welfare is greater without risk. Thus, the combination of these two mechanisms reverses the predictions from the benchmark model.

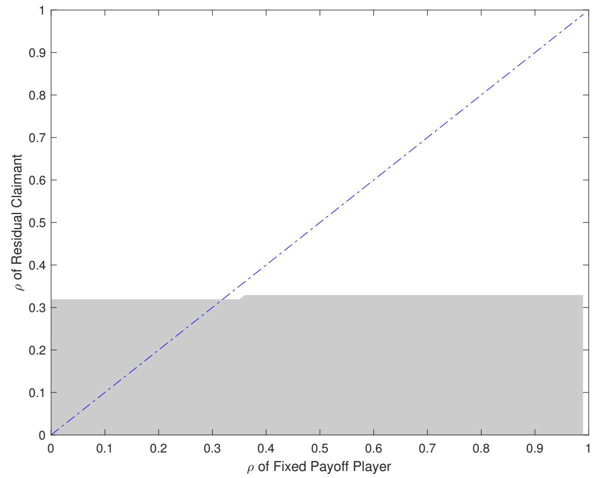
Figure B.3 provides an analogy to Figure 2 by plotting in grey-shade the region of risk preference parameter values over which RCs are predicted under fairness-adjusted NBS to do better in expected utility terms for two pie-distributions used in the experiment: $(16, 20, 24)$, which is the least risky of the uncertain pie-distributions, and $(12, 28)$, which is the the most risky. As can be seen, in both cases it is the less risk averse RCs that are predicted to benefit from their exposure to risk. Furthermore, this prediction is less responsive to the risk attitude of the FP player than is the case in the benchmark model.

Figure B.3: Region over which Exposure to Risk is Advantageous for RC players—Fairness-Adjusted NBS Example

(a) $(16, 20, 24)$



(b) $(12, 28)$



Note: In the grey region RC players are predicted to do better in expected utility terms. The broken 45-degree line indicates the locus for which the RC and FP players have identical risk preferences. These figures are drawn under the assumption that players have, commonly known, CRRA utility functions. For the fairness-adjusted cases, the fairness ideas are the $50 - 50$ demand by the FP player for both pie-distributions, The respective fairness ideas are a $50 - 50$ demand by the FP player, and the $50 - 50$ demand by the RC player for the certain pie-distribution and the empirically fitted fairness idas for residual claimants for risky pie-distributions. This latter fairness idea is found by matching the predicted and actual rates of riskier choice in the endogenous environment when the RC is presented with a choice between the certain pie-distribution and the risky pie-distribution. Note that, if the RC player's fairness idea is taken to zero for the risky pie-distributions then all RCs are predicted to benefit in both pie-distributions.

B.3 Concession Process

The least willingness to face the risk of a conflict is measured by a players risk limit. Given two incompatible offers, $y^k_{RC} < y^k_{FP}$, this is given by

$$r_{RC} = \frac{\mathbb{E}_\pi\left[u_{RC}\left(\pi - y^k_{RC}\right)\right] - \mathbb{E}_\pi\left[u_{RC}\left(\pi - y^k_{FP}\right)\right]}{\mathbb{E}_\pi\left[u_{RC}\left(\pi - y^k_{RC}\right)\right] - d_{RC}}$$

$$r_{FP} = \frac{u_{FP}\left(y^k_{FP}\right) - u_{FP}\left(y^k_{RC}\right)}{u_{FP}\left(y^k_{FP}\right) - d_{FP}}$$

for the residual claimant and the fixed payoff player, respectively, where (d_{FP}, d_{RC}) equals $(u_{FP}(0), u_{RC}(0))$ in the case of standard Nash bargaining and $(\tilde{d}^\pi_{FP}, \tilde{d}^\pi_{RC})$ in the case of fairness-adjusted Nash bargaining. The concession principle predicts that the player with the lower risk limit will make the next concession.

Suppose, without loss of generality, that $r_{FP} < r_{RC}$. Re-arranging the above expressions gives (see Harsanyi, 1977; Bolton and Karagözoğlu, 2016):

$$\begin{aligned} r_{FP} < r_{RC} \iff & \left[u_{FP}\left(y^k_{FP}\right) - d_{FP}\right] \cdot \left[\mathbb{E}_\pi\left[u_{RC}\left(\pi - y^k_{FP}\right)\right] - d_{RC}\right] \\ & < \left[u_{FP}\left(y^k_{RC}\right) - d_{FP}\right] \cdot \left[\mathbb{E}_\pi\left[u_{RC}\left(\pi - y^k_{RC}\right)\right] - d_{RC}\right]. \end{aligned}$$

That is, the player predicted to concede next is the one whose open offer corresponds to the lower (fairness-adjusted) Nash product. Given a concession towards the other can only increase the Nash product of this player's subsequent offer, the (adjusted) Harsanyi-Zeuthen concession process would converge towards the (fairness-adjusted) Nash bargaining solution, which selects the feasible agreement with the highest such value.

B.4 Private Information

The benchmark predictions are derived under the assumption that risk preferences are common knowledge. In the real world, as well as in the lab, risk preferences may be private information. Myerson (1979) provided a generalization of the Nash bargaining solution to the case where player may have private information on their type (e.g., risk preferences) drawing on insights from mechanism design.

Consider a simple environment in which the residual claimant has two possible types $\{\rho_1, \rho_2\}$, which correspond to different risk preferences, while the fixed payoff player has a single type denoted by ρ. We assume that ρ_2 is more risk averse than ρ_1 and that each possible type of the residual claimant is equally likely. Let $\mu : \{\rho_1, \rho_2\} \to [0,1] \times \Delta([0, \pi_{min}])$ denote a mechanism. In particular, $\mu(\cdot) = (d(\cdot), F(x|\cdot))$, where d is interpreted as the probability of disagreement and $F(x|\cdot)$ is a distribution over $[0, \pi_{min}]$. Let $U^r(\mu(\rho_i)|\rho_j)$ denote the expected utility of the type ρ_j residual claimant when he reports his type as ρ_i. Let $U^f(\mu) = (1/2)(U^f(\mu(\rho_1)) + U^f(\mu(\rho_2)))$ denote the fixed payoff player's expected utility from the mechanism. The generalized Nash bargaining solution is then the mechanism, μ^*, that maximizes:

$$(U^r(\mu(\rho_1)|\rho_1))^{0.5} \times (U^r(\mu(\rho_2)|\rho_2))^{0.5} \times \Big(U^f(\mu)\Big) \tag{1}$$

subject to:

$$U^r(\mu(\rho_1)|\rho_1) \geq U^r(\mu(\rho_2)|\rho_1)$$
$$U^r(\mu(\rho_2)|\rho_2) \geq U^r(\mu(\rho_1)|\rho_2).$$

That is, each type of residual claimant must find it in his interest to truthfully reveal his type. We do not need to worry about the individual rationality constraints, as they will be automatically satisfied given the constraint that an allocation, x, must be in $[0, \pi_{min}]$.

An Extension to Two FP Player Types. One can extend the generalized Nash bargaining solution to the case in which the fixed-payoff player has multiple types as well. We conducted a numerical exercise in which both players had two equally likely types: ρ_1^r and ρ_2^r for the residual claimant and ρ_1^f and ρ_2^f for the FP player. One is also free to make different assumptions about the relationship between the FP and RC players' type spaces. In our numerical analysis, below, we consider both the case in which type spaces may be different and one in which there is a single, common type space but that each player's realized type is drawn independently and with equal probability.

A Numerical Exercise. Given the non-linearity of the expected utility functions, it is analytically intractable to characterize the full set of incentive compatible mechanisms. Therefore, we focus our attention on three classes of mechanisms and—for the case of one FP Type—numerically optimize (1) over the set of incentive compatible mechanisms that fall into these three classes. The mechanisms are:

$$\text{Pooling: } \mu(\rho) = (0, x), \text{ where } x \in [0, \pi_{min}] \ \forall \rho$$
$$\text{Binary: } \mu(\rho_1) = \begin{cases} (d_1, x_1), & \text{w.p. } p \\ (d_1, x_1'), & \text{w.p. } 1-p \end{cases} \text{ and } \mu(\rho_2) = (d_2, x_2)$$
$$\text{Uniform: } \mu(\rho_1) = (d_1, \mathcal{U}[\bar{x}_1 - \nu, \bar{x}_1 + \nu]) \text{ and } \mu(\rho_2) = (d_2, x_2).$$

For the binary mechanism, we assume that $x_1 \leq x_1'$ and that $p \in [0, 1]$. A special case of this mechanism is when $p \in \{0, 1\}$ so that the outcome, conditional on an agreement being implemented is a deterministic function of the reported types. For the uniform mechanism, $\mathcal{U}[\bar{x}_1 - \nu, \bar{x}_1 + \nu]$ denote a uniform random variable with support $[\bar{x}_1 - \nu, \bar{x}_1 + \nu] \subseteq [0, \pi_{min}]$. Of course, when $\nu \to 0$, this also collapses to the special form of the binary mechanism. For the case in which the FP player has two types, we restricted attention to mechanisms of the form, $\mu(\rho_i^r, \rho_j^f) = (d_{ij}, x_{ij})$. That is, for each possible report, either a disagreement occurs or, if agreement occurs, the allocation is deterministic (but, potentially dependent on the reported types).

The pooling mechanism is a special mechanism in which the allocation is the same irrespective of the reported residual claimant type and, moreover, there is never disagreement. Such mechanisms are clearly incentive compatible and are also Pareto efficient since any change necessarily means allocating less to at least one residual claimant type or the fixed payoff player. The other mechanisms all include the possibility of disagreement and, at least for the less risk averse residual claimant, may introduce some degree of randomness to the allocation. This is done in order to prevent the more risk averse residual claimant from mimicking the less averse residual claimant. Such mechanisms may be incentive compatible and Pareto efficient.[34]

More specifically, we numerically solved (1) over the set of mechanisms as discussed above for a 50,000 draws of risk parameters, where each risk parameter, $\rho \in \{0, 0.01, \ldots, 0.99\}$. For the case of one FP type, this led to (ρ_1, ρ_2, ρ), where $\rho_1 < \rho_2$, while for the case of two FP types, this led to $(\rho_1^r, \rho_2^r, \rho_1^f, \rho_2^f)$, where $\rho_1^j < \rho_2^j$ for $j \in \{r, f\}$ and for the case of a common type distribution, this led to (ρ_1, ρ_2) where $\rho_1 < \rho_2$.

For the same set of risk parameters, we solved for the generalized Nash bargaining solution for three cases: (i) when the pie was riskless, (20), (ii) a risky pie with distribution $(16, 24)$

[34]Note that we do not consider mechanisms in which the more risk averse residual claimant's payoff, upon a truthful report is random. Under the assumption of risk aversion of all player types, such mechanisms are unlikely to be Pareto efficient. A mean preserving reduction in variance would make both the more risk averse residual claimant and the fixed payoff player strictly better off. While such a change would also increase the temptation of the less risk averse residual claimant to misreport his type, one could simultaneously provide stronger incentives to this type to restore incentive compatibility while not hurting the other players relative to the initial mechanism.

Table B.1: Who Benefits From Risk Exposure?

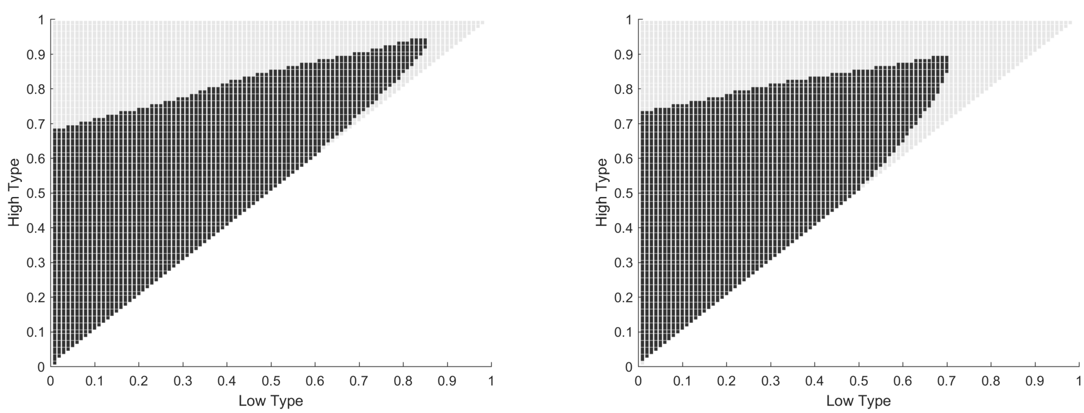
Risky Pie	Type Space	Which Residual Claimant Type Benefits From Risk			
		Low Type	High Type	Both Types	Neither Type
$(16, 24)$	2 RC, 1 FP	34.09	23.16	18.16	24.59
$(16, 24)$	2 RC, 2 FP (ind.)	44.73	16.66	23.00	15.62
$(16, 24)$	2 RC, 2 FP (com.)	65.83	30.33	0.06	3.78
$(12, 28)$	2 RC, 1 FP	37.93	13.17	24.66	24.24
$(12, 28)$	2 RC, 2 FP (ind.)	49.61	12.64	21.34	16.4
$(12, 28)$	2 RC, 2 FP (com.)	62.10	9.84	2.38	15.68

and (iii) a relatively more risky pie with distribution $(12, 28)$. These three distributions were each implemented in our experiment. Table B.1 provides the frequency that one, both or neither type of residual claimant benefits from risk exposure for each of the three settings we considered. As can be seen, the most common outcome is that only the less risk averse residual claimant benefits from risk exposure. In fact, the less risk averse residual claimant benefits from exposure to risk (either alone or together with the more risk averse residual claimant) over 60% of the time.

In addition to the summary results in Table B.1, Figure B.4 gives a visual depiction of the parameter values for which the less risk averse residual claimant benefits from risk exposure (the dark shaded region) for the case of a common type distribution. As can be seen, as long as the less risk averse residual claimant type is not, herself, too risk averse and as long as the more risk averse type is not too risk averse, then the less risk averse type benefits from exposure to risk.

Figure B.4: Regions Where Low Type Residual Claimant Prefers Risky Distribution

(a) Common Type Distribution; Pie is $(16, 24)$ **(b)** Common Type Distribution; Pie is $(12, 28)$



Note: The darker shaded region indicate the set of parameter types where the less risk averse type of residual claimant benefits from exposure to risk, while the lighter shaded region indicate the set of parameter types such that the less risk averse residual claimant suffers from exposure to risk.

This analysis suggests that an analog to Hypothesis 3 does not extend to the case of private information. Instead we summarize our discussion as follows:

SUMMARY 1 (WELFARE) *When risk preferences are private information, no definitive welfare conclusions can be made about exposure to ex post risk. Adding ex post risk may be either harmful or helpful to both the less and more risk averse residual claimant type. However, numerical analysis suggests that the less risk averse residual claimant type is more likely to benefit from risk exposure.*

Disagreement. We also analyzed disagreement rates, which may arise in the presence of private information based on the above numerical analysis. The results are in Table B.2. As can be seen, disagreements do occur but over all parameter combinations, they are relatively unlikely, unconditionally occurring less than 1% of the time. It turns out that, very often, given the risk parameters, the model does not predict any disagreement. What is more, we see that the disagreements become *less likely* as the pie over which subjects bargain becomes more risky, and this remains true if we condition on parameter values such that disagreement occurs with non negligible probability (i.e., > 0.001). That disagreement goes down as risk increases should be intuitive because the increase provides stronger incentives for the more risk averse type to truthfully reveal her type, meaning the chance of disagreement can go down when a player reports she is the less risk averse type.

Table B.2: Disagreement Rates Under Private Information

Distribution	2 RC, 1 FP	2 RC, 2 FP (ind.)	2 RC, 2 FP (com.)
(20)	0.37%	0.95%	0.89%
(16,24)	0.36%	0.76%	0.73%
(12,28)	0.01%	0.51%	0.48%

SUMMARY 2 (DISAGREEMENT) *When risk preferences are private information, disagreement may occur as part of the solution to the generalized Nash bargaining solution. As the riskiness of the pie increases, disagreement does* not necessarily *become more likely.*

C Sample Instructions

C.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.

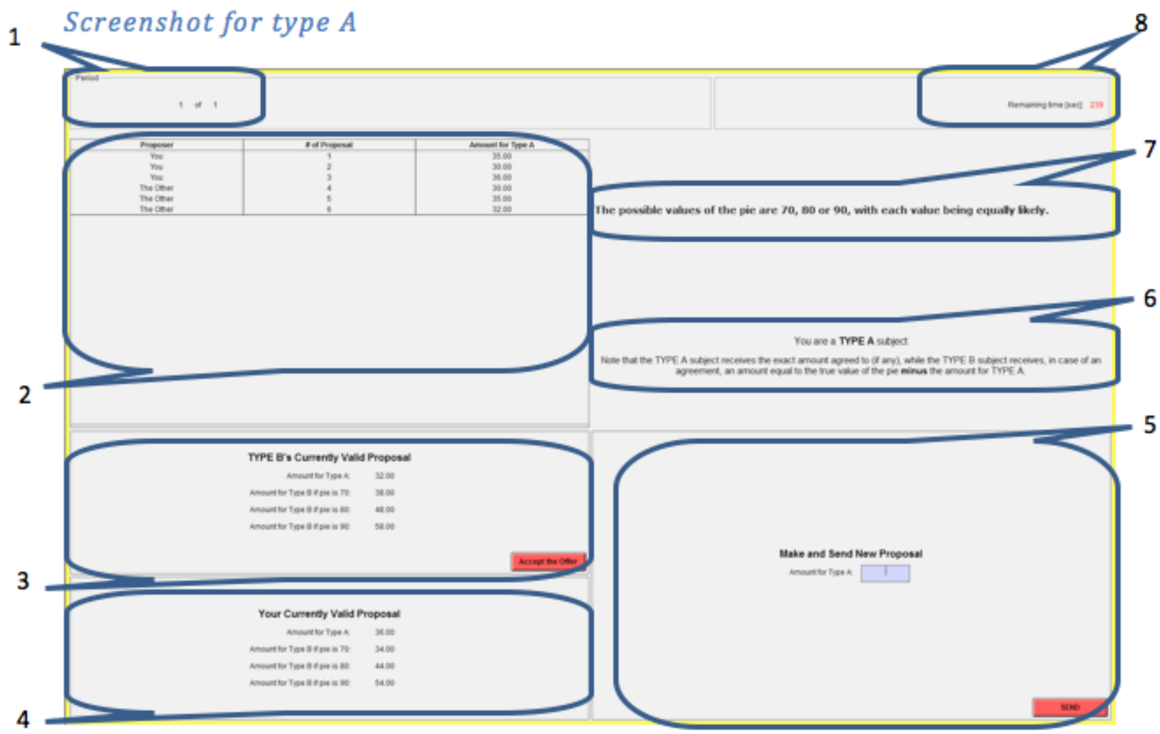
17. After your final payoff for part 1 has been calculated, the session will move on to part 2. Instructions for part 2 will be displayed on your computer terminal. Please read them carefully and proceed through part 2 at your own pace.

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.

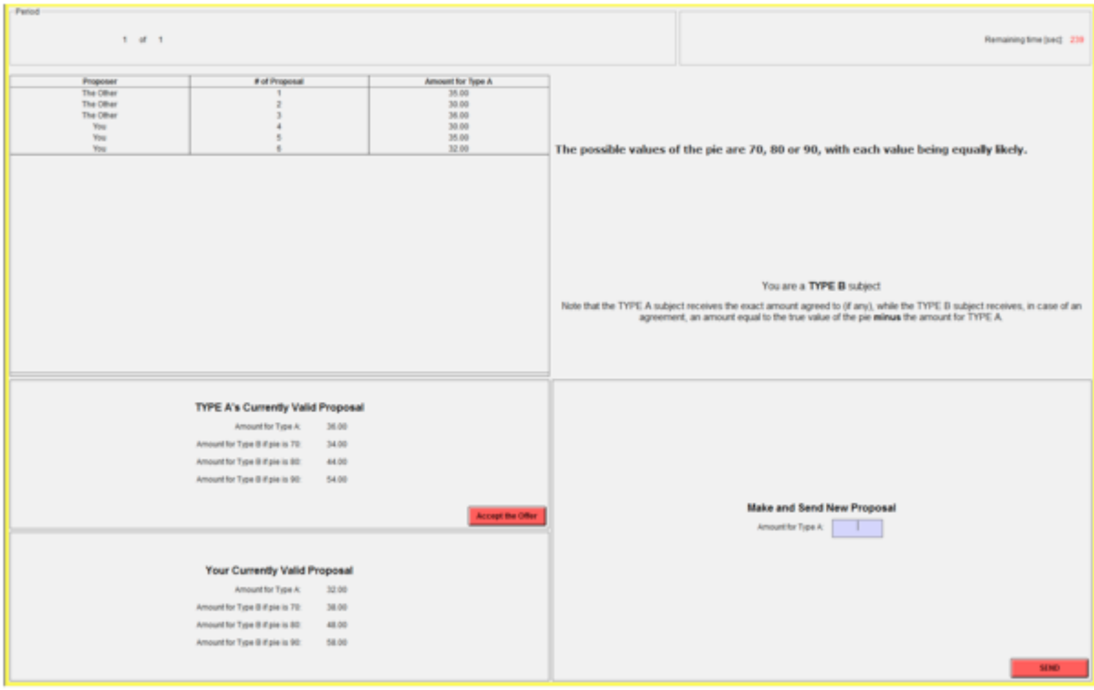
Please note that the possible sizes of the pie, and the offers shown on the screen, are not values that you will see during the session itself. They have been selected for illustrative purposes only.



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



C.2 Endogenous Distribution – Transparent Choice

The instructions were virtually unchanged from the control treatment instructions. The main difference is that we divided the description of Periods 1 to 10 into two parts: Periods 1 to 5, which was copied verbatim from the control treatment instructions and Periods 6 to 10, which explained the choice of the residual claimant between two distributions. This part is copied below for completeness.

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.

C.3 Endogenous Distribution – Non-Transparent Choice

The instructions were identical to the transparent choice treatment instructions, with the exception of the following section.

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.

D Endogenous Environment: Transparent versus Non-Transparent Choice

In the endogenous environment, choosing the riskier distribution might be perceived as an unfair act (see, e.g., Cappelen et al., 2013; Cettolin and Tausch, 2015), and thus alter subsequent bargaining behavior. We, therefore, conducted two variations of the endogenous environment treatments. In the first, the choice of the residual claimant is implemented for sure (transparent choice); in the second, the choice is implemented with probability 0.7 (non-transparent choice). The latter treatment masks intentionality by reducing the responsibility of the residual claimant in pie-distribution choice, which should increase the frequency with which residual claimants choose the riskier pie-distribution (Dana et al., 2007).[35]

Despite our prior belief that the transparency of the choice of pie-distribution would affect the RC players' choice to bargain over the riskier pie-distribution, our initial analysis found no difference in behavior between the transparent and non-transparent choice treatments. For example, residual claimants are equally likely to choose the risky pie-distribution, and agreements and disagreements appear to be unaffected by this treatment variation. For this reason, and expositional ease, the main text pools design and data analysis from the transparent and non-transparent sessions. This section details the design considerations and procedural details of this aspect of the endogenous environment, and presents the data analysis for the transparent versus non-transparent contrast.

D.1 Design Considerations and Procedural Details

A large literature in behavioral economics emphasizes the role of fairness in bargaining, often based around fairness considerations and the role of intentions; that is, how kind 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 pie-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 pie-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 a specific pie-distribution (Konow, 1996; Cettolin and Tausch, 2015). If there is some randomness about which pie the players bargain over, then the FP player cannot conclude with certainty that the riskier pie-distribution was actually chosen by the RC, making him (perhaps) more willing to compensate her for the extra risk. If this is the case, such lack of transparency could restore the RC player's willingness to choose the riskier pie-distribution.

[35] 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."

These considerations led to an additional treatment dimension to the design. The complete 2×2 design is summarised in Figure D.1. The first dimension varies the riskiness of the pie-distributions that the RC player must choose between, as discussed in the main text. The second dimension varies the transparency of RC's choice of the pie-distribution. In the *transparent choice* setting, the RC's chosen pie-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 pie-distribution is implemented 70% of the time and the non-chosen pie-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 pie-distribution is a salient consideration for RC players (cf. Konow, 2000).

Figure D.1: 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

D.2 Results

Table D.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 D.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 D.2, which runs a linear random-effect regression on a complete set of alternative dummies (the certain versus ternary 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 3.2 hold: there is a general reluctance to choose the riskier of the two distributions with the certain versus ternary alternative being the notable exception, where around 50% of RCs choose the ternary 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).

Table D.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.

Tables D.3 and D.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 D.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 D.4—there is a significant increase for both ternary 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 D.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.

Table D.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)	
1[(16, 20, 24)]	0.07	(0.060)	0.19^{**}	(0.074)	0.05	(0.061)	0.17^{**}	(0.078)
1[(16, 24)]	0.06	(0.055)	0.09^{**}	(0.037)	0.04	(0.051)	0.06	(0.042)
1[(12, 20, 28)]	-0.04^{*}	(0.025)	0.13^{***}	(0.048)	-0.08^{*}	(0.045)	0.07	(0.046)
1[(12, 28)]	0.17^{***}	(0.065)	0.07	(0.068)	0.10	(0.094)	−0.00	(0.089)
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.

E Endogenous Environment: Bargaining Outcomes in the First Five Periods

Table E.1 presents summary statistics, and Table E.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 3.[36] In particular, agreed pay-

[36]There are two experimental implementation details that should be considered when comparing behavior from the early rounds of the endogenous environment to the results from the exogenous environment. First, the endogenous environment does not vary across matching groups the order of presentation during the first five periods—doing so in a balanced way would have required twice as many matching groups in each cell of the 2×2 treatment design, as well as requiring matching groups where the pie-distribution from period 5 featured in period 6. Consequently, for all matching groups of the endogenous environment, (16, 24) is the first pie-distribution that subjects experience with uncertainty. Second, in order for the experimental instructions to be as transparent as possible, subject were informed at the beginning of the session that the last five periods

ments to FP players are significantly lower with risk, confirming Hypothesis 1. Furthermore, Hypothesis 5 is rejected: as the risk increases, the frequency of disagreements increases and significantly so for the two low risk distributions.

Table E.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.

Table E.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 E.3 replicates the analysis of Table 3. With respect to Hypothesis 2, for a given 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 A.4 of the main text.

would include the endogenous choice stage.

Table E.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)
ρ_{RC} × 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.

F Robustness Checks using Matching-Group Averages

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

	Certain versus Ternary	Certain versus Binary	Ternary 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).

G Concession Predictions

This section provides the details for testing the concession predictions given in Hypotheses 6 and 6 (ALT), which are based on the HZ concession process. For this analysis, we pool the offers data from the exogenous and endogenous distribution sessions. The HZ concession principle primarily makes predictions about the identity of the player making a subsequent concession, rather than whether there is a stand off or whether the subsequent standoff ends with a concession. Consequently, the analysis focusses on episodes where there are open and incompatible offers from both parties—what is referred to as a stand off—and one party subsequently concedes to the other. A concession can take the from of an acceptance of the other's offer, and the subsequent end of bargaining, or a new offer with terms more favourable to the other player but still incompatible with their current demand.

Subsection G.1 provides an overview of the data. Table G.1 gives a breakdown of the number of observations in each category across pie-distributions. Table G.2 gives a breakdown of the number of valid concessions for the benchmark, fairness-adjusted and alternative fairness-adjusted models (the fairness-adjusted and alternative fairness-adjusted model differ only in the way the fairness ideas for the RC player under risky pie-distributions are determined; see Section B.2 and below for more details). For the latter two, the risk limit definition is adapted to accommodate observations where one party makes an offer that violates the the assumed fairness ideas—i.e. the FP player makes a demand for more than 10, or the RC player makes an offer lower than their associated fairness idea. In the case where only one player violates the fairness idea, the risk limit of the other player is assigned to be 1.1 (i.e. strictly larger than 1), while the fairness-violating player's risk limit is calculated as normal. This ensures that the fairness-violating player is predicted to make the next concession. However, there is no particular prediction for the case where both players violate their respective (self-serving) fairness ideas, and such observations are dropped for the purpose of testing the fairness-adjusted models.

The hypotheses are tested via a series of regressions. In all cases the dependent variable is a simple indicator of whether the residual claimant was the one to concede. The independent variables of interests are indicator variables that indicate if the risk limit of the residual claimant is smaller than that of the fixed payoff player, and their interaction terms with other explanatory variables such as the riskiness of the pie-distribution, whether the pie-distribution was the riskier of the two possibilities in endogenous rounds, and whether the current stand-off was the last one before acceptance or disagreement.

The main regression specifications are reported in the main text. Section G.3 provides a series of additional analyses to support these conclusions. Table G.3 considers whether there is an important difference between concessions made during negotiations and the final concession (i.e. accepting the other's open offer). For both the benchmark and fairness-adjusted models this does not seem to be the case. Table G.3 also considers alternative models for unobserved heterogeneity by comparing the results from using subject level fixed effects to group specific fixed effects, as well as the case without any fixed effects. In both cases, adding controls for unobserved heterogeneity at either the subject or group level increases the size and significance of the risk limit variables. Table G.4 considers whether bargaining over the riskier of the two pie-distributions in the endogenous environment plays a role. For the benchmark model this does not seem to be the case. For the fairness-adjusted model there is some evidence that residual claimants might be less inclined to concede when they have the lower adjusted risk tolerance given they are bargaining over the riskier of the two pie-distributions. Table G.5 analyses further of the role of the pie-distribution risk. While the benchmark model is equally informative across the pie-distributions, the fairness-adjusted model makes better predictions in the risk-less and less risky distributions.

The fairness-adjusted prediction has some free parameters in that the fairness idea for the residual claimants in the case of risky pie-distributions is not fixed ex-ante. The predictions in the main text, as well as in Sections G.2 and G.3 pin down these free variables by matching the proportion of riskier choices from the endogenous sessions (see Section B.2 for details). Section G.4 considers an alternative, which produces a greater distance between the self-serving fairness ideas of the RC and FP players to the (predicted) advantage of the former. These fairness ideas are found by using the reported fairness perceptions of RC players. The results are not qualitatively affected by this choice of RC fairness ideas.

G.1 Concessions Data

Table G.1: Summary of Raw Concession Data

Pie-Distribution	No Concession	Concession by FP	Concession by RC	Not a Standoff	Total
	All Offers				
(20)	866	303	352	217	1738
(16,20,24)	1301	619	657	213	2790
(16,24)	1489	495	576	207	2767
(12,20,28)	1298	506	583	180	2567
(12,28)	939	432	457	168	1996
Total	5893	2355	2625	985	11858
	Last Offers				
(20)	4	54	57	56	171
(16,20,24)	18	68	82	13	181
(16,24)	18	65	63	24	170
(12,20,28)	8	64	74	10	156
(12,28)	19	55	59	11	144
Total	67	306	335	114	822

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players.

Table G.2: Summary of Concession Data for Benchmark and Fairness-Adjusted Models

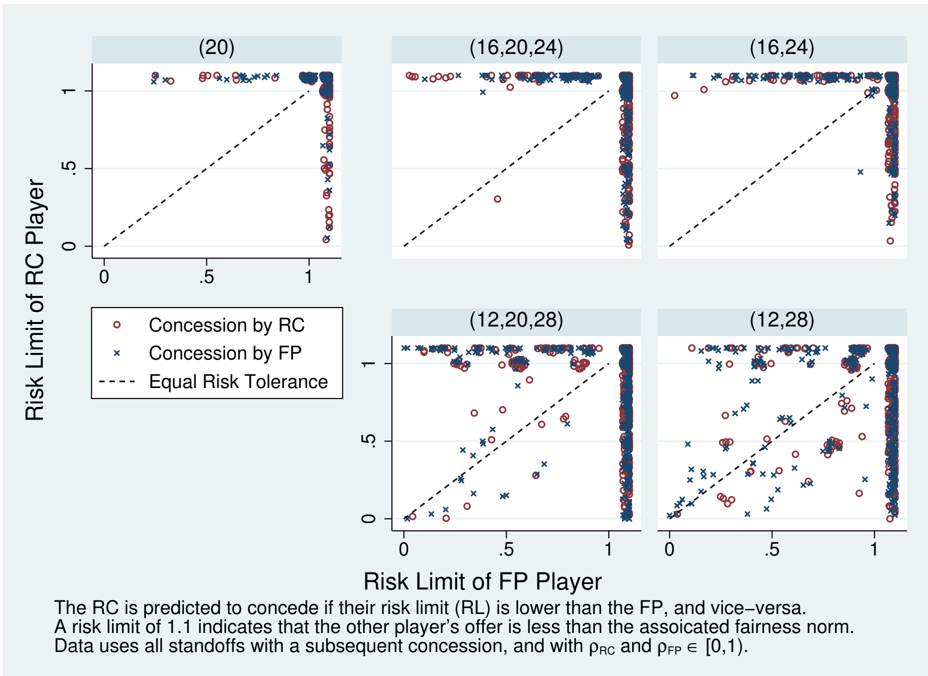
Pie-Distribution	Benchmark Model FP	RC	Total	Fairness-Adjusted Model FP	RC	Total	Alternate RC Fairness Ideas FP	RC	Total
	All Concessions								
(20)	399	256	655	136	152	288	136	152	288
(16,20,24)	585	691	1276	146	355	501	643	214	857
(16,24)	480	591	1071	134	293	427	521	191	712
(12,20,28)	423	666	1089	164	514	678	665	278	943
(12,28)	350	539	889	180	464	644	445	317	762
Total	2237	2743	4980	760	1778	2538	2410	1152	3562
	Last Concessions								
(20)	64	47	111	49	53	102	49	53	102
(16,20,24)	65	85	150	41	87	128	110	35	145
(16,24)	58	70	128	43	62	105	93	25	118
(12,20,28)	67	71	138	52	75	127	105	30	135
(12,28)	56	58	114	42	66	108	76	36	112
Total	310	331	641	227	343	570	433	179	612

Notes: Data includes only observations for which $|\rho_i| < 1$ for both RC and FP players.

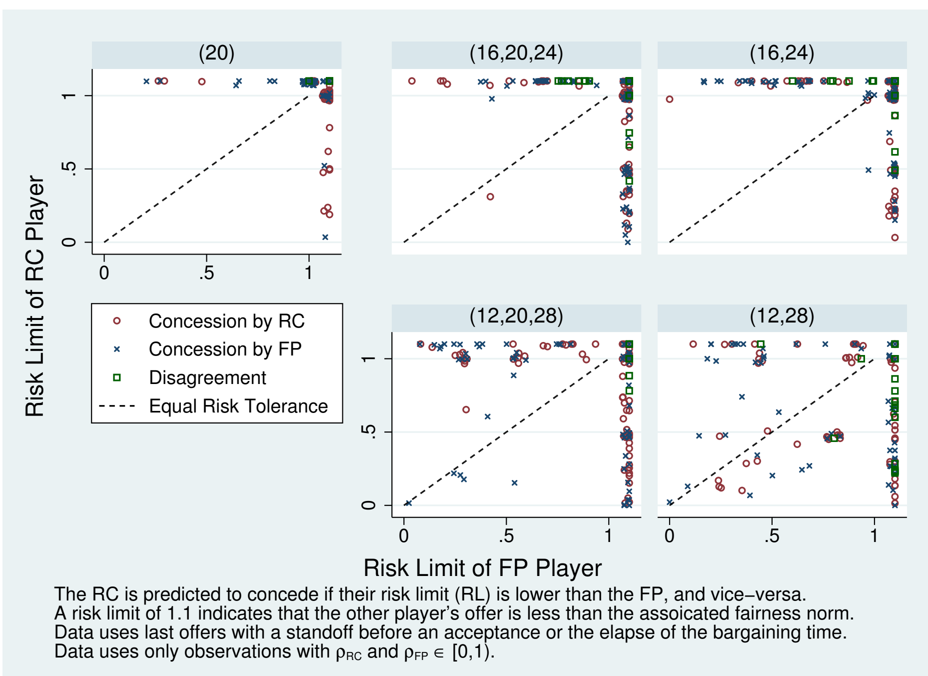
G.2 Additional Figures

Figure G.1: Scatter Plot of Risk Limits for Fairness-Adjusted Model

(a) All Concessions



(b) Final Concessions



G.3 Further Regression Tables

Table G.3: Linear Regressions of RC Concession: Role of Last Offers Analysis and Modeling Unobserved Heterogeneity Analysis

	Benchmark Model			Fairness-Adjusted Model		
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$	0.13***	0.25***	0.40***			
	(0.000)	(0.000)	(0.000)			
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}]$				0.28***	0.36***	0.51***
				(0.000)	(0.000)	(0.000)
Last Offers	0.01	0.00	−0.00	0.02	0.00	0.07
	(0.841)	(0.903)	(0.943)	(0.589)	(0.960)	(0.176)
$\mathbf{1}[RL_{RC} \leq RL_{FP}]\times$(Last Offers)	−0.01	−0.01	−0.01			
	(0.790)	(0.901)	(0.909)			
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}]\times$(Last Offers)				−0.04	−0.04	−0.15*
				(0.608)	(0.636)	(0.086)
Constant	0.46***	0.22***	0.31***	0.34***	0.25***	0.18***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N. Obs	4980	4980	4980	2538	2538	2538
N. Pairs			734			654
N. Clusters	20	20	20	20	20	20
R^2	0.02	0.11	0.04	0.06	0.20	0.03

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. Models (1) and (4) are simple linear regressions; models (2) and (5) include subject level fixed effects; models (3) and (6) include group level fixed effects.

Table G.4: Linear Regressions of RC Concession: Higher Risk Choice Analysis

	Benchmark Model (1)	(2)	Fairness-Adjusted Model (3)	(4)
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$	0.25***	0.25***		
	(0.000)	(0.000)		
$\mathbf{1}[RL^{adj}_{RC} \leq RL^{adj}_{FP}]$			0.36***	0.39***
			(0.000)	(0.000)
Last Offers	0.00	−0.02	0.00	−0.01
	(0.903)	(0.659)	(0.960)	(0.777)
Riskier Chosen		−0.01		0.00
		(0.674)		(0.948)
(Last Offers)×(Riskier Chosen)		0.14		0.18
		(0.172)		(0.211)
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$×(Last Offers)	−0.01	0.01		
	(0.901)	(0.891)		
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$×(Riskier Chosen)		−0.02		
		(0.548)		
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$×(Last Offers)×(Riskier Chosen)		−0.10		
		(0.581)		
$\mathbf{1}[RL^{adj}_{RC} \leq RL^{adj}_{FP}]$×(Last Offers)			−0.04	−0.04
			(0.636)	(0.623)
$\mathbf{1}[RL^{adj}_{RC} \leq RL^{adj}_{FP}]$×(Riskier Chosen)				−0.10**
				(0.021)
$\mathbf{1}[RL^{adj}_{RC} \leq RL^{adj}_{FP}]$×(Last Offers)×(Riskier Chosen)				−0.09
				(0.554)
Constant	0.22***	0.22***	0.25***	0.23***
	(0.000)	(0.000)	(0.000)	(0.000)
N. Obs	4980	4980	2538	2538
N. Clusters	20	20	20	20
R^2	0.11	0.11	0.21	0.20

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. All models include subject level fixed effects.

Table G.5: Linear Regressions of RC Concession: Pie-Distribution Risk

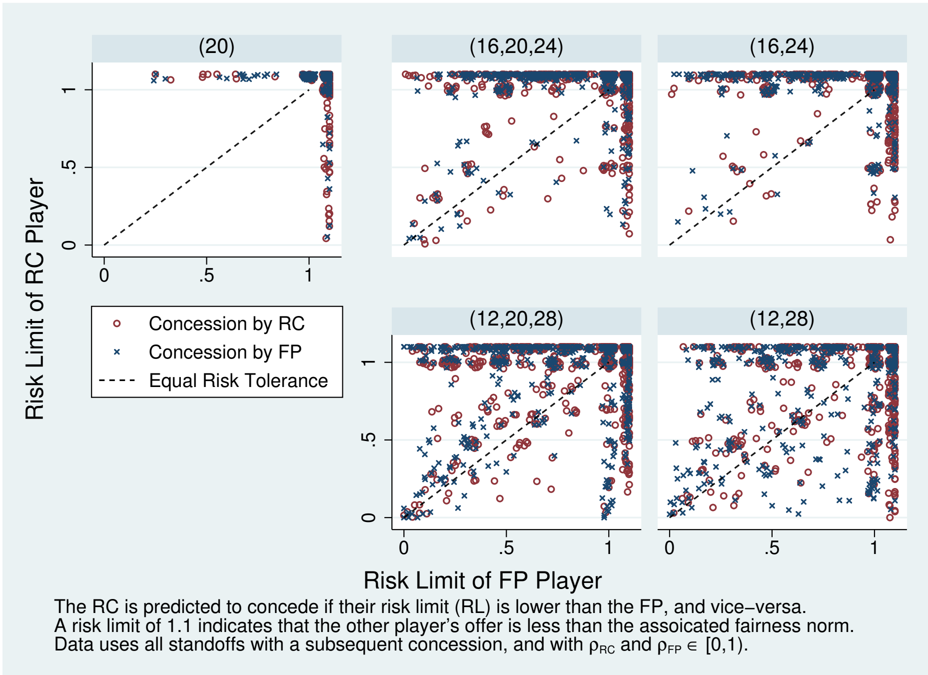
	Benchmark Model		Fairness-Adjusted Model	
	(1)	(2)	(3)	(4)
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$	0.30^{***} (0.000)	0.30^{***} (0.000)		
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}]$			0.62^{***} (0.000)	0.64^{***} (0.000)
$\mathbf{1}[\text{Var.} > 0]$	0.01 (0.673)		0.17^{***} (0.002)	
(16,20,24)		−0.00 (0.916)		0.06 (0.299)
(16,24)		0.02 (0.549)		0.15^{**} (0.020)
(12,20,28)		0.02 (0.616)		0.27^{***} (0.001)
(12,28)		0.01 (0.687)		0.22^{***} (0.002)
$\mathbf{1}[RL_{RC} \leq RL_{FP}] \times \mathbf{1}[\text{Var.} > 0]$	−0.06 (0.185)			
$\mathbf{1}[RL_{RC} \leq RL_{FP}] \times (16, 20, 24)$		−0.07 (0.148)		
$\mathbf{1}[RL_{RC} \leq RL_{FP}] \times (16, 24)$		−0.08 (0.190)		
$\mathbf{1}[RL_{RC} \leq RL_{FP}] \times (12, 20, 28)$		−0.04 (0.420)		
$\mathbf{1}[RL_{RC} \leq RL_{FP}] \times (12, 28)$		−0.06 (0.220)		
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}] \times \mathbf{1}[\text{Var.} > 0]$			-0.32^{***} (0.000)	
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}] \times (16, 20, 24)$				-0.16^{**} (0.024)
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}] \times (16, 24)$				-0.28^{***} (0.000)
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}] \times (12, 20, 28)$				-0.45^{***} (0.000)
$\mathbf{1}[RL_{RC}^{adj} \leq RL_{FP}^{adj}] \times (12, 28)$				-0.40^{***} (0.000)
Constant	0.22^{***} (0.000)	0.21^{***} (0.000)	0.11^{**} (0.024)	0.12^{**} (0.018)
N. Obs	4980	4980	2538	2538
N. Clusters	20	20	20	20
R^2	0.11	0.11	0.21	0.21

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. All models include subject level fixed effects.

G.4 Alternative RC Fairness Ideas for Uncertain Pie-Distributions

Figure G.2: Scatter Plot of Risk Limits for Alternative Set of Fairness Ideas

(a) All Concessions



(b) Final Concessions

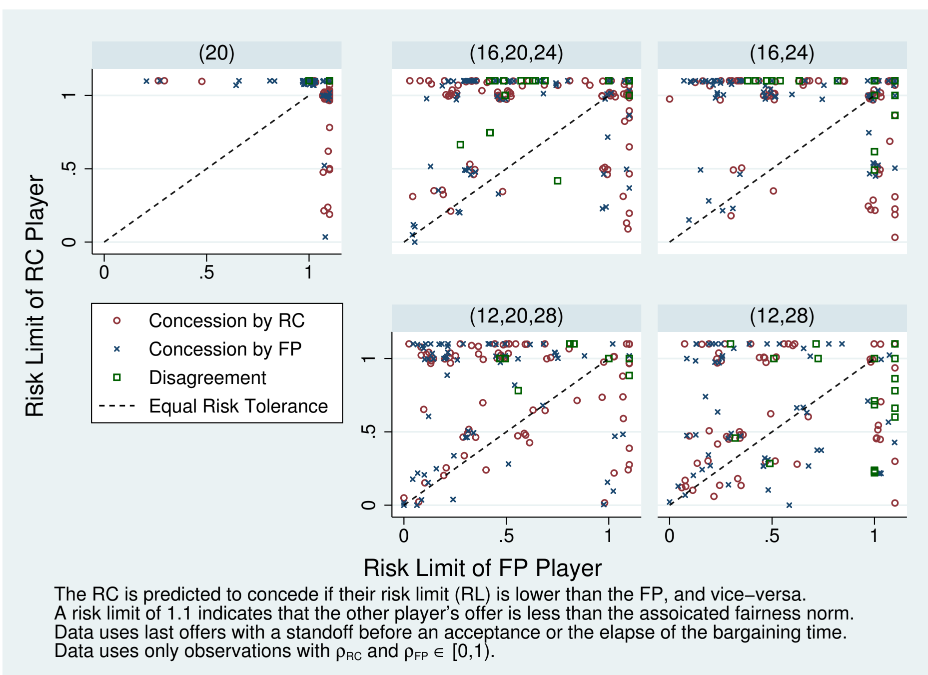


Table G.6: Linear Regressions of RC Concession for the Fairness-Adjusted Model using an Alternative Set of RC Fairness ideas for the Risky Pie-Distributions: Main Regression Specifications and Horse-Race Regressions versus the Benchmark Model.

	Fairness-Adjusted Model				Benchmark vs. Fairness			
	(1)		(2)		(3)		(4)	
$\mathbf{1}[RL_{RC} \leq RL_{FP}]$					0.08^{***}	(0.007)	0.19^{***}	(0.000)
$\mathbf{1}[RL^{adj}_{RC} \leq RL^{adj}_{FP}]$	0.22^{***}	(0.000)	0.28^{***}	(0.000)	0.19^{***}	(0.000)	0.21^{***}	(0.000)
Last Offers	0.02	(0.441)	-0.00	(0.955)	0.02	(0.541)	-0.01	(0.758)
$\mathbf{1}[RL_{RC} \leq RL_{FP}]\times$(Last Offers)					0.00	(0.945)	0.01	(0.867)
$\mathbf{1}[RL^{adj}_{RC} \leq RL^{adj}_{FP}]\times$(Last Offers)	-0.03	(0.601)	-0.01	(0.912)	-0.02	(0.717)	0.01	(0.914)
Constant	0.44^{***}	(0.000)	0.40^{***}	(0.000)	0.41^{***}	(0.000)	0.25^{***}	(0.000)
N. Obs	3562		3562		3562		3562	
N. Clusters	20		20		20		20	
R^2	0.04		0.14		0.05		0.15	

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. All models include subject fixed effects. Models (1) and (3) a simple linear regressions; models (2) and (4) include subject level fixed effects.